DRAFT Alternatives Analysis Report

International Bridge

over Maine Northern Railroad, St John River, and Canadian National Railroad

MaineDOT Bridge #2399 / NBDTI Bridge # E320

Madawaska, Maine – Edmundston, New Brunswick

WIN 021736.00

March 8, 2019

Introduction

MaineDOT, in cooperation with the New Brunswick Department of Transportation and Infrastructure (NBDTI), the United States General Services Administration (GSA), and other agencies is completing the preliminary design for the replacement of the International Bridge connecting Madawaska, Maine and Edmundston, New Brunswick, Canada. The preliminary design phase efforts involve consideration and evaluation of multiple bridge types and geometries, identification of a preferred alternative through consideration of constructability, maintenance needs, satisfying project purpose and need, and project cost, among other aspects, and concludes with an approximate 30% design progression of the preferred alternative.

To provide a cost-effective and expedient, yet complete investigation, and to meet the needs of this complex project, the Preliminary Design Phase follows a progressive, tiered approach toward selecting a preferred alternative. A summary of this approach is as follows:

- Tier 1 – A high-level assessment of multiple structure types and span configurations was performed by comparing relative advantages and disadvantages among the various solutions. Through this high-level assessment, two alternatives were identified as most appropriate for this project and advanced for further investigation.

- Tier 2 – A more detailed investigation of two alternatives, the results of which are discussed herein, was performed to assess and compare project cost, schedule, and impacts, among other aspects. Each of these alternatives were developed to an approximate 15% level of design completion.

- Tier 3 – The next phase of the project, anticipated to commence upon selection of a preferred alternative, will develop the project to an approximate 30% level of design.

The design of the proposed bridge requires close coordination with the development of a new US port facility (led by the GSA), and reconfiguration of the site layout at the Canadian port facility (led by NBDTI). Similarly, construction of the bridge will require close coordination with contractors responsible to simultaneously construct these facilities.

This report provides an overview of project background information, an assessment of alternatives investigated to-date, a summary of contractor input sessions, and a recommendation on structure type to advance toward a 30% design level, and ultimately complete the Preliminary Design phase of the project.

Background

Project and Site Overview

The existing International Bridge, carrying Bridge Avenue, connects the existing U.S. Land Port of Entry (LPOE) to the existing Canadian Port of Entry (POE) with an approximate 90º crossing orientation over the Saint John River and Canadian National Railroad (CNR) tracks. Originally built in 1920, each of the four spans consist of a Pennsylvania Truss measuring 235.5-ft (71.8-m) long, for an overall bridge length of 942-ft (287.1-m). The roadway width is 20.67-ft (6.3-m) and the vertical clearance is 14.25-ft (4.3-m). A separated 6-ft (1.83-m) sidewalk is provided on the west fascia. Additional background information, existing bridge information, and a location map can be found in Appendix C.

After nearly 100 years of service, the overall bridge is in poor condition. Despite efforts to maintain the bridge, the rate of deterioration has accelerated to the point that the end of the useful service life of the bridge is fast approaching. The bridge is currently load restricted with a 5-ton (4.5 tonnes) limit. Refer to the "Madawaska/Edmundston International Bridge and Border Crossing, Feasibility and Planning Study", dated May 2018, for additional details of the existing bridge.

The new bridge is proposed to be located upstream of the existing bridge and will connect a new U.S. LPOE to the existing Canadian POE. The new bridge will cross the Maine Northern Railroad (MNR) tracks, St John River, and CNR tracks with an approximate 45º skew resulting in an approximate 1,880-ft (573-m) structure length.

Construction of the proposed bridge, and demolition of the existing bridge, will be heavily constrained by steep terrain and high river banks; existing roadways, railroads, public and private utilities, and buildings; the Saint John River; an active paper mill; active LPOE and POE operations; as well as adjacent construction activities occurring as part of the concurrent Madawaska LPOE construction project and the Madawaska town sewer line relocation project. The following provides a brief overview of each of these site-specific conditions:

Steep Terrain and High River Banks

The project is located within a well-defined, terraced, and deep river valley. River banks are generally characterized by approximate 1.75H:1V slopes with light vegetation/brush and observable, sporadic slope failures. Railroad tracks on each side of the river are located immediately atop the river banks and approximately 60-ft (18.3-m) above river bed on the US side, and 40-ft (12.2-m) above river bed on the Canadian side. Approximate 1.75H:1V to 2H:1V slopes extend upward from the tracks approximately 35-ft (10.7-m) on both sides of the river to the proposed LPOE and existing POE.

Existing Roadways, Railroads, and Buildings

The project site is located within the downtown district of two active communities which historically developed along the river banks and around the primary community connection point: The International Bridge. As such, the project is surrounded by a network of local roadways and commercial and residential properties which limit project access points and adjacent staging areas.

Located between the river and communities, on each end of the bridge, are two active railroads: the Maine Northern Railroad and Canadian National Railroad. Preliminary discussions with the railroad companies reveal the following:

> *Maine Northern Railroad* – MNR requires a 23.0-ft (7.0-m) vertical clearance in the project's final condition and will allow a reduction to 18.0-ft (5.5-m) during construction. The two southern spur tracks are not in use and may be used to access the site, provided appropriate rail protection is provided. MNR typically operates a single train in the morning and in the evening Monday through Friday and does not typically operate on the weekend. Tracks entering the Twin Rivers warehouse operate once per night, except Saturdays; it may be possible for the contractor to coordinate, with Twin Rivers, movement of train cars stationed on the spur tracks at the end of the warehouse to accommodate contractor access across the tracks. Collision protection of the proposed bridge will be in accordance with the latest version of AREMA; collision protection requirements during construction are unknown and require further coordination with MNR.
>
> *Canadian National Railroad* – CNR requires a 23.0-ft (7.0-m) vertical clearance in the project's final condition and will allow a reduction to 22.0-ft (6.7-m) during construction. CNR typically operates approximately 10 trains through the project site on a daily basis and all tracks are utilized regularly, resulting in short-term track outage allowances of approximately 5-6 hours per occurrence. CNR has expressed that trains as long as 14,000-ft (4267-m) may be queued through the project site for approximately an hour in the morning and evening each day. Collision protection of the proposed bridge will be in accordance with the latest version of AREMA; collision protection requirements during construction are unknown and require further coordination with CNR.

Saint John River

Water flow within the channel varies significantly depending on rain intensity, duration, and season (i.e.: snow melt conditions). As shown on the conceptual plans provided in Appendix A, varying hydrological conditions result in water depths ranging from approximately 2-ft deep to 28-ft deep (0.6-m to 8.5-m). Water velocities within the river range from approximately 7.4-fps to 9.5-fps (2.2-mps to 2.9-mps.

The northern climate and major riverine environment promotes severe ice conditions. Ice floe thicknesses of approximately 2.8-ft (0.85-m) have been measured at the project site; thicknesses up to 3.5-ft (1.1-m) are anticipated during the life of the structure. Ice conditions will require some combination of increased trestle member sizing, widespread use of trestle pilings, routine ice break up, or other means to prohibit ice-jamming and excessive loading/failure of temporary works during construction.

Active Paper Mill

Twin Rivers Paper Company operates an active mill in Madawaska immediately adjacent to the existing U.S. LPOE, the MNR tracks, and on each side of Bridge Avenue. Operations are continuous and multiple delivery trucks access the perimeter of the buildings daily, thereby prohibiting onsite storage/staging for this project. Twin Rivers owns several utility lines on the existing International Bridge – these utilities will be relocated by Twin Rivers to their privately owned, downstream utility bridge ahead of contract award for this project. Twin rivers also owns and operates several water intake pipes buried within the river, at the east end of the Twin Rivers facility, near an access road extending to the river. These pipes are critical to the mill's operation and were not designed to accept transient loads.

Twin Rivers frequently accesses the western side of their warehouse which is situated adjacent to the southern span of the proposed bridge. Allowance of falsework and construction activities within this region will require additional coordination.

Active LPOE and POE Operations and Construction Projects

The existing and proposed bridges are located between two active border crossing stations (ports of entry), with approximately 40-ft to 175-ft (12.2-m to 53.3-m) between the bridge abutments and the adjacent security booths, depending on location. To facilitate the safe and efficient movement of goods and people, both entry points are anticipated to be active throughout construction and demolition of the bridges. However, bridge construction/demolition activities are only anticipated to occur adjacent to active border crossing activities at the Canadian POE; the new US LPOE will be constructed concurrently with the bridge (by others) and will begin operating near simultaneously with the proposed bridge opening.

The U.S. GSA is developing the design of a new LPOE. Construction of this new facility will occur under a separate contract and is anticipated to be concurrent with construction of the proposed bridge. Coordination of the construction limits, phasing, and staging of the two concurrent projects is ongoing.

The Canadian POE building and booths will remain unchanged; however, the entry/exit movements, parking areas, and associated utility and drainage features will be modified to accommodate the proposed bridge. Construction of this new site layout will occur under a separate contract and is anticipated to be concurrent with construction of the proposed bridge. Coordination of the construction limits, phasing, and staging of the two concurrent projects is ongoing.

Purpose and Need

Project Purpose: The purpose of this project is to provide for the long-term safe and efficient flow of current and projected traffic volumes, including the movement of goods and people, between Edmundston, New Brunswick and Madawaska, Maine.

Project Needs: The proposed project is needed because: 1) the existing International Bridge is nearing the end of its useful life, and 2) the size and conditions of the existing building and overall site of the Madawaska LPOE are substandard, preventing the agencies assigned to the LPOE from adequately fulfilling their respective missions.

Feasibility and Planning Study

A project feasibility and planning study, completed in May 2018, evaluated nearly 20 different combinations of crossing locations and alignments. Alternatives ranged from rehabilitating the existing bridge to building a new bridge on several alternate alignments both within the down town area and outside the downtown area.

During the previous project phase, analysis and discussion of an initial pool of alternatives led to the identification of three alternatives for additional evaluation. Through the additional evaluation, a preferred corridor was identified following a northeasterly trajectory and connecting the Canadian POE to land purchased in the U.S. for development of a new LPOE site. The corridor, shown in Figure 1, did not identify a specific alignment, but provided a projected envelope (shown as a cyan strip in Figure 1) in which the proposed bridge centerline could be located. This approach provided the project team with reasonable flexibility to develop a preferred alignment during future phases of the project.

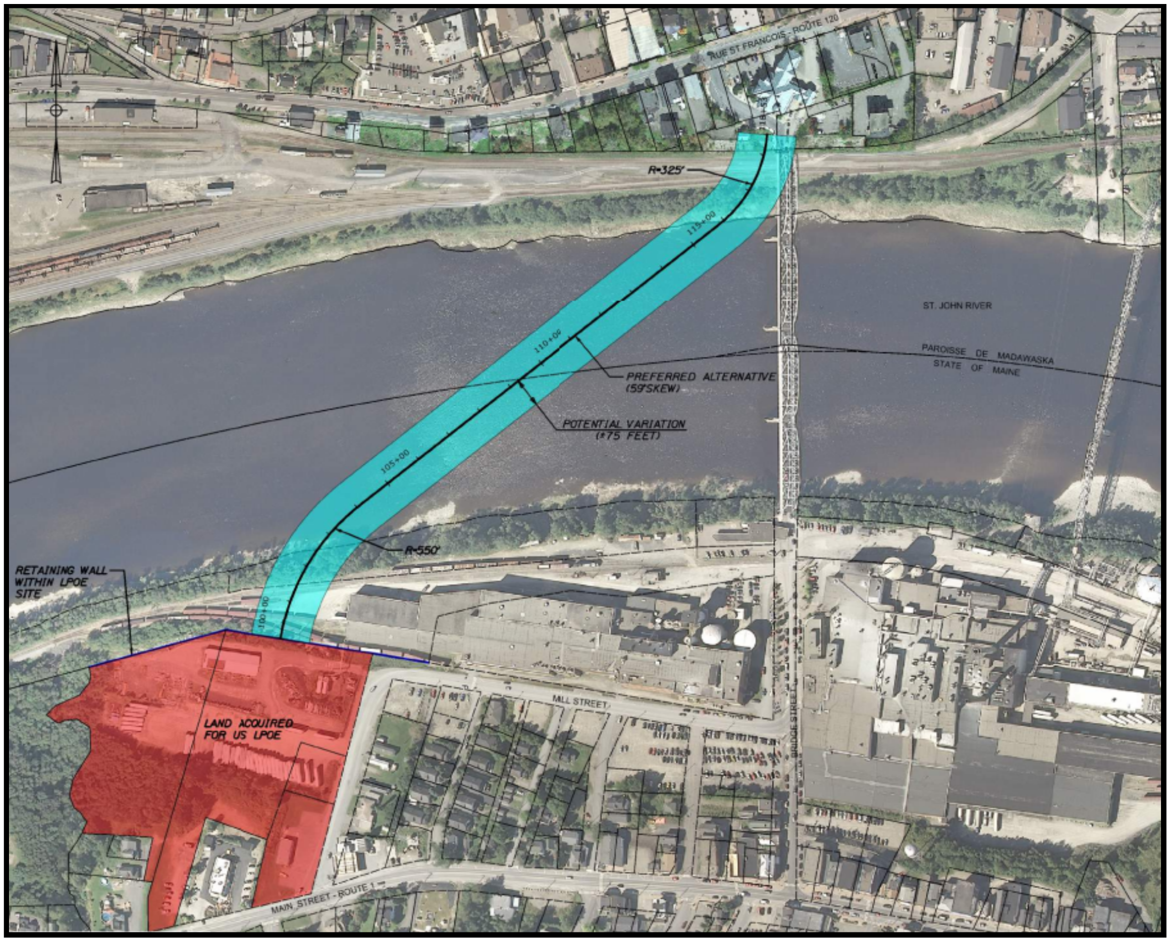


Figure 1: Preferred off-alignment bridge corridor from the project Feasibility Study.

Additional details of this earlier project phase and information on the identification of the preferred crossing corridor can be found in the report titled, "Madawaska/Edmundston International Bridge and Border Crossing, Feasibility and Planning Study", dated May 2018.

Initial Alternatives Investigations

The Preliminary Design Phase of this project began with a high-level assessment of multiple structure types, span configurations, and typical section arrangements (i.e.: number of beam lines). This initial assessment evaluated a wide range of feasible crossing solutions and resulted in the identification of two combinations of structure type(s) and span arrangements that were advanced for further investigation. The initial alternatives considered and dismissed from further investigation include:

- Steel tub girder structures;
- Precast concrete segmental structures;
- 5-span and 7-span steel I-girder structures;
- Steel I-girder structures with 5-girder lines;

Additional discussion regarding the above structure types and configurations can be found within memos provided in Appendix H. Structures with more than seven spans were not investigated due to site constraints, pier cost, impacts, and concerns of long-term ice-jamming within the St. John River. Conversely, structures with fewer than five spans were not considered due to increasing superstructure depth, profile constraints, constructability challenges, and vertical clearance limitations.

Alternatives Discussion

Overview

Through the previously discussed initial alternatives assessment, two alternatives were identified for advancement with further analysis and investigation: a steel plate girder alternative and a cast-in-place segmental concrete alternative. Both alternatives were progressed to an approximate 15% level of design concurrent with a series of external stakeholder coordination efforts. Although several coordination items and decisions are outstanding, the details discussed herein and presented on the attached plans are considered representative of each alternatives' geometric and structural characteristics. At the time of this report the following major coordination/decision items are outstanding:

- The bridge-end flare width, landing location, and alignment orientation at the U.S. LPOE are subject to change based upon further coordination needs surrounding LPOE operations and land use.

- The bridge landing location and orientation at the Canadian POE are subject to change based upon further coordination needs surrounding POE operations and construction phasing.

- The overall bridge width and distribution of shoulder widths are subject to change as a recreational lane is considered.

- Pier and abutment locations may be adjusted slightly to suit the final bridge alignment and configuration.

Although these items will affect the overall geometry, phasing, and cost of the project, there impacts are of similar magnitude to each of the alternatives. As such, alternatives discussions, comparisons, and recommendations made in this report are considered valid.

Alternative 1: 6-Span Steel Girder Structure

Overview

This 6-span continuous structure consists of four, variable depth, steel plate girders with a composite cast in-place concrete deck. The span lengths from south to north are 293-ft, 4 spans at 330-ft, and 253-ft (89.3-m, 4 spans at 100.6-m, and 77.1-m). Superstructure supports at abutment 1 and each pier are normal to the alignment; the supports at abutment 2 are skewed approximately 45° to minimize abutment width and framing flare magnitude.

Preliminary analyses indicate the beam web depths will vary from approximately 8-ft (2.4-m) at midspan to approximately 12-ft (3.7-m) at the piers; flange widths may vary from approximately 20-inches to 40-inches (508-mm to 1016-mm) and could likely be reduced through the use of HPS Grade 70W steel. The steel beams will be spaced at 11'-10" (3.6-m), necessitating a 10.5-inch (267-mm) thick concrete deck and resulting in 3'-10 ½" (1.2-m) deck overhangs. Flares at each end of the bridge will require a single splayed girder at the US abutment and three splayed girders at the Canadian abutment, with a maximum splayed girder length of 115-ft (35.1-m).

The steel girders are anticipated to be fabricated with a combination of AASHTO M270 Grade 50W and Grade 70W uncoated weathering steel with the ends of the beams, adjacent to expansion joints, painted to avoid early onset corrosion. The deck, abutment backwalls, and tops of wingwalls will be reinforced with stainless steel; remaining concrete is to be reinforced with uncoated mild rebar. The girders will be supported with disc bearings and bridge expansion will be accommodated at the abutments using finger joints and fabric troughs.

Constructability

[This subsection has been intentionally left blank and will be completed following the receipt of input from the Contractor Input During Design process.]

Fabrication/Erection Overview

Access Requirements

Impacts

Maintenance/Inspection

[This subsection has been intentionally left blank at this time.]

Ice Jamming Concerns

Maintenance/Inspection Needs

Access

Alternative 2: 5-Span Segmental and Steel Structure

This 5-span alternative consists of a 4-span continuous cast-in-place concrete segmental box girder bridge with a single steel plate girder span over the CNR tracks. The span lengths from south to north are approximately 370-ft, 2 spans at 460-ft, 365-ft, and 222.5-ft (112.8-m, 2 at 140.2-m, 111.3-m, and 67.8-m). Superstructure supports at abutment 1 and each pier are normal to the alignment; the supports at abutment 2 are skewed approximately 45^{o} to minimize abutment width and framing flare magnitude.

A 5-span continuous segmental structure was initially investigated for structure-type continuity and to optimize appearance and construction cost. However, competing profile grade and vertical clearance constraints over the CNR tracks approaching the Canadian POE, as well as significant bridge-end flare and skew requirements, prohibited the use of a segmental structure in the northern-most span. Although a 5-span continuous segmental concrete structure was not feasible, a hybrid segmental concrete and steel alternative was advanced for additional consideration due to perceived lower future maintenance and for its omission of a pier within the river.

Preliminary analyses indicate the segmental concrete structure depth will vary from approximately 11.9-ft (3.6-m) at midspan to approximately 25.5-ft (7.8-m) at the piers. The box webs will have a constant spacing at their intersection with the top slab and follow a constant vertical incline, resulting in a bottom slab width varying from approximately 19.83-ft to 13.83-ft (6.1-m to 4.2-m). The top slab will be 9-inches (228-mm) minimum with transverse post-tensioning.

The steel end span will be arranged similarly to the end span associated with Alternative 1. Preliminary analyses indicate a constant web depth of 84-inches (2134-mm) for the main girders with approximate 36-inch (914-mm) wide flanges which could likely be reduced through the use of HPS Grade 70W steel. Three splayed girders will be required at the Canadian abutment, with a maximum length of 115-ft (35.1-m).

The cast in-place segmental concrete boxes are anticipated to be constructed through a balanced-cantilever method with 8-ksi concrete and AASHTO M203 Grade 270 low relaxation prestressing strands in both the longitudinal and transverse directions. The steel girders are anticipated to be fabricated with the ends of the beams, adjacent to expansion joints, painted to avoid early onset corrosion. Alternatively, the steel girders could be entirely painted gray to avoid color differences between the segmental and steel bridge spans. The deck and top slab, abutment backwalls, and tops of wingwalls will be reinforced with stainless steel; remaining concrete is to be reinforced with uncoated mild rebar. The steel girders will be supported with elastomeric or disc bearings and the segmental boxes will be cast integral with the piers. Bridge expansion will be accommodated through finger joints and fabric troughs at the ends of the segmental structure and an asphaltic plug joint at the abutment-end of the steel span.

Constructability

[This subsection has been intentionally left blank and will be completed following the receipt of input from the Contractor Input During Design Process.]

Fabrication/Erection Overview

Access Requirements

Impacts

Maintenance/Inspection

[This subsection has been intentionally left blank at this time.]

Ice Jamming Concerns

Maintenance/Inspection Needs

Access

Service Life

Both alternatives incorporate materials and details to promote a targeted minimum 75 to 100-year service life, as follows:

- Stainless steel rebar will be used in the superstructure deck, curbs, sidewalk, and other select regions exposed to deicing salts.
- Low permeability concrete will be used to construct concrete curbs and sidewalk.
- The number of expansion joints and bridge drains will be minimized.

[Additional information regarding service life of the two alternatives will be provided at a later date.]

Alternative Cost Estimates

[This section, which will discuss estimated construction costs, projects costs, and life cycle costs for each of the two alternatives, is intentionally left blank at this time.]

Schedule

[This section, which will discuss estimated construction schedules for each of the two alternatives, is intentionally left blank at this time.]

Contractor Input

[This section, which will discuss the outcome of a contractor input meeting, is intentionally left blank and will be completed following the receipt of input from the Contractor Input During Design Process.]

Summary

Summary of Alternatives Analysis

[This section, which will summarize the alternatives assessment to-date, is intentionally left blank and will be completed at a later date.]

Recommendation Structure type

[This section, which will recommend a structure type (alternative) to advance toward a 30% design level and complete the Preliminary Design Phase, is intentionally left blank and will be completed at a later date.]

Future Efforts

[This section, which will discuss future coordination efforts and external involvement, is intentionally left blank and will be completed at a later date.]

Appendices

Appendix A - Alternatives Plans
Appendix B - Alternatives Matrix
Appendix C - Preliminary Design Report Forms
Appendix D - Design Criteria
Appendix E - Estimated Construction Costs
Appendix F - Estimated Construction Schedules
Appendix G - Conceptual Access and Staging Plans
Appendix H - Initial Alternatives Discussion

Appendix A

Alternatives Plans

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

MADAWASKA - EDMUNDSTON AROOSTOOK COUNTY - NEW BRUNSWICK

INTERNATIONAL BRIDGE
OVER
SAINT JOHN RIVER

BRIDGE AVE.
PROJECT LENGTH 0.36 mi.
BRIDGE NO. 2399

STEEL ALTERNATIVE

SPECIFICATIONS

Design: Load and Resistance Factor Design per AASHTO LRFD Bridge Design Specifications, Eighth Edition, 2017.

DESIGN LOADING

Live Load .... HL - 93 Modified for Strength I
CL-625-ONT

TRAFFIC DATA

Current (2020) AADT	2220
Future (2040) AADT	4080
DHV - % of AADT	10
Design Hour Volume	408
Heavy Trucks (% of AADT)	5
Heavy Trucks (% of DHV)	5
Directional Distribution (% of DHV)	55
18 kip Equivalent P 2.0	144
18 kip Equivalent P 2.5	137
Design Speed (mph)	25

HYDROLOGIC DATA

Drainage Area	5,985 sq mi
Design Discharge (Q50)	163,120 cfs
Check Discharge (Q100)	176,980 cfs
Headwater Elevation (Q1.1)	455.3 ft
Headwater Elevation (Q10)	465.0 ft
Headwater Elevation (Q25)	466.2 ft
Headwater Elevation (Q50)	467.3 ft
Headwater Elevation (Q100)	468.3 ft
Discharge Velocity (Q1.1)	7.4 fps
Discharge Velocity (Q10)	8.0 fps
Discharge Velocity (Q25)	8.3 fps
Discharge Velocity (Q50)	8.5 fps
Discharge Velocity (Q100)	9.5 fps

MATERIALS

Concrete:	
Curbs & Transition Barriers	Class "LP"
All Other	Class "A"
Reinforcing Steel:	
Plain Reinforcing Steel	ASTM A 615, Grade 60
Stainless Reinforcing Steel	ASTM A 955, Grade 75
Structural Steel:	
All Material (except as noted)	ASTM A 709, Grade 50W (unpainted)
High Strength Bolts	ASTM F 3125, Grade A325, Type 3

BASIC DESIGN STRESSES

Concrete, Class "A"	f 'c = 4,000 psi
Concrete, Class "LP"	f 'c = 5,000 psi
Plain Reinforcing Steel	f y = 60,000 psi
Stainless Reinforcing Steel	f y = 75,000 psi
Structural Steel:	
ASTM A 709, Grade 50W	F y = 50,000 psi
ASTM F 3125, Grade A325, Type 3	F μ = 120,000 psi

DRAFT PLANS
3/1/2019

LIST OF DRAWINGS

REVIEWER NOTES

Information depicted on these plans are for the purpose of relative comparisons between two structure-type alternatives; the designs are based on an approximate 15% level of design completion and with incomplete coordination efforts.

The bridge-end flare width, landing location, and alignment orientation at the U.S. LPOE are subject to change based upon further coordination needs surrounding LPOE operations and land use.

The bridge landing location and orientation at the Canadian POE are subject to minor adjustments based upon further coordination needs surrounding POE operations and construction phasing.

The overall bridge width and distribution of shoulder widths are subject to change.

UTILITIES

Twin Rivers Paper Company
Maine Northern Railroad
Canadian National Railroad
Town of Madawaska (Water and Sewer)
City of Edmundston (Water and Sewer)
Bell Aliant
Consolidated Communications

MAINTENANCE OF TRAFFIC

Maintain two lanes of traffic on the existing bridge.

PROJECT LOCATION:	International Bridge #2399 between Madawaska, Maine and Edmundston, New Brunswick carrying Bridge Avenue over the Saint John River. Latitude: 47°21'35"N Longitude: 68°19'57"W
PROGRAM AREA:	Bridge
OUTLINE OF WORK:	Replacement of the International Bridge with minor approach work.

HNTB

WIN 021736.00

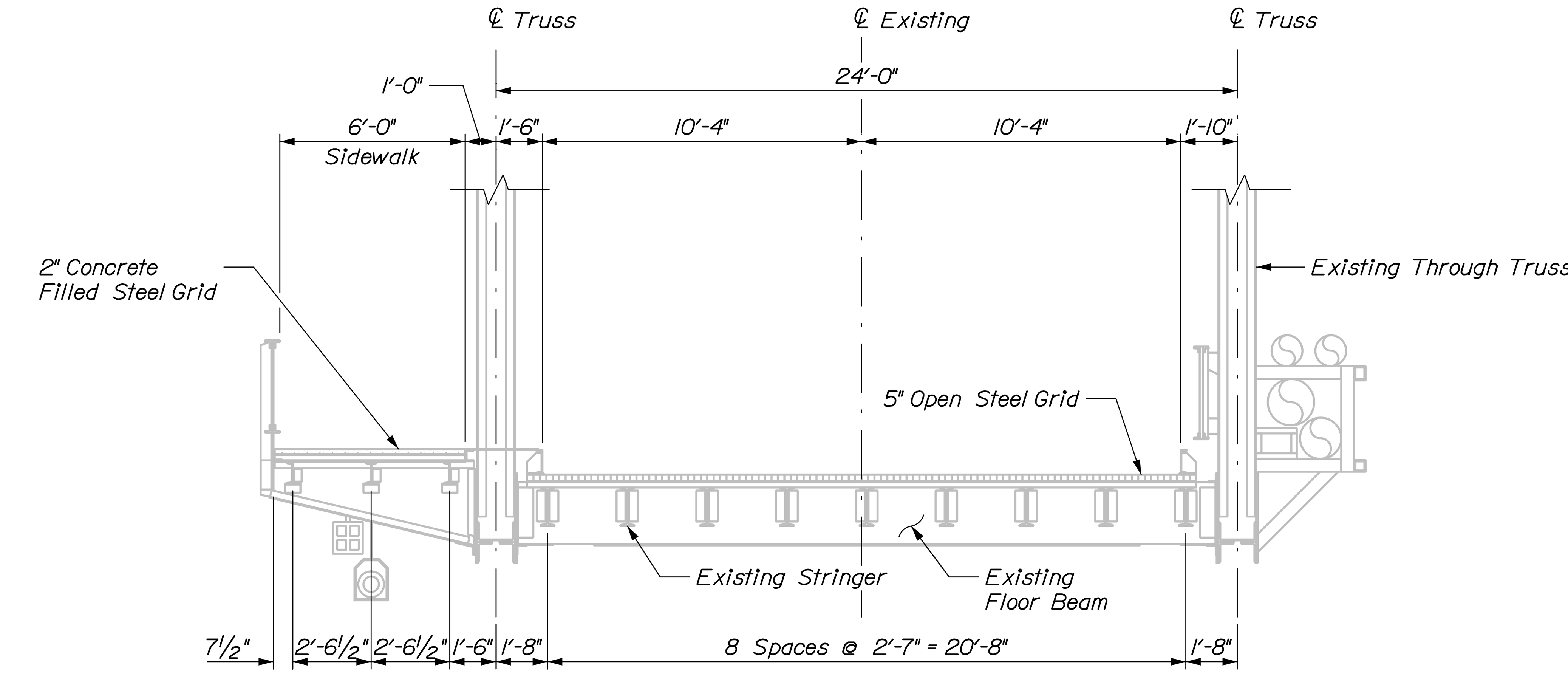
STATE OF MAINE DEPARTMENT OF TRANSPORTATION
APPROVED | DATE
COMMISSIONER:
CHIEF ENGINEER:

PROJECT INFORMATION
PROGRAM: BRIDGE
PROJECT MANAGER: JOEL KITTREDGE
DESIGNER
CONSULTANT: HNTB
PROJECT RESIDENT
CONTRACTOR
PROJECT COMPLETION DATE
SIGNATURE
P.E. NUMBER
DATE

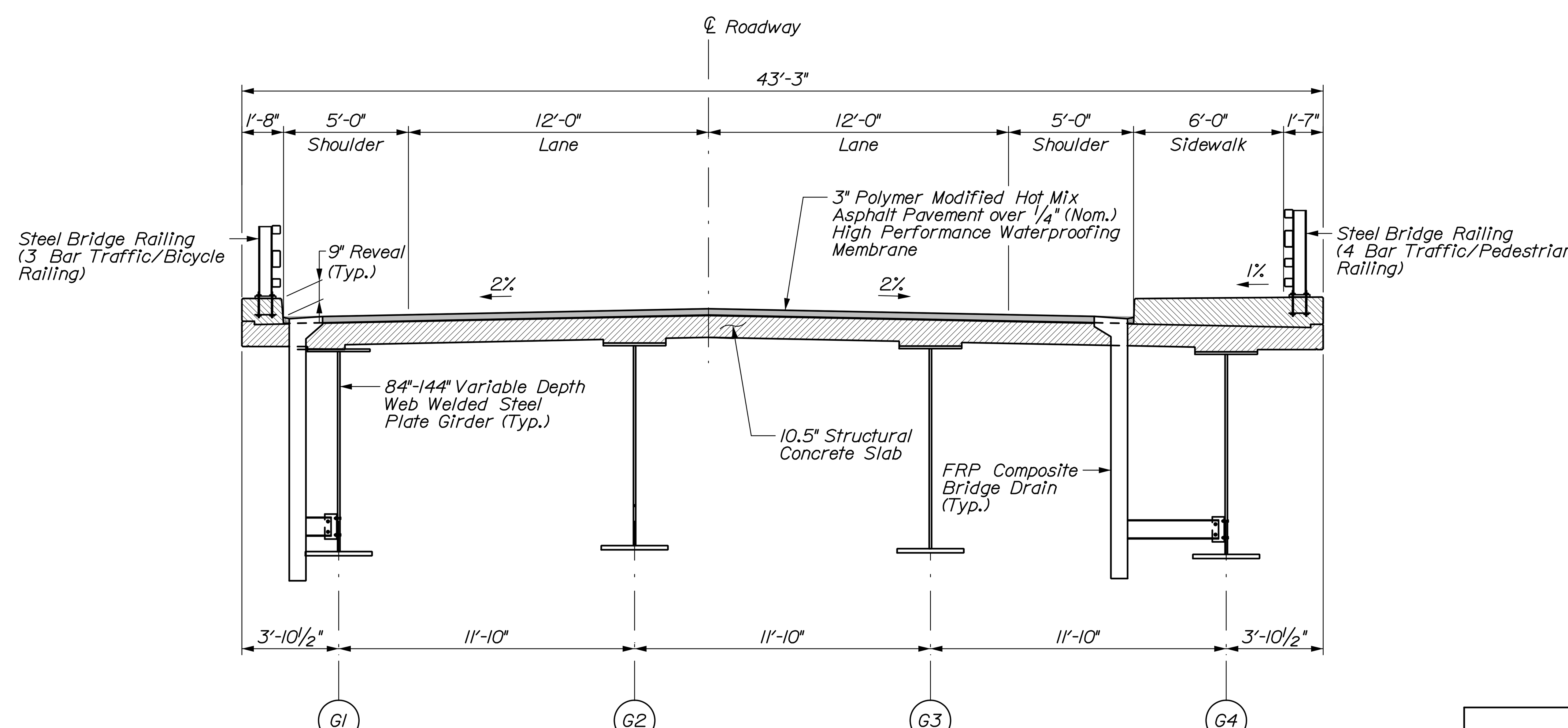
MADAWASKA-EDMUNDSTON INTERNATIONAL BRIDGE
STEEL ALTERNATIVE
TITLE SHEET

SHEET NUMBER
1
OF 11

Date:3/1/2019
Username:
Division:
Filename: 001_6 Span_Title.dgn



EXISTING BRIDGE SECTION



PROPOSED BRIDGE SECTION

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1	-	-	-
REVISIONS 2	-	-	-
REVISIONS 3	-	-	-
REVISIONS 4	-	-	-
FIELD CHANGES	-	-	-

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
TYPICAL SECTIONS

SHEET NUMBER
2
OF 11

Date:3/1/2019

Username:

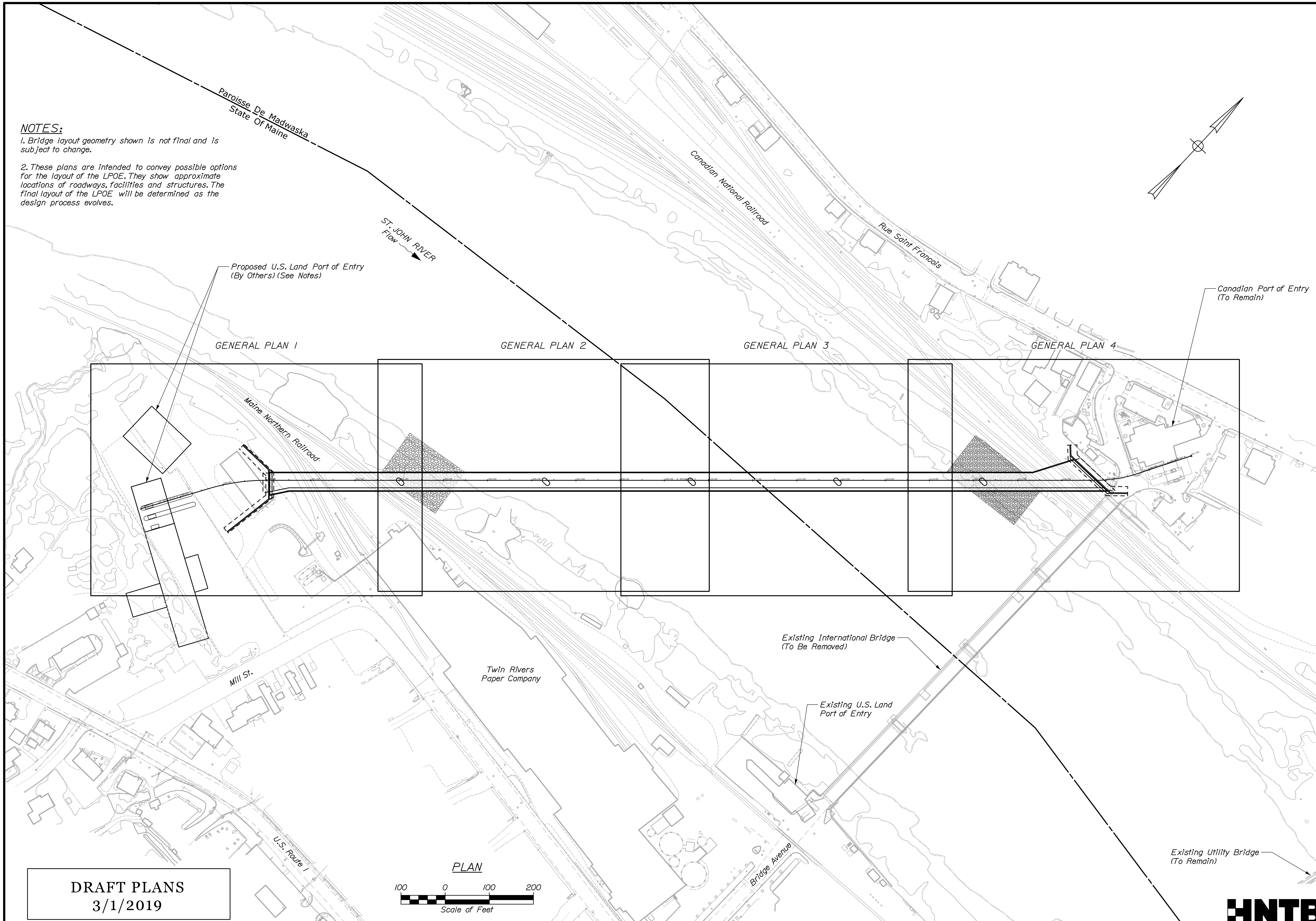
Division:

Filename: 003_Project Site Plan.dgn

NOTES:

1. Bridge layout geometry shown is not final and is subject to change.

2. These plans are intended to convey possible options for the layout of the LPOE. They show approximate locations of roadways, facilities and structures. The final layout of the LPOE will be determined as the design process evolves.



DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN 021736.00

BRIDGE PLANS

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DESIGN3-DETAILED3			DATE
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE PROJECT SITE PLAN

SHEET NUMBER

3

OF 11

NOTES:

1. Bridge layout geometry shown is not final and is subject to change.

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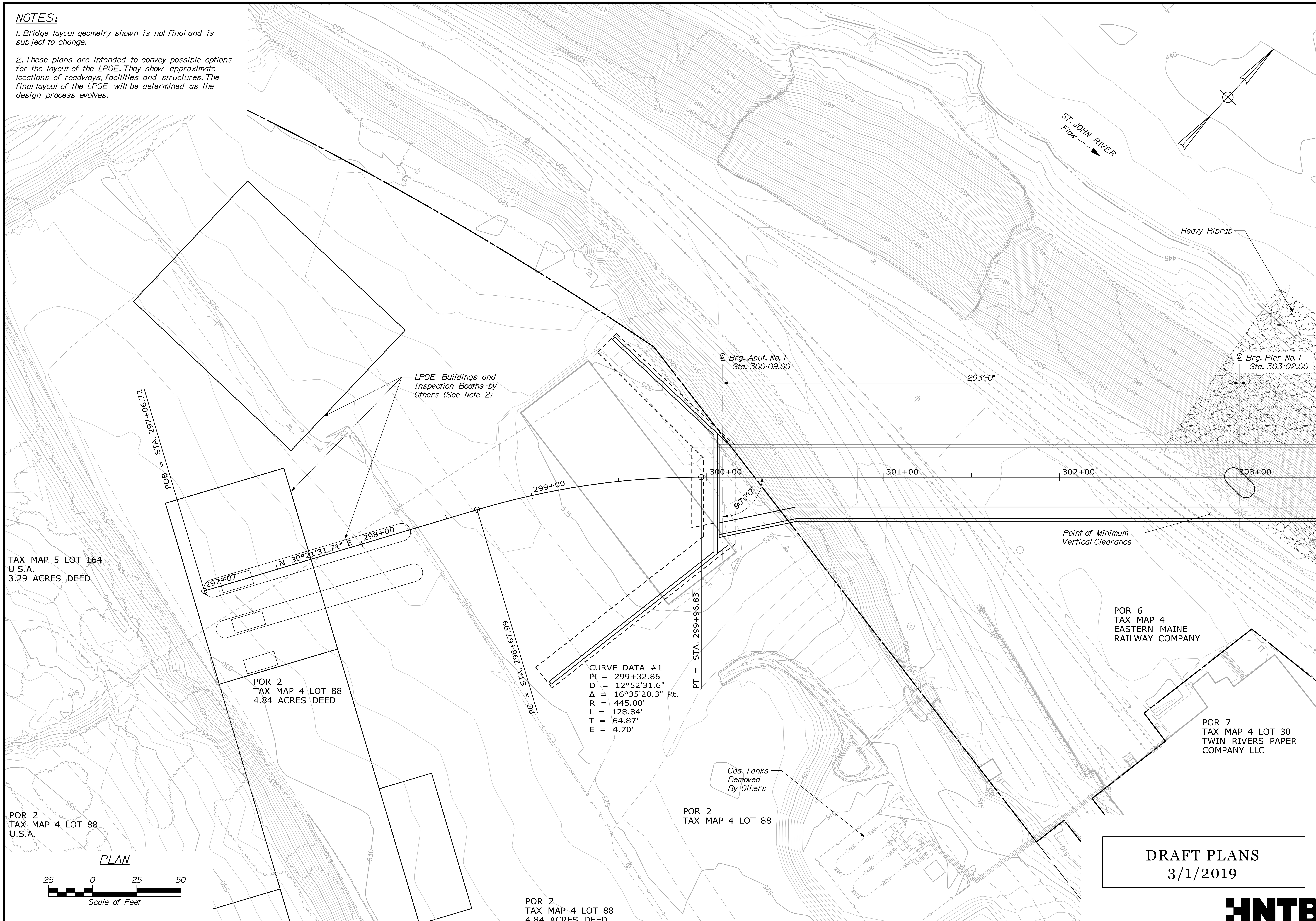

DRAFT PLANS
3/1/2019

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STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

WIN 021736.00
BRIDGE PLANS
BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED		
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DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
GENERAL PLAN 1

SHEET NUMBER
4
OF 11

Date:3/1/2019
Username:
Division:
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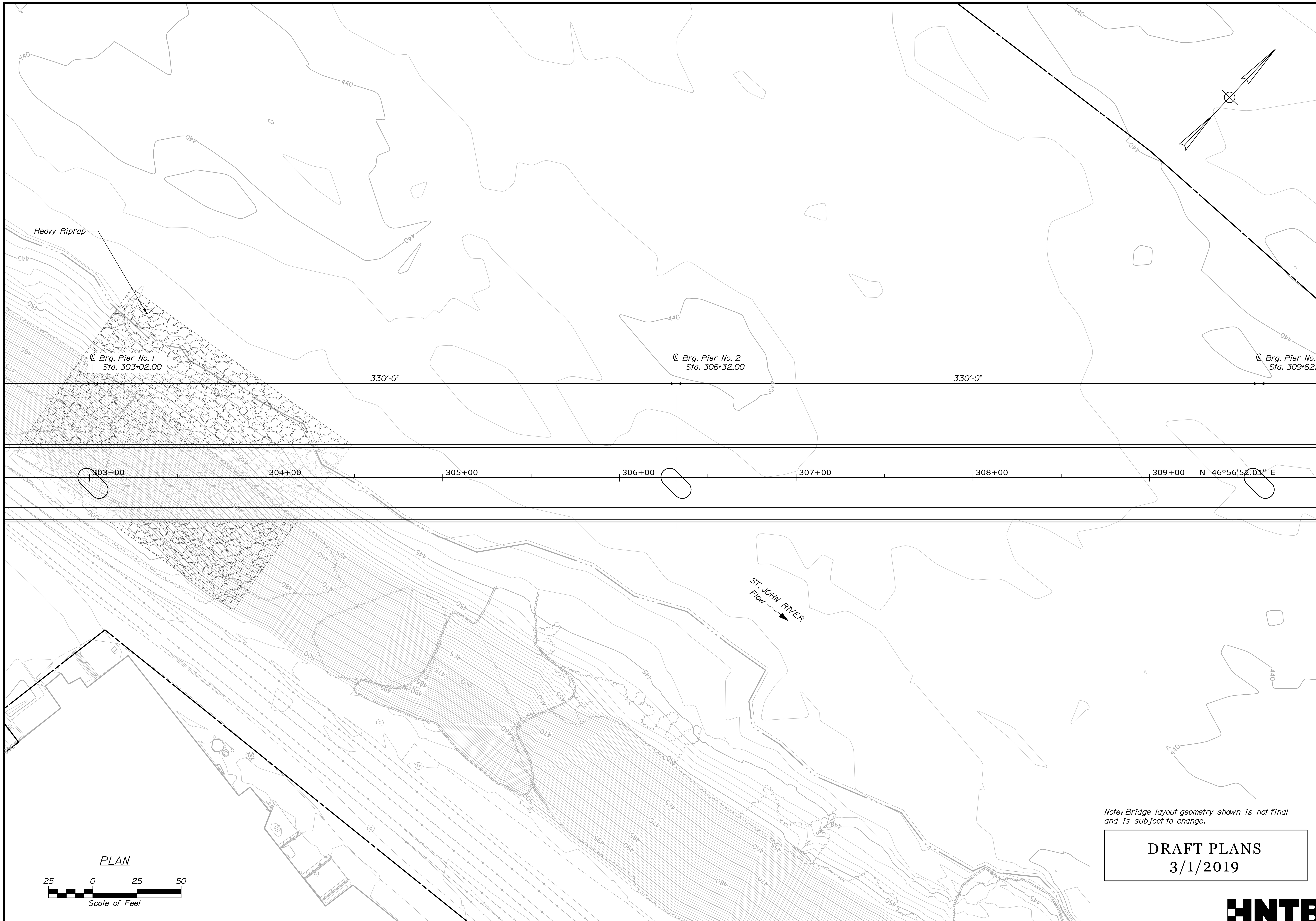
Date:3/1/2019
Username:
Division:
Filename: 005_6Span_Plan_02.dgn



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN
021736.00
BRIDGE PLANS

PROJ. MANAGER	J. Kittredge		
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1	-	-	-
REVISIONS 2	-	-	-
REVISIONS 3	-	-	-
REVISIONS 4	-	-	-
FIELD CHANGES	-	-	-

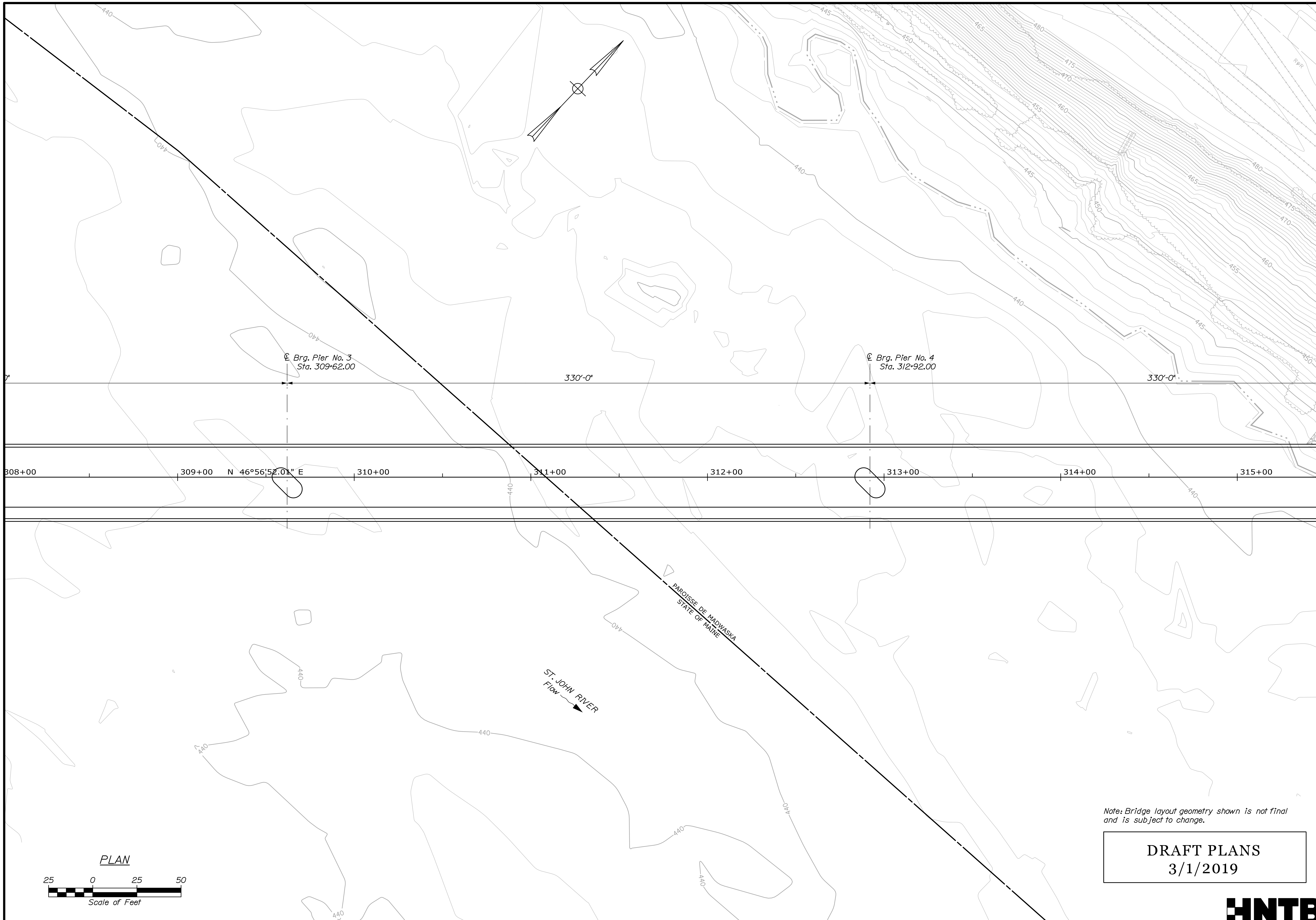
BY | DATE

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
GENERAL PLAN 2

SHEET NUMBER
5
OF 11



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

Date:3/1/2019
Username:
Division:
Filename: 006_6Span_Plan_03.dgn

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS
WIN 021736.00
BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	-
DESIGN-DETAILED	-	-
CHECKED-REVIEWED	-	-
DESIGN2-DETAILED2	-	-
DESIGN3-DETAILED3	-	-
REVISIONS 1	-	-
REVISIONS 2	-	-
REVISIONS 3	-	-
REVISIONS 4	-	-
FIELD CHANGES	-	-

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
GENERAL PLAN 3

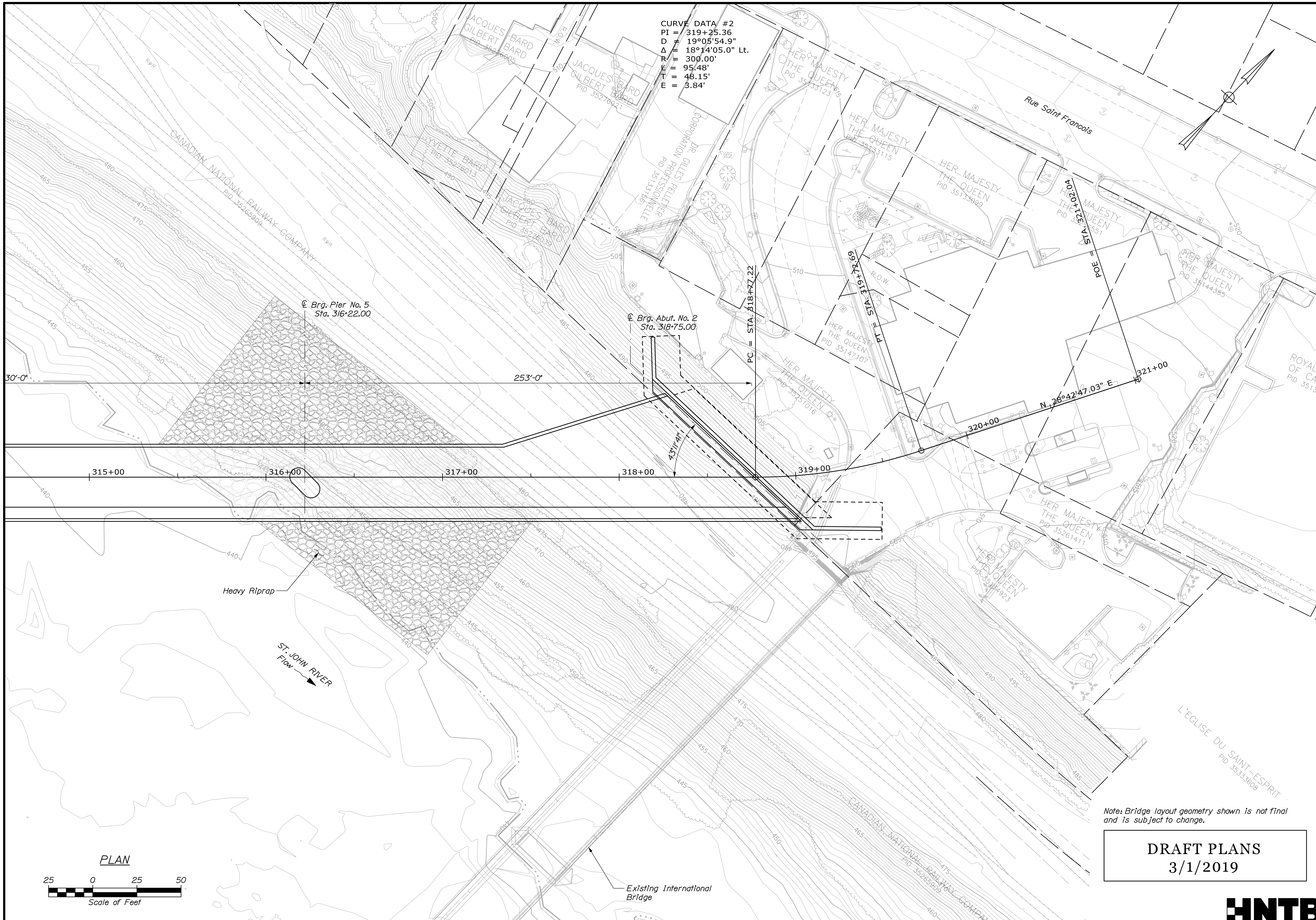
SHEET NUMBER
6
OF 11

Date:3/1/2019

Username:

Division:

Filename: 007_6Span_Plan_04.dgn



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN 021736.00

BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

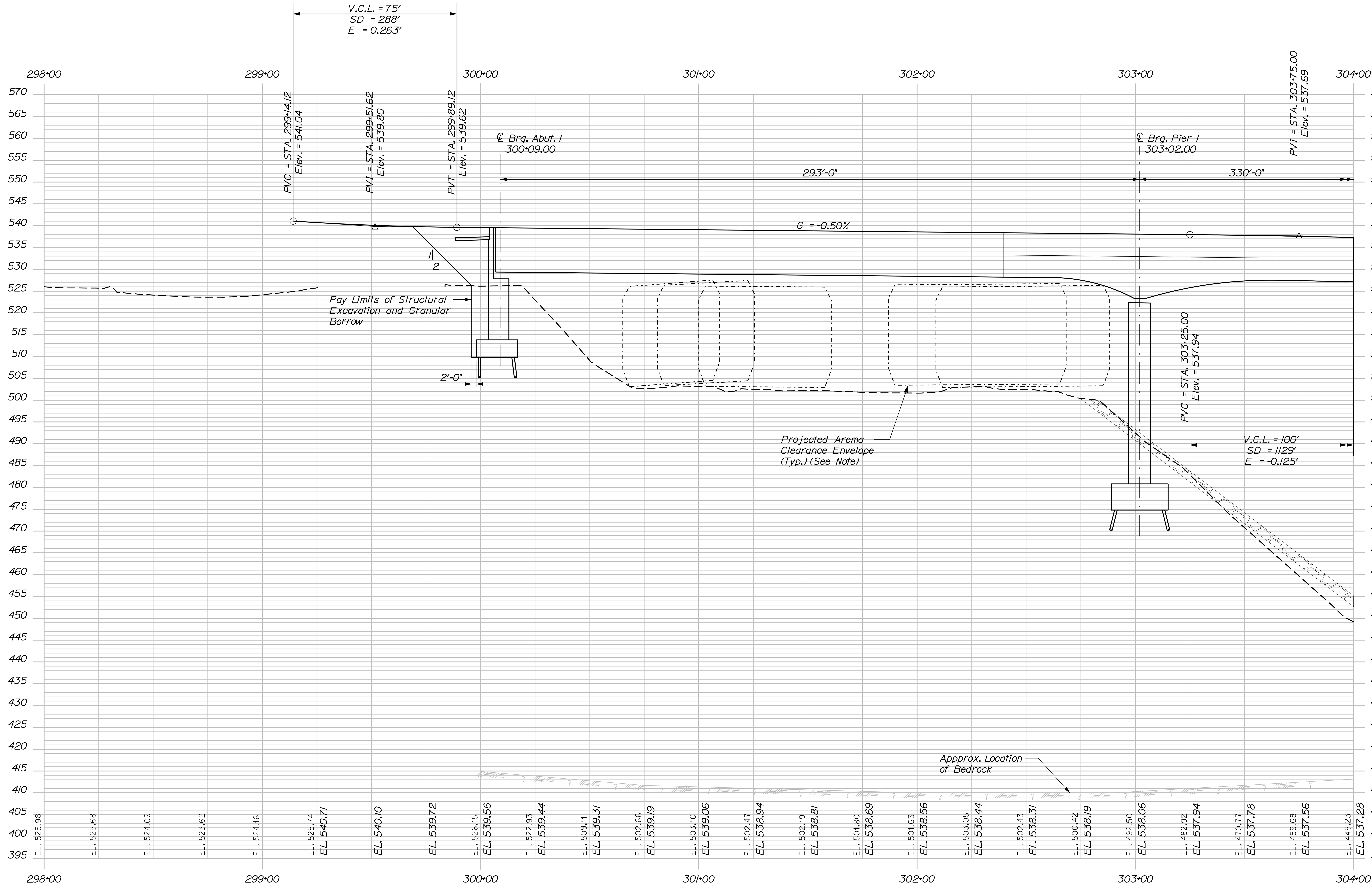
P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
GENERAL PLAN 4

SHEET NUMBER
7
OF 11



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

NOTE:
Minimum vertical clearance, measured from top of track, shall be 18'-0" during construction and 23'-0" in the final conditions.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

		BY	DATE
PROJ. MANAGER	J. Kittredge		
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

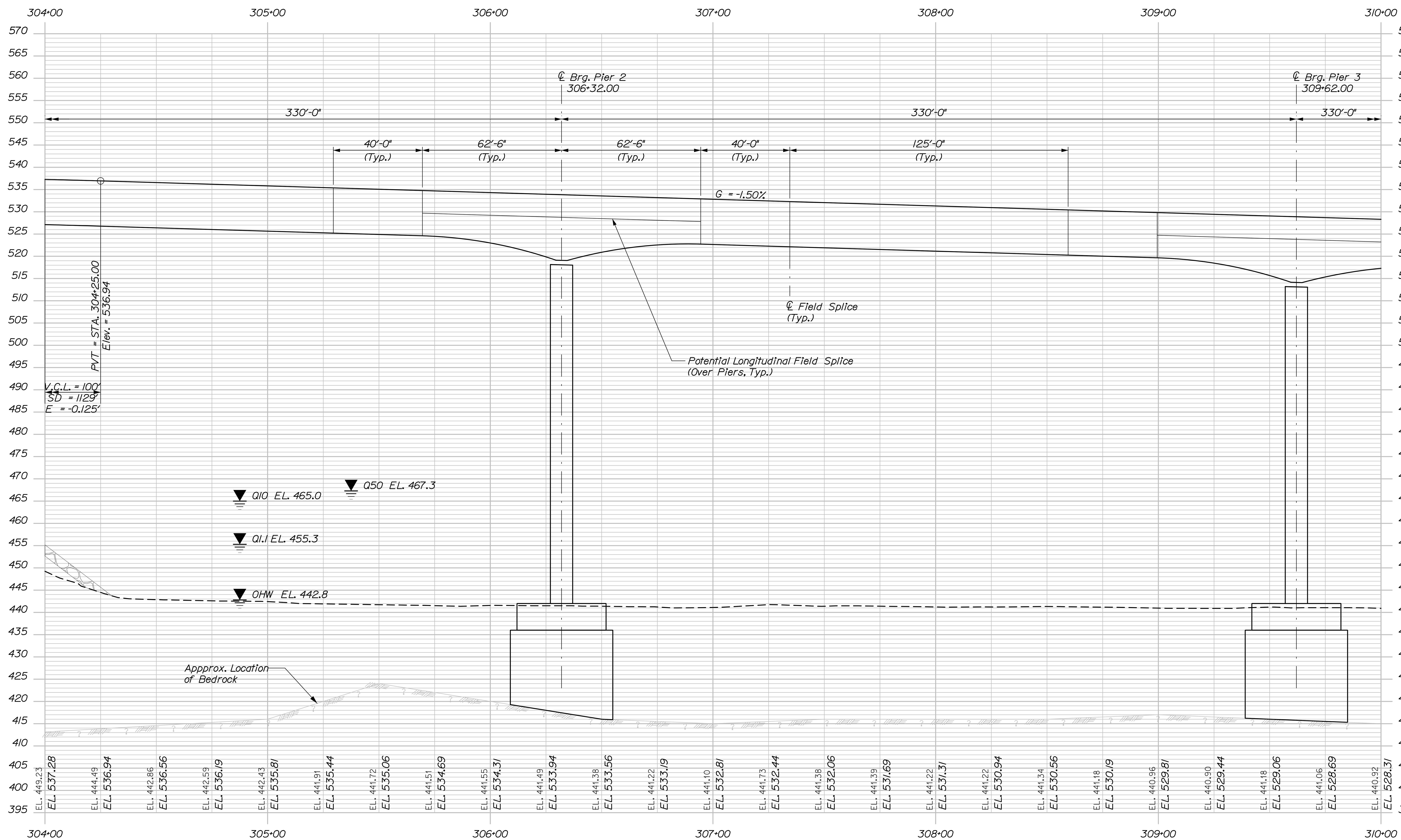
SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
PROFILE 1

SHEET NUMBER
8
OF 11

Filename: 008_6Span_Profile_1.dgn
Division:
Username:
Date: 3/1/2019



PROFILE

Horiz. 25 0 25 50

Vert. 12.5 0 12.5 25

Scale of Feet

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN 021736.00

BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED	-	-
CHECKED-REVIEWED	-	-
DESIGN2-DETAILED2	-	-
DESIGN3-DETAILED3	-	-
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

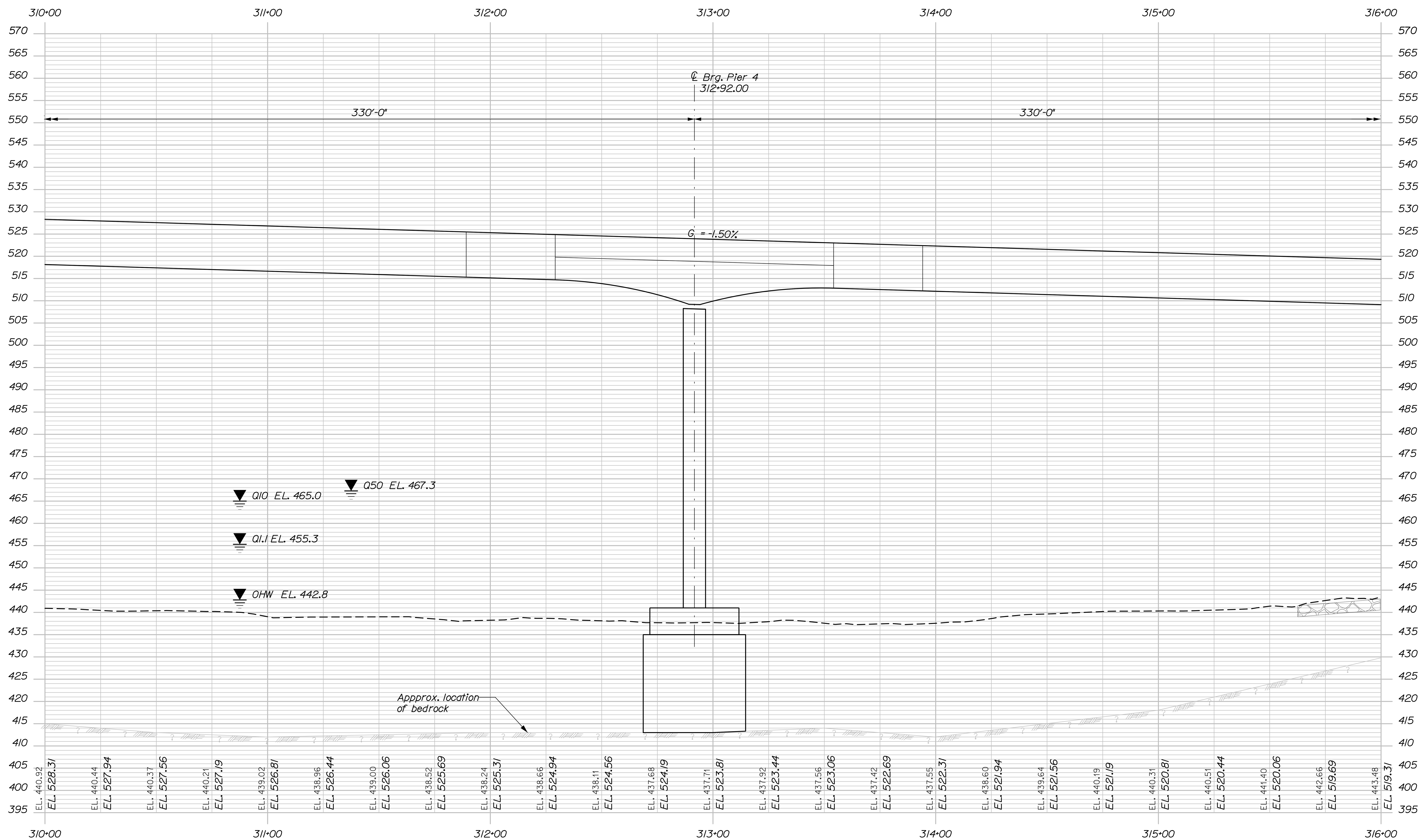
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
PROFILE 2

SHEET NUMBER
9
OF 11

Date:3/1/2019
Username:
Division:
Filename: 009_6Span_Profile_2.dgn



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

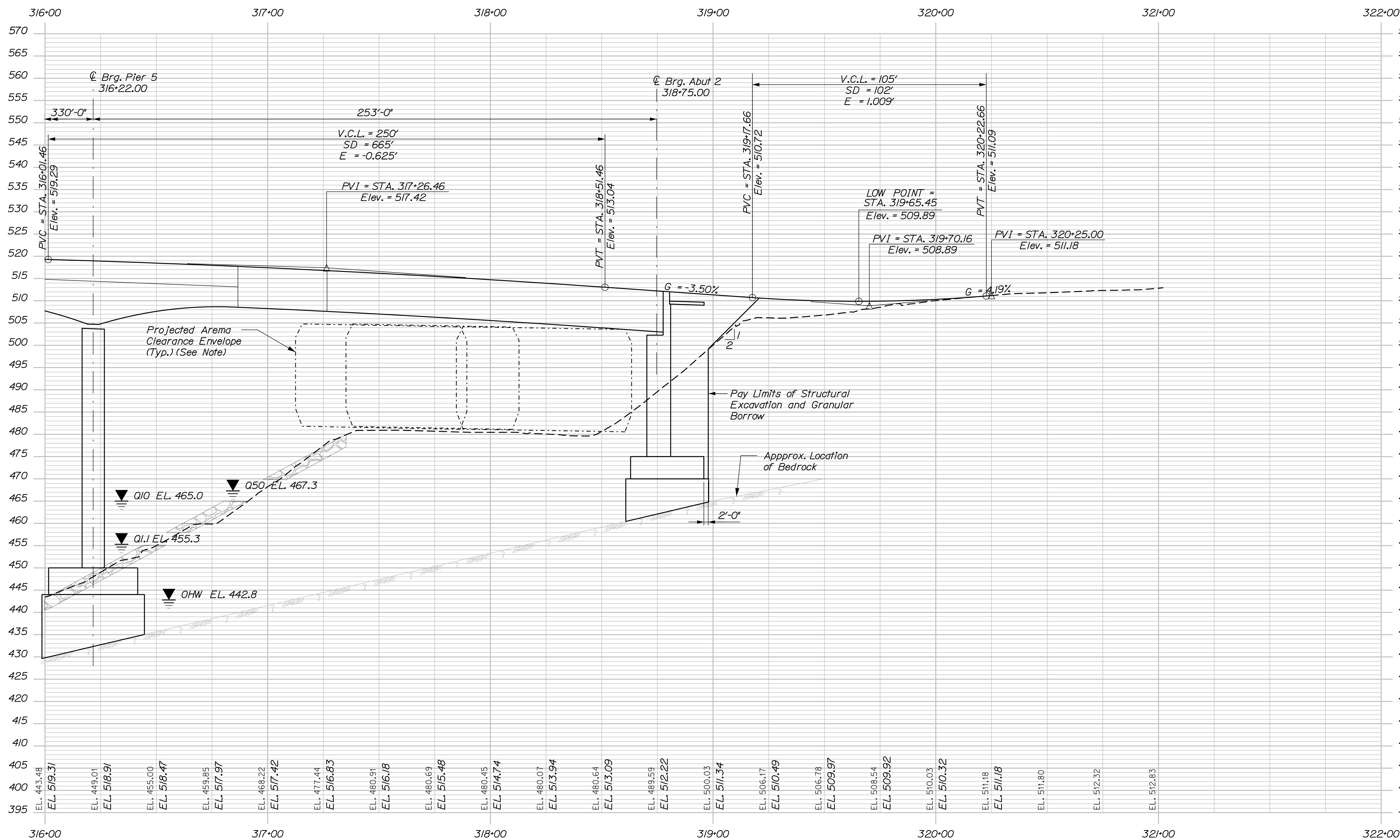
BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

PROJ. MANAGER	J. Kittredge	BY	DATE	SIGNATURE	
DESIGN-DETAILED	-	-	-	P.E. NUMBER	
CHECKED-REVIEWED	-	-	-		
DESIGN2-DETAILED2	-	-	-	DATE	
DESIGN3-DETAILED3	-	-	-		
REVISIONS 1	-	-	-		
REVISIONS 2	-	-	-		
REVISIONS 3	-	-	-		
REVISIONS 4	-	-	-		
FIELD CHANGES	-	-	-		

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE PROFILE 3

SHEET NUMBER
10
OF 11



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

NOTE:
Minimum vertical clearance, measured from top of track, shall be 22'-0" during construction and 23'-0" in the final conditions.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

STEEL ALTERNATIVE
PROFILE 4

SHEET NUMBER
11
OF 11

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SPECIFICATIONS

Design: Load and Resistance Factor Design per AASHTO LRFD Bridge Design Specifications, Eighth Edition, 2017.

DESIGN LOADING

Live Load .... HL - 93 Modified for Strength I
CL-625-ONT

TRAFFIC DATA

Current (2019) AADT	2220
Future (2039) AADT	4080
DHV - % of AADT	10
Design Hour Volume	408
Heavy Trucks (% of AADT)	5
Heavy Trucks (% of DHV)	5
Directional Distribution (% of DHV)	55
18 kip Equivalent P 2.0	144
18 kip Equivalent P 2.5	137
Design Speed (mph)	25

HYDROLOGIC DATA

Drainage Area	5,985 sq mi
Design Discharge (Q50)	163,120 cfs
Check Discharge (Q100)	176,980 cfs
Headwater Elevation (Q1.1)	455.3 ft
Headwater Elevation (Q10)	465.0 ft
Headwater Elevation (Q25)	466.2 ft
Headwater Elevation (Q50)	467.3 ft
Headwater Elevation (Q100)	468.3 ft
Discharge Velocity (Q1.1)	7.4 fps
Discharge Velocity (Q10)	8.0 fps
Discharge Velocity (Q25)	8.3 fps
Discharge Velocity (Q50)	8.5 fps
Discharge Velocity (Q100)	9.5 fps

MATERIALS

Concrete:
- Curbs & Transition Barriers .... Class "LP"
- All Other .... Class "A"

Reinforcing Steel:
- Plain Reinforcing Steel .... ASTM A 615, Grade 60
- Stainless Reinforcing Steel .... ASTM A 955, Grade 75

Prestressing Strands .... AASHTO M203 (ASTM A416) Grade 270, Low Relaxation

Structural Steel:
- All Material (except as noted) .... ASTM A 709, Grade 50W (unpainted)
- High Strength Bolts .... ASTM F 3125, Grade A325, Type 3

BASIC DESIGN STRESSES

Concrete, Class "A" (Segmental Superstructure)	f 'c = 8,000 psi f 'ci = 6,000 psi
Concrete, Class "A" (All Other)	f 'c = 4,000 psi
Concrete, Class "LP"	f 'c = 5,000 psi
Plain Reinforcing Steel	f y = 60,000 psi
Stainless Reinforcing Steel	f y = 75,000 psi
Prestressing Strand	F µ = 270,000 psi
Structural Steel:	
ASTM A 709, Grade 50W	F y = 50,000 psi
ASTM F 3125, Grade A325, Type 3	F µ = 120,000 psi

MADAWASKA - EDMUNDSTON
AROOSTOOK COUNTY - NEW BRUNSWICK

INTERNATIONAL BRIDGE
OVER
SAINT JOHN RIVER

BRIDGE AVE.
PROJECT LENGTH 0.36 mi.
BRIDGE NO. 2399

SEGMENTAL ALTERNATIVE

DRAFT PLANS
3/1/2019

HNTB

LIST OF DRAWINGS

REVIEWER NOTES

Information depicted on these plans are for the purpose of relative comparisons between two structure-type alternatives; the designs are based on an approximate 15% level of design completion and with incomplete coordination efforts.

The bridge-end flare width, landing location, and alignment orientation at the U.S. LPOE are subject to change based upon further coordination needs surrounding LPOE operations and land use.

The bridge landing location and orientation at the Canadian POE are subject to minor adjustments based upon further coordination needs surrounding POE operations and construction phasing.

The overall bridge width and distribution of shoulder widths are subject to change.

UTILITIES

Twin Rivers Paper Company
Maine Northern Railroad
Canadian National Railroad
Town of Madawaska (Water and Sewer)
City of Edmundston (Water and Sewer)
Bell Aliant
Consolidated Communications

MAINTENANCE OF TRAFFIC

Maintain two lanes of traffic on the existing bridge.

PROJECT LOCATION:	International Bridge #2399 between Madawaska, Maine and Edmundston, New Brunswick carrying Bridge Avenue over the Saint John River. Latitude: 47°21'35"N Longitude: 68°19'57"W
PROGRAM AREA:	Bridge
OUTLINE OF WORK:	Replacement of the International Bridge with minor approach work.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
APPROVED | DATE
COMMISSIONER:
CHIEF ENGINEER:

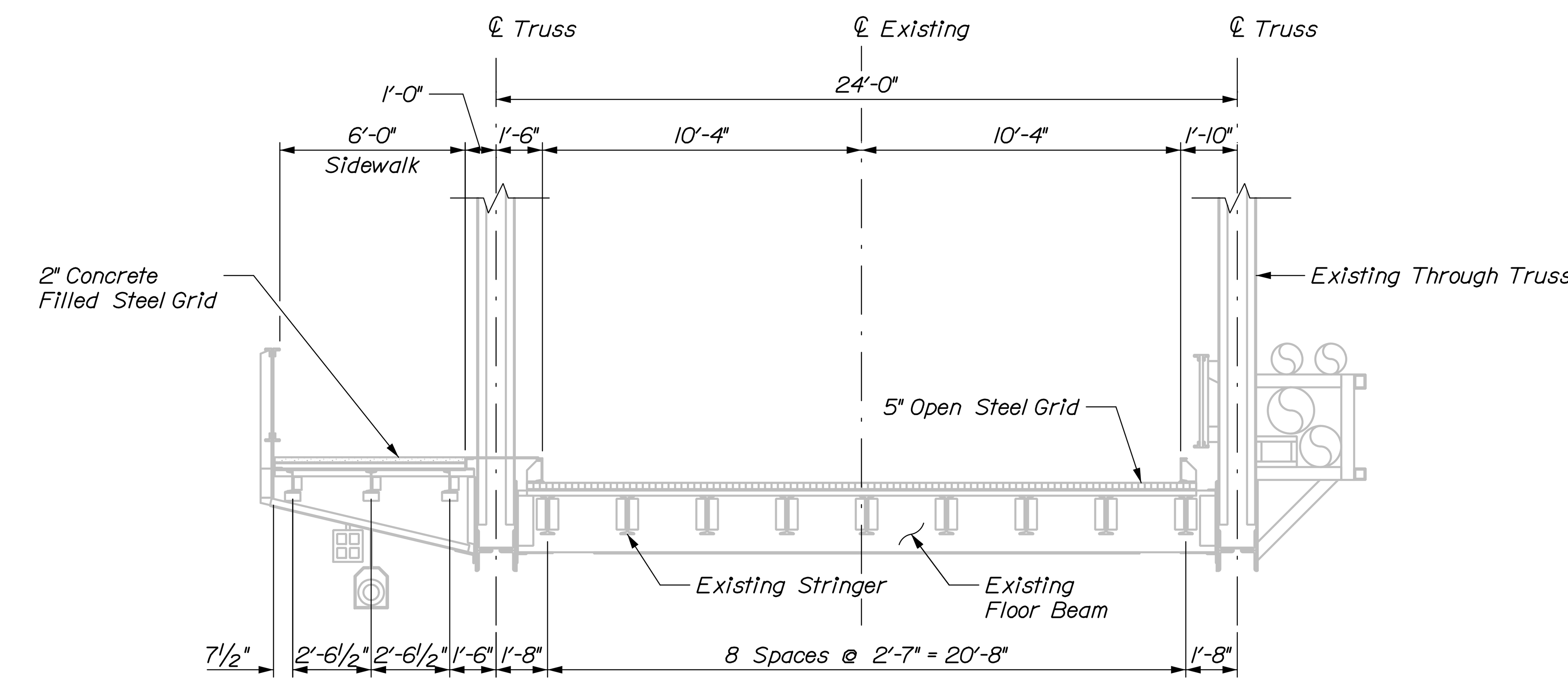
WIN 021736.00

PROJECT INFORMATION | SIGNATURE | P.E. NUMBER | DATE
PROGRAM: BRIDGE
PROJECT MANAGER: JOEL KITTREDGE
DESIGNER
CONSULTANT: HNTB
PROJECT RESIDENT
CONTRACTOR
PROJECT COMPLETION DATE

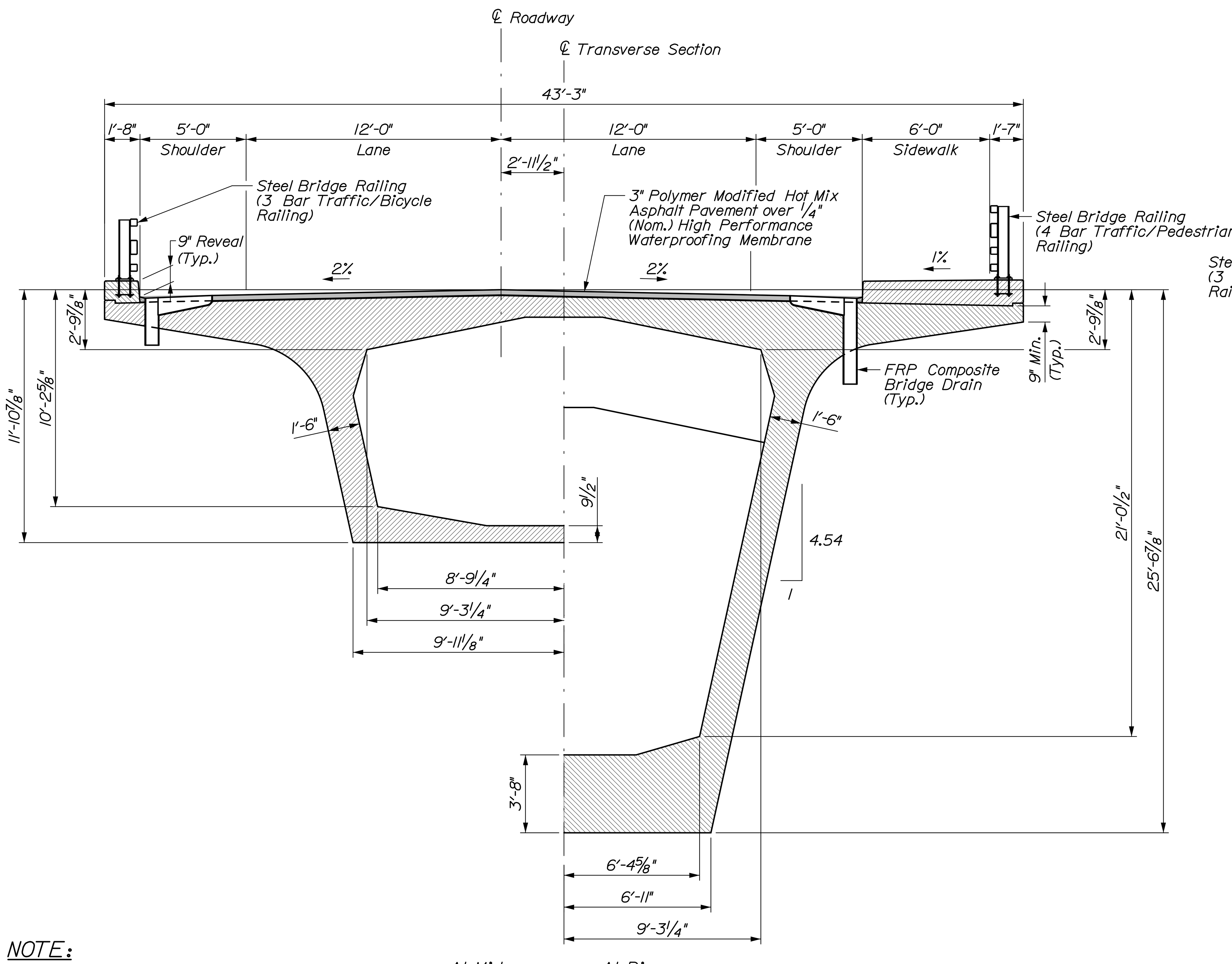
MADAWASKA-EDMUNDSTON
INTERNATIONAL BRIDGE
SEGMENTAL ALT.
TITLE SHEET

SHEET NUMBER
1
OF 11

Date:3/1/2019
Username:
Division:
Filename:001_Hybrid_Title.dgn

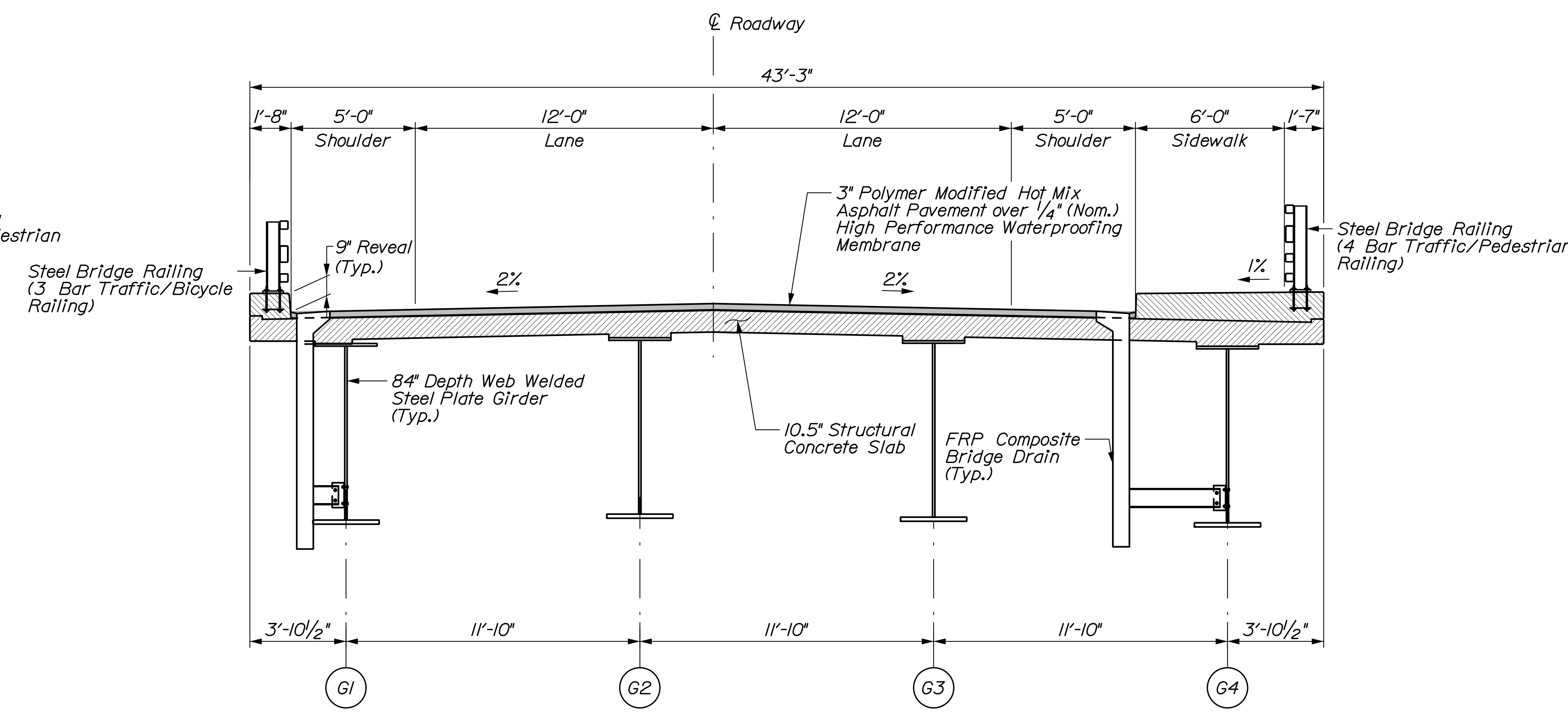


EXISTING BRIDGE SECTION



PROPOSED BRIDGE SECTION
(Spans 1 Through 4)

NOTE:
Typical segment length is approximately 15'-8". Total number of segments is approximately 3 pier segments, 78 balanced cantilever construction segments, 4 closure pour segments, and 175' of end span construction.



PROPOSED BRIDGE SECTION
(Span 5)

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS
WIN 021736.00
BRIDGE NO. 2399

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
TYPICAL SECTION

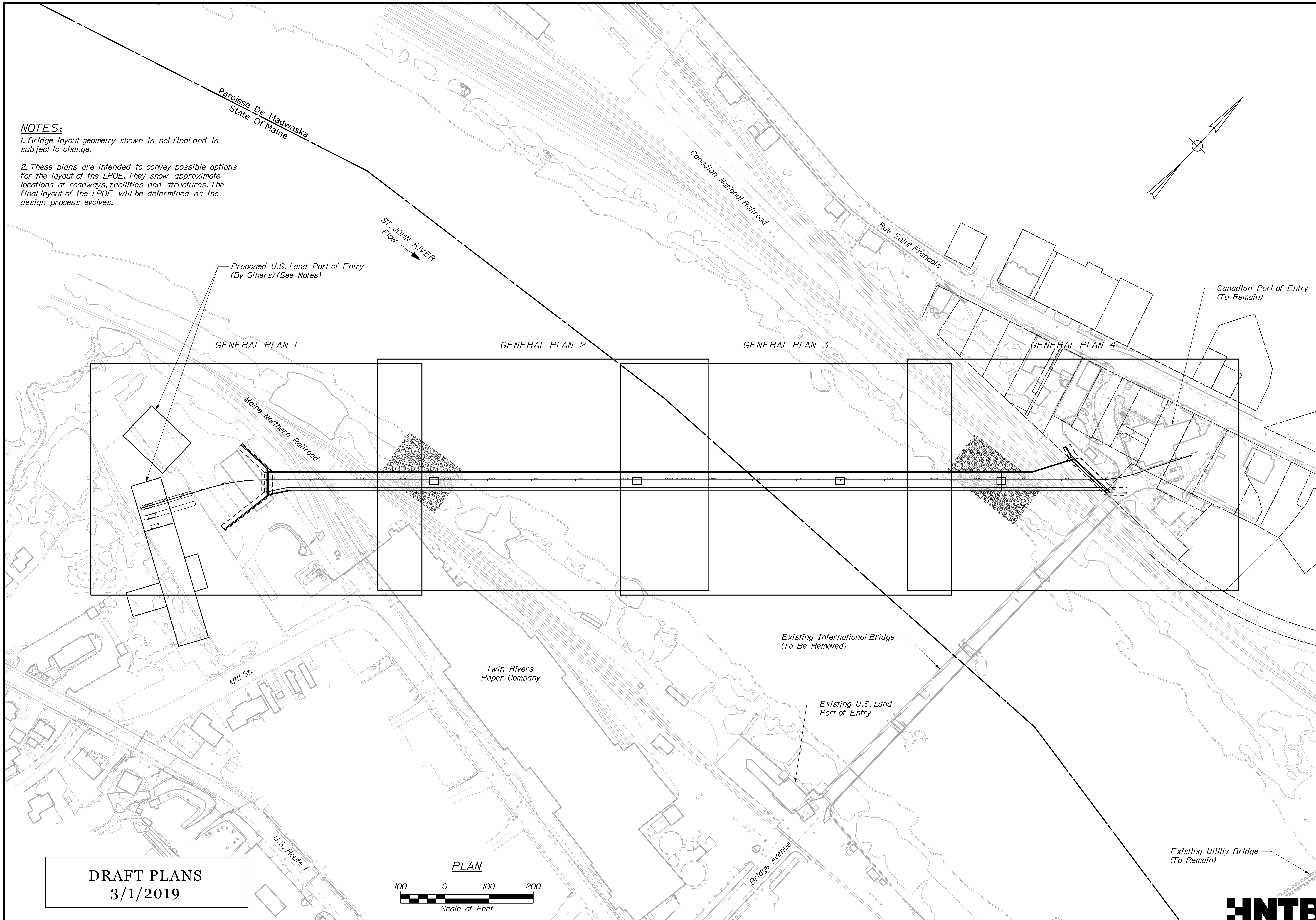
SHEET NUMBER
2
OF 11

Filename: 003_Project Site Plan Segmental.dgn Division: Username: Date:3/1/2019

NOTES:

1. Bridge layout geometry shown is not final and is subject to change.

2. These plans are intended to convey possible options for the layout of the LPOE. They show approximate locations of roadways, facilities and structures. The final layout of the LPOE will be determined as the design process evolves.



DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN
021736.00

BRIDGE PLANS

	BY	DATE
PROJ. MANAGER J. Kittredge		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
PROJECT SITE PLAN

SHEET NUMBER
3
OF 11

Date:3/1/2019

Username:

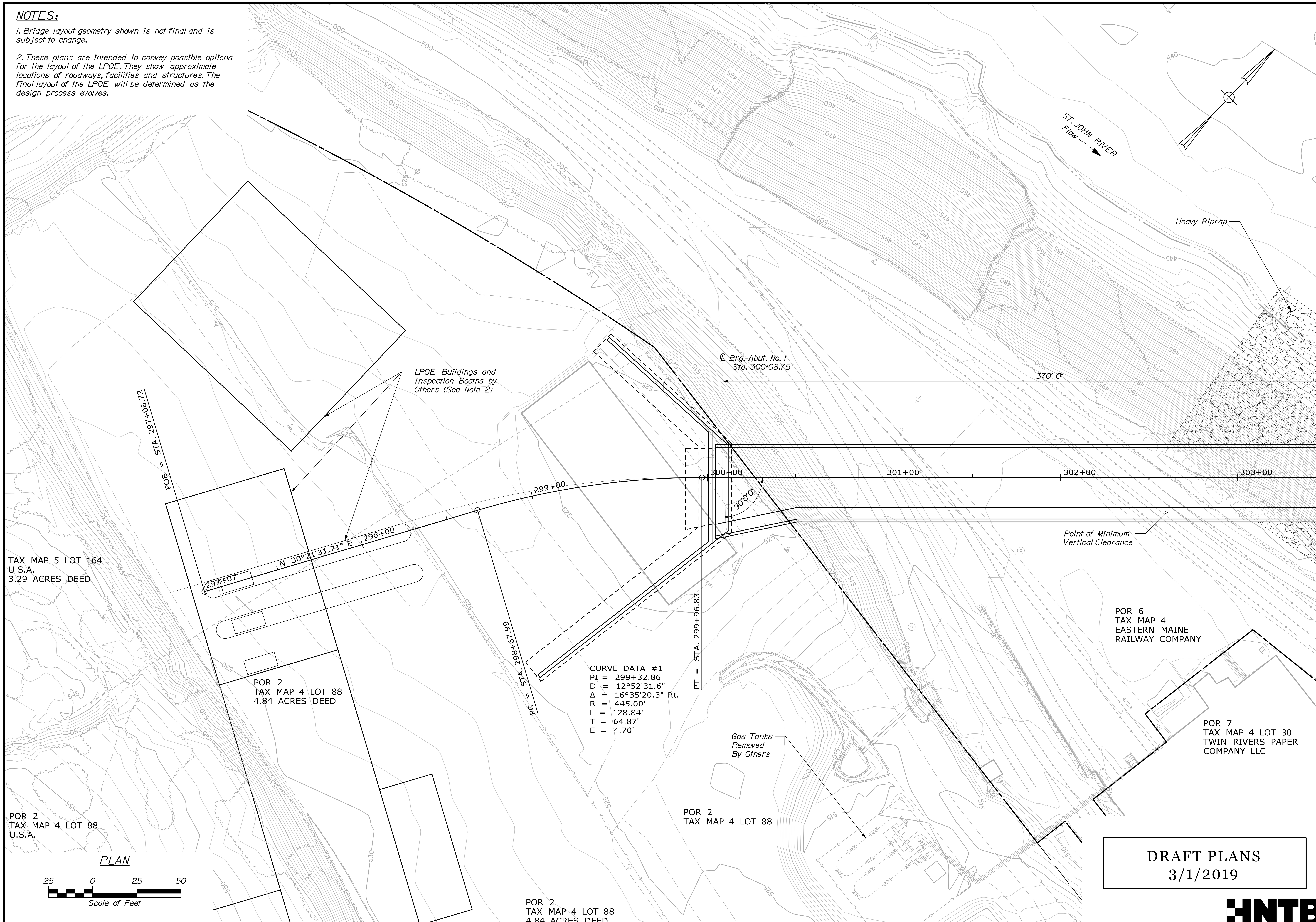
Division:

Filename: 004_Hybrid_Plan_01.dgn

NOTES:

1. Bridge layout geometry shown is not final and is subject to change.

2. These plans are intended to convey possible options for the layout of the LPOE. They show approximate locations of roadways, facilities and structures. The final layout of the LPOE will be determined as the design process evolves.



DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN
021736.00

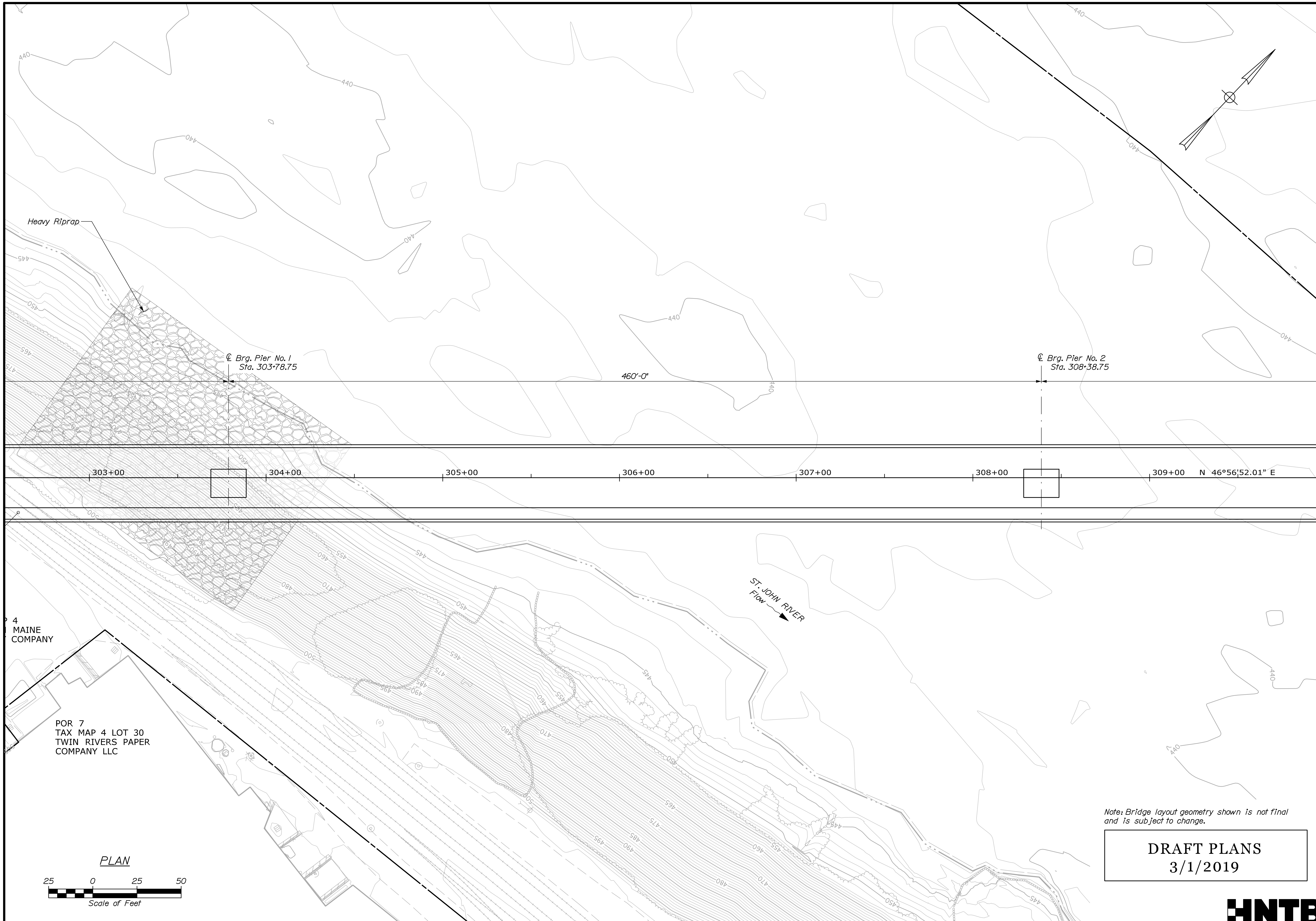
BRIDGE NO. 2399

			SIGNATURE	P.E. NUMBER	DATE
	BY	DATE			
PROJ. MANAGER	J. Kittredge	-			
DESIGN-DETAILED	-	-			
CHECKED-REVIEWED	-	-			
DESIGN2-DETAILED2	-	-			
DESIGN3-DETAILED3	-	-			
REVISIONS 1	-	-			
REVISIONS 2	-	-			
REVISIONS 3	-	-			
REVISIONS 4	-	-			
FIELD CHANGES	-	-			

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
GENERAL PLAN 1

SHEET NUMBER
4
OF 11



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

SIGNATURE
P.E. NUMBER
DATE

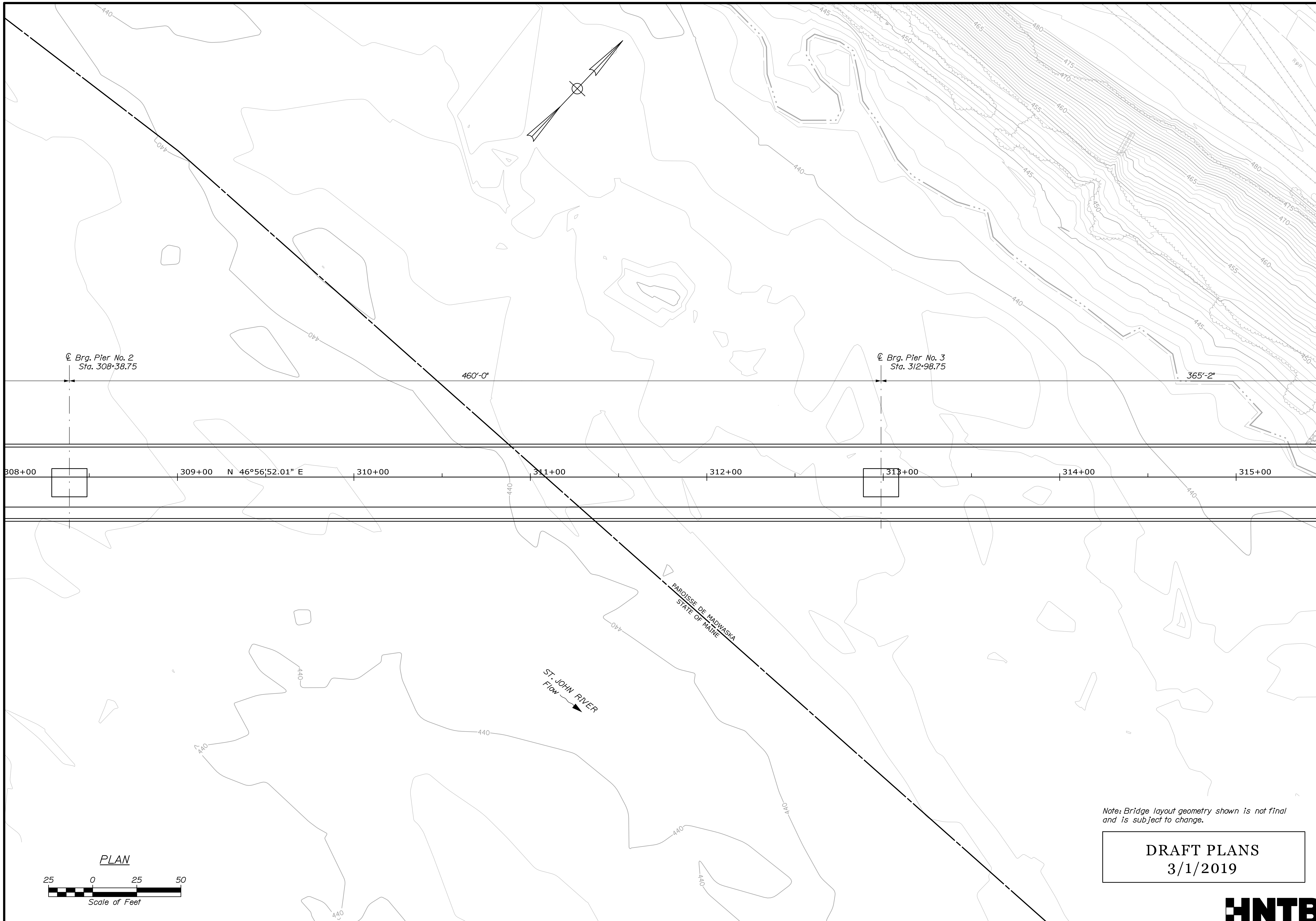
		BY	DATE
PROJ. MANAGER	J. Kittredge		
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
GENERAL PLAN 2

SHEET NUMBER
5
OF 11

Filename: 005_Hybrid_Plan_02.dgn
Division:
Username:
Date: 3/1/2019



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

Date:3/1/2019

Username:

Division:

Filename: 006_Hybrid_Plan_03.dgn

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

WIN 021736.00

BRIDGE PLANS

BRIDGE NO. 2399

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
GENERAL PLAN 3

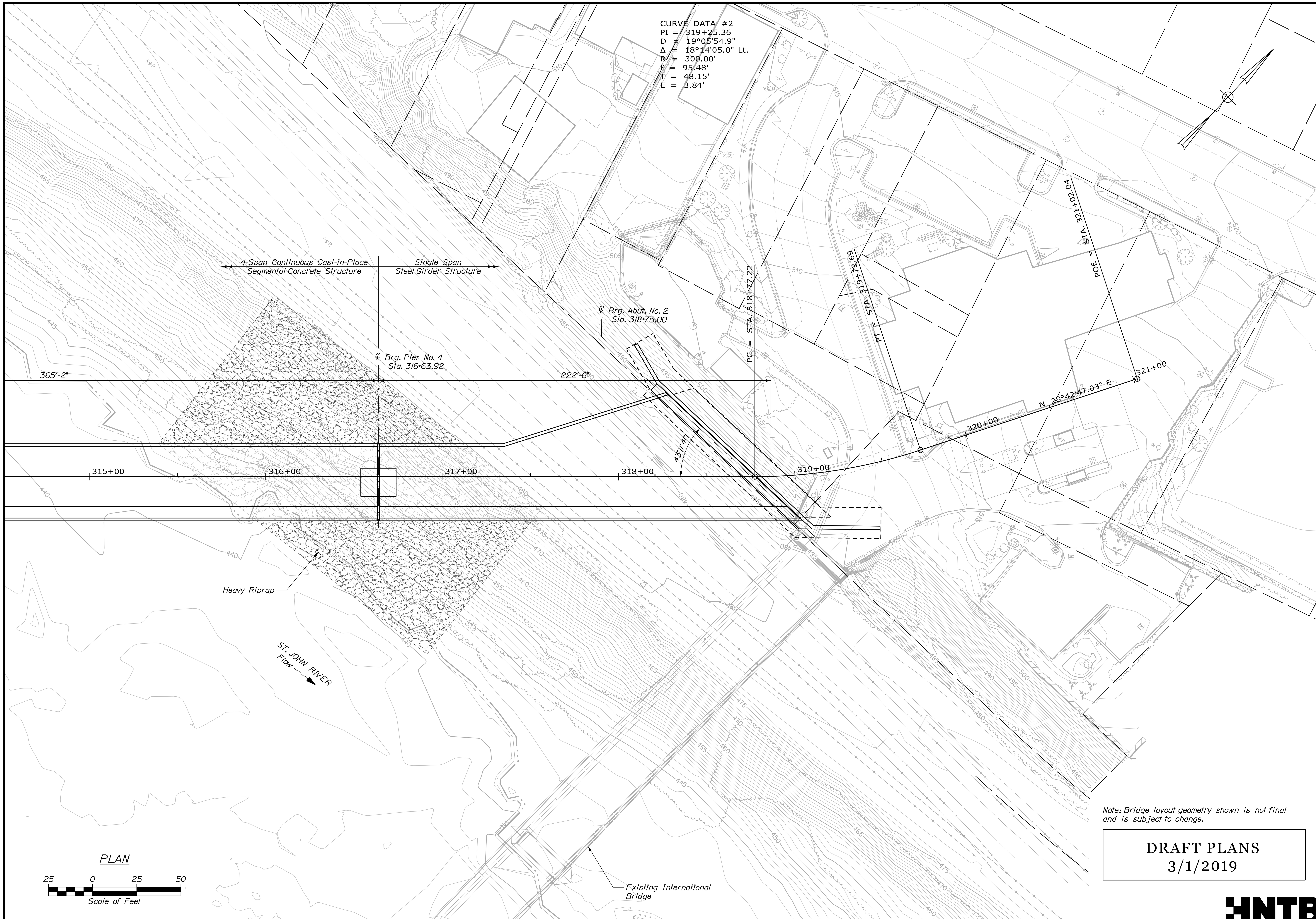
SHEET NUMBER
6
OF 11

Date:3/1/2019

Username:

Division:

Filename: 007_Hybrid_Plan_04.dgn



Note: Bridge layout geometry shown is not final and is subject to change.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN 021736.00

BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

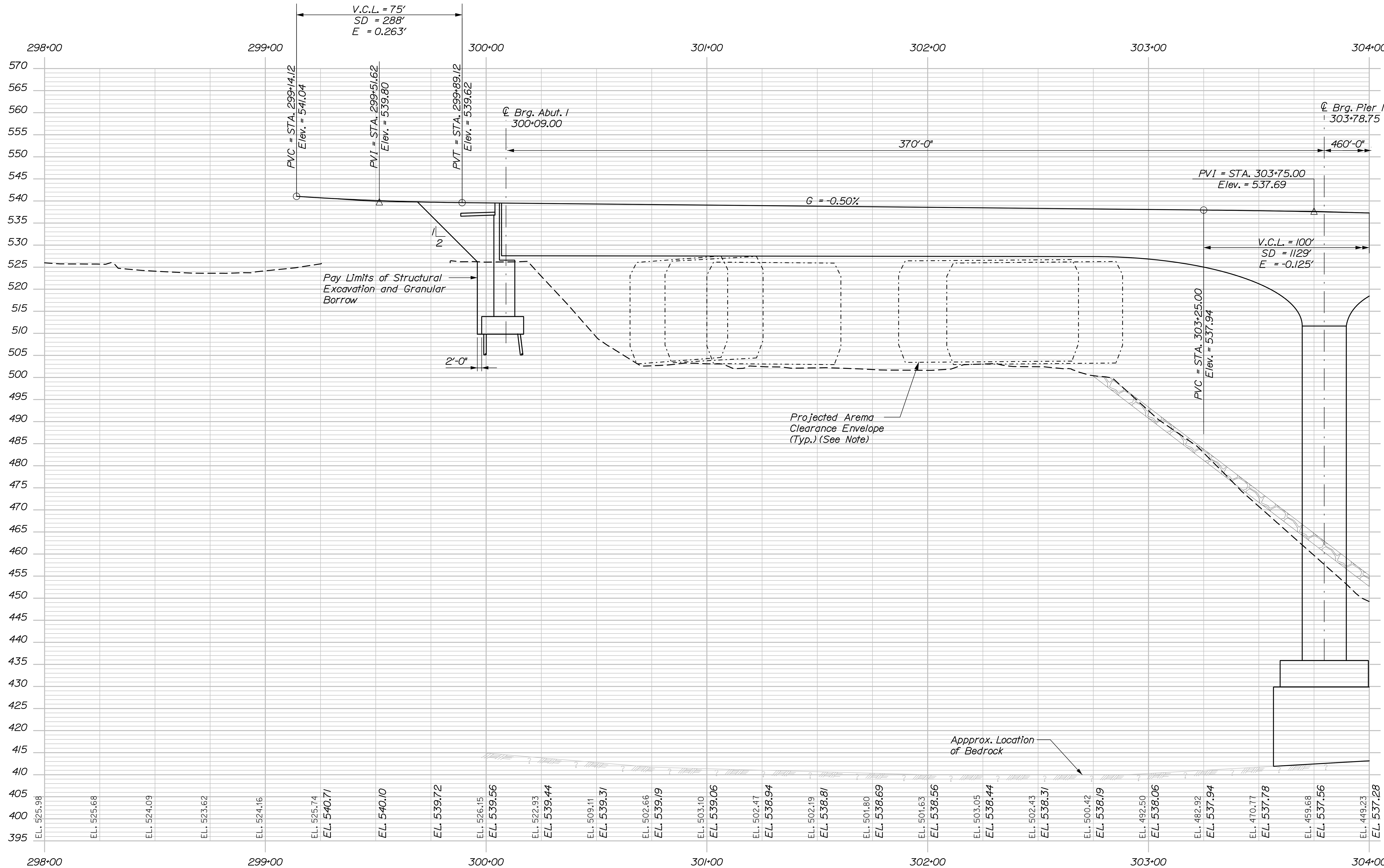
P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
GENERAL PLAN 4

SHEET NUMBER
7
OF 11



PROFILE

Horiz. 25 0 25 50

Vert. 12.5 0 12.5 25

Scale of Feet

NOTE:

Minimum vertical clearance, measured from top of track, shall be 18'-0" during construction and 23'-0" in the final conditions.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN
021736.00

BRIDGE PLANS

		BY	DATE
PROJ. MANAGER	J. Kittredge		
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DESIGN3-DETAILED3	-	-	-
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INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
PROFILE 1

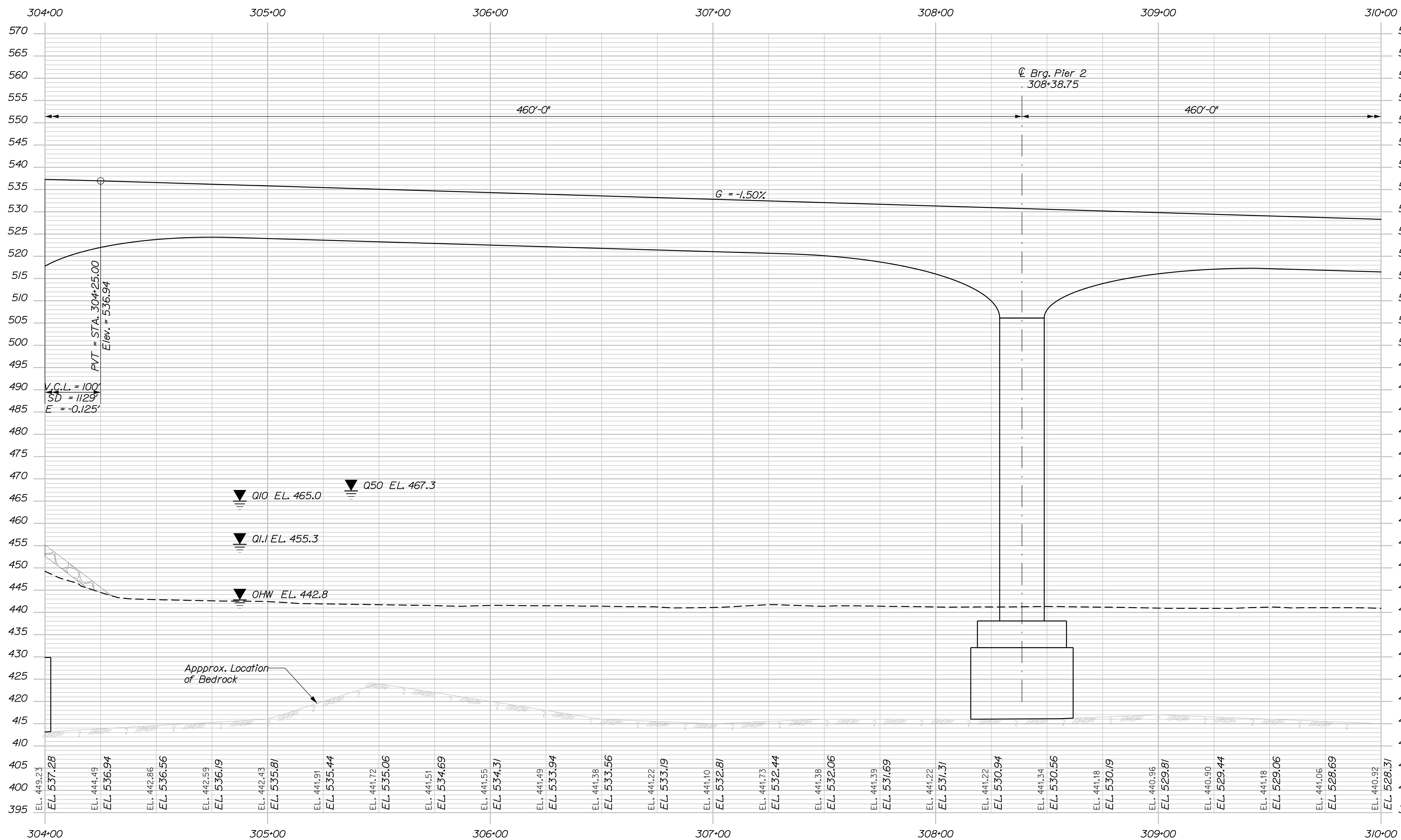
SHEET NUMBER
8
OF 11

Filename: 008_Hybrid_Profile_1.dgn

Division:

Username:

Date:3/1/2019



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN 021736.00

BRIDGE PLANS

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
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REVISIONS 4	-	-	-
FIELD CHANGES	-	-	-

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
PROFILE 2

SHEET NUMBER

9

OF 11

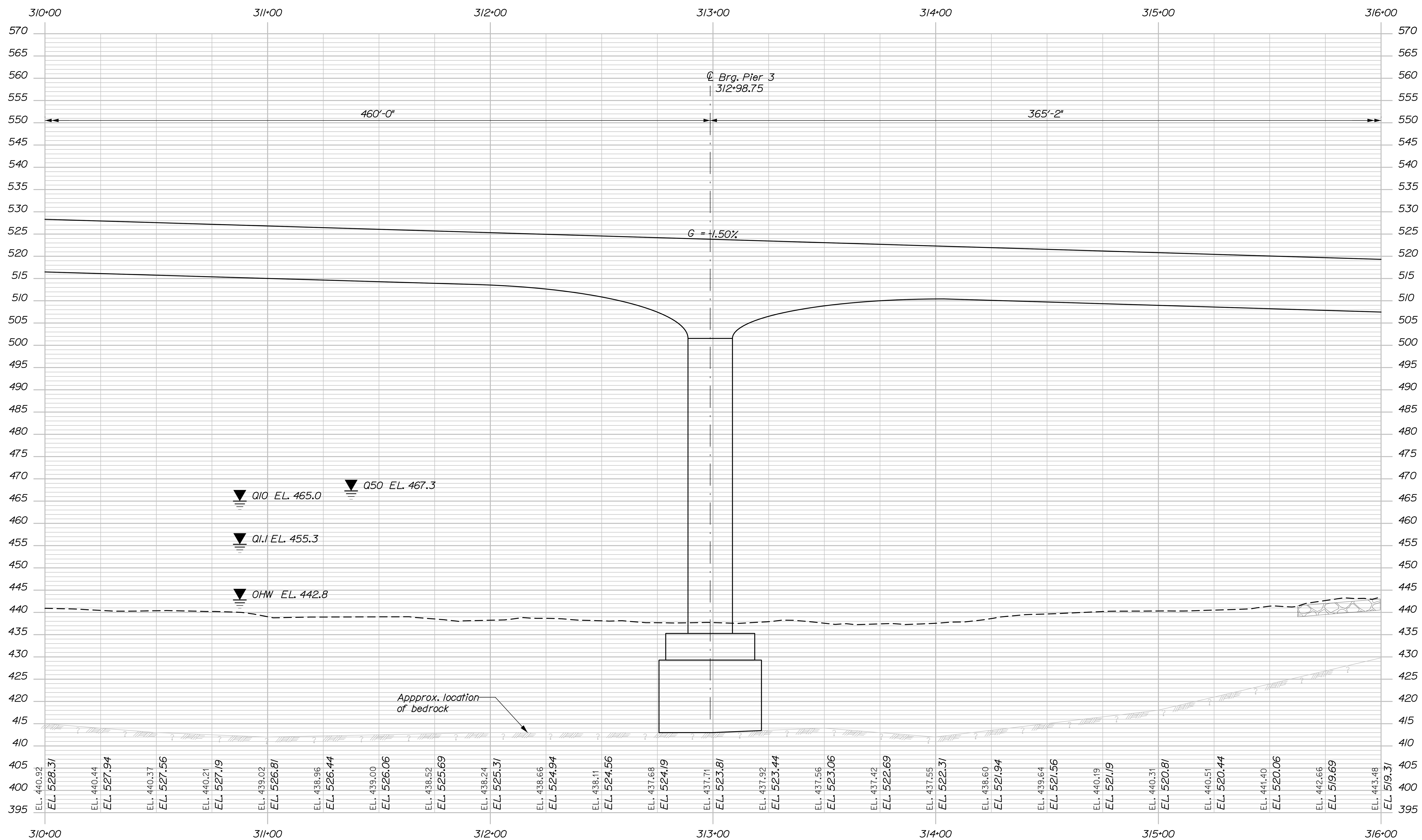
Filename: 009_Hybrid_Profile_2.dgn

Division:

Username:

Date:3/1/2019

Filename: 010_Hybrid_Profile_3.dgn Division: Username: Date:3/1/2019



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399
WIN 021736.00
BRIDGE PLANS

			DATE
PROJ. MANAGER	J. Kittredge	-	-
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	-
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1	-	-	-
REVISIONS 2	-	-	-
REVISIONS 3	-	-	-
REVISIONS 4	-	-	-
FIELD CHANGES	-	-	-

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
PROFILE 3

SHEET NUMBER
10
OF 11

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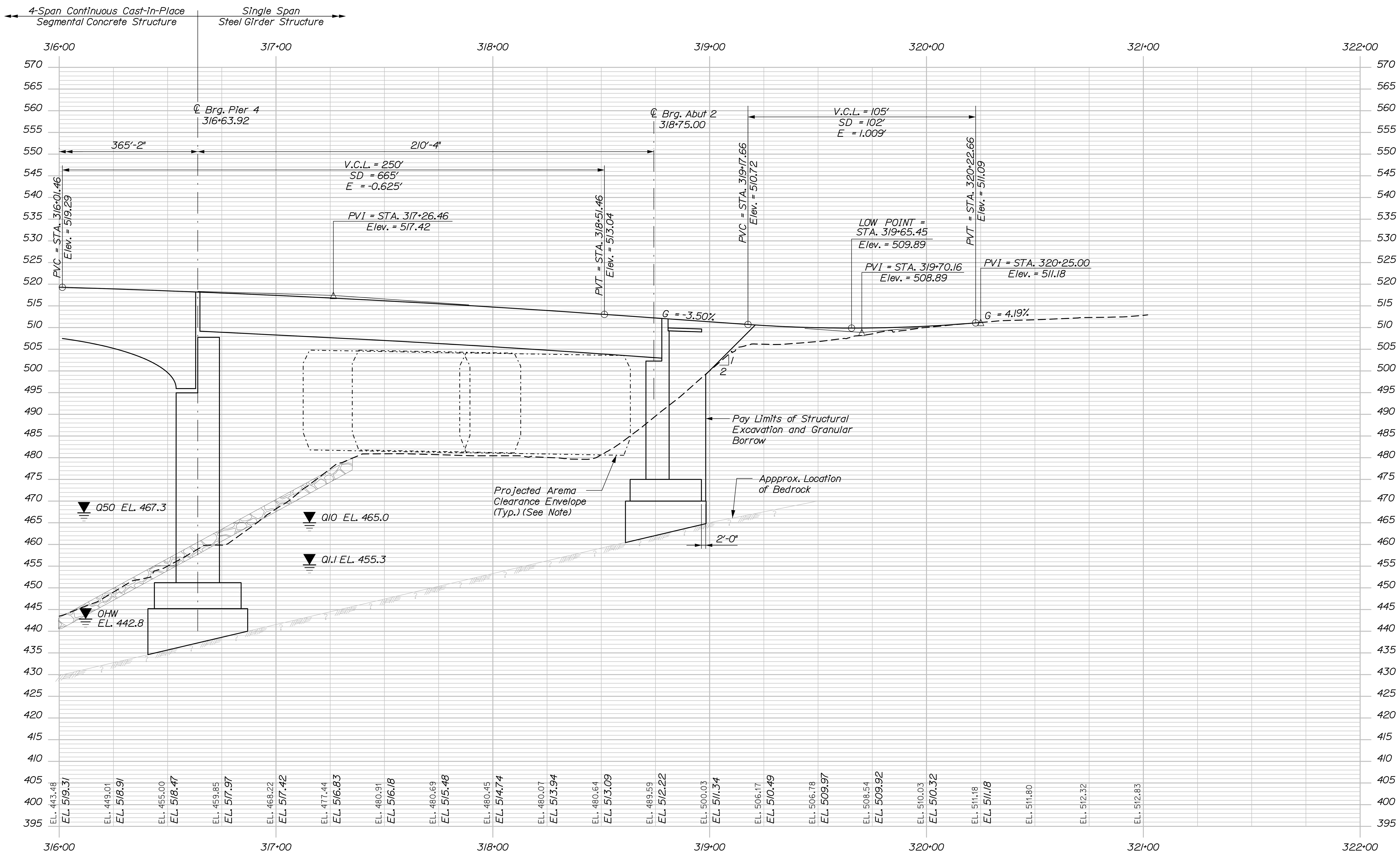
Division:
Username:
Date:3/1/2019



PROFILE

Horiz. 25 0 25 50
Vert. 12.5 0 12.5 25
Scale of Feet

NOTE:

Minimum vertical clearance, measured from top of track, shall be 22'-0" during construction and 23'-0" in the final conditions.

DRAFT PLANS
3/1/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

WIN 021736.00
BRIDGE NO. 2399
BRIDGE PLANS

	BY	DATE
PROJ. MANAGER	J. Kittredge	-
DESIGN-DETAILED	-	-
CHECKED-REVIEWED	-	-
DESIGN2-DETAILED2	-	-
DESIGN3-DETAILED3	-	-
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

SEGMENTAL ALT.
PROFILE 4

SHEET NUMBER
11
OF 11

Appendix B

Alternatives Matrix

<u>International Bridge #2399</u>

Madawaska, Maine to Edmundston, New Brunswick
WIN 21736.00

Alternatives Assessment Matrix

3/8/2019

<table>
<tr><th colspan="2">Evaluation Criteria</th><th>Alternative 1: 6-Span Steel Girder Structure</th><th>Alternative 2: 5-Span Segmental and Steel Structure</th></tr>
<tr><td rowspan="4">Geometry and Details</td><td>No. Spans</td><td>6</td><td>5</td></tr>
<tr><td>No. Girders / Cells</td><td>4 Girders, with additional splayed girders at both bridge ends</td><td>Single Concrete Cell with flared deck at US bridge end;
5 Girders, with additional splayed girders at NB bridge end</td></tr>
<tr><td>Span Lengths</td><td>293-ft; 4 @ 330-ft; 253-ft
(89.3-m, 4 @ 100.6-m, and 77.1-m)</td><td>370-ft; 2 @ 460-ft; 370-ft (Segmental) and 222.5-ft (Steel)
(112.8-m, 2 @ 140.2-m, 111.3-m, and 67.8-m)</td></tr>
<tr><td>Structure Depths</td><td>Varies: 10-ft to 14-ft
(3.05-m / 4.27-m)</td><td>Varies: 11.9-ft to 25.5-ft (3.63-m / 7.77-m) (Segmental)
9.25 ft (2.82-m) (Steel)</td></tr>
<tr><td rowspan="3">Constructability</td><td>Impacts</td><td colspan="2">Staging areas, access differentiators, and ground supported falsework to be Identified at a Later Date</td></tr>
<tr><td>Fabrication/Erection</td><td colspan="2">Unique fabrication/erection requirements to be Identified at a Later Date</td></tr>
<tr><td>Estimated Construction Duration</td><td colspan="2">Approximate Durations to Substantial Completion Contract Completion to be Identified at a Later Date</td></tr>
<tr><td rowspan="4">Maintenance / Inspection</td><td>Inspection Considerations</td><td colspan="2">Discussion Surrounding Inspection Needs, Access, and Costs to be Added at a Later Date</td></tr>
<tr><td>Maintenance Needs/Considerations</td><td colspan="2">Discussion Surrounding Common Maintenance Needs to be Added at a Later Date</td></tr>
<tr><td>Ice Jamming Considerations</td><td colspan="2">The Number of Piers, Pier Width, Location, and Details to be Added at a Later Date</td></tr>
<tr><td>Estimated Service Life</td><td></td><td></td></tr>
<tr><td rowspan="8">Estimated Construction Cost</td><td>Superstructure</td><td colspan="2" rowspan="8">Estimated Construction Costs to be Added at a Later Date</td></tr>
<tr><td>Piers</td></tr>
<tr><td>Abutments</td></tr>
<tr><td>Access</td></tr>
<tr><td>Demolition</td></tr>
<tr><td>Miscellaneous</td></tr>
<tr><td>Total Construction Cost (Initial)</td></tr>
<tr><td>Service Life Cost</td></tr>
</table>

Note: All information provided in this matrix is preliminary and subject to change.

Appendix C

Preliminary Design Report Forms

BACKGROUND INFORMATION

TOWN	Madawaska, ME – Edmundston, NB	**WIN**	021736.00
BRIDGE NO.	2399		
BRIDGE	International Bridge	**ROAD**	Bridge Avenue

FUNDING: Sources to be determined

PROGRAM SCOPE: Bridge Replacement

PROGRAM DESCRIPTION: International Bridge (#2399) over St. John River. Located 0.27 of a mile north of Route 1 on the Canadian Border.

PROJECT BACKGROUND: This bridge was constructed in 1921. Past repair projects have included a 1961 replacement of the original timber deck and sidewalk with an open steel grid deck and sidewalk and the installation of floorbeam top and bottom flange cover plates. In 2001 the steel grid deck was replaced in spans 3 and 4, as well as replacement of stringers in all floorbeam bays in spans 3 and 4, concrete repair with steel post tensioning rods in the front face of the south abutment bridge seat, concrete repairs in exposed surfaces of the south abutment breastwall and wingwalls, and concrete repair with steel post tensioning rods in the front faces of the pier 3 cap. In 2005 repairs included sidewalk replacement in spans 3 and 4 and superstructure repainting in all spans. The deck is currently in poor condition and in need of replacement. The substructure and superstructure are in poor and fair condition, respectively and in need of replacement.

JURISDICTION	State Highway	**NHS**	Yes
FUNCTIONAL CLASSIFICATION	Minor Arterial	**CORRIDOR PRIORITY**	1
URBAN/RURAL	Rural	**FHWA SUFFICIENCY RATING**	23.6
POSTED SPEED	25 mph	**LOAD POSTING**	5 Ton
TRAFFIC: 2020 **AADT**	2220	**ACCIDENT DATA, CRF**	TBD
2040 **AADT**	4080	**DHV**	408

EXISTING BRIDGE

YEAR BUILT 1921 **SPAN LENGTHS** 4 @ 235'-6" **CURB TO CURB WIDTH** 20'-8"

TYPE OF SUPERSTRUCTURE: Four simple spans consisting of painted, Pennsylvania-style steel through trusses with transverse floorbeams, longitudinal stringers, and a cantilevered sidewalk on the upstream (west) fascia. The deck is an open steel grid with finger joints at the south abutment and all piers and an armored joint at the north abutment. The curb is rolled steel channel with built-up riveted steel-lattice style railing.

GENERAL CONDITION: Steel truss members are in poor condition and were most recently painted in 2005. Open steel grid deck is in poor condition with cracking in numerous areas, failed or missing sections of transverse and longitudinal distribution bars, and isolated distressed areas with visible deflection under truck tire loading.

TYPE OF SUBSTRUCTURE: Concrete stub abutments on spread footing on soil (US Abutment) and on rock (Canadian Abutment). Piers are solid shafts with upstream nosing, supported on spread footings on soil.

GENERAL CONDITION: The concrete for both abutments and piers are in fair condition. Both abutments exhibit numerous spalls, cracks, and delamination. Pier columns exhibit several areas of moderate delamination and spalling with exposed reinforcing due to shallow concrete cover. Pier caps exhibit map cracking with moisture. Pier caps also exhibit moderate delamination and spalling throughout, and there is moderate surface rust of the steel post tensioning rods and anchor blocks in the pier 3 cap. Scour holes are present around the piers; grout bag repairs beneath the piers occurred in 1989.

LOAD RATINGS:	**OPERATING**	**INVENTORY**
HL-93	13.68 Tons	18.00 Tons
Rating Factor	0.38	0.50

LEGAL LOADS

Controlling Configuration:	15.48 Tons (For CL-625-ONT Inventory Truck)
Rating Factor:	0.43 (For CL-625-ONT Inventory Truck)
Controlling Member:	Floorbeam at midspan in positive flexure
	See Appendix E for load rating summary

STRUCTURALLY DEFICIENT Yes **FUNCTIONALLY OBSOLETE** N/A

MAINTENANCE PROBLEMS: Several stringers with 100% section loss. Stay-in-place forms in serious condition with extensive areas of 100% section loss. East curb at north abutment in span 1 has minor bend due to collision damage and isolated vertical welds between adjacent curb sections are cracked up to full height. North abutment deck joint has a sheared off transverse bar in the southbound lane. The sidewalk has numerous transverse cracks and the concrete filled steel grid deck of the sidewalk is in poor condition.

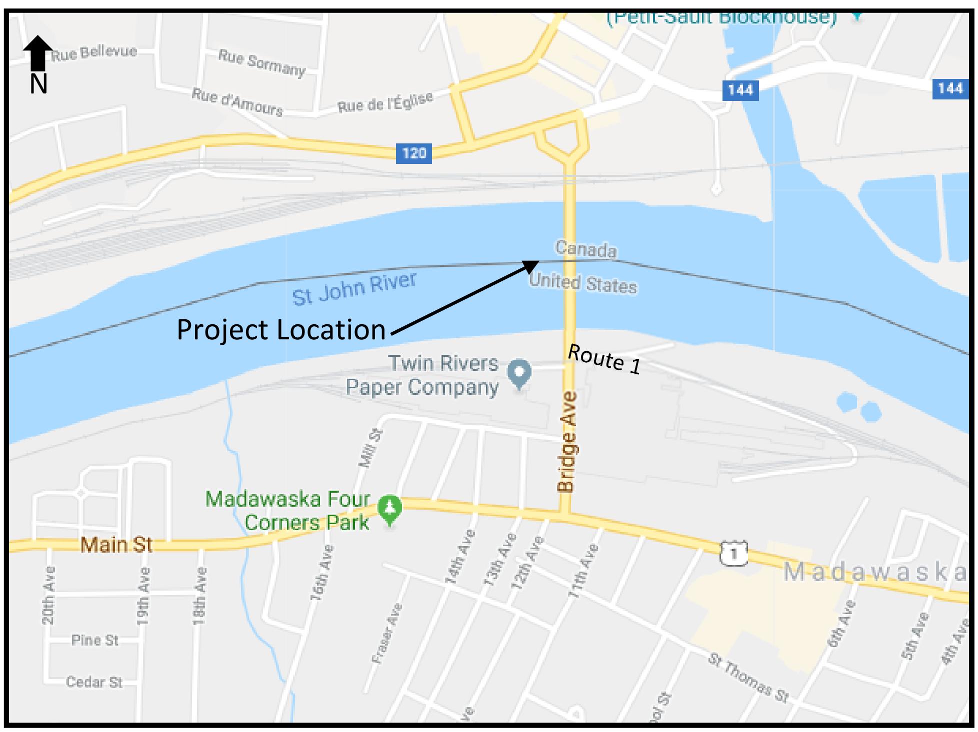
MAINTENANCE WORK:

PREVIOUS STRUCTURE: None

OTHER COMMENTS: None

LOCATION MAP

Madawaska, ME – Edmundston, NB, International Bridge #2399, WIN 021736.00
Bridge Avenue over St. John River



Latitude: 47° 21' 34" N, Longitude: 68° 19' 43" W

Appendix D

Design Criteria

Not Included at this Time

Appendix E

Estimated Construction Costs

Not Included at this Time

Appendix F

Estimated Construction Schedules

Not Included at this Time

Appendix G

Conceptual Access and Staging Plans

DRAFT PLANS
3/8/2019

Filename: 001_6-Span ConceptualPlan Phase 1.dgn Division:

Username:

Date:3/8/2019

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN
021736.00

BRIDGE PLANS

PROJ. MANAGER	J. Kittredge	BY	DATE
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED		-	
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1	-		-
REVISIONS 2	-		-
REVISIONS 3	-		-
REVISIONS 4	-		-
FIELD CHANGES	-		-

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

CONSTRUCTION ACCESS
AND STAGING - PHASE 1

SHEET NUMBER
1
OF 4

HNTB

Filename: 002_6-Span ConceptualPlan Phase 1.dgn Division: Username: Date:3/8/2019

DRAFT PLANS
3/8/2019

HNTB

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE NO. 2399

WIN
021736.00

BRIDGE PLANS

		BY	DATE
PROJ. MANAGER	J. Kittredge		
DESIGN-DETAILED	-	-	-
CHECKED-REVIEWED	-	-	
DESIGN2-DETAILED2	-	-	-
DESIGN3-DETAILED3	-	-	-
REVISIONS 1	-		-
REVISIONS 2	-		-
REVISIONS 3	-		-
REVISIONS 4	-		-
FIELD CHANGES	-		-

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

CONSTRUCTION ACCESS
AND STAGING - PHASE 1

SHEET NUMBER
2
OF 4

Filename: 003_6-Span ConceptualPlan Phase 2.dgnDivision:
Username:
Date:3/6/2019

120 0 60 120
Scale of Feet

DRAFT PLANS
3/6/2019

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN
021736.00

BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

CONSTRUCTION ACCESS
AND STAGING - PHASE 2

SHEET NUMBER
3
OF 4

Filename: 004_6-Span Conceptual Plan Phase 2.dgnDivision: Username: Date:3/6/2019

DRAFT PLANS
3/6/2019

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS
WIN 021736.00
BRIDGE NO. 2399

	BY	DATE
PROJ. MANAGER	J. Kittredge	
DESIGN-DETAILED	-	-
CHECKED-REVIEWED	-	-
DESIGN2-DETAILED2	-	-
DESIGN3-DETAILED3	-	-
REVISIONS 1	-	-
REVISIONS 2	-	-
REVISIONS 3	-	-
REVISIONS 4	-	-
FIELD CHANGES	-	-

SIGNATURE
P.E. NUMBER
DATE

INTERNATIONAL BRIDGE
SAINT JOHN RIVER
MADAWASKA, ME EDMUNDSTON, NB

CONSTRUCTION ACCESS
AND STAGING - PHASE 2

SHEET NUMBER
4
OF 4

Appendix H

Initial Alternatives Discussion

Date	To
October 4, 2018	Joel Kittredge – MaineDOT
	From
	Tim Cote, P.E.
	Subject
	WIN 21736.00: Madawaska-Edmundston International Border Crossing Bridge Precast Segmental Alternatives Assessment

HNTB

Project Correspondence

Introduction & Background

The Preliminary Design Phase follows a progressive, tiered approach toward selecting a preferred alternative. Initial investigative efforts commenced with a high-level assessment of four different bridge superstructure types with two span configurations each (eight total alternatives). The goal of this initial, high-level assessment is to identify the most reasonable alternatives to advance into a more refined investigation to quickly and efficiently arrive at a preferred alternative. The four different superstructure types assessed include: Steel Plate Girders, Steel Tub Girders, Precast Segmental Concrete, and Cast-In-Place Segmental Concrete.

This memorandum discusses the high-level assessment of the Precast Segmental Concrete alternatives and provides justification for removal of this structure type from further consideration.

Structure Type Overview

The project feasibility study, finalized in May 2018, recommended an approximately 1,850-ft (564-m) long structure and a bridge typical section consisting of two travel lanes with shoulders and a single sidewalk resulting in an overall 43.75-ft (13.33-m) wide bridge.

For this structure type, the overall crossing is best accommodated with either a 5-span or 6-span bridge configuration. Individual span lengths would range between 260-ft and 410-ft (79.2-m to 125.0-m). Girder depths for these span lengths are anticipated to range from 9.0-ft to 23.0-ft (2.74-m to 7.01-m), depending on the span length, number of web lines, and positive or negative moment locations. Despite these variables, the discussion herein applies regardless of the number of spans, span configuration, span lengths and structure depths selected.

Evaluation and Discussion

The overall design and behavior of both precast and cast in-place concrete segmental bridges is quite similar. However, several major differences exist between these structure types including fabrication processes, access and staging needs, and construction activities. The following summarizes the differences and the general difficulties surrounding the use of a precast segmental system at this site. Although the use of precast segments provides an opportunity to accelerate construction, we believe this benefit is outweighed by the factors outlined below. Based on these factors, we believe the use of a cast-in-place superstructure is the most appropriate solution for the segmental bridge alternative.

1. Since this is the only bridge of its type and span configuration currently being designed in the region, there will be insufficient economy of scale to offset the significant expense associated with establishing a new temporary onsite precast concrete fabrication facility. Generally, precast segmental construction becomes more cost competitive than cast-in-place construction for bridge projects with deck areas greater than approximately 200,000-ft^2 (18,580-m^2). The proposed deck area for the Madawaska-Edmundston International Bridge is approximately 80,940- ft^2 (7,520-m^2), less than half the threshold value for cost-effectiveness.

2. The size of the precast concrete segments will be substantial, especially for segments at pier locations where the superstructure depth is expected to be between 20 and 25 feet. Shipping weight and geometry limitations are a major consideration for these large precast segments. Considering these limitations, fabrication of the precast segments will need to occur as near to the bridge as practical to facilitate delivery. This will necessitate the purchase of property, or the acquisition of a temporary construction easement, to allow for the development of a large casting and storage site with a direct, unobstructed transportation route to the bridge site. Since the depth of the St. John River is inadequate to support delivery of the segments by barge, the segments will need to be delivered by truck, or by rail.

   Shipping by rail may be feasible but necessitates delivery of the segments on a schedule and delivery timetable that works for the railroads. Generally, Contractors prefer to self-perform delivery of the segments since it places control of the work directly in their own hands.

   Shipping large segments by truck requires overlimit permits and escort vehicles, and may result in damage to local roads due to excessive shipping weights. This damage may require repair following the completion of construction. In addition, bridge capacity limitations may also limit the shipping routes available to the Contractor.

   Additionally, depending on the location of the precasting operations and available shipping routes, the precast segments may need to be transported across the river via a trestle which could prove to be a cumbersome and time-consuming undertaking.

3. Individual precast segment weights will likely range between 125-kip and 225-kip (56,700-kg and 102,060-kg) for an 8-ft (2.44-m) long section, depending on structure depth and concrete element thicknesses. Increased crane sizes will be required within the channel to transport and lift precast segments into their final position. This requirement results in greater equipment costs compared to cast-in-place construction.

   Additionally, the trestle capacity will need to be increased to support the increased crane size, precast segments, and associated equipment since the use of barges likely is not viable. To minimize the construction schedule to the extent practical, these large trestles would likely be required throughout the winter and will be required to withstand ice floes and jams.

4. Segment depths are anticipated to vary throughout any given span to balance positive and negative moment demands, as well as construction demands. The variation from segment to segment diminishes, in part, the economy of standardization offered by precast segmental fabrication.

5. Geometry control is increasingly challenging with precast segments used on long span structures. Camber corrections to the precast segments are based on theoretical, time and material dependent

estimates occurring ahead of actual installation. In contrast, camber corrections for cast in-place segmental construction can be adjusted through progressive construction to better meet design intent.

6. Joints between precast segments are generally joined with shear keys, epoxy bonding agents, and compressive stresses induced through post tensioning. Cast-in-place segmental boxes offer improved joint connections through the use of mild reinforcement across the joint. The use of mild reinforcement across segment joints provides increased durability and relaxes design tensile stress requirements. This relaxed tensile stress requirement reduces post-tensioning needs and directly reduces post-tensioning costs.

7. The magnitude of the precast segments will result in difficult handling operations, which in turn increases the probability of accidents and damage to the segments themselves.

Conclusion

Precast segmental construction is typically faster and more economical for bridges with deck areas that far exceed the anticipated area of the Madawaska-Edmundston International Bridge. On these larger structures fabrication can be standardized and segments can be mass-produced.

Precast construction is also most appropriate when segment sizes and weights are less than what is expected on the Madawaska-Edmundston International Bridge. The use of smaller segments simplifies the cost and complexity of shipping and erecting the segments.

For this project the limited deck area, combined with large anticipated segment sizes and difficult site access, creates a series of complexities that will make the use of precast segments inefficient and costly. The use of cast-in-place construction is expected to negate these challenges while still providing the benefits of a segmental concrete bridge. Therefore, discontinuing investigation of the precast concrete segmental alternative in favor of the cast-in-place alternative is recommended.

Date	To
October 8, 2018	Joel Kittredge – MaineDOT

HNTB

Project Correspondence

From

Tim Cote, P.E.

Subject

WIN 21736.00: Madawaska-Edmundston International Border Crossing Bridge Steel Tub Girder Alternatives Assessment

Introduction & Background

The Preliminary Design Phase follows a progressive, tiered approach toward selecting a preferred alternative. Initial investigative efforts commenced with a high-level assessment of four different bridge superstructure types with two span configurations each (eight total alternatives). The goal of this initial, high-level assessment is to identify the most reasonable alternatives to advance into a more refined investigation to quickly and efficiently arrive at a preferred alternative. The four different superstructure types assessed include: Steel Plate Girders, Steel Tub Girders, Precast Segmental Concrete, and Cast In-Place Segmental Concrete.

This memorandum discusses the high-level assessment of the Steel Tub Girder alternatives and provides justification for removal of this structure type from further consideration.

Structure Type Overview

The project feasibility study, finalized in May 2018, recommended an approximately 1,850-ft (564-m) long structure and a bridge typical section consisting of two travel lanes with shoulders and a single sidewalk resulting in an overall 43.75-ft (13.33-m) wide bridge. Recent discussions with project stakeholders during team meetings indicate preference for a tangential alignment.

For this structure type, the overall bridge length is best accommodated with either a 6-span or 7-span bridge configuration. Individual span lengths would range between 180-ft and 330-ft (54.9-m to 100.6-m). Girder depths for these span lengths are anticipated to range from 7.5-ft to 11.5-ft (2.29-m to 3.50-m), depending on the span length, number of girder lines, and positive or negative moment locations. Despite these variables, the discussion herein applies regardless of the number of spans, span configuration, span lengths and structure depths selected.

The overall structure width can be accommodated with two tub girders with a spacing between web lines of approximately 12-ft (3.66-m). However, this geometry provides several challenges:

- Tub girders with web-to-web widths of 12-ft (3.66-m), and approximately 15-ft (4.57-m) out-to-out of top flange tips, present shipping difficulties that require wide load permits and may limit shipping lengths depending on traveled route and turn movement restrictions.

- The weight per unit length of beam is anticipated to be between approximately 1.5 and 2.0 kip/ft (2,232 kg/m and 2,983 kg/m) which may limit shipping lengths and necessitate additional field splices.

- Stay in-place formwork is often used within tub girders for casting the deck. While this is easily accommodated during initial off-alignment construction, redecking operations are significantly complicated in the future if traffic is to be maintained on the structure during construction.

- Two girder systems are often considered non-redundant; however, these configurations may be proven redundant through analysis allowed by AASHTO.

Due to these challenges, a 3-girder, 6-web line system is assumed necessary with a web-to-web spacing of approximately 7.67-ft (2.34-m).

Evaluation and Discussion

The purpose of this evaluation was to understand, at a conceptual level, the structure type benefits, constructability challenges, fabrication costs, and long-term maintenance/inspection needs of this structure type. This evaluation is based on a limited review of comparable bridges, literature review, and engineering judgement – no specific calculations or staging schematics were prepared.

Structure Type Benefits: Steel tub girders have a high torsional stiffness, making them an ideal candidate for supporting structures with a curved horizontal alignment. However, this primary benefit is lost through elimination of horizontal curvature of the crossing.

Constructability Challenges: Steel tub girders are inherently stable during erection due to wide bottom flanges and multiple web lines per girder. As such, steel tub girders do not require the same amount of temporary, external lateral bracing as steel I-girder structures.

However, tub girders are nearly twice the weight of a single I-girder, on a per-foot (per-meter) basis, which either requires a larger crane during erection or more frequent field splices to limit pick weights. The use of a larger crane has direct rental/usage cost implications and demands higher capacity trestles. Conversely, crane and trestle capacities can be limited by increasing the number of field splices, which is more labor intensive, requires additional temporary shoring towers, and can have design implications in locating the splices.

Fabrication Costs: Geometric complexities of steel tub girders, as well as additional intricate details associated with internal vs external bracing, lateral bracing, diaphragm portals, and access hatches, results in increased fabrication demands and schedules compared to steel I-girder structure. As a result, steel tub girder bridges typically cost 5 to 15% more than comparable I-girder structures to fabricate. On a structure of this magnitude, the fabrication premium results in an approximate $1-million increase, compared to an I-girder bridge, without consideration of added construction costs.

In addition to general fabrication cost increases, a three girder, tub girder system results in one or two additional web lines compared to a traditional I-girder bridge which has direct cost implications.

Long-Term Maintenance: Interior portions of steel tub girders are protected from the elements and therefore are less prone to environmental corrosion loss. However, the enclosed space may also require a confined space certification for inspection of the interior portions of the tub girders and will require permanent interior lighting for the inspection to occur. Although inspection access is different than traditional I-girders, the overall maintenance needs are comparable from a cost perspective.

Conclusion

Steel tub girder bridges provide structural benefit for horizontally curved bridges through heightened torsional stiffness and general stability during erection. However, their use on tangent alignment structures generally results in greater overall construction costs without proportionate benefit. Beyond the inherent loss of structural benefit resulting from a tangent alignment, economical steel tub girders for this project will be difficult to ship, will require additional field splices compared to comparable steel I-girder bridges, and will create difficulties during re-decking operations in the future. As such, we recommend eliminating steel tub girder alternatives from further investigation.

Date	To
Not Submitted Separately	Joel Kittredge – MaineDOT

HNTB

Project Correspondence

From

Tim Cote, P.E.

Subject

WIN 21736.00: Madawaska-Edmundston International Border Crossing Bridge Seven Span Layout Assessment

Introduction & Background

The Preliminary Design Phase follows a progressive, tiered approach toward selecting a preferred alternative. Through this approach, initial high-level qualitative and semi-quantitative investigations are performed across multiple solutions to provide relative comparisons among common structure types. This process allows for identification of more favorable alternatives to advance with more refined analyses and investigations.

Initial steel plate girder alternatives consist of both 6-span and 7-span arrangements, and both 4-girder and 5-girder cross sections. The selection of these structure arrangements, for a high-level assessment, was based on consideration of pier costs, span lengths, girder shipping lengths, girder spacing, future maintenance, and projects of similar arrangements and magnitudes. These two span arrangements and cross sections were investigated to determine preliminary girder depths, deck thickness, possible pier locations, constructability, and relative item costs.

This memorandum discusses the findings of the above steel plate girder structure type assessments and provides justification for removal of 7-span and 5-girder sections from further consideration.

Span Arrangement Investigations

The project feasibility study, finalized in May 2018, recommended an approximately 1,850-ft (564-m) long structure and a bridge typical section consisting of two travel lanes with shoulders and a single sidewalk resulting in an overall 43.75-ft (13.33-m) wide bridge. Project stakeholders have indicated acceptance of a tangential alignment, and therefore a tangent structure is used for these discussion purposes.

For a steel plate girder structure type, the overall bridge length is best accommodated with either a 6-span or 7-span bridge configuration. Individual span lengths would range between 180-ft and 330-ft (54.9-m to 100.6-m). Girder depths for these span lengths are anticipated to range from 6.5-ft to 12.0-ft (-m to 3.66-m), depending on the span length, number of girder lines, and positive or negative moment locations. The overall structure width can be accommodated with either four or five girders with an approximate spacing of either 9.5 ft or 12.0 ft. However, the following span arrangement discussion is unaffected by the number of girder lines utilized. A conceptual 7-span layout is shown in Figure 1; a close up of the corresponding Pier 1 location, near the Twin Rivers warehouse and between railroad tracks, is shown in Figure 2.

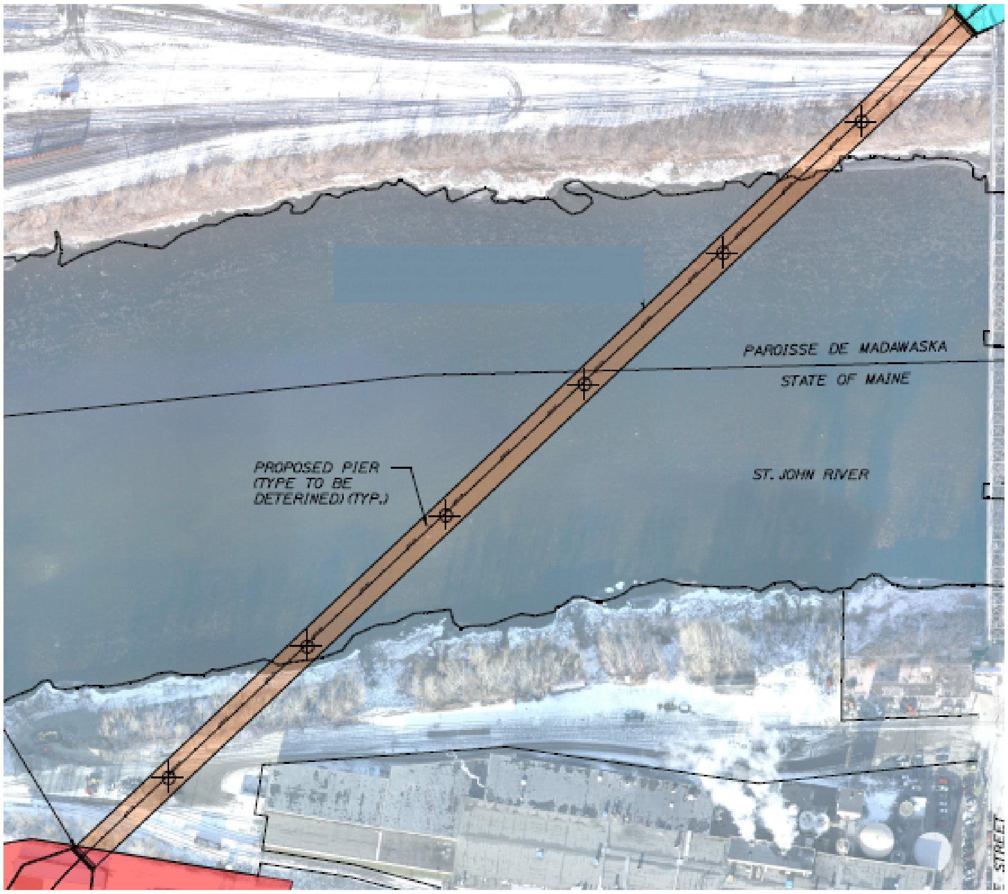


Figure 1: Conceptual 7-Span Layout

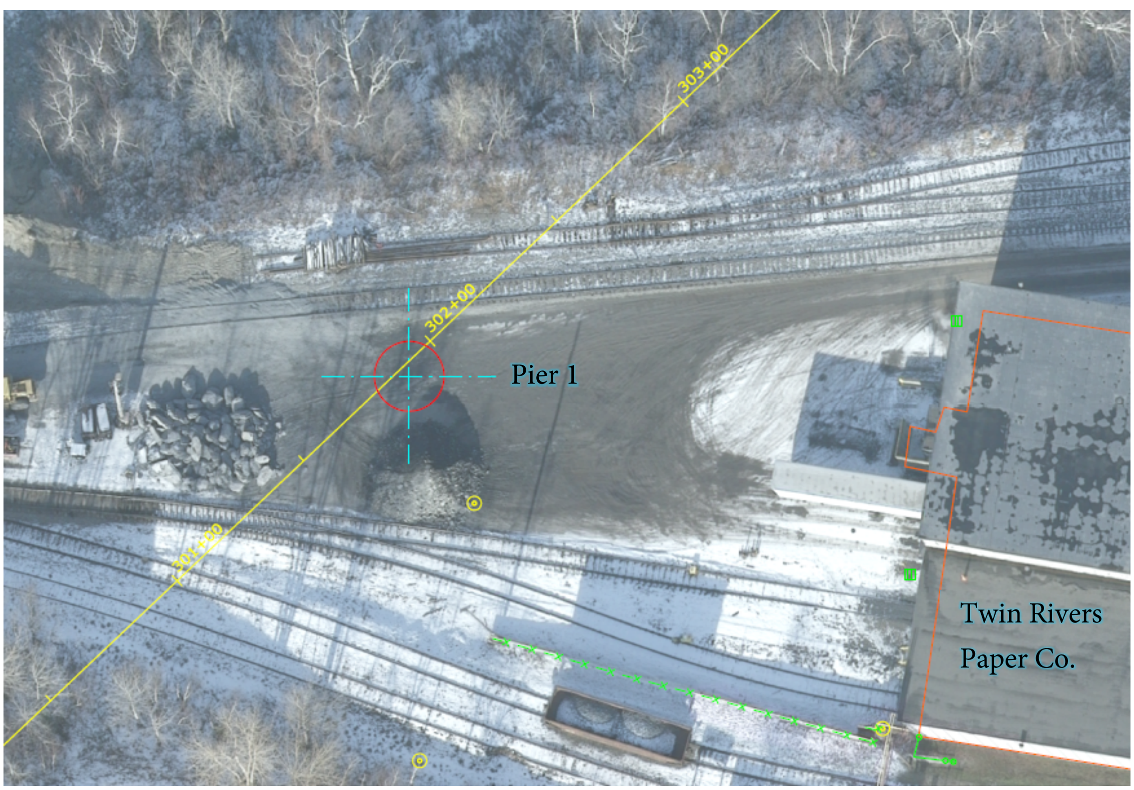


Figure 2: Closeup of Pier 1

The purpose of this span arrangement investigation was to understand, at a preliminary level, the project impacts, construction challenges, and costs of the 7-span steel plate girder alternative relative to a 6-span alternative. This investigation is based on a preliminary span layout, relative girder designs, and cost estimates; detailed evaluation of the pier size and type has not been completed.

Structural Steel: The additional support point, provided by a 7-span arrangement, decreases the maximum positive and negative moment demand by approximately 10% and 30%, respectively; however, the reduction in the total weight of structural steel is not quite proportionate due to constructability requirements, force redistribution through changed member stiffness's, and other serviceability requirements. Through preliminary analyses, a 7-span structure will reduce steel quantities by approximately 275,000-lbs compared to a 6-span structure, for an item-based cost reduction of $800,000.

Impacts to Twin Rivers Operations: A 7-span layout places the southern-most pier (pier 1) between two active rail lines and in an area used for the loading and unloading of trucks at the west end of Twin Rivers' warehouse. Due to the pier's location, surrounded by rail and commercial traffic operations, crash protection or collision design force accommodation is necessary on all sides; long-term frequent maintenance (e.g.: patching) may be necessary. Additionally, a larger footprint will be necessary for the excavation and staging to construct the footing, which will create additional impacts to rail and mill trucking operations which may not be acceptable, nor achievable through a negotiation process.

Atypical Pier Design: Vertical clearance over the railroad is limited and needs to be balanced with structure depth and profile coordination with the adjacent LPOE. Due to the location of pier 1, either a significant increase in profile or the use of an integral pier cap will be necessary to accommodate railroad clearance requirements. Alternatively, while the pier cap could be skewed to the bridge approximately 45° to the girders to avoid conflicts with the railroad clearances, potential vertical clearance conflicts resulting from the trucking operations could ultimately necessitate a costly integral pier cap. The trucking operations are not fully known at this time, thus the extent of the conflicts are not fully known at this stage and would require further investigation if the 7-span layout is advanced.

Pier Foundation: The foundation for the pier 1 presents some constructability challenges. Based on the location of the pier and anticipated footing size, the footing will be in close proximity to, and perhaps overlapping, the southern track of the two rail lines that run along the river. Depending on final size of the footing and temporary earth support system, the footing may not be constructible based upon negotiations and allowances set by Maine Northern Railroad. If the footing is constructible, a very stiff and heavily braced temporary earth support system will be required to prevent undermining the track during excavation for the footing. Additionally, installation of a temporary earth support system opposite the railroad track and the existing unstable embankment slope could exacerbate the slope stability situation and lead to further slope failures and/or undermining the railroad tracks.

Cost Considerations: The landside pier (pier 1) is estimated to cost approximately $750,000 after consideration of construction access, pier magnitude, and foundation installation complexities. A simplistic comparison to the savings in steel girder costs results in an overall project savings of $50,000 which is considered insignificant compared to the overall project cost and within limits of estimating tolerance at this preliminary evaluation phase. However, the additional pier, associated with a 7-span layout, is one more substructure unit that will have to be maintained for the life of the bridge.

Furthermore, because of the proximity to Twin River's warehouse and the railroad future maintenance activities will require close coordination and may be more expensive than typical maintenance.

Cross Section Investigations

The purpose of this investigation was to understand, at a preliminary level, the construction costs and future phasing of four- and five-girder cross sections. This evaluation is based on a preliminary 6-span layout, but the discussion is considered similar for a 7-span arrangement.

Structural Steel: The total weight of structural steel required of a five-girder section is approximately 750,000 lbs more than a four-girder cross section. Most of the additional structural steel is associated with the additional web line. The total area of flange steel is not significantly different between the two cross sections. Although the weights of individual pieces are decreased in a five-girder cross section, the overall constructability and shipping ability of the girders is not improved with any significance.

Girder Depth: One of the primary reasons to consider an increased number of girders is to reduce the girder depth. However, due to the long spans used on this project, only an approximate 10" reduction in girder depth was achieved (approximately 10% of the structure depth). A greater reduction in girder depth is possible; however, this will further increase the amount of structural steel required resulting in a larger differential between the four and five-girder cross sections. Furthermore, girder depth is not a controlling criterion (except over the railroad tracks) and reasonable profiles can be achieved with a deeper girder section – the current profile provides sufficient clearance for either the four or five girder cross section.

Future Phased Deck Replacement: The use of an additional girder line can often be justified to simplify a future phased deck replacement. Construction phasing for a full deck replacement was developed for both the four and five-girder cross sections. Due to the need for a future longitudinal closure pour, to accommodate beam displacement during deck casting operations, overhang brackets and three separate casting phases are required for both four and five-girder cross sections.

Future Maintenance: To maximize the longevity of the replacement structure, the girders may need to be coated in the future to prevent unforeseen deterioration. The cost of the work is directly proportional to the surface area to be coated. Therefore, a five-girder cross section will have increased future maintenance compared to the four-girder cross section.

Construction Costs: A cost estimate for the major superstructure items was developed to estimate the superstructure cost for the four and five-girder cross sections. The items included in the estimate were, structural steel, deck reinforcement, deck concrete, steel rail, high performance membrane, expansion joints, and bearings. The estimate showed that the five-girder alternative was approximately $1.5 to 2.0-million more expensive, primarily due to the increased structural steel.

Conclusion

Both 6-span and 7-span bridge layout configurations were investigated, as well as cross sections with four and five-girders. These initial investigations identified the 7-span layout does not provide enough benefit to offset the long-term maintenance and construction challenges associated with the pier 1 and a five-girder system increases project cost significantly, without any apparent benefit to the project during initial construction nor during future maintenance operations. Therefore, steel plate girder bridges comprised of a 7-span layout and/or a 5-girder cross section are recommended to be removed from further consideration and a 6-span, 4-girder alternative should advance with refined investigation.