This document is provided for informational purposes only. The Design-Build Proposer shall not rely on this information in the preparation of a project Proposal. Please refer to the project’s Request for Proposal (RFP) for the final project requirements.
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1.0 Introduction

The Kosciuszko Bridge, which was opened to traffic in time for the 1939 World’s Fair in Flushing Meadows, Queens, provided a new high level crossing of Newtown Creek. The bridge replaced the Penny Bridge, a swing span approximately 600 feet downstream and was the first part of a Brooklyn-Queens Connecting Highway. Although initially referred to as the Meeker Avenue Bridge, the new bridge’s alignment did not follow Meeker Avenue. In Brooklyn its approach was located parallel to and midway between Thomas and Cherry Streets. In Queens the new bridge’s approach was just west of and parallel to Laurel Hill Boulevard.

The new bridge, which was designed by the New York City Bureau of Bridges, contained five sections: a 750 foot long Queens Ramp, a 1,662 foot long Queens high level Approach, a 300 foot long Main Span, a 1,560 foot long Brooklyn high level Approach and a 2,142 foot long Brooklyn Ramp. The typical section had a 4'-6" median, one 10'-0" and two 11'-0" lanes in each direction, 2'-4" outside barriers and 8'-0" sidewalks. The deck was reinforced concrete. The main span deck was similar except that the sidewalk was interrupted by the through truss. While the Queens Ramp has been removed, much of the original bridge, although modified, remains in service.

Based on the available plans it appears that at least eight construction contracts were required and the most significant contract, referred to as Contract 8, was for the Main Span and its high level Approaches, starting at 54th Road (formerly known as Waters Avenue) and ending near Varick Street in Brooklyn.

The original Queens and Brooklyn Ramps utilized reinforced cast in place concrete construction, which, as was the case with the high level Approach and Main Spans, included many architectural features. The Queens Ramp, Contract No.6, was 750 feet long and, except for an underpass at 54th Avenue, utilized cast in place frames with cast in place curtain walls. The curtain walls had small grilles near the top to provide ventilation to the enclosed space, but there did not appear to be any provisions for access on the plans.

Similar construction was used in the Brooklyn Ramp, Contract 7, i.e. reinforced concrete frames with concrete curtain walls. However, this was a much longer structure than the Queens Ramp as it provided an elevated viaduct back to Meeker Avenue ending at grade at Kingsland Avenue. The viaduct passed over and provided underpass structures at Varick, Vandervoort, and Morgan Avenues. The underpass structures were reinforced concrete rigid frames with hinges at the interface of the vertical leg of the frames and the footings as was the practice at that time.

The Approach Spans are Warren trusses, which are distinguished in the use of alternating diagonals that form isosceles triangles. The diagonals alternate in carrying compression or tension. The alternate verticals carry tension; the remaining verticals carry only nominal loads. (In contrast, in a Pratt truss all the diagonals are parallel and all carry tension). The Approach Span piers are reinforced concrete, typically supported on spread footings except for the three piers in Brooklyn and the two piers in Queens closest to the creek, which are pile supported.

The Main Span is a steel Camelback truss (also known as a Parker truss) with a span of 300 feet that provides a vertical clearance of approximately 125 feet over the waterway. At its highest point, the top of the truss is approximately 50 feet above the existing roadway. The Main Span truss, while identified as a Camelback truss, has a similar arrangement of diagonals
and verticals as a Warren truss, the difference being that the top chords approximate a curved shape whereas in a Warren truss the top and bottom chords are parallel.

The two Main Span piers utilized steel truss construction, possibly to minimize the dead load on the Main Span footings, but also possibly as an architectural feature. The Main Span pier on the Brooklyn side of Newtown Creek is supported on a concrete spread footing, and the pier on the Queens side of the creek is pile supported. When constructed, the Main Span foundations extended well into the waterway on both sides of the creek, although they are now less exposed, as the adjacent land has been largely filled in up to the bulkhead line.

The construction of the bridge is documented in the November 23, 1939 *Engineering News Record, New York’s Latest Interborough Bridge*, by N. Deutschman. The article describes how in Queens, the discovery of highly acid soil with a pH of 2.5 was encountered and as result special measures were required to protect six of the piers. Lime was used to mitigate the acid, and according to the Supplementary Drawings, four spread footings in Queens were modified by increasing the footing depths and covering the footings with emulsified asphalt below grade. Two other foundations in Queens, which are pile supported, were constructed inside and enclosed in steel sheeting with well points. The bottom 3'-0" of the footing was enclosed in waterproofing. The configuration of these modified piers will be shown on the plans along with a note to alert the contractors in case any work is needed at these piers. The recent environmental testing indicates that the acid soil condition no longer exists, apparently the lime and ground water have removed the contaminant.

It is clear that considerable effort went into the design of these sections as both the concrete Approach and steel truss Main Span piers are carefully detailed. For example the plan set contains a drawing for the steel truss piers, which was prepared by New York City Bureau of Architecture – Bridges, and a related sheet of the architectural details for the concrete piers, which was prepared by the New York City Bureau of Bridges. And as documented in the plans, the Approach trusses were initially designed to have curved bottom chords so that there would be an arch like appearance to each span, as was done for example on the Pulaski Skyway. The plans indicate that in late 1938 the Approach trusses were changed to parallel chord (Warren) trusses, likely as a cost saving as the parallel chord deck trusses would be more efficient structurally. However, the curved upper chord of the Main Span truss remains.

It is notable that at the time of construction the United States was still recovering from the effects of the Great Depression, yet at the same time the City of New York, which was constructing the Bronx-Whitestone Bridge while also preparing for the 1939 World’s Fair in Flushing Meadow, would choose to invest in creating an attractive bridge with a number of architectural features that enhanced the overall appearance of the structure. As will be discussed below, the replacement of the Kosciuszko Bridge is also taking into consideration the overall impact of the structure and its architectural features.

The original bridge underwent extensive rehabilitation between 1967 and 1972, including renumbering all of the spans. The Queens Ramp was removed when that portion of the structure was incorporated into an interchange with the Long Island Expressway. As part of the Long Island Expressway Interchange, a short portion of the Queens Ramp was replaced with two composite steel girder spans that provide a transition to fill that is part of the interchange. This portion of the structure is now referred to as the Queens Connector. The 1970’s work included new brick faced retaining walls, similar to the brick curtain walls that were added in Brooklyn as part of this same project.
The Brooklyn Ramp west of Morgan Avenue was removed and replaced with steel framed bents with a reinforced concrete deck. The legacy of this is that the original 1939 footings remain and will need to be avoided as part of the current Kosciuszko Bridge Replacement. However, between Morgan Avenue and the Brooklyn high level Approach Spans, much of the original Brooklyn Ramp remains. This portion of the structure is now referred to as the Brooklyn Connector. The existing structure was modified by cutting off the superstructure at the top of the columns and casting a new reinforced concrete frame and deck. It is noted that the work was done while maintaining traffic using staged construction in a process somewhat similar to the sequence being proposed now for replacement of the Brooklyn Connector. While the Varick and Morgan Avenue rigid frames remain, the Vandervoort underpass was replaced and the span length was increased. The replacement span utilizes adjacent prestressed concrete box girders. The other significant change was that in lieu of the original concrete curtain walls, brick curtain walls were added.

The 1967 to 1972 rehabilitation of the Main Span and the Approaches included the replacement of the original concrete deck slab with a concrete filled steel grating, the elimination of the sidewalks, and widening of the roadway, although shoulder and lane widths still do not meet current criteria. The Main Span truss floor system consists of floor beams that support stringers, which in turn support cross beams and the deck. The original steel construction utilized riveted steel construction. On the Main Span, the existing reinforced concrete deck and crossbeams were removed and new welded cross beams were field welded to the existing stringers. Then 4¼" steel grid deck panels were field welded to the new cross beams and filled with concrete. This has proven to be problematic as has been the case with many early welded steel bridges from the 1970’s. Fatigue associated with the welded deck system has led to cracking and the need for maintenance repairs. In addition, the concrete fill in the grid wears under roadway traffic, forming shallow depressions that fill with water that can freeze in the winter, creating an unsafe condition. To address this issue the deck has been overlaid, but the surfacing tends to break down and requires considerable maintenance. A similar deck replacement scheme was used on the Approach trusses, with the same resulting issues. One unusual feature of the deck replacement on the Approaches was the use of welded wedge shaped cross beams on curved sections. As with the Main Span, these too were field welded to the stringers.

The bridge has undergone extensive interim repairs since the early 1990s, yet the structural condition of the bridge is still deteriorating. The 2008 Biennial Inspection Report indicates that several structural elements on the bridge exhibit severe deterioration and require repair or replacement. The inspection report gives the structure a general recommendation of 4, which indicates that there is moderate deterioration of primary and secondary members as well as the substructure.

As described above, the existing Kosciuszko Bridge is made up of several different structure types along the length of the project. The “Existing Bridge Plan and Elevation” depicted in Figures 1.1 through 1.4 shows the limits of each bridge segment. Since each bridge segment is unique, the new bridge will replace each of these segments with new structure types. This Structure Justification Report examines the Main Span, Approach Spans and Connectors separately to find the most appropriate bridge type replacement structure for each segment.
2.0 Main Span

Structure Summary – Main Span
P.I.N.: X731.24, X731.25, X731.26 and X729.77
Title: Kosciuszko Bridge – Main Span
Date: November 2011
Site Data Received:

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<tr>
<td>Span 89: 300 ft</td>
<td>Span EB23: 362-0”</td>
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<td>Span EB24: 639'-0”</td>
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<td>Span WB25: 356'-0”</td>
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<td><strong>WIDTH:</strong></td>
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<td>88'-8” (out to out)</td>
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<td><strong>SUBSTRUCTURE:</strong></td>
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The existing Main Span (span 89) spans 300 feet across Newtown Creek. The bridge has a vertical clearance of approximately 125 feet over the waterway. The existing structure is 88'-8" wide and carries three lanes of traffic in each direction. Although widened in the 1967-1972 rehabilitation, the shoulder and lane widths do not meet current criteria. The existing travel lanes over the Main Span are approximately 10'-10" wide with 1'-0" wide shoulders.

The existing superstructure is a steel Camelback truss with a concrete filled grid deck supported on steel stringers. The two Main Span piers utilize steel truss construction. The Main Span pier on the Brooklyn side of Newtown Creek is supported on a concrete spread footing, and the pier on the Queens side of the creek is pile supported. The existing foundations extend into the waterway on both sides of the creek. See Figure 2.1 below for a cross section of the existing Main Span.

The new structure type will replace the existing bridge by constructing a new eastbound bridge that is parallel to and on the eastbound side of the existing bridge, demolishing the existing
structure and building a new westbound bridge within the footprint of the existing structure.

The new eastbound and westbound roadways will be supported on separate parallel structures, which will facilitate both staged construction and future maintenance and inspection of the structures. The Main Span of the eastbound and westbound structures will be separated by approximately 18'-11" to allow sufficient clearance for underdeck inspection and maintenance using an Underdeck Inspection Vehicle.

The new westbound structure will be 79'-0" wide and will carry four 12'-0" lanes of traffic with standard shoulders and a new wide bikeway/walkway on the north side of the structure. The bikeway/walkway will be a shared use pathway and be 13'-1" wide. The new eastbound roadway will be 97'-0" wide and carry five 12'-0" lanes of traffic with standard shoulders. The eastbound roadway will be split by a concrete median barrier into a two lane roadway for vehicles remaining on the BQE (Mainline) and a three lane roadway for vehicles wishing to access the LIE and vehicles entering from the Vandervoort Avenue entrance ramp (Collector Distributor). The physical separation of the “Mainline” and the “Collector Distributor” using a concrete median barrier will provide operational improvements by eliminating the merging and weaving problems that currently exist on the structure.

Figure 2.1 Existing Cross Section at Main Span

The new Main Span will have a longer span length than the existing bridge, allowing the new piers and foundations to be constructed outside of the creek. Also, the roadway will be, at the
highest point, approximately 30 feet lower than the existing roadway, improving the existing non-standard vertical grades while maintaining sufficient vertical clearance for ship navigation. In order to minimize acquisition of private property, the new bridge will be constructed in close proximity to the existing alignment, limiting the curvature of the horizontal alignment. The span lengths and proposed foundation locations have been chosen to limit impact to the local streets below and to avoid impact to the Long Island Rail Road tracks that cross under the bridge in Queens.

Four structure types were identified as suitable Main Span replacement alternatives:

- Alternative 1: Cable-Stayed (Preferred Option)
- Alternative 2: Concrete or Steel Box Girder
- Alternative 3: Concrete Deck Arch
- Alternative 4: Steel Through Arch

The Main Span is aesthetically significant because of its high visibility and the interest that the public has expressed in a “signature” Main Span. Therefore, due to the significance of the structure, a numerical scoring system was developed for the final selection of the new Main Span bridge type. The system rates how well a particular bridge type would meet specific project criteria pertaining to project costs, construction complexity, environmental impacts, bridge aesthetics and public input. The Cable-Stayed Main Span had the highest overall measure of effectiveness rating; therefore it is the preferred structure type for replacement of the Main Span. The selection criteria and matrix are presented in Section 2.15 of this report.

2.1 Main Span Considerations

These Main Span bridge types were developed by a team of bridge engineers and bridge architects in concert with Department staff with the overall goal of providing an attractive, economical structure that is an appropriate solution for the site. Each of the Main Span bridge type alternatives were designed within the following project constraints:

- locate the new foundations outside of the waterway;
- avoid impact to the LIRR Right-of-Way;
- provide 88’-6” minimum vertical clearance over the navigable waterway;
- avoid impacts to private property beyond that presented in the FEIS;
- avoid impacts to local at-grade streets; and
- maintain an overall structure height of less than 300 feet above grade.

2.1.1 Cable-Stayed (Preferred Option)

A Cable-Stayed bridge uses steel cables that splay out from a tower (or pylon) to support the bridge roadway deck. The cables induce a compressive force into the roadway deck so that the roadway deck not only serves to carry traffic but it also serves as a main member of the overall structural system. It has proven to be both attractive and very cost competitive as the structural system is very efficient – the construction is essentially made of cantilevers that can be constructed by building out from the towers. While initially developed in Europe as an outgrowth of segmental concrete construction, which is why the same strands are used for the stays as are used to post tension segmental bridges, cable stayed bridges are now built worldwide with
some spans in Asia exceeding 1000 meters. Numerous cable stayed bridges have been built in the United States. Constructability of the Cable-Stayed bridge is discussed in further detail in Section 2.4.3 of this report.

While many cable stayed bridges use two towers, for the Kosciuszko Bridge Main Span, a single tower is proposed for each roadway. The reason for the single tower is twofold, the span length would not warrant two towers – the single span is in an economical range, and, as discussed below, the single tower is advantageous for both aesthetic reasons - the towers serve as a gateway, and the single towers best fit the constrained site conditions. The tower supporting the westbound roadway would be located in Queens and the tower supporting the eastbound structure would be located in Brooklyn, each providing a gateway into the respective boroughs.

The Main Span length would be approximately 630 feet with backspans of approximately 360 feet. (If a pair of towers was used they would provide a 1260 foot main span, which is a typical range found in the United States.) See Figure 2.2. However, the Main Span towers would be staggered giving the illusion of a shorter 450 foot long Main Span. The towers would extend approximately 190 feet above the proposed roadway (approximately 290 feet above the ground surface or 125 feet above the top of the existing Main Span truss).

Figure 2.2: Cable-Stayed Main Span Elevation

The structure would likely have canted-H shaped towers. See Figure 2.3. The towers would be hollow reinforced concrete structures with walls approximately 3 feet thick. The superstructure would be steel edge girders with transverse steel floorbeams spaced between 15 and 16 feet on centers. The edge girders would be approximately 6’-6” deep. There would be two planes of cables at each tower. Each plane would have a total of 22 stay cables, 11 to the Main Span and 11 to the back span. The back span deck anchorages would be spaced at approximately 30 feet on centers. The Main Span deck anchorages would be spaced at approximately 48 feet on centers. The anchorages in the towers would be spaced at 6 feet on centers resulting in a fan design of the cables.
There would only be one tower and one tower foundation on each side of the creek. Based on foundation studies to date, each foundation would consist of 6 drilled shafts. The drilled shafts would be approximately 6 feet in diameter and extend approximately 160 feet to the top of rock with an approximately 5'6" diameter rock socket extending approximately 20 feet into the rock.

This Cable-Stayed alternative has been developed through several iterations that began with an initial meeting at Region 11 on June 24, 2009, when the project team introduced Michel Virlogeux, the lead bridge architect. At that meeting Mr. Virlogeux presented sketches of several tower shapes. At that time he favored a V shaped tower, but as that was only one of several shapes that were considered as the various main span schemes were developed. See Figure 2.4. Following this initial meeting, the team developed a range of main span types that evolved into eight different schemes that were presented to the Stakeholders Advisory Committee (SAC) meeting in November 2009.

Initially, a longer span length was considered as were taller towers. Initially a span of 800 feet was considered. It was anticipated that the longer span would provide a better solution to clear local conflicts such as the Long Island Rail Road. At the same time a shorter span, in the range of the current concept was developed. It became clear that the larger span was not appropriate as it dominated the site as was confirmed when both options were presented to the SAC, who clearly preferred the shorter span option at the November 2009 meeting. At the same time, after further development of the shorter option it became clear that a reasonable layout that minimizes local impacts could be developed. At that time the longer span option was eliminated.
At the same time the various tower shapes were evaluated. The tower geometry is limited by the following constraints:

- maintain an overall height above the roadway of less than 190 feet;
- maintain a vertical clearance of 16'-0" above the roadway deck;
- limit the width of the tower to fit within the 18'-11" gap between the eastbound and westbound roadways;
- locate the tower foundations within the footprint of the roadway structure to avoid impacting additional public and private property; and
- minimize the visual impact of the two different structure widths.

It became clear that an H or Diamond shaped tower were advantageous as they had the smallest footings, which were highly advantageous given the constrained site. The Diamond shaped tower was dropped as the cables conflicted with the roadway, leaving the current modified H shaped tower. After consultation with the Department it was agreed that the canted-H shape (see Figure 2.3) is the preferred tower shape. This shape best meets the constraints while providing an attractive structure. The tower shape may require some refinement to maintain clearance requirements between the roadway and the cables along the curve of the Main Span.

However, although the shorter span had a shorter tower, the height of the tower became a concern as it could pose a potential risk to migrating birds and was found to be unacceptable to the Federal Aviation Administration (FAA) due to the proximity of LaGuardia Airport. As a result the pier height was refined based on the direction issued by the FAA and the need to mitigate possible migratory bird conflicts. These issues are further discussed in Sections 2.12 and 2.13 of this report.

The final span lengths were selected to locate the proposed foundations outside the waterway without impacting the LIRR right-of-way or local streets. By providing a single tower on each side of the creek, and staggering the Main Span, these objectives will be met with a 630 foot Main Span, while still providing a gateway to users of each roadway. Staggering the Main Span also made the structure more aesthetically pleasing by centering the creek between the two towers. In addition, the proposed foundation locations will avoid impact to the existing ground water collection system in Queens, as discussed in Section 2.9 of this report.

The proposed superstructure has also been modified. Initially, a superstructure made up of a pair of 10 foot deep steel box girders with a concrete deck was proposed. The box girders would be aligned with the box girders on the approaches. The box girders framed into steel transverse floorbeams that would be in turn supported by the cable stays at the edge of the deck. This configuration, although aesthetically pleasing, required more structural steel than is typically used in cable stayed bridges and as a result was costly. The box girder superstructure, as previously estimated, would require approximately seven million more pounds of structural steel than the edge girder and floorbeam configuration and would likely cost over $30 million more. Therefore the current estimate is based on a more efficient superstructure: steel floorbeams with steel edge girders as described above, this is the system that is commonly found in cable stayed bridges. As we advance into final design we intend to conduct additional design studies as the lead architect, Michel Virlogeux, has indicated that the concept of a box girder superstructure offers considerable aesthetic value. It may be possible, to accommodate this change if the spacing of the floorbeams is increased, and the number of stays is reduced. If
the box girder alternative is advanced further study of the configuration of the maintenance traveler will be required.

In addition to the configuration of the superstructure framing, the final design will also consider the possibility of using concrete box girders on a portion of the back span. The concrete box girders would have the same shape as the approach span box girders, and could be advantageous due to the heavier weight of the concrete that could help resist uplift, which is characteristic of the back spans of a cable-stayed bridge. Also, the geometry of the structure will need to be considered in detail, due to the slight horizontal curvature of the Main Span.

And while the approximate shape of the tower has been established, its details will need to be developed. Modifications to the tower shape may be required to maintain sufficient vertical clearance below the cables along the curve of the Main Span. Issues such as internal access provisions, details of the cable anchorages, and the possibility of using precast sections will need to be investigated. The footing designs will also need to be refined. As it is anticipated that high capacity drilled shafts will be used, the objective will be to minimize the number of shafts by maximizing their efficiency. One simple example is to avoid a shaft in the center of a footing. One particular issue will be to confirm the footing sizes and for the footings to minimize impacts to existing footings.

2.1.2 Box Girder

The Box Girder option was advanced as the base line option since this structure is the most straightforward construction of all the types considered. Therefore, the objective of this alternative was to provide a simple straightforward design for comparison to the other more elaborate bridge type alternatives. Therefore, the span length of 360 feet was selected to keep the span short yet to remove the foundations from the waterway.

Figure 2.5: Box Girder Main Span Elevation

The Box Girder bridge would use trapezoidal box shaped girders supported on either end by vertical reinforced concrete piers. This type of structure is now fairly commonly used in the United States in this span range and its proportions will fall within established ratios, of approximately 1:40 at mid span and 1:20 at the pier. The bridge would be constructed of either steel or concrete box girders. For the box girders, the deck is integral with the box, however, with the steel box a cast in place concrete deck would be required. The cross section would consist of four boxes, two boxes to support each roadway. Each box would be supported by concrete piers that would be tapered to add visual interest. There would be no structural elements above the bridge deck other than traffic barriers, walkway railing, roadway signs and lighting.

This concept has a Main Span length of 360 feet over Newtown Creek and side spans of 205
feet in Brooklyn and 235 feet in Queens. If constructed of steel, the boxes would vary in depth from 10 feet at mid-span to 21 feet at the piers. If concrete boxes are used, the boxes would vary from 11'-6" at the mid-span to 23 feet at the piers.

Due to the relatively short span length and the simple load path of this bridge type and multiple piers, the foundations would be relatively small. There would be a pair of foundations on each side of the creek. Based on foundation studies to date, each main span foundation would have approximately 60 cast-in-place concrete piles. The piles would be approximately 24 inches in diameter and approximately 85 feet long.

2.1.3  Deck Arch

The Deck Arch is a bridge in which the roadway deck is supported from below by a reinforced concrete arch. The superstructure would consist of four concrete box girders, two supporting each roadway. Each box girder would be supported from below by a reinforced concrete arch and back-strut. There would be no structural elements above the bridge deck other than traffic barriers, walkway railing, roadway signs and lighting.

Concrete arch bridges are less common in the United States currently, and the configuration considered is a style that was developed in Switzerland in the 1920’s by Maillart, where there are a number of dramatic examples of this style. This concept has a Main Span length of approximately 445 feet over Newtown Creek with side spans of 170 feet in Brooklyn and 180 feet in Queens. The concrete box girders would be a constant depth and approximately 11'-6" deep.

The span length of the deck arch was selected in order to avoid impacts to the Long Island Rail Road right-of-way and local streets while centering the arch about the creek. A shorter span
length was eliminated from consideration since it would interfere with the navigation channel.

2.1.4  Through Arch

A Through Arch bridge supports the roadway deck from above. The arches, which would be structural steel, rise above the deck so that the roadway passes through the arches. Vertical cables support the deck from the arch. This concept would include three arches, one between the roadways and one on either side of the outer roadway fascias. The superstructure would consist of four steel box girders with 10 feet deep transverse floorbeams that would be suspended from cables. These cables would carry the weight of the roadway into the steel arches. Four steel back-struts would extend from the arch foundations up to each of the box girders to resist the horizontal thrust reaction from the arches.

As with the deck arch, this type of structure is less frequently used in the United States, and the use of a central arch that will need to serve to support both the Eastbound and Westbound roadways would be a design challenge, as it would need to accommodate staged construction.

This concept has a Main Span length of approximately 520 feet over Newtown Creek with side spans of 230 feet in Brooklyn and 220 feet in Queens. The top of the steel arch would extend approximately 50 feet above the proposed roadway, 15 feet below the top of the existing through truss.

![Figure 2.7: Through Arch Main Span Elevation](image)

As with the deck arch the lateral thrust of the arch needs to be resisted and as with the deck arch, canted back-struts have been utilized to partially balance the lateral thrust. But there is a further complication with this concept as there are four box girders but only three arches. Therefore there will be four canted back-struts that will frame into the footing. There would be three footings on either side of the creek, one for each arch. The center arch foundation would require approximately 60 cast-in-place concrete piles and the outer foundations would require approximately 30 piles each. Based on foundation studies to date, each pile would be approximately 85 feet long and have a diameter of approximately 24 inches. Drilled shaft foundations could also be used with the limitations regarding their efficiency as stated above for the deck arch.

The span length of the through arch was chosen in order to limit impacts to local streets, avoid further acquisition of private property and the LIRR right-of-way, while centering the span over Newtown Creek. The radius of the arch was selected to provide an aesthetically pleasing scaled structure and to give it similar visibility to the existing structure.
2.2 Innovative/Unusual Structure

As per Section 20.2.2 of the NYSDOT Bridge Manual, the preferred Cable-Stayed Main Span structure is an innovative and unusual structure as are the Deck Arch and Through Arch options. The Kosciuszko Bridge project as a whole is also considered a complex project due to the large scope of work and the intricate construction staging and contract breakdown. However, while complex these structures are derived from structures that have been designed and built and are well within the capacity of our industry.

2.3 Geotechnical Considerations

A geotechnical subsurface investigation was performed between September and November 2009. The full results of this investigation can be found in the Preliminary Geotechnical Report included in Appendix B. The investigation included sixteen 4-inch diameter boreholes.

Based on the results of the subsurface investigation the soil/rock stratigraphy above bedrock at the project site can be generally described in the following 5 sections:

- Stratum 1: Fill;
- Stratum 2: Organic Deposits
- Stratum 3: Silty Sand
- Stratum 4: Silty Clay
- Stratum 5: Decomposed Rock.

Strata 1 and 2 are not considered as suitable foundation bearing strata. Strata 3, 4 and 5 are considered adequate foundation bearing strata. Since the Fill and the Organic soils are present at the Main Span, shallow footings are not considered a viable foundation option due to depth of excavation and the disposal of potentially contaminated soils.

For the Main Span, deep foundations are considered adequate, therefore cast-in-place concrete piles and drilled shafts were analyzed.

The preliminary pile analysis (for vertical load only) indicates a 270 ton capacity for a 24 inch diameter pile with a length of approximately 85 feet. Drilled shafts are recommended to carry the large loads of the Cable-Stayed tower foundations and transfer the load directly to bedrock. Preliminary analysis indicates the required drilled shaft would be approximately 6 feet in diameter and extend approximately 160 feet to the top of rock with an approximately 5’-6” diameter rock socket extending approximately 20 feet into the rock.

2.4 Construction Considerations

2.4.1 Construction Cost

The structure type chosen for the new Main Span will impact the overall project cost. As each of the Main Span structure types vary in length, one cannot directly compare their costs, since the longer Main Spans would reduce the cost of the Approaches. Therefore, the overall project cost has been estimated in order to compare the different structure types.

The overall project costs presented here include detailed estimates completed during the initial stage of Final Design for the different Main Span and Approach structure types, the Brooklyn and Queens Connectors, temporary bridges required, and the new parks. In addition, estimated
costs from the Final EIS were included for the following items: demolition of the existing bridge, at-grade street reconstruction, utility relocation, streetscape construction, boat launches, highway and local street lighting, property acquisition, business and residential relocation, and building demolition. These preliminary estimates do not include drainage facilities, sign structures and reconstruction of the pedestrian overpass in Queens. As the final design is developed further, the estimated costs used from the Final EIS will be refined. However, they are not expected to vary among the Main Span bridge type options, and are therefore acceptable for purposes of a comparative evaluation. The Final EIS costs have been escalated to 2010 dollars to be consistent with the estimated bridge costs.

For each of the bridge types, detailed cost evaluations were completed for significant bridge items including piles, drilled shafts, structural concrete, reinforcement, segmental box girders, and structural steel. These detailed estimates were prepared by professional estimators using the same methodologies as are employed in the construction industry in preparing competitive bids. As a result, the estimates are based on a detailed breakdown of the following costs:

- Labor;
- Materials;
- Fabrication;
- Delivery of materials to the site;
- Equipment required to construct the new bridge structure;
- Subcontractor mark-ups;
- Insurance; and
- Office overhead.

For other typical bridge items, such as concrete barriers and bearings, the unit prices were estimated by a professional estimator using best judgments based on previous experience. The costs are specific to the New York City market and reflect factors such as local wage rates and equipment costs.

For the concrete segmental box girders, costs are based on a quote from Bayshore Concrete for the Kosciuszko Bridge Project. The cost includes fabrication, delivery to the site by barge, and erection of the segments. The Cable-Stayed option includes an elevator in each tower and a traveler over the creek beneath the roadway for inspection and maintenance.

The estimated overall project costs in 2010 dollars, including a contingency of 25%, are summarized below in Table 2.4.1. The detailed cost breakdown is included in Appendix C.

Although the least expensive Main Span bridge type is the Concrete Box Girder, assuming concrete box approaches, the cost for the Cable-Stayed Main Span option, assuming concrete box approaches, is only 3.7% greater.
Table 2.4.1 – Estimated Overall Project Cost

<table>
<thead>
<tr>
<th>Approach Structure Type</th>
<th>Main Span Structure Type</th>
<th>Total Estimated Construction Cost (2010 Dollars)</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Box Girder</td>
<td>Concrete Box Girder</td>
<td>$672 M</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Concrete Deck Arch</td>
<td>$680 M</td>
<td>+1.2%</td>
</tr>
<tr>
<td></td>
<td>Steel Through Arch</td>
<td>$688 M</td>
<td>+2.4%</td>
</tr>
<tr>
<td></td>
<td>Cable-Stayed</td>
<td>$697 M</td>
<td>+3.7%</td>
</tr>
</tbody>
</table>

2.4.2 Life Cycle/Maintenance Requirements

The NYSDOT will continue to be responsible for the maintenance of the Kosciuszko Bridge. All bridge types will require periodic inspection and preventive maintenance, including cleaning and washing, pavement re-striping, joint repair/replacement and wearing surface replacement. In addition, all bridge types will require bearing replacement at 20 to 30 year intervals.

For those bridge types that include structural steel elements, it is expected that the steel elements will require painting every 12 to 15 years. Further, the bridge types that include cables to support the superstructure will require inspection and eventual replacement of the cables. However, it is anticipated that full replacement of these elements would not be required for approximately 50 years. While the inspection and replacement of the cables is an increased cost, it is not significant on a life cycle basis. Similarly, there are methods such as galvanizing and metalizing finishes that could be used in lieu of painting. These methods would increase the time intervals between which maintenance is required, thus reducing life cycle costs.

Since the new structure will have standard lane and shoulder widths, there would be minimal impact to traffic flow during maintenance activities.

2.4.3 Constructability

All four (4) Main Span structure types would be supported by foundations consisting of drilled shafts or cast-in-place concrete piles with reinforced concrete pile caps. The Main Span support on the Queens side of Newtown Creek could affect the former Phelps Dodge Refining site, which is a New York State Class 2 Inactive Hazardous Waste Site. Since the site contains hazardous materials, the foundation installation may require special handling, disposal and health and safety procedures, depending upon the location and type of foundation.

Installation of the cast-in-place concrete piles would not displace any soil or groundwater, minimizing impacts to contaminated materials. However, the installation of drilled shafts would involve removal of contaminated soils and groundwater. Similarly, the foundations would require excavation and dewatering of contaminated materials that would require special handling and disposal.

Due to the longer span length and the location of the towers, the Cable-Stayed option would have a lesser impact than the other three options on the former Phelps Dodge Refining site, and
therefore, would require less handling and disposal of contaminated material. In addition, the foundation for the Cable-Stayed option would avoid impact to the groundwater collection and treatment system that is located at the southwest corner of the former Phelps Dodge Refining site.

The use of pile foundations reduces potential impacts, as does the location of the Cable-Stayed option foundation on the Queens side of Newtown Creek.

Above grade, the Deck Arch and Concrete Box Girder options could be constructed using either precast elements or cast-in-place construction. The arch for the deck arch would likely be cast in place using complex curved formwork supported by temporary bents or temporary tie backs, while construction of the concrete box girder superstructure would use precast or cast-in-place construction using a form traveler. The Concrete Box Girder piers could be constructed using either cast-in-place or precast construction, while the superstructure would use precast or cast-in-place construction using a form traveler. Temporary falsework bents would likely be required on the back spans for both options. Construction materials for these two alternatives, except for precast elements, would likely be delivered to the site by truck. Following the construction of the concrete box girders for either option, the concrete median and roadway barriers would be cast in place and then an overlay/wearing course placed on the roadway surface.

The piers for the Steel Box Girder option would be constructed using either cast-in-place or precast construction, while the superstructure would be fabricated offsite in segments and delivered to the project site, which due to their weight and size, do not lend themselves to transportation by truck. Delivery of these segments by barge would be a practical and cost effective option. The steel box girder segments would be lifted into place by crane and spliced together using balanced cantilever construction. Above the creek, the crane would be barge mounted. As with the above options, temporary falsework bents would likely be required on the back spans. Once the steel box girders are in place, a reinforced concrete deck would be cast in place, followed by the reinforced concrete median and barriers. An overlay/wearing course may not be required for this option. The added step of constructing a cast-in-place deck could increase the construction time associated with the Steel Box Girder option compared with the construction time associated with the cast-in-place Concrete Box Girder option, although this can be somewhat offset by the lesser weights and equipment costs associated with a steel box option.

For the Through Arch, the steel arch segments would be shop fabricated and delivered to the site, then lifted into place by crane and spliced in place to create each of the three arches. Tie backs or temporary falsework would be required to support the arch segments until each arch is closed at mid span, with temporary falsework bents required on the back spans. As with the Steel Box Girder option, prefabricated steel box girder segments would be lifted into place and spliced together. It is possible that the suspenders would need to be adjusted as each segment is lifted into place to control the moments in the arch segments. Once the steel box girders are in place, a reinforced concrete deck would be cast in place, followed by the reinforced concrete median and barriers. An overlay/wearing course may not be required for this option. Delivery of the steel segments by barge would be a practical and cost effective option.

Once the Main Span footings are complete, the towers of the Cable-Stayed bridge type would be constructed using cast-in-place construction that likely would be accomplished in approximately 14 foot high lifts. Once the towers are complete or near completion, the erection of the superstructure would begin using cantilever construction that would progress symmetrically on either side of the tower out over the creek and land. The superstructure
construction would begin at the towers with the construction of a pier table that is typically supported off the towers. The construction would then proceed stepwise out from the pier tables. Depending on wind stability considerations, a temporary falsework bent may be required on the back spans. As each section of deck steel consisting of an edge girder and floorbeams is added, it would be connected to a stay and an initial force would be introduced into the stay that is to support the new section of edge girder. Precast concrete deck panels would be placed on the floorbeams and edge girders, and the stay forces adjusted, then the panels would be grouted into place and the construction would advance. The steel floorbeams, girders and precast deck panels of the Cable-Stayed option would be fabricated offsite and could be delivered to the project site by either barge or truck. They would be lifted into place by cranes or by deck mounted travelers. The steel and concrete segments above the creek would likely be lifted directly off of barges. Once the deck is complete, the stays may be further adjusted and the cast-in-place concrete barriers and an overlay would be placed.

For all options, once the deck is in place, the remaining work items such as roadway drainage, joints, lighting, railing, signage and striping would be completed.

2.4.4 Construction Material Delivery

In order to limit an increase in local truck traffic during construction, an alternative means of material delivery was proposed in the Final EIS. To take advantage of the project’s proximity to Newtown Creek, the Final EIS proposed the use of barges as the primary means to transport materials and equipment to the project site during construction, although the specifics of which materials are to be transported were not specified in the Final EIS. Temporary platforms or docks would be required along the shoreline on both sides of the creek to dock the barges and off-load the materials and equipment.

The barges will likely be used to transport materials that do not lend themselves to transportation by truck. Examples of these types of materials include the following:

- precast concrete segments that may be used for the Box Girder superstructure;
- precast concrete segments that may be used for the pier columns or towers;
- precast concrete deck panels and structural steel girders and floorbeams that would be used if the cable stayed option is selected for the Main Span of the new bridge; and
- welded steel box girders that may be used for the Box Girder.

However, there are other construction materials that would not lend themselves to barge traffic such as formwork, reinforcing steel, and cast-in-place concrete, as these items can be more readily delivered by trucks.

Therefore, although means and methods of material delivery will be determined by the various contractors during construction, barge delivery is a practical and cost effective option. This is especially true for the large bridge components, such as precast concrete segments, which due to their weight and size, may not be suitable for truck transport. It is anticipated that contractors will choose to deliver these components by barge, since truck delivery will be difficult due to the size and weight of the segments. Final feasibility of barge transport will also depend on the navigation clearances in the creek at the time of construction.
2.4.5  **Construction Duration**

As the length of the Main Span accounts for less than 10% of the overall length of the bridge, it is clear the total construction duration will be governed by the length of time to complete the Brooklyn and Queens Approaches, which would be the same for any Main Span bridge types. Although the time needed to construct the new Main Span will vary depending on the structure type chosen, the overall construction duration will be similar, independent of the structure type chosen for the Main Span. Based on additional studies conducted as part of the initial stage of Final Design, the overall construction duration is expected to take a minimum of approximately six (6) years to complete.

2.5  **Architectural Considerations**

The four (4) Main Span options under consideration have distinct visual qualities. In order to best assess the bridge aesthetics, the different viewer groups who will be impacted by the new bridge need to be considered. The first viewer group will be those using the bridge: drivers, pedestrians and bicyclists. Users will not see the portion of the new structure beneath the roadway; they will only be impacted by those structural elements that extend above the bridge deck. The second viewer group will be the local communities in both Brooklyn and Queens. The entire structure will affect how viewers in this group are impacted by the new bridge. As noted in the Final EIS and ROD, the existing Kosciuszko Bridge’s height provides a prominent visual landmark to members of the community. In addition, the existing through truss provides a “gateway” between the boroughs of Brooklyn and Queens for users crossing Newtown Creek.

2.5.1  **Cable-Stayed (Preferred Option)**

![Cable-Stayed Rendering from Maspeth Creek](image)

Figure 2.8:  Cable-Stayed Rendering from Maspeth Creek

The Cable-Stayed option is the most technologically advanced of the four options and also the most dramatic. The towers would extend approximately 190 feet above the proposed roadway, almost 125 feet above the top of the existing through truss, making it highly visible to the surrounding communities. These tall canted-H shaped towers, see Figure 2.8, would create a unique iconic “Gateway” to the district and would be clearly visible for miles around. The towers
would be shaped in an upward tapered look and have a variation of the “expanding” chamfer to further accentuate the vertical slenderness of the towers by manipulating the patterns of light and shadow.

Both the Through Arch and Cable-Stayed options offer the opportunity to use above deck aesthetic lighting to further enhance their visual appeal.

2.5.2 Box Girder

The Box Girder, see Figure 2.9, is a sleek, streamlined design with clean simple lines. In order to increase its structural efficiency, the girder would be deeper at the piers creating a slight arch to the bottom profile. The columns would be sculpted with quasi “capitals” formed by chamfers. These chamfers would start at the bottom of the girder and widen to 4 feet at an elevation 10 feet below the girder and then gradually narrow to just 1 foot wide at ground level. This would express the support for the girder and provide strong shadows along the columns that would create a more slender, graceful appearance.

![Box Girder Rendering from Maspeth Creek](image)

Figure 2.9: Box Girder Rendering from Maspeth Creek

2.5.3 Deck Arch

The large arch, softened by the shadows and highlights of the “expanding” chamfers, framed by the canted struts of the back spans, would give a bold and expressive composition. The approach span columns would have simple expanding chamfers, which start at the girders and expand to 6 feet at ground level.
Figure 2.10: Deck Arch Rendering from Maspeth Creek

Similar to the Box Girder option, the arch and all structural elements would be located below the bridge deck, see Figure 2.10, invisible to the bridge users and not offering a gateway between the boroughs. As with the Box Girder, the top of the new structure would be approximately 70 feet below the top of the existing through truss, limiting visibility of the deck arch. However, workers in the industrial area located adjacent to Newtown Creek and boaters on the creek would have clear views of a graceful arch structure.

2.5.4 Through Arch

Figure 2.11: Through Arch Rendering from Maspeth Creek
The Through Arch option, see Figure 2.11, is a set of three graceful steel arches that would support the deck with suspender cables. This would allow the depth of the deck to remain the same as the approach spans, giving a slender, constant line to the bridge, accented by the arches springing over the creek. Being above the deck, these arches are a dramatic iconic statement for the bridge, as well as an historic reference to the existing bridge it is replacing. The only dissonant visual element are the end piers for the arch, which must be out of plane from the approach span piers, offset approximately 20 feet from the approach piers.

Since the steel arches would extend approximately 50 feet above the roadway, users would experience the crossing between the two boroughs. The top of the arch would be approximately 15 feet below the top of the existing through truss. Therefore, visibility of the new bridge’s Main Span from the local community would be similar to that of the existing bridge.

2.6 Work Zone Traffic Control

The existing Main Span carries three lanes of eastbound traffic and three lanes of westbound traffic over Newtown Creek. Independent of the Main Span structure type selected, six lanes of traffic will be maintained on the BQE throughout construction.

The existing Main Span will be replaced by constructing a new eastbound bridge that is parallel to and on the eastbound side of the existing bridge. The new eastbound Main Span will be wide enough to carry three 11'-0" lanes of traffic in both the eastbound and westbound directions while the existing bridge is demolished and the new westbound bridge is constructed within the footprint of the existing structure. See Figures 2.12 and 2.13 for staging cross sections at the Main Span.

In the final configuration, the new Main Span structures will carry four 12'-0" lanes of westbound traffic and five 12'-0" lanes of eastbound traffic with standard shoulders.

The overall project preliminary construction staging plans are included in Appendix D.

2.7 Utilities

The existing Main Span carries electrical supply for the roadway lighting, a police emergency telephone system and an Intelligent Transportation System. All three of these utilities will be maintained on the bridge throughout construction. The new structure will carry these utilities as well as a new Fire Department standpipe.

2.8 Asbestos

Several suspect asbestos containing materials are present in this bridge structure:

- Asbestos material in the south bulkhead wall
- Asbestos material beneath the railing base plates
- Asbestos material between the jersey barrier joints

See the Asbestos Assessment and Design Report for further information. The report provides the results from the field investigation including asbestos materials identified, location, type and quantity found. Appropriate handling and disposal procedures will be specified in the construction documents.
EXISTING

STAGE 1
* CONSTRUCT NEW EASTBOUND MAIN SPAN

STAGE 5
* DEMOLISH EXISTING MAIN SPAN

Figure 2.12
Construction Staging Cross Sections Main Span-1
STAGE 6
- CONSTRUCT NEW WESTBOUND MAIN SPAN

FINAL

Figure 2.13
Construction Staging Cross Sections Main Span-2
2.9 Contaminated/Hazardous Soil and Groundwater Impacts

Several environmental investigations completed for the project identified soil and groundwater across much of the project site with volatile organic compounds, semi-volatile organic compounds, metals, and polychlorinated biphenyls, likely as a result of the historic industrial nature of the area. In addition to project-wide impacts that would affect all of the bridge types relatively equally, the Main Span is specifically impacted by the contamination found on the former Phelps Dodge Refining site.

Four privately owned land parcels in Queens that could be affected by construction and/or fee acquisition for the project are part of the former Phelps Dodge Refining site (“Laurel Hill Site”); which is a New York State Class 2 Inactive Hazardous Waste Site. United States Environmental Protection Agency (USEPA) has also identified the Phelps Dodge Corporation as a potentially responsible party to the listing of Newtown Creek on the Federal National Priorities List for contamination originating from the Phelps Dodge Site. The site has undergone extensive remediation under a New York State Department of Environmental Conservation (NYSDEC) Consent Order, with additional mandated remediation requirements yet to be completed. The portion of the former Phelps Dodge Refining site that lies within the Kosciuszko Bridge project limits abuts the east side of the existing BQE from Newtown Creek northward to 55th Avenue.

Parcel 2529-70 contains an extensive groundwater collection and treatment system components, and Parcel 2529-1 is reported to have relatively high levels of contaminants remaining in site soils such that NYSDEC has required a physical cap be constructed and maintained indefinitely on this parcel (to date this has not been installed).

Parcel 2529-70 is currently owned by Sagres 9 LLC, but Phelps Dodge Corporation has contractual responsibility for operation and maintenance of the groundwater collection and treatment system, which is scheduled to require operation and maintenance for an indefinite duration under current conditions.

Excavation on any of the four parcels located within the former Phelps Dodge Site has potential to encounter contaminated soil and groundwater that would require special handling, disposal, and health and safety procedures. Ground intrusive work on Parcels 2529-70 and 2529-1 would have a significant potential to damage the groundwater collection and treatment system components, which would require NYSDOT to repair or re-route many of these components. Any repair or relocation of the system would have to be completed to the satisfaction of NYSDEC to maintain the intended function of the long-term collection and treatment system.

The Box Girder, Deck Arch, and Through Arch options would require excavation of portions of Phelps Dodge Parcels 2529-70 and 2529-1 for construction of new piers and foundations. Excavation on these two parcels would not be necessary for the Cable-Stayed option since this design does not require piers or foundations on these parcels. The Cable-Stayed option will result in less excavation in significantly contaminated areas, which correlates to cost savings for material handling and disposal, and less potential human exposure to hazardous materials.

The most significant difference in impacts among the four Main Span bridge types is the lack of disturbance to the groundwater collection and treatment system on Parcel 2529-70 from the Cable-Stayeded option, while the other three options all would impact the groundwater system. Construction of the Box Girder, Deck Arch, and Through Arch would all likely require relocation
of some groundwater system components on Parcel 2529-70, which would require additional
design approvals, coordination, and oversight from NYSDEC. It may also warrant consideration
that if repair or relocation of the groundwater system is required on Parcel 2529-70, and a
suitable relocation scheme cannot be agreed upon with NYSDEC, then NYSDEC could require
some alternative method to prohibit the metal contaminated groundwater from flowing towards
the creek. Such alternatives may include extensive and costly excavation and disposal of
significant quantities of contaminated soil from the impacted parcels as well as upland parcels to
negate the potential for contaminated soil particles to migrate with groundwater towards the
creek. Another possible alternative is in-situ soil solidification of site soils as well as upland site
soils to immobilize the metal contaminated soils and prohibit migration in groundwater.

Since the Cable-Stayed option would not impact the groundwater collection and treatment
system on Parcel 2529-70, there would not be a need to relocate the system or institute an
alternative groundwater remediation method to satisfy NYSDEC. The Cable-Stayed option
would also require less handling and disposal of contaminated material. The result would be
cost savings to the project due to reduced volumes of hazardous materials requiring disposal.
When compared to the other three bridge options, the Cable-Stayed option would also have
less potential for human exposure to hazardous materials, and reduced Department exposure to
future remediation requirements.

2.10 Slope Protection:

The existing Main Span piers will be removed and the deteriorated bulkhead will be replaced
with new riprap. The new piers will be located on land outside of the creek.

2.11 Hydraulics

The replacement of the Kosciuszko Bridge will have no discernable effect on the tidal hydraulics
of the waterway. The existing piers will be removed from the waterway and the stream bank
backfilled with suitable material. The banks will be covered with rip rap. The proposed pier
foundations for all Main Span bridge types considered would be constructed outside of the
creek. The Hydrology and Hydraulics Analysis Report is located in Appendix E.

2.12 Aviation/Air Navigation Impacts

Since the Kosciuszko Bridge is located along a flight path to LaGuardia Airport, coordination
with the Federal Aviation Administration (FAA) was required. The Box Girder, Deck Arch and
Through Arch options would be at a lower elevation than the top of the existing bridge and
would not have an impact on navigable airspace. However, a portion of the proposed towers
and cables of the Cable-Stayed option would extend above the top elevation of the existing
structure. To initiate coordination concerning the possible effects of a higher bridge structure,
the NYSDOT completed FAA Form 7460-1, “Notice of Proposed Construction or Alteration,”
which was filed with the FAA on December 11, 2009.

The original application proposed tower heights of 382 feet (Queens) and 379 feet (Brooklyn)
above ground level, which is 282 feet and 279 feet, respectively, above the roadway deck.
Following the completion of an aeronautical study under the provisions of 49 U.S.C., Section
44718, a “Notice of Presumed Hazard” was issued by the FAA on February 24, 2010, stating
that “the structure as described exceeds obstruction standards and/or would have an adverse
physical or electromagnetic interference effect upon navigable airspace or air navigation
facilities.” The FAA noted that if the structure were reduced in height so as not to exceed 303 feet above ground level in Brooklyn and 296 feet above ground level in Queens, the proposed towers “would not exceed obstruction standards and a favorable determination could subsequently be issued.” The FAA also indicated that alternatively a taller structure could be pursued but that it would require further evaluation.

The project team reviewed the preliminary design and revised both tower heights to approximately 290 feet above ground level so as not to exceed the elevations stipulated by the FAA. This design revision was conveyed to the FAA in a letter dated March 31, 2010.

The FAA issued a “Determination of No Hazard to Air Navigation” on July 26, 2010 based on the revised tower heights. However, their determination stipulated that aerial beacons would be required on top of the towers.

Based on the FAA determination, air navigation will not be impacted by any of the four Main Span bridge types being considered.

2.13 Avian/Bird Impacts

In a March 3, 2010 meeting with representatives of the United States Fish and Wildlife Service (USFWS) and the New York State Department of Environmental Conservation (NYSDEC), it was indicated that both agencies had expressed concerns over the potential for increased bird mortality associated with the proposed Cable-Stayed option because it would extend higher than the top of the existing bridge main span. The agencies’ concerns did not apply to the other Main Span options (Box Girder, Deck Arch and Through Arch) since these structures would be built at a lower elevation than the existing bridge.

In response to the stated concerns, an avian impact evaluation was conducted for the proposed Cable-Stayed option to determine the potential collision/mortality risk to birds that reside in, or migrate through, the area. The study was based on an extensive literature and database review, discussions with USFWS and maintenance staff who are familiar with existing cable-stayed bridges, the professional experience of Parsons Brinckerhoff, as well as short-term field observation conducted by Parsons Brinckerhoff’s Lead Ecologist, Kyle Spendiff and review by AKRF, a consultant to NYSDOT. Since the Cable-Stayed option is the only one taller than the existing bridge superstructure, the study focused solely on potential avian impacts with this bridge type.

The study concluded that there was a low potential risk of increased bird mortality due to the Cable-Stayed Main Span option, and that this potential could be further mitigated using the following measures: limit the height of the bridge to below 300 feet; use flashing aerial beacons, preferably white strobe lights; use light colored stays; turning off aesthetic lighting, if any, during periods of bird migration; use LED aesthetic lighting; and limiting the type of vegetation around the bridge.

2.14 Public Input

The extensive public outreach that began during the EIS stage has continued through the initial stage of Final Design. These outreach efforts have been made to keep the public informed of the project schedule and the design advancements as well as to receive input from the community regarding the project design.
Two Open Houses were held to update the general public on the status of Final Design activities and to receive input on the Main Span bridge type options under consideration. One Open House was held in Queens on February 18, 2010 and the other in Brooklyn on February 24, 2010. The Open Houses were held from 3 p.m. to 8 p.m.

The materials presented at these Open Houses included the following:

- Renderings of each bridge type from 6 different viewports throughout the project area;
- 3D simulations from both the driver’s and pedestrian’s perspective;
- A description of each bridge type; and
- A discussion of the bridge type selection criteria.

At both Open Houses there was an approximately 30 minute long PowerPoint presentation that provided detailed information on the overall project and each Main Span bridge type option, followed by a question and answer period. In addition, members of the project team were available to respond to individual questions. The Open House received considerable coverage in the local media, both on television and in print.

This information was also made available to the larger public through the NYSDOT project website (www.nysdot.gov/regional-offices/region11/projects/kosciuszko-bridge-project).

The public was asked to share their preference for the Main Span bridge type. The project team received 87 comment cards by May 14, 2010 indicating Main Span bridge type preferences. In addition, 34 email comments were received by the project team recording a preference. The overall tally of the 121 votes received to date is broken down as follows:

- Box Girder 13
- Deck Arch 18
- Through Arch 37
- Cable-Stayed 53

2.15 Bridge Type Selection

All bridge type options shall meet the following project objectives:

- Safe and secure structure that conforms to all applicable design standards;
- Lower elevation at the Main Span to reduce roadway grades on the approaches;
- Standard lane and shoulder widths;
- Auxiliary lanes in both directions, carrying five (5) lanes of eastbound traffic and four (4) lanes of westbound traffic, to improve merging and weaving conditions;
- New bikeway/walkway;
- Sufficient vertical clearance for ship navigation; and
- Maintain six (6) lanes of BQE traffic during construction.

In addition, each Main Span bridge type option would be constructed below the elevation designated by the Federal Aviation Administration (FAA) to avoid any potential impacts to air navigation. Also, all structure types being considered would implement the same maintenance and protection of traffic plan and the same slope protection and would have the same impacts to
existing asbestos and utilities. Therefore, these were not decisive factors in selecting the Main Span bridge type.

In order to choose between the Main Span bridge type options, further consideration was given to the criteria below:

- Minimize Project Costs;
- Minimize Construction Complexity
- Minimize Environmental Impacts
- Incorporate Bridge Aesthetics into Final Design; and
- Consider Public Input in the Selection Process.

For the final selection of the new Main Span bridge type, a numerical scoring system, which allows for comparison of each bridge type option, balancing the benefits and impacts of each bridge type, was used.

For each criterion, measures of effectiveness were defined to establish how well a particular bridge type would meet that criterion. A simple ratings system was used to score a bridge type option on each measure of effectiveness. The bridge type options were given a rating of 0, 1, or 2 for each measure based on how well each met the various criteria, with 2 being the best score. These ratings are assigned as follows:

2 – Projected to meet the given measure to a meaningful degree.
1 – Projected to meet the given measure, but to a lesser degree.
0 – Not likely to meet the given measure.

2.15.1 Bridge Type Selection Criteria

Minimize Project Costs

This criterion considers both short-term (construction period) and long-term costs associated with the project. It is expected that all bridge type options will require the same typical life cycle and maintenance requirements, such as cleaning and washing, pavement re-stripping, joint repair/replacement and wearing surface replacement.

Construction Cost Measure of Effectiveness: Minimize total cost of construction. (To differentiate between options, the overall project cost was estimated for each bridge type option and compared to the lowest cost option assuming concrete box approaches.)

2 – Cost difference is less than 2% higher than lowest cost option.
1 – Cost difference is between 2% and 5% higher than lowest cost option.
0 – Cost difference is greater than 5% higher than lowest cost option.

Assuming the approach spans are concrete box girders, the Box Girder and Deck Arch options would have a measure of effectiveness rating of 2. The Through Arch and Cable-Stayed options would each have a measure of effectiveness rating of 1.

Life Cycle Cost Measure of Effectiveness: Minimize life cycle/maintenance costs by avoiding steel elements that require regular painting cycles and structural elements (e.g., cables) that
require specialized repair or replacement.

- 2 – No steel elements and no special structural elements included.
- 1 – Either steel elements or special structural elements included.
- 0 – Both steel elements and special structural elements included.

The Through Arch and Cable-Stayed options would have steel superstructures and cable supports, therefore, these two options would have a measure of effectiveness rating of 0. The Steel Box girder would have a rating of 1 and the Concrete Box Girder and Deck Arch would each have a measure of effectiveness rating of 2.

Minimize Construction Complexity

This criterion considers construction duration and complexity of construction operations.

**Construction Duration Measure of Effectiveness:** Minimize length of construction.

- 2 – Overall construction duration is estimated to be less than 5 years.
- 1 – Overall construction duration is estimated to be between 5 and 6 years.
- 0 – Overall construction duration is estimated to be greater than 6 years.

Based on additional studies conducted as part of the initial stage of Final Design, the overall construction duration is expected to take approximately six (6) years to complete. Therefore, each of the structure types would have a measure of effectiveness rating of 1.

**Constructability Measure of Effectiveness:** Minimize risk of potential problems encountered during construction.

- 2 – Construction is typical and straightforward.
- 1 – Construction is somewhat complex, but simplified given the proposed conditions.
- 0 – Construction is complex, but feasible.

The Deck Arch, Through Arch and Cable-Stayed options would require complex construction techniques, therefore these options would have a measure of effectiveness rating of 0. The Steel and Concrete Box Girder options are somewhat complex due to the site conditions. The new roadway structure will be approximately 100 feet above grade, spanning approximately 360 feet over Newtown Creek. Therefore, both the Steel and Concrete Box Girder options would have a measure of effectiveness rating of 1.

Minimize Environmental Impacts

This criterion considers both short-term (construction period) and long-term environmental impacts.

Privately owned land parcels on Block 2529 in Queens that could be affected by construction and/or new foundations are part of the former Phelps Dodge Refining site, which is a New York State Class 2 Inactive Hazardous Waste Site. The site has undergone extensive remediation under a New York State Department of Environmental Conservation (NYSDEC) Consent Order, with additional mandated remediation requirements yet to be completed. All bridge type options will have some impact on these properties and the proper treatment of all contaminated
materials will be taken into consideration, as discussed in the Final EIS. However, minimizing impacts to these properties is an important objective. Block 2529 has a relatively high level of contaminant remaining in site soils such that the NYSDEC has required a physical cap be constructed and maintained indefinitely on this property. Therefore, minimizing impacts to this property is advantageous to the project by reducing the potential for exposure to contaminated materials and the NYSDOT’s exposure to future remediation and maintenance requirements.

**Contaminated/Hazardous Soil and Groundwater Impacts Measure of Effectiveness:** Minimize disturbance of contaminated materials and the existing wet wells associated with the remediation by avoiding the placement of new bridge foundations on Block 2529.

- 2 – No bridge foundations on Block 2529.
- 0 – Bridge foundations would be constructed on Block 2529.

Since the Cable-Stayed option does not require foundations on Block 2529, it would have a measure of effectiveness rating of 2. All other alternatives would require a foundation in this location therefore, the measure of effectiveness ratings would be 0.

As part of the project’s Reevaluation Statement, an avian impact evaluation was conducted to determine potential mortality risks to birds that reside in, or migrate through, the area.

**Avian Impacts Measure of Effectiveness:** Avoid increased risk of bird mortality.

- 2 – No bridge elements above the roadway reduce the risk of bird mortality.
- 1 – Bridge elements above the roadway possess features or characteristics that would not significantly increase the risk of bird mortality.
- 0 – Bridge elements above the roadway possess features or characteristics that would significantly increase the risk of bird mortality.

The Through Arch and Cable-Stayed alternatives both have elements above the roadway, however, these elements would not significantly increase the risk of bird mortality therefore the measure of effectiveness for both options is 1. The Box Girder and Deck Arch alternatives do not have elements above the roadway therefore both options have a measure of effectiveness of 2.

In order to limits an increase in local truck traffic through the community during construction, the use of barges is a preferred means to transport materials to the project site.

**Community Impact Measure of Effectiveness:** Minimize impact to the community during construction by reducing the delivery of materials by truck and increasing the use of barges to deliver construction materials.

- 2 – Bridge type would make extensive use of precast or prefabricated elements that could be barged to the site.
- 1 – Bridge type could use precast or prefabricated elements that could be barged to the site or could involve in-place construction where materials would not be barged to the site.
- 0 – Bridge type would not lend itself to use of precast or prefabricated elements that could be barged to the site and would require in-place construction where materials would not be barged to the site.
The Steel Box Girder, Through Arch and Cable-Stayed options would likely use prefabricated elements that could be barged to the site and therefore would have a measure of effectiveness of 2. The Concrete Box Girder and Deck Arch options could be constructed of either precast or cast-in-place concrete and therefore they would both have a measure of effectiveness of 1.

**Incorporate Bridge Aesthetics into Final Design**

This criterion considers the opportunity for the NYSDOT to provide a “signature” bridge that would act as a visual landmark for New York City and the local communities, as well as a “gateway” for users of the bridge (e.g., motorists, pedestrians and bicyclists).

**Community Aesthetics Measure of Effectiveness:** Provide a signature Main Span structure that would serve as a visual landmark for the local communities.

- 2 – Bridge type is highly visible and provides a unique visual experience from many viewpoints throughout the adjacent communities.
- 1 – Bridge type provides a unique visual experience, but only from select viewpoints close to the creek.
- 0 – Bridge type does not provide a unique visual experience to the local communities.

The Through Arch and Cable-Stayed options have elements above the roadway, they would be highly visible to the adjacent communities and therefore would have a measure of effectiveness of 2. The Deck Arch would provide a unique visual experience but only to limited viewers adjacent to Newtown Creek therefore this option would have a measure of effectiveness of 1. The Box Girder option would have a measure of effectiveness of 0.

**User Aesthetics Measure of Effectiveness:** Provide a Main Span structure that would serve as a gateway between the boroughs of Brooklyn and Queens for users of the bridge.

- 2 – Bridge elements above the roadway provide a gateway for users.
- 0 – Lack of bridge elements above the roadway does not provide a gateway for users.

The Through Arch and Cable-Stayed options would have elements above the roadway, therefore they would provide a gateway to users and would have a measure of effectiveness of 2. The Deck Arch and Box Girder options would have a measure of effectiveness of 0.

**Consider Public Input in the Selection Process**

This criterion considers public input in the decision-making process. The NYSDOT presented the bridge type options under consideration to the general public at Open Houses in February 2010. During the comment period following the Open Houses, members of the public and local community provided preferences on bridge type options.

**Public Input Measure of Effectiveness:** Provide a structure that meets the preferences of the general public and local community.

- 2 – Bridge type is highest ranked option from public poll.
- 1 – Bridge type is ranked 2nd or 3rd from public poll.
0 – Bridge type is lowest ranked option from public poll.

2.15.2 Bridge Type Selection Matrix

The matrix presented in Table 5.2 below scores the bridge type options on each measure of effectiveness to establish how well each bridge type would meet the screening criteria.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Concrete Box Girder</th>
<th>Steel Box Girder</th>
<th>Deck Arch</th>
<th>Through Arch</th>
<th>Cable-Stayed</th>
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<tr>
<td>Construction Cost</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>Contaminated Soils and Groundwater</td>
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<td>0</td>
<td>0</td>
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<td>Avian Impacts</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Community Impact</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Community Aesthetics</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>User Aesthetics</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Public Input</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>9</strong></td>
<td><strong>10</strong></td>
<td><strong>10</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

The Cable-Stayed Main Span has the highest overall measure of effectiveness rating, therefore it is the preferred structure type for replacement of the Main Span.
3.0 Approach Spans

Structure Summary - Brooklyn Approach

P.I.N.: X731.24, X731.25, X731.26 and X729.77
Title: Kosciuszko Bridge – Brooklyn Approach
B.I.N.: 1-07569-9
P.S.&E.: January 2014 (Eastbound)
County: Kings and Queens
Date: November 2011
Adv. Prelim. Plan:
July 2019 (Westbound)
Site Data Received:
April 2013 (Eastbound)
October 2018 (Westbound)

<table>
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<tr>
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<th>EXISTING</th>
<th>PROPOSED</th>
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</thead>
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<td>YEAR BUILT:</td>
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<td>Anticipated 2020</td>
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<tr>
<td>NO. OF SPANS:</td>
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<td></td>
<td></td>
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<td>SPAN LENGTH:</td>
<td>Span 79: 118'-4 ½&quot;</td>
<td>Eastbound Structure:</td>
</tr>
<tr>
<td></td>
<td>Span 80 through 82: 120'-0&quot;</td>
<td>Span 16 through 21: 180'-0&quot;</td>
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<tr>
<td></td>
<td>Span 83 through 86: 159'-0&quot;</td>
<td>Span 22: 171'-0&quot;</td>
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<tr>
<td></td>
<td>Span 87: 216'-2 ¾&quot;</td>
<td>Westbound Structure:</td>
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<td></td>
<td>Span 17: 177'-8&quot;</td>
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<td></td>
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<td>Span 18 and 19: 168'-0&quot;</td>
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<td>Span 20: 168'-5&quot;</td>
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<td></td>
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<td>Span 21: 170'-8&quot;</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Span 23: 180'-0&quot;</td>
</tr>
<tr>
<td>WIDTH:</td>
<td>88'-8&quot; (out to out)</td>
<td>Eastbound Structure: 97'-0&quot; (out-out)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Westbound Structure: 79'-0&quot; (out to out)</td>
</tr>
<tr>
<td>SUPERSTRUCTURE:</td>
<td>Steel Warren Deck Truss</td>
<td>Concrete Box Girder</td>
</tr>
<tr>
<td></td>
<td>with concrete filled grid deck.</td>
<td></td>
</tr>
<tr>
<td>SUBSTRUCTURE:</td>
<td>Piers 79 through 84 are</td>
<td>Hollow concrete piers on</td>
</tr>
<tr>
<td></td>
<td>concrete piers on concrete</td>
<td>reinforced concrete pile</td>
</tr>
<tr>
<td></td>
<td>spread footings.</td>
<td>caps and cast-in-place</td>
</tr>
<tr>
<td></td>
<td>Piers 85 through 87 are</td>
<td>concrete piles</td>
</tr>
<tr>
<td></td>
<td>concrete piers on concrete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>footings and piles</td>
<td></td>
</tr>
<tr>
<td>SKEW:</td>
<td>Varies</td>
<td>Varies</td>
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Structure Summary – Queens Approach

P.I.N.: X731.24, X731.25, X731.26 and X729.77
Title: Kosciuszko Bridge – Queens Approach
Date: November 2011
Site Data Received:

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<td>1938 / Modified 1972</td>
<td>Anticipated 2020</td>
</tr>
<tr>
<td>NO. OF SPANS:</td>
<td>11</td>
<td>Eastbound Structure: 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Westbound Structure: 8</td>
</tr>
</tbody>
</table>
| SPAN LENGTH: | Span 90: 230'-0”
               | Span 91: 198'-0”
               | Span 92 through 95: 159'-0”
               | Span 96 through 99: 120'-0”
               | Span100: 118'-0” | Eastbound Structure: Span 25 through 32: 180'-0”
|              |            | Span 33: 157'-7” |
|              |            | Westbound Structure:
               |              | Span 26: 174'-8”
               |              | Span 27 and 28: 174'-8”
               |              | Span 29: 177'-11”
               |              | Span 30 through 32: 180'-0”
               |              | Span 33: 157'-8” |
| WIDTH:      | 88'-8” (out to out) | Eastbound Structure: 97'-0” (out to out) |
| SUBSTRUCTURE: | Steel Warren Deck Truss with concrete filled grid deck | Concrete Box Girder |
|            | Piers 90 and 91 are concrete piers on concrete footings and piles.
               | Piers 92 through 99 are concrete piers on concrete spread footings. | Hollow concrete piers on reinforced concrete pile caps and cast-in-place concrete piles |
| SKEW:       | Varies | Varies |

County: Kings and Queens

B.I.N.: 1-07569-9
P.S.&E.: January 2014 (Eastbound)
July 2019 (Westbound)
Adv. Prelim. Plan:
April 2013 (Eastbound)
October 2018 (Westbound)
The existing Brooklyn Approach consists of ten spans (spans 79 through 88) from east of Varick Avenue to the Main Span over Newtown Creek. The existing roadway profile contains grades that vary between 3.75% and 4.3%, rising from approximately 30 feet to approximately 120 feet above grade adjacent to the creek.

The existing Queens Approach consists of eleven spans (spans 90 through 100) from the Main Span to east of 54th Road. The existing roadway profile contains grades that vary between 2.9% and 3.75%, and rises from approximately 20 feet near 54th Road to approximately 120 feet above grade adjacent to the creek.

The Brooklyn and Queens Approaches were constructed in 1939 and rehabilitated from 1967 to 1972. Both approaches utilize a concrete-filled steel grid deck with a steel stringer and floorbeam system that is supported by a steel Warren deck truss on concrete piers. See Figure 3.1 for a cross section of the existing Approach structure. For further history of the existing structure refer to Section 1.0 of this report. The existing Approaches are approximately 88'-8" wide and carry three lanes of traffic in each direction with shoulders and lane widths that do not meet current standards. The stopping sight distances along the Approaches are non-standard for a 60 mph design speed. The roadway is currently posted for 50 mph. The existing grid deck and stringer system is prone to fatigue cracking and has been an ongoing maintenance problem.

Figure 3.1   Existing Cross Section at Approach Spans

The new structure type will replace the existing bridge by constructing a new eastbound bridge that is parallel to and on the eastbound side of the existing bridge. Subsequent to the demolition
of the existing structure, a new westbound bridge will be built within the footprint of the existing structure.

The eastbound and westbound roadways will be supported on separate parallel structures that will facilitate both the staged construction and future maintenance and inspection of the structure. The Approach spans of the eastbound and westbound structures will be separated by approximately 18'-11" to allow sufficient clearance for underdeck inspection and maintenance using an Underdeck Inspection Vehicle.

Both the eastbound and westbound Brooklyn Approach structures will begin at the same pier line east of Varick Avenue. However, they will end at different locations since the preferred Main Span structure type, the Cable Stayed bridge, has staggered piers on each side of Newtown Creek. The Cable-Stayed tower for the eastbound roadway is located on the Brooklyn side of Newtown Creek and the tower for the westbound roadway is located on the Queens side of the creek. Therefore, similarly the eastbound and westbound Queens Approach structures will begin at different locations however; they will both end at the same pier line west of 54th Avenue. See Figures 3.2 and 3.3 for the two span layout options considered for the Approach structures.

The new westbound structure will be 79'-0" wide and will carry four 12'-0" lanes of traffic with standard shoulders and a new bikeway/walkway on the westbound side of the structure. The bikeway/walkway will be a shared use pathway and be 13'-1" wide. The new eastbound roadway will be 97'-0" wide and carry five 12'-0" lanes of traffic with standard shoulders. The eastbound roadway will be split by a concrete barrier into a two lane roadway for vehicles remaining on the BQE (Mainline) and a three lane roadway for vehicles wishing to access the LIE and vehicles entering from the Vandervoort Avenue entrance ramp (Collector Distributor). The physical separation of the “Mainline” and the “Collector Distributor” using a concrete median barrier will provide operational improvements by eliminating the merging and weaving problems that currently exist on the structure. Both the “Mainline” and “Collector Distributor” will include standard shoulders.

At the highest point above Newtown Creek, the new roadway will be approximately 30 feet lower than the existing roadway. This change reduces the vertical grades on the Approach spans while maintaining sufficient vertical clearance over local streets. A change in horizontal curvature and the addition of standard shoulders will also improve stopping sight distances along the Approaches. In order to minimize acquisition of private property, the new bridge will be constructed in close proximity to the existing alignment.

The following four (4) structure types have been identified as suitable replacements for the Brooklyn and Queens Approach structures:

- Northeast Bulb Tees (NEBT)
- Steel Girders
- Concrete Box Girders
- Steel Box Girders

The principal differing factors between the Girder and the Box Girder options are constructability, material delivery, maintenance requirements and aesthetics.
The steel and concrete box girder options would have similar span lengths and structure depths and would be very similar aesthetically. The differing factors between the Box Girder options are construction cost, constructability and maintenance requirements of the two different materials.

3.1 Approach Spans Considerations

In coordination with the NYSDOT, the Approach span bridge types described below were developed by a team of bridge engineers and bridge architects with the overall goal of providing an attractive, economical structure that is an appropriate solution for the site.

Several different span lengths were investigated to avoid impacts to the local streets that cross below and to minimize private property acquisitions to those specified in the FEIS. Two different span layouts were identified as suitable options. See Figures 3.2 and 3.3. Figure 3.2 depicts the shorter span length option with typical span lengths between 100 and 130 feet. There is a single span length in Brooklyn that would be a minimum of 150 feet in order to avoid impact to Gardner Avenue and Cherry Street below and the adjacent private property right-of-way. Figure 3.3 depicts the longer span option with typical span lengths of 180 feet. It is noted that the approach alignments include both curved and tangent sections and that the options being considered need to be suitable for both tangent and curved sections.

For the shorter span length option, the composite girder options, both steel and concrete, would be suitable. Per the NYS Bridge Manual, bulb-tees are suitable for span lengths of up to 150 feet therefore are considered for the composite concrete girder option. The concrete and steel box girder options are being considered for the longer span length option.

3.1.1 Concrete Box Girder

Alternative 1 consists of prestressed segmental box girders. Since the box shape resists torsion it is suitable on the curved horizontal alignment of the Approach spans. The proposed structure would consist of four trapezoidal shaped girders, two boxes to support each roadway. There would be a 2'-0" cast-in-place closure pour between the two box girders. See Figure 3.4. The boxes would be a constant depth of approximately 11'-6". The span lengths would vary from 160 feet to 180 feet, and the typical span length for this option would be 180 feet. See Figure 3.3 for the proposed span layout.

As the deck cannot be replaced, it would be protected with a 2 inch low permeability cementitious overlay and the deck itself would also use low permeability concrete. The permeability of the deck and overlay would be established to prevent chloride penetration to the reinforcing steel in the deck. In addition the deck itself would be post tensioned and designed to have zero tension under the design live load. As indicated below, the tendon ducts would be internal to the boxes, not embedded in the deck, and would be encased in plastic. As it is proposed that there would not be any roadway joints throughout the length of the box girder approach, as a result the tendons would not be affected by leaking roadway joints.

Each box would be supported by hollow reinforced concrete piers, tapered to add visual interest. The overall pier dimensions would be approximately 8 feet by 20 feet with approximately 1'-6" thick walls. The top 4 feet of each pier would be solid concrete. The piers could be either precast or cast-in-place. The foundations would consist of cast-in-place concrete piles with cast-in-place reinforced concrete pile caps. All bearings would be standard
disc or pot bearings.

The Brooklyn Approach structures would consist of seven eastbound spans and eight westbound spans. The Queens Approach structures would consist of nine eastbound spans and eight westbound spans. The approaches would only have expansion joints at each end, thus minimizing the number of joints and bearings. The difference in the number of eastbound and westbound piers is due to the configuration of the eastbound and westbound main spans.

The interior of the boxes would be illuminated to facilitate inspection and maintenance. Access hatches would be provided in the bottom of the box at each pier to allow for access to the bearings and piers. The top of each pier would be provided with an access hatch and an interior ladder for inspection and maintenance. It is anticipated that the exterior of the pier tops would be enclosed in flexible stainless steel mesh to prevent pigeon roosting.

A preliminary multi-mode response spectrum seismic analysis was conducted based on New York State Seismic Criteria for Downstate Bridges. The new approaches would be classified as a Critical Bridge, and therefore were evaluated using the 2500-year return period (upper level) event. In addition to dead and seismic loads, creep and shrinkage (CR&SH) effects were also considered. Dead and live loads were checked for several individual piers.

Based on preliminary geotechnical information available at this time, the NYSDOT standard response spectra for Soil Classification D was assumed. This is considered to be conservative, as it is anticipated that the final site-specific site response (Pro-Shake) analyses will yield a design response spectra somewhere between Soil Classifications C and D.

Soil-Structure Interaction (SSI) effects were included in the response spectrum analyses by explicitly modeling the footings and piles down to an equivalent depth of pile fixity. The depth of pile fixity was determined based on available preliminary geotechnical data and the AASHTO LRFD criteria.
Based on analysis of the Brooklyn Approach spans for the segmental concrete box option, it was determined that the NYSDOT seismic design criteria for Critical Bridges can be reasonably met with traditional (NYSDOT standard) bearings through appropriate arrangement of fixed/expansion bearing configuration.

For the segmental concrete box girder option, it was assumed that the approach superstructure would be continuous from the beginning of the Approach to the anchor pier for the cable stayed spans. The two end piers would be expansion bearings and intermediate piers would generally be fixed, except that one or more of the shortest intermediate piers would also be expansion. All bearings would be NYSDOT standard multi-rotational pot or disc bearings.

The box girders would be fabricated off site in approximately 10 feet long segments and transported to the site, most likely by barge since the segments do not lend themselves to transport by truck due to their weight and size. The boxes would then be erected likely using span by span construction, which is discussed in more detail below.

The following factors were considered to arrive at the proposed concrete box girder cross section and span lengths.

*Constant versus variable depth boxes*

Aesthetically it is preferred to have constant depth girders that provide clean and simple lines. Constant depth girders will also simplify the fabrication of the segments. The same form can be used to fabricate each of the box segments, which translates to a more efficient fabrication and reduced construction costs as described below.

*Number of parallel girders*

Due to the roadway widths, two parallel box girders are required to support each roadway. Two boxes supported by individual piers will also allow any future repairs required to be completed without requiring closure of the entire roadway.

*Span lengths*

As stated previously, span lengths between 160 and 180 feet are desirable to avoid impacts to local at-grade streets and to minimize private property acquisitions. It is desired to keep span lengths similar along the approaches to provide an aesthetically pleasing and economical structure. Longer span lengths were also considered but eliminated due to desired span to depth ratios and more economical constant depth section that lends itself to the span-by-span construction method.

*Span to depth ratio*

The most efficient box girder cross section typically results when span to depth ratios are between 1/11.5 and 1/13.5 for spans of approximately 200 feet. Also, for aesthetic reasons and handling, it is desired to keep the structure depth between 10 to 12 feet. This span length is the maximum allowable while still utilizing span by span construction which is more cost efficient than cantilever construction as described below.
Minimize fabrication complexity

The most economical box girder structure is achieved by simplifying the required formwork by making the boxes as consistent in size and shape as possible. Therefore, although the eastbound and westbound roadways are different widths, all four boxes would have the same cross section dimensions, with only the cantilevers varying in length. See Figures 3.5 and 3.6 below for the preliminary design of the eastbound and westbound box girders respectively. Both boxes provide adequate space for interim inspection.

Figure 3.5: Preliminary Cross Section of Concrete Box at Eastbound Roadway

Figure 3.6: Preliminary Cross Section of Concrete Box at Westbound Roadway
Construction method

Two different construction methods were considered: balanced cantilever construction and span by span construction. In balanced cantilever construction, segments are placed symmetrically about a pier until the mid-span is reached and closure is made with the previous half span cantilevered from the preceding pier. The cantilever tendons are the principal reinforcement and are located in the deck slab and they are anchored at the end of each segment.

Span by span construction involves the erection of all segments of a span on a temporary support system with small closure joints cast at one or both ends next to the segments over the pier. Tendons, usually external, are installed and stressed from the pier segment at one end of the span to that at the other end. External tendons are preferred since the ducts can be installed easier than internal ones and anchorage segment details are simpler. In addition, external tendons are easier to inspect and simpler to replace if damaged.

Since the tendons are installed and stressed along the entire length of the span instead of at each segment, span by span construction is typically faster to erect and more economical than balanced cantilever construction. Therefore this is the preferred construction method for the Approach spans. Preliminary design shows that span lengths of 180 feet can be achieved with span by span construction but longer span lengths would require balanced cantilever construction. See Section 3.5.3 and Appendix F for further information regarding span by span construction.

These parameters defined the most appropriate segmental box girder solution for the site.

3.1.2 Steel Box Girder

Alternative 2 consists of a curved steel tub (or box) girder system with a composite, stainless steel reinforced concrete deck. The roadway geometry and span lengths would match those of the Concrete Box Girder. The proposed structure would consist of four trapezoidal shaped girders, two girders to support each roadway. The tub girders would utilize a transverse floorbeam system to support the concrete deck. See Figure 3.7. Transverse floorbeams and cantilever brackets would be spaced at approximately 10 feet to be within the NYSDOT Bridge Manual’s maximum recommended girder to girder spacing limits for isotropic deck reinforcement.

The use of stainless steel reinforcement in the concrete deck allows for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The reduced deck thickness also leads to a more efficient girder design, as the dead load would be reduced, although the overall reduction compared to the concrete box girder is mitigated by the weight of the piers and footings.

The trapezoidal shape of the tub girders utilizes inclined webs to maximize the spacing of the top flanges as well as minimize the width of the continuous bottom flange. The steel tubs would be a constant depth of approximately 10 feet. Each tub would be supported by a hollow reinforced concrete pier, tapered to add visual interest. Pier sizes and configuration would be similar to that of the Concrete Box Girder option. The foundations would consist of cast-in-place
concrete piles with cast-in-place reinforced concrete pile caps. All bearings would be NYSDOT standard disc or pot bearings.

As with the concrete box girder option, each approach would be continuous with an expansion joint at each end of the approach. As the heavier concrete box was evaluated for seismic forces, a separate analysis was not required for the steel boxes as by observation they would result in lower seismic demands.

The steel boxes would be painted on both the interior and exterior, with the interior being painted a light colored paint, possibly just the primer, to facilitate inspection of the interior. As with the concrete boxes, the interior of the boxes would be illuminated to facilitate inspection and maintenance. Access hatches would be provided in the bottom of the box at each pier to allow for access to the bearings and piers. The top of each pier would be provided with an access hatch and an interior ladder for inspection and maintenance. It is anticipated that the exterior of the pier tops would be enclosed in flexible stainless steel mesh to prevent pigeon roosting.

As the exposed steel brackets and floorbeams would be roosting places for pigeons and a long term maintenance problem, products can also be added to the bottom flange to deter pigeons from perching and roosting on the structure. Potential products include stainless steel spikes, netting, bird slopes and bird wire. These methods would require installation along the entire length of each girder on both sides of each bottom flange, for an overall length of approximately 130,000 feet. Most manufacturers guarantee these products from between 2 and 10 years, therefore periodic maintenance would be required.

To avoid this maintenance problem, elimination of the transverse floor beam system was considered. This would be accomplished using additional parallel box girders. However, it was found that the additional boxes required would lead to a less structurally efficient superstructure. To maintain a two column pier arrangement, the steel tub girders would have to be integral with floorbeams at each pier line. This would lead to further increases in cost and constructability concerns.

Figure 3.7: Steel Box Girder Alternative Cross Section
A tub girder is effectively “closed” once the concrete deck has hardened. However during erection and deck placement the tub girder is considered a “quasi-closed” section and is prone to warping stresses and torsional deformations. The use of internal cross frames and lateral bracing would be essential components during construction to maintain the tub girder’s shape during erection.

3.1.3 Northeast Bulb Tee (NEBT)

Alternative 3 is composite multi-precast girder option. The superstructure would consist of prestressed Northeast Bulb Tees (NEBT) with a composite stainless steel reinforced concrete deck. The use of stainless steel reinforcement in the concrete deck allows for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity.

The typical span length would be between 100 and 130 feet with a single span of 150 feet. There would be three expansion joints on each of the Brooklyn and Queens Approaches, one intermediate joint and one at each end. See Figure 3.2 for the span layout. The girders for the typical spans would be 5'-3" deep spaced at a maximum of 8'-4". See Figure 3.8. Therefore, the typical westbound roadway span would have ten girders and the eastbound roadway would have twelve girders. The 150 foot span would have 6'-7" deep girders spaced at 4'-0" on center. These longer girders could be either NEBTs or the equivalent PCEF girders.

The Brooklyn Approach would consist of 11 eastbound roadway spans and 12 westbound spans. The Queens Approach would consist of fourteen eastbound roadway spans and twelve westbound spans. There would be an additional eastbound span in order to avoid impact to 56th Road.

Figure 3.8 Northeast Bulb Tee Alternative Cross Section
Each pier would require an approximately 7’ by 7’ cast-in-place reinforced concrete cap beam with two approximately 10’ by 8’ reinforced concrete columns. Unlike the hollow piers proposed for the box girder options, these columns would likely be solid concrete since the material savings on this smaller column would be offset by the additional time and labor costs required to form the interior column face. The piers and cap beams would likely be cast-in-place since it would likely be more efficient than erection of precast segments for the cap beams. Each column would have a single foundation supported by cast-in-place concrete piles. This option would utilize elastomeric bearings.

A preliminary multi-mode response spectrum seismic analysis was conducted based on New York State Seismic Criteria for Downstate Bridges. The new approaches would be classified as a Critical Bridge, and therefore were evaluated using the 2500-year return period (upper level) event. In addition to dead and seismic loads, creep and shrinkage (CR&SH) effects were also considered. A separate analysis was conducted for dead and live loads for selected piers.

Based on preliminary geotechnical information available at this time, the NYSDOT standard response spectra for Soil Classification D was assumed. This is considered to be conservative, as it is anticipated that the final site-specific site response (Pro-Shake) analyses will yield a design response spectra somewhere between Soil Classifications C and D.

Soil-Structure Interaction (SSI) effects were included in the response spectrum analyses by explicitly modeling the footings and piles down to an equivalent depth of pile fixity. The depth of pile fixity was determined based on available preliminary geotechnical data and the AASHTO LRFD criteria.

Based on analysis of the Brooklyn Approach spans for the precast bulb-tee girder option, it was determined that the NYSDOT seismic design criteria for Critical Bridges can be reasonably met with traditional (NYSDOT standard) bearings through appropriate arrangement of expansion joints and fixed/expansion bearing configuration.

For the precast girder option, it was assumed that the approach spans superstructure will be constructed as simple spans for dead loads and continuous for live loads, except there would be one intermediate expansion joint near mid-length of each approach. Bearings at the ends of the continuous span units would be expansion, and bearings at intermediate piers would generally be fixed. All bearings would be NYSDOT standard elastomeric bearings.

Based on analyses discussed in the section on the Connectors, the NEBT is the most efficient prestressed concrete multi-girder option for the proposed span lengths and roadway geometry. The cross section is lighter than the equivalent AASHTO Type V girder.

While precast girders can be efficient sections on tangent alignments, they can be less efficient on a curved alignment as the overhang between piers will vary and will require special forming and reinforcing steel. For the pier layout proposed for this option, the maximum overhang would vary between 3 feet and 4 feet. This also requires more careful detailing and forming at the piers as the girders have different angles at the pier diaphragms in the curved sections.

The precast girders may provide roosting sites for pigeons, and experience has shown that the pier caps will be occupied by pigeons and soon become difficult to maintain. It would be possible to mitigate this problem with steel mesh barriers at the piers. Products can also be added to the bottom flange of each girder to deter pigeons from perching and roosting on the
structure. Potential products include stainless steel spikes, netting, bird slopes and bird wire. These methods would require installation along the entire length of each girder on both sides of each bottom flange, for an overall length of approximately 130,000 feet. Most manufacturers guarantee these products from between 2 and 10 years, therefore periodic maintenance would be required.

The bulb tees would be fabricated off site and delivered to the site by either truck or barge. Only one beam would be delivered per truck. For the single spans length of 150 feet, the bulb tees, if shipped by truck, would need to be shipped in two pieces and post tensioned into single units on site. The bulb tees would be unloaded on-site by crane and erected in one of two ways: using a gantry for overhead construction or using two cranes to lift each girder into place from the ground. These options are discussed further in Section 3.5.3.

3.1.4 Composite Steel Girders

Alternative 4 is a composite steel multi-girder option. The superstructure would consist of welded steel girders with a stainless steel reinforced concrete deck. The use of stainless steel reinforcement in the concrete deck allows for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The girders would use weathering steel (ASTM A 709 Gr 50W). The exterior girders and girder ends at the expansion joints would be painted.

The typical span length would be between 100 and 130 feet with a single span of 150 feet. There would be three expansion joints on each of the Brooklyn and Queens Approaches, one at each end and one intermediate joint. See Figure 3.2 for the span layout. The girders for the typical spans would be 5'-3” deep spaced at a maximum of 8'-4”. See Figure 3.9. Therefore, the typical westbound roadway span would have ten girders and the eastbound roadway would have twelve girders.

The Brooklyn Approach would consist of 11 eastbound roadway spans and 12 westbound spans. The Queens Approach would consist of fourteen eastbound roadway spans and twelve westbound spans. There would be an additional eastbound span in order to avoid impact to 56th Road. As with the bulb-tee option, there would be one intermediate expansion joint near mid-length of each Approach. As the heavier concrete girder option was evaluated for seismic forces, a separate analysis was not required for the steel girders as by observation they would result in lower seismic demands.
Each pier would require an approximately 7' by 7' cast-in-place reinforced concrete cap beam with two approximately 10’ by 8’ reinforced concrete columns. Unlike the hollow piers proposed for the box girder options, these columns would likely be solid concrete since the material savings on this smaller column would be offset by the additional time and labor costs required to form the interior column face. Each column would have a single foundation supported by cast-in-place concrete piles. This option would utilize elastomeric bearings.

At the area where the approach is on a curved alignment composite steel girders would be curved to follow the alignment, allowing a constant deck overhang. However, the curved girders would require closely spaced cross frames that would need to be designed as primary load carrying members. This would add weight, erection complexity and cost as well as maintenance issues when compared to other alternatives.

All of this framing, both the girder flanges and added cross frames would lead to pigeon roosting locations and long term maintenance problems. In addition, as pointed out above, the pier caps would be additional roosting locations for pigeons. While the piers could be protected with steel mesh, that would not be possible for the girder flanges, which would require an alternative means of pigeon protection as discussed above for the NEBT option.

The girders would be fabricated off site and delivered to the site likely by truck as delivery by barge would require additional handling, which would be costly. As the girder sections can be field spliced as they are erected, the sections would be designed and fabricated to facilitate shipping. The girders, which would be much lighter than the comparable NEBT girders, could be erected by cranes using a single or a pair of cranes depending upon the site geometry and construction cost considerations. Additional temporary falsework would likely be required to support some girders, particularly in the curved sections.

Based on similar evaluations used in the Connectors, the composite concrete girder option is
less expensive and is preferable from a long term maintenance perspective when compared to a composite steel alternative. Therefore, this option was eliminated from consideration.

3.2 Innovative/Unusual Structure

As per Section 20.2.2 of the NYSDOT Bridge Manual, the Brooklyn and Queens Approach Spans are not considered an unusual structure. However, the Kosciuszko Bridge Project as a whole is considered a complex project due to the extensive construction coordination with utility relocation, stormwater drainage reconstruction, local street realignment, and the intricate construction staging and contract breakdown.

3.3 Geotechnical Considerations

A geotechnical subsurface investigation was performed between September and November 2009. The full results of this investigation can be found in the Preliminary Geotechnical Report included in Appendix B. The investigation included sixteen 4-inch diameter boreholes.

Based on the results of the subsurface investigation the soil/rock stratigraphy above bedrock at the project site can be generally described in the following 5 sections:

- Stratum 1: Fill;
- Stratum 2: Organic Deposits
- Stratum 3: Silty Sand
- Stratum 4: Silty Clay
- Stratum 5: Decomposed Rock.

Strata 1 and 2 are not considered as suitable foundation bearing strata. Strata 3, 4 and 5 are considered adequate foundation bearing strata. Since the Fill and the Organic soils are present along a significant length of both the Brooklyn and Queens Approaches, shallow footings are not considered a viable foundation option due to depth of excavation and the disposal of potentially contaminated soils. Therefore, cast-in-place concrete piles are recommended subject to NYSDOT GEB approval. The preliminary cast-in-place concrete pile analysis (for vertical load only) indicates a 270 ton capacity for a 24 inch diameter pile with a length of approximately 75 feet.

3.4 Substructure Considerations

As per the results of the geotechnical subsurface investigation, it is anticipated that the new structure will be founded on pile supported foundations.

For both box girder options, each box would be supported by an individual pier column and foundation, and pleasing aesthetics can be incorporated into the design of the pier.

Based on foundation studies to date, the typical foundation for the concrete box girder option would be approximately 30 feet by 30 feet and be supported by approximately sixteen 24-inch diameter piles. At the two shorter piers, where the longitudinal restraints would be released, the
foundations would be approximately 30 feet by 18 feet with twelve 24-inch diameter piles. The steel box girder alternative could result in smaller foundations and reduced pile quantity when compared to the concrete box girder alternative due to the steel superstructure being lighter than the concrete alternative. However, the total vertical load would only be approximately 10% less than that of the concrete alternative, therefore, foundation and pile reductions would not be significant.

The piers of the composite girder options would have two columns per roadway. Each column would have a single foundation of approximately 24 feet by 24 feet and be supported by approximately thirteen 24-inch diameter piles. Although the steel girder would be lighter than the concrete girder, the total vertical load would only be approximately 10% less than that of the concrete alternative, therefore, foundation and pile reductions would not be significant.

3.5 Construction Considerations

3.5.1 Construction Cost

The structure type chosen for the Approaches will impact the overall project cost. The costs presented here include detailed estimates completed during the first stage of Final Design for both box girder options and the NEBT alternative. A separate cost estimate was not prepared for the composite steel girder option as, based on similar evaluations used in the Connectors, the composite concrete girder option is less expensive and is preferable from a long term maintenance perspective when compared to a composite steel alternative.

For three alternatives, detailed cost evaluations were completed for significant bridge items including piles, structural concrete, reinforcement, segmental box girders, NEBTs and structural steel. These detailed estimates were prepared by a professional estimator, who had been employed by contractors for many years, using the same methodologies as are employed in the construction industry in preparing competitive bids. As a result the estimates are based on a detailed breakdown of the costs of materials, fabrication, delivery of materials to the site, and the labor and equipment required to install the items, subcontractor mark-ups, insurance and office overhead. For other typical bridge items, such as concrete barriers and bearings, the unit prices were estimated by a professional estimator using best judgments based on previous experience. As requested, these costs have been compared to the average bid prices for the Kew Gardens Project and were found to be similar and acceptable for use in this preliminary comparative estimate.

These preliminary estimates are comparative estimates and do not represent the full construction cost estimate as they do not include demolition, drainage, lighting, sign structures, etc. The costs for these items would be similar independent of the structure type selected.

For the concrete segmental box girder, costs are based on a quote from Bayshore Concrete, Virginia, for the Kosciuszko Bridge project. The cost includes fabrication, delivery to the site by barge, and erection of the pieces.

The preliminary overall project costs in 2010 dollars, including a contingency of 25%, are summarized below in Table 3.5.1.
Table 3.5.1 – Estimated Cost of Approach Structures assuming Cable-Stayed Bridge Main Span

<table>
<thead>
<tr>
<th>Approach Structure Type</th>
<th>Total Estimated Project Cost (2010 Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Box Girder</td>
<td>$226 M</td>
</tr>
<tr>
<td>Steel Box Girder</td>
<td>$297 M</td>
</tr>
<tr>
<td>Northeast Bulb Tee*</td>
<td>$217 M*</td>
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</tbody>
</table>

*The NEBT cost does not include the cost to acquire additional ROW for conventional crane erection of the beams or for a gantry system to launch the girders from above.

The Concrete Box Girder Approach is less expensive than the Steel Box Approach. This is due to the added cost of constructing a cast-in-place deck for the steel box option and the higher cost of the steel box girder and framing. As previously discussed, the foundation sizes and pile quantities could be further reduced for the steel option, which would potentially result in a cost reduction of approximately 5%. Even with this reduction, the Steel Box Approach would be significantly more expensive than the other alternatives.

The estimate for the NEBT alternative is approximately 3.5% less than the cost of the Concrete Box Girder, which is within the limit of accuracy of the estimate. However, this estimate does not reflect the cost of acquiring additional ROW for crane erection or for a self-launching gantry system. Either erection method would significantly increase the construction cost of the NEBT alternative. The additional ROW cost has not been quantified, however, the cost of an overhead gantry would likely be approximately $3 to $4 million each. The contractor would likely use two gantries, one on each side of Newtown Creek. See section 3.5.3 for further discussion regarding constructability.

3.5.2 Life Cycle/Maintenance Requirements

The NYSDOT will continue to be responsible for the maintenance of the Kosciuszko Bridge. All bridge types will require periodic inspection and maintenance, including cleaning and washing, pavement re-striping, and joint repair/replacement. In addition, all bridge types will require bearing replacement at 20 to 30 year intervals.

The Steel Boxes would require painting every 12 to 15 years, although the interior of the steel boxes may need less frequent painting as they are protected from the weather. While painting of the structural steel elements can be minimized through the use of weathering steel, ASTM A 709 Gr. 50W, this is not recommended for the boxes. The use of unpainted steel is typically limited to the interior girders of a multi-girder system as that steel is not exposed to frequent wet/dry cycles. However, for the boxes most of the webs would be exposed – there is a gap in the superstructure between the eastbound and westbound roadways – so that there is no girder that would not need to be painted. The stainless steel reinforced deck of the Steel option is anticipated to require replacement every 40 years. Also, the floorbeam bottom flanges would require periodic maintenance, either cleaning or replacement of anti-pigeon devices that prevent pigeon roosting.

The composite steel girder option would use weathering steel, however the exterior girders would require painting every 10 to 15 years. Also, as with the steel box floorbeams, the girder bottom flanges and the cross frames would likely require periodic maintenance due to pigeon roosting.
While there is less experience with the long term maintenance of segmental box girder bridges than the other options being considered, a recent article in the Fall 2011 issue of Aspire Magazine written by Matthew Royce regarding New York State’s experience with the 40 year old Genesee River Bridge, which was segmental concrete construction, states that the spans are “performing well with minimum maintenance”. See Appendix H for a copy of the article. It is anticipated that sealing and patching of the Concrete Box Girder’s overlay would be required periodically and full replacement of the two inch overlay is estimated to be required every 20 years. Typically, sealing and patching of the overlay is recommended every five years. Timely maintenance of the overlay is important to avoid deterioration of the deck below however as discussed above the deck would also be designed with low permeability concrete to minimize chloride penetration.

As also discussed above, the tendons of the Concrete Box Girder would be internal to the box, and would not be a part of the deck system so they would be protected from chlorides. The duct would be made of non-corrosive polyethylene and would be isolated within the cross-section. In addition, stainless steel bars could be used in the deck of the box girder to further reduce the long term vulnerability of the deck to deterioration. However they would be inspected as part of the normal biennial inspection procedure.

The Box Girder would require repair of spalled and hollow concrete in the piers as well as cracks in the Box Girders. These repairs are anticipated every 15 years. In addition, the 160 disc bearings will likely require replacement every 25 years.

The NEBT option would require repair of spalled and hollow concrete in the piers and cap beam as well as cracks in the Bulb Tees. These repairs are anticipated every 15 years. The NEBT option would require the inspection and replacement of 1,130 bearings compared to the box girder option’s 160 bearings. The stainless steel reinforced deck of the NEBT options is anticipated to require replacement every 40 years. In addition, routine maintenance would be required to address pigeon roosting.

A comparative Life Cycle Cost Estimate was prepared for the Concrete Box Girder and NEBT options and the anticipated Life Cycle Costs were found to be similar as presented in Table 3.5.2 below. See Appendix G for further information regarding the Life Cycle Cost Estimate.

<table>
<thead>
<tr>
<th>Approach Structure Type</th>
<th>Estimated Present Worth of Total Major Maintenance Costs</th>
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</thead>
<tbody>
<tr>
<td>Concrete Box Girder</td>
<td>$17.3 M</td>
</tr>
<tr>
<td>Northeast Bulb Tee</td>
<td>$19.1 M</td>
</tr>
</tbody>
</table>

As stated previously, since the new structure will have standard lane and shoulder widths, there would be minimal impact to traffic flow during maintenance activities. The Approach spans of the eastbound and westbound structures will be separated by approximately 18’-11” to allow sufficient clearance for underdeck inspection and maintenance using an Underdeck Inspection Vehicle.

3.5.3 Constructability

Both the Steel and Concrete Box Girder options would be supported by foundations consisting
of cast-in-place concrete piles with cast-in-place reinforced concrete pile caps. Installation of the cast-in-place concrete piles would not displace any soil or groundwater, minimizing impacts to contaminated materials. The hollow piers for both options could be constructed using either cast-in-place or precast construction. It is anticipated that the use of precast piers would accelerate the construction.

The concrete superstructure would be prestressed segmental concrete boxes. The boxes would be fabricated offsite in segments approximately 10'-0" long and delivered to the project site. The deck slab would be cast with the box girder and would further reduce the field work associated with a separate cast-in-place deck pour required by the steel and NEBT alternatives. Segments could be stockpiled on the partially completed portion of the structure in order to reduce the need for staging areas immediately adjacent to the site. The segments would then be brought to the span on a transporter and lifted into place with a high capacity crane.

The segments would be erected using span by span construction. Span by span construction is accomplished using falsework of an erection gantry from which all the segments in an individual span are temporarily supported until they are post tensioned into a single span. In span-by-span construction, the bulk of the dead load in each span is applied initially to the structure by a positive moment at or near the mid-span. Consequently, the post tensioning tendons that hold the spans up tend to be heavy about the mid-span and placed low in the bridge cross-section. The tendons drape between the piers, being anchored near the top of the section over the piers but deviated to the bottom of the section within the mid-span region. See Figure 3.5 and 3.6 for tendon locations. In order to achieve continuity with the next span, the tendons from one span overlap with the tendons of the next span in the top of the pier segment. At the very end of each continuous unit, the ends of the tendons anchor in the diaphragm of the expansion joint segment with anchors dispersed vertically and approximately parallel to the web of the box girder. See Appendix F for further discussion regarding span by span erection.

Once the box girders are post tensioned, a final longitudinal deck closure pour would be completed to tie the two boxes together. The concrete median and roadway barriers would be cast in place and then a low permeability overlay would be placed on the roadway surface. Once the overlay is in place, the remaining work items such as roadway drainage, joints, lighting, railing, signage and striping would be completed.

The Steel Box superstructure would be fabricated offsite in segments and delivered to the project site. The girder sections would be very large and difficult to ship and would likely require field bolted longitudinal splices just to be shipped.

Steel box girders can be erected in various methods. One method would be to have the spans erected in two elements: a pier segment over the pier and a central portion connecting to the pier segment of the previous pier. However this would be very large picks, on the order of 50 – 80 tons each and require very large cranes and temporary falsework to stabilize the pier segment. As stated in the EIS, this requires a construction area parallel and adjacent to the bridge for crane installation and material delivery/storage. This would result in a number of impacts to local streets and private property outside the right-of-way being acquired by the project. Given the size of the boxes, span by span erection using a gantry is likely to not be practical.

Once the steel box girders are in place, a reinforced concrete deck would be cast in place, followed by the reinforced concrete median and barriers. An overlay/wearing course would not
be required for this option. Once the deck is in place, the remaining work items such as roadway drainage, joints, lighting, railing, signage and striping would be completed.

The NEBT option would be supported by foundations consisting of cast-in-place concrete piles with cast-in-place reinforced concrete pile caps. Installation of the cast-in-place concrete piles would not displace any soil or groundwater, minimizing impacts to contaminated materials. The columns and cap beam would likely be constructed using cast-in-place construction. The girders would be fabricated off site and delivered to the project site by either truck or barge. If delivered by truck, only one NEBT would be delivered per truck. Each truck would be considered a superload and would require police escorts for transport. If delivered by barge, a temporary platform would be constructed to unload the girders similar to the Concrete Box Girder option.

The longer girders required for the single 150 foot span would likely be fabricated in two pieces and spliced in the field using post tensioning. This would facilitate lifting of the beams out of the forms during fabrication and would also ease delivery by truck.

Provided there was adequate space for crane placement, the NEBT girders could be erected by two cranes at either end making tandem picks from the ground to place each girder. As stated in the EIS, this would require a construction area parallel and adjacent to the bridge. Based on discussions with a local contractor, it is estimated that approximately 75 feet outside the fascia would be required for the crane movements and to pick and place the girders. This would impact local streets and private property outside of the right-of-way being acquired for the project. See Figure 3.10. To mitigate these potential effects, the spans could be erected from above using a self launching, span-by-span gantry. As an example, this method was used on the Colorado River Bridge in Austin, Texas. The contractor, Hensel Phelps, utilized two portal cranes running on temporary box beam tracks placed the inner 5 girders (of 9) in 4 spans of 120 ft directly into position before the whole assembly was launched forward. The center portion of the deck slab was then poured over the 4 spans and the outer 2 girders on each side erected by cranes running on the completed deck slab. This method has the advantage of allowing the girders to be lifted from a fixed location where there is adequate space for crane placement, on to the superstructure where they can be picked up and carried forward into position, provided that there is a means to preposition the temporary box beam tracks.

Once the girders are in place, a stainless steel reinforced concrete deck would be cast in place, followed by the reinforced concrete median and barriers. Once the deck is in place, the remaining work items such as roadway drainage, joints, lighting, railing, signage and striping would be completed.

3.5.4 Construction Material Delivery

The concrete - and likely the steel box girders - would be fabricated offsite and likely delivered to the site by barge, since these materials do not lend themselves to transportation by truck due to the weight and size of the segments. This will limit an increase in local truck traffic during construction. Temporary platforms or docks would be required along the shoreline on both sides of the creek to dock the barges and off-load the materials and equipment. The precast column would likely be delivered to the site via barge as well.

Therefore, although means and methods of material delivery will be determined by the various contractors during construction, barge delivery is a practical and cost effective option. Final
feasibility of barge transport will also depend on the navigation clearances in the creek at the
time of construction. The use of barges to deliver construction materials will minimize impact to
the community during construction by reducing the delivery of materials by truck.

The NEBT girders however, could be delivered to the site by truck or barge. Transportation by
barge would require temporary platforms along the shoreline similar to the Box Girder option.

If delivered by truck, only one NEBT girder would be shipped per truck and they would be
considered a superload. The weight of the truck and beams would be approximately 130,000
lbs. Security escorts would be required for each truck. There are 565 beams therefore
requiring 565 truck trips for the beam delivery, not counting the longer beams that would be
shipped in sections.

In addition, the cast-in-place concrete piers and cap beams of the NEBT option would require
additional truck trips. This option would result in more truck traffic in the community than the
box girder options due to the larger concrete volume required for the NEBT piers and pile caps.

3.5.5 Construction Duration

Based on additional studies conducted as part of the initial stage of Final Design, the overall
construction duration is expected to take a minimum of approximately six years to complete.
The overall project construction duration would be similar for both the steel box girder and
concrete box girder options. The NEBT option could potentially take a few more months to
construct than the box girder options as the NEBT option requires 35% more piers. The
additional duration would be required for excavation, pile placement, and the concrete forming
and pouring of these additional piers. If accelerated construction techniques were used,
particularly the use of precast piers for the box girder options, there may be an opportunity for
time savings.

3.6 Architectural Considerations

The Box Girder is a sleek, streamlined design with clean simple lines. Both the steel and
concrete box girders would be constant depth girders and would have similar span lengths. The
exterior fascia has a sloped surface and is devoid of stiffeners and bracing elements, allowing a
smooth appearance. The span lengths would be approximately equal in order to create the
most aesthetically pleasing structure. These span lengths will also result in greater open area
below the structure.

The columns would be chamfered to add visual interest. The chamfers would provide strong
shadows along the columns that would create a more slender, graceful appearance. The tops of
the piers would be enclosed with stainless steel netting to prevent pigeon infestation.
Alternatively the pier tops could be enclosed with a concrete parapet and a neoprene closure
stip. However, for the steel box option the floorbeams could serve as roosts for pigeons,
although this could be mitigate to some extent with pigeon control methods.

The NEBT option would have a more cluttered appearance than the box girder option. The
shorter span lengths would require additional piers from the box girder option and the piers are
offset. Large pier caps would also be required adding to the cluttered appearance. The
roadway curvature would result in varying overhangs and from below, the girders would be
spaced closely together. In addition, the bottom flange of the girders and piers could serve as
roosts for pigeons, although this too could be mitigate to some extent with pigeon control methods.

3.7 Work Zone Traffic Control

The existing Approach Spans carry three lanes of eastbound traffic and three lanes of westbound traffic. Independent of the structure type selected, six lanes of traffic will be maintained on the BQE throughout construction.

The existing Approach Spans will be replaced by constructing a new eastbound bridge that is parallel to and on the eastbound side of the existing bridge. The new eastbound Approach Spans will be wide enough to carry three 11'-0" lanes of traffic in both the eastbound and westbound directions while the existing bridge is demolished and the new westbound bridge is constructed within the footprint of the existing structure.

The demolition of the existing Approaches will occur in two separate stages. The six existing spans closest to the LIE Interchange will be demolished first and the four proposed Queens Approach spans will be erected within its footprint. During this stage a temporary bridge over Laurel Hill Boulevard will be utilized to carry local traffic to the existing mainline structure. The temporary bridge will connect the local ramp traffic to the existing mainline structure near 55th Avenue. Once complete these new Queens Approach spans will provide a transfer of local traffic to the new eastbound roadway. The new eastbound Approach spans will then carry both eastbound and westbound traffic while the remainder of the existing structure is demolished and the westbound Main Span, the Brooklyn Approach as well as the remaining Queens Approach spans are constructed.

This staging will require the construction of the Queens Approach spans in two separate stages and possibly by different contractors. In order to maximize the girder fabrication efficiency and therefore minimize cost, the girders could be procured during the first contract with the fabrication of the eastbound spans. The girders could then be stored on-site for use during the second contract. This would maximize the fabrication efficiency of all structure types being considered and especially for the concrete box girders that would require unique formwork. It would also be possible to require the eastbound contractor to leave any gantry for use by the second contractor. Although erection of these spans could likely be done with crane picks and the girders assembled on false work in lieu of a gantry, as the roadway profile is relatively low in this area. In the final configuration, the new Main Span and Approach structures will carry four 12'-0" lanes of westbound traffic and five 12'-0" lanes of eastbound traffic with standard shoulders.

The overall project construction staging plans are included in Appendix D.

3.8 Utilities

The existing structure carries electrical supply for the roadway lighting, a police emergency telephone system and an Intelligent Transportation System. All three of these utilities will be maintained on the bridge throughout construction. The new structure will carry these utilities as well as a new Fire Department standpipe.

Currently all roadway drainage is discharged on to splash blocks and then on to the streets below. The new structure will include a new closed drainage system. All of the Approach
drainage will be directed to Vortech Chambers prior to discharge into the creek. See the Draft Drainage Report for further information.

3.9 Asbestos

The following suspect asbestos containing materials are present in the bridge structure:

- Asbestos material beneath the railing base plates
- Asbestos material between the jersey barrier joints

See the Asbestos Assessment and Design Report for further information. The report provides the results from the field investigation including asbestos materials identified, location, type and quantity found. Appropriate handling and disposal procedures will be specified in the construction documents.

3.10 Contaminated/Hazardous Soils and Groundwater

Several environmental investigations completed for the project identified soil and groundwater across much of the project site with volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs), likely as a result of the historic industrial nature of the area. Construction of the Approach span foundations will require excavation and dewatering in areas of known contamination. The Meeker Avenue Chlorinated Solvent Plume is a source of contamination along the Brooklyn Approach and the former Phelps Dodge Refining Site is a source of contamination along the Queens Approach.

Meeker Avenue Chlorinated Solvent Plume

The New York State Department of Environmental Conservation (NYSDEC) has been investigating an underground chlorinated solvent contaminant plume in Brooklyn, which includes a portion of the Kosciuszko Bridge Project limits, primarily along Meeker Avenue and Cherry Street, between Vandervoort Avenue and Scott Avenue. Soil, groundwater, and soil vapor in this area have been found to contain the solvents trichloroethylene (TCE) and tetrachloroethylene (PCE) at elevated levels. TCE and PCE were commonly used in the dry cleaning industry and as commercial degreasers. Although NYSDEC had not yet formally identified the "Meeker Avenue Chlorinated Solvent Plume," sampling investigations conducted for the project’s EIS identified these compounds in site soils and groundwater, and their impacts to construction were evaluated in the Final EIS. Methane gas was also detected in soil vapor during investigations conducted for the Final EIS at some locations in Brooklyn at levels less than but approaching hazardous explosive levels.

Ground intrusive work during project construction in Brooklyn has the potential to encounter the Meeker Avenue Solvent Plume in soils, groundwater, and soil vapor. Of most importance will be the need to ensure that proper worker exposure monitoring, personnel protection equipment (PPE), and hazardous gas ventilation measures are in place for excavations in these areas. Also significant will be the need to handle, transport and dispose contaminated soil, and to collect and treat contaminated groundwater removed from excavations during construction dewatering.

The excavation work in the area of the Meeker Avenue solvent plume would be similar independent of which structure type is chosen for replacement of the Brooklyn Approach.
Former Phelps Dodge Refining Site

Two privately owned land parcels in Queens that could be affected by the construction of the Approach Span foundations are part of the former Phelps Dodge Refining site ("Laurel Hill Site"); which is a New York State Class 2 Inactive Hazardous Waste Site. United States Environmental Protection Agency (USEPA) has also identified the Phelps Dodge Corporation as a potentially responsible party to the listing of Newtown Creek on the Federal National Priorities List for contamination originating from the Phelps Dodge Site. The site has undergone extensive remediation under a New York State Department of Environmental Conservation (NYSDEC) Consent Order, with additional mandated remediation requirements yet to be completed. The portion of the former Phelps Dodge Refining site that lies within the Kosciuszko Bridge project limits abuts the eastbound side of the existing BQE from Newtown Creek northward to 55th Avenue.

Excavation on any of the parcels located within the former Phelps Dodge Site has potential to encounter contaminated soil and groundwater that would require special handling, disposal, and health and safety procedures.

The Box Girder options would have eight foundations located on the former Phelps Dodge Refining site while the NEBT option would have thirteen foundations on the site. The NEBT option would require approximately 30% more excavation of the potentially contaminated soil and groundwater on these parcels.
4.0 Connectors

Structure Summary – Brooklyn Connector

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</table>
Brooklyn Connector

The existing Brooklyn Connector (Spans 1 through 78) is a low level viaduct that extends from west of Morgan Avenue to east of Varick Avenue in Brooklyn. The viaduct was completed in 1939 as part of the replacement of the Penny Bridge. At that time the viaduct extended from east of Varick Avenue to Kingsland Avenue where it terminated at the local street system. In 1971 the viaduct was rebuilt as part of the construction of the Brooklyn Queens Expressway. The Brooklyn Ramp west of Morgan Avenue was removed and replaced with steel frame bents and reinforced concrete deck. This segment is now referred to as the Meeker Avenue Viaduct and is discussed in a separate Structure Justification Report (SJR). The remaining portion of the Brooklyn Ramp, now referred to as the Brooklyn Connector, was reconstructed in 1971 including the replacement of the bridge superstructure between Morgan Avenue and the Approach Spans, except for the two rigid frame bents at Morgan Avenue and Varick Avenue, which remain. The rigid frame bent at Vandervoort Avenue was replaced with a longer span consisting of precast adjacent box beams. For further information and a history of the existing Connector see Section 1.0 of this report.

The overall Brooklyn Connector is approximately 1,663 feet long. The existing structure is approximately 86 feet wide and carries three lanes of traffic in each direction. Shoulder and lane widths do not meet current standards. With the exception of the three local street crossings, the current structure consists of reinforced concrete deck slab that is monolithic with reinforced concrete cap beams and supported by individual reinforced concrete columns on spread footings. See Figure 4.1. The area below the structure is enclosed by reinforced concrete walls with brick veneer. The three local street crossings are located over Morgan Avenue, Vandervoort Avenue and Varick Avenue. The existing spans over Morgan Avenue and Varick Avenue are both the original 1939 concrete rigid frames. The existing span over Vandervoort Avenue consists of prestressed concrete box beams, which were part of the 1971 reconstruction.

Figure 4.1: Existing Cross Section at Brooklyn Connector
The proposed Brooklyn Connector will meet the existing Meeker Avenue Viaduct west of Morgan Avenue and then curve south until it meets the Brooklyn Approach east of Varick Avenue. The structure will serve as a transition from 4 to 3 lanes of westbound traffic and from 3 to 5 lanes of eastbound traffic. The structure width will vary from approximately 86 feet at the Meeker Avenue Viaduct to approximately 170 feet at the Brooklyn Approach as it will also serve as a transition from the full shoulder widths provided on the Brooklyn Approach to the non-standard shoulder widths of the existing structure.

The horizontal alignment is constrained by westbound Meeker Avenue to the north and eastbound Meeker Avenue to the south. The new structure will require the realignment of Cherry Street to the south. In order to avoid further property acquisitions, the eastbound Meeker Avenue alignment will remain and the new structure will cantilever over Meeker Avenue with a maximum cantilever length of approximately 18’-6”. A minimum vertical clearance of 14’-6” will be maintained over Meeker Avenue as well as the three local street crossings at Morgan Avenue, Varick Avenue and Vandervoort Avenue.

Since much of the new structure will be constructed within the footprint of the existing structure, construction will occur in multiple stages in order to maintain traffic. Also, a temporary bridge over eastbound Meeker Avenue between Kingsland Avenue and Vandervoort Avenue will be required.

Due to the required staged construction, the structure must be constructed in limited widths, and within relatively short spans. The following three structure types were considered candidates for replacement of the Brooklyn Connector:

- Retained Earth
- Expanded Polystyrene (EPS) Fill
- Steel Girder
- Precast Concrete Girder

In order to find the most suitable structure types, the Brooklyn Connector is evaluated in different segments as described below:

**Segment 1: Meeker Avenue Viaduct to Vandervoort Avenue (Spans 1 through 11)**

This segment begins west of Morgan Avenue and ends at Vandervoort Avenue (proposed Spans 1 through 11). The proposed segment is approximately 623 feet long, and varies in width from approximately 84 feet to 97 feet. The structure will carry three lanes of traffic in each direction.

The proposed structure will have an alignment that overlaps the existing alignment at the project limit and gradually curves to the south, cantilevering over the proposed realigned Meeker Avenue until the proposed eastbound alignment is shifted fully offline of the existing structure at Vandervoort Avenue. The maximum cantilever length over Meeker Avenue will be approximately 18’-6”. There will be a minimum vertical clearance of 14’-6” below the cantilevered structure over Meeker Avenue in the final condition. There will be a concrete median barrier separating the eastbound and westbound traffic, and concrete barriers on both fasciae.
During reconstruction of the Brooklyn Connector, a temporary bridge is required in order to provide enough capacity to maintain three lanes of eastbound BQE traffic during the staged construction. The temporary bridge will be constructed adjacent to the eastbound side of the BQE above eastbound Meeker Avenue, between Kingsland Avenue and Vandervoort Avenue, and will carry three 11'-0" lanes of eastbound BQE traffic. The temporary bridge will be integrated with the proposed structure and utilize floorbeams that will be cantilevered in the final condition. The Brooklyn Connector will then be reconstructed one half at a time, with traffic maintained on a combination of the temporary bridge and the Brooklyn Connector. A minimum vertical clearance of 14'-0" will be maintained below the structure over Meeker Avenue during construction.

Span 3 will span approximately 67'-0" over Morgan Avenue with skewed piers to accommodate the local street alignment. Minimum horizontal and vertical clearances will be maintained. Spans 1 and 2 and spans 4 through 11 will be enclosed by precast concrete closure walls on both the north and south sides of the roadway.

The proposed eastbound alignment from the project limit west of Morgan Avenue to the west side of Vandervoort Avenue will contain three 12'-0" wide travel lanes. The left shoulder will be 1'-0" wide and the right shoulder will vary in width from 2'-6" to 10'-0". The proposed westbound alignment will contain three 12'-0" wide travel lanes. The left shoulder will be 1'-0" wide and the right shoulder will be 2'-6" wide. The reduced shoulder widths match the existing shoulder widths and are required to make the transition to the existing structure beyond the project limit.

Expanded Polystyrene (EPS) fill with cast-in-place concrete cantilever brackets is the preferred structure type for this segment of the Brooklyn Connector. The span over Morgan Avenue will utilize prestressed concrete Northeast Extreme Tee (NEXT) Beams. See Section 4.1.1 for a discussion of the structural alternatives.

Segment 2: Vandervoort Avenue Crossing (Span 12)

Span 12 over Vandervoort Avenue will span approximately 129 feet on a curved alignment with skewed piers on either side. Minimum required vertical and horizontal clearances will be maintained.

The structure over Vandervoort Avenue will be constructed in two stages to maintain three lanes of traffic in each direction throughout construction. The eastbound roadway will be constructed to the south of the existing structure. The existing eastbound roadway will then be demolished and the new westbound roadway will be constructed within its footprint. Once all traffic is transferred to the new structure, the existing westbound structure will be demolished.

The structure over Vandervoort Avenue will be approximately 97 feet wide and contain three 12'-0" wide travel lanes in each direction. The left and right shoulders of the eastbound roadway will be 1'-0" and 10'-0" wide respectively. The left and right shoulders of the westbound roadway will be 1'-0" and 2'-6" wide respectively. There will be a concrete median barrier separating the eastbound and westbound traffic, and concrete barriers on both fasciae.

Precast Concrete I-Girders are the preferred structure type for this span due to their aesthetics and the low construction and maintenance costs. See Section 4.1.2 for a discussion of the structural alternatives.
Segment 3: Vandervoort Avenue to Varick Avenue

This segment extends from the east side of Vandervoort Avenue to the west side of Varick Avenue. This segment is approximately 745 feet long and varies in width from approximately 98 feet to 162 feet. The Brooklyn Connector in this area contains eastbound and westbound roadways, as well as a westbound exit ramp and a portion of the Vandervoort Avenue entrance ramp. The westbound exit ramp and the Vandervoort Avenue entrance ramp are discussed further in SJR – BIN 1-07569-A and SJR-BIN 1-07569B respectively.

The proposed eastbound alignment from Vandervoort Avenue to the west side of Varick Avenue will transition from three to four 12'-0" wide travel lanes. The two outside lanes will have a constant width of 12'-0". The interior lane will vary in width as the single lane transitions to two 12'-0" lanes divided by solid striping. As the four lanes approach Varick Avenue they will begin to diverge while the left and right shoulders are maintained at 1'-0" and 10'-0" wide respectively. The proposed westbound alignment will contain three 12'-0" wide travel lanes with a 1'-0" left shoulder and 2'-6" right shoulder. The westbound exit ramp will contain a single 12'-0" travel lane along with a 3'-6" left shoulder and a 6'-6" right shoulder.

The eastbound roadway and eastbound entrance ramp will be constructed first and to the south of the existing bridge. The existing eastbound roadway will then be demolished and the new westbound roadway constructed within its footprint. Once all traffic is transferred to the new structure, the existing westbound structure will be demolished.

An EPS filled structure is the preferred structure type for this segment of the Brooklyn Connector since there are no local street crossings or overhangs. See Section 4.1.3 for a discussion of the structural alternatives.

Segment 4: Varick Avenue Crossing (Span 14)

Span 14 over Varick Avenue will be approximately 67 feet long and constructed in three stages. Three lanes of traffic in each direction will be maintained throughout construction. Span 14 will also include a portion of the Vandervoort Avenue entrance ramp, which is further discussed in a separate SJR. The eastbound roadway and eastbound ramp will be constructed to the south of the existing structure. The existing eastbound roadway will then be demolished and the new westbound roadway will be constructed within its footprint. Once all traffic is transferred to the new structure, the existing westbound structure will be demolished. Once the existing westbound structure has been demolished, the proposed bikeway/walkway will be constructed.

The span over Varick Avenue will vary in width from approximately 162 to 165 feet. When completed, the eastbound roadway in this segment of the connector will contain four 12'-0" travel lanes that are separated by a varying width gore with two lanes on each side. There will be an 8'-0" left shoulder and a 10'-0" right shoulder.

The westbound roadway will contain four 12'-0" travel lanes, a 4'-0" left shoulder and 6'-6" right shoulder. There will be a gore of varying width separating the four travel lanes with one lane on the north side, and three lanes on the south. A 13'-1" wide bikeway/walkway is also included on the westbound side of the bridge.
The eastbound and westbound roadways will be separated by two concrete barriers. There will be concrete barriers located on the south fascia and between the westbound roadway and bikeway/walkway. There will be a concrete parapet on the north fascia.

Precast Concrete NEXT Beams are the preferred structure type for this span due to their aesthetics and the low construction and maintenance costs. See Section 4.1.4 for a discussion on the structural alternatives.

Segment 5: Varick Avenue to Brooklyn Approach

This segment is approximately 120 feet long and will be enclosed by walls on both the north and south side. (The use of wall enclosures in this area was dictated in the EIS.) The structure will be constructed in concurrence with span 14. The structure will vary in width from approximately 165 feet to 170 feet and contain the same roadway configuration as the Varick Avenue Span. This segment of the Brooklyn Connector also contains a portion of the Vandervoort Avenue entrance ramp, which is further discussed in a separate SJR.

EPS fill is the preferred structure type for this segment of the Brooklyn Connector. See Section 4.1.4 for a discussion on the structural alternatives.

Queens Connector

When completed in 1939, the Queens Connector was 730 feet long and it served as a transition from the Queens Approach to grade. The existing Queens Connector (Spans 102 and 103) was completed in 1971 and it replaced all of the original 1939 structure. The current Queens Connector is approximately 247'-0" long and is part of the interchange with the Long Island Expressway (LIE). For further information and a history of the Connector see Section 1.0 of this report.

The existing structure consists of reinforced concrete deck slab supported by steel girders. See Figure 4.2. The steel I-girders comprise two simple spans. The girders are splayed to accommodate the transition of the existing roadway alignment. The girders are supported by an abutment on the either end and a center pier on spread footings. Span 103 crosses above 54th Avenue where there is an existing minimum vertical clearance of approximately 14'-0". The existing structure carries four lanes of westbound traffic and transitions from three to four lanes of eastbound traffic.

The new Queens Connector will provide a transition from the Queens Approach to the LIE Interchange and will consist of two single span bridges over 54th Avenue that will each be approximately 100 feet in length. Minimum required vertical and horizontal clearances will be maintained.

One bridge will be for the eastbound roadway and one bridge will be for the westbound roadway. During construction the Queens Connector will provide essential crossovers between the structures in order to maintain traffic throughout the staged construction. The crossover will extend approximately 529 feet in length and extend through part of the Queens approach spans. The approximate 529 feet in length of the proposed crossover is defined by the required transition length for the westbound traffic during the staged construction.

The eastbound and westbound roadways will be supported on separate parallel structures to
facilitate the staged construction and future maintenance and inspection of the structure. The Connector spans of the eastbound and westbound structures will be separated by approximately 16 feet to allow sufficient clearance for underdeck inspection and maintenance using an Underdeck Inspection Vehicle.

![Diagram of the Queens Connector](image)

**Figure 4.2: Existing Cross Section at Queens Connector**

The new westbound structure will vary in width from approximately 94 feet to 115 feet and transition carry five 12'-0" lanes of traffic. The roadway will have standard shoulders and a new bikeway/walkway on the north side of the structure. The new eastbound roadway will vary in width from approximately 112 feet to 114 feet and carry six 12'-0" lanes of traffic. Four lanes will be dedicated to the eastbound BQE and two lanes on the south side of the roadway will be dedicated to the LIE exit ramp.

The new structure will replace the existing bridge by constructing the new eastbound Queens Connector on the south side of the existing structure. Once complete, the eastbound roadway will carry both eastbound and westbound mainline traffic while the existing Queens Connector is demolished and the new westbound structure is constructed in its footprint. During this stage of construction a temporary bridge will be utilized on the north side of the existing structure over Laurel Hill Blvd. to carry westbound ramp traffic from the LIE interchange to the existing Queens Approach west of 55th Avenue. Once the westbound Queens Connector is complete, it will serve as a transition roadway to support westbound traffic from the LIE ramps to the new eastbound structure and the temporary bridge can be removed. The eastbound roadway will carry both eastbound and westbound traffic while the existing Approaches and Main Span are demolished and the new westbound structures are constructed in their footprint.

Prestressed Concrete Northeast Bulb-Tee Girders are the preferred structure type for the Queens Connector. See Section 4.1.5 for a discussion on the structural alternatives.

### 4.1 Connector Considerations

In coordination with the NYSDOT, the bridge types described below were developed by a team of bridge engineers and bridge architects with the overall goal of providing an attractive,
economical structure that is an appropriate solution for each segment described above.

Brooklyn Connector

The horizontal and vertical alignments of the Brooklyn Connector, as well as the staged construction that is required to maintain traffic throughout construction, define the feasible structural alternatives. Minimum vertical clearances must be maintained over the at-grade streets that cross below the structure. The allowable superstructure depth required to maintain standard vertical clearances is also a controlling factor in possible structure alternatives and span lengths. The necessity of a temporary bridge to maintain all eastbound BQE travel lanes during the replacement of the existing structure in combination with the limited horizontal clearance between the existing structure and the buildings located along Meeker Avenue plays a major role in the development of feasible structure alternatives.

In order to find the most suitable structure types, the Brooklyn Connector is evaluated in different segments as described below:

4.1.1 Segment 1: Meeker Avenue Viaduct to Vandervoort Avenue

Alternative 1: Expanded Polystyrene (EPS) Fill

Alternative 1 consists of EPS fill with cast-in-place concrete piers and brackets supporting the cantilevered roadway along eastbound Meeker Avenue. See Figure 4.3. The span over Morgan Avenue would be accomplished with the use of Northeast Extreme Tee (NEXT) Beams made composite with a monolithic concrete deck. See Figure 4.4.

Figure 4.3: Proposed Cross Section – Meeker Avenue Viaduct to Vandervoort Avenue
Figure 4.4: Proposed Cross Section – Morgan Avenue Crossing

The EPS fill is a self standing alternative to M.S.E.S. walls or other retained earth alternatives. The EPS fill would be enclosed by solid concrete piers at the street crossings and western project limit, and by precast concrete wall panels along eastbound and westbound Meeker Avenue. The EPS fill consists of a composite pavement slab supported on a layer of earth fill, a reinforced concrete slab, and below the EPS. The earth fill would be a minimum of 4 feet thick to prevent differential icing in accordance with NYSDOT requirements and as recommended in NCHRP Web Document 65, Geofoam Applications in the Design and Construction of Highway Embankments. The EPS fill would consist of large blocks that would be glued together using an adhesive and that would be founded gravel leveling course. All surfaces of the EPS would be protected with a petroleum-compatible polymer geomembrane. The pavement slab would also serve to anchor the precast concrete side walls that would enclose the fill.

The use of EPS as the fill material would provide advantages over an earth fill alternative. Benefits of utilizing an EPS-embankment include: (1) significant reduction in truck traffic that would be required to place earth fill, (2) ease and speed of construction, (3) possible elimination of the need for preloading and surcharging (4) little to no lateral load on retaining structures, and (5) excellent durability.

When compared to a retained earth alternative, the use of EPS fill would minimize the number of truck loads to the highly congested area, one of the stated objectives of the EIS. Standard EPS blocks are 8' x 4' x 3' and are relatively massless. The EPS blocks can be brought to the site by tractor trailer (flatbed or closed box) and quickly offloaded and placed. It is estimated that approximately 80% fewer truck trips would be involved.

The soil conditions west of Vandervoort Avenue vary slightly from the rest of the project area. According to borings DM-B-1 and DM-B-1A of the preliminary geotechnical report, an underlying clay layer exists approximately twenty five feet below the ground line. Preliminary analysis is indicating that this clay layer has the potential to cause settlement of up to 3 inches to the existing adjacent bridge foundations during stage construction of a retained earth alternative. Additional borings and soil testing would be required to confirm these preliminary findings but because of its low unit weight, the use of EPS fill would mitigate this potential problem.
The EPS fill would also distribute little to no lateral load to the retaining structures. This would allow the end piers at the street crossings and western project limit to be designed primarily as solid concrete piers, and not abutments, thereby minimizing the numbers of piles required.

The cantilevered roadway over eastbound Meeker Avenue would be supported by a series of cast-in-place reinforced concrete columns and cantilever brackets. The cast-in-place concrete pier columns would each be supported on bored in mini-piles with the steel casing extending through the height of the column, thereby potentially minimizing the need for additional flexural reinforcement and eliminating the need for a separate foundation. Cast-in-place reinforced concrete cantilever brackets would extend from the columns to support the roadway slab. A cast-in-place reinforced concrete girder would span the columns and function as an edge beam along the inside face of the cantilevered roadway slab. Intermediate cast-in-place reinforced concrete rib brackets would extend from the edge beam to assist in supporting the roadway slab. The use of intermediate brackets would eliminate the need for a stringer system to support the deck. The edge beam would be subjected to torsional loads as well as vertical bending and shear forces. These loading conditions would be addressed in design and construction. The limited horizontal clearance along Meeker Avenue necessitates the utilization of the cantilevered structure, in combination with temporary girders and supports, to function as the temporary eastbound bridge until the proposed westbound structure is constructed and fully operational. This could be accomplished by the use of simple dap connections on the proposed concrete cantilever brackets to support the temporary floorbeams. Temporary support towers would be provided to support the brackets in the temporary condition.

There would be a total of twelve pier lines west of Vandervoort Avenue. Pier 0 would be a solid concrete pier that supports the edge beam in addition to the last span of the Meeker Avenue Viaduct, which is covered under SJR - BIN 1-06560-9. Piers 2 and 3 would also be solid concrete piers and would be skewed to accommodate the alignment of Morgan Avenue. Piers 2 and 3 would be located within the footprint of the existing rigid frame. The span lengths for spans 1 through 4 would be approximately 60'-6", 63'-0", 67'-0" (over Morgan Avenue), and 47'-0" along the EB1 TGL. The span lengths for Spans 5 through 10 would be approximately 61'-0" along the EB1 TGL with piers oriented radial to the eastbound fascia roadway curvature. Span 11 would be approximately 40'-0" long along the EB1 TGL and extend from the last radial pier column to the skewed pier on the west side of Vandervoort Avenue. Precast concrete wall panels would be located between the pier columns.

The use of a cast-in-place reinforced concrete system has advantages over other systems. The methods of construction are standard and lend themselves to numerous bidders. The utilization of the edge beam with intermediate rib brackets eliminates the need for a stringer system to support the deck. There is no post-tensioning required, thereby simplifying construction. In addition, the long term maintenance of the structure will be minimized by utilizing a concrete structure as no painting will be required and no bearings will need to be maintained.

The simple span over Morgan Avenue can be accomplished with the use of prestressed NEXT Beams, which resemble a double tee beam with wider stems to provide a deck form for a cast-in-place concrete deck, thereby saving substantial time during construction. The beams would be constructed utilizing concrete with a minimum strength of 10 ksi, in accordance with Section 9.6 of the NYSDOT BM. Beam spacing would vary to accommodate the construction staging and transition in width of the eastbound roadway. Standard top flange width can vary from 8 feet wide to 12 feet wide. Developments in pre-cast beam forming techniques make adjustment of the forms very easy, using magnetically attached side forms that can be adjusted to produce a
top flange of any varying width. The use of adjustable forms will be beneficial during stage construction sequences due to the relative ease with which the skew of the superstructure and transitioning deck areas that will be formed at staging limits will be accommodated. The stem geometry is fixed in a standard double tee form with 5 feet center-to-center spacing.

The cast-in-place deck slab will be 8 ½ inches thick with a monolithic wearing surface. Stainless steel reinforcement would be utilized in the deck slab. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The reduced deck thickness also leads to a more efficient girder design, as the dead load would be reduced. The concrete deck will be composite with the tee beam section. The top flange will act as a form for the cast-in-place concrete deck.

The NEXT beam configuration will provide for the same benefits as double tee beams, which are very stable and resistant to lateral buckling. The cast-in-place concrete deck will provide for the live load distribution among adjacent beam stems. No intermediate diaphragms will be required with the NEXT beam configuration. End diaphragms will be used to support the unstiffened slab edge for live loads. The end diaphragms can be cast-in-place with the deck slab in the field.

This alternative for the span over Morgan Avenue would provide a shallower structure depth than other alternatives such a Bulb-Tee or steel multi-girder span. This would provide an advantage for the cantilevered portion of the roadway over eastbound Meeker Avenue where available structure depth is limited, as more depth would be available for the beam ledge of the supporting cantilever bracket. Although additional depth would be available for the cantilever bracket beam ledge at Pier 2 that would support the NEXT Beams over Morgan Avenue, no bearing pedestals would be provided, as the available structure depth is too shallow for the additional 6 inch minimum pedestal, as required under Section 11.6.2.2 of the NYSDOT BM.

The design of the NEXT beam system offers typical design and fabrication details that will result in a high degree of efficiency. This option would require minimal or no temporary shoring, resulting in lower construction costs. This option creates a highly redundant system. If a section of the NEXT beam is damaged, its load path will be redistributed amongst the adjacent tee beams and will not result in structure failure.

Next Beams, similar to other prestressed concrete girders, are fabricated off site and delivered via truck to the bridge site. Erection can be accomplished with conventional equipment. Long term maintenance costs for concrete superstructures are typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of unpainted weathering steel. The NEXT Beam alternative would offer a competitive initial construction cost and a lower maintenance cost when compared with a steel alternative over Morgan Avenue.

For the reasons mentioned above, Alternative 1 is recommended as the preferred alternative.

Alternative 2: Retained Earth

Alternative 2 is identical to Alternative 1 except an earth fill, utilizing M.S.E.S. walls, would be provided instead of EPS fill. Although the initial construction cost of an M.S.E.S. wall alternative
is slightly lower than that of an EPS fill alternative, there are two primary disadvantages when compared to the EPS fill alternative.

The first disadvantage is the logistics of transporting the fill material to the site. The area west of Vandervoort Avenue is highly congested with limited available space. The use of EPS-blocks would minimize the number of trucks and the offloading time of each truck.

The second disadvantage for the area west of Vandervoort Avenue is the potential for settlement of the existing structure foundations. This potential problem would be mitigated with the use of the EPS fill, which is much lighter than earth fill. There may also be a problem in obtaining suitable fill for this option.

Alternative 3: Steel Multi Girder System

Alternative 3 consists of steel I-Girders made composite with a monolithic concrete deck slab, and supported on multiple column cast-in-place concrete piers. The eastbound and westbound roadways would be joined to form a combined structure in the final condition. This can be accomplished with the use of mechanical connectors for the deck reinforcement, providing diaphragms between the two superstructures, and the use of shear and moment splices for the steel floorbeams. The girders would use Grade 50 weathering steel (ASTM A 709 Gr 50W) that would be unpainted except at the fascia girders, if required, and at the roadway expansion joints.

The area under the spans would be enclosed on the north and south by precast concrete enclosure walls. The concrete pier foundations can be supported on spread footings or bored in mini-piles.

A multi-girder system is a redundant framing system. The floorbeams could be constructed to follow the roadway cross slope and the longitudinal girders would frame into the floorbeams with adequate top of steel elevation to provide uniform haunches over the girder. However, the skew would complicate the framing details. Small flange widths would allow for efficient slab design by minimizing haunches and slab thicknesses.

There would be a total of eleven spans. Spans 1 through 10 would be a ten span continuous steel multiple girder system. All steel girders would be made composite with the concrete deck. Pier 0 would be shared by the last span of the Meeker Avenue Viaduct, which is covered under a separate SJR. Piers 2 and 3 would be skewed to accommodate the alignment of Morgan Avenue and would be located in the footprint of the existing rigid frame. The span lengths for Spans 1 through 4 would be approximately 60'-6", 63'-0", 67'-0", and 47'-0" along the EB1 TGL. The span lengths for Spans 5 through 10 would be approximately 61'-0" in length along the EB1 TGL with piers oriented radial to the westbound fascia roadway curvature. Each span would consist of thirteen 40" deep rolled steel girders with varying spaces to accommodate the roadway curvature and staged construction. The roadway alignment cantilevers over Meeker Avenue with the maximum cantilever length of 18'-6" located at Pier 6. The cantilever with the minimum allowable structure depth to maintain a clearance of 14'-6" is located at Pier 2. The cantilever length at Pier 1 would be approximately 7'-6" long and the maximum allowable structure depth to accommodate a minimum vertical clearance of 14'-6" is approximately 4'-0".

Span 11 would be a simple span, steel multiple girder system on a skewed alignment. Span 11 would contain fourteen, chorded, 40" deep girders with varied spacing to accommodate the
construction staging. Span 11 would be approximately 40'-0” long along the EB1 TGL and extend from the last radial pier to the skewed pier on the west side of Vandervoort Avenue.

Due to the skew of Pier 11 at Vandervoort Avenue, the girders of Span 11 could not be made continuous with either the continuous arrangement flanking the west, or the single span over Vandervoort Avenue flanking the east. Continuity was investigated but the girders on the south side of the eastbound roadway would be in an uplift condition under live load.

Due to the large cantilevers over Meeker Avenue, and limited structure depth available to accommodate a vertical clearance of 14’-6”, steel framing would be an appropriate solution for this area of the connector. This alternative offers the most traditional construction type, utilizing temporary shoring for steel girder erection where necessary, and a cast in place concrete deck slab. The proposed span lengths would permit the use of rolled girder sections that would minimize fabrication time. The proposed span lengths, and use of bored-in mini-piles, would also allow for the majority of piers to be fully installed while the existing structure is still in place, thereby reducing the overall construction duration. The limited horizontal clearance along Meeker Avenue would necessitate the utilization of the cantilevered structure, in combination with temporary girders and supports, to function as the temporary eastbound bridge until the proposed westbound structure is constructed and fully operational. This would be accomplished by the use of temporary shear and moment splices connecting the proposed and temporary floorbeams.

Alternative 4: Concrete Girders.

The presence of large cantilevers combined with limited vertical clearance does not provide enough room for pier caps being located below the girders for the majority of the Brooklyn Connector in this segment, thus limiting the potential use of concrete girders. Staged construction would lead to girder field splices in both the temporary and final conditions. These splices would result in constructability concerns that are more efficiently addressed with the use of steel girders and floorbeams.

4.1.2 Segment 2: Vandervoort Avenue Crossing (Span 12)

Alternative 1: Precast Concrete Multi Girder System (Preferred Alternative)

Alternative 1 is a simple span, precast concrete, multi girder system on a skewed alignment. See Figure 4.5. It consists of twelve, chored, AASHTO Type V Girders spaced at approximately 8'-2” and 8'-3” on the westbound and eastbound roadways respectively, and made composite with a monolithic concrete deck. Stainless steel reinforcement would be utilized in the deck slab. The use of stainless steel reinforcement in the concrete deck allows for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The reduced deck thickness also leads to a more efficient girder design, as the dead load would be reduced. The 5’-3” deep girders would be constructed utilizing concrete with a minimum strength of 10 ksi, in accordance with Section 9.6 of the NYSDOT BM. The concrete girders would be supported on both ends by pile supported solid concrete piers. The maximum superstructure depth over Vandervoort Avenue that will accommodate a minimum vertical clearance of 14’-6” would be approximately 6’-6”.

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The use of concrete PCEF-63 Bulb-Tee girders was investigated but eliminated from consideration as five additional girders would be required. To maintain the vertical clearance over Vandervoort Avenue, a deeper and potentially more efficient Bulb-Tee could not be utilized.

The use of adjacent concrete box beams was also investigated but eliminated from consideration as the curved roadway alignment would not allow for the minimum recommended cantilever length of 4 inches while maintaining a maximum cantilever length of 6 inches. In addition, the vertical curvature and steep cross slope of 4.8% would lead to a thick and heavy deck.

Prestressed concrete girders are fabricated off site and delivered via truck to the bridge site. Erection can be accomplished with conventional equipment. Long term maintenance costs for concrete superstructures are typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of weathering steel. The favorable span to depth ratio allows for a low profile structure that could be the same depth as the steel alternative.

The concrete alternative would offer a lower initial construction cost and a lower maintenance cost when compared with a steel alternative. For those reasons, AASHTO Girders are considered the preferred alternative.

Alternative 2: Steel Multi Girder System

Alternative 2 would be a simple span, steel, multi girder system on a skewed alignment. It would consist of twelve, chorded, 5'-3" deep, steel plate girders spaced at approximately 8'-2" and 8'-3" apart under the eastbound and westbound roadway respectively. The girders would utilize weathering steel (ASTM A 709, Grade 50W), and would be unpainted except for the fascia girders, if required, and the ends of the girders at expansion joints. As with the precast concrete girder alternative, the deck would use stainless steel reinforcing.
Although there are advantages to using steel girders, as the girders would be lighter than comparable prestressed concrete girders, hence easier to ship and erect, and may have lower substructure costs due to their lighter weight, the steel alternative would have higher future maintenance costs than the concrete alternative. For those reasons, the steel alternative was eliminated from consideration.

4.1.3 Segment 3: Vandervoort Avenue to Varick Avenue.

Alternative 1: Expanded Polystyrene (EPS) Fill

Alternative 1 consists of the use of composite pavement slab supported on EPS. See Figure 4.6. The EPS fill is a self standing alternative to M.S.E. walls or other retained earth alternatives. The EPS would be enclosed by solid concrete piers at Vandervoort Avenue and Varick Avenue, and by precast concrete wall panels along the north and south. In addition, since this segment of the connector will be enclosed regardless of the alternative chosen, the EPS fill alternative would provide identical aesthetics to the structural alternatives. It would be sealed on top by a reinforced concrete load distribution slab that would also anchor and assist in laterally supporting the precast concrete wall panels. The EPS would be placed in blocks and be protected by a geomembrane that would prevent possible exposure to petroleum products. Each successive stage of construction could be constructed up to the face of the previous stage, or placed in a stair step arrangement that extended into the area of the adjacent stage, with shotcrete utilized to protect the exposed EPS-blocks. At least four feet of cover would be placed between the top of EPS blocks and top of roadway surface to prevent a differential icing condition. The benefits of EPS fill when compared to other retained earth alternatives have been described in Section 4.1.1. The advantage of minimizing truck traffic and the shorter construction duration when compared to a retained earth alternative outweigh the slightly higher initial construction cost.

Figure 4.6: Proposed Cross Section – Vandervoort Avenue to Varick Avenue

The EPS fill would also distribute little to no lateral load to the retaining structures. This would allow the end piers to be designed primarily as solid concrete piers, and not abutments, thereby minimizing the numbers of piles required.

For the above reasons, Alternative 1 is the Preferred Alternative.

Alternative 2: Retained Earth

Alternative 2 consists of the use of reinforced pavement slab supported on retained earth fill. The earth fill would be retained by Mechanically Stabilized Earth Walls (M.S.E. walls) and temporary Geotextile Reinforced Earth Structure (G.R.E.S.) walls that could be constructed in
stages as the existing bridge is demolished. Unlike structural alternatives 3 and 4 below, the final structure would be without any gaps or discontinuities in the cross section. Each successive stage of construction would be constructed right up to the face of the temporary G.R.E.S. wall located at the limit of the previous stage. There would be cast-in-place solid piers located on the east side of Vandervoort Avenue and the west side of Varick Avenue. The solid end piers would be supported on cast-in-place concrete piles.

A modular (T-Wall) system was also investigated but the necessity of installing the bikeway/walkway in a separate stage would prohibit the use of the system on the north side. The vertical height would require a larger stem length for the modular system than what could be installed within the limited horizontal width of the bikeway/walkway construction stage.

This alternative has the lowest initial construction cost and lowest maintenance costs. Also, since this segment of the connector would be enclosed regardless of the alternative chosen, the retained earth alternative would provide identical aesthetics to the structural alternatives. However, disadvantages to utilizing retained earth instead of EPS fill would be the likely longer construction time to place and compact the earth fill as well as the potential differential settlement of adjacent existing structure foundations during construction. When compared to the use of EPS fill another significant disadvantage would be the larger number of trucks required to transport the fill to this highly congested area. There is also a potential concern regarding the availability of suitable fill.

For these reasons, Alternative 2 is not the preferred alternative.

Alternative 3: Rolled Steel Girders

Alternative 3 consists of two distinct structures; the eastbound and westbound roadways. Both structures would consist of multi-span continuous steel girders that act compositely with the monolithic concrete deck for live load. The girders would be weathering steel (ASTM A 709 Gr. 50W) and would be unpainted except as required at the fascia girders and roadway expansion joints. The deck would be concrete reinforced with stainless steel reinforcing bars.

The mainline structures for the eastbound and westbound traffic would consist of 12 spans between the east side of Vandervoort Avenue and the west side of Varick Avenue. For the eastbound roadway near Vandervoort Avenue there would be a 2-span continuous section with skewed piers and girders lengths ranging from approximately 62'-0" to 67'-0" due to the horizontal curvature of the roadway. On the east end of the simple spans and extending to the west side of Varick Avenue there would be three multi-span continuous sections. From west to east, there would be two 3-span sections followed by a 4-span section, with each of the ten spans measuring approximately 62'-3". The eastbound and westbound structures would both be supported by a series of pile bents consisting of a continuous reinforced concrete piers supported on piles. The westbound roadway structure would include the main westbound alignment as well as the westbound exit ramp and the bikeway/walkway.

Similar to the eastbound structure, there would be a 2-span continuous section adjacent to Vandervoort Avenue with girder lengths ranging from approximately 59'-0" to 63'-0". On the east end of the simple spans and extending to the west side of Varick Avenue there would be three continuous sections similar to the eastbound structure, with each span measuring approximately 62'-3". The bikeway/walkway would mirror the westbound roadway with four continuous 62'-3" spans along the westbound roadway. The bikeway/walkway would be supported on pile bents.
that extend from the westbound roadway and would be supported on cast-in-place concrete piles.

The girders of the bikeway/walkway would be on a straight alignment. The girders on the eastbound and westbound roadway would be splayed to accommodate the widening of the roadway while maintaining a consistent deck overhang. The spacing of the girders would range from 6'-0" to 7'-4".

Similar to the existing bridge in this segment of the Brooklyn Connector, the structures would be enclosed by precast concrete enclosure walls.

The span lengths and girder spacing allows for the efficient use of rolled sections, which would provide for a decrease in material costs and fabrication time over welded steel plate girders. In addition, a multi-girder system would provide member redundancy.

Although the use of steel girders is feasible along this segment, the steel alternative would have a higher initial construction cost. In addition, the steel alternative has a higher maintenance cost than the EPS/retained earth alternatives.

Alternative 4: Concrete Girders

Alternative 4 consists of prestressed concrete Northeast Bulb-Tee girders made composite with a monolithic concrete deck. Span lengths would be identical to the steel girder option. However the girder spacing would be slightly greater as the capacity of the Bulb-Tee girders would be able to accommodate a greater tributary area. The concrete girders would be designed as simple spans for dead load and as continuous spans for live load.

The use of prestressed concrete girders has several advantages relative to the steel girder option including the lower long term maintenance cost of a concrete structure since repainting of the structure would not be necessary, although this would be mitigated by the use of unpainted weathering steel wherever possible. Both bridge structure types share the redundancy of a multi-girder system.

A disadvantage of the prestressed concrete girders would be their weight. Transportation and erection costs would be greater as more shipments would be required to deliver the girders and larger construction equipment would be required to erect the girders. Another consequence of the concrete girder weight is that the quantity or capacity of the piles would be greater than the steel option due to increased dead load.

Although the use of Bulb-Tee girders is feasible along this segment, this alternative would offer a higher initial construction cost and a higher maintenance cost than the EPS fill / retained earth alternatives.

Alternative 5: Adjacent Box Beams

Adjacent Box Beams were eliminated from consideration for the following reasons.

The common advantages of using adjacent box beams would be the elimination of deck formwork, a shallow superstructure, and the ability to use a thinner deck slab. In this case, due
to the variable roadway width and varying cross slope, the boxes would need to be splayed which would require additional deck formwork and prohibit the use of the thinner deck slab and negate the advantage of eliminating deck forming. Thus, they would be similar to the use of bulb tee girders. The advantage of a shallower superstructure would not provide any benefit in this location as there are no vertical clearance issues. In addition, there are long term maintenance concerns associated with the use of box beams based on past performance.

4.1.4 Segment 4: Varick Avenue Crossing

Alternative 1: NEXT Beams (Preferred Alternative)

The simple span over Varick Avenue can be accomplished with the use of prestressed NEXT Beams, which resemble a double tee beam with wider stems to provide a deck form for a cast-in-place concrete deck, thereby saving substantial time during construction. See Figure 4.7.

The deck slab would be 8 ½ inches thick with a monolithic wearing surface. Stainless steel reinforcement would be utilized in the deck slab. The use of stainless steel reinforcement in the concrete deck allows for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The reduced deck thickness also would lead to a more efficient girder design, as the dead load would be reduced. The concrete deck would be composite with the tee beam section. The top flange would act as a form for the cast-in-place concrete deck.

The 32 inch deep beams would be constructed utilizing concrete with a minimum strength of 10 ksi, in accordance with Section 9.6 of the NYSDOT BM. Beam spacing would vary to accommodate the construction staging and transition in width of the eastbound and westbound roadway. Standard flange width can vary from 8 feet wide to 12 feet wide. To accommodate the final stage of construction, the bikeway/walkway, the forms would have to be customized to produce a minimum flange width of 7’-4”. Developments in pre-cast beam forming techniques make adjustment of the forms very easy, using magnetically attached side forms that can be adjusted to produce a top flange of any varying width. The use of adjustable forms would be beneficial during stage construction sequences due to the relative ease with which the skew of the superstructure and transitioning deck areas that would be formed at staging limits will be accommodated. The stem geometry is fixed in a standard double tee form with 5 feet center-to-center spacing.

Figure 4.7: Proposed Cross Section – Varick Avenue Crossing
The structure would be constructed in stages, with the eastbound and westbound roadways forming a combined structure in the final condition. Cast in place solid concrete piers would be utilized on the east and west sides of Varick Avenue. The foundations would be supported on cast-in-place concrete piles due to their efficiency at carrying high loads (both axial and lateral loads) at this site.

The NEXT beam configuration would provide for the same benefits as double tee beams which would be more stable and resistant to lateral buckling than Bulb-Tee Girders. The cast-in-place concrete deck would provide for the live load distribution among adjacent beam stems. No intermediate diaphragms would be required with the NEXT beam configuration. End diaphragms would be used to support the un-stiffened slab edge for live loads. The end diaphragms could be cast-in-place with the deck in the field.

The design of the NEXT beam system offers typical design and fabrication details that would result in a high degree of efficiency. This option would require minimal or no forming, resulting in lower construction costs. This option would create a highly redundant system. If a section of the NEXT beam is damaged, its load path will be redistributed amongst the adjacent tee beams and will not result in structure failure.

Next Beams, similar to other prestressed concrete girders, are fabricated off site and delivered via truck to the bridge site. Erection could be accomplished with conventional equipment. Long term maintenance costs for concrete superstructures are typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of weathering steel. The NEXT Beam alternative would offer a competitive initial construction cost and a lower maintenance cost when compared with a steel alternative.

For the reasons mentioned above, Alternative 1, NEXT Beams, is recommended as the preferred alternative.

Alternative 2: Concrete Girders

Alternative 2 consists of a precast concrete multi girder system, utilizing Northeast Bulb-Tee girders made composite with the monolithic concrete deck. The girders would be approximately 48 inches deep. The deck would be reinforced with stainless steel reinforcing.

The girders of the eastbound and westbound bridges would be splayed with consistent spacing to match the transition of the roadway alignment and to maintain a consistent deck cantilever width. The maximum girder spacing for the eastbound and westbound roadways would be approximately 10'-0" and 9'-9" respectively.

As stated previously in this SJR, precast concrete girders have advantages over other superstructure types as prefabrication of the bridge can significantly reduce the construction duration. Erection could be accomplished with conventional equipment not requiring the use of field splices. Intermediate diaphragms could be cast in place or prefabricated offsite adding flexibility to the contractor’s means and methods.

Long term maintenance costs for concrete superstructures typically would be less than steel superstructures as steel components are more susceptible to weather induced corrosion.
requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of weathering steel. However, the added cost of deck formwork with the multi girder alternative makes Alternative 2 less desirable than Alternative 1.

Alternative 3: Steel Girders

Alternative 3 consists of a rolled steel multi-girder system. All steel girders would be made composite with the monolithic concrete deck and be approximately 40 inches deep. The girders would be weathering steel (ASTM A 709 Gr. 50W) and would be unpainted except as required at the fascia girders and roadway expansion joints. The deck would be concrete reinforced with stainless steel reinforcing bars.

Similar to Alternative 2, the girders of the eastbound and westbound bridges would be splayed with consistent spacing to match the transition of the roadway alignment and to maintain a consistent deck cantilever width. The maximum girder spacing for the eastbound and westbound roadways would be approximately 6'-6" and 6'-9" respectively.

A multi-girder system is a redundant framing system. The steel girders could easily be adjusted using variable pedestal heights as well as varying haunch depths to accommodate the roadway cross slopes and profile. Small flange widths would allow for efficient slab design by minimizing haunches and slab thicknesses. In addition, the span lengths and girder spacing would allow for the efficient use of rolled sections that provide for a decrease in material costs over built-up steel sections. However, future maintenance costs would be higher for the steel alternative than the concrete alternatives. Therefore, steel girders were eliminated from consideration.

4.1.5 Segment 5: Area between Varick Avenue and the Brooklyn Approach

Alternative 1: Expanded Polystyrene (EPS) Fill

For the segment between Varick Avenue and the Brooklyn Approach the preferred alternative would be to utilize a composite pavement slab supported on EPS fill. Similar to area between Vandervoort Avenue and Varick Avenue, the EPS is a self standing alternative to M.S.E.S. walls or other retained earth alternatives. The EPS would be enclosed by solid concrete piers at Varick Avenue and the Brooklyn Approach, and by precast concrete wall panels along the north and south. In addition, since this segment of the connector would be enclosed regardless of the alternative chosen, the EPS fill alternative would provide identical aesthetics to the structural alternatives. It would be sealed on top by a reinforced concrete load distribution slab that would also anchor and assist in laterally supporting the precast concrete wall panels. The EPS blocks would also be protected by a geomembrane that would prevent possible exposure to petroleum products. Each successive stage of construction could be constructed right up to the face of the previous stage, or placed in a stair step arrangement that extended into the area of the adjacent stage, with shotcrete utilized to protect the exposed EPS-blocks. At least four feet of cover would be placed between the top of EPS blocks and top of roadway surface to prevent a differential icing condition. This would be accomplished by utilizing a composite pavement with concrete foundation and sub base. The benefits of EPS fill when compared to other retained earth alternatives have been described in Section 4.1.1. One advantage in this area would be the limited accessibility to the westbound roadway during construction. The EPS blocks could be quickly offloaded and put in place without the need for secondary heavy equipment.
The EPS fill would also distribute little to no lateral load to the retaining structures. This would allow the end piers to be designed primarily as solid concrete piers, and not abutments, thereby minimizing the numbers of piles required.

For the above reasons, Alternative 1, EPS Fill, is the Preferred Alternative.

Alternative 2: Retained Earth

Alternative 2 is identical to Alternative 1 except an earth fill, utilizing M.S.E.S. walls, would be provided instead of EPS fill. Although the initial construction cost of an M.S.E.S. wall alternative is slightly lower than that of an EPS alternative, there are disadvantages when compared to the EPS fill.

The logistics of transporting the fill material to the site are a disadvantage when compared to the utilization of EPS-blocks. The area is highly congested with limited available space. The use of EPS-blocks would minimize the number of trucks and the offloading time of each truck. In addition it is anticipated that there will be a savings in time as the blocks can be placed more quickly and with smaller equipment than the earth fill, which will need to be placed in layers and compacted.

In addition, there is limited accessibility to the small westbound roadway during construction and a concern regarding the availability of suitable fill.

A modular (T-Wall) system was also investigated but the necessity of installing the bikeway/walkway in a separate stage would prohibit the use of the system on the north side. The vertical height would require a larger stem length for the modular system than what could be installed within the limited horizontal width of the bikeway/walkway construction stage.

For the above reasons, EPS fill was the preferred alternative to retained earth.

Alternative 3: NEXT Beams

Alternative 3 would utilize structure to span the distance between Varick Avenue and the Brooklyn Approach, forming a continuous arrangement with the span over Varick Avenue. Alternative 3 would be accomplished with the use of prestressed NEXT Beams in a three span, continuous arrangement.

The deck slab would be 8 ½ inches thick with a monolithic wearing surface. Stainless steel reinforcement would be utilized in the deck slab. The use of stainless steel reinforcement in the concrete deck would allow for a thinner slab when compared to an epoxy coated reinforced deck. This reduced deck thickness leads to a lighter superstructure and minimizes foundation size and pile quantity. The reduced deck thickness would also lead to a more efficient girder design, as the dead load would be reduced. The concrete deck would be composite with the tee beam section. The top flange would act as a form for the cast-in-place concrete deck.

The 32 inch deep beams would be constructed utilizing concrete with a minimum strength of 10 ksi, in accordance with Section 9.6 of the NYSDOT BM. Beam spacing would vary to accommodate the construction staging and transition in width of the eastbound and westbound roadway. Standard flange width can vary from 8 feet wide to 12 feet wide. To accommodate the
final stage of construction, the bikeway/walkway, the forms would have to be customized to produce a minimum flange width of 7'-4". Developments in pre-cast beam forming techniques make adjustment of the forms very easy, using magnetically attached side forms which could be adjusted to produce a top flange of any varying width. The use of adjustable forms would be beneficial during stage construction sequences due to the relative ease with which the skew of the superstructure and transitioning deck areas that would be formed at staging limits will be accommodated. The stem is fixed in a standard double tee form with 5 feet center-to-center spacing.

The structure would be constructed in stages, with the eastbound and westbound roadways forming a combined structure in the final condition. Cast in place solid concrete piers would be utilized on the east and west sides of Varick Avenue, as well as the eastern end of the connector. The east end pier would also be shared by the Brooklyn Approach. The intermediate pier would be a pile bent consisting of reinforced concrete and cast-in-place concrete piles. The foundations for all solid piers would be supported on cast-in-place concrete piles due to their efficiency at carrying high loads (both axial and lateral loads) at this site.

The spans on the east side of Varick Avenue leading to the Brooklyn Approach would be enclosed by precast concrete enclosure walls as the existing structure is currently enclosed in this location.

The NEXT beam configuration would provide for the same benefits as double tee beams that are very stable and resistant to lateral buckling. The cast-in-place concrete deck would provide for the live load distributed among adjacent beam stems. The use of intermediate diaphragms would not be required with the NEXT beam configuration. End diaphragms would be used to support the un-stiffened slab edge for live loads. The end diaphragms can be cast-in-place with the deck in the field.

The design of the NEXT beam system offers typical design and fabrication details which would result in a high degree of efficiency. This option would require minimal or no temporary shoring, resulting in lower construction costs. This option creates a highly redundant system. If a section of the NEXT beam is damaged, its load path would be redistributed amongst the adjacent tee beams and will not result in structure failure.

Next Beams, similar to other prestressed concrete girders, are fabricated off site and delivered via truck to the bridge site. Erection can be accomplished with conventional equipment. Long term maintenance costs for concrete superstructures are typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated using weathering steel. The NEXT Beam alternative would offer a competitive initial construction cost and a lower maintenance cost when compared with other structural alternatives. However, the multi span alternatives were eliminated from consideration as it was determined that utilizing retained earth or EPS fill for the segment between Varick Avenue and Brooklyn Approach would provide the lowest initial construction cost and long term maintenance costs.

**Alternative 4: Concrete Girders**

Alternative 4 would utilize structure to span the distance between Varick Avenue and the Brooklyn Approach, forming a continuous arrangement with the span over Varick Avenue.
Alternative 4 would consist of a three span, continuous, precast concrete multiple girder system, utilizing Northeast Bulb-Tee girders made composite with the monolithic concrete deck. The girders would be approximately 48 inches deep. The deck would be reinforced concrete reinforced with stainless steel reinforcing bars.

The structure would be constructed in stages, with the eastbound and westbound roadways forming a combined structure in the final condition. Cast in place solid concrete piers would be utilized on the east and west sides of Varick Avenue, as well as the eastern end of the connector. The east end pier would also be shared by the Brooklyn Approach. The intermediate pier would be a pile bent consisting of reinforced concrete and cast-in-place concrete piles. The foundations for all solid piers would be supported on cast-in-place concrete piles due to their efficiency at carrying high loads (both axial and lateral loads) at this site.

The girders of the eastbound and westbound bridges would be splayed with consistent spacing to match the transition of the roadway alignment and to maintain a consistent deck cantilever width. The maximum girder spacing for the eastbound and westbound roadways would be approximately 10'-0" and 9'-9" respectively.

The spans on the east side of Varick Avenue leading to the Brooklyn Approach would be enclosed by precast concrete enclosure walls as the existing structure is currently enclosed in this location.

As stated previously in this SJR, precast concrete girders have advantages over other superstructure types as prefabrication of the bridge can significantly reduce the construction duration. Erection could be accomplished with conventional equipment not requiring the use of field splices. Intermediate diaphragms could be cast in place or prefabricated offsite adding flexibility to the contractor’s means and methods.

Long term maintenance costs for concrete superstructures would be typically less than steel superstructures. However, the multi span alternatives were eliminated from consideration as it was determined that utilizing retained earth or EPS fill for the segment between Varick Avenue and Brooklyn Approach would provide the lowest initial construction cost and long term maintenance costs.

Alternative 5: Steel Girders

Alternative 5 consists of three span, continuous, rolled steel multi girder systems. All steel girders would be made composite with the monolithic concrete deck. Span lengths would match that of Alternative 4, as would the enclosure of the two spans east of Varick Avenue. The steel would be weathering steel (ASTM A 709 Gr. 50W) and would only be painted at the fascia girders as required and at the roadway deck expansion joints. The deck would utilize stainless steel reinforcing bars.

Similar to Alternative 4, the girders of the eastbound and westbound bridges would be splayed with consistent spacing to match the transition of the roadway alignment and to maintain a consistent deck cantilever width. The maximum girder spacing for the eastbound and westbound roadways would be approximately 6'-6" and 6'-9" respectively.

A multi-girder system is a redundant framing system. The steel girders could easily be adjusted using variable pedestal heights as well as varying haunch depths to accommodate the roadway
cross slopes and profile. Small flange widths would allow for efficient slab design by minimizing haunches and slab thicknesses. In addition, the span lengths and girder spacing would allow for the efficient use of rolled sections which provide for a decrease in material costs over built-up steel sections. However, the initial construction cost and future maintenance costs are higher than the EPS/retained earth alternatives therefore, steel girders were eliminated from consideration.

4.1.6 Queens Connector

The Queens Connector consists of two simple spans over 54th Avenue and 54th Road that are approximately 100 feet long, with one span dedicated to the eastbound roadway and one span dedicated to the westbound roadway. The eastbound Queens Connector would be constructed in the subsequent stage to the eastbound Queens Approach. The westbound Queens Connector will be constructed in a separate stage, and subsequent to the westbound Queens Approach, in order to provide a transition for westbound traffic and maintain traffic throughout construction.

The profile proposed in the EIS provided a minimum vertical clearance of 14'-6" over 54th Avenue with a maximum structure depth of less than 6 feet. However, during preliminary design, the mainline profile of the Queens Approach and Queens Connector was modified to provide a smoother transition of traffic during construction and to simplify the maintenance of traffic plan. These revisions also raised the profile over 54th Avenue allowing for a maximum structure depth of approximately 9'-0" while still maintaining a minimum vertical clearance over 54th Avenue. Despite the revision in profile, there is still insufficient available structure depth to utilize the approximately 10'-0" deep box girder cross section proposed for the Queens Approach spans over 54th Avenue. Since the available structure depth does not allow for a continuation of the Queens Approach box girder cross section to extend over 54th Avenue, there are two primary alternatives being considered for the Queens Connector; prestressed concrete Northeast Bulb-Tee Girders and steel I-Girders. Prestressed concrete NEXT Beams were also considered but NEXT Beam spans are limited to approximately 85 feet in length, rendering them inappropriate for the Queens Connector.

The Queens Connector was initially conceived as a multiple span arrangement but one advantage of the previously mentioned profile adjustment was that it allowed for an extension of the Approach Structure to the west side of 54th Avenue, thereby eliminating the need for multiple spans. There were three multi-span alternatives initially being considered but they have now been superseded. The two primary alternatives will be discussed first, followed by a discussion on the three superseded multiple span alternatives. The three superseded alternatives would provide structure depths of less than 6'-0" therefore exceeding the minimum vertical clearance over 54th Avenue.

Alternative 1: Precast Concrete Multi Girder System (Preferred Alternative)

Alternative 1 consists of simple span, precast concrete, and multi girder systems on skewed alignments. There will be one span for the eastbound roadway and one span for the westbound roadway. See Figure 4.8. These spans could be accomplished with the use of splayed Northeast Bulb-Tee girders constructed with a maximum spacing of approximately 8 feet. The girders would be made composite with a monolithic lightweight concrete deck. Stainless steel reinforcement would be utilized in the deck slab. The use of stainless steel reinforcement in the concrete deck would allow for a thinner slab when compared to an epoxy coated reinforced
deck. This reduced deck thickness would lead to a lighter superstructure and minimize foundation size and pile quantity. The reduced deck thickness would also lead to a more efficient girder design, as the dead load would be reduced.

The approximately 5'-11" deep girders would be constructed utilizing concrete with a minimum strength of 10 ksi, in accordance with Section 9.6 of the NYSDOT BM. The concrete girders will be supported on the west side of 54th Avenue by pile supported solid concrete piers and the east side of 54th Avenue by a pile supported concrete abutment.

Prestressed concrete girders would be fabricated off site and delivered via truck to the bridge site. Erection could be accomplished with conventional equipment. Long term maintenance costs for concrete superstructures would be typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life. The favorable span to depth ratio would allow for a low profile structure that could be the same depth as the steel alternative.

The concrete alternative would offer a lower initial construction cost and a lower maintenance cost when compared with a steel alternative.

For those reasons, Northeast Bulb-Tee Girders are the preferred alternative.

Figure 4.8 Proposed Cross Section – Queens Connector – 54th Avenue Crossing

Alternative 2: Steel Multi Girder System

Alternative 2 would have the same arrangement as Alternative 1 but utilize steel plate girders constructed with Grade 50 weathering steel (ASTM A709 Gr, 50). The steel would be unpainted except for the fascia girders and the girder ends at the roadway joints. The deck would utilize stainless steel reinforcing bars.

Although there are advantages to using steel girders, as the girders would be lighter than comparable prestressed concrete girders, hence easier to ship and erect, the steel alternative would have an increased project construction cost. In addition, the steel alternative would have higher future maintenance costs than the concrete alternative due to the need for repainting, although this could be mitigated by the use of unpainted weathering steel, except at the fascia and at the roadway deck joints where the steel would be painted. For those reasons, it was eliminated from consideration.
The following three alternatives discuss the superseded multiple span arrangement.

Alternative 3: Steel I-Girders with Integral Floorbeams

Alternative 3 consists of two adjacent four span structures that would be steel multiple girder systems made composite with the monolithic concrete deck. The steel girders would be weathering steel and the deck would utilize stainless steel reinforcing. The steel would be unpainted except at the fascia girders and at the roadway expansion joints.

In order to balance the span arrangement as much as possible while avoiding the skewed crossed features of 54th Avenue and 54th Road, the span lengths would be approximately 122'-0", 122'-0", 133'-0" and 122'-0". The girder depths would be approximately 5'-3". The first three spans of the eastbound and westbound bridges would consist of eleven and nine girders respectively on a splayed alignment to accommodate the transition in roadway width. The first three spans would run continuous and on a straight alignment. The fourth spans 54th Avenue and would be simply supported. For this location, the eastbound and westbound bridges would both consist of eleven splayed girders. The girders over 54th Avenue would be splayed to accommodate the transition in roadway width. Both bridges would share the same abutment on the east side of 54th Avenue. The girders would frame into 10'-0" deep steel floorbeams that would be supported on the same two column arrangement as the approach spans. The piers on the west end of the structures would be shared by the Queens Approach. The foundations for all piers and the abutment would be supported on cast-in-place concrete piles.

The floorbeams could be constructed to follow the roadway cross slope and the longitudinal girders would frame into the floorbeams with adequate top of steel elevation to provide uniform haunches over the girder. However, the skew would complicate the framing details. Small flange widths would allow for efficient slab design by minimizing haunches and slab thicknesses.

A steel I-girder structure would have the added benefit of being able to support the temporary structure required to allow for the traffic to cross from the eastbound to westbound structure for staging purposes. A steel floorbeam and girder system could be partially supported on the south side by the north fascia girder of the proposed eastbound roadway, and on the north side by the use of temporary towers. This configuration would eliminate the need for a fully independent structure and would minimize initial construction cost. In addition, steel girders can be fabricated with a varying flange sizes to better utilize additional strength requirements where necessary, thereby minimizing steel quantity and maintaining a higher vertical clearance over 54th Avenue.

Long term maintenance costs for concrete superstructures would be typically less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of weathering steel,. This is a distinct advantage over the use of steel girders for the Queens Connector.

Therefore this alternative was eliminated from consideration.
Alternative 4: Steel Tub Girders with Integral Floorbeams

Alternative 4 consists of two adjacent four span structures that would be steel multiple trapezoidal tub girder systems. All steel girders would be made composite with the monolithic concrete deck and would have inclined webs to maximize spacing of top flanges. The steel girders would be weathering steel and the deck would utilize stainless steel reinforcing. The steel would be unpainted except at the fascia girders and at the roadway expansion joints.

Span arrangements would match those of the steel I-girder alternative. Girder depth would be approximately 5'-3". The first three spans would run continuous and on a straight alignment. The westbound and eastbound bridges would both consist of five girders. The fourth span of each bridge would be simply supported and bridge 54th Avenue. The eastbound bridge over 54th Avenue would consist of five girders on a straight alignment with varying cantilever widths. The westbound bridge over 54th Avenue would consist of five splayed girders to accommodate the transition in roadway width, as the maximum allowable cantilever width of 6'-0" can not be accommodated with a straight alignment. Both bridges would share the same abutment on the east side of 54th Avenue. The girders would frame into 10'-0" deep steel floorbeams that would be supported on the same two column arrangement as the approach spans. The piers on the west end of the structures would be shared by the Queens Approach. The foundations for all piers and the abutment would be supported on cast-in-place concrete piles.

The transitioning roadway width and limited superstructure depth of 6'-3" available over 54th Avenue at the time of development of this alternative eliminated the possibility of extending the approach span 2 tub girder concept to the abutment located on east side of 54th Avenue.

A tub girder is effectively “closed” once the concrete deck has cured. However during erection and deck placement the tub girder is considered a “quasi-closed” section and is prone to warping stresses and torsional deformations. The use of internal cross frames and lateral bracing are essential components which are designed to maintain the tub girder’s shape during erection. Once the deck has cured the torsional stiffness of the tub girder would be superior to that of an I-girder. Since these are not curved bridges, torsional capacity would not be a controlling factor for design. The sectional properties of a box girder would larger than those of an I-girder therefore making box girders more suited for long span bridges where structure depth is not restricted by clearances which the structure is spanning. However the structure depth would also need to allow enough vertical clearance for 54th Avenue traffic and to provide sufficient access space for maintenance and inspection services inside the structure. This depth may then control the design and may lead to inefficient section properties and a non-economical box girder design over an I-girder system.

The assembling and welding of box girders requires more time and can lead to significantly higher fabrication costs than an I-girder system.

Similar or possibly superior to the appearance of an I-girder system, the box girders are aesthetically pleasing. However the aesthetic qualities of the box girder would not outweigh the technical and economic disadvantages it may have for this alignment. If the design span lengths were longer and/or torsional capacity was a governing factor of design, the strengths of the box girders would mitigate the above arguments.

Furthermore, to minimize the number of girders on the westbound bridge over 54th Avenue, the maximum spacing between adjacent box girder flanges would be 11'-4", which is higher than
the 11'-0" maximum recommended distance suggested in the NYSDOT Bridge Design Manual for monolithic decks. This may lead to additional reinforcement requirements in the bridge deck.

Therefore, the box girder system was eliminated from consideration.

Alternative 5: Concrete I-Girders with Integral Floorbeams

Alternative 5 consists of two adjacent four span bridges that would be precast concrete AASHTO Type V I-Beam systems made composite with the monolithic concrete deck. The deck would utilize stainless steel reinforcing.

Span arrangements and girder depth would match those of the steel I-girder alternative. Each span would be designed as simply supported for dead load. The first three spans would be designed as continuous systems for live load. The first three spans of the eastbound and westbound bridges would consist of eleven girders and nine girders, and be on straight alignments with varying cantilever widths. The fourth span of each bridge would span over 54th Avenue and consist of eleven splayed girders to accommodate the transition of the roadway alignment. Both bridges would share the same abutment on the east side of 54th Avenue. The girders of each bridge would be supported by framing into ten foot deep cast in place concrete floorbeams that would bear on twin concrete columns that are identical to those proposed for the approach spans. The west end piers would also be shared by the Queens Approach. The foundations for all piers and the abutment would be supported on cast-in-place concrete piles.

The use of precast concrete Bulb Tee girders was eliminated from consideration as the transitioning width of the roadway alignment does not allow for a continuous arrangement of girders while meeting the NYSDOT recommended minimum cantilever length of 2'-8" and maintaining a maximum cantilever length of 4'-0". The use of Bulb Tee girders would require an all simple span arrangement.

As stated previously in this SJR, precast concrete girders would have advantages over other superstructure types as these are prefabricated off site and delivered via truck to the bridge site. Erection time is typically reduced and can be accomplished with conventional equipment not requiring the use of field splices. Intermediate diaphragms could be cast in place or fabricated offsite adding flexibility to the contractor’s means and methods.

Long term maintenance costs for concrete superstructures would typically be less than steel superstructures as steel components are more susceptible to weather induced corrosion requiring steel repairs and repainting multiple times throughout the service life, although this can be mitigated through the use of weathering steel. This is a distinct advantage over the use of steel girders for the Queens Connector.

Unlike the steel girder option, the inside fascia girders of the concrete girder option would not be able to support a temporary crossover structure between the westbound and eastbound roadways that is required until the westbound approaches are completed and operational. The space between fascia girders would be more than double the maximum spacing recommended for prestressed girders of that particular span length. Therefore, the temporary crossover would have to be an independent structure complete with its own temporary piers and pile foundations. The additional independent structure required would offset any initial construction savings of the precast girder option.
For these reasons, Alternative 5 was eliminated from consideration.

4.2 Innovative/Unusual Structure

As per Section 20.2.2 of the NYSDOT Bridge Manual the Brooklyn and Queens Connectors are not considered unusual structures. However, the Kosciuszko Bridge Project as a whole is considered a complex project due to the geometric constraints of the replacement structure being located within the tight transportation corridor, the extensive construction coordination with utility relocations, storm water drainage reconstruction, local street realignment and the intricate construction staging and contract breakdown.

4.3 Geotechnical Considerations

A geotechnical subsurface investigation was performed between September and November 2009. The full results of this investigation can be found in the Preliminary Geotechnical Report included in Appendix B. The investigation included sixteen 4-inch diameter boreholes.

Based on the results of the subsurface investigation the soil/rock stratigraphy above bedrock at the project site can be generally described in the following 5 sections:

- Stratum 1: Fill;
- Stratum 2: Organic Deposits
- Stratum 3: Silty Sand
- Stratum 4: Silty Clay
- Stratum 5: Decomposed Rock.

Strata 1 and 2 are not considered as suitable foundation bearing strata. Strata 3, 4 and 5 are considered adequate foundation bearing strata.

In some areas along the Brooklyn Connector, Stratum 3 exists at a depth of approximately 10 to 15 feet from the ground surface. As a result, deep spread foundations are anticipated to achieve adequate soil bearing capacity.

The use of pile foundations can also be considered. Where limited vertical clearance exists during construction along a portion of the Brooklyn Connector, the foundations can be supported on bored in mini-piles. The use of mini-piles in this location would provide the advantage of allowing pile installation for the majority of the piers while the existing structure is still in place.

Results based on the preliminary bored-in (mini-pile) analysis (for vertical load only) using the obtained boring data are as follows:

- Allowable Pile Capacity:
  9 5/8" OD: 120 tons
- Pile Length Required:
Since the Fill and the Organic soils are present to a significant depth along the length of the Queens Connector, shallow footings are not considered a viable foundation option due to depth of excavation and the disposal of potentially contaminated soils. Therefore, cast-in-place concrete piles are recommended.

Results based on the preliminary pile analysis (for vertical load only) using the obtained boring data are as follows:

- **Allowable Pile Capacity:**
  - 16-in OD: 135 tons
  - 20-in OD: 200 tons
  - 24-in OD: 270 tons

- **Pile Length Required:**
  - 70 feet

Cast-in-place concrete piles with the same allowable pile capacity can also be used along portions of the Brooklyn Connector for which overhead clearance is not a concern.

### 4.4 Substructure Considerations

#### 4.4.1 Piles

Where limited vertical clearance exists during construction along a portion of the Brooklyn Connector, the foundations can be supported on mini-piles. The use of mini-piles in lieu of cast-in-place concrete piles in this location would provide the advantage of allowing pile installation for the majority of the piers while the existing structure is still in place.

For the cast in place solid wall piers that would be utilized at Vandervoort Avenue, Varick Avenue and the shared pier of the Brooklyn Approach, where vertical clearance is not an issue, cast-in-place concrete piles are the preferred option for foundation support, subject to NYSDOT GEB approval. The use of piles would minimize the potential for differential settlement of strip foundations that would be constructed in stages, as required under this project. The use of piles would also minimize excavation depth, thereby minimizing excavation support requirements and reducing the quantity of contaminated material that would require disposal. Installation of the cast-in-place concrete piles would not displace any soil or groundwater, minimizing impacts to contaminated materials.

Cast-in-place concrete piles are also recommended for the Queens Connector foundations.

#### 4.4.2 Spread Footings

In some areas along the Brooklyn Connector, a suitable bearing layer exists at a depth at approximately 10 to 15 feet from the ground surface.

Therefore, spread footings can be considered in these areas. However, the use of spread footings may require a deeper excavation than pile supported footings in order to reach the suitable bearing layer, and may require that all existing foundations in the vicinity of the
proposed foundations be removed prior to installation of the proposed structure. In addition, the concrete cantilevers along eastbound Meeker Avenue would require considerably large spread footings due to the large overturning forces. The preferred alternative requires no foundations as the piles would extend through the length of the columns.

As stated in Section 4.3, the use of spread footings to support the Queens Connector was eliminated due to the significant depth of suitable bearing material.

4.5 Construction Considerations

4.5.1 Construction Cost

For each of the bridge types, detailed cost evaluations were completed for significant bridge items including foundations, structural concrete, reinforcement, and structural steel. These detailed estimates were prepared by a professional estimator, who had been employed by contractors for many years, using the same methodologies as are employed in the construction industry in preparing competitive bids. As a result the estimates are based on a detailed breakdown of the costs of materials, fabrication, delivery of materials to the site, and the labor and equipment required to install the items, subcontractor mark-ups, insurance and office overhead. For other typical bridge items, such as concrete barriers and bearings, the unit prices were estimated by a professional estimator using best judgments based on previous experience.

These preliminary estimates are comparative estimates and do not represent full construction cost estimates as they do not include demolition, drainage, lighting, sign structures, etc.

The preliminary costs in 2010 dollars, including a contingency of 25%, are summarized below in Tables 4.5.1 and 4.5.2.
Table 4.5.1: Brooklyn Connector Estimated Construction Cost

<table>
<thead>
<tr>
<th>Segment</th>
<th>Structure Type</th>
<th>Estimated Cost (2010 Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeker Ave. Viaduct to Vandervoort Ave. (including Temporary Bridge)</td>
<td>EPS fill $41.9 M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Retained Earth</td>
<td>$36.7 M</td>
</tr>
<tr>
<td></td>
<td>Steel Girder</td>
<td>$47.5 M</td>
</tr>
<tr>
<td>Vandervoort Ave. to Varick Ave.</td>
<td>Northeast Bulb-Tee $47.6 M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel Girder</td>
<td>$50.6 M</td>
</tr>
<tr>
<td></td>
<td>Retained Earth</td>
<td>$28.4 M</td>
</tr>
<tr>
<td></td>
<td>EPS fill</td>
<td>$38.2 M</td>
</tr>
<tr>
<td>Vandervoort Ave. Span</td>
<td>AASHTO I-Beam $2.6 M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel Plate Girder</td>
<td>$4.8 M</td>
</tr>
<tr>
<td>Varick Ave. Span</td>
<td>NEXT Beam $2.2 M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel Girder</td>
<td>$4.6 M</td>
</tr>
<tr>
<td></td>
<td>Northeast Bulb-Tee</td>
<td>$2.8 M</td>
</tr>
<tr>
<td>Varick Avenue to Brooklyn Approach</td>
<td>Northeast Bulb-Tee $19.5 M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EPS fill</td>
<td>$15.9 M</td>
</tr>
<tr>
<td></td>
<td>NEXT Beam</td>
<td>$17.3 M</td>
</tr>
<tr>
<td></td>
<td>Steel Girder</td>
<td>$21.3 M</td>
</tr>
</tbody>
</table>

Table 4.5.2: Queens Connector Estimated Construction Cost

<table>
<thead>
<tr>
<th>Segment</th>
<th>Structure Type</th>
<th>Estimated Cost (2010 Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queens Connector</td>
<td>Northeast Bulb-Tee</td>
<td>$12.7 M</td>
</tr>
<tr>
<td></td>
<td>Steel Girder</td>
<td>$13.3 M</td>
</tr>
</tbody>
</table>

4.5.2 Life Cycle/Maintenance Requirements

The NYSDOT will continue to be responsible for the maintenance of the Kosciuszko Bridge. All bridge types will require periodic inspection and maintenance, including cleaning and washing, pavement re-striping, joint repair/replacement and wearing surface replacement. The use of stainless steel reinforcing in the deck of the girder options is anticipated to provide a 100 year service life.

The retained EPS/earth option will require minimal inspection and maintenance of the precast panel walls. All other bridge types will require bearing and joint replacement at 20 to 30 year intervals. The decks on the girder spans are anticipated to required replacement at 40 year intervals. It is expected that any painted steel elements will require painting every 12 to 15 years.

The non-standard shoulders along the Brooklyn Connector will require limited lane closures for inspection and maintenance. However, this cannot be avoided since the shoulder widths are limited due to Right-of-Way and alignment constraints.
4.5.3 Constructability

Brooklyn Connector

Concrete girders would be lifted into place from ground level using a single crane, or a crane at each end. This may result in temporary night closures of affected streets as girders are lifted into place. (The final determination regarding lane closures will be made by the New York City OCMC and will be determined at a later date.)

For the Brooklyn Connector segment west of Vandervoort Avenue, the construction of the temporary eastbound bridge as well as the proposed eastbound and westbound structures may result in temporary night closures of Meeker Avenue, Morgan Avenue and Vandervoort Avenue.

Eastbound Meeker Avenue will be closed to pedestrian access during the construction of the temporary eastbound bridge and proposed eastbound structure. Local businesses along eastbound Meeker Avenue will still be accessible via existing alternate entrances along the adjacent streets.

For the Brooklyn Connector segment located between Varick Avenue and the Brooklyn Approach, temporary night closures with local detours may be required for Varick Avenue traffic as girders are lifted into place.

For the EPS alternative it is important that the site is prepared properly before installation of the blocks. The soil should not be frozen and there should be no debris or large pieces of vegetation protruding through the subgrade. Ideally there will be no standing water present although experience has shown that some standing water can be accommodated.

It is imperative that the blocks not be exposed to petroleum products or damaged before, during or after installation. If the blocks are to be stockpiled until placement, a secure area should be designated for this purpose. Shotcrete is typically used to protect the blocks during construction staging.

In general, the paving system can be constructed in the normal manner with only a few cautions related to the presence of EPS blocks. Vehicles and construction equipment such as earthmoving equipment must not directly traffic on the EPS blocks even if the load distribution slab is present as it is still possible to overstress the underlying EPS. One construction procedure that can be used to minimize damage to the EPS blocks is to use relatively lightweight equipment to push approximately 12 inches minimum of soil or aggregate onto the EPS blocks before compacting the material. Typically, placement of the first lift of unbound material is accomplished by pushing the material ahead using a relatively small bulldozer or front-end loader. Placement of additional unbound and bound layers of the pavement system can then be placed in the normal manner although trafficking of the surface by trucks or heavy equipment of all types should be minimized or avoided altogether until the pavement is completed. If necessary, temporary mats could be provided to distribute vehicle loads.

Queens Connector

For the Queens Connector, the construction of the temporary bridge as well as the proposed eastbound and westbound structures may result in temporary night closures with local traffic detours for Laurel Hill Boulevard as well as 54th Avenue, 54th Road and 56th Road.
The concrete superstructure would be prestressed concrete girders. Concrete girders would be lifted into place from ground level using a single crane, or a crane at each end.

4.5.4 Construction Material Delivery

Brooklyn Connector:

The construction materials for the Brooklyn Connector may be delivered to the site utilizing Newtown Creek for waterway delivery, or the Interstate Highway system and primary arterials in the vicinity for delivery by truck. The size of each structure member will be considered during final design to ensure that deliverability issues will be mitigated. Field splices may be utilized to control delivery problems. There are numerous low clearance bridges in the area but a preliminary evaluation indicates that truck delivery is feasible to the Brooklyn Connector.

Queens Connector:

The construction materials for the Queens Connector may be delivered to the site utilizing Newtown Creek for waterway delivery, or the Interstate Highway system and primary arterials in the vicinity for delivery by truck. The size of each structure member will be considered during final design to ensure that deliverability issues will be mitigated. Field splices may be utilized to control delivery problems. There are low clearance bridges in the area but a preliminary evaluation indicates that truck delivery is feasible to the Queens Connector.

4.5.5 Construction Duration

Based on additional studies conducted as part of the initial stage of Final Design, the overall construction duration is expected to take approximately six (6) years to complete. The overall construction duration would be the same for any of the structure types considered for the Brooklyn and Queens Connectors.

4.6 Architectural Considerations

The Brooklyn and Queens Connectors, although not as bold as the signature main span and approaches, should still be noteworthy additions to the Kosciusko Bridge Project, as well as efficient and functional modes of connection to the bridge.

The Brooklyn Connector, with the exception of the three local street crossings, will be enclosed on both the north and south sides by precast concrete closure walls. The precast panels will have a vertical architectural pattern. Enclosing the structure will provide a simple façade and keep the area beneath the bridge free from debris.

The Queens Connector will be open below, as it spans 54th Avenue. Architectural features will be included in the design of the structure to address the aesthetic concerns of the community. The wingwalls of the Queens Connector abutment will have an architectural finish that matches or compliments the Queens Approach and Main Span substructure.

4.7 Work Zone Traffic Control

Six lanes of traffic, three eastbound and three westbound, will be maintained throughout
construction on a combination of the new and existing structure, and the temporary bridges in Brooklyn and Queens.

A three lane eastbound temporary bridge will be required to maintain traffic during construction of the Brooklyn Connector. The temporary bridge will extend from Kingsland Avenue to Vandervoort Avenue above Meeker Avenue and must be operational before the existing eastbound structure can be demolished. Three eastbound lanes of traffic will be maintained on the temporary bridge until the proposed westbound structure is completed and fully operational.

A three lane westbound temporary bridge will be required in Queens above Laurel Hill Boulevard and extend approximately 1430 feet from the LIE Interchange to the Queens Approach. The temporary bridge must be constructed and operational before the existing Queens Connector can be demolished.

A temporary structure will be required along the Queens Connector from 54th Road to 54th Avenue. The temporary bridge will be approximately 16 feet wide and be located between the structures of the eastbound and westbound Queens Connectors. The temporary structure will allow westbound traffic to transfer to the eastbound structure while the existing Approach and Main Span are demolished and the new westbound structure is constructed.

Intermittent single lane closures will be utilized occasionally during off-peak hours to switch traffic patterns between construction stages. All temporary lanes will be a minimum width of 11'-0".

4.8 Utilities

Brooklyn Connector

The Brooklyn Connector will impact utilities along several local streets including: eastbound and westbound Meeker Avenue, Morgan Avenue, Cherry Street, Vandervoort Avenue, Varick Avenue and Driggs Avenue. As the existing Cherry Street and eastbound Meeker Avenue will be realigned to accommodate the proposed bridge realignment, several impacts on the utilities embedded in these roadways will be mitigated by relocating the utilities to the new realigned streets.

Several large and potentially volatile utilities service the Buckeye Pipe Company facility along Varick Avenue in the form of gas mains and oil pipe networks. A number of large water mains are also present in this area. All work on the east and west side of Varick Avenue will be coordinated during the design phases to confirm that all utilities will be protected and monitored as necessary.

Another item which will impact the utilities will be the construction of enclosure walls. These walls will eliminate the typical open space below the approach roadways and will eliminate utility access under the viaducts after construction. Enclosure walls are anticipated to be constructed for the length of the Brooklyn Connector outside of the three roadway crossings. Wall designs will be studied to determine the necessary details and steps required to provide the most practical utility network through this phase of the contract.

As part of the project, two new parks will be constructed in the vicinity of Vandervoort Avenue and Porter Avenue. These parks, referred to as Brooklyn Passive Park and Sergeant Dougherty
Park, will require new utility services to accommodate user comforts and safety features. Once the park designs have been finalized, the design team will meet with NYC Parks and all affected utility agencies.

Several at-grade streets will be enriched through a streetscape reconstruction program as part of this project. This program will enhance the surrounding community and accent the once-industrial sector of Brooklyn, in addition to revitalizing the local streets through the construction of new curbs, intersections, park settings, and sidewalks. This proposed work will potentially affect several utilities including FDNY, NYCEP, and Con Edison, all of which will be contacted during the design process. The most affected will be the utility poles and fire hydrants along Meeker Avenue, Morgan Avenue, Driggs Avenue and Vandervoort Avenue.

Queens Connector

Laurel Hill Boulevard and 43rd Street carry most of the utility trunk lines, with branches or spurs running north to south along the roadways crossed by the connector. Utility plate and field research indicates that several utility companies provide services to the local industrial sectors, including NYPD and several large recycling centers, below the existing roadway. Based on work to date, the following agencies have utilities in the project area: New York City Environmental Protection (NYCEP) water and sewer, Consolidated Edison (Con Ed), NYCDOT Street Lighting, Time Warner Cable, RCN Cable, Verizon and National Grid. Several of the structure mounted or overhead utilities will present construction challenges during erection operations. The existing century-old subterranean utility trunks, like the NYCEP water mains, sewers, and the potentially volatile gas lines may possibly present significant construction issues. The resulting designs must follow stringent regulations during the design phase.

Laurel Hill Boulevard has Con Edison utility poles and NYCDOT street lights within the limits of the Queens Connector, along with several service connections spliced from the electrical feeds. The proposed connector span is an elevated structure traversing the existing local street network below. This type of overhead erection can be complicated by the existing overhead or suspended electrical, lighting and telephone utility lines. The existing overhead utilities may also pose an interference with the proposed WZTC scheme, which utilizes temporary bridges along that alignment. Close coordination will take place between Con Ed and NYC Street Lighting and other affected utilities.

Utility feeder lines are located within the bed of 43rd Street. These utilities will be impacted since several large tracts of property and existing structures will be demolished during this project. The utilities servicing these structures, as well as the utilities conflicting with the proposed footings, will be relocated during this project.

4.9 Asbestos

The inspection of the existing bridge structure identified several locations of suspect asbestos containing materials along the length of the Queens Connector, the Brooklyn Connector and in the materials found inside the structure’s storage areas. The suspect materials include bond breaker, ebony boards, arc shields, floor tiles, window caulk, debris, duct seal, waterproofing membrane, and pipe wrap and insulation on utilities to be relocated.

See the Bridge Asbestos Assessment and Design Report for further information. The report provides the results from the field investigation including asbestos materials identified, location,
type and quantity found. Appropriate handling and disposal procedures will be specified in the 
construction documents. 

In addition there are several buildings that will be partially or fully demolished as part of the 
project. See the Building Asbestos Assessment and Design Report for further information 
regarding the presence and location of asbestos materials.

4.10 Contaminated/Hazardous Waste

Several environmental investigations completed for the project identified soil and groundwater 
across much of the project site with volatile organic compounds (VOCs), semi-volatile organic 
compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs), likely as a result of the 
historic industrial nature of the area. Construction of the Brooklyn Connector foundations will 
require excavation and dewatering in areas of known contamination. The Meeker Avenue 
Chlorinated Solvent Plume and the Greenpoint Underground Oil Spill are sources of 
contamination along the Brooklyn Connector.

Meeker Avenue Chlorinated Solvent Plume

The New York State Department of Environmental Conservation (NYSDEC) has been 
investigating an underground chlorinated solvent contaminant plume in Brooklyn, which includes 
a portion of the Kosciuszko Bridge Project limits, primarily along Meeker Avenue and Cherry 
Street, between Vandervoort Avenue and Scott Avenue. Soil, groundwater, and soil vapor in 
this area have been found to contain the solvents trichloroethylene (TCE) and 
tetrachloroethylene (PCE) at elevated levels. TCE and PCE were commonly used in the dry 
cleaning industry and as commercial degreasers. Although NYSDEC had not yet formally 
identified the “Meeker Avenue Chlorinated Solvent Plume,” sampling investigations conducted 
for the project’s EIS identified these compounds in site soils and groundwater, and their impacts 
to construction were evaluated in the Final EIS. Methane gas was also detected in soil vapor 
during investigations conducted for the Final EIS at some locations in Brooklyn at levels less 
than but approaching hazardous explosive levels.

Ground intrusive work during project construction in Brooklyn has the potential to encounter the 
Meeker Avenue Solvent Plume in soils, groundwater, and soil vapor. Of most importance will 
be the need to ensure that proper worker exposure monitoring, personnel protection equipment 
(PPE), and hazardous gas ventilation measures are in place for excavations in these areas. 
Also significant will be the need to handle, transport and dispose of contaminated soil, and to 
collect and treat contaminated groundwater removed from excavations during construction 
dewatering.

Greenpoint Underground Oil Spill

A free-phase oil plume exists floating on the groundwater table within the project limits in 
Brooklyn from the release of an estimated 17 million gallons of petroleum from the Exxon/Mobil 
Greenpoint Terminal located approximately 0.5 miles northwest of the project site. The 
underground plume is believed to be the result of decades of spills and leaks from this facility 
dating to the late 1800’s, and was first reported when the US Coast Guard observed an oil 
sheen on Newtown Creek in the 1970s. Monitoring data from November 2009 provided by 
NYSDEC identifies the oil plume present beneath the project corridor along Cherry Street and 
Meeker Avenue, roughly between Vandervoort Avenue and Stewart Avenue; with oil layer 
thicknesses in this area ranging from a few inches to up to two feet. The depth from grade to
the oil layer in this area ranges from approximately 35 to 50 feet. The leading edge of the oil plume in November 2009 was shown to be located slightly further south than what was evaluated in the Final EIS; however, the impacts to construction are consistent with those evaluated in the Final EIS.

Based on projected product removal rates, NYSDEC estimates the leading southern edge of the oil plume, which is located within the project limits, will shrink northward of the BQE by the planned start of construction. Although ongoing product removal will likely decrease the extent of the oil plume within the project limits over the next several years, there is no guarantee that the removal effort will shrink the oil plume entirely northward beyond the project limits prior to construction. Periodic fluctuations in groundwater elevation have also contributed to the creation of a vertically contaminated “smear zone” above the oil layer where residual petroleum contamination will remain after product removal.

As evaluated in the Final EIS, deep operations over the oil plume, such as for placement of piles for the roadway structure, have potential to encounter the oil plume and smear zone. Preliminary conversations with the NYSDEC suggest that since there is no confining layer separating the water table aquifer from a deeper aquifer, that penetrating the oil layer with piles would not result in negative impacts to a deeper aquifer, and would also not be expected to interfere with the ongoing oil recovery efforts (further discussion with NYSDEC will be conducted pending advancement of design). However, special waste handling and disposal, and health and safety procedures will be required for work that encounters the oil layer or smear zone.

4.11 Slope Protection

Wingwalls and retaining walls will be required at the Queens Abutment and along the LIE Interchange. MSE walls will be considered due to the following advantages: simple and rapid construction, little space required in front of the structure for construction operations, opportunity for aesthetic enhancements, flexibility and tolerance to vertical and horizontal ground movements.
5.0 Conclusion and Recommendations

Each segment of the Kosciuszko Bridge is unique therefore each segment has been evaluated independently in order to select the most appropriate structure types for the site. As described below, each structure type has been selected based on its ability to meet the project objectives while minimizing environmental and community impacts. The overall project will provide an attractive and economical structure.

The recommended structure types are presented below for each section of the structure.

Main Span

The Cable-Stayed option is the recommended structure type for the new Main Span of the Kosciuszko Bridge.

The Cable-Stayed structure type best meets the project objectives while minimizing environmental impacts. While having a low potential to impact migratory and resident birds, the Cable-Stayed option would require less handling and disposal of contaminated materials and reduce the potential for NYSDOT exposure to future remediation requirements. Also, since the Cable-Stayed option would not impact the groundwater collection and treatment system on the former Phelps Dodge Refining site, there would not be a need to relocate the system or institute an alternative groundwater remediation method to satisfy NYSDEC. This reduced impact to the property would tend to reduce the cost difference between the Cable-Stayed option and the other three Main Span bridge type options.

In addition, the Cable-Stayed option provides the most dramatic visual experience for bridge users and for the local communities in both Brooklyn and Queens, providing an opportunity for the NYSDOT to provide a “signature” bridge that would act as a visual landmark for New York City. The bridge’s Main Span is aesthetically significant because of its high visibility. During the EIS phase, there was interest by the public for a “signature” Main Span. This preference was reinforced at the February 2010 Open Houses, where the Cable-Stayed option received the strongest support, including endorsement by the Brooklyn Chapter of the American Institute of Architects.

Approaches

The Concrete Segmental Box Girder is the recommended structure type for the new Brooklyn and Queens Approach Spans of the Kosciuszko Bridge.

The Concrete Box Girder structure type best meets the project objectives while minimizing environmental impacts. Construction Cost, Duration and Complexity as well as Life Cycle Costs are anticipated to be approximately the same for the two options. The required Work Zone Traffic Control plan in Queens will require some coordination between contracts for the Box Girder Option. However, the Box Girder option will require less handling and disposal of contaminated materials and will require fewer truck trips therefore reducing the impact on the surrounding community. Also, the Box Girder offers the most visually pleasing structure. The Box Girder is a streamlined design and the span lengths will provide more open space under the structure.
Connectors

Based on the parameters discussed relating to the technical criteria, construction methodology, initial construction costs, and future maintenance costs of each option, the preferred alternatives for each segment of the Connectors are apparent.

For the first segment of the Brooklyn Connector between the Meeker Avenue Viaduct and Vandervoort Avenue, the preferred EPS fill alternative with pile supported concrete cantilever brackets will provide significant constructability advantages and facilitate the staged construction while maintaining minimum vertical clearance over the local streets. Since most of this segment will be enclosed by precast concrete panel walls, aesthetics of the structure are not a concern.

The use of precast concrete NEXT Beams to span over Morgan Avenue will provide the appropriate aesthetic appearance, material durability, lowest initial cost, and the lowest long term maintenance cost.

For the Vandervoort Avenue crossing the precast concrete AASHTO Type V girder alternative provides the appropriate aesthetic appearance, material durability, lowest initial cost, and the lowest long term maintenance cost. Therefore, the precast concrete girder system is the preferred alternative.

For the segment between Vandervoort Avenue and Varick Avenue, and the segment between Varick Avenue and the Brooklyn Approach, the EPS fill alternative provides the identical aesthetic appearance of any structural alternative, and one of the lowest long term maintenance costs. The EPS will also require much fewer truck trips to the site than the retained earth option, resulting in far less impacts to the community and to traffic in the area. For these reasons, even though retained earth would provide a lower initial construction cost, the EPS system is the preferred alternative.

For the Varick Avenue crossing the precast concrete NEXT Beam alternative provides the appropriate aesthetic appearance, material durability, lowest initial cost, and the lowest long term maintenance cost described in this report. Because of these reasons the precast concrete girder system is the preferred alternative.

For the Queens Connector the Northeast Bulb-Tee girders provide the lowest initial construction cost and long term maintenance costs. For these reasons the Northeast Bulb-Tee system is the preferred alternative.

Signature/Title: __________________________________________
Date: __________________________________________