Project Report

November 18, 2019

City of Kingston
Third Crossing Bridge

Bridge Design and Construction Methodology Report

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1. Project Description

This Report describes the scope of the project. It first introduces refinements to the preferred design and constructability framework for the project since the Municipal Class EA.

1.1 Preferred Bridge and Approach Roadway Design

The following sections describe the preferred bridge and approach roadway design for the Kingston Third Crossing Bridge Project.

1.1.1 Design Codes

The bridge and approach roadways are designed in accordance with:

- The CHBDC CSA S6-14.
- MTO's Structural Manual 2016.
- The Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads, 2017.
- The Ontario Provincial Standards for Roads and Public Works.
- Technical documents issued by the U.S. Department of Federal Highway Administration (FHWA).

More specific design requirements and standards are as follows:

1. **Vertical Clearance:** The bridge clearance above the water is to be based on:

    a) The minimum 6.7 m Federally regulated vertical clearance requirement for the navigable channel [or elevation 82.4 m, based on WSEL 75.7 m (AHW)] for the entire 15 m navigation channel horizontal width based upon the high water datum used for the Highway 401 bridge north of the proposed bridge.

    b) The minimum 1 m vertical clearance above the normal water level outside the navigable channel, as per the CHBDC [or elevation 76.26 m, based on WSEL 75.26 m (AHW)].

    c) The minimum 3 m vertical clearance within the navigation channel and adjacent rowing lanes based on discussions with the Kingston

Rowing Club [or elevation 78.26 m, based on WSEL 75.26 m (AHW)].

2. **Traffic Data:** The Project corridor is designated as a future arterial road, as per the City's Official Plan; and a Highway Class Urban Arterial, based on the annual average daily traffic (AADT). The design speed is 70 km/hr, with a posted speed of 50 km/hr.
3. **Design Life:** In accordance with the ESR, the bridge is to be designed for a minimum 100-year design life, which exceeds the minimum 75-year design life requirement in the CHBDC.
4. **Loading:** The loading requirements for the bridge are to be as follows:
    a) **Dead Loads:** The dead load of the bridge is to include the weight of all components of the structure and appendages fixed to the structure. The material densities for common structural components are listed in Table 1.1, and the superimposed dead loads are listed in Table 1.2.

Table 1.1: Unit Weights of Structural Components

Material	Unit Weight
Reinforced Concrete	24 kilonewton / cubic metre (kN/m^3)
Structural Steel	77 kN/m^3
Prestressed Concrete	24.5 kN/m^3
Waterproofing and Asphalt	23.5 kN/m^3

Table 1.2: Superimposed Dead Loads

Material	Unit Weight
Traffic Barrier (Median)	6.6 kilonewton / metre (kN/m)
Traffic Barrier (Exterior)	10.1 kN/m
Pedestrian Railing	1.4 kN/m
Drainage	2.6 kN/m
Noise Barrier	1.4 kN/m

The dead loads of other materials and components not listed above will be based on more precise information from the material suppliers and material unit weights, as specified in the CHBDC.

b) **Live Loads: The bridge is to be designed for:**

i. the CL-625-ONT truck load, and the CL-625-ONT lane load;

ii. 2 or 3 design lanes (whichever produces the governing loads); and

iii. a pedestrian loading on the multi-use pathway of up to 4 kPa, and a gross maintenance vehicle loading of 80 kN.

c) **Seismic Loads:** The bridge is to be classified as an irregular 'Major-Route Bridge', and a Site Class 'D', from preliminary assessment of the properties at the Project corridor. Based on the fundamental period, the bridge is to be within Seismic Performance Category 2. As such, the seismic design is to be based on the Performance Based Design method for the following performance levels:

i. 475 years event (10% probability in 50 years): The service level is 'Immediate' and the damage level is 'Minimal', in that the bridge is to be fully serviceable for normal traffic, and the repair work is not to cause any service disruption;

ii. 975 years event (5% probability in 50 years): The service level is 'Limited' and the damage level is 'Repairable', in that the bridge:

a) is to be usable for emergency traffic and be repairable without requiring bridge closure (at least 50% of the lanes, but not less than 1 lane shall remain operational); and

b) if damaged, normal service is to be restored within 1 month, and based on CSA S6-14, the design for this performance level is optional, unless required by the Owner or Regulatory Authority; and

iii. 2475 years event (2% probability in 50 years): The service level is 'Service Disruption' and the damage level is 'Extensive', in that the bridge is to be usable for restricted emergency traffic after inspection, and is to be repairable, which might require bridge closure.

Based on this information from preliminary assessment and performance levels, the minimum seismic analysis requirements for the bridge would be Elastic Dynamic Analysis and Inelastic Static Push-Over Analysis.

A more detailed site-specific assessment of the ground will be conducted to determine the seismic requirements and loads for this site, in accordance with CHBDC 2014.

d) **Wind Loads:** Based on the CHBDC and the minimum 100-year design life requirement, the bridge design is to be based on the wind pressure associated with a return period of 100 years for which the hourly mean reference wind pressure, for a structure with a maximum span length less than 125 m, is 520 pascals (Pa) at the Project corridor.

e) **Ice Loads:** The dynamic ice force and the ice impact forces on the piers are to be based on the following estimates:

i. a 100-year ice thickness of 0.84 m;

ii. a crushing strength of 1100 kPa;

iii. an ice jam pressure of 5 kPa, as the clear opening between the piers is more than 30 m; and

iv. an ice accretion thickness of 31 mm, as per the CHBDC.

f) **Vessel Collisions:** The bridge is to be classified as a ‘Class 2 Bridge’, signifying that it has ‘regular importance’, and is to remain open to emergency and security vehicles after a vessel collision. The design vessel used for the calculation of the vehicle collision load is the Kawartha Voyageur, which as described earlier, is the largest vessel that regularly uses the Rideau Canal system.

The material properties and strengths used in the bridge design are shown in Table 1.3.

Table 1.3: Bridge Material Properties

Material	Location	Strength
Concrete	Deck (Cast in Place)	35 MPa
	Deck Forms (Stay in Place)	40 MPa
	Girders	65 MPa
	Piers/Abutments	35 MPa
	Caissons	35 MPa
Reinforcing	Carbon Steel Stainless Steel	fy = 400 MPa fy = 420 MPa
Structural Steel	Approach Spans and Navigation Channel Span	fy = 350 MPa (350 AT)
Prestressed Steel	Precast Elements for Superstructure	fpu = 1860 MPa

The bridge design is to have redundancy with multiple load paths available. If it is not capable of providing multiple load paths, then internal redundancies are to be detailed.

5. **Superimposed Deformations:** The bridge superstructure is to be classified as a ‘Type B: steel beams with concrete deck’ or ‘Type C: concrete systems with concrete deck’, depending on selection of the preferred superstructure alternative. Based on the maximum mean daily (30^{o}C) and minimum mean daily temperatures (-30^{o}C) for the City, a construction temperature of 15°C is to be incorporated into the design to balance the anticipated thermal movements of the structure.

6. **Barriers:** Based on the AADT, design speed, and geometry of the bridge, a TL-4 Performance Level traffic barrier is to be required for the north barrier and the intermediate barrier. The south barrier is to accommodate pedestrian and cyclist loading, as any maintenance vehicle potentially using the multi-use pathway will be travelling at slow speeds.

7. **Noise Walls:** All noise walls are to be designed in accordance with the CHBDC, and CAN/CSA-Z107.9, Standard for Certification of Noise Barriers.

8. **Scour:** The top of the riverbed may be subject to scour and as such, an analysis was performed as to whether scour protection is to be to be included at the foundations.

9. **Accessibility:** The City's Facility Accessibility Design Standards (FADS), which are currently under review by the City, apply mainly to the design of accessible exterior circulation routes such as sidewalks and pathways, and other associated elements. The City's FADS are summarized below, and, if required, will be incorporated:

    a) The City's existing minimum standard width of 1.5 m may be used.

    b) The running slope is not to be steeper than 1:25 (or 4%), unless accessible ramps are provided.

    c) Cane-detectable curbs at least 75 mm high are to be provided along the edges of planting beds and in areas where variations in grading are potentially hazardous.

    d) The cross slope is not to be steeper than 1:50 (or 2%).

    e) Exterior lighting is to be in compliance with Illuminating Engineering Society of North America (IESNA) Standards, except in outdoor park settings where routes are not normally illuminated, additional illumination is not required.

    f) Level rest areas are to be spaced no more than 30 m apart.

    g) Gratings and grills are to be located to one side.

Each of the components noted above include more specific standards including, but not limited to, the use of colour contrasting, directional signage, plantings, bench seating and street furniture design. It is recommended that the FADS continue to be reviewed and incorporated into the Project, as required.

1.1.2 Bridge Alignment and Profile

As shown on Drawing 1.1.2.1, the preferred horizontal alignment of the bridge is modified from the ESR to include two 2200 m radii horizontal curves. The curves result in a more efficient superstructure, and also simplifies construction as the bridge deck is constant along its entire length.

The vertical profile of the ESR bridge profile, shown in Drawing 1.1.2.2, was modified to a 0.67% grade to the abutments in the preferred bridge profile, as shown on Drawing 1.1.2.3. Drawing 1.1.2.2 shows a v-pier design, which was subsequently refined during the validation phase to the modified conventional pier design shown in Drawing 1.1.2.3, as the preferred pier design. For more details on the preferred pier design, see Section 1.1.7.

As highlighted in Table 1.1, design review considerations for the preferred vertical profile focused on ensuring that vertical curve length, deck drainage, vertical clearance and sight lines would comply with bridge design codes and requirements, satisfy Parks Canada design guidelines, and optimize capital costs by reducing material costs and construction effort. Based on the preferred profile option:

a) Refine the high point of the bridge from the east side of the arch in the ESR design to approximately the center of the navigation channel span, which facilitates the design and construction of the navigation channel span; allows for repeatability in the haunched girder arch pier design as the grade on both sides of the high point is the same; allows stormwater to drain from the center of the arch to stormwater management facilities on-land; and further highlights the haunched girder arch as the focal point of the bridge.

b) Lower the high point of the bridge, from elevation 92.5 m in the ESR design to elevation 87.34 m (or 5.16 m lower than the ESR design),

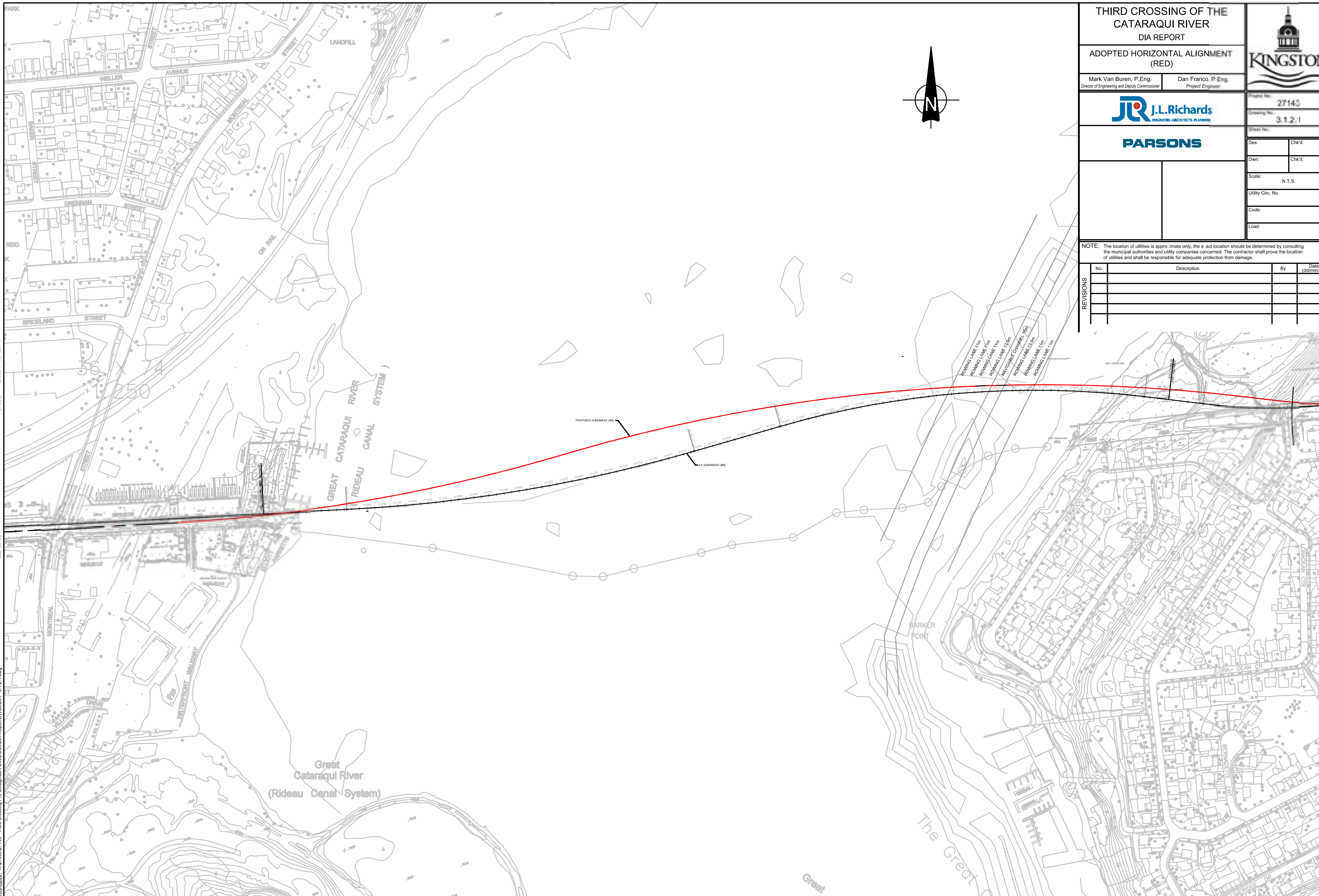
c) while still accommodating existing topographic conditions on both shorelines, and exceeding both Federal and CHBDC vertical clearance requirements. Furthermore, and relative to the higher vertical profile of the ESR design, there is also the added effect of the lower profile on visual impacts.

d) Provide unencumbered through-navigation for the navigable channel and adjacent rowing lanes, in accordance with vertical and horizontal clearance requirements.

e) Have generally similar residual impacts on construction as well as future operation and maintenance requirements.

Compared to the vertical profile in the ESR, the preferred vertical profile decreases the height of the piers and abutments resulting in material cost efficiencies and also simplifies construction.

In specific regards to the on-shore multi-use pathway, the ESR design included a multi-use pathway to pass under the bridge in front of both the east and west abutments. For the preferred bridge design, to accommodate the preferred vertical profile, bridge span arrangement and abutment locations, the multi-use pathway has been re-configured at both east and west ends.



THIRD CROSSING OF THE CATARAQUI RIVER

DIA REPORT

ADOPTED HORIZONTAL ALIGNMENT (RED)

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS-ARCHITECTS-PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	3.1.2.1
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is appro imate only, the e act location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

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Last Saved: December 6, 2017 4:53:44 PM

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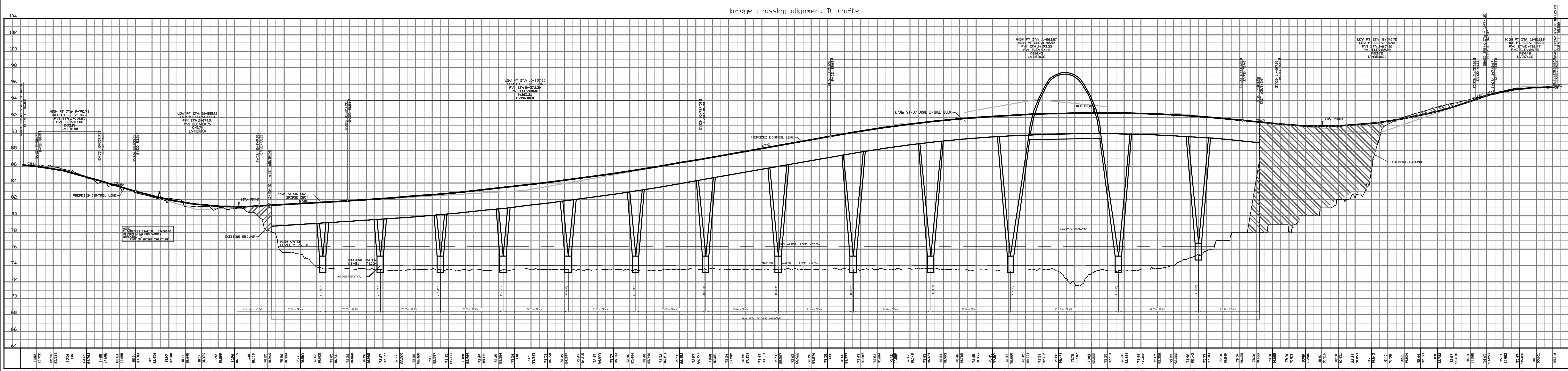

B: PROFILE AND PIER LOCATIONS (LOOKING NORTH)

PROJECT:
CATARAQUI RIVER THIRD CROSSING
EA - STAGE 2
ENVIRONMENTAL STUDY REPORT

DRAWING:
ARCH WITH V-PIERS CONCEPT
PLAN VIEW

J.L.Richards
ENGINEERS·ARCHITECTS·PLANNERS

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DESIGN:
DRAWN:
CHECKED:
PLOTTED: 26-Jan-12

DRAWING NO.:
PS-4

JLR NO:
23446-02

File Location: C:\Documents and Settings\djudson\Desktop\23443-02 - Third Crossing ESR\Figures\Figure PS-4 Arch with V-Piers Concept.dwg

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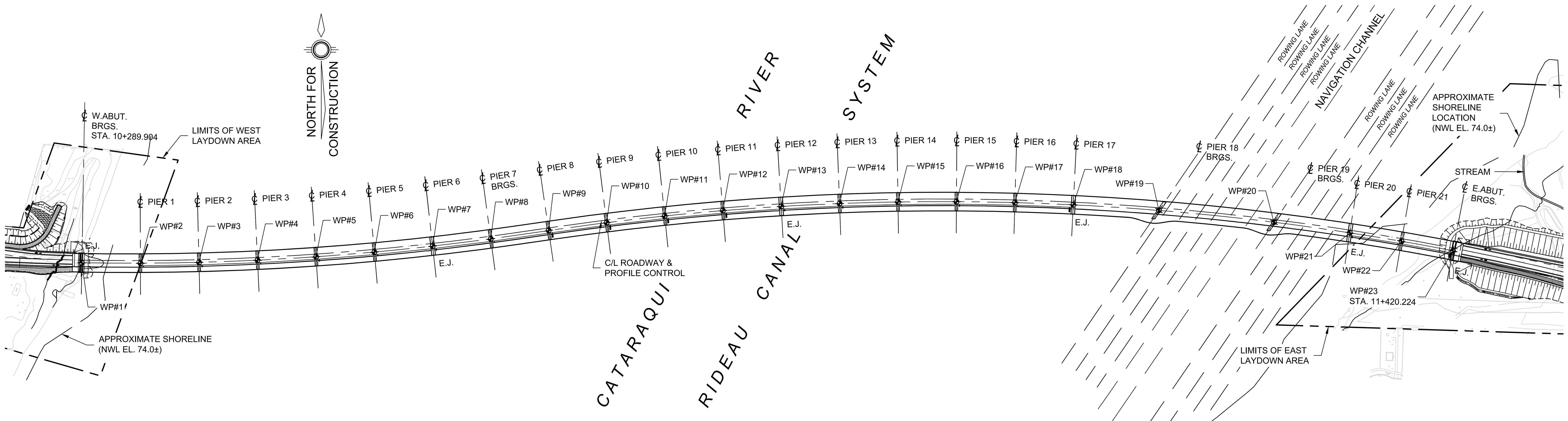

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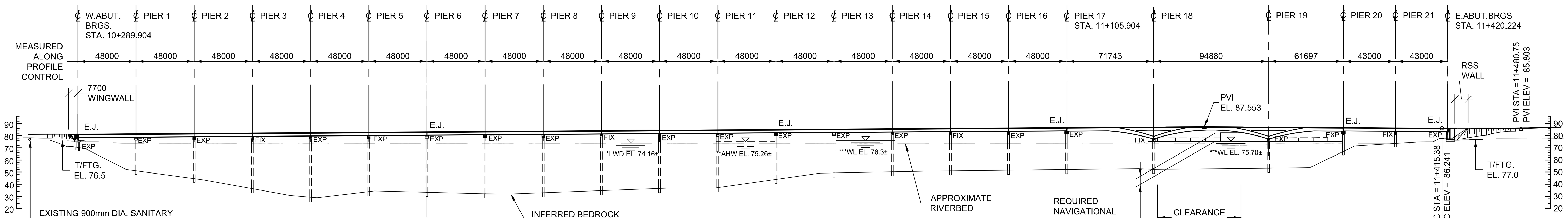

ELEVATION

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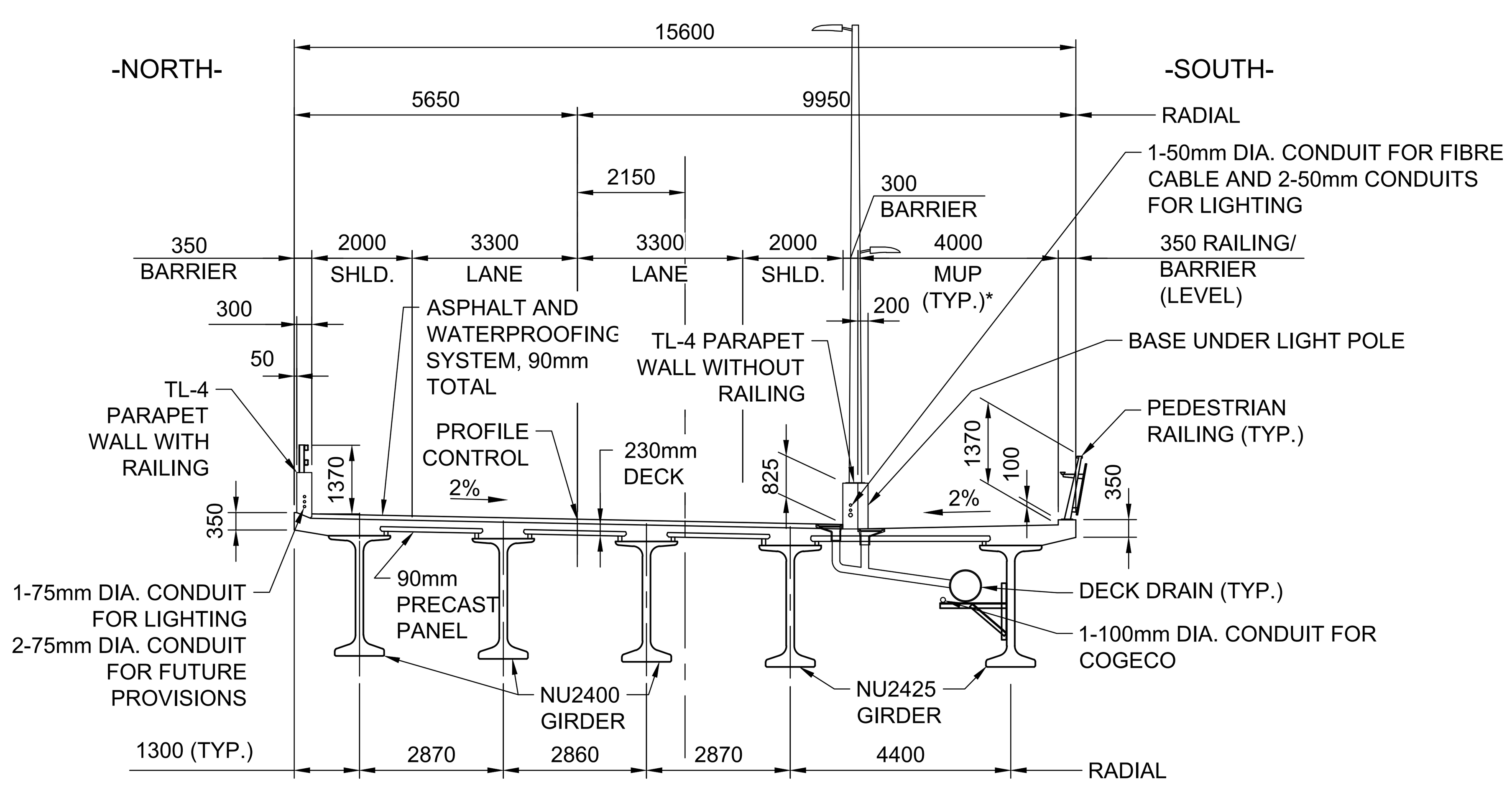
** AVERAGE HIGH WATER	EL. 75.26	MINISTRY OF NATURAL RESOURCES (LAKE ONTARIO)
*** NAVIGATION CHANNEL HIGH WATER LEVEL	EL. 75.70	PARKS CANADA
**** REGULATORY WATER LEVEL	EL. 76.30	CATARAQUI REGION CONSERVATION AUTHORITY "REGULATORY LIMIT WITHIN THE STUDY AREA"



NU GIRDERS

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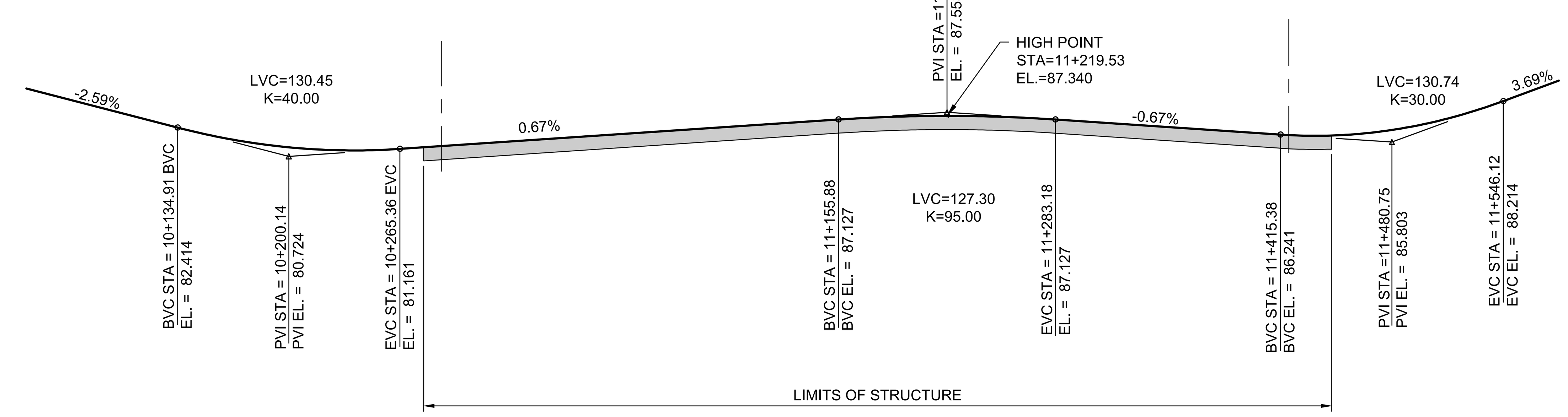

CROWN PROFILE CONTROL (ROADWAY)

N.T.S.

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INTEGRATED PROJECT DELIVERY TEAM:

HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: MA	KINGSTON THIRD CROSSING	DRAWING NO. 1.1.2.3
DRAWN: YZ	DIA REPORT	SHEET NO.
CHECKED: MA	PREFERED PROFILE	REVISION
	DATE: 11-18-19	SCALE: N.T.S.

Table 1.4: Comparison of Vertical Profile Options

Criteria	Sub-Criteria	Profile from ESR	Preferred Profile (0.67% Grade to Abutments)
Span Arrangement		• Less spans and piers	• More spans and piers
High Point		• ~92.52 m at east side of arch	• ~87.34 m at approximately the navigation channel span
Federal Navigation Clearance	6.7 m above WSEL 75.7 m AHW (min.) for the entire 15 m navigation channel horizontal width based on high water datum used for the Hwy 401 bridge north of the proposed bridge	• ~14 m	• ~6.8 m
CHBDC Clearance (Outside Navigable Channel)	1 m above AHW (min.)	• > 1 m	• > 1 m
Structural Steel for Navigation Channel Span	Max Span Length	• ~131 m (initial); ~150 m (proposed)	• ~95 m
Piers	Max Height (to LWD)	• ~15.5 m	• ~9.5 m
Main Span		• ~85 m clear span of the arch above	• ~70 m clearance envelope for the haunched girder arch below
Construction	No. of Crane Mobilizations	• Similar in both cases	• Similar in both cases
	Duration	• Longer construction duration in and around the navigation channel due to the size and complexity of the Arch and V-piers.	• Reduced construction overall and around the navigation channel.
Aesthetics		• Taller piers (higher profile than preferred design) • Openness still provided under the structure	• Shorter piers (lower profile than ESR design) • Openness still provided under the structure
Operation and Future Maintenance		• Less but more complex bearings to maintain • Larger jacks needed to replace bearings • Less piers than preferred design • Taller piers to maintain	• More but simpler bearings to maintain • Smaller jacks needed to replace bearings • More piers than ESR design • Shorter piers to maintain
In-Water Footprint		• Larger due to extent of V-Piers	• Smaller due to simplification of Pier Design even with additional piers

1.1.3 Bridge Deck

1.1.3.1 Deck Cross-Section

As shown on Drawing 1.1.3.1, the preferred bridge deck cross-section is modified from the ESR, in that it is reduced from 22.9 m to 15.6 m. It comprises the following main features:

1. A 2-lane vehicular roadway (1 lane for eastbound travel and 1 lane for westbound travel) as per the 2015 KTMP. The 3.3 m wide vehicular lane width complies with TAC's Geometric Design Guide for Canadian Roads (2017).
2. Two 2 m wide shoulders adjacent to the vehicular lanes, as per MTO design standards. The shoulders provide for temporary snow storage, drainage, cyclist travel (should cyclists choose to use them), and passing, should there be a vehicle break-down or maintenance vehicle stopped on the bridge.
3. A multi-use pathway with a width varying from 4 m (on the approach spans) to 7 m at the south pedestrian overlooks (either side of the navigation channel span) as shown in Figure 1-1 and Figure 1-2 on the south side of the bridge for active transportation. Figure 1-1 and Figure 1-2 show conceptually the view from the multi-use pathway at various locations.
4. A 0.35 m wide barrier along the north side of the bridge, and a 0.35 m wide railing along the south side of the bridge.
5. A 0.3 m wide center barrier separating the multi-use pathway and shoulder.

More specific bridge deck components are as follows:

1. The bridge deck cross-section is uniform throughout, except at the navigation channel span where the multi-use pathway curves outward at both piers to provide twin pedestrian overlooks, with a varying width of up to 7 m over a distance of 40 m at each pier. This is shown on Drawing 1.1.3.1.
2. Light standards are integrated into the center barrier. Where provided, the multi-use pathway is narrower than 4 m. But it is still wider than the City's 3 m wide multi-use pathway design standard.

Figure 1-1: Multi-Use Pathway West of Navigation Channel Span (Looking East)

3. As shown on Figure 1-1, along the pedestrian overlook at the navigation channel span, benches will be planned to define and separate the multi-use pathway and look-out area.

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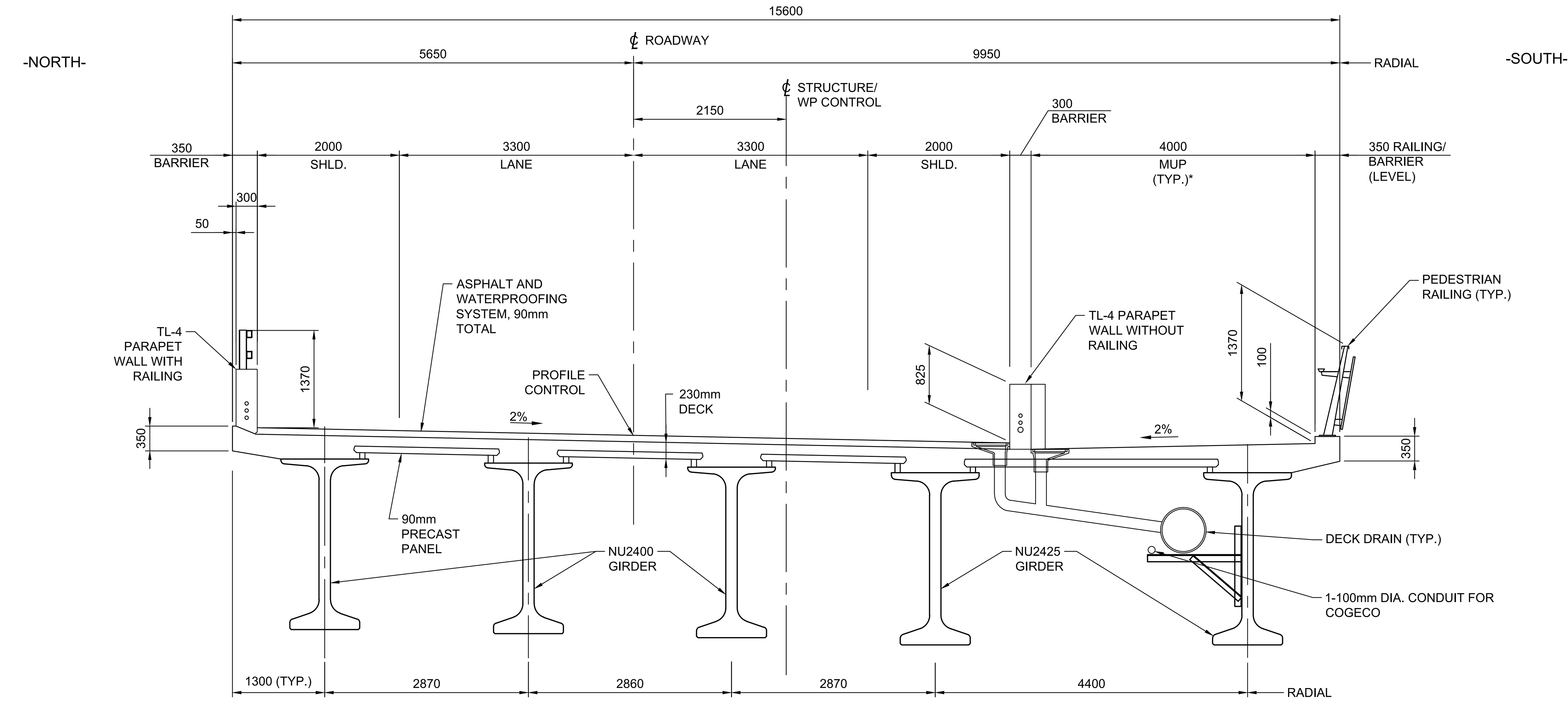

TYPICAL CROSS-SECTION - APPROACH SPANS

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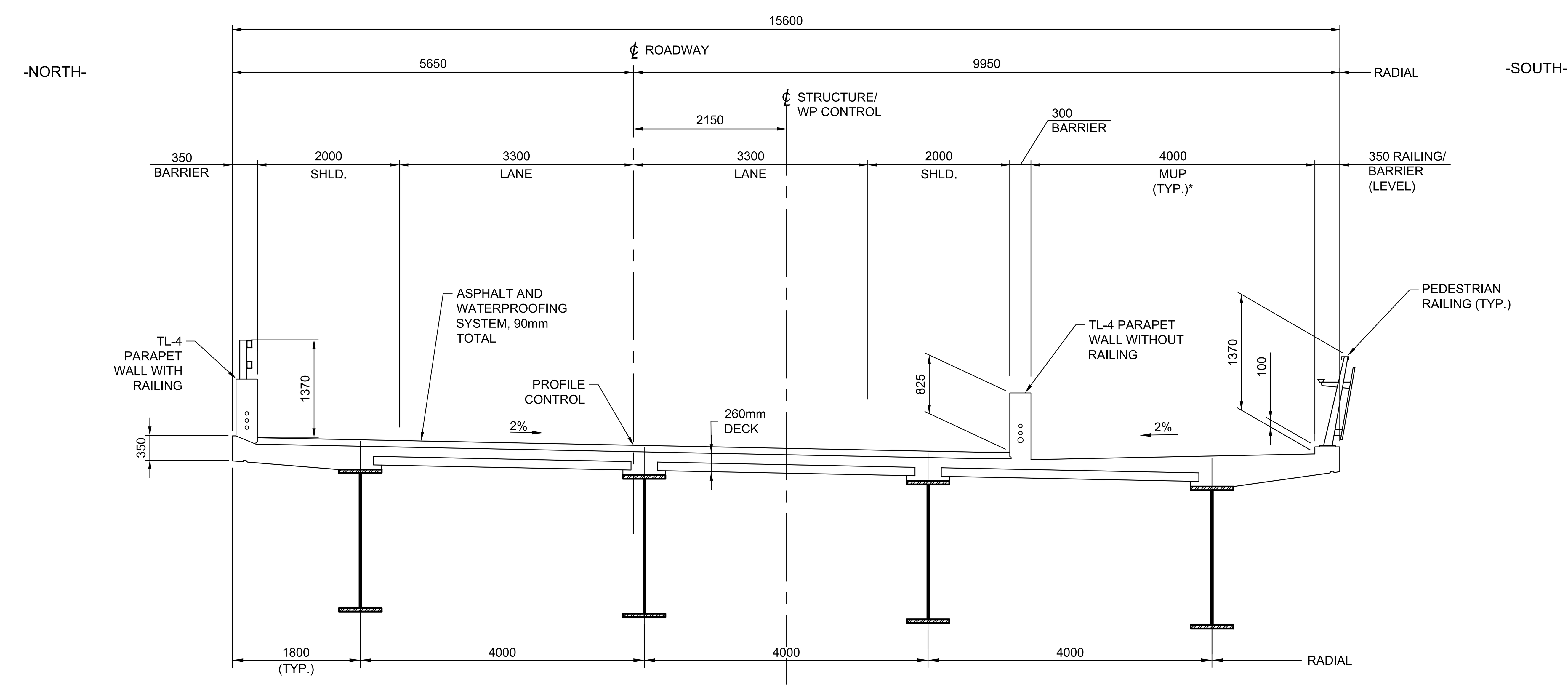

CROSS SECTION MAIN SPAN - AT MID-SPAN

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SAVED BY: ZHAO857409

INTEGRATED PROJECT DELIVERY TEAM:

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: MA
DRAWN: YZ
CHECKED: MA

KINGSTON THIRD CROSSING

DIA REPORT

PREFERRED BRIDGE CROSS-SECTIONS

DATE: 11-18-19
SCALE: N.T.S.

DRAWING NO. 1.1.3.1
SHEET NO.
REVISION

Figure 1-2: Look-Out Area at Navigation Channel Span (Looking East)

4. Cyclists are encouraged to use the multi-use pathway, unless they choose to use the shoulders. Design provisions are included to enable westbound cyclists to cross to the multi-use pathway, and then return to the north side of the approach roadway.

1.1.3.2 Deck Drainage

As stated earlier, the preferred vertical profile option for the bridge allows the stormwater on the bridge deck to drain from approximately the centre of the navigation channel span to the stormwater management facilities on-land. As shown on Drawing 1.1.3.1, the vehicular portion of the bridge deck is provided with a constant 2% cross-fall sloping downwards towards the center barrier. On the south side of the bridge, the multi-use pathway also incorporates a 2% cross-fall inwards from the south edge of the bridge deck to the barrier separating the vehicular lanes and multi-use pathway. The intent of the 2% cross-fall is to further facilitate the collection of stormwater on the bridge deck through cycle-friendly deck drain inlets located on both sides of the center barrier on the bridge approach spans.

In regard to confirming stormwater drain and piping requirements on the bridge deck during the pre-design Project phase, rainfall data from ECCC was used to calculate the rainfall intensity for the City. The following 2 key design standards / parameters were then used in the flow spread analysis:

1. MTO standards, which require: a minimum return period of 10 year and 100 year events to calculate the flow spread; and that the flow spread is restricted to the 2 m wide shoulders for the 10 year storm and a flow spread for the 100 year storm, which maintains a width of 3.5 m of open roadway.
2. A 'multi-use pathway' design parameter, which includes a minimum return period of 10 years; and restricts the flow spread to a 1.5 m wide portion of the pathway specifically (meaning there is a 2.5 m wide stormwater-free portion of the pathway for pedestrians and cyclists).

One cycle-friendly deck drain was used in the flow spread analysis:

1. Ontario Provincial Standard Drawing (OPSD) 3340.150 Deck Drain, which has a 1 m by 0.23 m grate with the long side of the drain located adjacent to the barrier and parallel to the flow.

The results of the flow spread analysis are summarized in Table 1.5:

Table 1.5: Flow Spread Analysis Summary

Design Standards / Parameters	Deck Drain Type - OPSD 3340.150	
	West of Navigation Channel Span	East of Navigation Channel Span
MTO: 2 m flow spread, 10 years	18	6

Based on the above, and relative to the preferred bridge deck cross-section shown on Drawing 1.1.3.1:

1. The ‘cycle-friendly’ and ‘multi-use pathway’ design parameters are the recommended two-fold design approach, as it exceeds MTO standards for a 10 year storm event. Furthermore, cyclists that are on the bridge during rainfall events that exceed the 10 year storm event would be able to use the stormwater-free portion of either the vehicular lanes or the multi-use pathway. Pedestrians would similarly be able to use the stormwater-free portion of the multi-use pathway as well.
2. The following drainage pipes are required, which are located underneath the bridge deck, and extend through the expansion joints to connect to the stormwater management system on-land via sleeves through the abutment walls:
   a) Draining to the west approach, one pipe with diameter varying from 300 mm to 525 mm to collect the stormwater from the vehicular lanes, shoulder and multi-use pathway.
   b) Draining to the east approach, one 300 mm diameter pipe to collect the stormwater from the vehicular lanes, shoulder and multi-use pathway.

1.1.3.3 Deck Surface

As shown on Drawing 1.1.3.1, for the 4-steel girder superstructure for the navigation channel span and its back spans, a 260 mm concrete deck, which includes a combination of cast-in-place concrete and partial depth 110 mm precast prestressed panels between girders, is required in order to achieve the vehicular portion’s and multi-use pathway’s 2% cross-falls for stormwater management provisions. For the 5-concrete girder superstructure for the approach spans, a typical 230 mm concrete deck with 250 mm concrete deck between the two most southern girders are required, which include a combination of cast-in-place concrete and partial depth 90 mm and 110 mm precast prestressed panels between girders. The concrete will be protected by a hot-applied asphalt waterproofing system and protection boards as well as 2 layers of asphalt for a total thickness of 90 mm.

The surface of the multi-use pathway is concrete. It has a 2% cross-fall for stormwater management, sloping downwards towards the center barrier. The concrete will be protected by a sealant coating.

Galvanized/GFRP and/or stainless steel rebar will be used in corrosion prone areas.

1.1.3.4 *Future Design Considerations*

The concrete deck can either be cast-in-place, precast or a combination thereof. The preferred design cross-sections utilize partial depth precast panels with cast-in-place concrete overlay. Full depth precast panels with closure pieces in between may be considered during detail design.

1.1.4 Approach Spans

1.1.4.1 *Concrete Versus Steel Girders*

The use of either concrete (precast prestressed NU girders girders) or steel (plate or box girders) for the approach spans was evaluated during the pre-design, preliminary and validation Project phases. Both concrete and steel are highly durable options. As shown in Table 1.6, in two steel and one concrete girder options were considered: 3-box steel girders (see Figure 1-3); 4-plate steel girders (see Figure 1-4); and 5-NU concrete girders (see Figure 1-5).

Concrete has a higher weight-to-strength ratio than steel. This increases the dead load, which effectively results in larger foundations or shorter spans with more piers, and introduces larger seismic loading in the case of seismic events. However, optimization to reduce the concrete deck depth could help to reduce the dead load from the deck.

The 3-box steel girder and 5-NU concrete girder options have girders with a constant depth, which is simpler to construct. For the 4-plate steel girder option, the girders have variable depths from 2 m at mid-span to 3.2 m at the pier locations to maximize the efficiency of the superstructure. This efficiency is achieved, presuming the girders are erected from a causeway, temporary work bridge or barges. The girder framing system is a combination of typical K-frame or X-frame cross bracing comprised of angles spaced up to 8 m apart for lateral stability during construction and for live load sharing. The NU concrete girders would require larger cranes to erect the girders; however, the girders would be stable when erected like the 3-box steel girder option. The 4-plate steel girders would need to be erected in pairs with bracing, requiring more time. The vertical profile could also be optimized with the constant depth 3-box steel girder and 5-NU concrete girder options to reduce substructure heights and associated material costs.

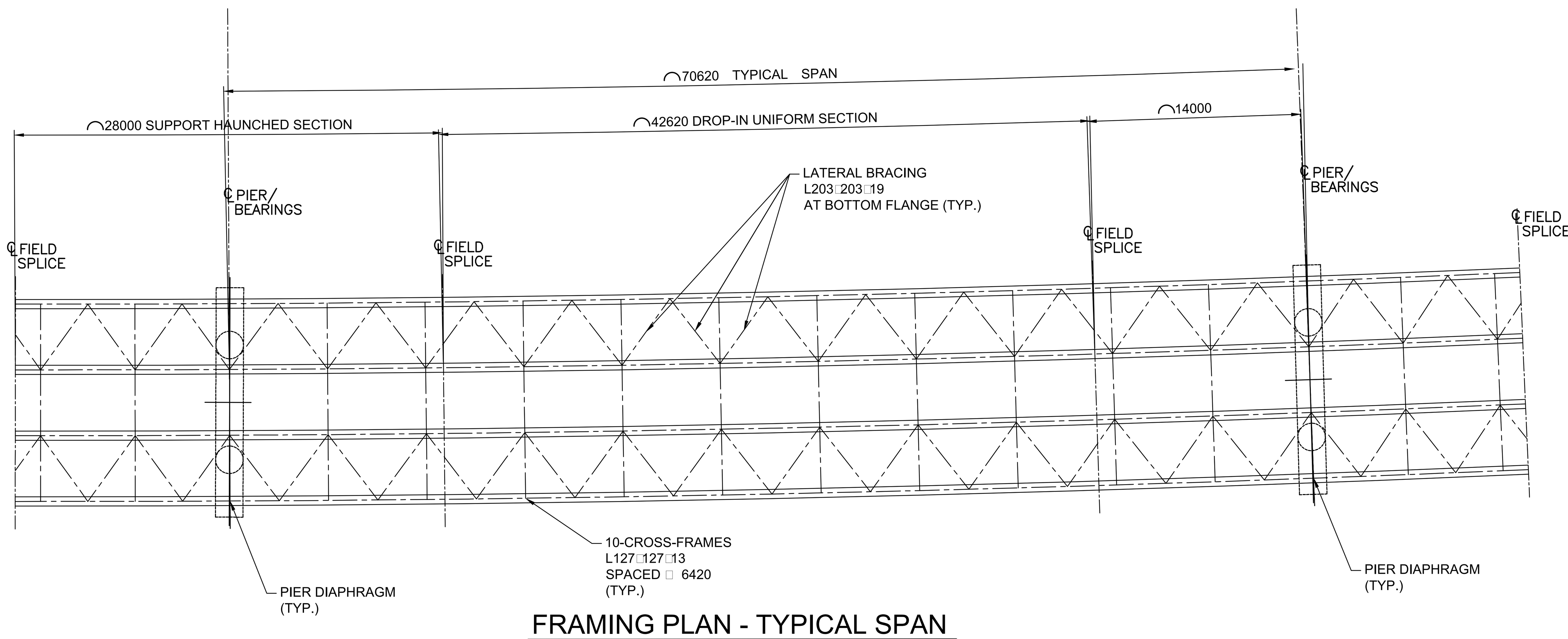
Cold weather affects any segmental construction that requires cast-in-place concrete to join pre-cast concrete segments. Although, the concrete girder option would not require field splicing, which would require more time for construction.

The 4-plate steel girder and 5-NU concrete girder options would have minimal interference with the drainage pipes underneath the bridge deck. The 5-NU concrete girder options would have the least interference as it does not have cross bracing between girders.

The steel girder options would be curved to match the horizontal alignment, as shown in Drawing 1.1.4.1 for the 4-plate steel girder option. For the 4-plate steel girder option, less cross bracing is required when compared to a kinked girder layout. The concrete girder option would have a chorded girder layout, as this is most economical. In general, straight girders are simpler to fabricate. The 4-plate steel girder option would have the widest cast-in-place concrete deck overhangs, requiring more temporary brackets to support the wet concrete and more labour associated with their installation. The exterior girders would also have to be modified to account for the loading during concrete placement, depending on the spacing and detailing of the overhang brackets.

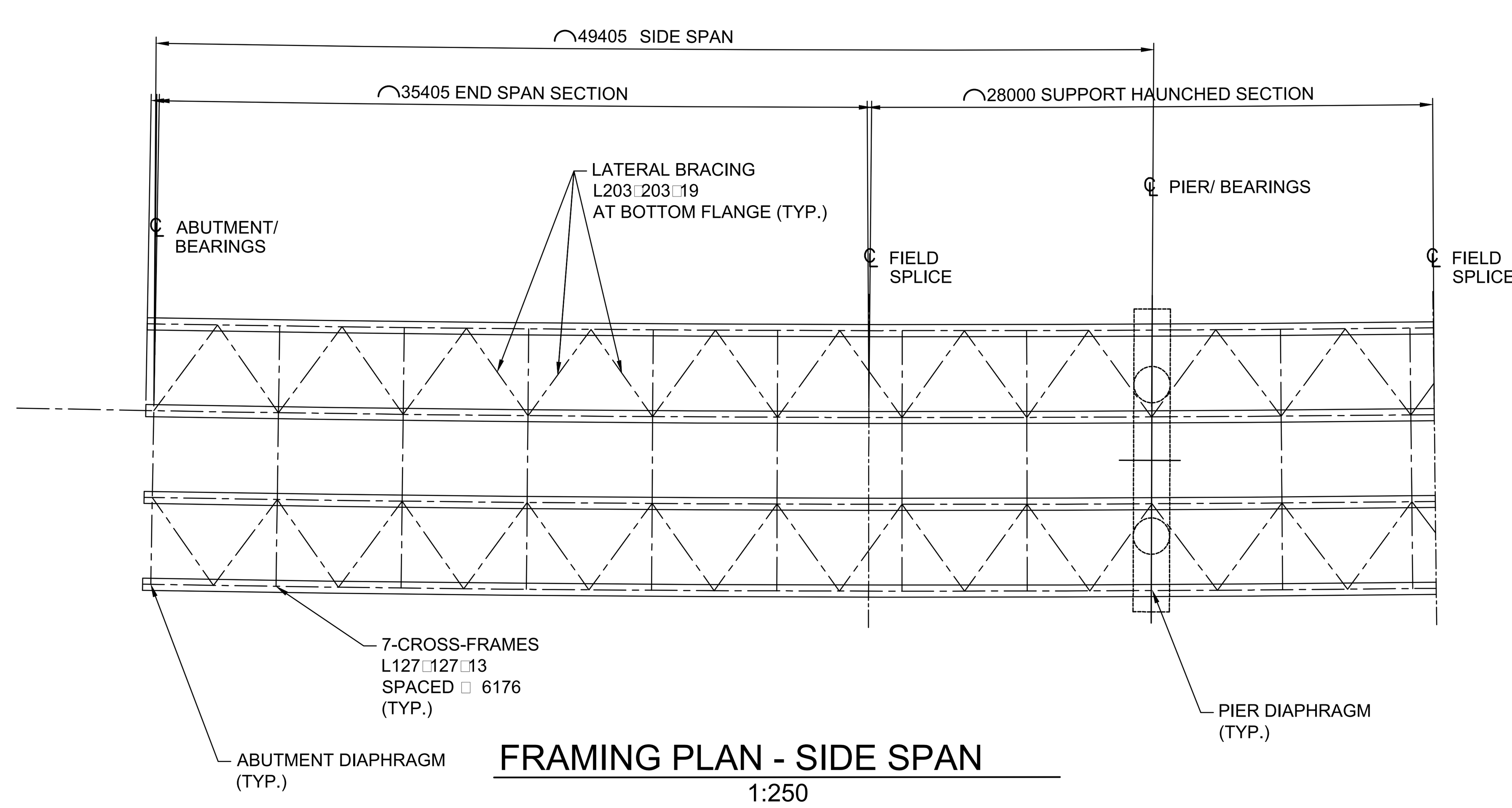
Also, with the steel girder options, which will be supported by concrete piers and abutments, over time there is the possibility of rust staining on the pier caps and abutment walls from the girders. Drip bars or zinc painting of girder ends can be used to reduce staining. Painting of the girder ends would increase material and associated maintenance costs as reapplication of coating the girder ends and/or sealing/resealing the adjacent concrete surfaces would be needed through the life of the structure.

METRIC



FRAMING PLAN - TYPICAL SPAN

1:250



FRAMING PLAN - SIDE SPAN

1:250

DRAWING NAME: Drawing 3.1.4.1.dwg
SAVED BY: zhao857409 SAVE DATE: 12/19/2018 3:26 PM PLOT DATE: 12/19/2018 3:28 PM

INTEGRATED PROJECT DELIVERY TEAM: HATCH, SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES, Kiewit, KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN:	MA
DRAWN:	YZ
CHECKED:	MA

KINGSTON THIRD CROSSING

DIA REPORT
STEEL WORK DETAILS
WEST APPROACH SPANS

DATE:	SCALE:
18-12-19	N.T.S.

DRAWING NO. 1.1.4.1

SHEET NO.

REVISION

Table 1.6: Steel Box Girder, Steel Plate Girder and NU Concrete Girder Comparison for Approach Spans

Criteria	3-Box Steel Girders	4-Plate Steel Girders	5-NU Concrete Girders
Weight of Steel/Concrete (includes navigation channel and back spans)	~6400 tonnes	~4700 tonnes	~11300 tonnes of concrete (for approach spans) ~1300 tonnes of steel (for navigation channel and back spans)
Girder Depth	~2.6 m	~2.0 to 3.2 m	~2.4 m
Girder Width	2.8 m to 4.8 m	0.6 m	1.235 m (top flange) 0.985 m (bottom flange)
Number of Bearings	2-4 per pier	4-8 per pier	9-10 per pier
Erection	Stable	Erected in pairs and should be braced	Stable
Transportation	Non-Routine Oversize/ Overweight Loads	Routine Oversize/ Overweight Loads	Non-Routine Oversize/ Overweight Loads
Drainage	Drainage pipes must pass through box girders (CHBDC approval needed) Issues if pipes freeze/burst	Minimal interference with drainage pipes	Minimal interference with drainage pipes. Least interference compared to steel girder options.
Pier Configuration	Large wall type piers	Modified Conventional Pier (pier cap with two columns)	Modified Conventional Pier (pier cap with two columns)
Fabrication	More steel and harder to fabricate compared to 4-plate steel girder option	Less steel and easier to fabricate compared to 3-box steel girder option	Similar ease of fabrication to 4-plate steel girder option as a NU2400 girder is a standard size for the

Criteria	3-Box Steel Girders	4-Plate Steel Girders	5-NU Concrete Girders
			MTO (structural standard drawing SS107-23)

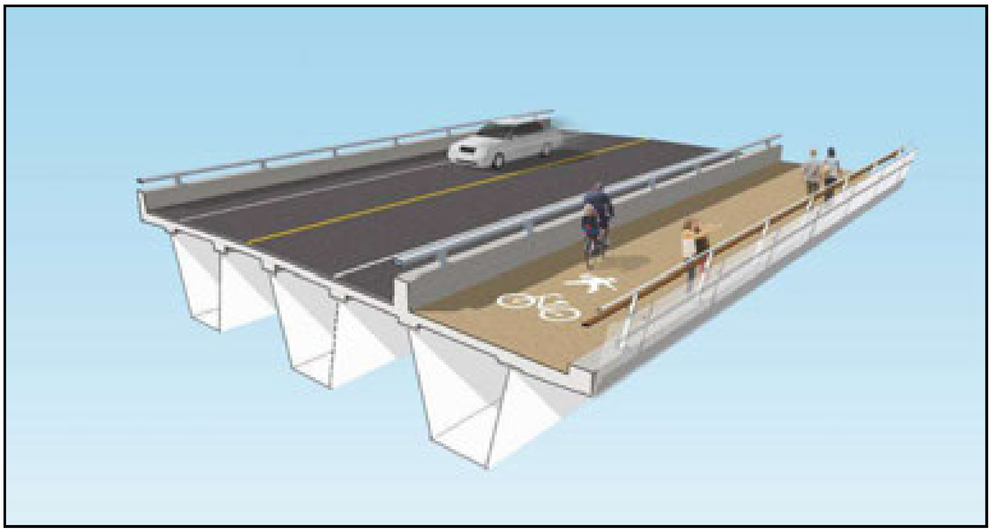


Figure 1-3: 3-Box Steel Girder Option

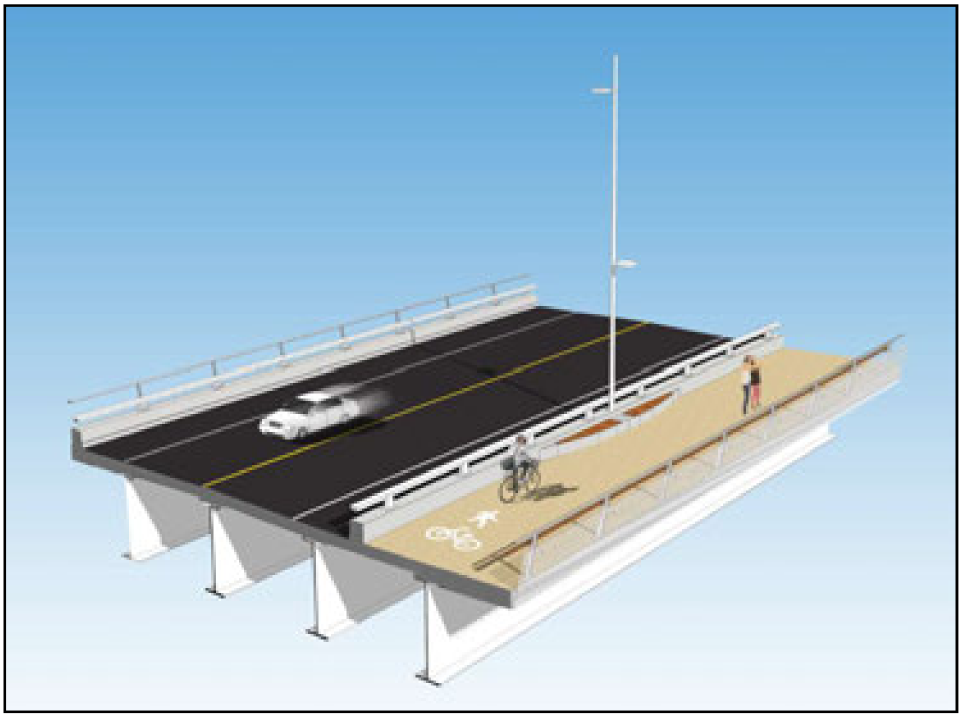


Figure 1-4: 4-Plate Steel Girder Option

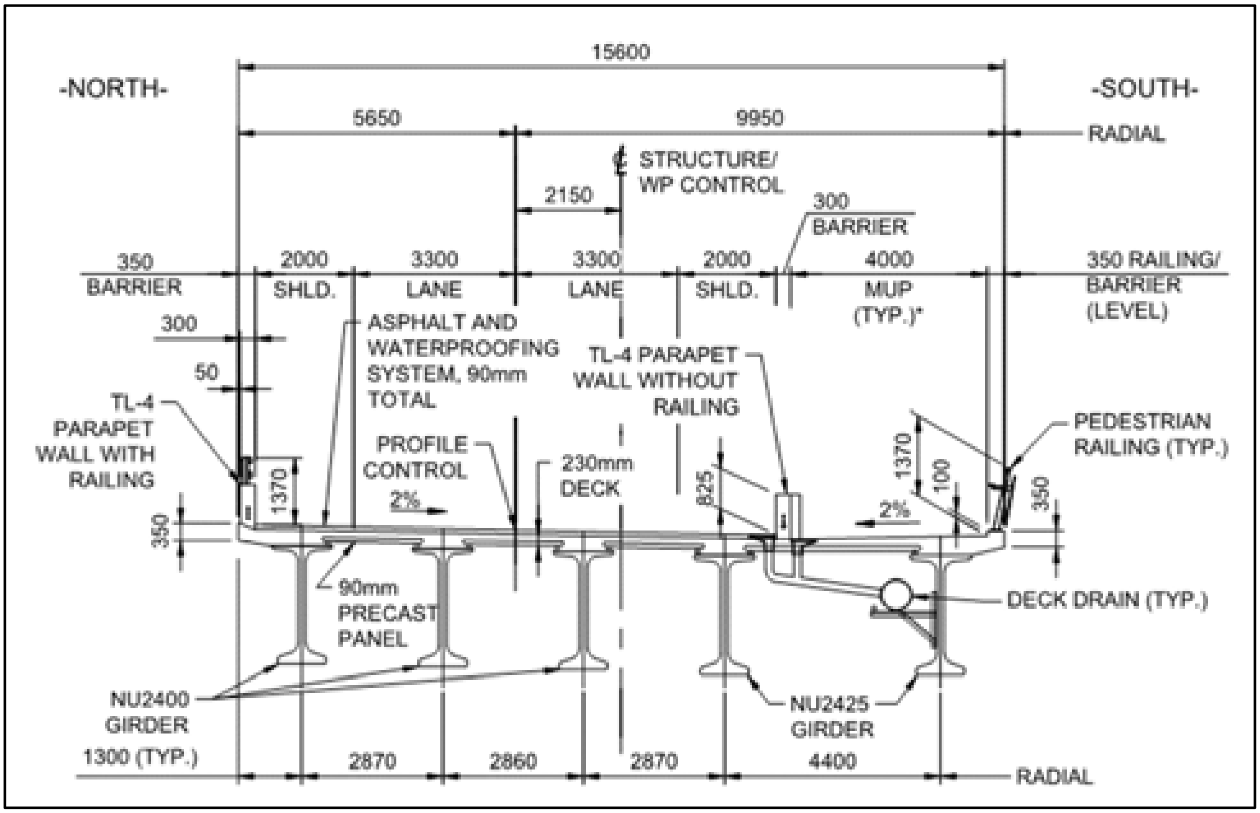


Figure 1-5: 5-NU Concrete Girder Option

1.1.4.2 *Preferred Girder Alternative*

The 5-NU concrete girder option is preferred due to:

1. The minimal interference, and the least interference among the alternatives, with the drainage pipes underneath the bridge deck.
2. The ease of fabrication and erection.
3. Aesthetically pleasing with preferred concrete pier design, and shallower constant girder depth.
4. Most cost-effective alternative in terms of material and fabrication.

1.1.5 Navigation Channel Span

The proposed crossing design is visually defined as a rhythmic low-lying viaduct comprising a repetitive series of uniform spans with constant depth concrete superstructure. Individual spans combine to form a continuous line of structure separated from the water sheet by simple piers, recessed into shadow. The rigorously horizontal composition is a modest and singular gesture intended to minimise visual impact on the riverscape.

At the eastern end of the crossing the Navigation Channel Span provides a legible gateway structure, as shown in Figure 1-6. This span is visually distinct from the rest of the bridge but maintains a fluid integrated profile rather than an overt change of form. The river is a grand, wide horizontal body of water and the design seeks to provide a holistic response to this context, mindful of the critical importance of the Rideau Canal that shares its waters.

Figure 1-6: View of Navigation Channel Span Looking North

At approximately 95 m the Navigation Channel Span is longer than the typical spans across the remainder of the crossing. The longer span consequently requires and allows for the structure to be deeper and this situation is exploited by arranging the haunched girders to be as deep as possible at the piers. A classic arch profile is thus formed, spanning across the navigation channel and 4 competitive rowing lanes to the immediate west. Three further ‘return’ rowing lanes are located under the adjacent span to the east.

Figure 1-7, Figure 1-8, Figure 1-9, and Figure 1-10 show the view from the navigation channel approaching the navigation channel span from the south at increments from 300 m. Note that the rowing lanes extend about 150 m south of the bridge.

Figure 1-7: View of Bridge from Navigation Channel from 300 m

Figure 1-8: View of Bridge from Navigation Channel from 200 m

Figure 1-9: View of Bridge from Navigation Channel from 100 m

Figure 1-10: View of Bridge from Navigation Channel from 50 m

The design addresses the inter-related concerns of many groups including the ‘live’ viewer, the ‘virtual’ viewer, the bridge user, the river and canal users. It is important that the bridge provides a memorable visual experience with which the City, the community and the waterways can identify. The arch structure provides this opportunity with an identifiable ‘motif’ that will allow the bridge to become firmly associated with its place.

At the piers, the approximately 9 m deep haunches are perforated with large scale apertures, such that the structure appears as a slender arch rib, rather than a deep girder. The apertures are an important visual feature, contributing to an overall lightness of form and revealing the parallel layers of structure beyond. This adds three-dimensional richness to what is essentially a simple, but proportionally elegant form. They also act to allow through and beyond the structure from bankside and marine positions. The visual permeability of the navigation span works in concert with the slender profile of the typical spans to minimise visual interruption of landscape and waterscape panoramas.

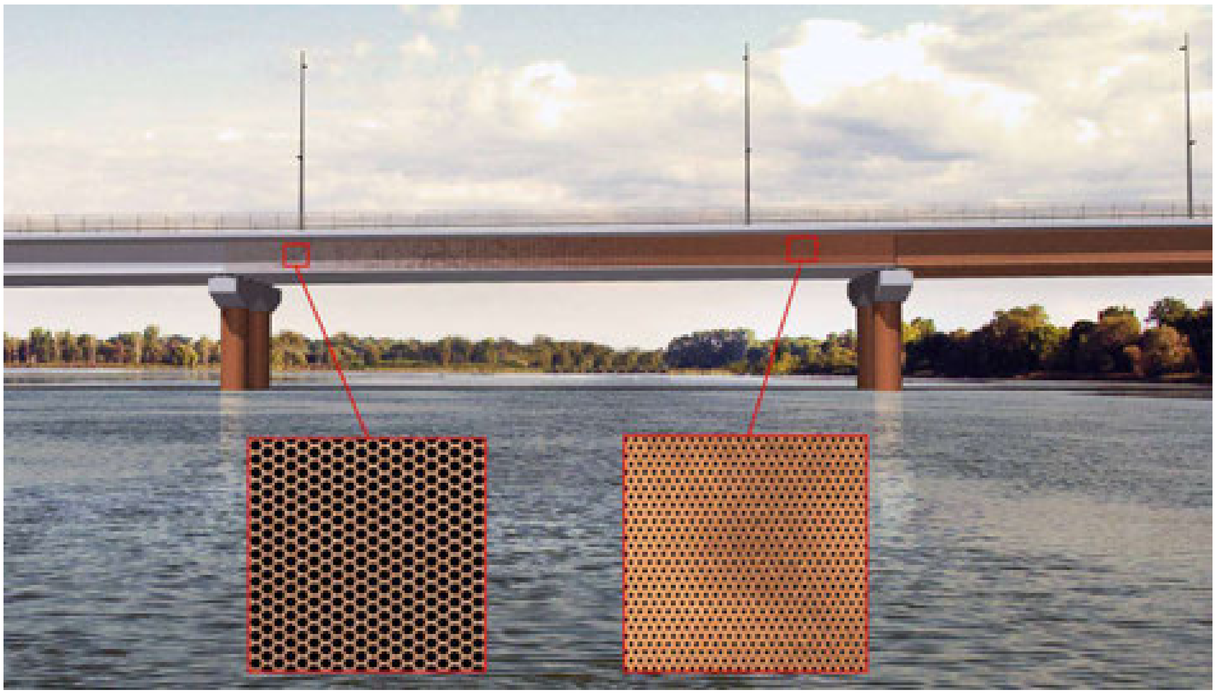


Figure 1-11: View of Transition from Weathering Steel of the Navigation Channel Span to Concrete of the Approach Spans

The Navigation Channel Span (including side spans) is further distinguished by a number of unique features that differentiate the span from the remainder of the viaduct. Most significantly the superstructure is constructed of weathering steel in contrast to the concrete girders of the standard spans. A transition between these materials may be explored and confirmed during detailed design; although, the difference in materiality can accentuate the navigation channel span (including side spans) as being a special piece to the water crossing as a whole. Figure 1-11 shows a potential transition between the weathering steel of the navigation channel span to the concrete of the approach spans over the last approach span, adjacent to each of the back spans of the navigation channel span. This transition could be created by applying a tinted stain or sealant onto the approach span concrete girders; through the use of a perforated metal panel mounted onto the concrete; or through another method to achieve the same result. This transition creates a smooth integration and harmonization of these materials.

Specifically, the perforated steel plate would be used as a device to mediate the earthy tones of the weathering steel of the main span structure with the lighter finish of the concrete girders. The intent is to bring the same visual continuity to the disparate materials of the girders, and to provide graduated continuity in colour and texture in keeping with all other aspects of the proposal. By increasing the apertures in the weathering steel plate away from the main span, more of the concrete substructure is visible through the plate. Smaller apertures mean that more or the weathering steel is visible in elevation views. In this way, a visually smooth transition can be achieved from solid weathering steel to solid concrete. The steel girder height would be made to match the height of the concrete girders so as to create a smooth, consistent line into and across the transition.

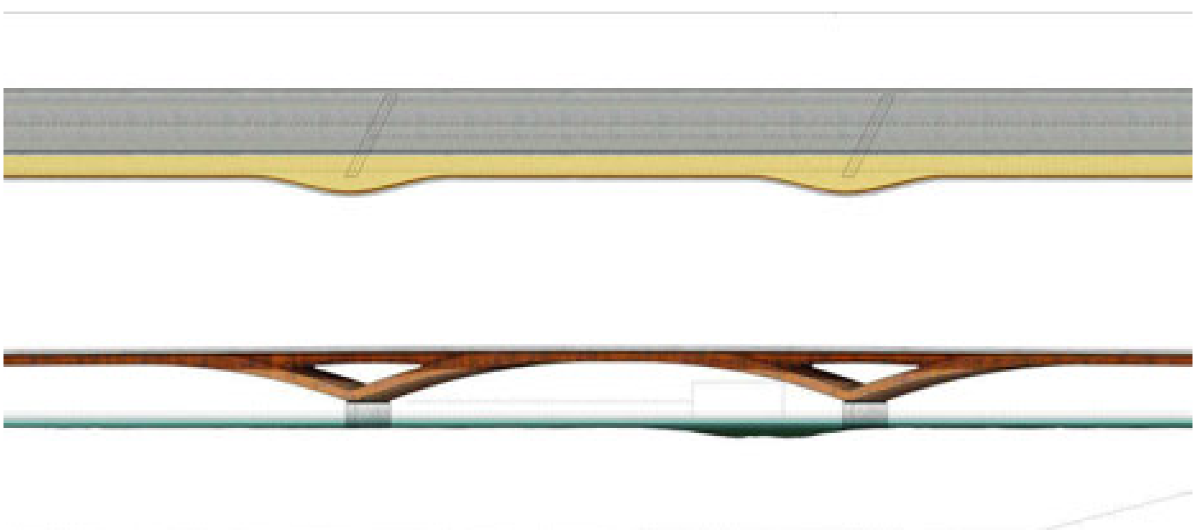


Figure 1-12: View of Viaduct Looking East Plan and True Elevation of Navigation Channel Span

As shown in Drawing 1.1.5.1, the piers supporting the arched structure are arranged parallel to the navigation channel rather than perpendicular to the bridge deck as all other piers are. This skew alignment is reflected in the bridge superstructure - each of the four parallel girders being offset from the next. This has a marked impact on visual perception of the bridge and in particular on the true elevation of the span which will highlight receding layers of structure beneath and through the bridge, as shown in Figure 1-12 and Figure 1-13.

a) View Near the Navigation Channel Span

b) View Under the Navigation Channel Span

Figure 1-13: Views Showing Skew Arrangement of Navigation Span

The span marks the southern gateway to The Rideau Canal which presents both a design opportunity and a design responsibility. The proposed design attempts to navigate the distinguished historic and cultural context with an elegant form that has sense of gravitas as well as a dynamic presence. The classic arch form provides historic continuity with the engineering language of the canal but is evidently a contemporary example of type, as shown in Figure 1-14 and Figure 1-15. Another example where below deck arch type is found on the Rideau Canal is the Flora Footbridge in Ottawa, currently being constructed. Amongst many functional requirements the ‘gateway’ function significantly influences the chosen bridge form- an arch is a universally understood signifier of entrance. The containment of the arch below the deck provides a very different experience to previous proposals for a high over-deck arch. Passing *through* an arch can be considered a more engaging experience than passing *beneath* an arch and seems an appropriate and legible portal to the UNESCO world heritage site.

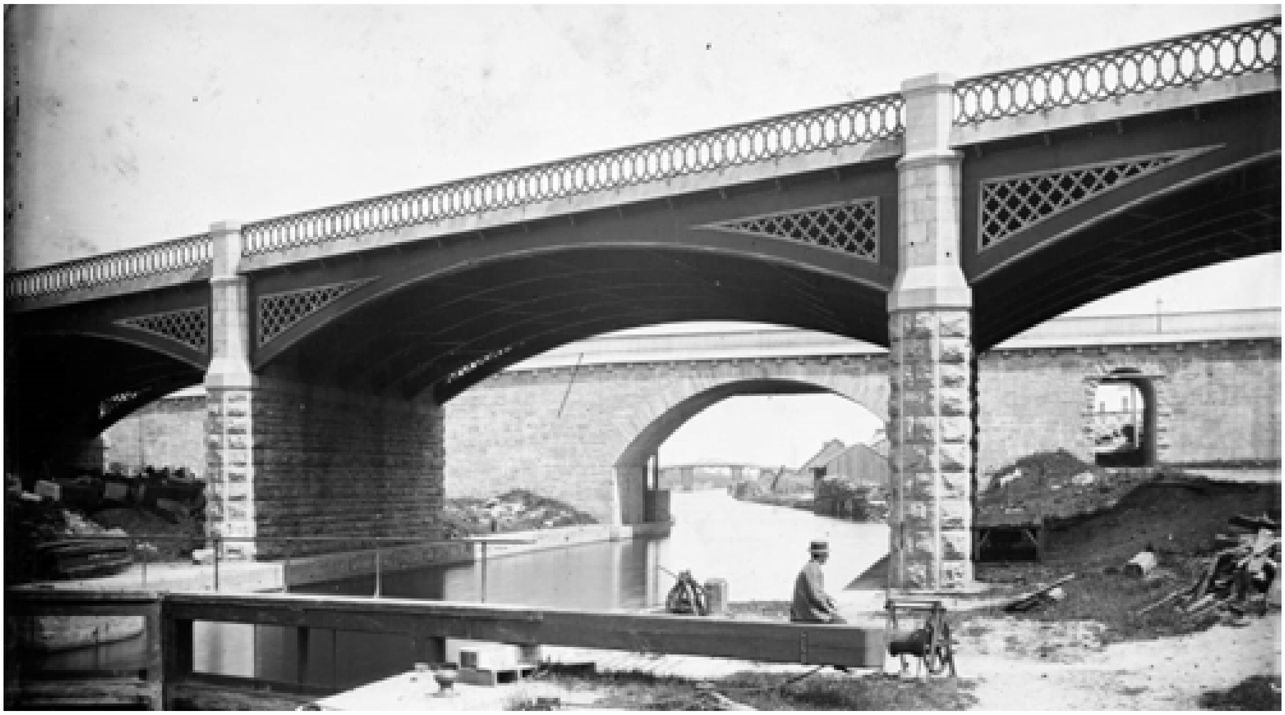


Figure 1-14: Historic Sappers Bridge over the Rideau Canal

Figure 1-15: Historic Laurier Bridge over the Rideau Canal

Standard piers on the bridge are simple compositions in which the twin piles are extended up to a shaped concrete pier-cap. The standard piers have been shaped to maximise the perception of lightness to the deck. The pier caps are coded in pairs to break down their visual mass and are tapered to minimise bulk. This arrangement means that there is no pile-cap at water level and helps in the perception of the bridge touching the water lightly. Although they do share a commonality in terms of shape and material piers on the Navigation Channel Span are designed to be clearly distinct from the typical piers, set out at a skew alignment, and at a much lower level to allow the arch profile to be as deep as possible. Navigation span piers can share a similar tapered form but have a wide base at water level to give these piers a more grounded appearance, or can have vertical-face sides.

The shape of the navigation span piers will be confirmed during detailed design where design considerations will include aesthetics, safety, permanent in-water footprint, and clearance to the adjacent rowing lanes. Advantages to the vertical-face sides shape include improved construction safety, lower concrete material volume which in turn lowers the permanent in-water footprint, and provides greater clearance to the adjacent rowing lanes than provided with the tapered shape.

While both give direct support to the girders which carry the bridge deck, they have different functions in terms of the loads being transmitted and they have a different place in the visual hierarchy of the whole crossing.

A version of the typical pier arrangement is used but set out lower, with the elevation of the underside of the pier cap between the average high water level of 75.26 m and the regulatory water level of 76.3 m. While the approach span pier caps and the navigation span pier caps do have different functions and are shaped differently for visual and structural reasons, they should nonetheless be understood as the same “family” of components as both are concrete. By matching the materiality, these purposefully disparate components will be more visually consistent and will be more readily understood holistically as related elements, as shown on Figure 1-16, which show conceptual renderings of the navigation span pier shapes to be considered during detailed design. The approach span piers will have a smooth concrete surface finish to them. To try to accentuate the importance of the navigation channel span’s piers to the water crossing, alternatives to achieve a coarse-textured concrete surface finish will be explored and confirmed during detailed design. The texture could be achieved in a number of ways, such as by tooling, by using textured form liners, or by jet washing after casting to expose surface aggregate.

(a) Tapered Navigation Span Piers

(b) Vertical Navigation Span Piers

Figure 1-16: Navigation Span Piers and Approach Span Piers viewed from Downstream

The design features pedestrian overlooks on the southside of the deck for users of the multi-use path (MUP). Overlooks on modern bridges derive from the ancient convention for providing small refuges over the piers of stone arch bridges, used to allow carriages to pass unimpeded over narrow roadways. This simply involved surfacing the pier constructions which were in any case wider than the bridge deck, and wedge shaped to ‘cut’ the oncoming water. In contemporary bridges the piers are not available to support these refuges but there is an innate sense of ‘rightness’ in widening the deck at the pier location rather than in free-space, particularly on arch bridges. At the Navigation Channel Span there are consequently two overlook positions, one over each of the piers as shown in Figure 1-2, Figure 1-6 and Figure 1-16. These overlook southward panoramas including both the urban skyline of Kingston and the important landscape Belle Island, with consequent opportunities for interpretive material. The eastern most overlook will be in close proximity to the boating channel, and both will overlook the final lengths and finish line of the 2,000 m rowing lanes.

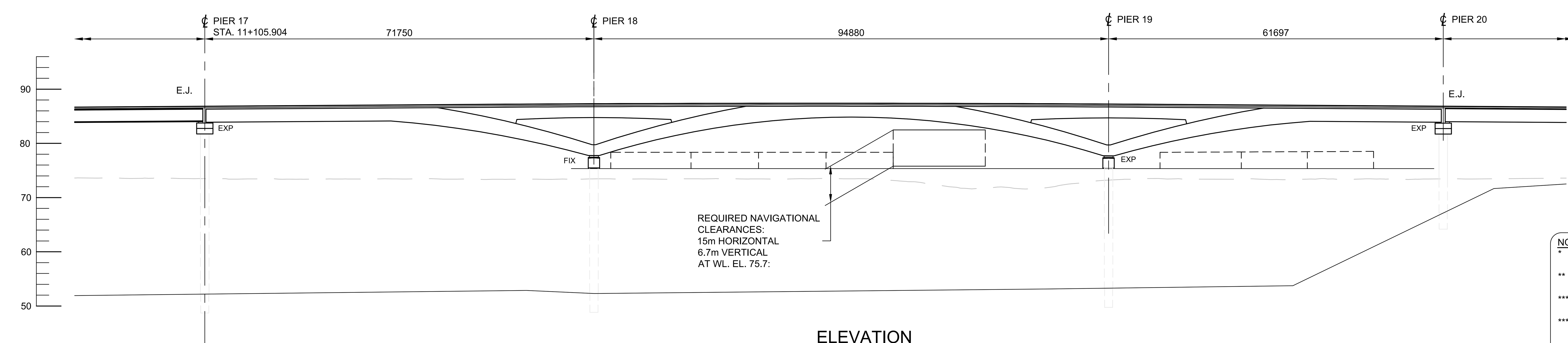
By limiting the extent of the overlooks, it may be appropriate to consider the provision of an additional overlook on shore at the western end of the bridge, in recognition of the fact that the eastern overlooks will service only a limited percentage of the public visiting from the City side. This would allow a more direct engagement with the riverscape and wildlife of the western shore and provide bookends to leisure journeys across the MUP.

Relative to former design proposals the current design is both more cohesive as a shore-to-shore composition and less focused on additional large-scale pedestrian provision at the east end of the crossing. This allows a more even experience for users of the MUP across the whole bridge rather than just at the Navigation Channel Span, as shown in Figure 1-1. An opportunity exists to engage the entire length of the bridge in interpretation, perhaps reflecting linear themes of river and canal. The Rideau Canal is 202 km long and features 45 locks and 44 bridges as well as other significant structures. It seems appropriate to mark this long north-south journey on the somewhat shorter east-west journey across the Third Crossing, utilising the rhythm and modulation of structure and appurtenances (light poles, parapet posts etc) to map out and explain the story of the canal and the river as it extends northwards from this gateway structure.

Table 1.7 provides a summary of Parks Canada design criteria for aesthetics from Appendix A, and description of how the preferred design addresses these design criteria.

METRIC

PLAN
1:500



ELEVATION
1:500

GENERAL NOTES:

DESIGN LOADS

BRIDGE: CL-625-ONT TRUCK LOAD, CL-625-ONT LANE LOAD OF CHBDC.
SIDEWALK: PEDESTRIAN LOADS AND MAINTENANCE VEHICLE OF CHBDC S6-14.

CONSTRUCTION NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. CHAINAGES AND ELEVATIONS ARE IN METRES.
2. MAINTAIN FULL NAVIGATIONAL CLEARANCE THROUGHOUT CONSTRUCTION.
3. INFERRED BEDROCK PROFILE IS BASED ON BOREHOLE LOGS FROM GOLDER ASSOCIATES REPORT ENTITLED "PRELIMINARY GEOTECHNICAL INVESTIGATION - THIRD CROSSING OF CATARAQUI RIVER - JOHN COUNTER BOULEVARD TO GORE ROAD, KINGSTON, ONTARIO", DATED MARCH 2017, REPORT NO. 1541774/2000/003.

LEGEND:

WP	DENOTES WORKING POINT
C/L	DENOTES CENTRELINE
T/A	DENOTES TOP OF ASPHALT
T/FTG.	DENOTES TOP OF FOOTING
T/CAISSON	DENOTES TOP OF CAISSON
– – – –	DENOTES NOISE BARRIER

NOTE:

*	LOW WATER DATUM	EL. 74.16	CANADIAN HYDROGRAPHIC SERVICE (LAKE ONTARIO)
**	AVERAGE HIGH WATER	EL. 75.26	MINISTRY OF NATURAL RESOURCES (LAKE ONTARIO)
***	NAVIGATION CHANNEL HIGH WATER LEVEL	EL. 75.70	PARKS CANADA
****	REGULATORY WATER LEVEL	EL. 76.30	CATARAQUI REGION CONSERVATION AUTHORITY "REGULATORY LIMIT WITHIN THE STUDY AREA"

PRELIMINARY DESIGN
FOR INFORMATION PURPOSES ONLY

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SAVED BY: ZHAO857409

HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

HATCH

DESIGN: E.R.	KINGSTON THIRD CROSSING	DRAWING NO. 1.1.5.1
DRAWN: G.C.	DIA REPORT	SHEET NO.
CHECKED: B.I.	GENERAL ARRANGEMENT STA. 11+105 TO STA. 11+333	REVISION
	DATE: 11-18-19 / SCALE: N.T.S.	

Table 1.7: Design Criteria for Aesthetics

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
Part A: Fundamental Aesthetic Strategies		
Functional Clarity	• The form of the structure should be an honest expression of its required function • The size and shape of structural elements should be appropriate for their respective structural tasks • Architectural expression and detailing should be respectful of the nationally- and internationally-recognized heritage character of the Rideau Canal • Materials should be appropriate for their function and express their inherent nature	The design represents a legible response to the functional brief. A consistent rhythmic horizontal viaduct is broken only at the Navigation Channel, both as a technical response to the required span length, and as a formal response to the gateway of the Rideau Canal. The change from constant depth concrete girders to arched weathering steel girders presents an unmistakeable indication of function.
Economy and Simplicity	• Aim at simplicity of form with clean uncluttered lines, without becoming monotonous • Provide economy in design in terms of capital, maintenance and lifecycle costs: minimum number of components, minimum dimensions	The viaduct is an economic structural type with standard profile concrete girders used at their maximum constructional and span length. The design is based upon calm geometry, clean lines, and a controlled palette of materials. The arched navigation span is configured to use minimal material in an appropriate structural form. The use of self-finished materials will reduce cost-in-use, without imposing a premium on initial capital cost.
Scale and Proportion	• The structure should be in scale and complement its surroundings • Bridge components should have good proportional relationships with one another • Minimize visual impact of structure as scale increases by maximizing transparency/lightness through the structure	The bridge is set out to respect the open horizontal landscape corridor of the Cataraqui River corridor with a composition intended to minimise visual impact. A rhythmic low-lying viaduct comprising a shallow line of structure is separated from the water sheet by simple piers, recessed into shadow. The navigation span is formed by a long low arch profile that is distinctive but elegant in context.
Harmony and Visual Balance	• Provide harmony and visual balance (utilizing order, symmetry, rhythm) amongst the structure's component parts as well as its composition in its surroundings • Order - elements are arranged logically without visual confusion • Rhythm - regular recurrence of similar elements to create a visual flow that is pleasing to the eye	The viaduct comprises a repetitive series of uniform spans with constant depth concrete superstructure which flows seamlessly into the navigation span. Weathering steel girders of the same depth and transverse spacing as the adjacent concrete structure ensures a fluid transition from the horizontal structure into to the curvaceous form of the navigation span.
Contrast and Complexity	• Consider incorporating solid and void to allow for the play of light and shadow on the structure • Consider surface texture to provide visual interest, both at a distance and up close • Consider colour to help integrate the bridge into its surroundings	The navigation span features large voids in the structure above the piers. This initiative, combined with the skewed alignment of the bridge across the navigation channel, acts to reveal layers of structure and provide a visually rich 'elevation' from the river. The contrasting use of concrete and weathering steel across the viaduct and the navigation span demonstrates both material contrast and cohesion.
Materials and Finishes	• Utilize high quality, durable, compatible materials and finishes to maintain a premium appearance, protect against adverse environmental effects and minimize ongoing maintenance • The effects of bird droppings on the appearance and condition of the bridge should be anticipated and appropriate design solutions explored	The concrete girders of the viaducts are supported on shaped concrete pier caps with weathering steel piers. The weathering steel girders of the navigation span is supported on low-level pile caps. Navigation span piers can share a similar tapered form but have a wide base at water level to give these piers a more grounded appearance, or can have vertical-face sides (shape to be confirmed during detailed design). While the approach span pier

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
	• Apply rigorous and consistent approach to details and connections • Allow for introducing texture, colour and visual interest to enhance the user's experience • Consider opportunities for introducing local stone and wood	caps and the navigation span pier caps do have different functions and are shaped differently for visual and structural reasons, they should nonetheless be understood as the same "family" of components as both are concrete.
Enduring Visual Quality	• The bridge should still be perceived as visually pleasing decades after its construction • Avoid extremes of "current fashion" design or overtly historicist references • Key factors: quality and durability of base materials, good design and detailing, regular maintenance procedures	We believe the bridge design is a composition that will endure given its simple and rigorous layout and form. The arch span provides a legible and dramatic gateway to the canal but deliberately avoids penetrating the silhouette above deck in an overt manner. This maintains the 'classic' arch form which is repeated many times across the Rideau Canal. The restrained composition provides the foundation for quality in detail.
Compatibility	• The bridge should be compatible with the heritage character of the Rideau Canal National Historic Site, Canadian Heritage River and UNESCO World Heritage Site and the Project setting.	The Rideau Canal exerts a significant influence on the setting of the bridge, although it shares the waters of the Cataraqui River at the crossing point. The proposal seeks to definitively define the canal's passage through the arched main span, and also to legibly acknowledge the world heritage and national historic asset through its design. The canal features numerous and diverse structures but not typical design types that the bridge might reference. Instead the design is founded on the principles of pragmatic, efficient, innovative engineering and visual design that is evident along the entire length of the canal
Part B: Context Specific Aesthetic Strategies		
High Quality	• Achieve a high-quality design that responds to and respects the Project setting • Achieve aesthetically pleasing structural solution beyond traditional highway bridge design	The bridge design is a bespoke reaction to site and situation employing a strategy of minimal visual intervention. The use of simple constant depth girders to support the highway across the majority of the crossing is an appropriate choice of structural system to deliver a discreet and economic construction. On this simple compositional base other design elements will differentiate the crossing from 'standard' highway bridge design. Cantilevered side spans will recess the girders into shadow on both sides, and the shared use path on the south side allows for a slender edge condition will be illuminated by direct sunlight in the foreground of views. The absence of water-line pile caps, the shaping of structural elements including pier caps, and the careful co-ordination of structure and appurtenances will all contribute to a high visual-quality construction.
Respect the Heritage Character of the Rideau Canal	• Ensure the bridge respects the heritage values stated in the "Commemorative Integrity Statement" for the Rideau Canal National Historic Site of Canada, and the "Statement of Outstanding Universal Value" of the Rideau Canal World Heritage Site	As the crossing navigates the boating channel it transfigures with a clear acknowledgement of the physical and symbolic presence of the Rideau Canal. The Canal, stretching 202 km northwards, obliges the Third Crossing design to respect its historic character, not least because of its gateway position at the southernmost point. The Canal includes a diverse range of functional and structural types and although there is no single defining characteristic that typifies the route-wide engineering expression, certain key factors are noted in development of the Third Crossing. These include:

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
		• Integrity - the navigation span does no more than it needs to do to fulfil its functional requirement and does not rely on unnecessary gestures of scale or composition to elevate its visual presence. • Elegance- the design does not sacrifice elegance for design or constructional convenience and is considered holistically to deliver a context sensitive solution. • Legibility- The design is easy to read. The classic arch form speaks clearly of gateway function and the design is related both in form and materiality to other structures across the length of the Canal.
Interpretive Opportunities	• Consider opportunities for users to learn about significant aspects of the canal's heritage, the history of First Nations communities in this area, and the ecological dynamics of the wetland • Allow for incorporating interpretive signage or nodes • Views from the bridge north provide a never-seen-before opportunity for a panoramic view of the Cataraqui Marsh and the canal channel • Provide viewing nodes for cyclists and pedestrians on the bridge with interpretive media • Identify opportunities for public contributions, such as public art	The bridge offers a range of opportunities for interpretive material, most obviously on the multi-use path (MUP) on the south side of the crossing, where visitors have a slower and potentially more immersive experience than highway users or boaters. The design is configured to concentrate pedestrian rest and viewing areas on the bridge to the navigating span, in the form of twin overlooks flanking the boating channel. These positions provide clear views southwards across the Cataraqui Marsh and the canal approach, and a clear opportunity to inform visitors via interpretative material about the Canal, the landscape and the history of inhabitation. The method of interweaving or separating these narratives requires careful consideration in relation to the physical opportunities the design provides. In addition to the on-bridge overlooks a land-based overlook is provided at the south-west abutment. The long, linear route along the MUP also provides the chance to 'curate' the pedestrian/cyclist journey across the river and canal, providing a linked series of enhancements or interventions along the path. This could take any form but would possibly be most effective as a simple pictorial story, that is integrated with the path environment. It is difficult to ignore the correlation between the linear route on deck with the linear route of the canal beneath and we would promote the development of a strategy to exploit this unique opportunity. Other positions below the deck can be augmented by features to be seen by other groups, for example boaters passing beneath the bridge. Similar opportunities to accord with appropriate cultural traditions of First Nations communities are not integrated at this stage pending appropriate engagement but could certainly be directly and/or discreetly incorporated.
Views	Given the values of the Rideau Canal in this initial assessment the key views are: • To the bridge from the navigation channel during the day and night and from the north and south • To the Great Cataraqui Marsh and the slopes of the river valley from the navigation channel • From the bridge to the navigation channel, the Great Cataraqui Marsh and the	The bridge is configured taking account of the impact of the structure on key views from land and water, balancing the imposition on the landscape with new views of the surrounding context made available from the bridge itself. These opportunities apply to all users but are particularly focused on users of the MUP who are provided unobstructed views southwards across the full length of the crossings and new panoramic views northwards across the highway deck. The key decision to maintain all structure below the deck even at the navigation span means that the visual balance between land and riverscape is maintained,

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
	slopes of the river valley, the northern entrance to the Inner Harbour and Kingston's skyline • From the Highway 401 and the slopes of the river valley to the bridge, navigation channel and the Great Cataraqui Marsh More specifically, the important views from the navigation channel include: • From approximately 1 km south of the Highway 401 bridge, boaters travelling south will have a dramatic and kinetic view of the entire bridge in its river setting, as well as the urban landscape emerging in the background over the 2 km approach; views to the marsh lands are not obstructed via this approach but the presence of a 1 km long modern structure stretching across the river may negatively impact the views of this predominantly natural setting • Boaters travelling north first encounter a view of the eastern-half of the bridge as the channel rounds Belle Island; the entire bridge in its river setting will not be visible from the south until the boater rounds Belle Island, approximately 250 m from the span; views of the marsh lands and the river are unobstructed once boaters travelling north pass under the bridge Views from the bridge: In this initial assessment views from the bridge are assumed to be from the central part of the span across the river: • Views to the south will include parts of the golf course and Belle Island, approximately 750 m distant; views south down the river will extend approximately 1.3 km as the channel enters the inner harbour. Neither the Inner Harbour nor Outer Harbour will be visible from the bridge. This southern view may provide an opportunity to communicate stories of the First Nations' use and occupation of this part of the river • Views from the bridge to the north should provide a new and significant opportunity to see the extensive wetlands of the Great Cataraqui Marsh and the navigation channel as it runs through the river valley. This northern view may provide an opportunity to communicate stories of the First Nations' use and occupation of this part of the river. Views from the land:	uninterrupted by inharmonious man-made interventions on the skyline. The imposition of structure across the open river setting will inevitably affect views but the crossing is a long, low-lying composition configured to minimise visual impact and maximise openness by optimising the depth of structure and the frequency of piers. In views of the bridge from the river up to about 300 m proximity, the deck will not penetrate the horizon line and will visually meld with the background land. To this end, the structure is relatively obscured and only becomes the object of foreground focus when it rises above the background horizon in closer views. The view for boaters travelling north is carefully choregraphed. The western half of the bridge will be visible at distance as the boater rounds Belle island with the eastern half and the navigation span revealing itself gradually as the northward journey progresses. The bridge will be largely disguised against the backdrop of the tree-lined banks until close proximity raises the deck above the horizon line. When the whole structure is visible the navigation span is the obvious axial focus of views but is set in the context of the long approach structure and the river context stretching out to the west. Within 200 m of the bridge the horizon in the background is extensively revealed beneath the deck which is then set against the sky.

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
	• The bridge will be visible from the Highway 401, the slopes of the river valley and Belle Island, and Fort Henry to the south • It should be noted that views from Cataraqui Park (Belle Island) looking north will see the western section of the bridge but not the entire span; views from Belle Island to the marsh lands to the north will be impacted with the construction of the bridge Maximize viewing opportunities from the bridge for all bridge users: • The design should provide opportunities for lookout vantage points or nodes above river, including seating and some interpretive signage and public art • Provide minimum height barriers and open railings to maximize views • Investigate the possibility of interpretive opportunities for boaters as they pass under the bridge	
Pathway User Experience	*Railings* • Provide continuous open railings to optimize views • Allow for custom design lo provide distinctive enhanced visual effect within the pathway user realm: consider use of stainless steel, aluminum or premium custom-colour paint finish over steel *Barriers* Enhance design of barriers between non-vehicle user realm and traffic: • Provide a code complying barrier that is not a full height concrete barrier • Provide custom-designed railings instead of typical functional approach such as chain link fence • Allow for enhanced and innovative barrier wall terminations e.g. shaped precast concrete, stone facing, inlaid text identification *Lighting/Poles* • Provide functional, high quality, attractively designed tow lighting directed and limited to the bridge • Lighting should be kept simple and subtle, in harmony with the Project setting • Avoid using constant-on lighting and flood lighting directed to the sky to minimize avian fatalities; white strobe or flashing lights, of a minimum number, intensity and	The quality of the MUP environment must reflect the fact that users have a closer and more tangible relationship with their surroundings than occupants of faster moving vehicles on the highway. Lightweight open railings on the outside of the MUP deck are set against solid concrete barriers on the back of the deck separating pedestrians from the highway. This deliberate coding of the path confines will naturally tend pedestrians to the deck edge, and cyclists to the inside contributing to an unmarked delineation that will aid compatible shared use. The length of the crossing means the MUP is a substantial feature but is unlikely to generate the frequency of pedestrian use that could justify the same kind of investment in high-cost materials that might be experienced on smaller footbridges. However, concentration of resources in high traffic areas including overlooks, and the rigorous co-ordination of structural and non-structural components including barriers, railings, screens, lighting poles, deck surfaces, signage, interpretation and art will elevate the experience of pathway users and clearly distinguish the MUP environment.

Aesthetic Strategy	Parks Canada Design Criteria for Aesthetics	Description of How the Preferred Design Addresses the Design Criteria for Aesthetics
	number of flashes is recommended at night • Include provision of above-deck pedestrian-scale lighting at appropriate intervals • Minimize number of pole systems on bridge by integrating support of roadway lighting, and possibly pedestrian scale lighting • Include provision of accent lighting at appropriate intervals to enhance night-time illumination of bridge structure *Signage* • Signage and the bridge and in the vicinity of the bridge should be well-integrated and planned from the beginning. It should not be treated as an isolated component. • Overhead signage is not recommended. The treatment of the approaches to the bridge need to complement the bridge design and not contrast with it nor detract from the aesthetics of the bridge. It should be planned as part of the evolving design.	

1.1.6 Structural Steel Coating

The following structural steel coating options were considered during the pre-design, preliminary and validation Project phases:

1. A 3-coat system consisting of a zinc primer, an epoxy mid-coat and a urethane top coat over all the structural steel: The coating system would be applied off-site and then touched-up after erection and at the field splices.

   The benefits of using a coating system are that the colour of the structural steel can be changed to enhance the look of the bridge; and a 3-coat system has an average design life of 25 to 30 years. At that time, an access platform with an environmental protection enclosure would be installed in order to sand blast the existing coating off the structural steel down to base metal, and apply a new 3-coat system.

2. Metallization of the structural steel: Metallizing consists of coating the structural steel in a thin layer of zinc or aluminum to protect the underlying structural steel. It is also standard practice to apply a layer of coating on top of the metallization to provide further protection and change the colour.

   Metallizing can occur off-site or in the field as it is spray-applied. Metallizing has a higher initial cost than a 3-coat system but it has a lower life cycle cost, since it is more durable.

3. Atmospheric Corrosion Resistant (ACR) steel: ACR steel is approximately 4 times more resistant to corrosion than plain carbon steels. It forms a rust patina which inhibits further corrosion of the structural steel, and is generally uncoated, except for the girder ends near the expansion joints.

   As shown in Table 1.8, a combination of structural coating options was also explored to provide additional protection in corrosion prone areas.

Table 1.8: Evaluation Matrix for Structural Steel Coating Option

Criteria	3-Coat System	Metallization and 1-Coat System	ACR Steel	ACR Steel with 1-Coat System on Exterior Girders
Estimate Design life	25-30 years	30-35 years	~100 years	100 years (steel) 25- 30 years (coating)

Criteria	3-Coat System	Metallization and 1-Coat System	ACR Steel	ACR Steel with 1-Coat System on Exterior Girders
Aesthetics	Can paint it a specific colour	Can paint it a specific colour	Rust colour due to patina	Exterior girders can be painted a specific colour Interior girders will be rust colour due to patina
Maintenance	Localized coating repairs Full coating removal and replacement at end of design life	Localized coating repairs Full coating removal and replacement at end of design life	No maintenance	Localized coating repairs on exterior girders No maintenance on interior girders Overcoat on exterior girders at end of design life

ACR steel is the preferred option for this Project's structural steel as ACR steel has the longest estimated design life and least amount of operational and maintenance costs.

1.1.7 Piers

1.1.7.1 Concrete Versus Steel Piers

The use of concrete or steel piers was evaluated during the pre-design Project phase:

1. Steel piers require a tall concrete pedestal in aquatic environments to prevent contact between the water and the structural steel. If the steel piers are integral with the steel superstructure, the bearings would be located at the base of the pier on the concrete pedestal. Steel piers are more complex to design and fabricate, as each pier would be different. However, steel piers can be fabricated off-site and are also lighter than concrete piers, resulting in a lower dead load on the foundations.

2. Concrete piers can either be cast-in-place or made of precast sections. Concrete v-piers may utilize a tie to balance the inclined loading in the pier leg. The ties can either be a steel section or post-tensioned concrete beam that is anchored into the pier leg. The bearings for concrete piers may be

located at the top of the pier leg or pier cap, since the pier is not integral with the superstructure. As noted above, concrete piers are considerably heavier than steel piers, but the use of hollow precast concrete sections can significantly reduce their weight.

The use of concrete piers is preferred, as:

1. The bearings required at the base of the steel piers could be less durable with the varying water levels in the Cataraqui River.
2. The steel piers require larger bearings which are more difficult to maintain and replace in the future.
3. The tall concrete pedestal required at each steel pier location would limit the efficiencies from having the steel piers fabricated off-site.

1.1.7.2 V-Piers Versus Conventional Piers

This section describes the evolution of the pier shape design from the Municipal Class EA with recommendation of v-pier design to the preferred modified conventional pier design, refined during the validation Project phase.

The Municipal Class EA recommended 13 v-piers and 14 spans. This pier and span configuration was refined during the pre-design and preliminary Project phases to include two separate v-piers with two tie-beams as it is the simple to construct; provides structural integrity; and enables a transparent pier design.

As shown on Drawing 1.1.7.1, based on the geotechnical fieldwork, ice loading requirements and preferred vertical profile of the bridge, the proposed span arrangement for the preferred v-pier option, starting from the west shore, consisted of:

a) 3 wall-type flared piers, which are used in response to the lower elevation of the west side of the Project corridor (and similarly lower vertical profile of the bridge at this location), and 10 v-piers.

b) The arch span is supported by 2 v-piers on eight 2100 mm diameter caissons with a pile cap. The other 8 v-piers are supported on five 2400 mm diameter caissons with a pile cap. The caissons would be rock-socketed in the bedrock.

It is noted that the use of steel H-Piles was also considered, but was not carried forward as each pier would require a significant amount of battered piles to resist the lateral forces. This would add constructability complexities that would compound risk, given the pile driving conditions, depth to competent bedrock and poor overburden soil conditions.

The arch v-piers have a 26 m jump span, and are inclined at 43˚ from the horizon to match the arch geometry. The interior radius of the v-pier is situated at elevation 77.1 m, which is 0.8 m above the regulatory water level. This ensures the v-piers have a consistently distinguishable v-shape.

As shown in Figure 1-17, the v-piers have a different geometry on the approach side to the arch in order to properly support the arch and plate girders:

1. The approach side legs have 2 separate legs with a 10˚ inclination on both sides to match the approach span piers and the inclination of the arch. Each pier leg supports 2 lines of girders based on the 4-plate girder option.
2. The arch side consists of 2 wider legs in order to support the arch bearings which are connected by a header beam at the top of the pier.

The caissons support a 2.5 m deep footing for the v-pier leg supports. The top of footing will be at an elevation of 74 m, which is lower than the low water level of the Cataraqui River. Therefore, the footing will be beneath the water. The arch pier footing is fitted with a pier nosing composed of either granite or steel which acts as an ice breaker to minimize the ice loading placed on the pier. The pier nosing is inclined so that the ice will be lifted and break apart as it moves.

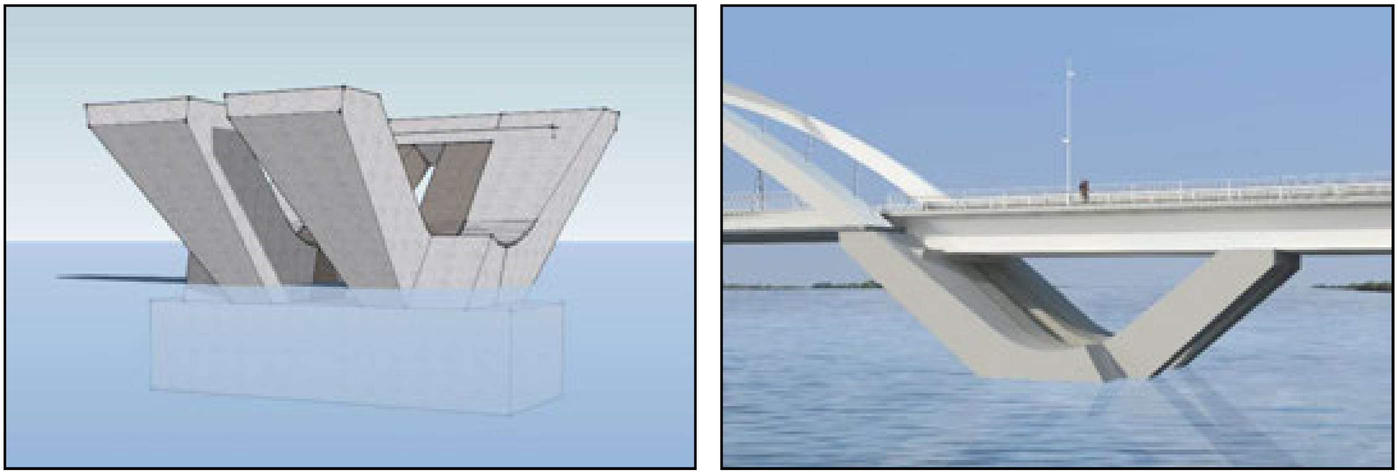

Figure 1-17: Rendering of Arch V-Piers (From Preliminary Design)

During the preliminary and validation Project phases, the v-pier design was subsequently refined with the objective of better balancing the environmental and economic impacts of the Project. The following 2 options were evaluated:

a) Conventional Piers: These would be used for all the piers, except for the v-piers at the arch. As shown in Figure 1-18, the design consists of circular 1500 mm-diameter pier columns on top of the caissons with a hammerhead pier cap. The circular caissons extend above the high-water level, and are protected by a steel casing to add protection to the concrete from ice and abrasion.

As there is less ice loading on the conventional piers due to the circular shape of the columns and no footing at the river level, the foundation requirements are reduced significantly, from five 2400 mm diameter caissons to two 1800 mm diameter caissons. The associated impacts on the riverbed and in-water footprint from the foundations are similarly reduced.

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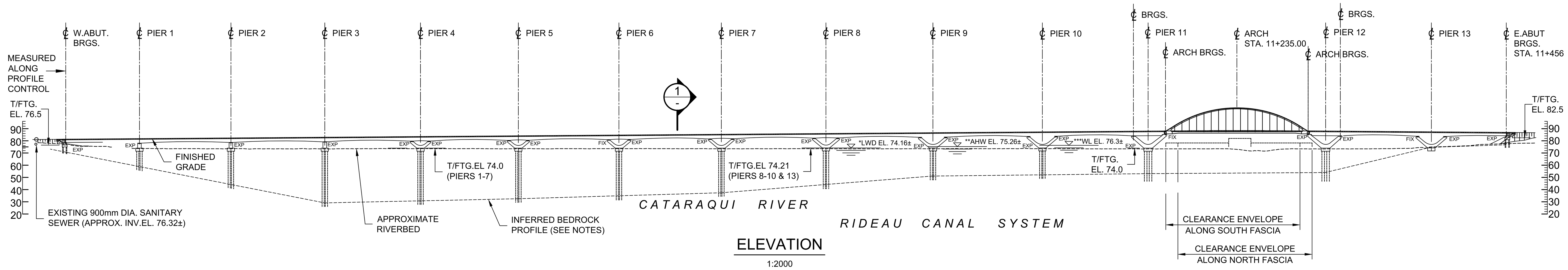

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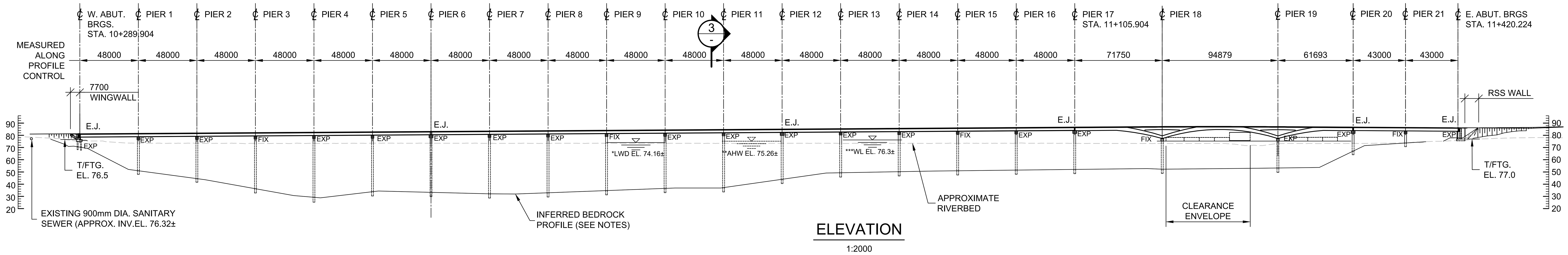
V-PIER CONFIGURATION



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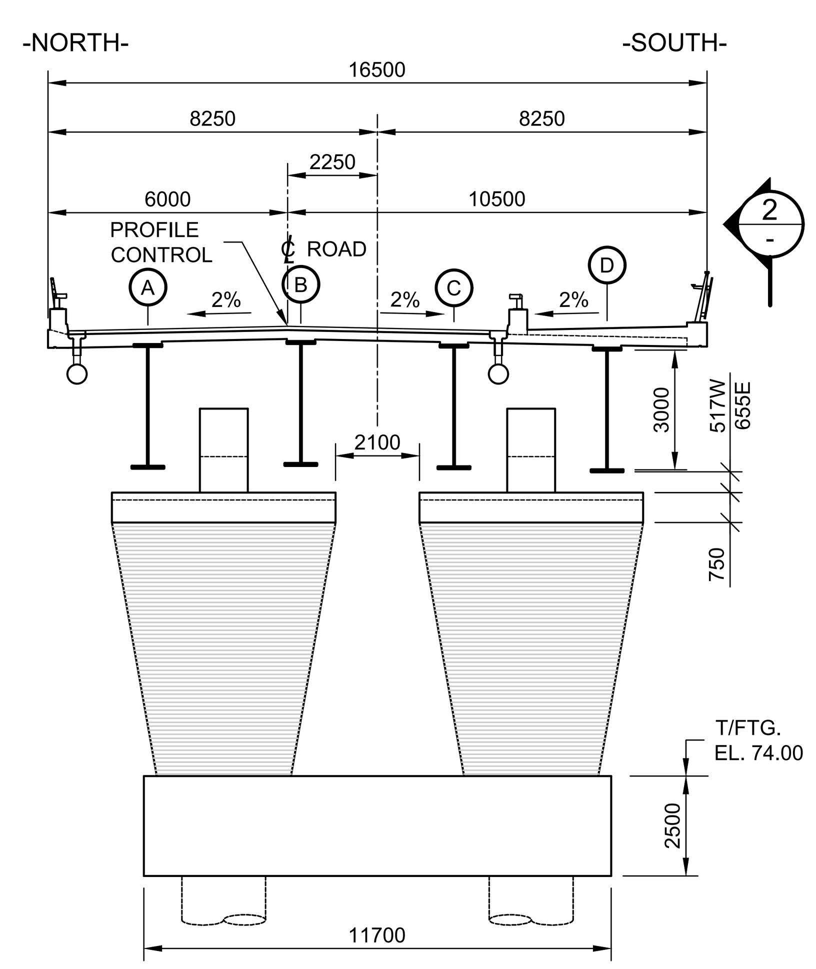
MODIFIED CONVENTIONAL PIER CONFIGURATION



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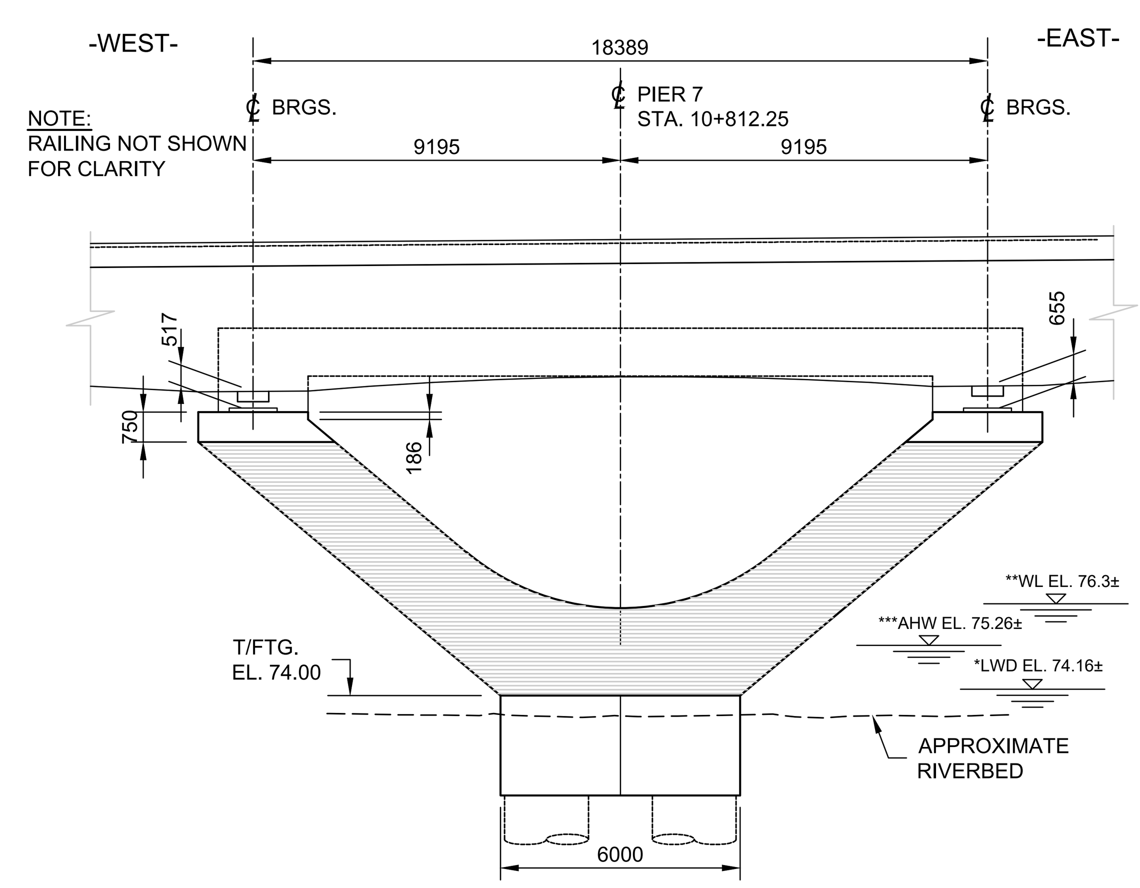

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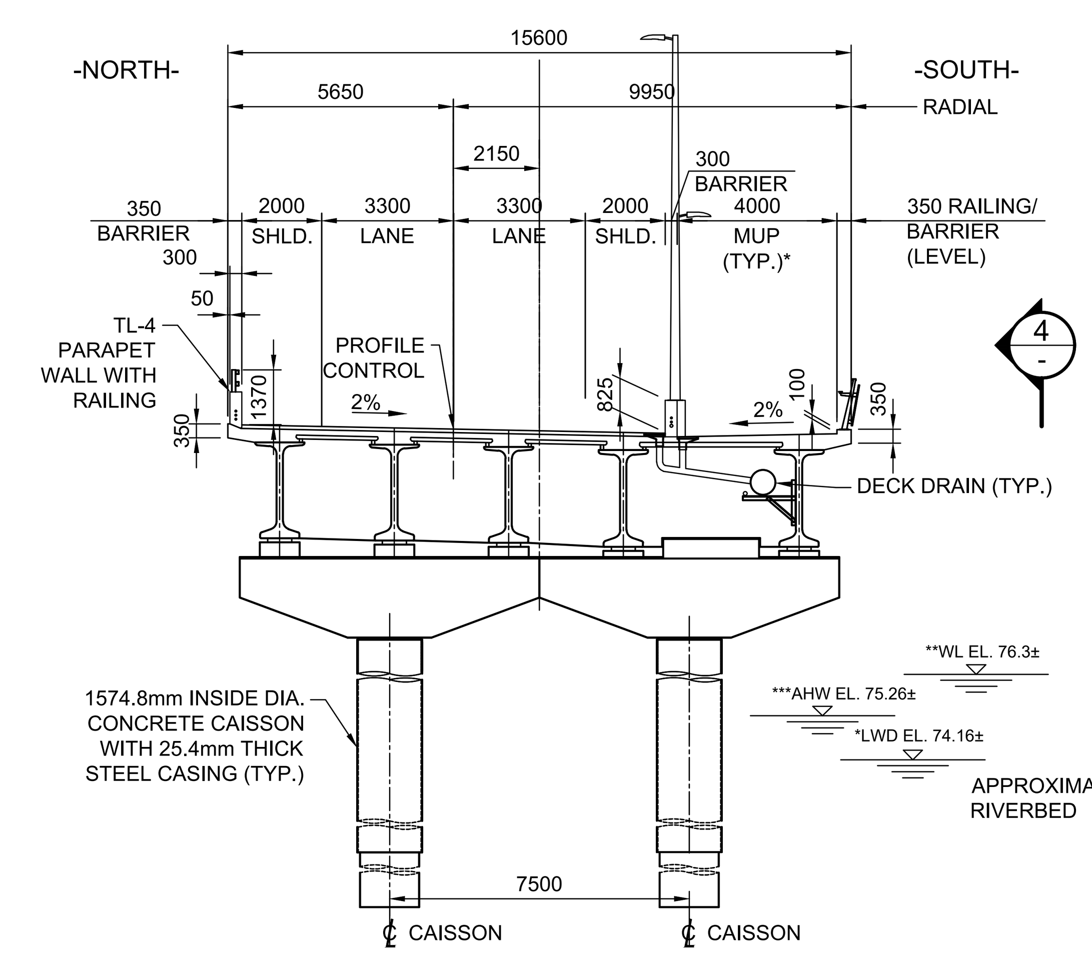

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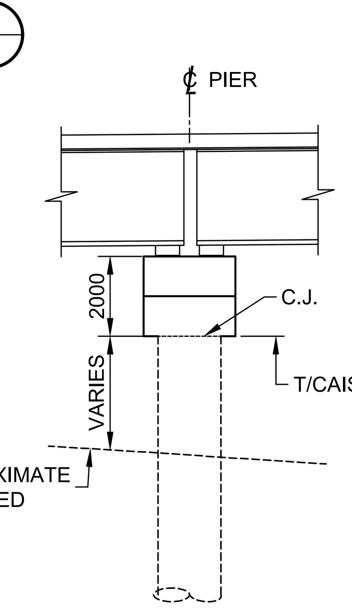

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INTEGRATED PROJECT DELIVERY TEAM:

HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: MA
DRAWN: YZ
CHECKED: MA

KINGSTON THIRD CROSSING

DIA REPORT
COMPARISON OF V–PIERS AND MODIFIED CONVENTIONAL PIERS

DATE: 11–18–19
SCALE: N.T.S.

DRAWING NO. 1.1.7.1
SHEET NO.
REVISION

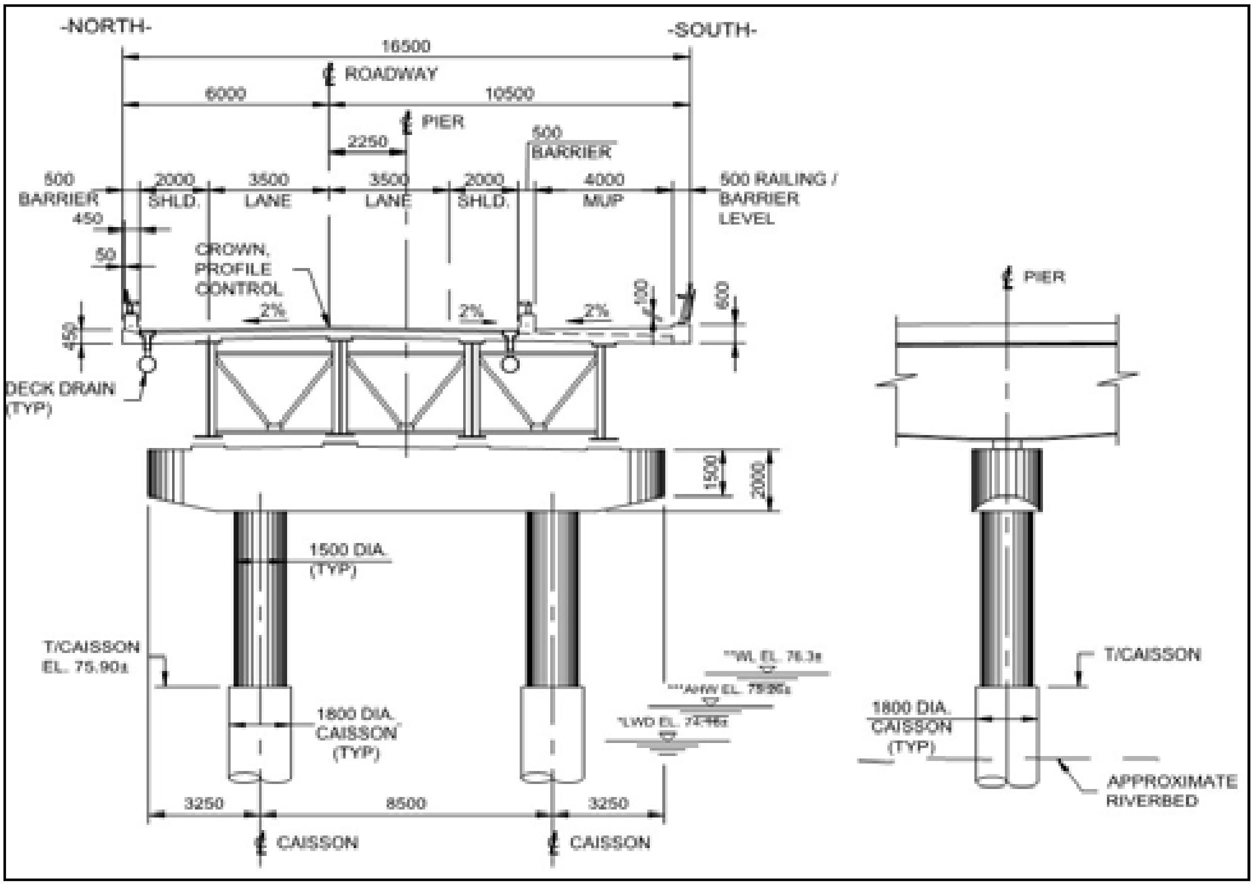


Figure 1-18:Conventional Piers with Hammerhead Pier Cap

b) Modified Conventional Piers (Preferred Option): As shown in Figure 1-19, these piers are a preferred modification to the conventional pier design in order to improve concrete protection and minimize deterioration and associated operational and maintenance costs. The modified conventional pier design for the approach spans utilize a modified conventional hammerhead pier cap supported by two 1574.8 mm inside diameter caissons with 25.4 mm thick steel casings that continue up to the underside of the pier cap. The piers at the navigation channel span will consist of a conventional hammerhead pier cap supported by three 1574.8 mm inside diameter caissons with 25.4 mm thick steel casings that continue up to the underside of the pier cap.

Figure 1-19: Modified Conventional Pier Rendering

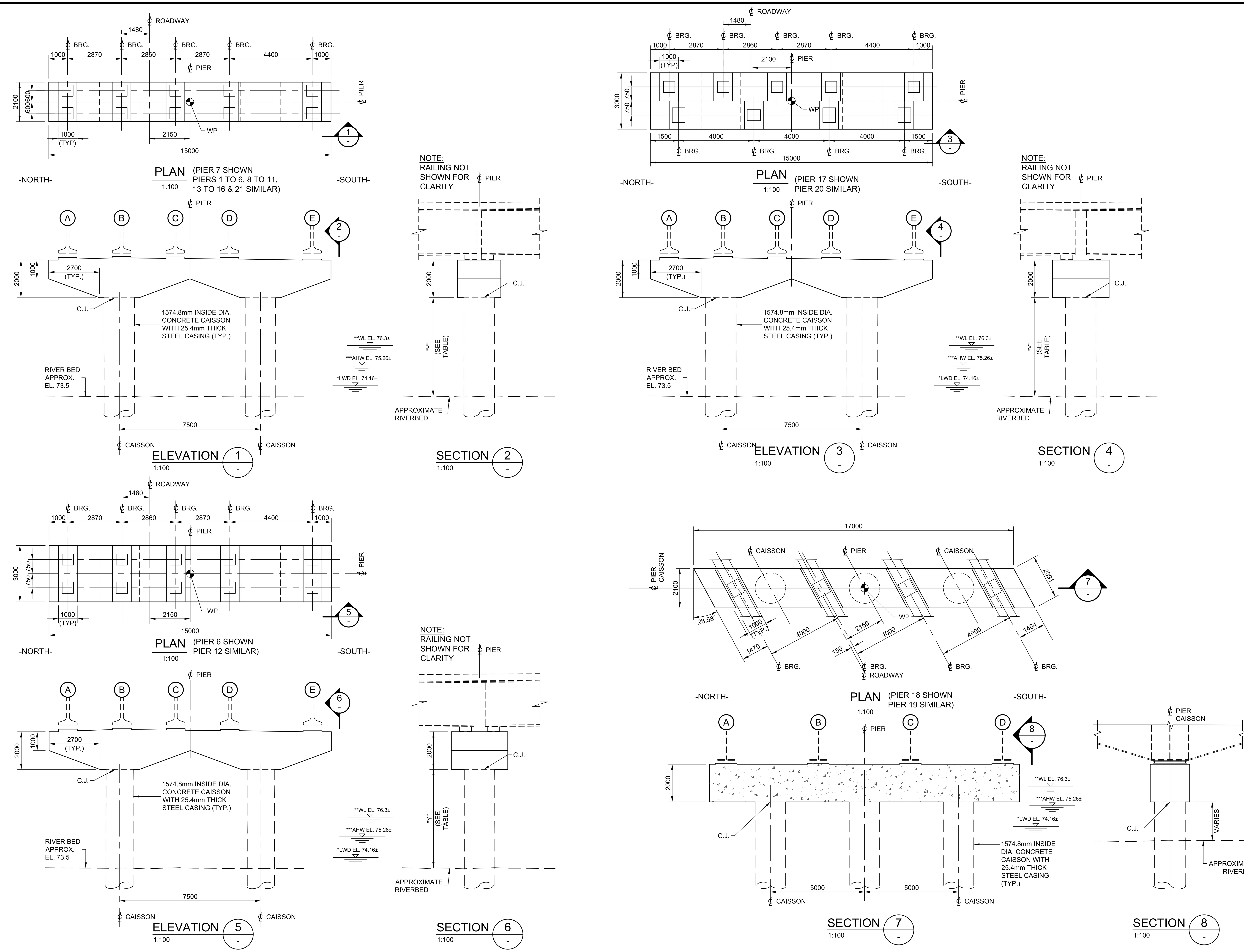
As shown on Drawing 1.1.7.2, compared to the v-pier option, there are 8 additional piers for the modified conventional pier option (one additional pier to the east of the haunched girder arch and seven to the west). The heights of the piers for the approach spans vary, growing taller from the abutments towards the back spans of the navigation channel span, while the approach span lengths are consistent at 48 m. Measured along the southern edge, the back spans of the navigation channel span are at 66 m, and the navigation channel span is at 95.0 m. Having consistent span lengths creates construction efficiencies.

Compared to the conventional pier, the modified conventional pier has less concrete and reinforcement in the pier cap, but more concrete in the pier legs. The shape of the modified conventional pier cap has less heavy and more open visual appearance. The pier legs can be cast separately from the pier cap to simplify the concrete placement. The pier cap is designed to provide jacking points on either side of the bearings to allow for jacking of the girders directly to replace the bearings. As shown in Drawing 1.1.7.2, for the approach span piers, the pier leg heights vary from 2.4 m tall to 7.5 m tall (above the lower water datum of 74.16 m); and the center-to-center spacing of the caissons is 7.5 m.

Table 1.9 further summarizes the comparison of the v-pier and modified conventional pier options. Based on this assessment, the modified conventional pier option is preferred for the following reasons:

1. The foundations reduce the in-water footprint.
2. The modified conventional pier design results in cost savings for design and construction.
3. It provides a simpler design which leads to construction efficiencies.
4. Similar to the v-pier option, the modified conventional piers are designed to accommodate future jacking for the inspection and replacement of the bearings without the need for temporary falsework.
5. The extension of the steel casing filled with concrete continued to the underside of the pier cap provides a consistent aesthetic appearance. The casing also provides improved protection of the pier leg concrete from ice, abrasion, weathering, and freeze/thaw damage from saturated concrete.

METRIC



PIERS 1 TO 17, 20 AND 21			
PIER NO.	DIMENSION "Y" (mm)	PIER NO.	DIMENSION "Y" (mm)
1	2780	11	6060
2	3180	12	6250
3	3510	13	6710
4	3830	14	7060
5	4080	15	7420
6	4270	16	7750
7	4780	17	7830
8	5170	20	7830
9	5490	21	7770
10	5820		

INTEGRATED PROJECT DELIVERY TEAM:

HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: MA
DRAWN: YZ
CHECKED: MA

KINGSTON THIRD CROSSING

DIA REPORT

PIER DETAILS

DATE: 11-18-19
SCALE: N.T.S.

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Table 1.9: V-Pier and Modified Conventional Pier Comparison

Criteria	Sub-Criteria	V-Piers	Modified Conventional Piers
Description		• 13 piers (3 wall-type piers at west side; and 10 v-piers elsewhere) • Supported on five 2400 mm diameter caissons • EA's arch span on 2 v-piers (eight 2100 mm diameter caissons)	• 21 piers • Supported on two 1574.8 mm (inside diameter) caissons with 25.4 mm thick steel casings • Navigation channel span (haunched girder arch) on three 1574.8 mm-inner diameter caissons with 25.4 mm thick steel casings
In-Water Footprint		• Permanent ~2400 m^2 • Temporary In-water footprint for V-piers ~1150 m^2 for 2 main span V-Piers	• Permanent ~92 m^2 • Temporary In-water Footprint for Piers ~ 0 m^2
Cost	Piers Only	• ~$53.8 million (M)	• ~$24 M
	Superstructure	• No change	• -$2.2 M
	Total	• ~$53.8 M	• ~$21.8 M
Ease of Construction	Caissons	• Larger equipment to install larger diameter caissons	• Equipment for caisson installation more readily available
	Formwork / Falsework	• Specialty formwork / falsework or made of precast box sections or varying geometry • Temporary supports required for some of the v-pier legs	• Simple standard formwork
Construction Duration Per Pier	Considerations	• 5 caissons • Longer to form piers as each is geometrically different • Reinforcing more complex to match pier geometry • Post-tensioning in ties and potentially in v-pier legs • 5 different pours - caissons, pile cap, base of v-pier, v-pier legs, tie	• 2 caissons • Simple standard formwork • Reinforcing tied off-site and lifted into place • 2 different pours - caissons and pier caps
	Total Duration	• ~15 weeks per pier	• ~2-4 weeks per pier
User Experience	On the Bridge	• Similar	• Similar
	On Boat	• Similar	• Similar within navigation channel
Maintenance and Operation Costs	Bearings	• 92 bearings to maintain	• 196 bearings to maintain
	Concrete	• Greater surface area of exposed concrete	• Smaller exposed concrete surface area (only pier caps) • Pier columns and caissons jacketed with steel liner
Maximum Spacing Between Piers (excluding navigation span)		• ~90 m	• ~66 m
Design	Advantages	-	• Less area exposed to ice loads • Less demand on substructure components
	Disadvantages	• Special treatment to break ice	-

1.1.8 Joints and Bearings

Expansion joints are required at 6 locations: at both abutments; at the ends of the navigation channel span's back spans (Piers 17 and 20); and at Piers 6 and 12. Due to the length of the spans, modular joints are anticipated to be used at all locations, except for the east abutment where strip seal expansion joint is anticipated to be used.

The expansion joints are designed, such that:

1. They include active drainage provisions (secondary seal, gutter and/or trough) to prevent water infiltration, thereby extending design life.
2. They are safe for both cyclists and pedestrians on the multi-use pathway.
3. They are durable, particularly on the roadway in order to withstand snow plow wear.

A total of 206 bearings are required, which are designed to account for large movements due to the continuous arrangement of the west approach while supporting large vertical loads due to the length of the spans. There are to be 10 bearings per pier, with the exception of 9 per pier at Piers 17 and 20, and 4 per pier for the navigation channel span (Piers 18 and 19). There are to be 5 bearings per abutment.

As highlighted below, the use of the following different bearings are anticipated:

1. For the navigation channel and back spans under the 4-plate steel girders:

   Pot bearings or mechanical bearings are to be used. Uni-directional transversely fixed bearings are to be used under one girder at all piers, except for Pier 18 to fix the bridge in the transverse direction. Pier 18 will utilize a fixed bearing for one girder and uni-directional longitudinally fixed bearings for the remaining girders.

2. For the approach spans and abutments under the 5-NU concrete girders:

   Elastomeric laminated bearings are to be used. A longitudinal or transverse restraint will be provided as required.

1.1.9 Barriers and Railings

MTO standard TL-4 concrete barriers are used for the roadway section of the bridge for driver safety while facilitating an unimpeded view of the landscape.

The barriers accommodate a railing fastened on top to protect cyclists on the north side barrier. Embedded ducts are also located within the concrete barriers for bridge lighting and utility assets.

For the barrier on the south side of the bridge deck, an open railing system will be developed in detailed design to optimize viewing opportunities from the bridge. A small concrete curb is provided at its base. This enables snow plows to ride against it without damaging the railing system and also prevents salt-laden water from flowing down the fascia.

1.1.9.1 Future Design Considerations

1. Spare embedded ducts can also be provided in the north barrier for utility assets, if needed.
2. Considerations during detailed design will be made to harmonize the railings to the natural lines, contours of the engineering work and cultural landscape.
3. Considerations during detailed design will be made to avoid as much as possible superimposing railings, in an effort to minimize visual obstructions to the viewscape and waterscape.

1.1.10 Abutments

The west abutment is reinforced concrete with wingwalls and RSS wall behind on the south side, that is founded on ten 915 mm diameter caissons rock socketed into the bedrock. The east abutment is reinforced concrete with wingwalls and RSS walls behind it that is founded directly on the bedrock. During the validation Project phase, the spans arrangement was optimized, and locations of the abutments were shifted inwards towards the river compared to the Municipal Class EA recommended location of the abutments. The east abutment centreline is shifted to approximately 40 m from the approximate shoreline (elevation 74.0± m), and west abutment centreline is shifted to approximately 18 m from the approximate shoreline.

The top of the abutment footing elevations are above the lower water datum (74.16 m) at elevation 76.5 m for the west abutment and elevation 77.0 m for the east abutment, and are also above the regulatory water level (76.3 m).

The west abutment requires some excavation for its construction; and the east abutment is in a fill condition, but may require a minimal quantity of excavation. Construction of the approach embankments to achieve finished grade levels will consist of soils graded and compacted to the performance requirements. The fill behind the embankments will be designed to meet settlement and vehicular load requirements, and the exposed surfaces will consist of material graded to resist erosion. Generally the material will consist of soils graded and compacted to meet the performance requirements, capped with Granular B and Granular A. In potential flood areas there will be scour protection that will consist of local rock. Behind the east abutment, RSS walls and suitable material would be used to avoid infilling of the historic survey camp and trees.

1.1.11 Approach Roadways

1.1.11.1 Design

The 2-lane vehicular bridge is integrated into the existing road network on-shore through a transportation assessment that was undertaken during the pre-design Project phase. Both east and west approaches adopt a conventional road cross section, with:

1. 3.5 m wide basic through traffic lanes with auxiliary lanes.
2. Urban cross-sections including raised curb and gutter along the edge of pavement. Catchbasins required for stormwater management include cycle-friendly grating.
3. Concrete sidewalks or paved multi-use trails (MUT) located adjacent to, or offset from, the vehicular lanes.
4. Various underground and above ground utility accommodations, including the relocation of overhead electrical transmission lines along John Counter Boulevard.

As shown on Drawing 1.1.11.1, the west approach includes 2 intersections with associated turning lanes in each direction. More specific details include:

1. The John Counter Boulevard-Montreal Street intersection is signalized and upgraded with new granular and asphalt pavement and stormwater drainage system construction to accommodate the west approach.
2. Ascot Lane is reconfigured as a perpendicular intersection to John Counter Boulevard, and is also signalized to allow both cyclists and pedestrians to cross at the intersection on the west side of the bridge and to service turning traffic into and out of the reconfigured intersection.

3. The multi-use pathway from the bridge connects to proposed and future pathways on-shore.

As shown on Drawing 1.1.11.2, the east approach also includes 2 intersections with associated turning lanes in each direction. More specific details include:

1. The Gore Road-Highway 15 intersection is signalized, with the lane arrangements leading up to the intersection connecting with planned upgrades to Highway 15 including the transition of pavement widening beyond the intersection i.e. further to south, north and east of the intersection.

* APPROXIMATE FUTURE/EXISTING TRANSIT STOP WITH SHELTER PAD

1. PROPOSED DITCH GRADING AND LOCATION OF STORM MANAGEMENT & DRAINAGE ELEMENTS ARE SUBJECT TO REVISION.

METRIC

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SAVED BY: WEST867507

INTEGRATED PROJECT DELIVERY TEAM:

HATCH | SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES | Kiewit | KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY:

DESIGN:	AC
DRAWN:	LW
CHECKED:	AK

KINGSTON THIRD CROSSING OF THE CATARAQUI RIVER
DIA REPORT

WEST APPROACH

DATE: 08-28-2019
SCALE: N.T.S.

DRAWING NO. 1.1.11.1
SHEET NO. 1 OF 2
REVISION

* APPROXIMATE FUTURE/EXISTING TRANSIT STOP WITH SHELTER PAD

1. PROPOSED DITCH GRADING AND LOCATION OF STORM MANAGEMENT & DRAINAGE ELEMENTS ARE SUBJECT TO REVISION.
2. PROPOSED ROADWAY IMPROVEMENTS SHOWN FOR THE SECTIONS EAST OF LIBRARY ROAD AND POINT ST. MARK DRIVE INTERSECTION ARE SUBJECT TO CHANGE.

INTEGRATED PROJECT DELIVERY TEAM:

HATCH | SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES | Kiewit | KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY:

DESIGN: AC	KINGSTON THIRD CROSSING OF THE CATARAQUI RIVER DIA REPORT	DRAWING NO. 1.1.11.2
DRAWN: LW	EAST APPROACH	SHEET NO. 2 OF 2
CHECKED: AK	DATE: 08-28-2019 / SCALE: N.T.S.	REVISION

DRAWING NAME: H357883-20-260-SEC0-DIA Report.dwg
SAVED BY: WEST867507 SAVE DATE: 8/28/2019 3:33 PM PLOT DATE: 8/28/2019 3:34 PM

2. The Gore Road Library entrance is reconfigured as a perpendicular intersection with Point St. Mark Drive, and is also signalized.
3. The multi-use pathway from the bridge connects to proposed and future pathways on-shore.

1.1.11.2 Future Design Considerations

1. The future transit stop locations shown on Drawing 1.1.11.1 and Drawing 1.1.11.2 are subject to confirmation by Kingston Transit.
2. Traffic calming options through the Point St. Mark neighborhood, which were conceptualized during the Municipal Class EA and pre-design and validation Project phases (see, Figure 1-20 and Figure 1-21) should be considered further by the City and Point St. Mark residents.

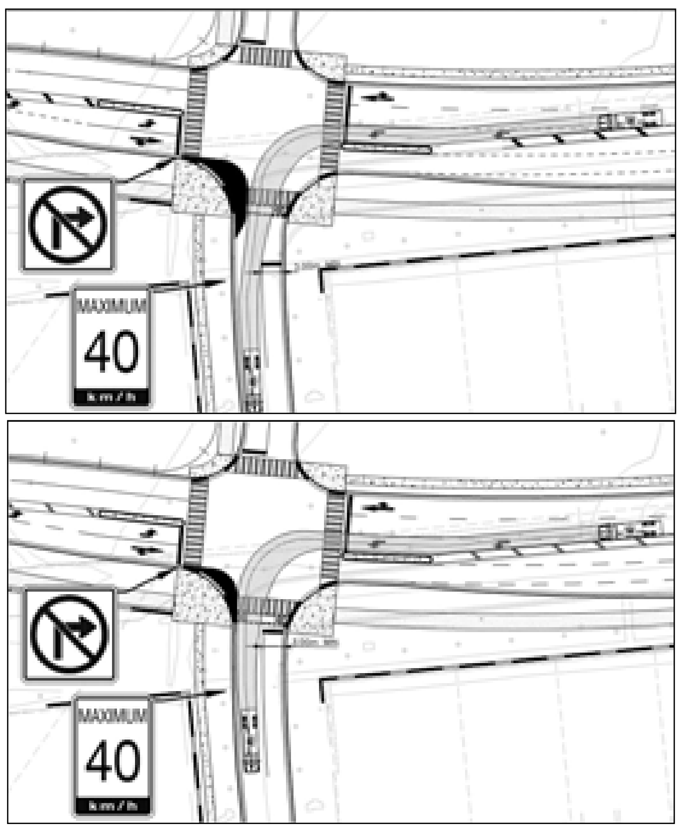

Figure 1-20: Directional Lane Closure

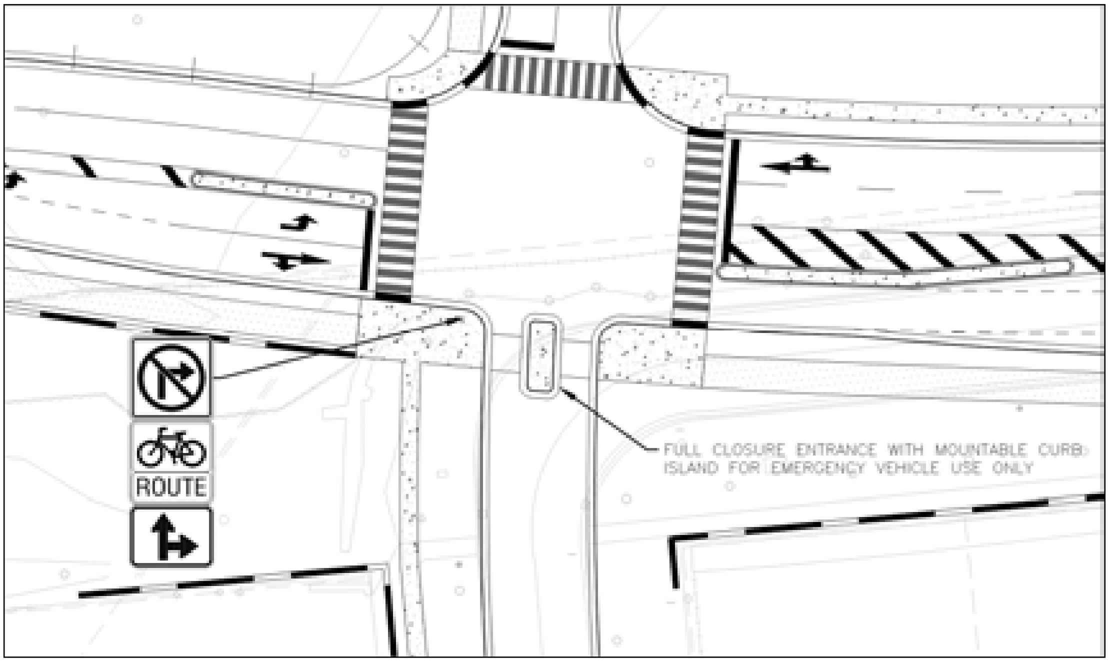

Figure 1-21: Full Lane Closure

1.1.12 Lighting, Electrical and Communications

1.1.12.1 Design

The intent of the lighting design within the Project corridor is to provide safe, effective illumination that is focused on the roadways, multi-use pathway and navigation channel (including the adjacent rowing lanes), while at the same minimizing any potential impacts to wildlife, navigation and visitor experience. The design includes:

1. **Roadway Illumination:** As per City standards, as an urban arterial, the illumination design level for the roadway has an average, maintained, horizontal illuminance level of 17 lux with an average to minimum ratio of 3:1.
2. **Multi-Use Pathway Illumination (on the bridge):** The multi-use pathway illumination on the bridge has an average, maintained, horizontal illuminance level of 5 lux, as per City and IESNA guidelines. This is achieved with a smaller wattage luminaire mounted on the same poles in the median, as noted above.

3. **Intersection Illumination:** The intersection of illuminated roadways, whether signalized or not, require additional illumination levels. As per City standards, all intersections within the Project corridor have 50% higher illumination.

4. **Bridge Navigation:** Provisions are in place to accommodate navigational lighting on the north-and-south-facing sides of the bridge deck, directly above the navigable channel. This lighting would be used to supplement the buoy markers currently in use for the portion of the navigable channel affected by the bridge footprint.

   Light standards are integrated into the center barrier. Where provided, the multi-use pathway is narrower than 4 m. But it is still wider than the City's 3 m wide multi-use pathway design standard. Illumination is provided for both the roadway and MUP by two luminaires attached to the same pole. The spacing of the light poles is consistent with the spacing of the approach span piers, and spaced evenly and symmetrically over the navigation channel span and its back spans.

   Due to the length of the bridge, 2 separate supply points [Supply Control Cabinets (SCC)] support all the lighting and electrical requirements for the bridge, including the roadways, multi-use pathway, and navigation safety lighting as well as auxiliary power receptacles:

   1. There will be one SCC located on the east side of the bridge, just east of the abutment. This SCC will provide power for the east side of the bridge, to the halfway point of the bridge, which includes roadway and pedestrian lights on the bridge; and Gore Road street lights;

   2. The second SCC will be installed on the west side of the bridge, just west of the abutment. This SCC will provide power to the west side of the bridge, to the halfway point of the bridge, which includes roadway and pedestrian lights; and also, the roadway lights on John Counter Boulevard will be powered from this SCC.

   The exact locations of the Power Supplies has yet to be finalized ; however, they will be installed off the bridge and on-shore.

   Since penetrations through the bridge deck are to be minimized, the use of branch circuit wiring between luminaires is restricted to the center barrier. This will ensure that the deck penetrations occur where the service point feeds the first luminaire in a string of 10 luminaires.

Both shore land areas within the Project corridor are to be serviced by local SCC with power available on either approach.

In addition to electrical services:

1. A communications raceway system is also accommodated under the bridge for future emergency call button, closed circuit video monitoring, weather monitoring, structural health monitoring system (SHMS) or other real-time system installation, if required.
2. A catwalk will be installed between the middle girders to enable inspections and to locate the conduit pathways for both power and communications requirements, if required.

1.1.12.2 Future Design Considerations

1. The use of motion-sensors (which dims lighting to moonlight levels when no pedestrian, cyclist or vehicular traffic is present), and narrow spectrum LED light fixtures (reducing the impact of lighting on nocturnal and crepuscular wildlife), will be investigated further, as such features would promote energy conservation, extend the service life of the lighting system, and reduce the impacts of artificial light on adjacent wildlife and wildlife habitats. The use of motion sensors to control the multi-use pathway illumination will be considered to minimize light pollution in the wetland.
2. Illumination may not be required on pathways that are not adjacent to the roadway.
3. Communications and utility system(s) provisions under the bridge will be considered further, based on practicality.

1.1.13 Approach Drainage and Stormwater Management

The stormwater management design compares pre-development and post-development flows to demonstrate that the post-development flows are adequately managed. Factors to be considered include identification of major (overland) and minor (underground) drainage pathways, sizing and type of treatment facilities, and the discharge method at both shorelines. Drawing 1.1.13.1 shows pre-development flow conditions within the Project corridor:

1. On the west approach:

a) **The pre-development** condition shows no piped storm system east of Montreal Street. Runoff flows east towards the Cataraqui River and enters the river as sheet flow via ditches extending along the north side of John Counter Boulevard only.

b) The post-development condition, as shown on Drawing 1.1.13.2, includes:

i. for quantity control, enhanced grassed swales with 2 m wide, 3:1 side slopes installed to safely convey and control the outflow from the west approach;

ii. for quality control, a stormwater treatment unit (oil-grit separator units such as 'Stormceptors') will be used at the outlet of the enhanced grass swale runoff;

iii. new stormwater piping (1:10 year event via to low point on the approach road) using a 300 - 825 mm diameter outlet pipes with appropriately sized rip rap protection conveying runoff from the approach and bridge to the enhanced grass swales along the north side of John Counter Boulevard;

iv. from the low point, runoff is piped to the enhanced grass swales whereas major event flows will flow overland to the east towards the Cataraqui River; and

v. bridge drainage joins the approach drainage also at the low point.

2. On the east approach:

a) **The pre-development** condition shows an existing 600 mm diameter sewer on Gore Road which captures an area east of Highway 15 and the existing catchbasins on Gore Road. Flows are discharged into a swale which then transitions to small creek flow discharge into the Cataraqui River. Runoff that is not captured by the creek flow enters the river as sheet flow.

b) **The post-development** condition, as shown on Drawing 1.1.13.2, includes:

i. continued maintenance of the existing minor system that drains directly to the river along the south of Gore Road via a 600 mm diameter storm sewer;

ii. for quantity control, a dry pond facility near the east bank, having a 4:1 length-to-width ratio, a 4:1 side slope, and an active storage depth of less than 1 m. Grading of the dry pond will be completed during detailed design;

iii. for quality control, a stormwater treatment unit (oil-grit separator units such as ‘Stormceptors’) ahead of the dry pond facility;

iv. new stormwater piping (1:10 year event via to low point on the approach road) using a 300 - 450 mm diameter outlet pipes with appropriately sized rip rap protection conveying runoff from the approach and bridge flowing into enhanced grass swales, which drain to the dry pond facility;

v. accommodation of bridge drainage and overland flows from major events into the dry pond facility; and

vi. a new minor system conveying runoff to the enhanced grass swale north of Gore Road to capture the road widenings, including west of Point St. Mark Drive.

The existing Gore Road storm sewer network will be maintained providing treatment and conveyance consistent with the existing stormwater conditions. The proposed improvements Gore Road storm sewer network will be serviced by the dry pond facility. All additional flow controls are considered in the dry pond facility. The south system along Gore Road will be maintained with the existing capacity and flow conveyance provided.

The dry pond facilities are self-draining and conceptual water quality release rates and pond sizing (area and volume) are shown in Table 1.10: Water Quantity Control Targets and Table 1.11: East Pond Stage Storage Relationship.

Table 1.10: Water Quantity Control Targets

Flow Condition	West Shore (m^3/s)	East Shore (m^3/s)
Pre-development maximum flow to river	0.43	1.29
Maximum runoff from bridge surface	0.25	0.05
Target flow: pre-development plus bridge runoff	0.68	1.33
Post-development: maximum flow to river	0.63	1.32

Table 1.11: East Pond Stage Storage Relationship

East Pond	Elevation (m)	Area (m^2)	Volume (m^3/s)
Base of Pond	76.3	181	0
Maximum Water Level	77.2	456	285
Top of Pond	77.6	560	458

The pond outlet includes an orifice and spillway to manage the outlet flow to the existing drainage feature. Orifices are connected to 450 mm pipes. Along the west shoreline specifically, a 50 m long level spreader is also included in order to reduce discharge velocities to less than 0.9 m/s.

For additional supporting information, please refer to Appendix Q.

1.1.14 Bridge General Arrangement Drawing and Renderings

A general arrangement of the bridge is shown in Drawing 1.1.14.1. Renderings of the bridge from different vantage points are shown in Figure 1-22 to Figure 1-25.

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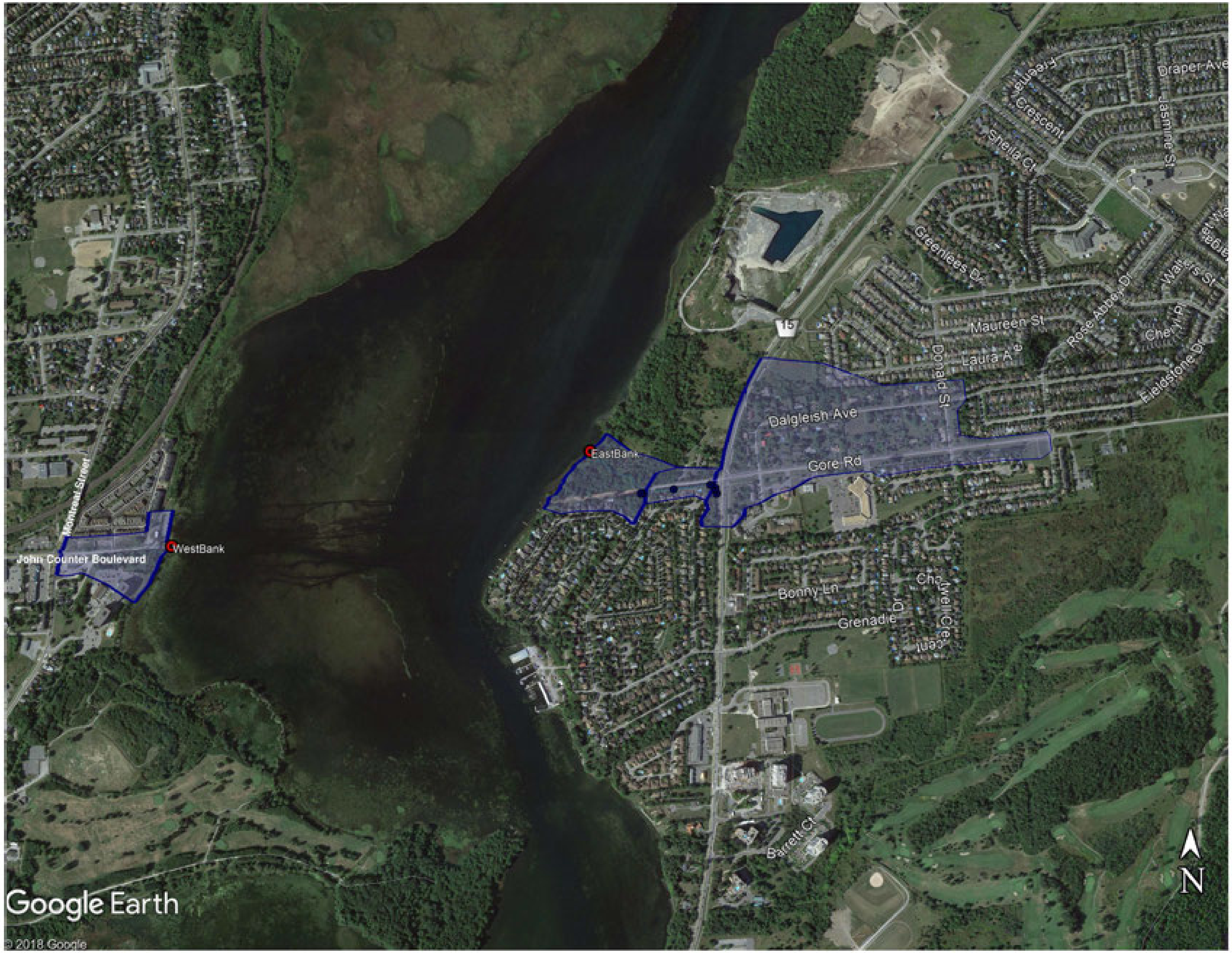


INTEGRATED PROJECT DELIVERY TEAM:

HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: EM
DRAWN: DJ
CHECKED: MD

KINGSTON THIRD CROSSING

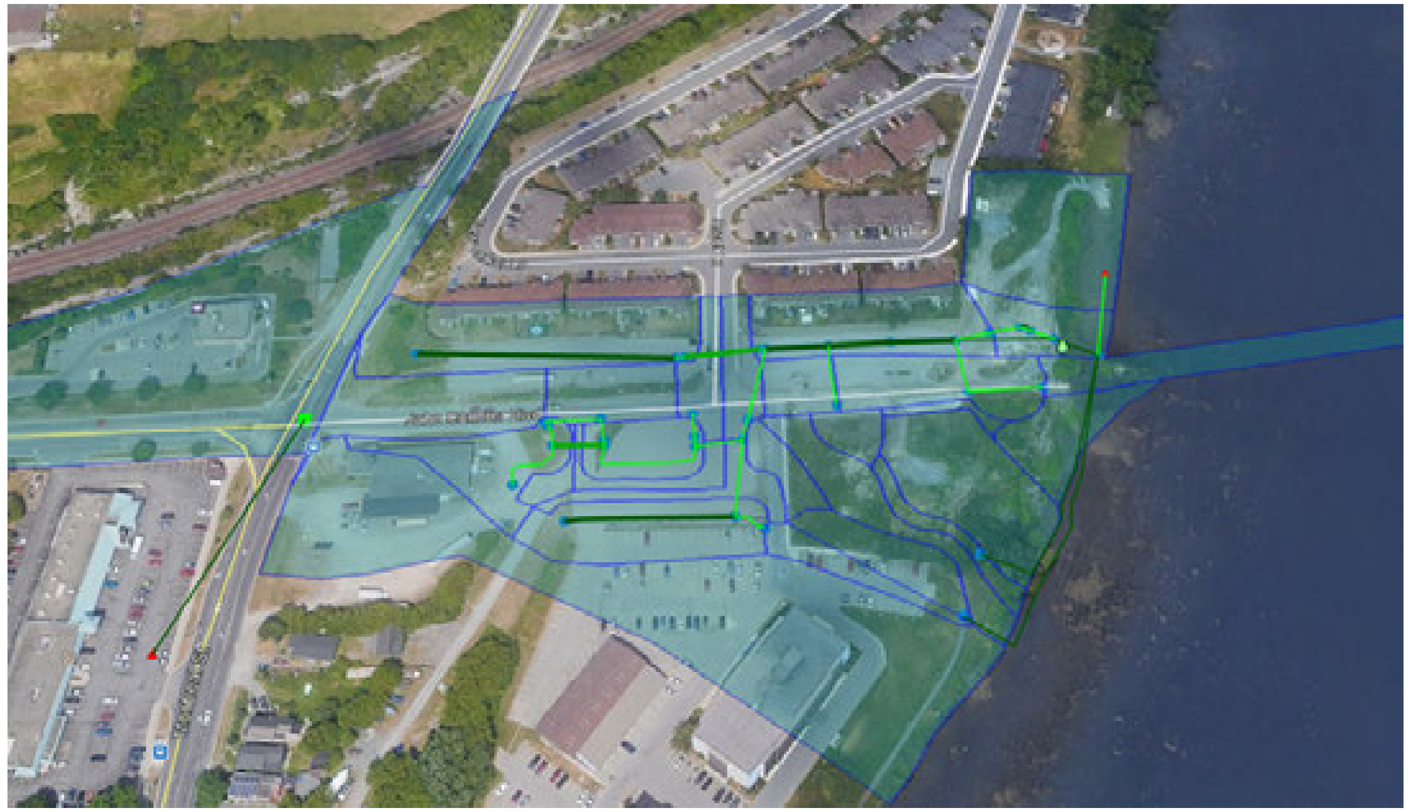
DIA REPORT

PRE-DEVELOPMENT CONDITIONS

DATE: 19-02-19
SCALE: N.T.S.

DRAWING NO. 1.1.13.1
SHEET NO.
REVISION

METRIC



A: WEST SIDE

B: EAST SIDE

INTEGRATED PROJECT DELIVERY TEAM: HATCH, SYSTRA International Bridge Technologies, Kiewit, Kingston

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN:	EM
DRAWN:	DJ
CHECKED:	MD

KINGSTON THIRD CROSSING

DIA REPORT

POST–DEVELOPMENT CONDITIONS

DATE: 11–18–19

SCALE: N.T.S.

DRAWING NO. 1.1.13.2

SHEET NO.

REVISION

DRAWING NAME: Figure 2 – Post–Development Flow Conditions.dwg
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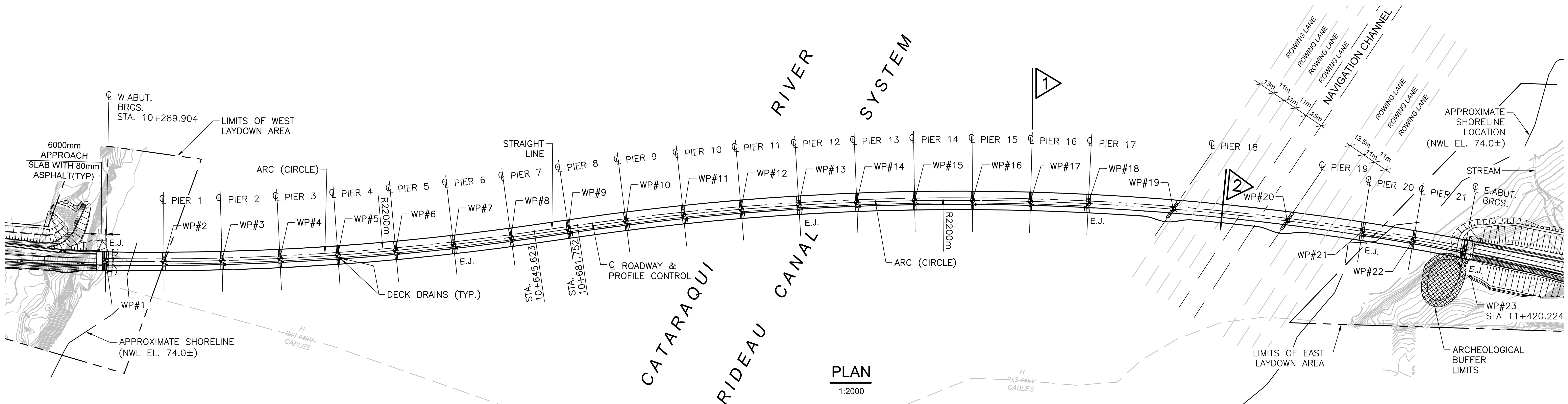
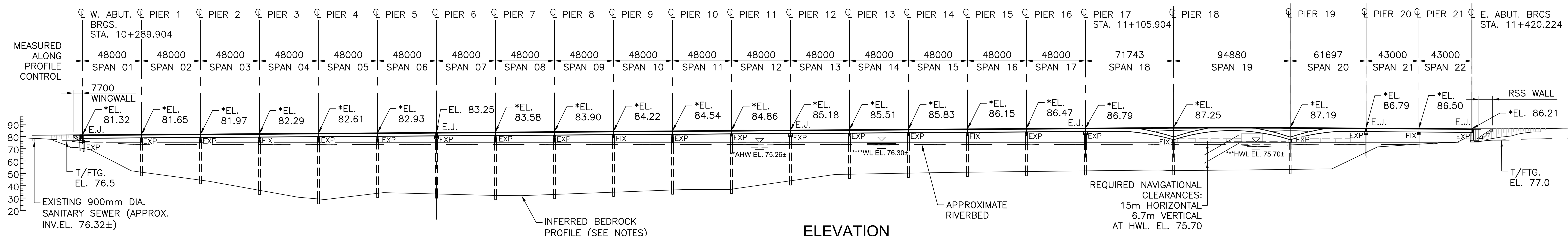
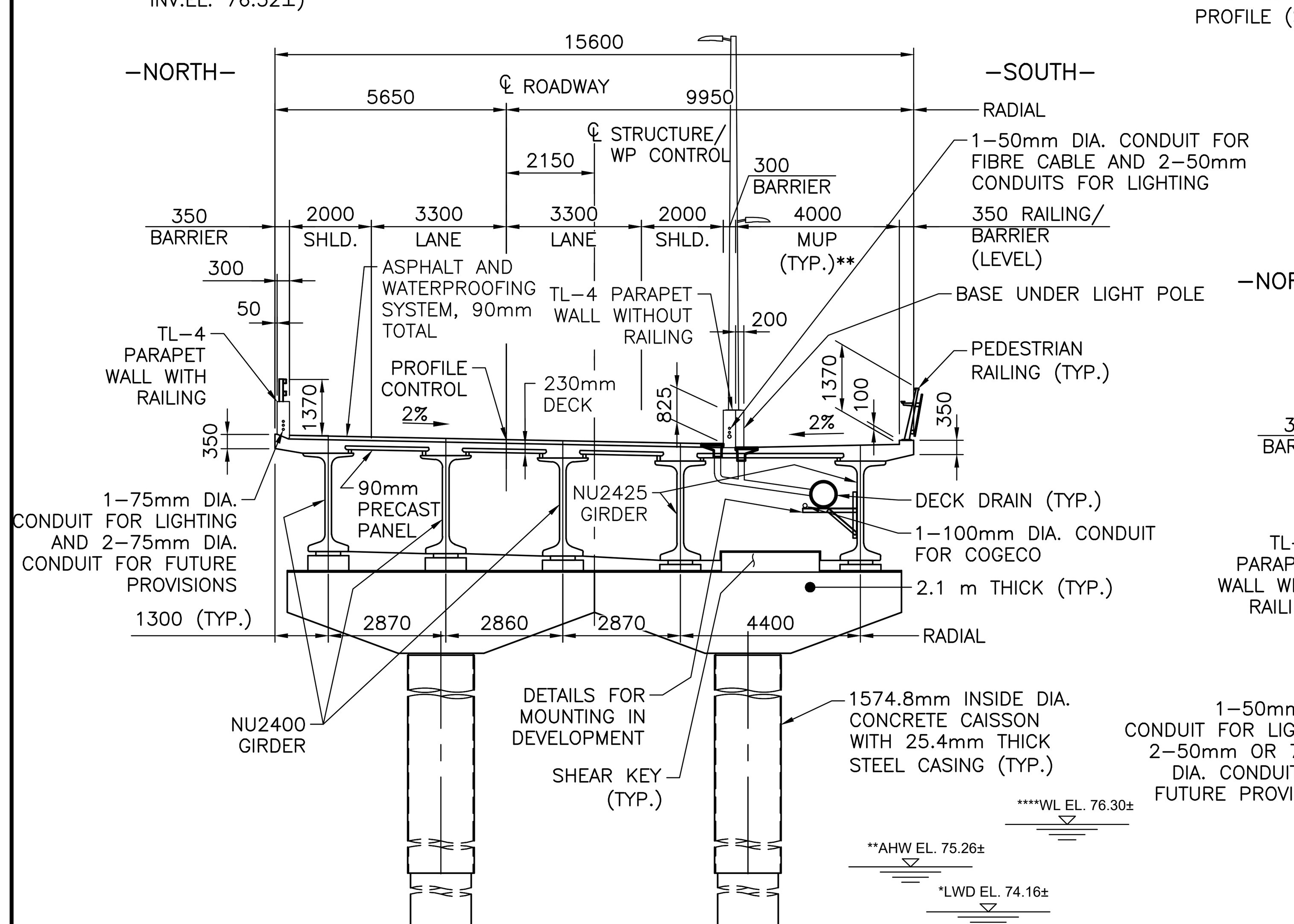


PLAN
1:2000



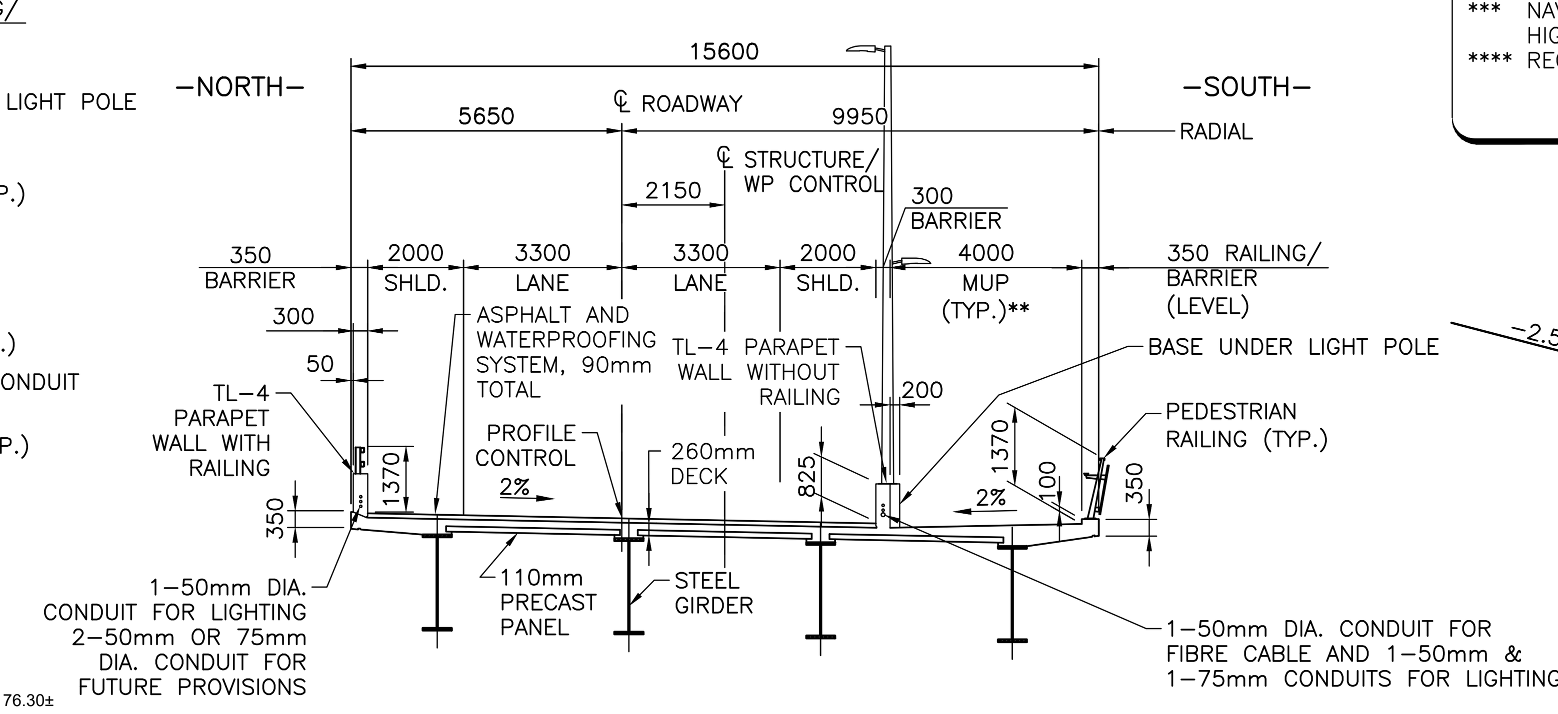
ELEVATION
1:2000

(* ELEVATION SHOWN ARE ALONG PROFILE CONTROL)



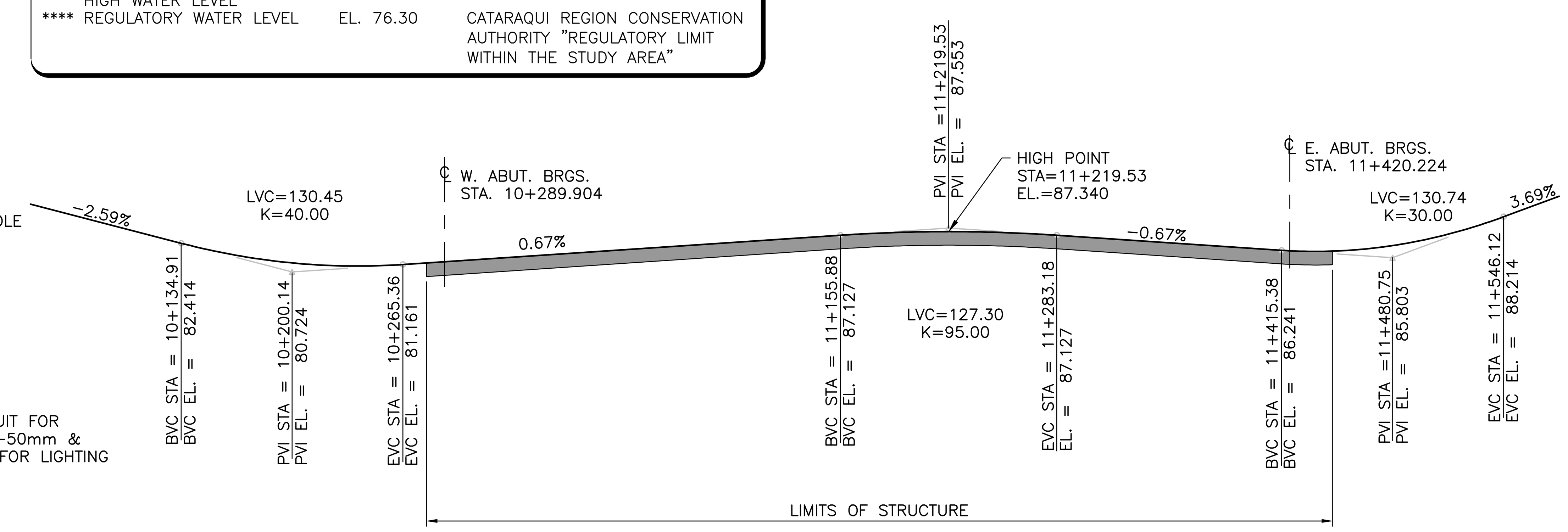
1 APPROACH SPANS AT TYPICAL PIER
SCALE 1:125

** LOCALLY REDUCED AT LIGHT POLE LOCATIONS. MINIMUM MULTI-USE PATH WIDTH OF 3000mm REQUIRED.



2 MAIN BRIDGE TYPICAL SECTION
SCALE 1:125

NOTE:			
* LOW WATER DATUM	EL. 74.16	CANADIAN HYDROGRAPHIC SERVICE (LAKE ONTARIO)
** AVERAGE HIGH WATER	EL. 75.26	MINISTRY OF NATURAL RESOURCES (LAKE ONTARIO)
*** NAVIGATION CHANNEL HIGH WATER LEVEL	EL. 75.70	PARKS CANADA
**** REGULATORY WATER LEVEL	EL. 76.30	CATARAQUI REGION CONSERVATION AUTHORITY "REGULATORY LAKE LIMIT WITHIN THE STUDY AREA"



PROFILE CONTROL (ROADWAY)
N.T.S.

NOTES

1. FOR GENERAL NOTES SEE SHEET S0001.
2. UNLESS OTHERWISE NOTED, DESIGN IS CONDUCTED AND ALL DIMENSIONS AND COORDINATES PROVIDED IN THE PROJECT'S K3C GROUND BASED REF. SYSTEM.
3. MAINTAIN FULL NAVIGATIONAL CLEARANCE THROUGHOUT CONSTRUCTION.
4. INFERRED BEDROCK PROFILE IS BASED ON 2018 BOREHOLE INVESTIGATION BY TULLOCH ENGINEERING AND BOREHOLE LOGS FROM GOLDER ASSOCIATES REPORT ENTITLED "PRELIMINARY GEOTECHNICAL INVESTIGATION – THIRD CROSSING OF CATARAQUI RIVER – JOHN COUNTER BOULEVARD TO GORE ROAD, KINGSTON, ONTARIO", DATED MARCH 2017, REPORT NO. 1541774/2000/003.

DRAWING NAME: Drawing 1.1.14.1.dwg SAVE DATE: 11/18/2019 9:41 AM PLOT DATE: 11/18/2019 10:00 AM
SAVED BY: ZHAO857409

INTEGRATED PROJECT DELIVERY TEAM:
HATCH SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES Kiewit KINGSTON

No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: HATCH

DESIGN: MA
DRAWN: YZ
CHECKED: MA

KINGSTON THIRD CROSSING
DIA REPORT
GENERAL ARRANGEMENT

DATE: 11-18-19
SCALE: N.T.S.

DRAWING NO. 1.1.14.1
SHEET NO.
REVISION

Figure 1-22: Bridge Rendering from the Elliott Avenue Parkette

Figure 1-23: Bridge Rendering Looking South (close to Buoy S33)

Figure 1-24: Bridge Rendering Looking from Point St. Mark during Winter

Figure 1-25: Bridge Rendering Looking North (close to Buoy S15)

2. Bridge Constructability Analysis

2.1.1 Options

The recommendation in the Municipal Class EA to dredge a channel to facilitate in-water construction barge access was based on an assessment of the following three options: dredging; temporary earth berm; and temporary work bridge. These options were further evaluated during the pre-design and validation Project phases before arriving at a hybrid option best suited for the conditions of the Project.

2.1.1.1 Dredging/Deep Draft Barge

As shown in Figure 2-1, dredging accommodates the draft for oversized construction barges which would be used to transport equipment and personnel to each pier location. The dredging could be done via mechanical (e.g. clamshell) or hydraulic (e.g. cutter suction) methods.

The depth of the dredged channel would be 1.5 m to 2 m below the mudline, which is mostly peat and aquatic vegetation. Its bottom width would be 20 m with 3:1 to 6:1 side slopes to accommodate the oversized barges required for the cranes. The overall in-water footprint of the dredged channel would be approximately 36,500 m^2. It should be noted that this estimate considered a dredged channel to allow one barge to access the alignment. Material supply barges and supplementary equipment barges would require additional dredging in this scenario, estimated to be up to 3 times, or approximately 109,000 m^2 of dredging.

It would take 3-4 months to dredge the channel. After bridge construction, the dredged channel could either be back-filled or left in place.

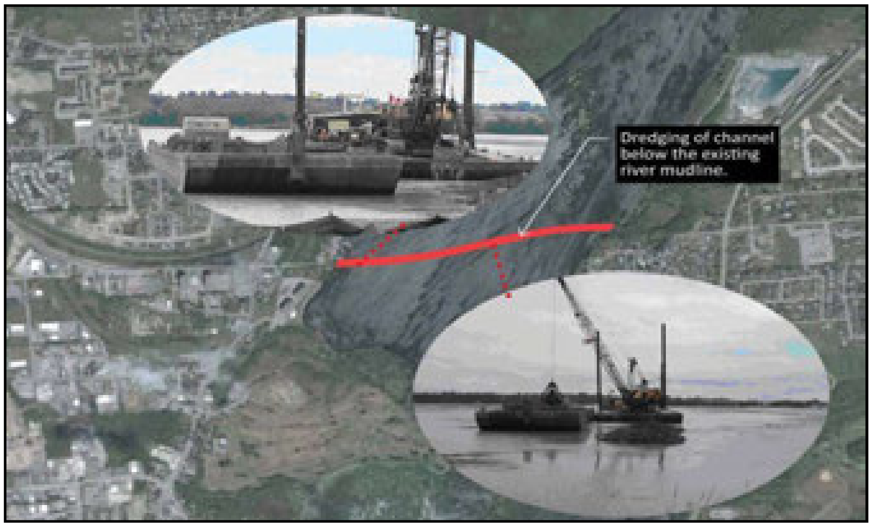


Figure 2-1: Dredging

2.1.1.2 *Temporary Earth Berm*

As shown in Figure 2-2, the temporary earth berm would infill rock to provide a temporary east / west in-water access road. For this Project, the temporary earth berm would extend from shore to the navigable channel on both sides. A barge or trestle would be used to transport material, equipment and personnel from one side of the navigable channel to the other.

The temporary earth berm would be 10 m to 12 m wide to accommodate the movement of construction equipment and materials as well as construction activities. The depth of fill would range from 2 m to 2.5 m. The rock fill causeway would be constructed of material that facilitates construction, removal and re-naturalization. The overall in-water footprint of the temporary earth berm would be approximately 40,000 m^2 which is less than the estimated in-water footprint of the dredging option.

It would take approximately 6 months to install the temporary earth berm, which could be installed in conjunction with the construction of the bridge substructure. After bridge construction, it would take 5 to 6 months to remove the temporary earth berm.

Figure 2-2: Temporary Earth Berm

2.1.1.3 Temporary Work Bridge

As shown in Figure 2-3, the temporary work bridge would be installed alongside the location of the permanent bridge. For this Project, it would consist of end bearing piles driven into the riverbed every 10 m to 12 m, supporting a cap beam and track beams with a timber crane mat. It would extend from shore to the navigable channel on both sides. A barge or lift span would be used to transport material, equipment and personnel from one side of the navigable channel to the other.

The temporary work bridge would be approximately 11 m wide to accommodate the movement of construction equipment and materials as well as construction activities. There would be extensions of the temporary work bridge at each pier location to further enable construction. The overall area of the temporary work bridge would be approximately 17,000 m^2, but its in-water footprint would be 3,000 m^2. As such, its in-water footprint is less than that of the dredging and temporary earth berm options.

It would take approximately 8 months to install the temporary work bridge, which would be advanced in conjunction with other construction activities.

After bridge construction, it would take approximately 6 months to remove the temporary work bridge: its platforms would be removed, while the piles could also be removed or cut off below the top of the riverbed and left in place.

Figure 2-3: Trestle or Temporary Work Bridge

2.1.1.4 *Causeway-Trestle Solution Construction Approach*

The Causeway-Trestle Solution (CTS) is a hybrid construction approach and would involve a combination of temporary causeways and a temporary work bridge (trestle) to access the piers and superstructure. A lifting span bridge will be used to transport equipment and material over the navigable channel when needed.

The temporary causeways and working platforms (for installing the pier caissons) would act as the means of access to Piers 1 to 17 and 20 and 21, from the west and east banks, respectively. The causeways and working platforms would have the following characteristics: a side slope between 2H:1V and 1.5H:1V that extends to the organic layer at an elevation ranging between 72.7 and 73.4 m, assuming the causeway crest is at an elevation of 76.5 m. Based on the peat layer thickness of the river bed of a specific section of causeway, the causeway area has been classed into three zones where three causeway designs are proposed to be utilized. The proposed cross-sections of the causeway zones are shown in Figure 2-4, Figure 2-5 and Figure 2-6, respectively.

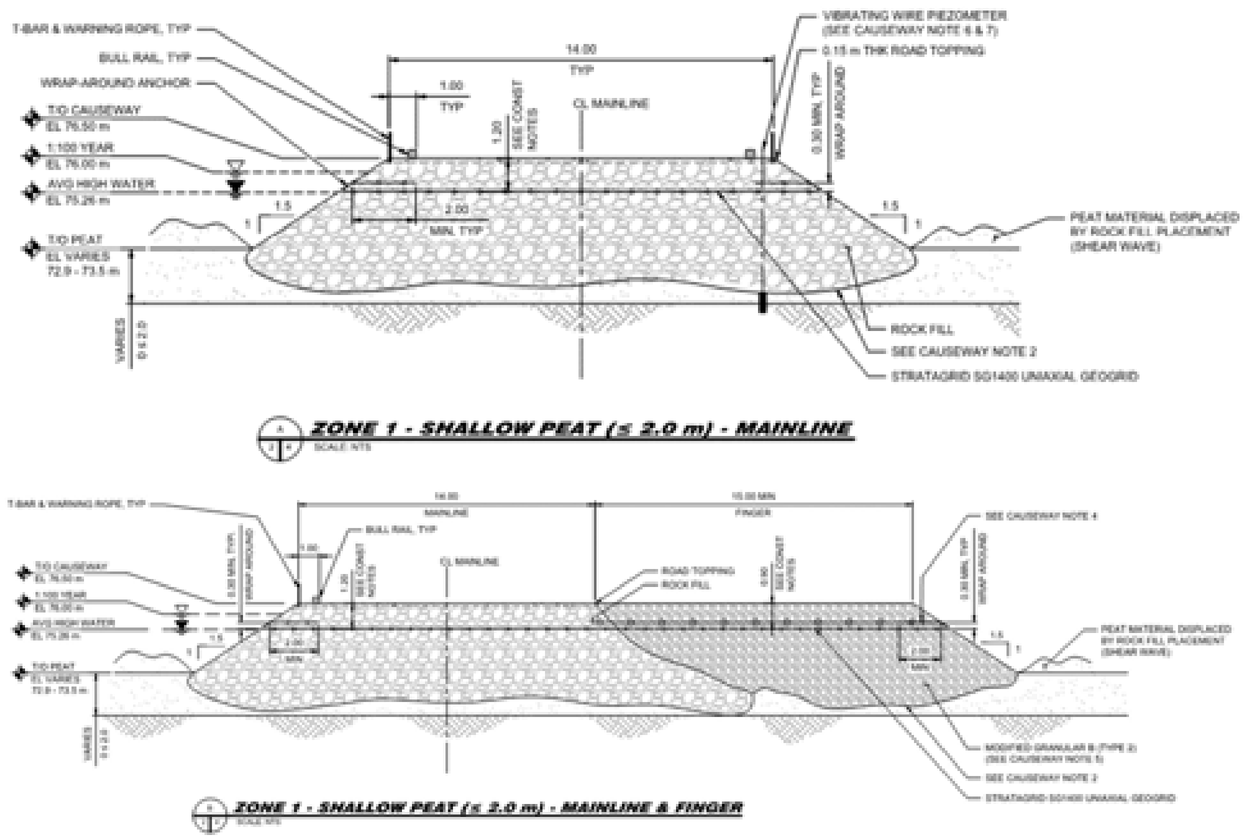


Figure 2-4: Causeway Zone 1 Cross Section

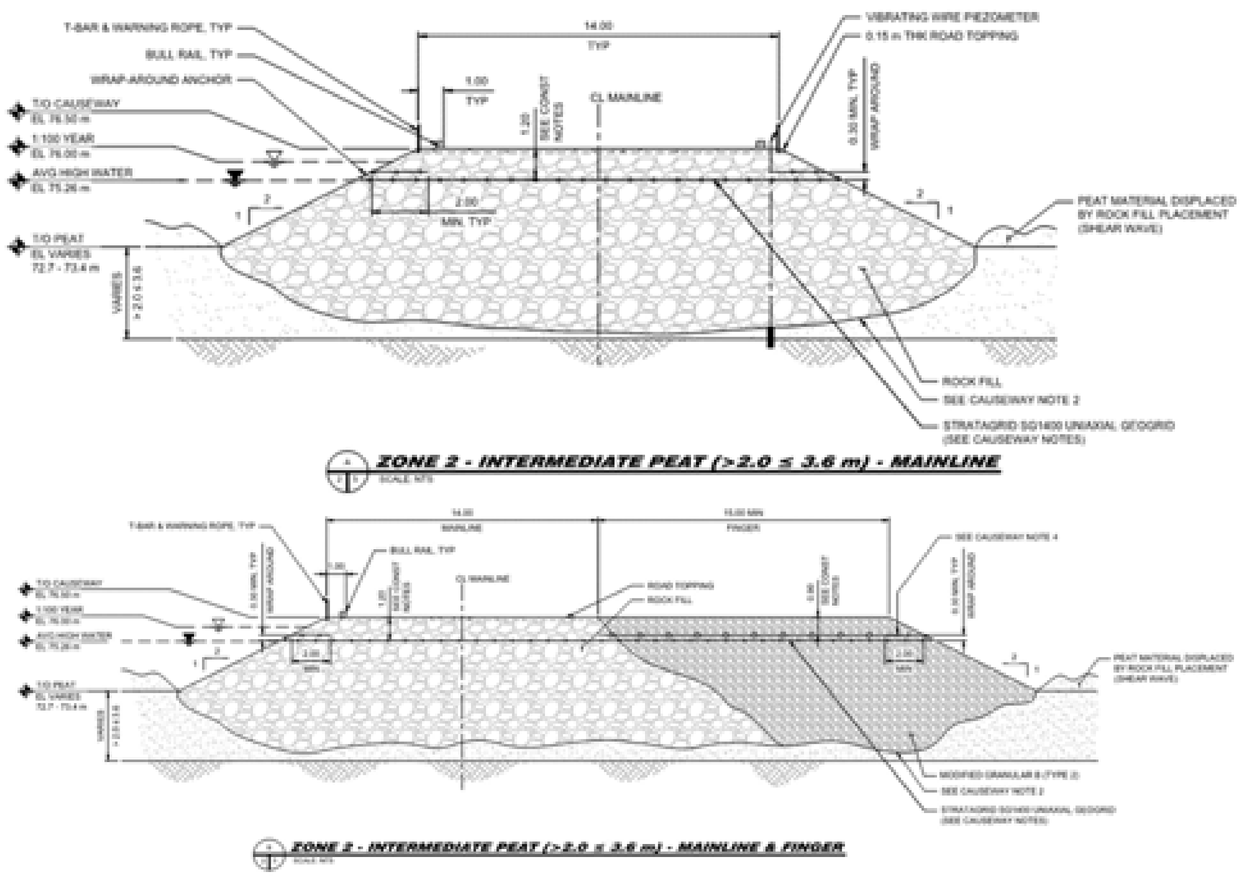


Figure 2-5: Causeway Zone 2 Cross Section

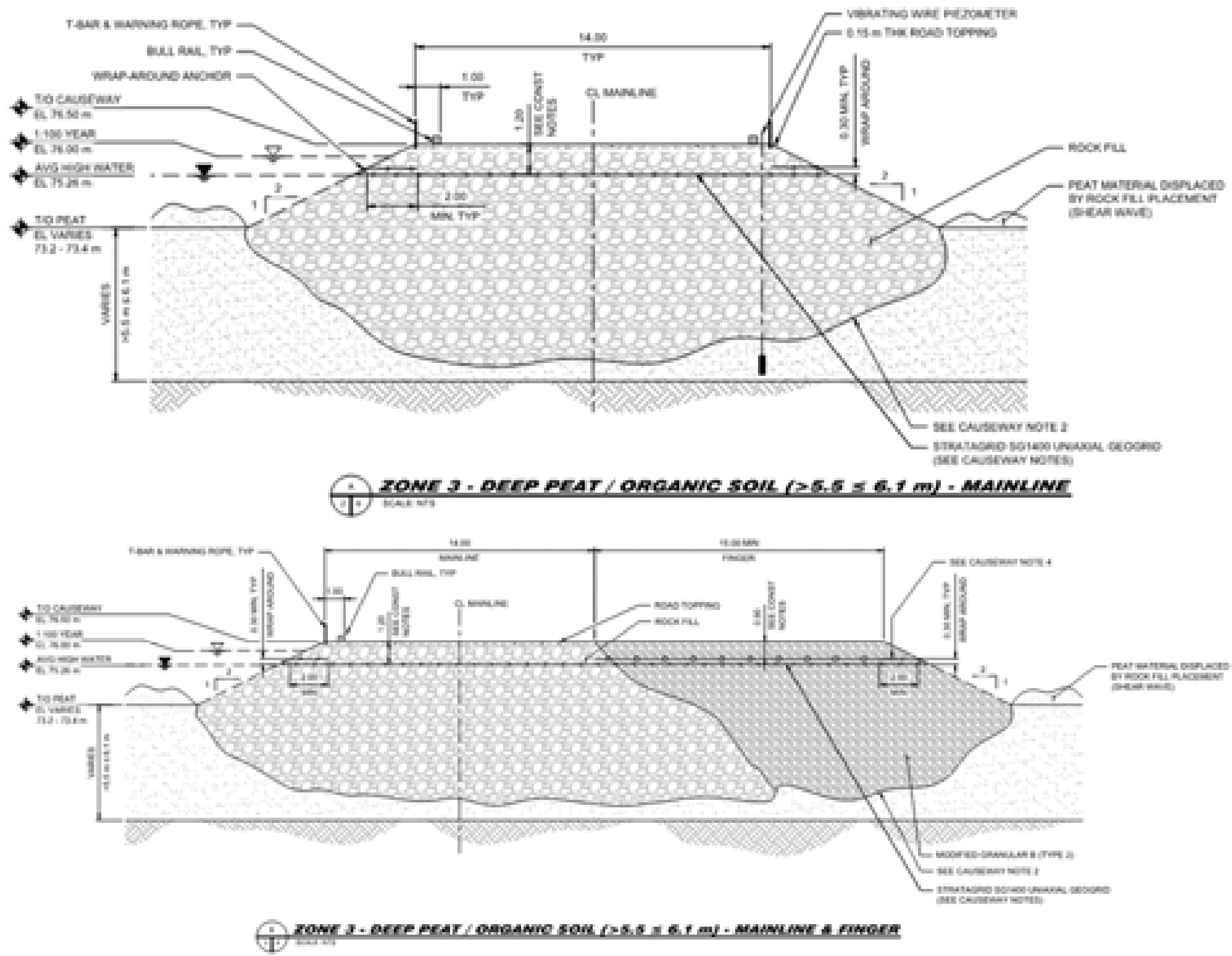


Figure 2-6: Causeway Zone 3 Cross Section

The temporary causeways would have a footprint of approximately 32,475 m^2, with 3,690 m^2 on the east bank and 28,785 m^2 on the west bank. The causeways would be progressively placed until the end of 2020 and would be progressively removed between 2021 to 2022, with removal completed as early as the end of 2022, depending on timing of approvals required to begin in water works. The rockfill material for the causeway will be quarried, crushed in a primary crusher (jaw run) to eliminate everything above 150 mm, screened to reduce the fines to 2%, and transported to the Project. The 17 working platforms will be constructed with finer grained material (D50 equal to 50mm minus) to enable the caissons to be installed through the placed material down to a desired depth below the riverbed with the pier constructed from the work platform. The intent is to construct the causeway access using locally sourced material suitable for long term placement within the river. Upon completion of the construction the majority of the causeway will be removed by excavators. It is expected that rock material will settle into the soft organic substrates and the causeway rockfill will be excavated to 100mm below the elevation of the surrounding substrate. The Causeway will compress the existing underlying sediments, removal of the granular material to 100mm below the existing river bed level will leave a portion of the granular material behind and will not require the removal of the sediments. The full size drawings for the Causeway can be seen in Drawings 1.3.3.1 to 1.3.3.11.

The trestle will be located alongside the location of the permanent bridge between Piers 17 and 20, connecting to east and west causeways as shown in Figure 2-7. The trestle consists of two temporary components, the mainline trestle and trestle fingers that will allow access to the piers. In total 78 piles with a diameter of 900mm will be required for the trestle. Resulting in a temporary footprint of 50 m^2, due to the main span and fingers.

To support the construction of the navigation channel span temporary main span piles known as falseworks or bents will be installed between Pier 17 and 20. The twenty four 0.6 m diameter falsework piles will represent a footprint of about 7 m^2. It is expected with the shorter length of pile (~20 m) all piles will be removed, however if a pile is unable to be removed with the equipment on site, the pile will be cut off below the river bed and left in place.

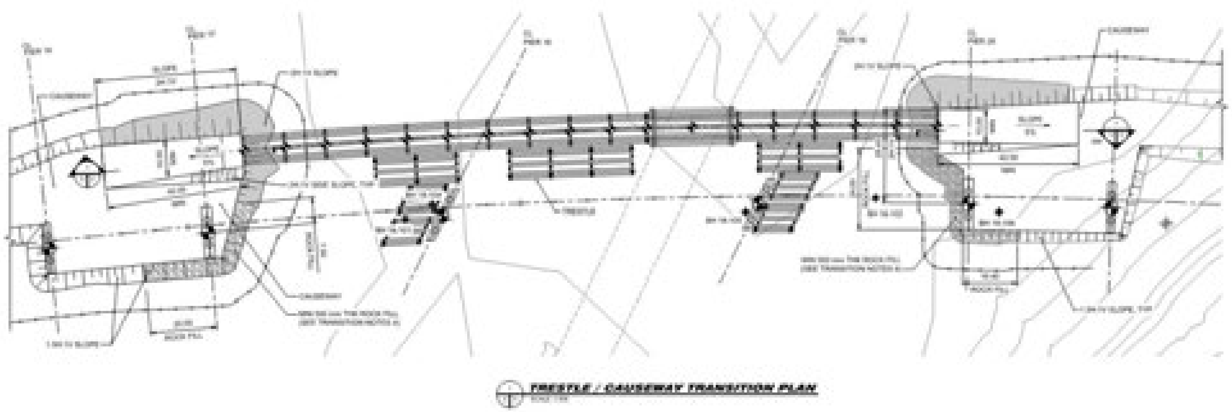


Figure 2-7: Temporary Trestle Arrangement

Access across the Navigation Channel will for the most part be serviced with a trestle lift span. Occasionally a barge may be used to ferry material or equipment across the navigational channel, however the barge would not be stationed within the navigation channel for any significant duration and is not planned to be the principal means of access in this location. Construction of the marine access located within the navigational channel (trestle lift span) is scheduled during the navigational closure calendar to avoid interference to marine traffic.

2.1.2 Preferred Option Selection - Validation Project Phase

The evaluation of the 4 construction options is shown in Table 2.1. The criteria cross-references those Valued Components and Secondary Components with which the construction options could potentially interact directly, both in-water and on-land. Highlights include.

1. All of the construction options are expected to impact the identified Valued Components and Secondary Components (for which mitigation measures would be required), except for:

    a) Submerged Cultural Resources, based on the fieldwork undertaken during the Municipal Class EA.

    b) Navigation, as the installation works would fall outside the boundaries of the navigable channel and adjacent rowing lanes.

2. The dredging and barge option would require on-site sediment storage and off-site sediment disposal provisions. This is not expected to be required with either the temporary earth berm, temporary bridge option or the CTS option.
3. The complete removal of the rock fill would result in a trench similar to the Dredging/Deep Draft Barge option. Due to resuspension of sediments that would result from the excavation of causeway material down to the rock fill/sediment interface, and the importation of material required to fill the depression infilling was not considered feasible from an environmental, time or cost perspective.
4. Causeway extent of the Causeway-Trestle Solution is anticipated to lead to compression of organic riverbed material ranging between 1/3 and 1/2 of thickness of sediment/organic layer. Removal of the granular material to 100mm below the existing river bed level will leave a portion of the granular material behind and will not require the removal of the sediments
5. The temporary earth berm and temporary work bridge options would provide consistent, year-round in-water access to facilitate construction of the permanent bridge.
6. In the east portion of the river, the temporary work bridge option has the least potential impacts to the identified Valued Components and Secondary Components due to its lower in-water footprint and temporary life cycle. However, at the west portion of the river the potential impacts to the identified Valued Components and Secondary Components will increase due to a lower probability of being able to remove the steel piles that support the work bridge due to the embedment in the deep overburden.
7. With the Causeway-Trestle Solution approach the temporary causeways will be used to access to Piers from the west and east banks. The temporary trestle will be installed to avoid embankment slope next to navigation channel and approximately replicate the hydraulic conditions that occur south of the Project alignment. Consideration of placing short segment(s) of trestle or culvert(s) in the causeway would be expected to reduce the potential effects to both species movement and flow alteration by increasing the opening area.

Regarding the more qualitative Valued Components and Secondary Components with which the construction options could potentially interact, as well as the schedule challenges, the Causeway-Trestle Solution construction approach addresses the challenges presented by the depth of bedrock while minimizing the impact on the landscape and integrity of the Rideau Canal. This is discussed later in this Report, in conjunction with the proposed mitigation measures and the analysis of residual effects associated with the Project as a whole. In the interim and based on the assessment in this Section, the Causeway-Trestle Solution construction approach was found to be the preferred bridge construction option during the validation Project phase.

Table 2.1: Comparison of Construction Options

	Temporary Earth Berm	Dredging / Deep Draft Barge	Temporary Work Bridge	Causeway-Trestle Solution
Description				
Overview	Infilling an access road with rock fill to provide a temporary east / west in-water access road extending from the shore to the navigable channel on both sides. Use of a barge to transport equipment and personnel from one side of the navigable channel to the other. The temporary earth berm would be constructed of material that facilitates construction, removal and re-naturalization.	Dredge ~1.5-2 m below the mudline via mechanical or hydraulic methods for construction barge draft. Barges would transport equipment and personnel to each pier location. The dredged channel could either be back-filled or left in place after bridge construction.	The work bridge would extend from the shore to the navigable channel on both sides, and is supported on piles. Use of a barge to transport equipment and personnel from one side of the navigable channel to the other. Up to 6 months to remove after bridge construction (platform would be removed, with piles also removed or cut-off below top of riverbed).	Temporary causeways from the west and east shores to facilitate east/west in-water access Temporary causeways would be constructed of material that facilitates construction, removal and re-naturalization Temporary trestles would extend from the end of the causeways to either side of navigation channel Use of a barge or lifting span bridge to transport equipment and personnel from one side of the navigable channel to the other.
Access Schedule	~ 6 months to install (could be done in conjunction with other construction activities). ~ 5 months to remove after bridge construction	~3-4 months to dredge the channel.	~8 months to install (would be done in conjunction with other construction activities). Slowest portion of installation at west shore where depth to rock ~45m below river bed would limit rate at which foundation work could progress from the west shore. 6 months to remove after bridge construction.	~6 month to install (could be done in conjunction with other construction activities). ~5-6 months to remove after bridge construction.
Construction Schedule		Slowest in comparison to the berm, work bridge and hybrid options as barge would be required to access shore.		
Constructability	Simple to construct and remove. Material and equipment are readily available.	Requires dredging equipment and over-sized barges to accommodate large cranes for construction.	Requires multiple pieces of equipment to install. Requires piles to extend to bedrock to provide sufficient bearing capacity which slows installation and removal	Temporary causeways are simple to construct and remove Material and equipment readily available Piles required for work bridge spans extend to shallower bedrock Multiple pieces of equipment required to install work bridge Dredging of riverbed sediments and peat will not be required

	Temporary Earth Berm	Dredging / Deep Draft Barge	Temporary Work Bridge	Causeway-Trestle Solution
Safety / Winter Work	Safest option for labour and equipment. Can be used year round.	Working from a barge would require extra safety precautions. Limitations during winter freezing conditions.	Safe for labour and equipment. Can be used year round.	Safe for labour and equipment. Temporary causeway and trestles can be used year round
Access to Site	Enables continuous access to each pier location during construction.	Access between each pier location and shore would be governed by barge movement.	Enables continuous access to each pier location during construction.	Enables continuous access to each pier location during construction.
Size	Rockfill accesses typically ~ 12 m wide at crown and ~27 m at base, with a depth of fill of ~ 2.8 m with bump outs for pier installation.	The required barge would be ~18.3 m wide, ~45.7 m long with a draft of ~1.8-2.4 m to support the crane. Bottom width of dredged channel would be ~60 m with 3:1 side slopes (for a total channel affected width of 69 m). Boats needed to move the barges would require a draft of ~2.4 m.	The work bridge would be up to 11 m wide with extensions at each pier location to further enable construction. The work bridge area is estimated at ~17750 m^2.	Temporary causeway typically ~ 12 m wide at crown and ~27 m at base, with a depth of fill of ~ 2.8 m with bump outs for pier installation Trestle would be typically ~11 m wide with extensions at the pier locations to enable construction
In-water Footprint	~34,000 m^2	~109,000 m^2	~3,000 m^2	Temporary Causeways ~32,475 m^2 Temporary Trestle ~ 50 m^2 Temporary Falsework ~7 m^2
Material Management	Rock fill material to be locally sourced from local businesses Material repurposed on site following removal, or reused in local construction	Dredged material to be disposed at appropriate facility or stored and replaced within the dredged footprint	Material for work bridge transported within a radius of 1200 km. Multiple transports required	Rock fill material to be locally sourced from local businesses Material repurposed on site following removal, or reused in local construction Material for work bridge transported within a radius of 1200 km. Multiple transports required
Costs				
Construction and Mitigation Costs	~$10 M	$10-30 M	~$35 M	~$ 17 M
Environmental Monitoring	~$200,000	~$400,000	~$200,000	~$200,000
Greater Cataraqui Marsh PSW				

	Temporary Earth Berm	Dredging / Deep Draft Barge	Temporary Work Bridge	Causeway-Trestle Solution
Fish and Fish Habitat Aquatic Wildlife / Habitat SAR	May need to schedule installation around sensitive time periods. Potential mortality risk to fish / reptile species during installation. Installation would be halted (temporary / seasonal) if SAR species found. Loss of access while rockfill access is in place and fragmentation of habitat. Re-establishment is expected to be 5-6 years. Rock fill used in construction of berm may attract turtles and put them at greater risk of mortality or non-viable nests during the construction window.	May need to schedule dredging around sensitive time periods. Potential mortality risk to fish / reptile species during dredging. Dredging would be halted (temporary / seasonal) if SAR species found. No physical barrier to mobility. Value of creating ‘different habitat type’ after dredging is uncertain, and re-establishment is expected to be slow (more than 6 years). Potential changes in sediment deposition may affect existing habitats / species composition.	May need to schedule installation around sensitive time periods. Potential mortality risk to fish / reptile species during installation. Installation would be halted (temporary / seasonal) if SAR species found. Temporary and localized physical barrier to mobility. Effects are temporary, affect several smaller areas, and post-disturbance rehabilitation expected to be faster. Noise mitigation for fish / reptile species may be required during installation.	Schedule causeway installation around sensitive time periods. Potential mortality risk to fish / reptile species during installation. Installation of causeway would be halted (temporary / seasonal) if SAR species found. Loss of access while temporary causeway is in place and fragmentation of habitat. Re-establishment is expected to be 5-6 years. Rock fill used in construction of temporary causeway may attract turtles and put them at greater risk of mortality or non-viable nests during the construction window. Work bridge is a temporary and localized physical barrier to mobility Noise mitigation for fish / reptile species may be required during work bridge installation,
Surface Water Quantity	Potential to affect water flow and result in flooding.	Potential to affect water flow due to change in riverbed elevation along dredged channel.	Effects are temporary and affect several smaller areas.	Potential to affect water flow and result in flooding.
Surface Water Quality	Potential for re-suspension of sediment and dispersion of associated contaminants from rock fill placement and removal. Potential future downstream water quality effects if sediment transport and turbidity dynamics change. Potential for creation of stagnant zones with reduced water quality at causeways.	Re-suspension of sediment and dispersion of associated contaminants during dredging. Potential future downstream water quality effects if sediment transport and turbidity dynamics change.	Minor localized potential for sediment re-suspension and scour along sides of piers. Cutting of temporary piles below the riverbed that cannot be removed using vibratory or direct-pull methods would eliminate additional excavations and subsequent sediment re-suspension required for full removal. Cutting below the streambed level and backfilling would reduce the amount of dissolved oxygen available lowering the corrosion rate of the remaining pile.	Potential for re-suspension of sediment and dispersion of associated contaminants from rock rill placement and removal. Potential future downstream water quality effects if sediment transport and turbidity dynamics change. Potential for creation of stagnant zones with reduced water quality at causeways. It is expected all piles will be removed, however if a pile is unable to be removed with the equipment on site, the pile will be cut off below the river bed and left in place. Cutting of temporary piles would eliminate additional excavations and subsequent sediment re-suspension required for full removal. Cutting below the streambed level and backfilling would reduce the amount of dissolved oxygen available lowering the corrosion rate of the remaining pile.

	Temporary Earth Berm	Dredging / Deep Draft Barge	Temporary Work Bridge	Causeway-Trestle Solution
Hydrologic Processes	Temporary earth berm temporarily constrict river during construction however modeling shows that this does not significantly increase flows or sediment dynamics. Potential for displacement (i.e. forcing of soft substrates laterally) of soft substrates during placement of berm material. Compaction of substrate after installation.	Creates a near-term permanent lowering of the riverbed, which may change flows and sediment dynamics such as deposition and scour of habitats in the area. Potential for slumping of side walls due to soft substrate. Re-dredging due to slumping may be constrained by seasonal effects.	Minor localized temporary potential change in flows. Effects are temporary and affect several smaller areas.	Temporary causeways temporarily constrict river during construction however modeling shows that this does not significantly increase flows or sediment dynamics. Potential for displacement (i.e. forcing of soft substrates laterally) of soft substrates during placement of rockfill material. Compaction of substrate after installation of granular material. Work bridge may result in minor localized temporary change in flows Work bridge effects are temporary and affect several smaller areas.
Aquatic Vegetation	Access would require cutting or covering of vegetation. Re-establishment of aquatic vegetation is expected to occur over 5-6 years after berm removal.	Access would require removal of vegetation and root wads. Re-establishment of aquatic vegetation is expected to be slow (more than 6 years).	Access would require removal of vegetation in localized areas. Effects are temporary, affect localized areas, and post-disturbance rehabilitation expected to be faster.	Temporary causeways would require cutting or covering of vegetation. Re-establishment of aquatic vegetation is expected to occur 5-6 years after causeway removal.
Migratory Birds and Habitat				
Migratory Birds / Habitat	Access would require cutting or covering of vegetation, and re-establishment is expected to occur over 5-6 years. May need to schedule installation around sensitive time periods. Potential mortality risk during installation. Temporary and localized physical barrier to mobility.	Access would require removal of vegetation, and re-establishment is expected to be slow (more than 6 years). May need to schedule dredging around sensitive time periods. Potential mortality risk during installation. No physical barrier to mobility.	Access would require removal of vegetation in localized areas, but long-term effects not expected as effects are to localized areas, and post-disturbance rehabilitation expected to be faster. May need to schedule installation around sensitive time periods. Potential mortality risk during installation. Temporary and localized physical barrier to mobility.	Access would require cutting or covering of vegetation, and re-establishment is expected to occur over 5-6 years. May need to schedule installation around sensitive time periods. Potential mortality risk during installation. Temporary and localized physical barrier to mobility.
Archaeology				
Submerged Cultural Resources	Neither evidence of, nor potential for, aquatic archaeological resources. Despite the above, archaeological monitoring and appropriate chance find management needed. Project shut-down if human remains found.	Neither evidence of, nor potential for, aquatic archaeological resources. Despite the above, archaeological monitoring and appropriate chance find management needed. Project shut-down if human remains found.	Neither evidence of, nor potential for, aquatic archaeological resources. Despite the above, archaeological monitoring and appropriate chance find management needed. Project shut-down if human remains found.	Neither evidence of, nor potential for, aquatic archaeological resources. Despite the above, archaeological monitoring and appropriate chance find management needed. Project shut-down if human remains found.
Navigation				

	Temporary Earth Berm	Dredging / Deep Draft Barge	Temporary Work Bridge	Causeway-Trestle Solution
Boat passage	Installation to be outside boundaries specified in Canadian Navigable Waters Act. Navigation markers and lights may be needed for certain construction activities.	Dredging to be outside boundaries specified in Canadian Navigable Waters Act. Navigation markers and lights may be needed for certain construction activities.	Installation to be outside boundaries specified in Canadian Navigable Waters Act. Navigation markers and lights may be needed for certain construction activities.	Installation to be outside boundaries specified in Canadian Navigable Waters Act. Navigation markers and lights may be needed for certain construction activities.
Terrain, Geology and Soils				
Sediment Disposal	Granular material is designed to be reused as construction material either onsite or at another construction site in Kingston. Potential approvals, testing and costs for excavation and handling.	Off-site disposal location for dredged material needed. Dewatering needs to be factored into overall schedule and costs. Potential approvals, testing and costs for excavation and handling.	Potential requirement for disposal of marine deposits embedded in piles.	Granular material is designed to be reused as construction material either onsite or at another construction site in Kingston. Potential requirement for disposal of marine deposits embedded in piles.
Terrestrial Habitat				
Terrestrial Vegetation	Access may require removal of vegetation.	Access may require removal of vegetation.	Access may require removal of vegetation.	Access may require removal of vegetation.
Other Terrestrial Wildlife	Wildlife access and dens / burrows may be affected.	Wildlife access and dens / burrows may be affected.	Wildlife access and dens / burrows may be affected.	Wildlife access and dens / burrows may be affected.
Air Quality				
Air Quality	Typical emissions from construction equipment and installation.	Typical emissions from construction equipment and dredging.	Typical emissions from construction equipment and installation.	Typical emissions from construction equipment and installation.
Restoration / Rehabilitation				
Restoration and Rehabilitation	Less substantive as the temporary earth berm has been designed for removal and passive restoration. Potential for shoreline restoration due to access requirements. Proponent would be responsible for on-going restoration or mitigation alternatives if planned work is not successful. Re-establishment is expected to occur over 5-6 years.	Substantive due to in-water footprint. Potential for shoreline restoration due to access requirements. Proponent would be responsible for on-going restoration or mitigation alternatives if planned work is not successful. Re-establishment is expected to be slow (more than 6 years).	Less substantive due to lower in-water footprint. Potential for shoreline restoration due to access requirements. Proponent would be responsible for on-going restoration or mitigation alternatives if planned work is not successful. Effects are temporary, affect several smaller areas, and post-disturbance rehabilitation expected to be faster.	Less substantive as the temporary causeway has been designed for removal and passive restoration. Potential for shoreline restoration due to access requirements. Proponent would be responsible for on-going restoration or mitigation alternatives if planned work is not successful. Re-establishment is expected to occur over 5-6 years. For work bridge, effects are temporary and affect several smaller areas. Post-disturbance rehabilitation is expected to be rapid.

3. Project Construction Phase

As noted earlier, the Business Plan recommended that the detail design and construction phases of the Project be merged into a Design-Build IPD procurement model. As such, the design phase includes activities such as field investigations, design refinements, permitting and approvals, land acquisition and agreements, public and stakeholder engagement and consultations.

A key advantage of the Design-Build IPD model is that additional field investigations are carried out during the detail design phase to further reduce the extent of unknown conditions. Using this additional information, the Design-Build IPD team will then develop strategies to manage and mitigate any environmental and constructability issues prior to the construction phase.

At the conclusion of the validation phase, a cost estimate will be generated and compared to the original budget for the Project. This will be used to inform the proponent's decision to either proceed or not proceed with the construction phase. It is anticipated that the construction phase for this Project will not commence unless funding is secured, all permits are in place, and the final Project cost estimate is within the allocated budget. The proponent anticipates that liaison with Parks Canada and the Design-Build IPD team will continue as part of the DIA process. The proponent also anticipates that this liaison will occur in parallel with the detail design work, leading up to the build or no-build decision.

3.1.1 Project Corridor Access

3.1.1.1 Options

As shown on Figure 3-1, construction access routes to the Project corridor are as follows:

1. By land via:

a) John Counter Boulevard on the west side with connections to Highway 401 (north) and the downtown area (south) using Montreal Street or other north-south arterials to the west. As shown on Figure 3-2 there is limited area along John Counter Boulevard to maneuver materials due to the narrow access. Water access is similarly limited. As such, Figure 3-2 highlights property acquisition and/or easement requirements south of the John Counter

Boulevard right-of-way to facilitate construction access and staging as well as material laydown provisions.

b) Gore Road on the east side with connections to Highway 401 (north) and the LaSalle Causeway-Highway 2 corridor (south) using Highway 15. The Gore Road Library property extends from the off-leash dog park located at the north end; to the Cataraqui River shoreline (west); to the Gore Road right-of-way (south); and to Highway 15 (east). This property will serve as the main construction access, staging and material laydown area. As shown on Figure 3-3, the installation of an access road will enable trucks to arrive from the north on Highway 15, turn into Gore Road and access the laydown area and causeway directly.

2. By water, via Lake Ontario through the LaSalle Causeway (south).

Figure 3-1: Project Corridor Access Routes

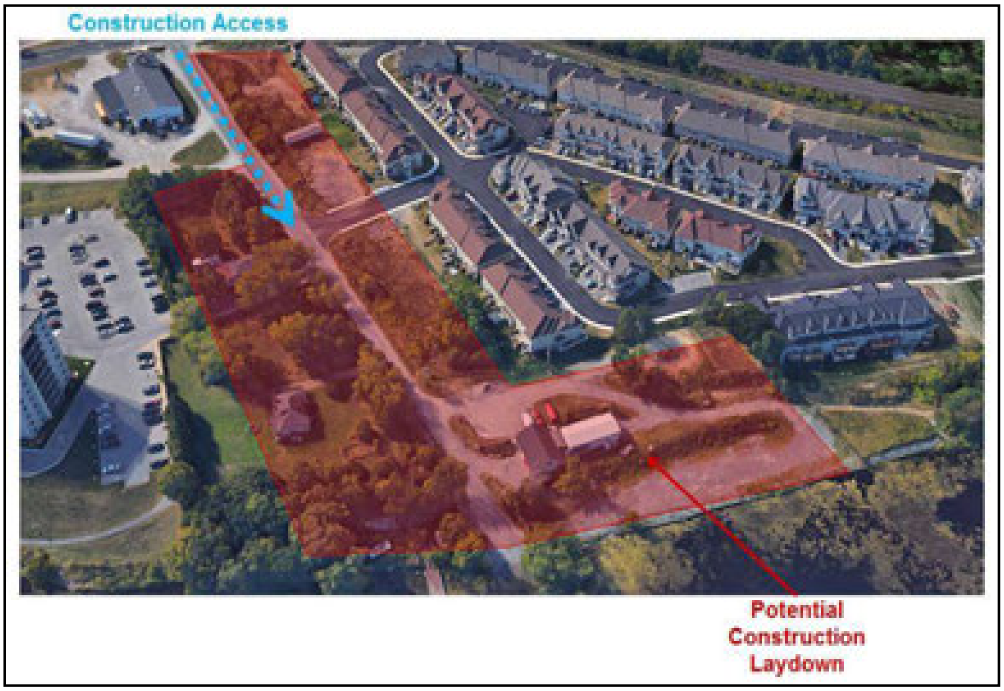


Figure 3-2: Construction Access (West)

Figure 3-3: Construction Access (East)

3.1.1.2 Future Design Considerations

1. The following should be considered further regarding accessing the Project corridor by water:

a) The width and height of the bascule lift bridge as well as the width and depth of the navigable channel could impact the transportation of equipment and materials.

b) The bridge has limited operating hours during the open season and is closed in the winter. The Contractor will need to contact the Bridge Master on-site to confirm capacity and timing of bridge operations as well as any special accommodations required to support Project construction.

3.1.2 Site Preparation

3.1.2.1 Physical Works and Activities

Table 3.1: lists the physical works and activities associated with the site preparation stage before mitigation measures are in place:

Table 3.1: Site Preparation Works and Activities

Project Phase	Core Project Components	Physical Works and Activities
Site Preparation	Pre-Construction Scheduling	Secure Project funding. Engage the final design and construction procurement phase, including the Environmental Management Plan (EMP) and CAP. Obtain final DIA approval and land lease / construction agreement from Parks Canada. Finalize property acquisition / easements (west side). Obtain permits and approvals (renew as required during the construction phase) in support of: works within fish habitat and confirmed or assumed habitats of SAR; Permit To Take Water requirements; and Ontario Regulation 148/06. Provide the City and Parks Canada with signed copies of the EMP and CAP from the Contractor prior to commencing any site works.
	Establish Work	Install site signage and perimeter fencing (on-

Project Phase	Core Project Components	Physical Works and Activities
	Zone and Staging Areas (Drawing 1.3.2.1; and Drawing 1.3.2.2)	land) and navigational signage (on-water). Confirm utility locates. Confirm low, medium, high impact construction site areas (e.g. parking, offices, material storage, active material assembly / construction) on-land and on-water work zone limits. Clear lands for installation of construction site access, staging and laydown areas. Install temporary electrical and communications services (potentially on utility poles) for site trailers, and construction site traffic controls. Install temporary stormwater management works. Confirm and obtain Category A (Routine Oversize / Overweight Loads) permits and/or Category B (Non-Routine Oversize / Overweight Loads) permits for any pre-fabricated bridge components that exceed any of the following limitations (including the transportation vehicle): Length = 19 m Width = 3.5 m Height = 2.6 m Weight = 30000 kg

Construction/Bridge Access

Construction Laydown Area

Bridge

Construction Site Office Area

Noise Wall

Potential Noise Wall

Construction Fencing

Public Pedestrian access to Library

During Construction (Draft- Subject to Change)

REV.	DATE	BY	DESCRIPTION	CHK'D
A	03/07/19	M.A.	ISSUED FOR REVIEW	X.X.X.

Kiewit

DESIGNED BY ----	SCALE AS NOTED IF SHEET IS LESS THAN 22"x34" IT IS A REDUCED PRINT SCALE REDUCED ACCORDINGLY	PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON
DRAWN BY M.A.		PROJECT TASK: CAUSEWAY DESIGN	JOB NO. 18-240 TASK NO. 501.02.01
CHECKED BY X.X.X.	DATE (MM-DD-YY) 03/07/19	DRAWING SUBJECT: EAST LAYDOWN & STAGING	SHEET NO. 1 OF 1

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Drawing No. 1.3.2.1

Bridge

Construction Laydown Area

Noise Wall

Construction Fencing

Construction Site Office Area

Construction/Bridge Access

During Construction (Draft - Subject to Change)

REV.	DATE	BY	DESCRIPTION	CHK'D
A	03/07/19	M.A.	ISSUED FOR REVIEW	X.X.X.

Kiewit

DESIGNED BY ----

DRAWN BY M.A.

CHECKED BY X.X.X.

SCALE AS NOTED

IF SHEET IS LESS THAN 22"x34" IT IS A REDUCED PRINT SCALE REDUCED ACCORDINGLY

DATE (MM-DD-YY) 03/07/19

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PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD

PROJECT LOCATION: KINGSTON, ON

JOB NO. 18-240

PROJECT TASK: CAUSEWAY DESIGN

TASK NO. 501.02.01

DRAWING SUBJECT: WEST LAYDOWN & STAGING

SHEET NO. 1 OF 1

Drawing No. 1.3.2.2

3.1.3 Construction

3.1.3.1 Physical Works and Activities

Table 3.2 lists the physical works and activities associated with the construction stage before mitigation measures are in place. There are instances where options are cited regarding certain physical works and activities. Their intent is to provide flexibility to the Contractor in order to promote creative, sustainable and cost-effective construction methods.

Table 3.2: Construction Works and Activities

Project Phase	Core Project Components	Physical Works and Activities
Construction	Earthworks and Stormwater Management	• Strip topsoil. • Install permanent surface water outlets, culverts and stormwater management dry pond facilities. • Engage storm sewer and underground utilities installation / relocations. • Install retaining walls. • West-East abutments will require earth excavation of all peat, silty clay and clayey silt within each footprint as these soils are compressible, and would be expected to settle under increased loads: ◆ West Abutment: Excavation at ~2.1 m with up to 4 m of backfill from the existing grade of John Counter Boulevard to the west abutment; and ◆ East Abutment: Excavation at ~0.6 m, with up to 9 m of backfill from the existing grade of Gore Road to the east abutment. • The use of suitable fill such as Select Subgrade Material or rock will need to be confirmed during the detail design phase.
	Causeway-Trestle Solution	• Layout of the Causeway-Trestle Solution construction approach is shown in Drawings

Project Phase	Core Project Components	Physical Works and Activities
		1.3.3.1 to 1.3.3.11. • Installation of temporary causeways on west and east shorelines. • Installation of temporary trestle piles and top sections at either end of navigation channel. • Setup of material and equipment ferry barge across the navigational channel.
	Permanent Bridge Foundation and Substructure	• Crane mobilization. ◆ Installation (first from the east side-to-the-navigable channel; and then from the west side-to-the-navigable channel) via the temporary trestle of the: ◆ Caissons: ▪ liners will be driven through the overburden and seated firmly into bedrock; ▪ the material will be excavated from within the liner; ▪ rock sockets will be drilled into the bedrock; ▪ a reinforcing cage will be lowered into the caisson; and ▪ concrete will be poured into the caisson from a concrete pump. ◆ Modified Conventional Piers: ▪ standard steel / timber formwork will be used to form the pier cap
	Permanent Bridge Superstructure	• Girder installation will coincide with installation of permanent bridge foundation and substructure.

Project Phase	Core Project Components	Physical Works and Activities
		◆ NU-concrete girders supporting the approach structure over the 17 spans on the West and the two spans on the East can either be: • Lifted into place by the cranes on the causeway, or temporary trestle bridge2 options are available for installing the bridge deck: ◆ Cast-in-place via concrete pump with stay in place forms and overhang brackets; or ◆ Precast panels, which: ▪ could either be: full depth precast supported on the girders with cast-in-place concrete at the joints; or partial depth precast with a cast-in-place concrete overlay on top; and ▪ these panels could be erected either from the new bridge deck, from causeway, or from a crane on an equipment barge. • Bridge deck installation will follow the installation of the permanent bridge superstructure.
	Steel Navigation Span and two back spans along with bridge deck	• The steel navigation channel span and the two 66m back spans will be erected from cranes on the trestle. The erection sequence and crane location for each pick is shown in Drawing 1.3.3.12. • 2 options are available for installing the bridge deck: ◆ Cast-in-place via concrete pump with stay in place forms and overhang brackets; or

Project Phase	Core Project Components	Physical Works and Activities
		◆ Precast panels, which: ▪ could either be: full depth precast supported on the girders with cast-in-place concrete at the joints; or partial depth precast with a cast-in-place concrete overlay on top; and ▪ these panels could be erected either from the new bridge deck, from causeway, or from a crane on an equipment barge. • Bridge deck installation will follow the installation of the permanent bridge superstructure.
	Bridge Finishes	• Install lighting (bridge deck and navigational), electrical and communications systems. • Engage paving and installation of barriers, railings, signs and markings.
	Approach Utilities, Paving and Intersections	• Rough grading. • Finalize installation / relocations of storm sewer and underground utilities. • Concrete pads and pole bases. • Pavement granulars. • Intersection staging. • Curbs and pathways. • Pavement surfaces. • Install barriers, signs, markings, lighting and traffic signals.

4. Site Restoration and Rehabilitation

The site restoration and rehabilitation phase, which follows the construction phase, focuses on the east and west side lands as well as an in-water area near the temporary causeways and temporary trestle.

4.1.1 Landscape

4.1.1.1 Design

The restoration works for the east and west side lands are shown on Drawing 1.4.1.1 and Drawing 1.4.1.2, respectively.

The main components of the landscape designs are as follows:

1. The constant gradual s-curve of the bridge, which lands north of the Point St. Mark neighbourhood, offers opportunities for:

a) Reduced potential noise and visual impacts on Point St. Mark residents.

b) 'Softer landscaping' along the Gore Road right-of-way.

2. Grounding the bridge structure dramatically and distinctively at each abutment using materials and proportions that reference and enhance the cultural landscape without overt imitation of heritage architecture.

3. The use of native plant materials to provide landscape variety and hardiness.

4. The incorporation of observation look-out / interpretive areas in order to:

a) Bring attention to the waterfront trail system at an appropriate scale with the bridge and gateway elements.

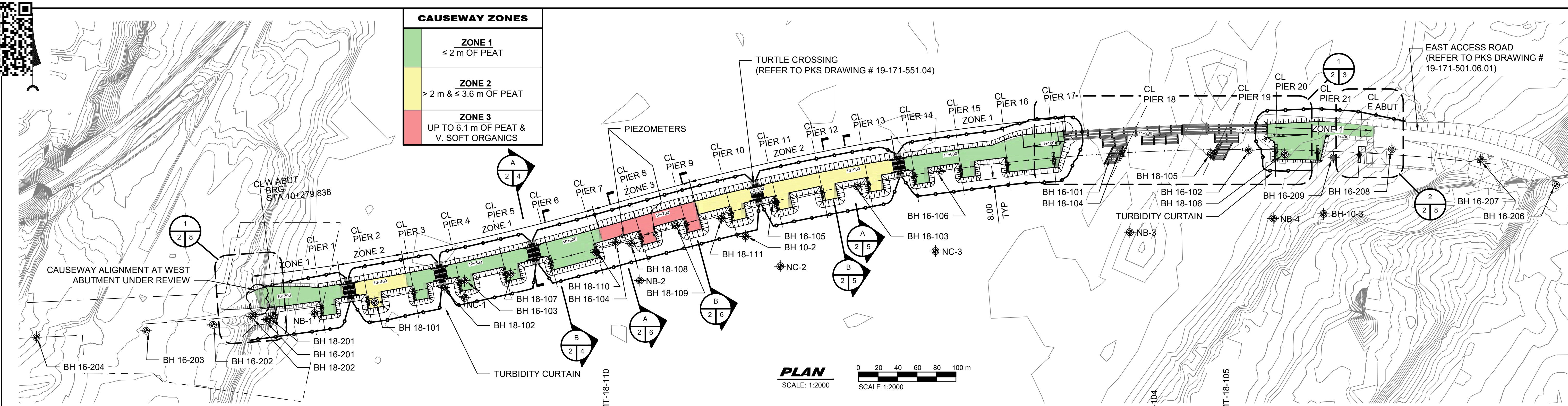
b) Provide a natural destination point, resting place or rendezvous.

c) Accentuate the public realm by accommodating interpretive panels about the Rideau Canal, Belle Island and the Greater Cataraqui Marsh as well as public art installations and site furniture.

5. The incorporation of active travel and commuter cycling provisions to connect with existing non-automotive networks on both sides of the Cataraqui River.

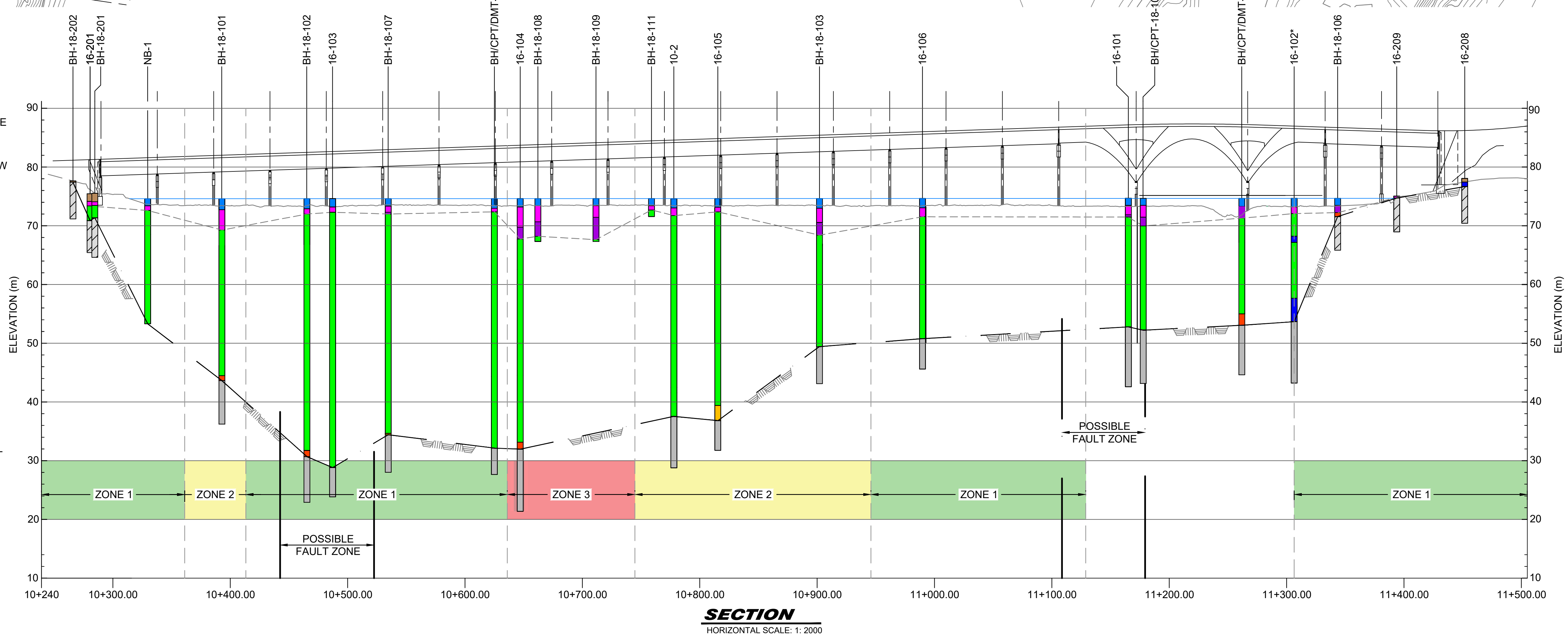
6. The accommodation of accessible multi-use pathways in terms of: width (2.7 m); running slope (4% or less); and cross slope (2% or less)[1].

[1] The accessible route to the east waterfront area is from the pathway on Kenwoods Circle.



LEGEND:

BH-18-101	BOREHOLE
	INFERRED BEDROCK PROFILE
	INFERRED BOUNDARY BELOW ORGANIC DEPOSITS
	WATER
	PEAT
	ORGANIC SOIL / SILT
	SILTY CLAY TO CLAY
	SILT AND SAND
	COHESIVE GLACIAL TILL
	NON-COHESIVE GLACIAL TILL
	GRANITE / GNEISS
	LIMESTONE / DOLOSTONE
	FILL



REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

DESIGNED BY	A.E.M.
DRAWN BY	J.R.P.
CHECKED BY	T.J.S.
SCALE	AS NOTED
DATE (MM-DD-YY)	10-11-19

PRINT IS ONE HALF INDICATED SCALE

IF SHEET IS LESS THAN 22"x34" IT IS A REDUCED PRINT SCALE REDUCED ACCORDINGLY

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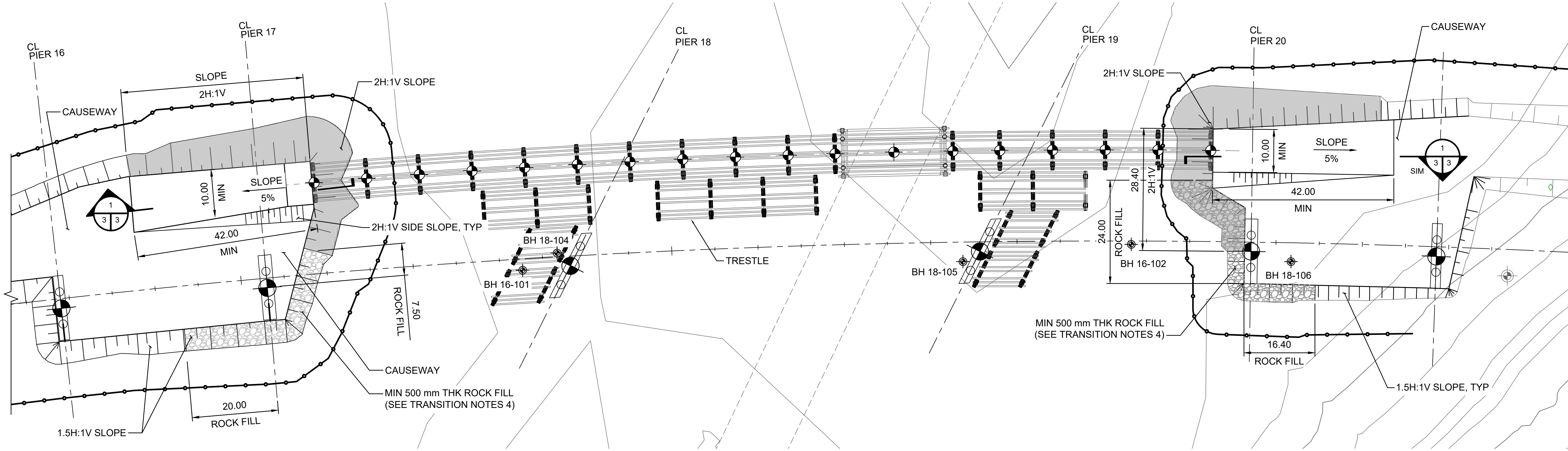
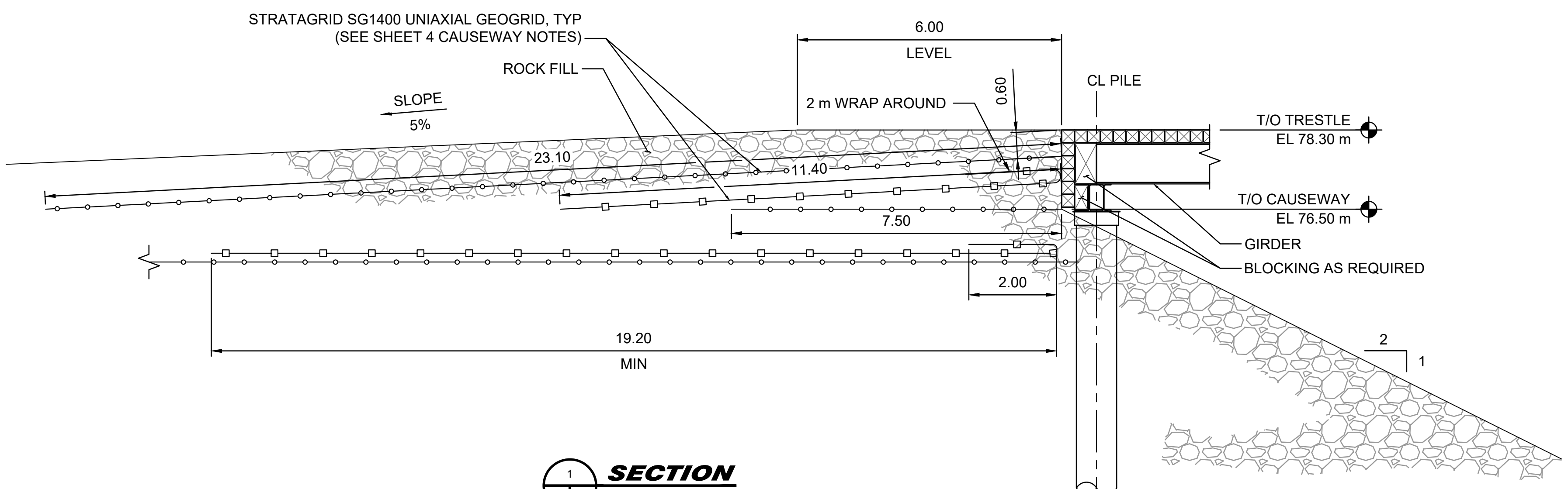
PROJECT TITLE	KINGSTON THIRD CROSSING BRIDGE IPD
PROJECT LOCATION	KINGSTON, ON
JOB NO.	19-171
PROJECT TASK	TEMPORARY ACCESS CAUSEWAY
TASK NO.	501.02.01
DRAWING SUBJECT	CAUSEWAY PLAN & GEOTECHNICAL PROFILE
SHEET NO.	2 OF 12

Drawing No. 1.3.3.1



TRESTLE / CAUSEWAY TRANSITION PLAN

SCALE: 1:500



SECTION

SCALE: 1:75

NOTE: ENSURE RAMP FLUSH WITH TOP OF TRESTLE DECK TO MINIMIZE POTENTIAL FOR EQUIPMENT / VEHICLE IMPACT ON TRESTLE

TRANSITION NOTES:

1. TRESTLE DETAILS NOT SHOWN. PLAN PROVIDED TO SHOW EXTENT OF ANTICIPATED WORK TRESTLE.
2. TRESTLE DESIGN BY OTHERS
3. TRESTLE DESIGN AND ALIGNMENT UNDER REVIEW.
4. DRESS SLOPE FACE WITH 500 mm THICK ROCK FILL FOR EROSION PROTECTION OF THE MODIFIED GRANULAR B USED AT FINGERS.
5. REFER TO PKS MEMO # 19-171-550.05.01 FOR EQUIPMENT AND EARTH LOADING ON TRESTLE BULKHEAD
6. THE FOLLOWING CRANE BOOM CONFIGURATIONS MUST BE MAINTAINED WHILE TRAVELING ON RAMP:
   A. LIEBHERR LR1300: 44 m LENGTH, 24 m RADIUS
   B. LIEBHERR LR1200: 44 m LENGTH, 24 m RADIUS
   C. LIEBHERR HS895: 46.4 m LENGTH, 24 m RADIUS
   D. LIEBHERR LTR1100: 33.9 m RADIUS, 24 m RADIUS
   E. BOOM MUST BE OVER FRONT DURING TRAVEL W/ NO LOAD
7. THE BAUER BG39 OR BG40 SHALL HAVE ITS MAST OVER THE FRONT W/ NO TOOLING WHILE TRAVELING ON RAMP
8. VEHICLES SHALL BE CENTERED WITH THE RAMP PRIOR TO CLIMBING AS NOT TO REQUIRE TURNING WHEN ON THE RAMP
9. THE CAUSEWAY/TRESTLE RAMPS SHALL BE COMPACTED WITH A 10 TON VIBRATORY ROLLER EVERY 0.6 m LIFT.

LEGEND:

- GEOGRID MACHINE DIRECTION ALIGNED NORTH-SOUTH
- GEOGRID MACHINE DIRECTION ALIGNED EAST-WEST

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

DESIGNED BY: A.E.M.	PRINT IS ONE HALF INDICATED SCALE	SCALE: AS NOTED	
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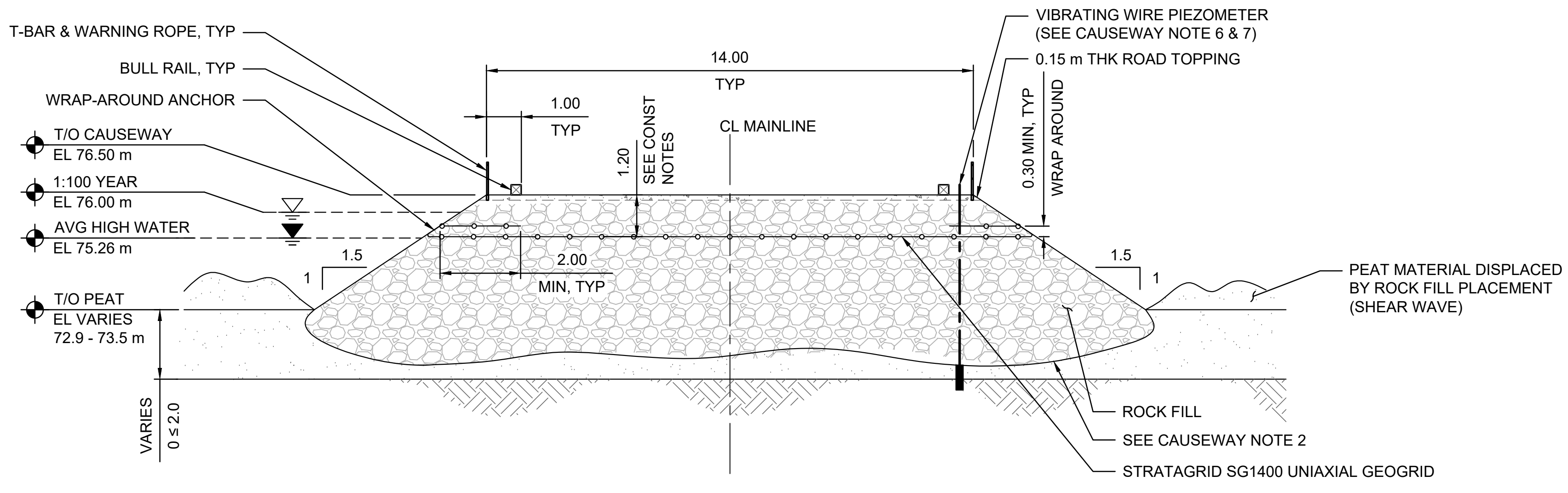
CHECKED BY: T.J.S.		DATE (MM-DD-YY): 10-11-19	Think! SAFETY BEGINS WITH ME

PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO.: 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO.: 501.02.01
DRAWING SUBJECT: TRESTLE / CAUSEWAY TRANSITION DETAILS		SHEET NO.: 3 OF 12

Drawing No. 1.3.3.2

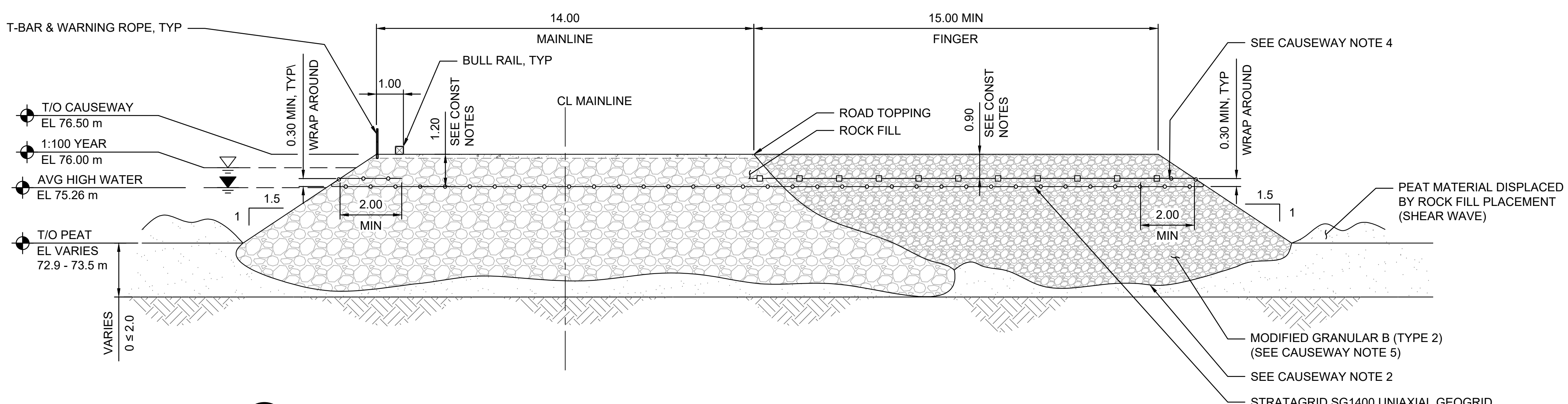
LEGEND:

- GEOGRID MACHINE DIRECTION ALIGNED NORTH-SOUTH
- GEOGRID MACHINE DIRECTION ALIGNED EAST-WEST



A 2 4 **ZONE 1 - SHALLOW PEAT (≤ 2.0 m) - MAINLINE**

SCALE: NTS



B 2 4 **ZONE 1 - SHALLOW PEAT (≤ 2.0 m) - MAINLINE & FINGER**

SCALE: NTS

CAUSEWAY NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND CAUSEWAY MATERIAL SPECIFICATIONS
2. LOWER EXTENT OF GRANULAR FILL WILL BE DEPENDENT ON DISPLACEMENT AND COMPRESSION OF EXISTING ORGANIC MATERIAL BELOW RIVERBED
3. GEOGRID SHALL HAVE TYPICAL CONFIGURATION SHOWN ON SHEET 8
4. ENSURE A LAYER OF GRANULAR MATERIAL BETWEEN TWO LAYERS OF GEOGRID TO PREVENT CONTACT BETWEEN SYNTHETIC MATERIALS
5. MODIFIED GRANULAR B SHALL BE USED AT THE LOCATIONS OF THE DRILLED SHAFTS
6. A MINIMUM OF 2 VIBRATING WIRE PIEZOMETERS SHALL BE INSTALLED ON THE SIDE SLOPES WITHIN ZONE 3 (LOCATIONS SHOWN ON SHEET 2). REQUIREMENTS FOR PIEZOMETERS IN ZONE 1 AND 2 SHALL BE DETERMINED BASED ON THE OBSERVED BEHAVIOR OF THE PEAT/ORGANIC MATERIAL, AND IF NECESSARY, SHALL BE INSTALLED PRIOR TO ANY DRILL RIG OR CRANE OPERATION. PORE PRESSURE MEASUREMENTS SHALL BE REPORTED TO THE EOR FOR SIGN-OFF AT LEAST 1 WEEK PRIOR TO DRILL RIG AND CRANE OPERATION.
7. VIBRATING WIRE PIEZOMETERS SHALL BE INSTALLED IN THE UPPER CLAY OR REMNANT PEAT, WHICHEVER IS ENCOUNTERED DURING THE DRILLING.

CONSTRUCTION NOTES:

1. THE CAUSEWAY CROSS SECTION SHOWN IS NOT TO SCALE.THE REALIZED BASE OF ROCK FILL PROFILE WILL BE A FUNCTION OF CONSTRUCTION METHOD, VARIABILITY OF GEOTECHNICAL CONDITIONS AND CONSISTENCY IN CONSTRUCTION TECHNIQUE. POCKET/ZONES OF PEAT ARE EXPECTED TO BE TRAPPED PARTICULARLY AT THE CENTER OF THE MAINLINE AND AT THE TRANSITION OF THE MAINLINE AND FINGERS. HOWEVER, CONSTRUCTION PROCEDURE MUST BE DEVELOPED TO MINIMIZE THE VARIABILITY TO THE PROFILE TO ASSURE SATISFACTORY PERFORMANCE. THE PROPOSED WORK PLAN SHOULD BE SUBMITTED TO THE ENGINEER OF RECORD FOR REVIEW.
2. THE INITIAL WORKING PLATFORM FOR PLACEMENT OF THE LOWER GEOGRID LAYER SHOULD BE NOT HIGHER THAN 0.2 TO 0.4 m ABOVE THE WATER LEVEL AT THE TIME OF PLACEMENT. BASED ON HISTORICAL WATER LEVELS IN LAKE ONTARIO AT KINGSTON, ON, THE HIGHEST EXPECTED WATER LEVELS DURING THE CAUSEWAY CONSTRUCTION ARE SHOWN BELOW.
3. THE TOP OF THE WORKING PLATFORM AND WATER LEVEL PRIOR TO PLACEMENT OF GEOGRID SHALL BE REPORTED TO THE ENGINEER OF RECORD FOR APPROVAL.

WATER LEVEL SCHEDULE

MONTH	FORCASTED AVERAGE WATER EL (m) *	HIGHEST EXPECTED WATER EL (m) *
AUG-2019	75.70	75.80 [1]
SEP-2019	75.40	75.60 [1]
OCT-2019	75.20	75.40 [1]
NOV-2019	75.00	75.30 [1]
DEC-2019	74.90	75.30 [1]
JAN-2020	-	74.90 [2]
FEB-2020	-	75.00 [2]
MAR-2020	-	75.00 [2]
APR-2020	-	75.50 [2]

* DATA BASED ON FORECASTS PUBLISHED BY THE INTERNATIONAL LAKE ONTARIO-ST. LAWRENCE RIVER BOARD WEBSITE HTTPS://IJC.ORG/EN/LOSLRB/WATERSHED/FORECASTS ON JULY 18 2019

[1] VALUES REPRESENT WATER LEVELS THAT WOULD BE EXCEEDED 5% OF THE TIME IF SIMILAR WET CONDITIONS WERE TO OCCUR

[2] VALUES REPRESENT HIGHEST WATER LEVELS OBSERVED BETWEEN 2017 TO 2019 INCLUSIVE

4. BASED ON THE CURRENT CONSTRUCTION SCHEDULE OF THE CAUSEWAY, IT IS EXPECTED THAT THE GEOGRID EMBEDMENT DEPTHS SHOWN CAN BE ACHIEVED. THE ELEVATION OF THE GEOGRID LAYERS SHALL BE REPORTED TO THE ENGINEER OF RECORD PRIOR TO PLACEMENT. AS-BUILT CONDITIONS, WHICH INCLUDE THE GEOGRID ELEVATIONS ALONG THE CAUSEWAY, SHALL BE RECORDED AND REPORTED TO THE ENGINEER OF RECORD TO ENSURE ACCEPTABLE CONDITIONS. SECTIONS WHICH MAY NOT HAVE SUFFICIENT GEOGRID EMBEDMENT MAY WARRANT SPECIAL CONSIDERATIONS.

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

DESIGNED BY A.E.M.
DRAWN BY J.R.P.
CHECKED BY T.J.S.

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SCALE AS NOTED
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DATE (MM-DD-YY) 10-11-19

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PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD
PROJECT LOCATION: KINGSTON, ON
JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY
TASK NO. 501.02.01
DRAWING SUBJECT: ZONE 1 CAUSEWAY - EXPECTED TYPICAL CROSS SECTIONS
SHEET NO. 4 OF 12

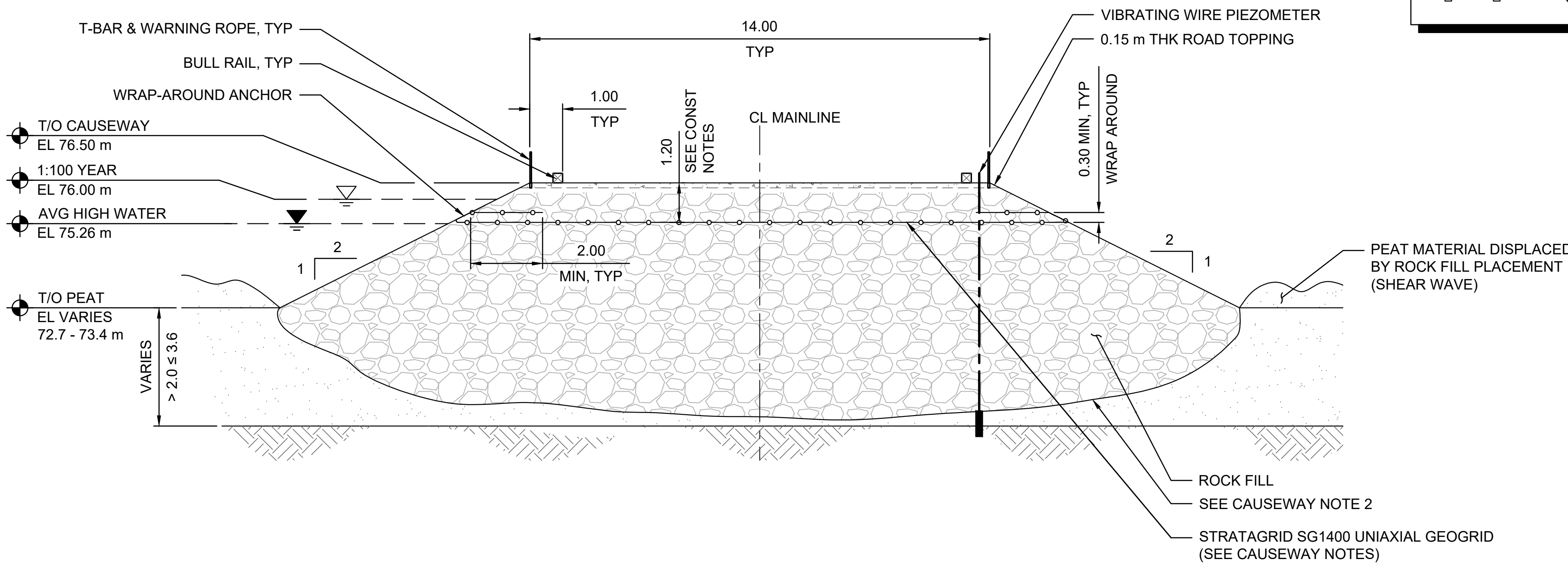
Drawing No. 1.3.3.3

LEGEND:

- GEOGRID MACHINE DIRECTION ALIGNED NORTH-SOUTH
- GEOGRID MACHINE DIRECTION ALIGNED EAST-WEST

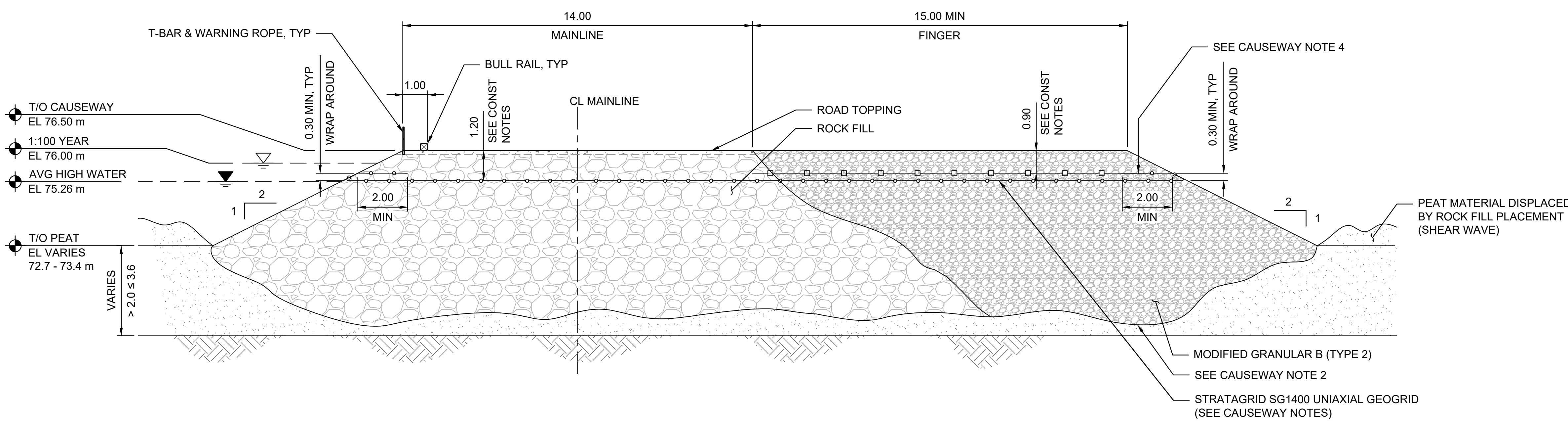
NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND CAUSEWAY MATERIAL SPECIFICATIONS
2. REFER TO SHEET 4 FOR CAUSEWAY NOTES AND CONSTRUCTION NOTES



A 2|5 **ZONE 2 - INTERMEDIATE PEAT (>2.0 ≤ 3.6 m) - MAINLINE**

SCALE: NTS



B 2|5 **ZONE 2 - INTERMEDIATE PEAT (>2.0 ≤ 3.6 m) - MAINLINE & FINGER**

SCALE: NTS

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

DESIGNED BY A.E.M.
DRAWN BY J.R.P.
CHECKED BY T.J.S.

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DATE (MM-DD-YY) 10-11-19

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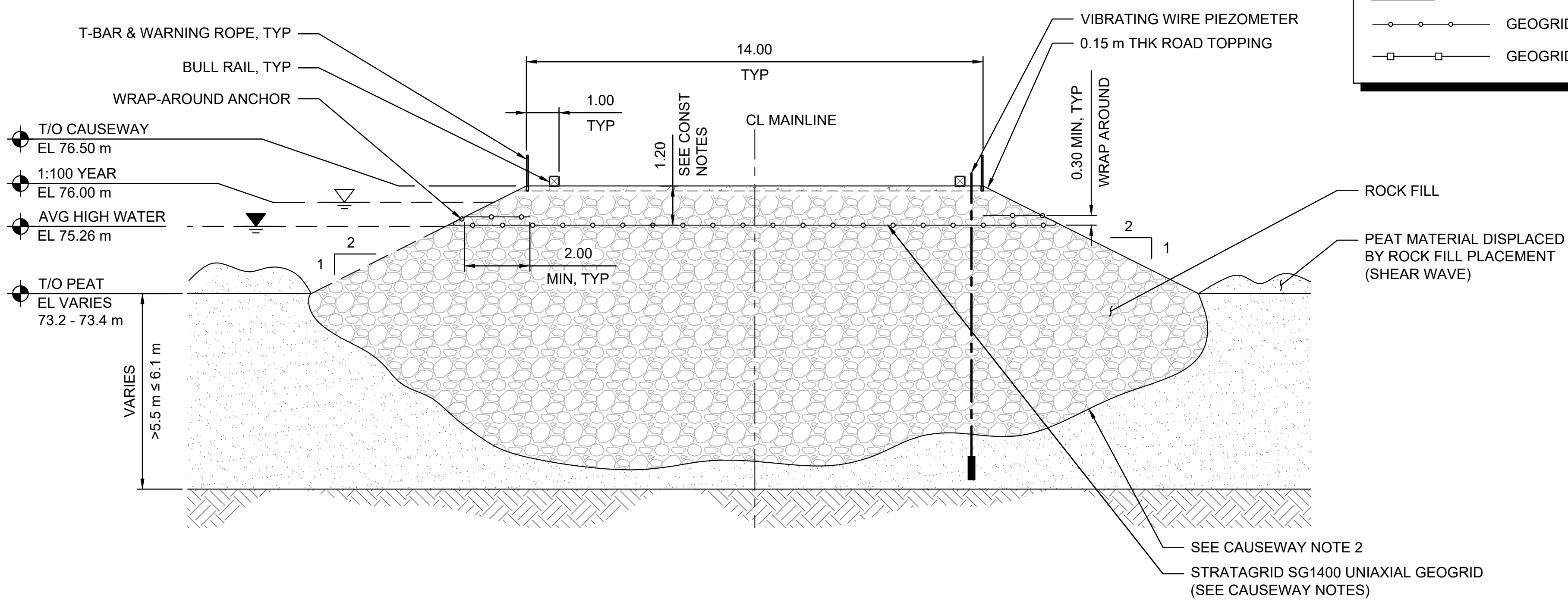
PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD
PROJECT LOCATION: KINGSTON, ON
JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY
TASK NO. 501.02.01
DRAWING SUBJECT: ZONE 2 CAUSEWAY - EXPECTED TYPICAL CROSS SECTIONS
SHEET NO. 5 OF 12

Drawing No. 1.3.3.4

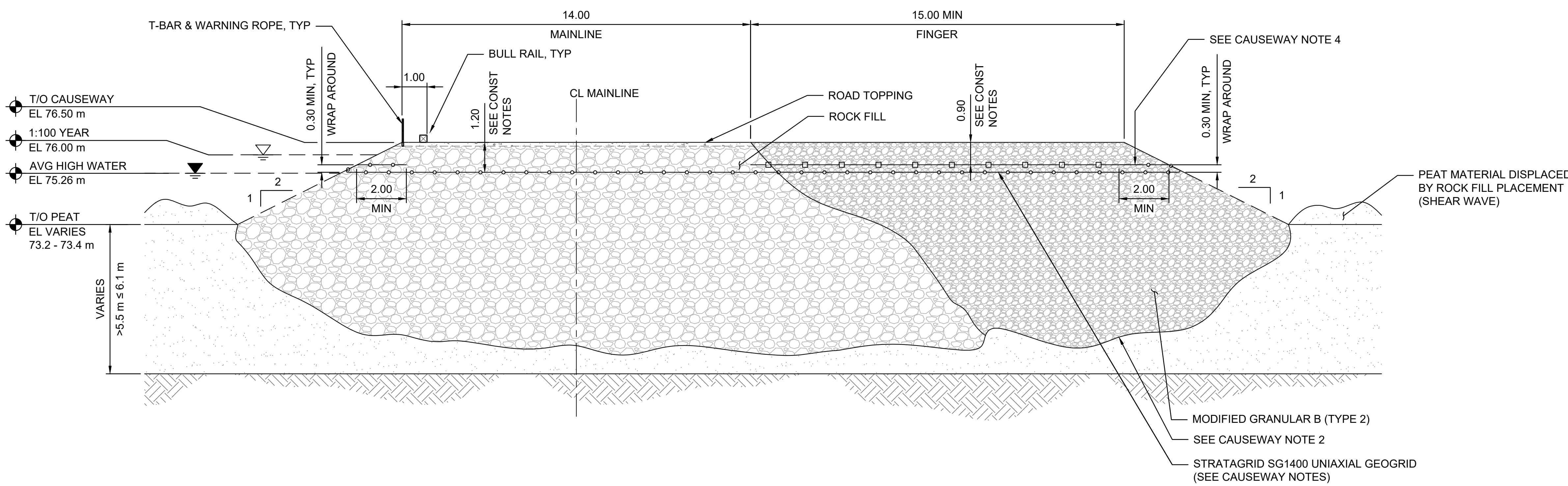
NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND CAUSEWAY MATERIAL SPECIFICATIONS
2. REFER TO SHEET 4 FOR CAUSEWAY NOTES AND CONSTRUCTION NOTES



ZONE 3 - DEEP PEAT / ORGANIC SOIL (>5.5 ≤ 6.1 m) - MAINLINE (A, 2 | 6)

SCALE: NTS



ZONE 3 - DEEP PEAT / ORGANIC SOIL (>5.5 ≤ 6.1 m) - MAINLINE & FINGER (B, 2 | 6)

SCALE: NTS

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

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DRAWN BY: J.R.P.
CHECKED BY: T.J.S.

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SCALE: AS NOTED
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DATE (MM-DD-YY): 10-11-19

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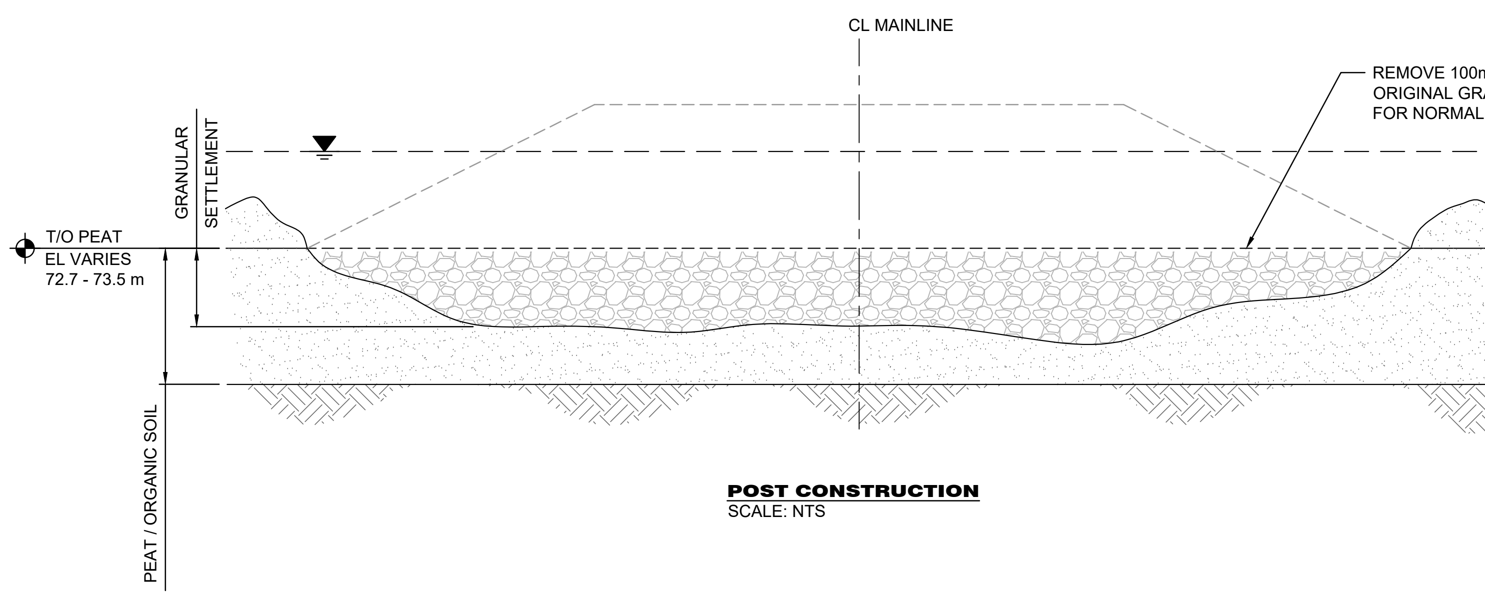
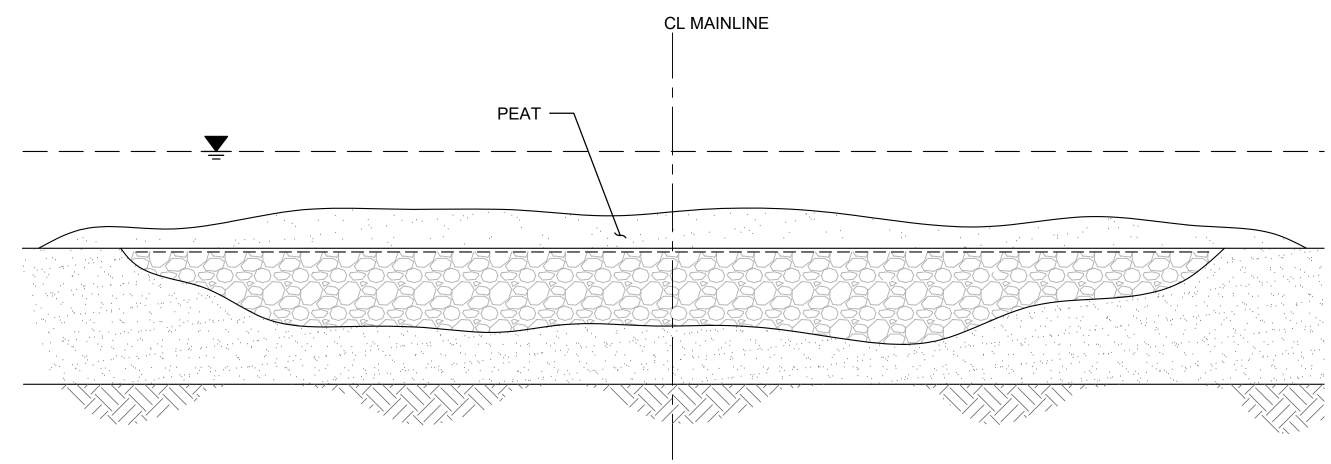
PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD
PROJECT LOCATION: KINGSTON, ON
JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY
TASK NO. 501.02.01
DRAWING SUBJECT: ZONE 3 CAUSEWAY - EXPECTED TYPICAL CROSS SECTIONS
SHEET NO. 6 OF 12



POST CONSTRUCTION
SCALE: NTS



SEDIMENT RE-NATURALIZATION
SCALE: NTS

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

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CHECKED BY T.J.S.		DATE (MM-DD-YY) 10-11-19	

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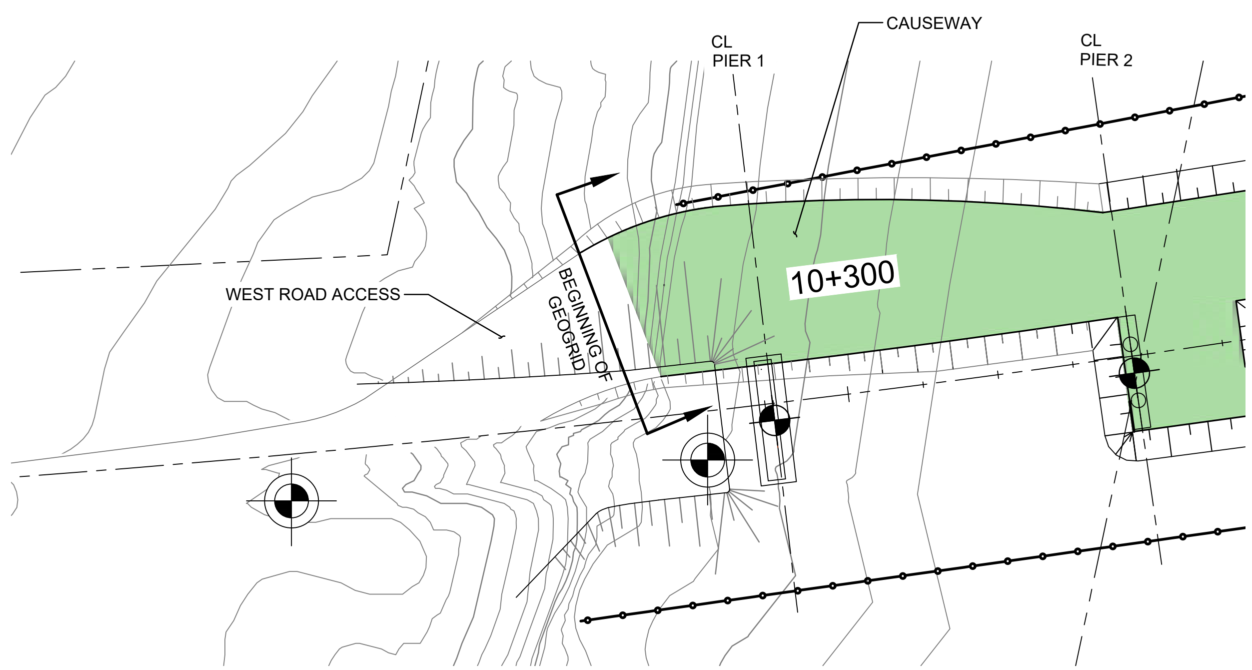
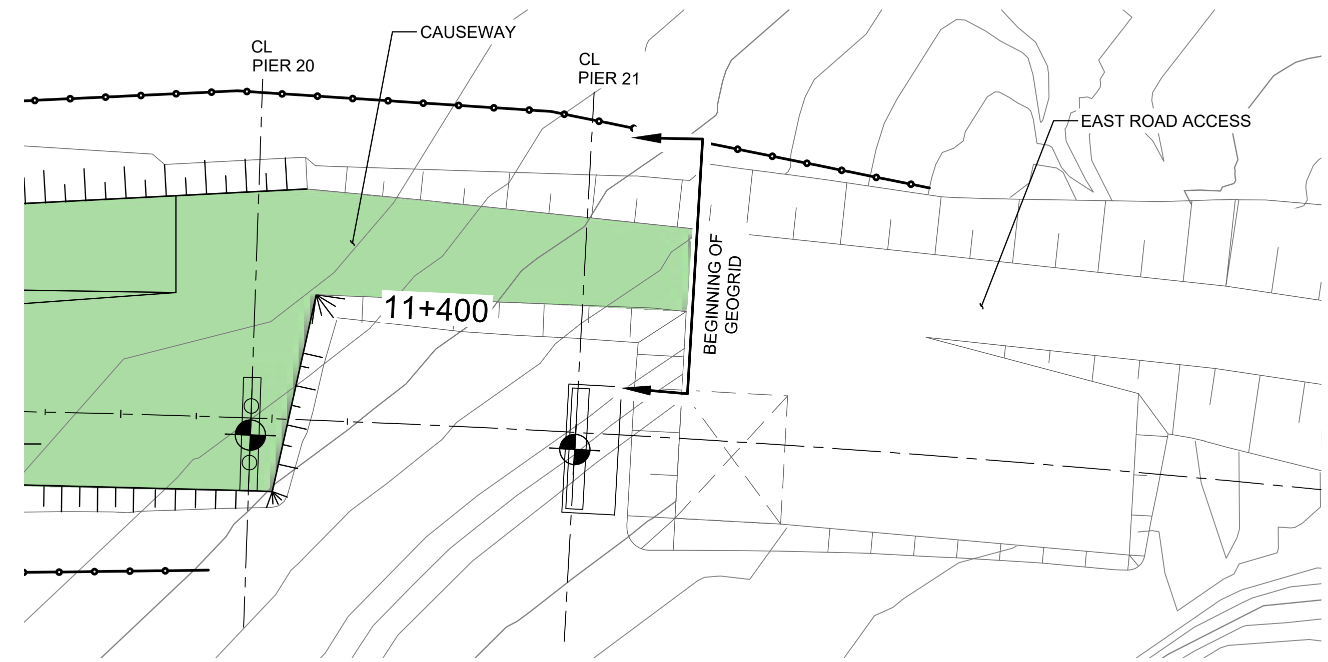
PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: TYPICAL NATURALIZATION CROSS SECTIONS		SHEET NO. 7 OF 12

Drawing No. 1.3.3.6



1 / 2 | 8 **BEGINNING OF GEOGRID -WEST SIDE**

SCALE: NTS



2 / 2 | 8 **BEGINNING OF GEOGRID - EAST SIDE**

SCLAE: NTS

GENERAL NOTES:

1. GEOGRID ARRANGEMENT ALONG MAINLINE AS SHOWN ON TYPICAL CAUSEWAY CROSS SECTIONS.

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

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CHECKED BY T.J.S.		DATE (MM-DD-YY) 10-11-19	

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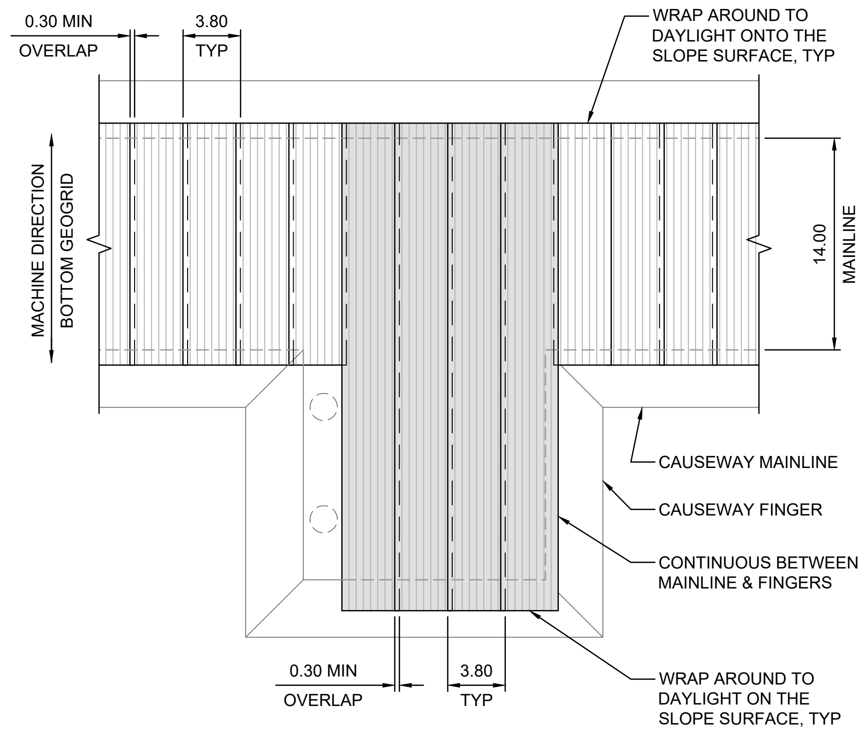
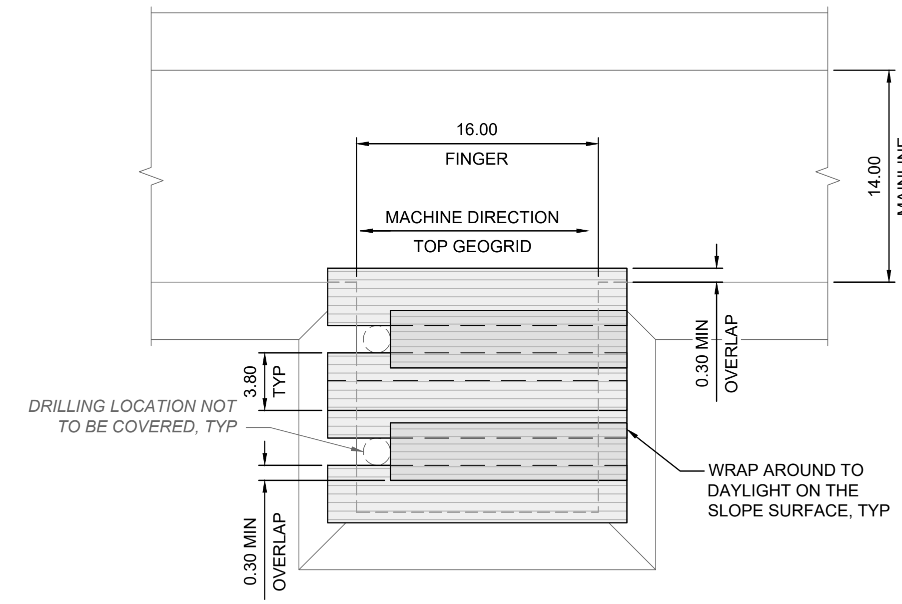
PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: GEOGRID AT ACCESS ROADS		SHEET NO. 8 OF 12



BOTTOM LAYER



TOP LAYER

TYPICAL GEOGRID LAYOUT

NTS

NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND CAUSEWAY MATERIAL SPECIFICATIONS
2. REFER TO SHEET 4 FOR CAUSEWAY NOTES AND CONSTRUCTION NOTES
3. NO SPLICING IS PERMITTED IN A GIVEN LENGTH OF GEOGRID
4. ZIP TIES SHOULD BE USED BETWEEN ADJACENT GEOGRID LENGTHS TO CONTROL OVERLAP AND PREVENT MOVEMENT OF SHEETS WHEN BACKFILLING ABOVE

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

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CHECKED BY T.J.S.		DATE (MM-DD-YY) 10-11-19	

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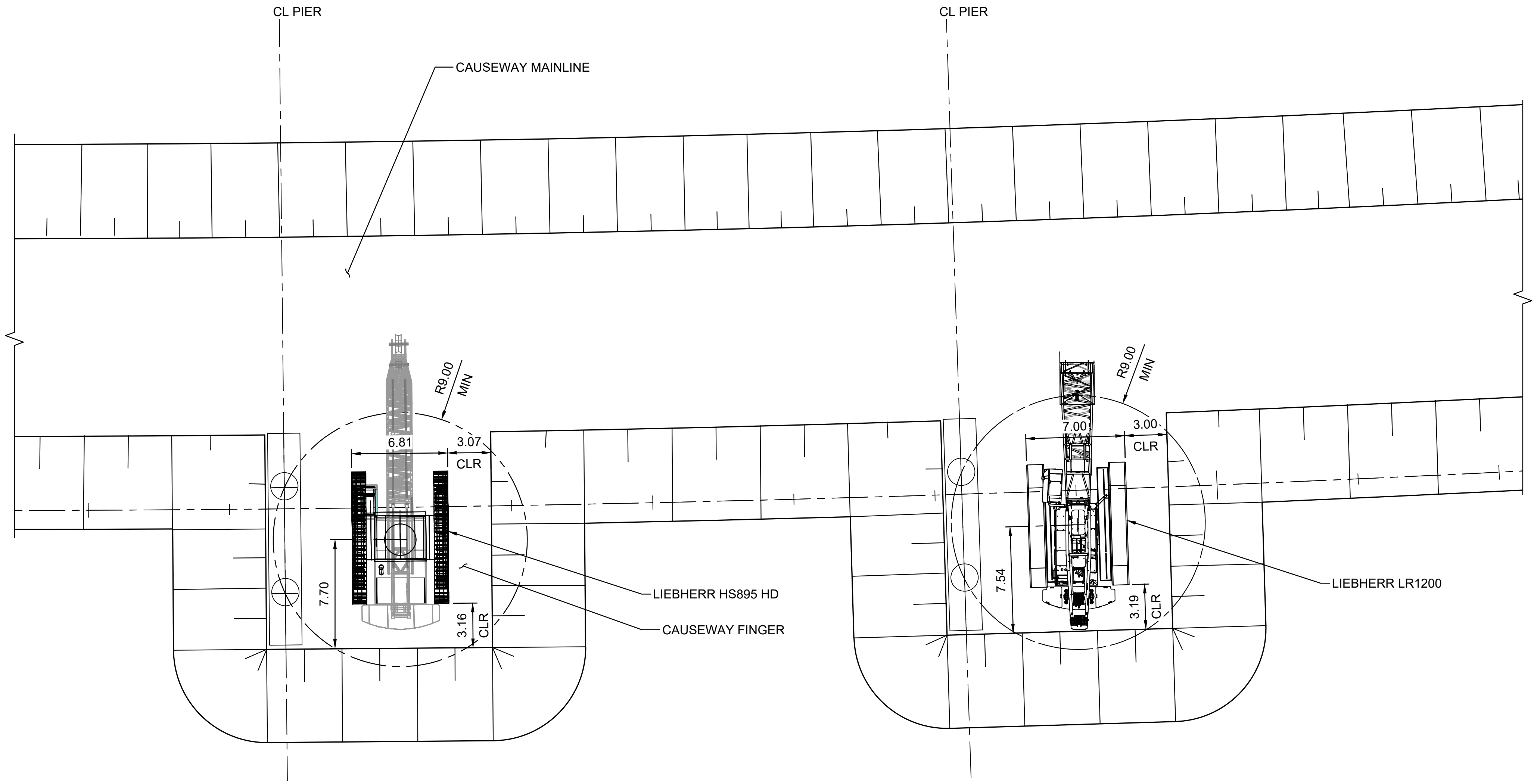
PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: TYPICAL GEOGRID ARRANGEMENT		SHEET NO. 9 OF 12



PLAN - CRANE POSITIONS AT TYPICAL CAUSEWAY FINGER

SCALE: 1:200

NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND EQUIPMENT ON CAUSEWAY
2. MINIMUM OFFSETS AND CRANE CONFIGURATIONS OF THE LIEBHERR LR 1200 AND HS 895 HD CRANES AT THE FINGERS SHOWN.
3. AT THE OFFSETS OF THE LR1200 SHOWN:
   A. THE CRANE BOOM RADIUS SHALL NOT BE <9 m AT ANY TIME
   B. AT BOOM RADIUS ≥9 m AND ≤44 m, THE CRANE UTILIZATION SHALL NOT EXCEED 80%
   C. MAX TRACK PRESSURE AT HIGH BOOM NO LOAD CONFIGURATION = 401 kPa
   D. MAX TRACK PRESSURE DURING CRANE PICKS AT ABOVE CONFIGURATIONS = 385 kPa
4. AT THE OFFSETS OF THE HS 895 SHOWN:
   A. THE CRANE BOOM SHALL NOT BE <9 m AT ANY TIME
   B. AT BOOM RADIUS ≥9 m AND ≤32 m, THE CRANE UTILIZATION SHALL NOT EXCEED 75%
   C. AT BOOM RADIUS >32 m AND ≤42 m, THE CRANE UTILIZATION SHALL NOT EXCEED 70%
   D. MAX TRACK PRESSURE AT HIGH BOOM NO LOAD CONFIGURATION = 393 kPa
   E. MAX TRACK PRESSURE DURING CRANE PICKS AT ABOVE CONFIGURATIONS = 424 kPa
5. THE LR 1200 AND HS 895 CRANES MAY OPERATE ON THE MAINLINE AT THE SAME OFFSETS AND SAME BOOM RESTRICTIONS AS THAT ON THE FINGERS. THE CRANE TRACKS MUST BE PARALLEL TO THE CAUSEWAY MAINLINE.
6. AT AN OFFSET OF 3.6 m BOTH LR1200 AND HS895 CRANES MAY OPERATE AT ANY BOOM RADIUS UP TO 85% CRANE CAPACITY
7. THE ABOVE ALLOWANCES ARE CONTINGENT UPON THE GEOGRID LAYERS PLACED AT THE EMBEDMENTS SHOWN IN THIS DRAWING PACKAGE FOR THE DIFFERENT ZONES. FOR SECTIONS OF THE CAUSEWAY THAT DO NOT ACHIEVE THESE ELEVATIONS, THE ABOVE CONDITIONS ARE NOT APPLICABLE, AND A RE-EVALUATION IS NECESSARY.
8. TO SAFE OFF FOR WEATHER EVENTS, ALL CRANES SHALL BE MOVED TO THE MAINLINE, CENTERED ON THE CAUSEWAY, WITH THE TRACKS PARALLEL TO THE MAINLINE.

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

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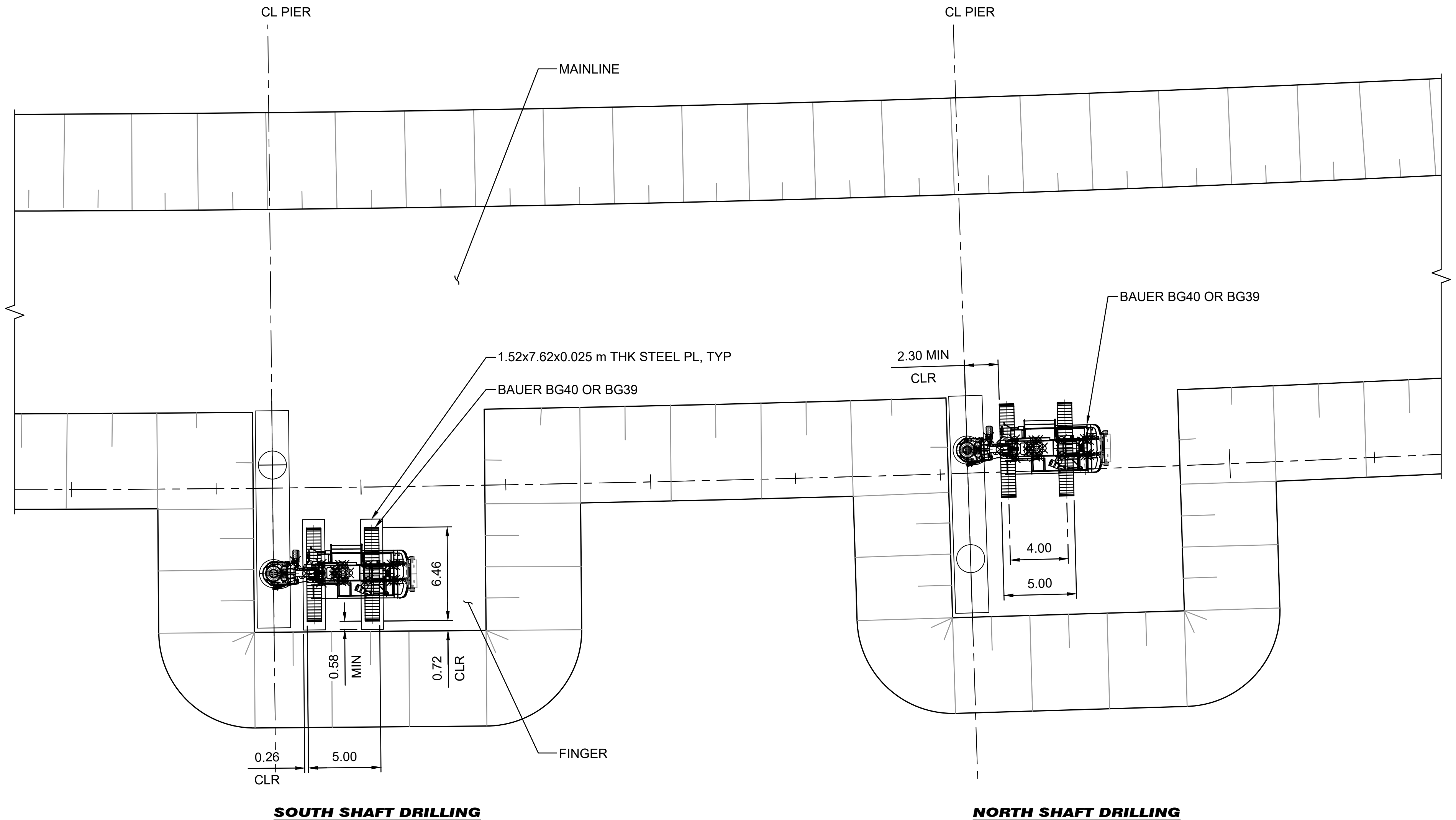
CHECKED BY T.J.S.		DATE (MM-DD-YY) 10-11-19	

PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: TYPICAL CRANE POSITIONS AT CAUSEWAY FINGERS		SHEET NO. 10 OF 12

Drawing No. 1.3.3.9



PLAN - BAUER BG40/BG39 POSITIONS

SCALE: 1:200

NOTES:

1. REFER TO SHEET 1 FOR GENERAL NOTES AND EQUIPMENT ON CAUSEWAY
2. STEEL PLATES SHALL BE USED UNDERNEATH EACH TRACK OF THE DRILL RIG DURING OPERATION FOR THE SOUTHERN DRILLED SHAFTS. THE TRACKS SHALL BE CENTERED ON THE STEEL PLATES.
3. A MINIMUM OF 0.10 m OF GRANULAR MATERIAL SHALL EXIST BETWEEN THE GEOGRIDS AND STEEL PLATES UNDERNEATH DRILL RIGS
4. THE DRILL RIGS MAY BE ORIENTED WITH THE TRACKS ALIGNED NORTH/SOUTH OR EAST/WEST AS SHOWN. THE OFFSETS SHOWN MUST BE MAINTAINED DURING DRILL SHAFT OPERATION.
5. THE DRILL RIGS SHALL MAINTAIN A MINIMUM OF 2.5 m OFFSET FROM THE EDGE OF THE SLOPE CREST DURING TRAVEL, EXCEPT WHILE ON THE STEEL PLATES POSITIONED
6. NO OPERATION SHALL BE PERFORMED UNTIL IN POSITION FOR DRILLING.

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

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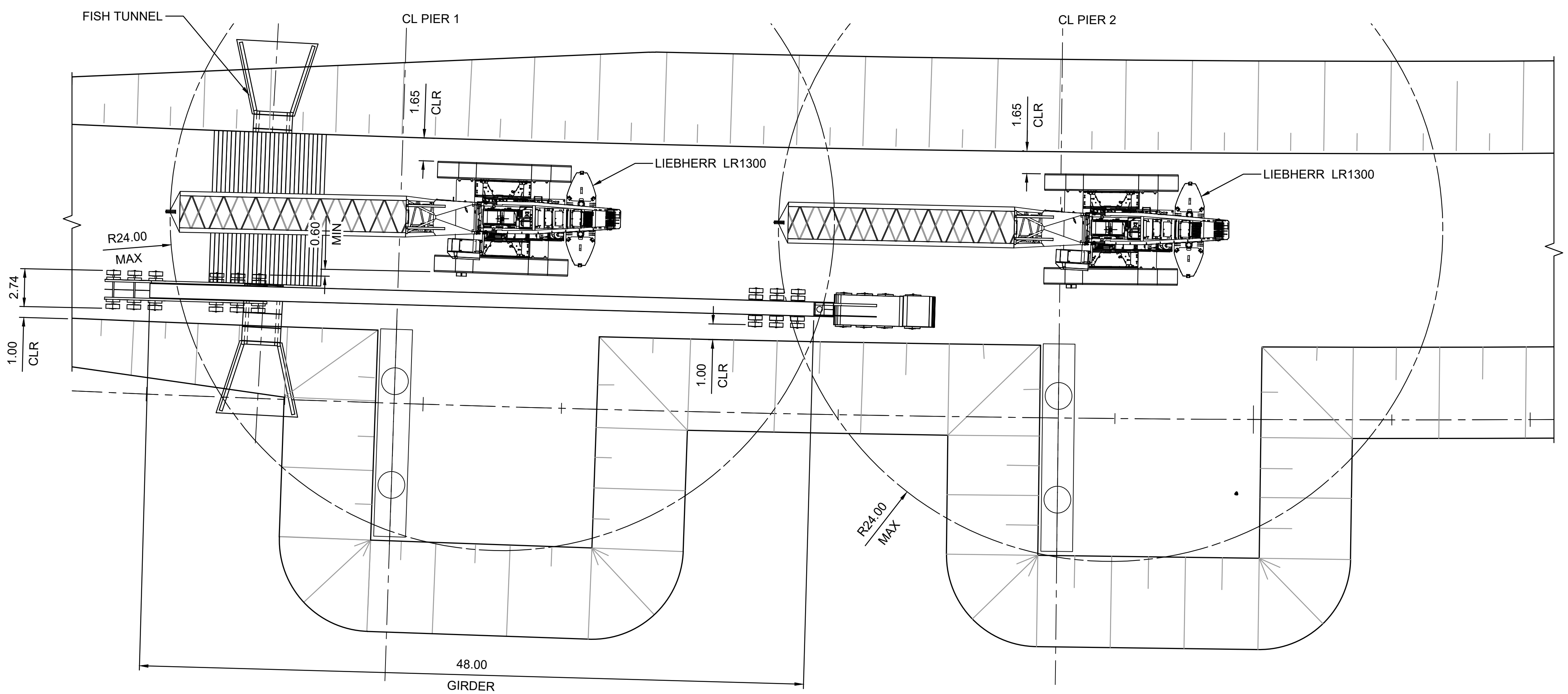
CHECKED BY T.J.S.		DATE (MM-DD-YY) 10-11-19	

PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: TYPICAL DRILL RIG POSITIONS		SHEET NO. 11 OF 12

Drawing No. 1.3.3.10



PLAN

SCALE: 1:200

NOTE: TYPICAL LAYOUT SHOWN BETWEEN PIER 1 AND 2, OTHERS ARE SIMILAR.

NOTES:

1. REFER TO SHEET 1 FOR ADDITIONAL GENERAL NOTES AND EQUIPMENT ON CAUSEWAY
2. THE LR1300 CRANES ARE ONLY PERMITTED TO OPERATE ON THE CAUSEWAY MAINLINE. THE CRANE TRACKS MUST ALWAYS BE PARALLEL TO THE CAUSEWAY MAINLINE, UNLESS INDICATED OTHERWISE.
3. TYPICAL OFFSETS DURING GIRDER LIFTS ARE SHOWN
4. THE LR1300 SHALL NOT EXCEED 85% CRANE CAPACITY AT THE OFFSET CLEARANCE SHOWN
5. A MINIMUM BOOM RADIUS OF 20 m SHALL BE MAINTAINED AT ALL TIMES AT THE OFFSET CLEARANCE SHOWN
6. MAX PEAK TRACK PRESSURES AT RESTRICTED BOOM RADIUS AT 85% CRANE CAPACITY = 495 kPa (INSIDE TRACK) AND 273 kPa (OUTSIDE TRACK)
7. MAX PEAK TRACK PRESSURES AT RESTRICTED BOOM RADIUS WITH NO LOAD ON HOOK = 369 kPa (OUTSIDE TRACK) AND 207 kPa (INSIDE TRACK)
8. CRANE ARRANGEMENTS FOR SPECIFIC GIRDER LIFTS WILL BE PROVIDED SEPARATELY AS PART OF THE LIFT PLANS.
9. IF CRANE TRACK IS OFFSET 3 m MIN FROM EDGE OF CAUSEWAY CREST, THE LR1300 CRANES MAY OPERATE AT CAPACITIES UP TO 85% WITH NO BOOM RESTRICTIONS. IF REQUIRED TO WORK AT A CAUSEWAY FINGER, OR A DIFFERENT OFFSET OR A DIFFERENT CRANE CAPACITY, A SEPARATE ASSESSMENT IS REQUIRED.
10. MAX PEAK TRACK PRESSURES WITH NO BOOM RESTRICTION AT 85% CRANE CAPACITY = 495 kPa AND 273 KPA (EITHER TRACK)
11. MAX PEAK TRACK PRESSURES WITH NO BOOM RESTRICTION AND NO LOAD ON HOOK = 468 kPa AND 230 kPa (EITHER TRACK)
12. THE ABOVE ALLOWANCES ARE CONTINGENT UPON THE GEOGRID LAYERS PLACED AT THE EMBEDMENT SHOWN IN THIS DRAWING PACKAGE FOR THE DIFFERENT ZONES. FOR SECTIONS OF THE CAUSEWAY THAT DO NOT ACHIEVE THESE ELEVATIONS, THE ABOVE CONDITIONS ARE NOT APPLICABLE, AND A RE-EVALUATION IS NECESSARY.
13. TO SAFE OFF FOR WEATHER EVENTS, ALL CRANES SHALL BE MOVED TO THE MAINLINE, CENTERED ON THE CAUSEWAY, WITH THE TRACKS PARALLEL TO THE MAINLINE.

REV.	DATE	BY	DESCRIPTION	CHK'D
0	10-11-19	J.R.P.	ISSUED FOR CONSTRUCTION	T.J.S.

Kiewit

DESIGNED BY	A.E.M.
DRAWN BY	J.R.P.
CHECKED BY	T.J.S.

PRINT IS ONE HALF INDICATED SCALE

SCALE	AS NOTED
IF SHEET IS LESS THAN 22"x34" IT IS A REDUCED PRINT SCALE REDUCED ACCORDINGLY	
DATE (MM-DD-YY)	10-11-19

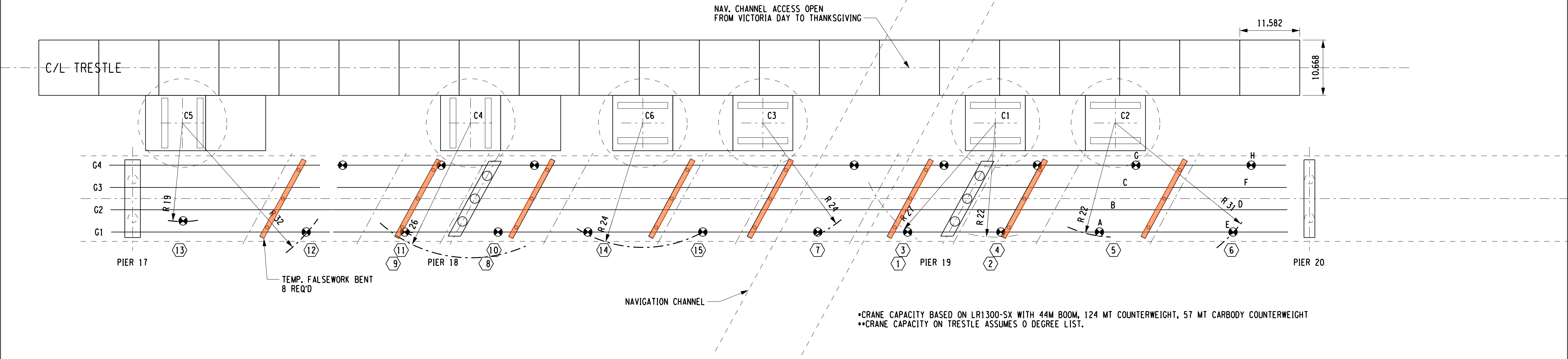
Think! SAFETY BEGINS WITH ME

PROJECT TITLE: KINGSTON THIRD CROSSING BRIDGE IPD	PROJECT LOCATION: KINGSTON, ON	JOB NO. 19-171
PROJECT TASK: TEMPORARY ACCESS CAUSEWAY		TASK NO. 501.02.01
DRAWING SUBJECT: TYPICAL CRANE POSITIONS DURING GIRDER LIFTS		SHEET NO. 12 OF 12

DRAWING FILE: 501.02.01.DWG 10/10/2019 8:42 PM

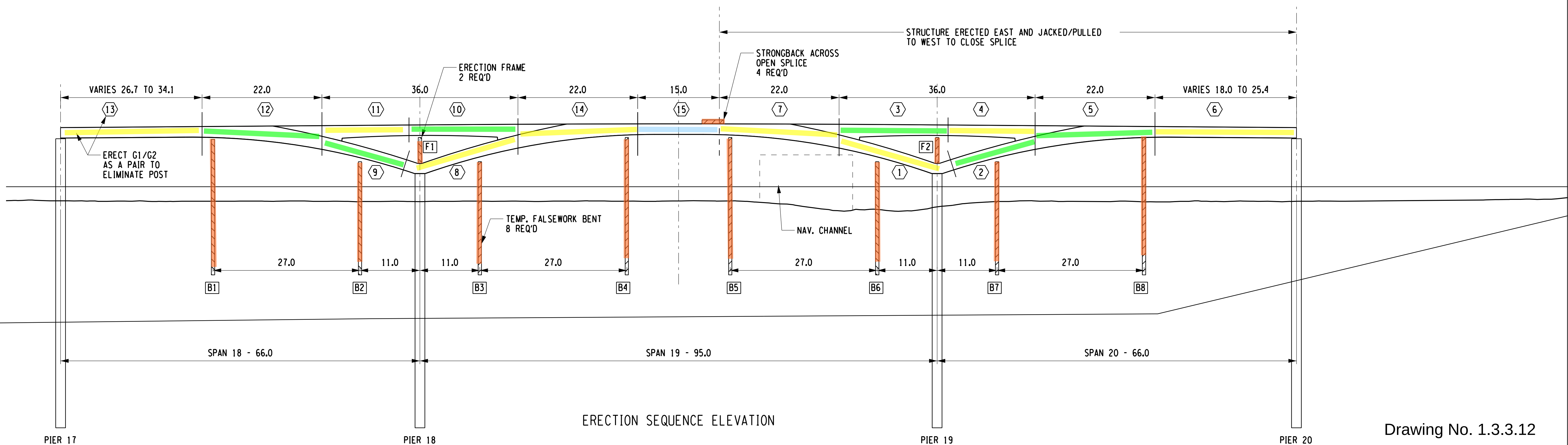
Drawing No. 1.3.3.11

BERGMANN	BY SJP	DATE 01-18-19	FILE NO.	SHEET NO. SK-1
	SUBJECT East Bridge - Concept Erection Sequence			



•CRANE CAPACITY BASED ON LR1300-SX WITH 44M BOOM, 124 MT COUNTERWEIGHT, 57 MT CARBODY COUNTERWEIGHT
••CRANE CAPACITY ON TRESTLE ASSUMES 0 DEGREE LIST.

ERECTION SEQUENCE PLAN



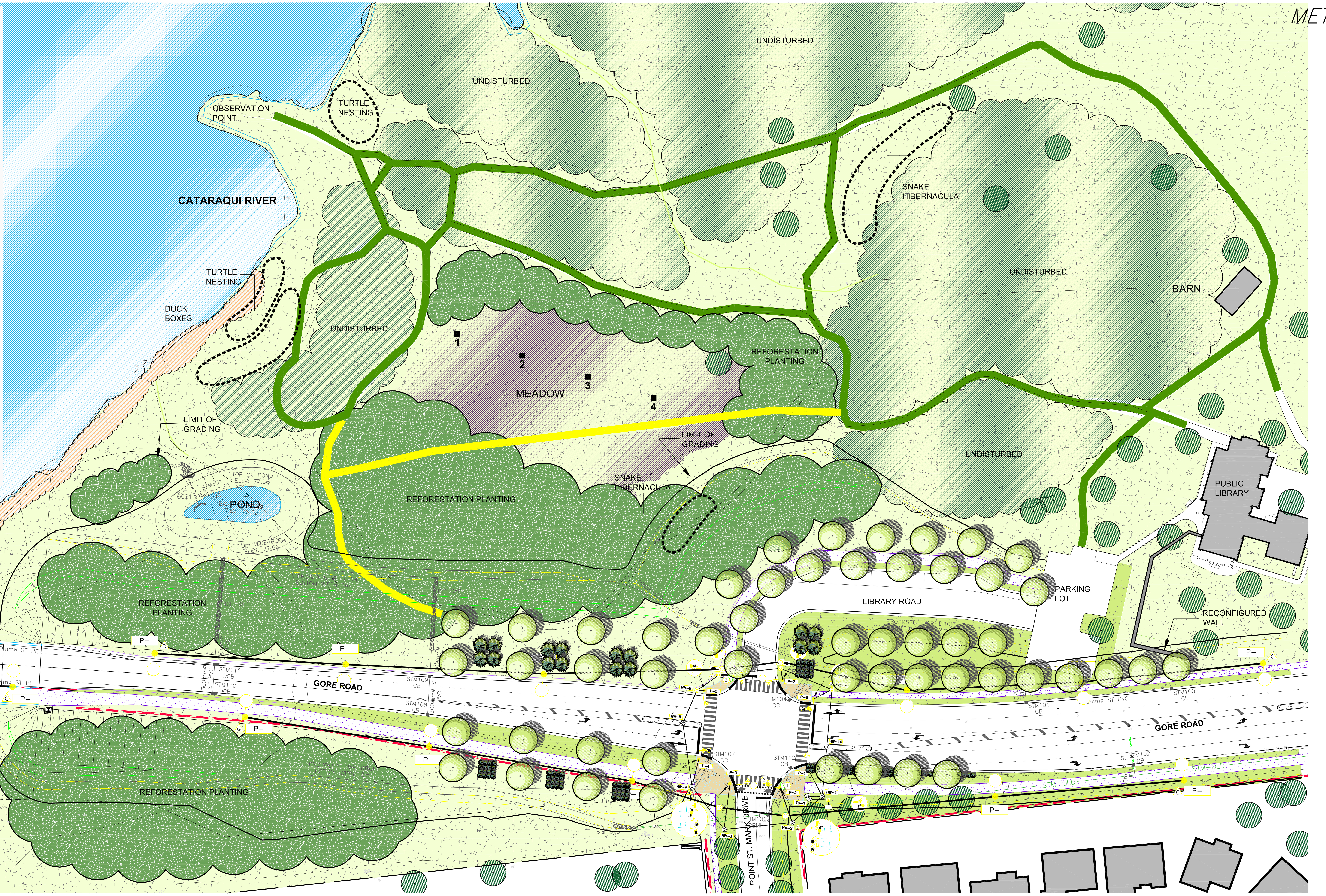
ERECTION SEQUENCE ELEVATION

Drawing No. 1.3.3.12

METRIC

LEGEND

- EXISTING WOODLOT (UNDISTURBED)
- EXISTING TREES
- PROPOSED TREES:
  Large trees: Deciduous trees, 60mm caliper, 3M to 4.5M height, spaced at 7M. Typical native tree species: Shagbard Hickory, Red Oak, Pin Oak, Red Maple, Sugar Maple.
  Small trees: Typical native tree species: Hackberry, Serviceberry
  Coniferous trees: 2M height spaced at 6M. Typical native tree species: White Pine, White Spruce, Eastern Hemlock, Balsam Fir.
- SHRUB PLANTING:
  2 gallon pot, typical native shrub species: Fragrant Sumac, Staghorn Sumac, Elderberry, Bush Honeysuckle, Seviceberry, Dogwood, Chokecherry, Ninebark, Whitch Hazel, Juniper
- REFORESTATION PLANTING:
  2/3 Trees - 30mm caliper deciduous trees 2500mm-3000mmHT, spaced at 4M Apart. 1/3 Shrubs - spaced at 2M Apart. Mixed deciduous woodland planting, native tree and shrub mix with species as listed under proposed trees and shrub planting.
- RIPARIAN PLANTING:
  1 gallon pot spaced at 1.5m apart. Mix of riparian shrubs, native grasses and forbs such as Speckled Alder, Black Cherry Chokeberry, Dogwood, Elderberry, Nannyberry, Bebb's Willow, Pussy Willow, Soft Rush, Cattail and Sedges.
- WILDFLOWER MEADOW:
  If disturbed, reinstate with custom wildflower seed mix. Hydroseeded. Mix of native grasses and perennials such as Big Bluestem, Canada Wild Rye, Switch Grass, Indian Grass, Little Blurstem, Prairie Dropseed, Azure Aster, Butterfly Weed, Common Mountain Mint, Golden Alexander, Giant Hyssop, Pearly Everlasting, Wild Columbine, Swamp Milkweed, Purple Coneflower, Joe Pye Weed, Yellow Coneflower, Black Eyed Susan
- LAWN - SEEDED
- EXISTING TO REMAIN
- CONCRETE PAVING and TINTED CONCRETE PAVING
- MULTI-USE PATH
- GENERAL LOCATION FOR WILDLIFE MICRO-HABITAT
- NOISE ATTENUATION BARRIER
- EXISTING PATHWAY TO REMAIN
- REINSTATED PATHWAY
- PROPOSED LOCATION OF BAT BOXES



INTEGRATED PROJECT DELIVERY TEAM:

HATCH | SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES | Kiewit | KINGSTON

#			JJ	MJL
No.	DATE	REVISIONS	BY	CHECKED

DESIGN COMPANY: VERTECHS DESIGN LANDSCAPE ARCHITECTS

DESIGN:	JJ
DRAWN:	RM/JJ
CHECKED:	MJL

KINGSTON THIRD CROSSING
LANDSCAPE LAYOUT
EAST

DATE: 08-05-19
DRAWING NO. 1.4.1.1

SCALE: 1:500
SHEET NO.
REVISION

DRAWING NAME:
PLOT DATE:

LEGEND

METRIC

- EXISTING WOODLOT (UNDISTURBED)
- EXISTING TREES
- PROPOSED TREES: Large trees: Deciduous trees, 60mm caliper, 3M to 4.5M height, spaced at 7M. Typical native tree species: Shagbard Hickory, Red Oak, Pin Oak, Red Maple, Sugar Maple. Small trees: Typical native tree species: Hackberry, Serviceberry. Coniferous trees: 2M height spaced at 6M. Typical native tree species: White Pine, White Spruce, Eastern Hemlock, Balsam Fir.
- SHRUB PLANTING: 2 gallon pot, typical native shrub species: Fragrant Sumac, Staghorn Sumac, Elderberry, Bush Honeysuckle, Seviceberry, Dogwood, Chokecherry, Ninebark, Whitch Hazel, Juniper
- REFORESTATION PLANTING: 2/3 Trees - 30mm caliper deciduous trees 2500mm-3000mmHT, spaced at 4M Apart. 1/3 Shrubs - spaced at 2M Apart. Mixed deciduous woodland planting, native tree and shrub mix with species as listed under proposed trees and shrub planting.
- RIPARIAN PLANTING: 1 gallon pot spaced at 1.5m apart. Mix of riparian shrubs, native grasses and forbs such as Speckled Alder, Black Cherry Chokeberry, Dogwood, Elderberry, Nannyberry, Bebb's Willow, Pussy Willow, Soft Rush, Cattail and Sedges.
- LAWN - SEEDED
- EXISTING TO REMAIN
- CONCRETE PAVING and TINTED CONCRETE PAVING
- MULTI-USE PATH
- GENERAL LOCATION FOR WILDLIFE MICRO-HABITAT
- NOISE ATTENUATION BARRIER

NOTE: FOR UNDERGROUND UTILITIES REFER TO CIVIL DWGS.

INTEGRATED PROJECT DELIVERY TEAM:

HATCH | SYSTRA INTERNATIONAL BRIDGE TECHNOLOGIES | PKS Kiewit | KINGSTON

No.	DATE	REVISIONS	BY	CHECKED
#			JJ	MJL

DESIGN COMPANY: VERTECHS DESIGN LANDSCAPE ARCHITECTS

DESIGN: JJ
DRAWN: RM/JJ
CHECKED: MJL

KINGSTON THIRD CROSSING
LANDSCAPE LAYOUT
WEST

DATE: 08-05-19
DRAWING NO. 1.4.1.2
SCALE: 1:500
SHEET NO.
REVISION

DRAWING NAME:
PLOT DATE:

More specific design provisions, yet to be confirmed on the east side lands include:

1. An urban landscape theme with avenue tree plantings to serve as a buffer from the Gore Road-Highway 15 intersection area to a plaza space at the Gore Road-Point St. Mark Drive-Gore Road Library intersection where a more natural landscape theme takes over closer to the bridge and shoreline. This includes meandering rock walls (if required) in order to:

a) Break up the grade change and thereby provide a more natural approach.

b) Maximize the usable ‘meadow’ space for future park development.

2. Selected plant materials are based on the list of vascular plants observed on the east side lands as well as native and non-invasive plant species suitable to the area, and which are resilient to environmental stresses. More specifically:

a) Reforestation planting includes predominantly mixed deciduous trees and shrub species.

b) Shrub planting includes a mix of deciduous and coniferous shrubs as well as a variety of fruiting species to provide a food source for wildlife.

c) If utilized as a laydown area, meadow area restoration will use existing topsoil (stockpiled during construction) with seed sources from the existing seed bank as well as a seed mix of native grasses and perennials.

d) Shoreline restoration will use hydric soils (stockpiled during construction) containing local seed and root stock as well as riparian shrub planting.

3. In regards to multi-use pathway provisions:

c) If the area is disturbed a circular 2.7 m wide multi-use pathway (asphalt) will be developed extending from the Gore Road Library parking lot to the shoreline and observation look-out / interpretive area (complete with 2 pedestrian bridges over the existing watercourses and a secondary stone dust path connection). The pathways will follow existing trails and the same route through the woodlot as the future construction access road.

d) A 1.5 m wide sidewalk arrangement is shown extending along the north side of Gore Road, with a 2.7 m multi-use pathway link along the south side of

Gore Road with a proposed crosswalk / cross-ride at the Gore Road-Point St. Mark Drive-Gore Road Library intersection.

4. A realigned portion of the dry stone wall on the Gore Road Library property is shown.
5. The following wildlife micro-habitats are shown:

a) Bat boxes, duck boxes and snake hibernacula.
b) Areas suitable for turtle nesting.
c) The retention of log piles to provide cover for wildlife.

More specific design provisions, yet to be confirmed on the west side lands include:

1. The existing metal piling along the west shoreline will be removed and reinstated with hydric soils (stockpiled during construction), riparian shrub planting, native grasses and forbs that further integrate the proposed stormwater outlet.
2. Avenue street tree planting will use native, drought tolerant species as well as clusters of specimen tree planting, including both deciduous and coniferous species, to provide screening to adjacent properties.
3. An area of reforestation planting is shown north of the bridge to extend the existing corridor of woodland vegetation along the western shore.
4. A 2.7 m wide multi-use pathway on the north side of John Counter Boulevard, to the west of Ascot Lane, is shown in order to allow:

a) A potential future connection to the multi-use pathway route north of John Counter Boulevard.

5. The extension of the multi-use pathway to the east of Ascot Lane on the south side of John Counter Boulevard is shown, which:

b) Connects with the existing Elliott Avenue Parkette and proposed observation look-out / interpretive area.
c) Provides an alternate route for pedestrians and cyclists.

6. Noise attenuation provisions adjacent to the River Park subdivision along the north side of John Counter Boulevard will include landscape elements such as climbers to soften their appearance.

4.1.2 In-Water

4.1.2.1 Design

As discussed in Section 2.0 of this Report, in-water construction of the bridge will be facilitated by a Causeway-Trestle Solution construction approach, which provides access from shore to the navigable channel on both sides via east and west temporary causeway and temporary trestle.

The overall in-water footprint of the east and west temporary causeway is up to 32,475 m^2. However, the footprint of the temporary access will change as the Project progresses and material is removed and re-used. Initial causeway placement is expected to take 12 months, starting late 2019, depending on timing of approvals required to begin in water works. Once constructed, the maximum causeway footprint will be in place for a total of 12 months, between late 2020 and late 2021. It is anticipated that the removal of portions of temporary causeways will begin in August 2020 as work platforms that are no longer required are progressively removed. In 2021, following the construction of the permanent bridge, the remaining temporary causeways will be removed along with the temporary trestles. It is anticipated that it could take between 9 to 14 months to remove the causeway access depending on the when removal begins relative to the fish timing window and ice-on conditions.

The temporary in-water footprint of the temporary trestle accesses is up to 50 m^2. During construction of the access, steel piles will be driven to bedrock to provide bearing for the work bridge. The bridge construction will also require temporary falsework (or bents) in the form of piles to support the main span and back spans while the bridge is being constructed, the footprint of this falsework is approximately 7 m^2. These piles will be removed along with the temporary trestle once construction is complete. It is anticipated that the removal of the temporary trestle is could take up to 4 months following construction of the permanent bridge. The temporary trestle access will be in place for a total of 18 to 26 months, from mid 2020 to early 2022.

In total, the compensation area is expected to be 32,532 m^2, for the temporary disturbances. The compensation area for the permanent losses and alternations due to the bridge and its approaches is up to 238 m^2. Table 4.1: provides a summary of the temporary and permanent footprints for the Project.

Table 4.1: Summary of Temporary and Permanent Footprints

Temporary Footprint:	
Temporary Causeway Access	32,475 m^2 West: 28,785 m^2 East: 3,690 m^2
Temporary Trestle Access	50 m^2
Falseworks	7 m^2
Total	32,532 m^2
Permanent Footprint:	
Piers and Drilled Shafts (permanent loss)	92 m^2
Abutment and fill below average high water mark (75.26 masl) (permanent loss)	146 m^2 West 0 m^2 East
Total	238 m^2

Discussions with the IPD Team, Parks Canada, and DFO have centred upon the permanent losses due to the in-water and on-land footprint of the bridge and its approaches and temporary losses due to the construction approach for the Third Crossing to consider compensation. The goal of the proposed in-water works is to apply at least a 1:1 compensation ratio to the wetland structure and function of an area up to 32,532 m^2. For this area, the temporary footprint encompasses the permanent footprint of the piers.

The former Music Marina and navigation channel are shown on Figure 4-1. The former Music Marina area consists of an area of open water of 13,200 m^2 and the associated navigation channel with an open water area of 24,100 m^2. This area, which is shown in Figure 4-1, has sustained various impacts related to the former Music Marina operation, specifically due to a history of dredging, vegetation cutting, and vessel operation. A further area of 46,700 and 23,000 m^2, respectively, to the north and south of the navigation channel have been historically disturbed by vessel operations, seen as recently as 2015 from aerial imagery, which will benefit from the closure of the Music Marina and the public boat launch. These boat disturbed PSW areas have not been included in the calculation of the potential compensation area. As shown earlier on Drawing 1.2.6.1, the area includes the Open Water (OW) as well as portions of the SuW1 and SuW2 wetland plant communities. Through the purchase of the Music Marina facility and the future closure of the public access boat launch, the open water areas provide an opportunity to allow the SuW1 and SuW2 areas to expand into the open water areas. The former OW areas could then be evaluated and included as part of the Greater Cataraqui Marsh PSW. As such the former Music Marina and its navigation channel represent a potential compensation area of approximately 37,300 m^2, less the area located within the temporary causeway footprint. It should be noted that restoration for the temporary causeways and the temporary trestle within the PSW would be also subject to restoration efforts to mitigate the effects of these temporary disturbances in these locations.

Legend

Project Location

- Aquatic Exclusionary Turbidity Curtain (AETC)
- Temporary Construction Components

Rockfill AccessTotal Area: East: 0.42 ha & West: 2.92 ha

- Permanent Components
- Provincially Significant Wetland (PSW)

Temporary West Rockfill Access In-Water Compensation

- Open Water Channel (0.05 ha)
- Music Marina (0.24 ha)

DATA SOURCES:

1. Spatial References: NAD 1983 UTM Zone 18N
2. Sources: Roads, Wetland - Land Information Ontario;

0 62.5 125 250 Meters

1:4,750

Project:	**City of Kingston - Third Crossing**
Figure Title:	**In-Water Compensation Area**
Prepared By:	HATCH, SYSTRA, Kiewit, Kingston
Date:	**November 18, 2019**
Figure: 4-1	**Page: 1 of 1**

User Name: vill77807

Document Path: T:\Maps\GIS_Data\CityOfKingston\MXD\K3C_DIA_Fig3-38_InWaterCompensation_1.mxd

Restoration activities will include the following:

1. Sedimentation and soil erosion control measures installed during the construction phase will be maintained, and removed only after the restoration work is complete and the exposed substrates are stabilized by vegetation.
2. Confirming that the specific location of the in-water compensation works is at a suitable distance away from the stormwater outlet.
3. Upon removal of the causeway material, the base of the causeway will be excavated to approximately 100 mm below original riverbed elevation (within the area of the placed material) by an excavator equipped with a GPS unit. The creation of this 100 mm depression has proven on similar projects to encourage settlement of sediment during natural post construction flow events (wind, wave and other currents). Utilizing the finer rock fill material, along with additional new sediment deposition, will accelerate the recovery of the causeway footprint.
4. Re-vegetation of the area will be accomplished by natural regeneration by the existing four dominant aquatic macrophyte (as seen by the re-vegetation naturally occurring in the former Music Marina area)
5. In the event vegetation does not recolonize at the predicted rate active revegetation measures will be employed this may include active transplanting of desired species from the local environment or greenhouses, promoting native seed dispersion onto the substrates. Under a worst-case scenario if limited vegetation is occurring throughout the construction footprint soils may be imported and placed via barge with active seeding or planting occurring.
6. The restored area will be periodically reviewed by a qualified wetland scientist.

4.1.2.2 Future Design Considerations

Additional measures that should be considered further in the in-water compensation area include:

1. As noted above, the approach to design will be to ensure that the causeway footprint returns to initial conditions as soon as possible. However, it may be determined that there is a local benefit for the creation of spawning habitat for targeted species.

2. Use of salvaged trees for use in wetland fish habitat creation where appropriate.
3. Installing signs and buoys to discourage boat traffic in the area.
4. Implementing:

a) Encourage reduced speeds to restrict the wakes of boats travelling the navigable channel.

b) Public awareness programs on the in-water compensation works and associated behaviours to facilitate success of the program.

4.1.3 Physical Works and Activities

Table 4.2 lists the physical works and activities associated with the site restoration and rehabilitation stage before mitigation measures are in place:

Table 4.2: Site Restoration and Rehabilitation Works and Activities

Project Phase	Core Project Components	Physical Works and Activities
Site Restoration / Rehabilitation	Bridge	Strip formwork. Remove falsework.
	Approaches / In-water	Remove top deck of work bridge access and remove pipe piles Remove temporary causeway to precise elevation below original grade to create a slight depression for renaturalization. Engage landscape and in-water restoration and rehabilitation works. Demobilize (site cleanup, trailer and material removals, temporary utility removals). Monitor and report on the progress of in-water restoration on an annual basis until restoration achieved. Engage additional in-water restoration works (if required).

5. Operations Phase

The operations phase, which follows the site restoration and rehabilitation phase, focuses on design, operations and maintenance provisions to ensure the long-term safety and viability of the Project.

5.1.1 Design Considerations

1. **Winter Provisions:** Since salt-laden snow deteriorates concrete and affects the service life of infrastructure, there are no obstructions on the roadway or multi-use pathway to impede the efficient removal of snow from the bridge deck:

a) The bridge deck lighting is situated on top of the center barrier.

b) On the multi-use pathway, a small concrete curb is provided at the base of the barrier on the south side of the bridge deck to enable snow plows to ride against it without damaging the railing system. It also prevents salt-laden water from flowing down the fascia and entering the river.

c) In the case of heavy snowfall or built up windrows, snow plowing within the multi-use pathway area can push snow to the center barrier. The windrows can then be blown over the barrier and into trucks for transport off the bridge.

d) The roadway and multi-use pathway are both sloped towards the center barrier to facilitate the flow of snowmelt to the deck drains.

2. **Expansion Joints:** Cleaning joints and replacing expansion joint seals is an ongoing maintenance and cost issue on all bridges. Minimizing the number of joints is important to reduce the amount of maintenance and operational cost in the future.

3. **Drainage System:** The inspection of the drainage system is important as leaks can cause corrosion of the structural steel if left unnoticed and unrepaired.

4. **Atmospheric Corrosion Resistant (ACR) Steel:** The durability of the structural steel is of the upmost important for the long term service life of the bridge. ACR steel is approximately 4 times more resistant to corrosion than plain carbon steels. It forms a rust patina which inhibits further corrosion of the structural steel, and is generally uncoated, except for the girder ends near the expansion joints.

5. **Bearings:** Although current bearing technology ensures maintenance free units over the long-term, they have in the past been susceptible to seizing and general wear-and-tear due to their continuous movement. Therefore, regular inspection is required to ensure that unwanted forces are not imposed on the bridge due to malfunctioning bearings.
6. **Inspections:** Inspections will be carried out with a bridge inspection vehicle.
7. **Emergency Provisions:** In case of an emergency on the bridge, there is sufficient space to allow for both lanes of traffic to continue to flow if all vehicles are pulled over onto the shoulder. But in case of a full road closure on the bridge:

e) There is ample room for non-emergency passenger vehicles to turn around. The vehicles would then be detoured to either the Highway 401 crossing to the north or the LaSalle Causeway crossing to the south.

f) There are no bridge design codes requiring that emergency vehicles be able to turn around on a bridge. As such, emergency vehicles would have to maneuver, based on the actual road closure conditions and traffic control provisions that are in place during the emergency event.

g) As noted earlier, the multi-use pathway will be subjected to pedestrian loading of up to 4.0 kPa; and/or Maintenance Vehicle gross loading of 80 kN. This load can accommodate an ambulance. Based on such provisions, it should then also be noted that removable bollards should be considered at both approaches to prevent non-emergency vehicle access onto the multi-use pathway.

5.1.2 Life Cycle Considerations

5.1.2.1 Bridge

A life cycle analysis of the Project was undertaken during the pre-design Project phase in accordance with the MTO Financial Analysis Manual. With regular maintenance, it is expected that the bridge would last more than 100 years. This assumes no quality issues with manufacturing/fabrication/placement/installation, proper maintenance, drainage, and waterproofing, as well as no damage from unplanned events.

Table 5.1 shows the service life of the different bridge elements and whether they will require replacement over the course of its life cycle.

Table 5.1: Service Life of Bridge Components

Bridge Component	Service Life (in years)
Permanent Components:	
Foundations, including caissons/ footings	100
Piers	100
Abutments	100
Deck	100
NU Girders	100
Steel Superstructure	100
Replaceable Components:	
Bridge Bearings	30
Strip Seal Expansion Joint - Neoprene Seals	15
Strip Seal Expansion Joints - Assemblies	30
Modular Expansion Joints - Assemblies	30
Deck Wearing Surface - Asphalt Top Lift	15
Deck Wearing Surface - Complete System	30
Deck Waterproofing	30
Traffic Railing	60
Noise Barriers	30
Drainage System	60
LED Luminaires	20
Light Standards and Brackets	50

More specifically, it is anticipated that:

1. Visual inspections would occur every 2 years and a comprehensive detailed and underwater inspection would occur every 2-3 years prior to a major rehabilitation to determine the scope of the rehabilitation work.
2. A minor rehabilitation would be required every 15 years which would consist of:

a) Mill and paving of the deck surface.

b) Replacing the expansion joint seals.

3. A major rehabilitation would be required every 25 to 30 years, depending on the existing condition of the element, and would consist of:

a) Replacing:
   i. the waterproofing membrane and asphalt; and
   ii. the bearings as well as the modular and strip seal joints and noise barriers.
   iii. A detailed condition survey of the top of the bridge deck concrete would be required when the waterproofing is removed for replacement.

b) Replacing the concrete in localized areas.

   At year 60, the major rehabilitation would include the items from the previous major rehabilitation, plus the replacement of the drainage system and traffic railings.

5.1.2.2 Approach Roadways

Table 5.2 shows the service life of the different road approach elements and an estimated replacement schedule over the life cycle of the Project. Such service life considerations are typical for municipal infrastructure projects.

Table 5.2: Service Life of Approach Roadway Components

Approach Roadway Component	Service Life (in years)
Surface Course Asphalt (1 lift)	15
Surface and Minor Base Asphalt (2 lifts)	30
Major Road Rehabilitation / Reconstruction (including storm sewers and structures, granulars, asphalt, guide rails, stormwater treatment devices, concrete sidewalks)	60
Granular Pathway Maintenance (rehabilitation)	15
Landscaping Renewal	25
Stormwater Management Pond Maintenance	25
Traffic Lights and Controllers	20
Noise Barriers / Fencing	30
LED Luminaires	15
Light Standards and Brackets	50

5.1.2.3 *Future Design Considerations*

The snow and ice on the bridge will be managed according to the City of Kingston's Winter Operations Level of Service Policy. The Public Works department will strive, as reasonably practical to provide safe and passable winter road and sidewalk conditions for vehicular and pedestrian traffic. From October 1 to April 30, the current and forecasted weather will be monitored once every shift or three times per calendar day, whichever is more frequent, at the intervals identified in the Winter Operations Plan. As a proactive measure, the City will apply pre-treatments in the form of Direct Liquid Application to roads in advance of snowfall events to prevent and/or treat ice formation.