

Appendix D

Hydraulics Assessment

Municipal Class Environmental Assessment of Blatchford Bridge – Hydraulics Assessment	
Date:	January 23, 2026
To:	William Van Ruyven, Project Manager
From:	Evan May, Drainage Engineering Lead
Firm Project No.	078320
Client Reference No.	B032085

1 INTRODUCTION

County of Wellington retained Gannett Fleming to provide consulting engineering services for the detailed design of Blatchford Bridge located on Wellington Road 32, bordering the Township of Guelph/Eramosa and Township of Puslinch, 0.8 km South of Wellington Road 124 (Figure 1). The crossing falls within the jurisdiction of the Grand River Conservation Authority (GRCA).

The Blatchford Bridge (No. B032085), constructed circa 1949, is a single-span, 31.7 m steel truss structure with an exposed concrete deck over the Speed River. The latest OSIM inspection was completed in 2025, the resulting Bridge Condition Index (BCI) score of 61.67 indicates the bridge is in fair to poor condition. The bridge exhibits severe steel deterioration, and is approaching the end of its service life. Municipal Class Environmental Assessment (MCEA) was planned for 2025, and the design of the replacement has been initiated to ensure continued safety and serviceability.

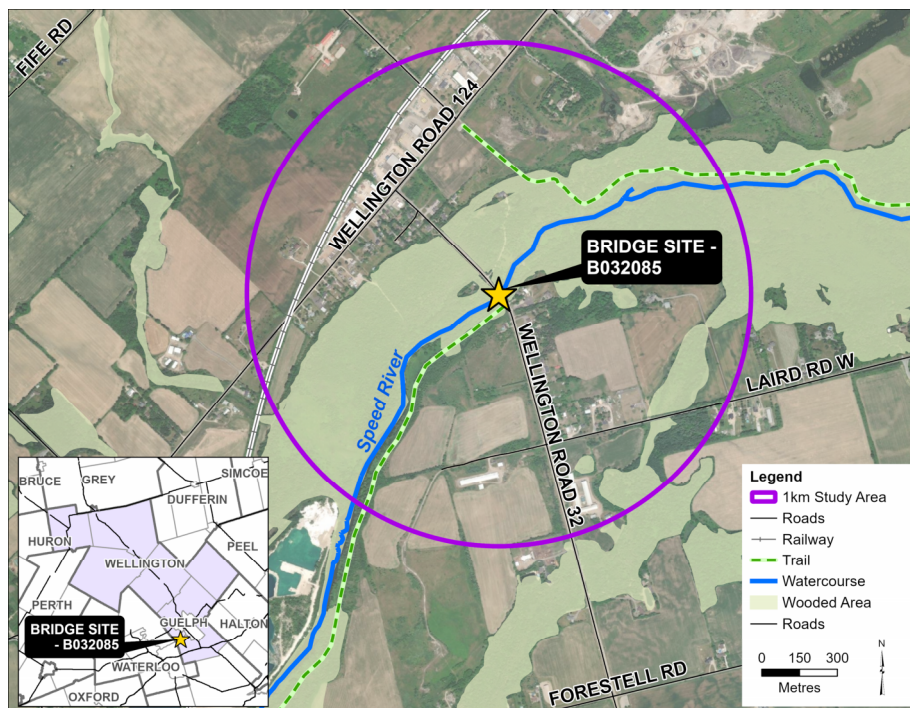


Figure 1: Project Site

1.1 Objectives

The purpose of this technical memorandum is to provide a preliminary assessment of the replacement of Blatchford Bridge (Structure ID: B032085). The memorandum summarizes the design criteria, existing site conditions, potential hydraulic impacts, identifies gaps in the current information, and preliminary design recommendations.

1.2 Criteria Summary

This section identifies the applicable standards and guidelines for design criteria development and the design criteria of the sites.

1.2.1 Applicable Standards and Guidelines

- MTO's *Highway Drainage Design Standards* (2023)
- MTO *Drainage Management Manual* (1997), and,
- Ministry of the Environment Conservation and Parks (MECP) *Stormwater Management Manual* (2003).
- National Cooperative Highway Research Program (NCHRP) *Countermeasures to Protect Bridge Abutments from Scour – Report 587* (2007).
- Ministry of Natural Resources and Forestry (MRNF) *Technical Guide River & Stream Systems: Flooding Hazard Limit*, (2002).
- Grand River Conservation Authority (GRCA) *Policies for the Administration of the Prohibited Activities, Exemptions and Permits Regulation - Ontario Regulation 41/24* (2024).

1.2.2 Hydraulic Crossing Design Criteria

1.2.2.1 Design Flows

Wellington Road 32 is classified as a rural arterial road within the project limit. In accordance with WC-1 (MTO HDDS, 2023), the Design Flow for culverts and bridges on watercourses with total span larger than 6 m is 50-year storm event.

1.2.2.2 Check Flow and Regional Flow and Relief Flow

According to WC-1 (MTO HDDS, 2023), the Check Flow shall be considered as 115% of 100-year storm event. The regional flow corresponds to the Hurricane Hazel Stormo, as defined in the Flood Hazard Criteria Zones Map (MRNF, 2002). To evaluate the roadway overtopping and consequent relief flow, the larger of the Check Flow or Regional flow shall be considered.

In accordance with WC-13 (MTO HDDS, 2023), the maximum depth of flow on the roadway shall not exceed 0.3 m and the product of depth x velocity shall not exceed 0.8 m²/s.

Additional criteria for flood hazard safety per the MNR flood hazard criteria requires the following:

- Maximum depth < 0.3 m but velocity cannot exceed 4.5 m/s and if depth is 0.3 to 0.6 m but the velocity cannot 0.6 m/s.
- Velocity cannot exceed 4.5 m/s at depths of < 0.3 and velocity cannot exceed 0.6 m/s at depths of 0.3 to 0.6 m.
- People's Safety, Low Risk at < 0.4 m*m/s.

1.2.2.3 Minimum Freeboard and Clearance

According to WC-2 (HDDS, 2023), the freeboard for bridges on Rural-Arterial Roads is equal to or greater than 1 m (High Vulnerability), which is measured from the edge of travelled lane to the High-Water Level (HWL) as minimum freeboard.

Also, the minimum required clearance for freeways is equal to or greater than 1 m for Design Flow. Clearance is measured from HWL to the lowest point on soffit. If the water level caused by ice jam is higher than HWL, ice jam water level should be used for measuring clearance. Figure 2 illustrates a visual representation of these criteria.

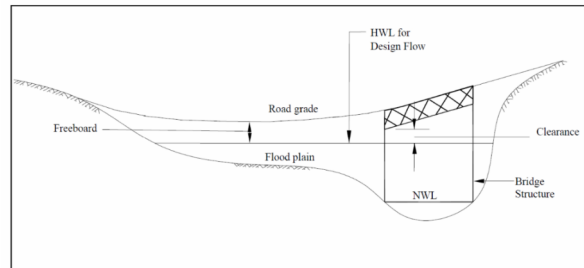


Figure 2: Freeboard and Clearance for Design Storms

1.2.2.4 Scour Protection

Scour Protection has been developed per HEC-18 and HEC-23 as the guideline for evaluating the scour at bridge. As noted in HEC-18, National Cooperative Highway Research Program (NCHRP) has provided state-of-practice for estimating the scour at bridges. NCHRP report 587 has been adopted as the reference to address the scour estimate and scour protection at bridge abutments.

As noted in MTO HDDS WC-3, the scour protection for structure foundation, including abutment, pier, and retaining wall should be determined based on the Design Flow and modified, if necessary, to ensure that structural failure will not occur as a result of Check Flow.

1.2.2.5 Temporary Works

The MTO HDDS 2023, TW-1 identifies the return period for the sizing of the temporary drainage works during construction. The minimum return period for temporary drainage works depends on the duration of the construction and the potential consequences (low, medium, or high) in terms of public safety, traffic delays, property damage due to flooding, and environmental impacts. The worst-case impact from the four categories shall be used to select the return period that shall guide the design. TW-1 provides the requirement for the minimum return period for temporary drainage works as following Table 1.

As the primary construction period where cofferdams will be required relates to the installation of embankment rock protection and abutments, it is expected that the construction period will be < 2 months for this activity, with a low consequence, and as result a 2- Year return period is recommended.

Table 1: Minimum Return Period for Temporary Drainage Works

Facility	Duration of Construction	Return Period (Years)		
		Consequence		
		Low	Medium	High
Design Flow for Temporary Works	Less than 2 months	2	2	2
	Up to 4 months	2	5	5
	Up to 8 months	5	5	10
	Up to 12 months	5	5	20
	Up to 18 months	5	10	25
	Greater than 18 months	10	10	25

2 EXISTING SITE CONDITIONS

The bridge consists of a single span half-through steel truss structure with an exposed concrete deck. An overview of existing site conditions is illustrated in Figure 3 to 10. Several components of the Blatchford Bridge are approaching the end of their service life due to advanced deterioration and require replacement.

The existing structure has a clear span of 30.38 m span, measured between the inside faces of the abutments, and a soffit elevation of 296.75 m.

2.1 Hydrologic Assessment

Flow data for the 2-year through 100-year design storms as well as the Regulatory storm, were provided in the approved GRCA HEC-RAS model. These flow values were used in the hydraulic assessment.

2.2 Hydraulic Assessment

The hydraulic performance of the existing bridge was evaluated using the GRCA-approved HEC-RAS hydraulic model incorporating detailed cross-section data and steady flow analysis. Minor refinements to the model were undertaken within the vicinity of the crossing to reflect current site conditions. These updates included revisions to the upstream and downstream bridge cross-sections, roadway profile, soffit elevation, and bridge span length.

The assessment results are summarized in Section 3, Table 2 and indicate the following:

- The existing structure does not meet the minimum freeboard of 1.0 m, with no vertical clearance between the bridge soffit and the modeled high-water level under 50-year design storm.
- The existing structure is predicted to overtop the roadway under the Regional Storm event and does not comply with MRNF flood hazard criteria.

			
Figure 3: B032085 – East elevation (upstream) of existing Bridge	Figure 4: B032085 – West (downstream) elevation of existing Bridge	Figure 5: B032085 – West (downstream) fascia, light to severe corrosion on truss beams	Figure 6: B032085– East (upstream) fascia, light to severe corrosion on truss beams
			
Figure 7: B032085 – Northwest wingwall of existing Bridge	Figure 8: B032085 – Southwest wingwall of existing Bridge	Figure 9: B032085 – Southeast wingwall of existing Bridge	Figure 10: B032085–Northeast wingwall of existing Bridge

3 PROPOSED SITE CONDITIONS

The preliminary design of the proposed replacement bridge was evaluated in GRCA-approved HEC-RAS hydraulic model. The proposed structure has a span of 35.6 m, measured from the inside faces of abutments, and a soffit elevation of 296.75 m. The proposed bridge layout is illustrated on the General Arrangement (GA) drawing provided in **Attachment 1**.

3.1 Hydraulic Modelling

HEC-RAS modelling for Blatchford Bridge was assessed for the 50-year design flow and the Regional Storm event. The MTO designated Check Flow (115% of 100-year flow) was not considered in this assessment as the Regional Storm exceeded this flow and therefore the governing flow rate.

Hydraulic performance results are summarized in Table 2 and indicate the following:

- The proposed structure does not meet the minimum freeboard of 1.0 m, with no vertical clearance between the bridge soffit and the modeled high-water level under 50-year design storm.
- The proposed structure is predicted to overtop the roadway under the Regional Storm event, and it does not comply with MRNF flood hazard criteria.
- The proposed structure has no negative impacts compared to the existing bridge, indicating no adverse impacts relative to current conditions.

The revised HEC-RAS model will be included in this submission as **Attachment 2**.

Table 2: Proposed Bridge Crossings Summary

Crossing	Span*	Rise	Soffit El.	Trav Lane El.	Design Storm - 50 Year Event			Regional								
					W/S El. U/S	Clearance (From Soffit)	Freeboard	W/S El.	Roadway Over Top	Depth	MNRF ^[1] Criteria Depth	Average Velocity	MNRF ^[2] Criteria Velocity	Depth x Average Velocity	MNRF ^[3] Criteria D x V	MNRF ^[6] Criteria
	m	m	m	m	m	m	m	m	Y/N	m	Y/N	m/s	Y/N	m *m/s	Y/N	Y/N
Existing Bridge	30.38	4.53	296.75	298.14	297.38	-0.63	0.76	298.69	Y	0.55	N	0.88	N	0.48	N	N
Proposed Bridge	35.60	4.53	296.75	298.14	297.34	-0.59	0.80	298.65	Y	0.51	N	0.86	N	0.44	N	N

[*] Span is measured between inside faces of abutments

MNFR Flood Hazard Assessment Criteria
[1] **MNRF Criteria; Maximum Depth;** < 0.3 m but velocity cannot exceed 4.5 m/s and **if depth is 0.3 to 0.6 m but the velocity cannot 0.6 m/s.**
[2] **MNRF Criteria;** velocity cannot exceed 4.5 m/s at depths of < 0.3 and **velocity cannot exceed 0.6 m/s at depths of 0.3 to 0.6 m.**
[3] **MNRF Criteria;** People’s Safety, **Low Risk at < 0.4 m*m/s.**

3.2 Sensitivity Analysis – Increased Bridge Span

A sensitivity analysis was performed on the model to assess whether the hydraulic non-compliance identified for the proposed 37 m bridge is primarily driven by incoming flow and bridge-span constraints or by broader river system controls within the hydraulic model. This sensitivity analysis was undertaken using a substantially increased bridge span of 75 m.

This span represents more than double the preliminary proposed bridge length and is not intended as a feasible design option, but rather as a diagnostic test to evaluate the influence of bridge opening size on hydraulic performance at the site. This assessment has been undertaken to support the review by GRCA and to provide additional context for understanding the hydraulic considerations governing the site, given that the preliminary bridge configuration does not satisfy applicable MTO HDDS and MNRF hydraulic performance criteria.

The hydraulic model was updated to replace the proposed 37 m bridge with a 75 m span structure, while maintaining the same deck level, soffit elevation, and channel geometry. Simulations were conducted for the 50-year design and the regulatory flow event. Model results indicate that, despite the significant increase in bridge span, the 75 m bridge does not achieve compliance with the design criteria.

Overtopping of the bridge deck remains present during the regulatory flow, with no vertical clearance achieved between the bridge soffit and the simulated water surface under the 50-year design flow. Compared to the 37 m bridge scenario, only marginal reductions in water levels were observed, with no meaningful improvement in hydraulic conveyance through the bridge opening.

The limited sensitivity of model results to the increased bridge span indicates that bridge span size is not the controlling factor governing flow-through capacity at this location within the received model apparatus. The results suggest that:

- Water surface elevations could be influenced by backwater impacts rather than local constriction effects at the bridge; or
- Due to the existing model having instabilities at and/or upstream of the existing structure.

When reviewing the downstream channel from the site, the anticipated backwater impacts at the site occur from the presence of a downstream channel constriction at the James Dick Aggregates site located approximately 1.2 km from the site. The constriction is modelled in HEC-RAS as an obstruction and provides a visually apparent backwater that propagates upstream to the bridge location. This backwater effect impacts bridge flow-through capacity during high-flow events at the site and limits the effectiveness of increasing bridge span alone as a mitigation measure.

However, in reviewing if this was the primary impact to the reduction of bridge flow through capacity, a scenario was run where the constriction was removed and bridge tailwater conditions were drastically reduced. The results of this scenario demonstrated negligible improvements to the bridge headwater elevations. This indicates that a more fundamental issue relating to the existing model set up, likely due to the river cross sections leading up to the bridge which could be of concern. At this stage of design development, it is beyond the scope of work to address underlying model issues. The sensitivity analysis therefore concludes that the existing model will be used as a comparison tool to evaluate if the proposed structure will not make conditions worse than the existing structure.

Results of the sensitivity analysis are illustrated in Table 3 and Table 4.

Table 33: HEC-RAS Results of 75m-span Bridge

Crossing	Span*	Rise	Soffit El.	Trav Lane El.	Design Storm - 50 Year Event			Regional								
					W/S El. U/S	Clearance (From Soffit)	Freeboard	W/S El.	Roadway Over Top	Depth	MNRF ^[1] Criteria Depth	Average Velocity	MNRF ^[2] Criteria Velocity	Depth x Average Velocity	MNRF ^[3] Criteria D x V	MNRF ^[6] Criteria
	m	m	m	m	m	m	m	m	Y/N	m	Y/N	m/s	Y/N	m *m/s	Y/N	Y/N
75 m Span Bridge	75.00	4.53	296.75	298.14	297.21	-0.46	0.93	298.50	Y	0.36	N	0.82	N	0.30	Y	N

[*] Span is measured between inside faces of abutments

MNFR Flood Hazard Assessment Criteria

[1] MNRF Criteria; Maximum Depth; < 0.3 m but velocity cannot exceed 4.5 m/s and **if depth is 0.3 to 0.6 m but the velocity cannot 0.6 m/s.**

[2] MNRF Criteria; velocity cannot exceed 4.5 m/s at depths of < 0.3 and **velocity cannot exceed 0.6 m/s at depths of 0.3 to 0.6 m.**

[3] MNRF Criteria; People’s Safety, **Low Risk at < 0.4 m*m/s.**

Table 44: Sensitivity Comparison under Regulatory Flow Event

Performance	W.S. US. (m)*	E.G. Elev (m)	Q Total (m³/s)	Q Bridge (m³/s)	Q Weir (m³/s)
Existing Condition (30.38 m Bridge Span)	298.69	298.77	653.00	313.91	339.09
Proposed Condition (35.60 m Bridge Span)	298.65	298.72	653.00	333.36	319.64
Sensitivity Analysis (75.00 m Bridge Span)	298.50	298.59	653.00	399.17	253.83

[*] Road Elevation at 298.14 m

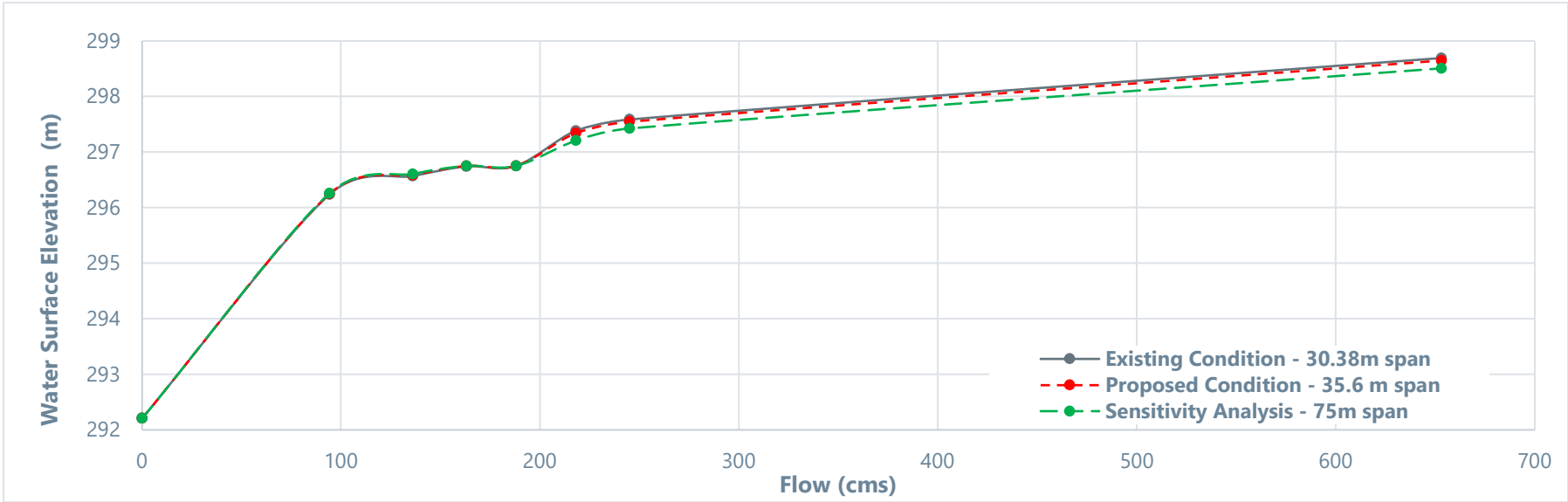


Figure 12: Rating Curves under Regulatory Flow Event



Figure 11: Location of Blatchford Bridge and Downstream Constriction

3.3 Scour Assessment

A detailed scour assessment has not been completed at this stage. Scour estimation and evaluation will be undertaken during the detailed design phase. The assessment will consider contraction scour, abutment scour, and long-term general scour for channel stability and to inform scour protection design.

4 CONCLUSION

This technical memorandum was prepared to support the Municipal Class Environmental Assessment for the replacement of Blatchford Bridge (Structure ID: B032085) on Wellington Road 32 by summarizing the hydraulic assessment. The assessment evaluated existing and proposed conditions, applicable design criteria, and potential hydraulic impacts in accordance with MTO and MNRF requirements.

Based on the review and analysis completed, the following conclusions are drawn:

- The existing structure does not meet the applicable MTO HDDS and MNRF hydraulic requirements.
- The preliminary proposed structure does not meet the design criteria; however, the proposed condition model results indicate minor improvements and no adverse hydraulic impacts compared to the existing conditions.
- The sensitivity analysis demonstrates that even a substantial increase in bridge span does not resolve the identified hydraulic non-compliances. Potential underlying issues within the existing model limit flow through capacity at site B032085. The findings provide technical support for GRCA consideration of the proposed works within the site-specific hydraulic limitations.
- A detailed scour assessment will be completed during the detailed design stage of the project.

Regards,



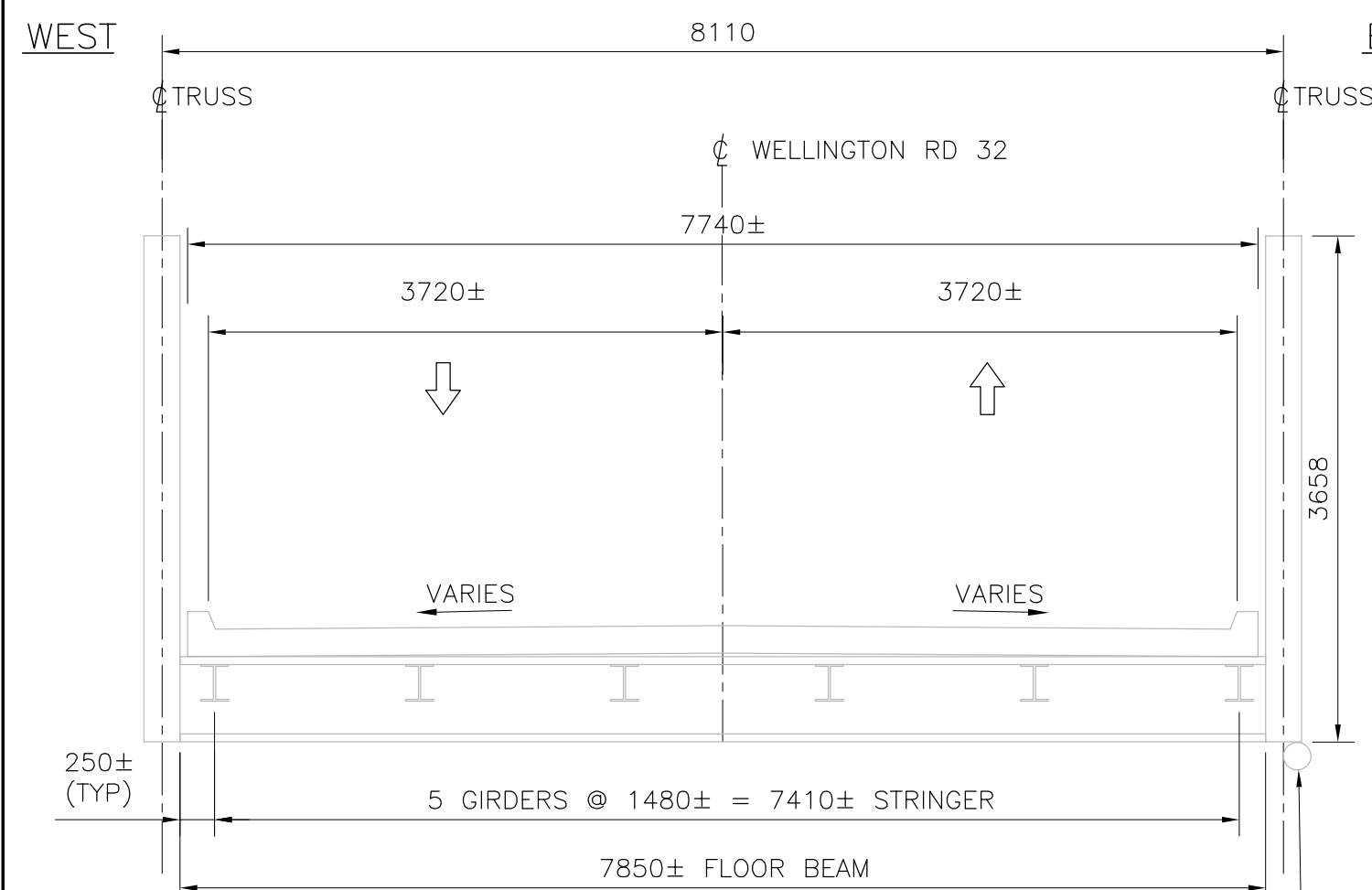
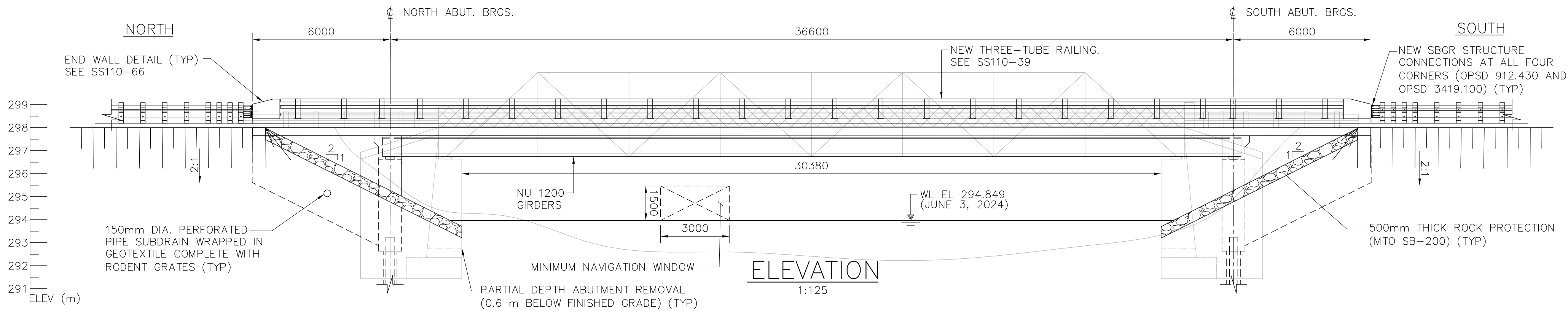
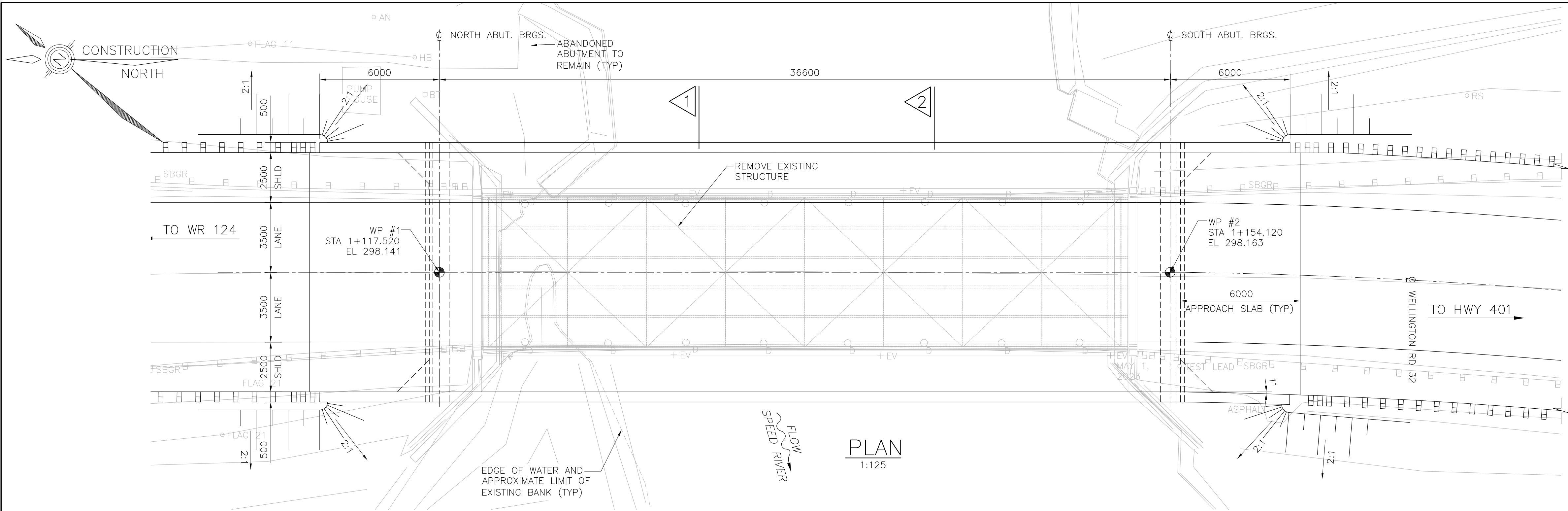
Evan May, P.Eng.

Principal Drainage Engineer, Gannett Fleming

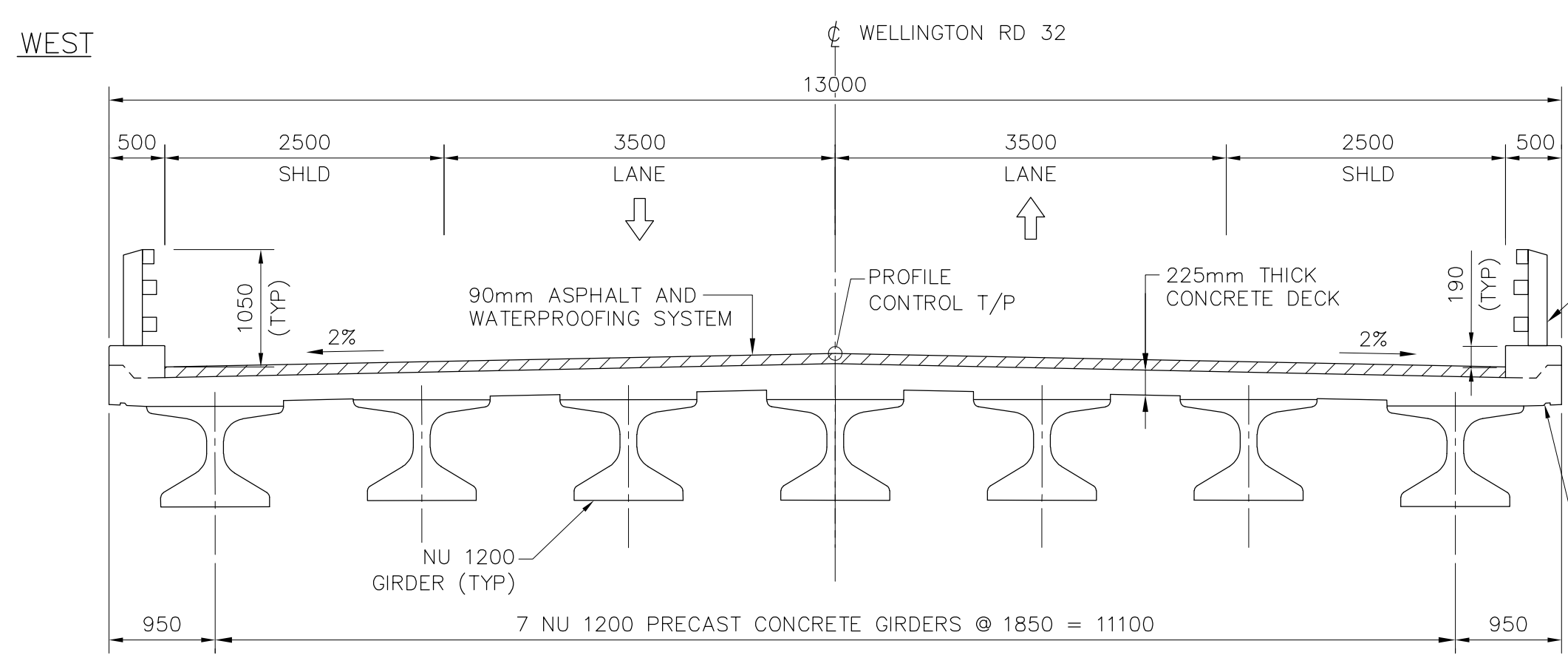
Included Attachments:

Attachment 1 – Proposed Bridge General Arrangements

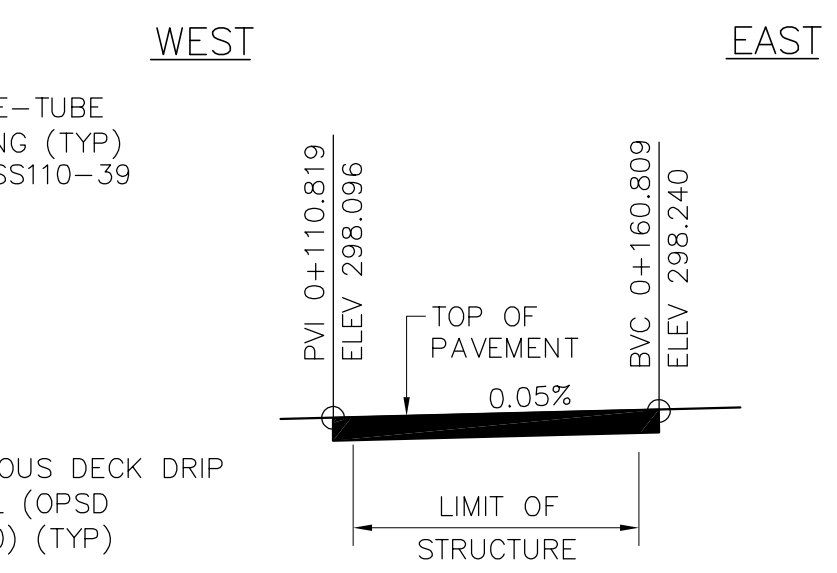
Attachment 2 – Digital HEC-RAS Model



1 TYPICAL EXISTING SECTION
1:50



2 TYPICAL PROPOSED SECTION
1:50



PROFILE OF COUNTY RD 32
N.T.S.

GENERAL NOTES:

DESIGN CODE:

CHBDC 2025 CAN/CSA S6-25 LIVE LOAD: CL-625-ONT

CLASS OF CONCRETE:

ALL CONCRETE UNLESS OTHERWISE NOTED 35 MPa AT 28 DAYS.
CLASS C-1 PER CSA 23.1

CLEAR COVER TO REINFORCING STEEL:

DECK:	TOP	70 ±	20
	BOTTOM	40 ±	10
REMAINDER, UNLESS OTHERWISE NOTED:		70 ±	20

REINFORCING STEEL:

- REINFORCING STEEL SHALL BE WELDABLE GRADE 500W.
- UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES FOR REINFORCING STEEL BARS SHALL BE CLASS B.
- STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa, UNLESS OTHERWISE SPECIFIED.
- BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL BARS.
- BAR MARKS WITH PREFIX 'G' DENOTE GRADE III GLASS FIBRE REINFORCED POLYMER BARS (E=60GPa).
- GLASS FIBRE REINFORCED POLYMER REINFORCING BARS SHALL BE GRADE I, GRADE II, OR GRADE III AS SPECIFIED IN THE CONTRACT DRAWINGS. THE NOMINAL DIAMETER, TENSILE MODULUS OF ELASTICITY AND GUARANTEED MINIMUM TENSILE STRENGTH SHALL BE AS SPECIFIED IN THE CONTRACT DOCUMENTS.
- BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWINGS SS12-1 AND SS12-2, UNLESS INDICATED OTHERWISE.

CONSTRUCTION NOTES:

- THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH DRAWINGS, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
- NO BACKFILL SHALL BE PLACED BEHIND END OF DECK UNTIL DECK SLAB IS IN PLACE AND HAS REACHED 70% OF ITS DESIGN STRENGTH
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
- CONSTRUCT ABUTMENTS AND WINGWALLS TO THE BEARING SEAT ELEVATIONS. THE CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS. FORMWORK AND LATERAL BRACING SHALL NOT BE REMOVED UNTIL CONCRETE HAS REACHED 70% OF ITS SPECIFIED STRENGTH.
- SUBDRAINS SHALL BE EXTENDED TO THE LIMIT OF GRADING FROM SLOPE TO SLOPE AND INSTALLED COMPLETE WITH RODENT GRATING (TYPICAL).
- ROCK PROTECTION (MTO WB-200) TO BE PLACED TO A MINIMUM DEPTH OF 500mm AS SHOWN. WB-200 LAYER TO BE TOP DRESSED WITH A 100mm THICK LAYER OF TABLE A SUBSTRATE.

LIST OF DRAWINGS:

- GENERAL ARRANGEMENT

LIST OF ABBREVIATIONS:

BRGS	DENOTES BEARINGS
WP	DENOTES WORKING POINT
T/P	DENOTES TOP OF PAVEMENT
T/FTG	DENOTES TOP OF FOOTING
HWL	DENOTES HIGH WATER LEVEL
SBGR	DENOTES STEEL BEAM GUIDE RAIL
SHLD	DENOTES SHOULDER

APPLICABLE STANDARD DRAWINGS:

- OPSD - 0219.130 HEAVY DUTY SILT FENCE BARRIER
OPSD - 0219.240 DEWATERING TRAP
OPSD - 0219.260 TURBIDITY CURTAIN
OPSD - 0219.261 TURBIDITY CURTAIN, SEAM DETAIL
OPSD - 0912.430 GUIDE RAIL SYSTEM, STEEL BEAM STRUCTURE CONNECTION
OPSD - 3101.150 WALLS, ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD - 3102.100 WALLS, ABUTMENT, BACKFILL DRAIN
OPSD - 3190.100 WALLS, RETAINING AND ABUTMENT WALL DRAIN
OPSD - 3370.100 DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD - 3390.100 DECK DRIP CHANNEL
OPSD - 3419.100 BARRIERS AND RAILINGS STEEL GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD - 3950.100 CONCRETE EXPANSION AND CONSTRUCTION JOINT ON STRUCTURE.

THESE DESIGN DOCUMENTS ARE PREPARED SOLELY FOR THE USE BY THE PARTY WITH WHOM THE DESIGN PROFESSIONAL HAS ENTERED INTO A CONTRACT AND THERE ARE NO REPRESENTATIONS OF ANY KIND MADE BY THE DESIGN PROFESSIONAL TO ANY PARTY WITH WHOM THE DESIGN PROFESSIONAL HAS NOT ENTERED INTO A CONTRACT.

NO.	DESCRIPTION	DATE	INITIAL	SCALE	AS SHOWN	DESIGNED	AW
				DATE	JANUARY 2026	CHECKED	WVR
				DRAFTING	SC	DESIGN CODE	CAN/CSA S6-19
				CHECKED	WVR		078320
				FIELD BK.	PAGE	PROJECT	
				BENCH M	297.058, 301.051		

COUNTY OF WELLINGTON	CW2026-0XX
REPLACEMENT OF BLATCHFORD BRIDGE STRUCTURE NO. B032085	PROJECT NO.
GENERAL ARRANGEMENT	DRAWING NO.
	S1