The Emergency Replacement of The Bridge over Manning Canal on PR 311

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Abstract

On May 10, 2023, an accidental field fire resulted in the destruction of the bridge located on Provincial Road (PR) 311 over the Manning Canal in the Rural Municipality (RM) of Hanover, Manitoba. The original structure, constructed in 1980, was a 61-meter-long timber bridge featuring a laminated deck over six (6) spans. This crossing served as a vital artery for the region, accommodating over 3,000 vehicles daily and acting as a critical corridor for local commuters, the movement of regional goods, and emergency services.

The sudden loss of this infrastructure impacted an essential transportation route, creating an urgent need for restoration. The main challenge was the necessity for an immediate response to replace the bridge quickly while ensuring the new structure could accommodate modern demands that exceeded the capacity of the previous 42-year-old timber crossing.

The primary objective was to fast-track the design and construction of a replacement structure that met modern Roads and Transportation Association of Canada (RTAC) loading requirements. Beyond simple replacement, the project aimed to improve roadside safety, enhance the hydraulic capacity of the crossing to handle major flood events, and improve the stability of the canal's slopes.

Manitoba Transportation and Infrastructure (MTI) retained Dillon Consulting Limited (Dillon) in May 2023 to facilitate a rapid transition from preliminary assessment to detailed design and provide construction advisory services. The methodology followed a two-phase approach:

Preliminary Design: This phase involved extensive data collection, including geotechnical analysis, topographical and hydraulic surveys, and environmental assessments. The team developed and evaluated three distinct replacement alternatives before selecting a preferred plan.

Detailed Design: This phase focused on the structural design of a new three-span continuous box girder bridge. It also included designing roadway grade raises to accommodate the deeper superstructure and finalizing construction staging and demolition plans.

Through an integrated approach involving all stakeholders, the project successfully accelerated the traditional delivery timeline. Following the completion of designs in November 2023 and a contract award in December, construction began on January 22, 2024. The new bridge and approach roadways opened to traffic on November 12, 2024, completing the project in eighteen (18) months from the initial destruction. The result is a resilient, high-capacity structure that restores vital connectivity to the RM of Hanover and provincial roadway network.

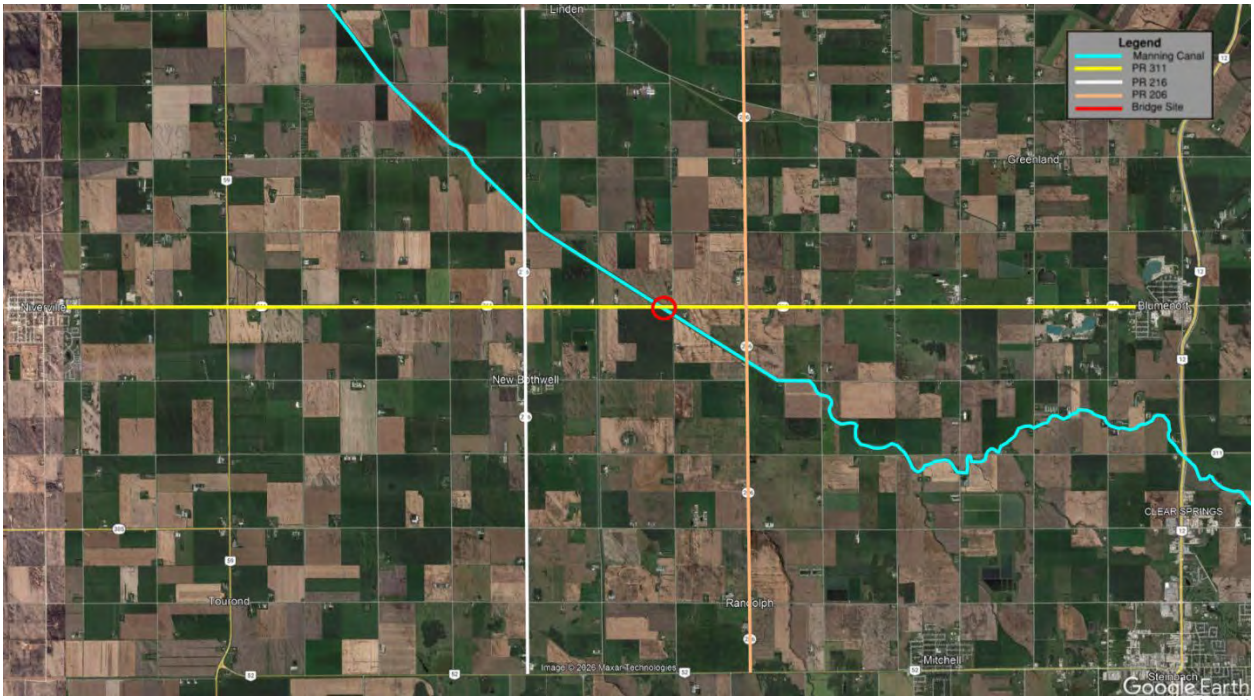
Introduction

Transportation infrastructure plays a critical role in supporting mobility, economic activity, and community connection across Manitoba. The Rural Municipality (RM) of Hanover, located southeast of Winnipeg, Manitoba within the productive Aspen Parkland Ecoregion, stands as one of Manitoba's most populous RMs and a cornerstone of the province's agricultural output. Central to this region's mobility and commercial strength is Provincial Road (PR) 311, a 49.1-kilometre east-west corridor connecting the communities of Niverville, New Bothwell, and Blumenort. This vital artery facilitates the daily movement of over 3,000 vehicles, acting as a critical corridor for local commuters, regional goods, and emergency services.

Project Background

On May 10, 2023, an accidental field fire resulted in the destruction of Bridge Site 3552-10 on PR 311 crossing the Manning Canal shown in figure 1.

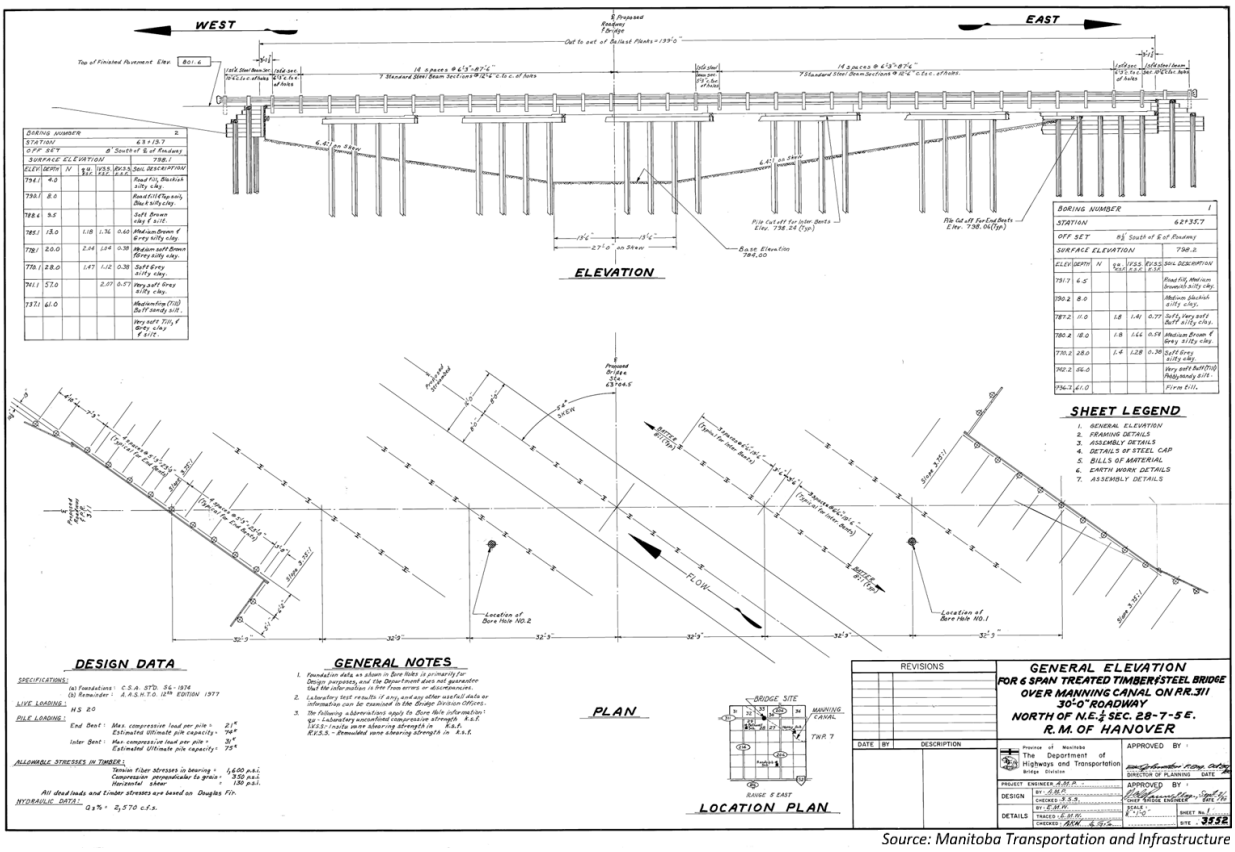
Figure 1. Bridge Site 3552-10 Location



Source: Google, Maxar Technologies (2026)

The original 61-metre-long structure, built in 1980, featured a laminated timber deck over six (6) spans supported by treated timber abutments and steel H-pile pier bents, situated on a 54-degree skew, shown in figure 2. A post-fire inspection by Manitoba Transportation and Infrastructure (MTI) determined the steel bents shown in figure 3 were structurally compromised by extreme temperatures, mandating a total replacement of the structure.

Figure 2. Existing Bridge Site 3552-10 - General Arrangement Drawing



Source: Manitoba Transportation and Infrastructure

Figure 3. Post Fire Condition of Bridge Site 3552-10



Source: Manitoba Transportation and Infrastructure

Recognizing that standard procurement timelines were undesirable for such a critical link, MTI fast-tracked the project through an existing “As, If and When” design support agreement, engaging Dillon Consulting Limited (Dillon) to initiate a highly integrated team approach to restore the structure. Beyond mere restoration, the project required modernizing the crossing to meet current RTAC[1] (heavy truck) loading standards, enhancing roadside safety, stabilizing channel embankments, and improving hydraulic capacity to withstand major flood and ice event.

Project Scope

The scope for the emergency replacement of Bridge Site 3552-10 was structured to facilitate a rapid transition from disaster response to the restoration of a permanent, resilient crossing. The project scope encompassed Preliminary Design (PD) to evaluate viable structure alternatives and conduct a Phase II Environmental Site Assessment, Detailed Design (DD) for the new bridge and approach roadworks, and Advisory Services During Construction (ASDC). Key objectives included upgrading the crossing to RTAC loading, improving the canals' hydraulic capacity, side slope stability in the vicinity of the bridge, and enhancing roadside safety through modernized design standards. The comprehensive assignment also involved geotechnical reviews, topographical surveys, and the preparation of tender packages for girder fabrication and for general construction.

Collaboration & Accelerated Delivery Innovation

The PR 311 Manning Canal bridge replacement represents an efficient approach to accelerated infrastructure delivery. Following a significant fire that destroyed this vital transportation link, the project was fast-tracked to restore the structure within an 18-month timeframe to meet commitments made to the RM of Hanover and local stakeholders. The true innovation of this project lies in its process and schedule-driven decision-making rather than bespoke structural novelty.

To achieve the accelerated timeline, the engineering team prioritized design selections that mitigated supply chain volatility and leveraged local expertise. While several alternatives were considered, the team ultimately specified a precast prestressed concrete box girder system on driven pipe piles. These systems were selected to leverage the local contracting industry's expertise, ensuring an expedited construction phase through familiar and proven installation methods. Furthermore, opting for concrete allowed the project to bypass the 8-to-10-month fabrication lead time typically required for steel girders at that time. To further compress the critical path and avoid common procurement delays, MTI proactively secured essential materials such as, steel pipe piles and reinforcing bars through separate contracts.

The traditional project delivery method including sequential design and tender phases was significantly compressed, bypassing standard lengthy processes. Preliminary Design was completed by August 31, 2023, and Detailed Design was finished by November 2023. This aggressive scheduling allowed the project to be tendered and awarded by December 22, 2023, with construction beginning exactly one month later on January 22, 2024.

The project's rapid turnaround was fundamentally rooted in the daily collaboration among all stakeholders and establishing a highly agile project delivery model. Recognizing the necessity of a rapid restoration, MTI utilized an existing design support agreement to immediately engage Dillon on May 16, 2023 - just six (6) days after the fire, bringing them directly into their team. Frequent meetings were

held between the project team and MTI's internal water infrastructure branch to rapidly evaluate hydraulic constraints and structural options.

A critical collaborative breakthrough occurred with the RM of Hanover. The RM agreed to the complete closure of the PR 311 crossing during construction, willingly absorbing the detoured commuter and commercial traffic onto their local roadway network. This strategy eliminated the need to design, permit, and build an onsite temporary detour bridge, which drastically reduced capital costs and significantly accelerated the overall construction schedule. The following sections of this paper explore the design methodology while highlighting the collaborative strategies and innovative efficiencies employed to deliver the project successfully.

Preliminary Design (PD) Phase

The PD phase initiated with a rigorous multidisciplinary data collection program, encompassing geotechnical analysis, topographical and hydraulic/bathymetric surveys, and a Phase II Environmental Site Assessment to manage the contaminated remnants of the burnt treated-timber piles. A physical constraint identified during this phase was the canal's severe 54-degree skew, which necessitated careful structural evaluation to ensure adequate clear spacing between substructure elements for the safe passage of ice and debris. To satisfy these stringent parameters, the structural engineering team working with MTI project team developed and evaluated three (3) distinct superstructure alternatives highlighted in the following sections.

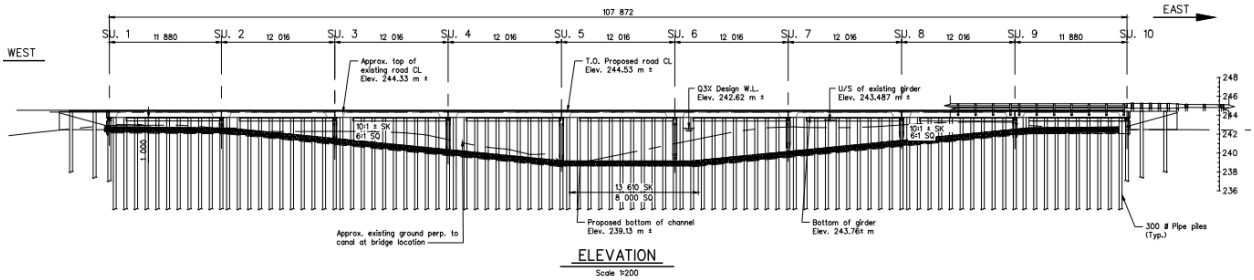
Due to severe slope stability issues along the Manning Canal, MTI's Water Infrastructure team designed a reconstruction that flattened the side slopes to a 6:1 ratio. This adjustment consequently increased the required span for the bridge alternatives. Additionally, MTI's Bridge team worked with Highway Planning Branch to establish the recommended roadway width, which determined the required number of girders for the structure.

To fast-track the preliminary design, standardized MTI structures were considered to expedite construction and reduce project costs. Typical MTI structures for provincial roads are limited to precast prestressed concrete girders with 12 m and 8 m spans, and TL-2 steel tubes side-mounted to the fascia girders. These standards were utilized in the PD to develop the alternatives discussed below.

Alternative 1 – 9 Span Precast Prestressed Concrete Channel (PPCC) Girder Bridge

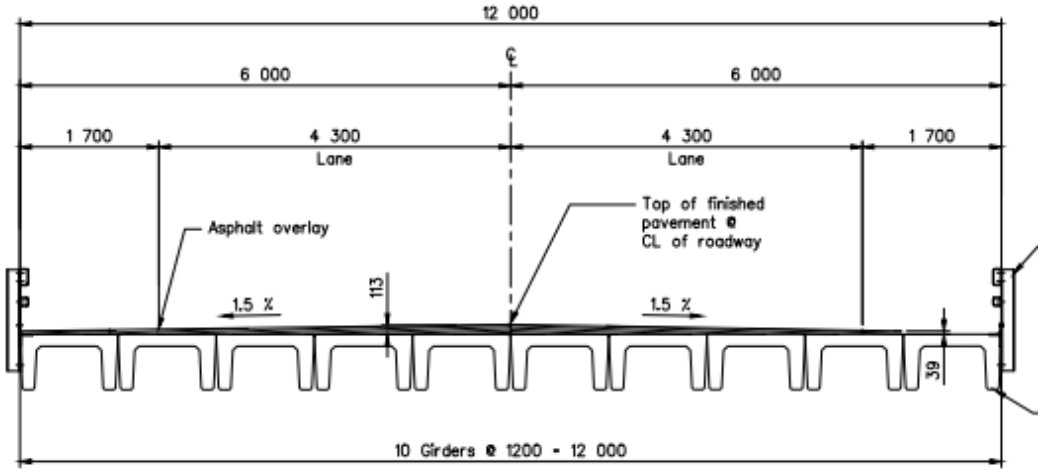
Alternative 1 illustrated in figure 4 and figure 5, proposed an MTI standard structure with a total length of 108 m and total width of 12.0 m. The superstructure consists of nine (9) 12 m spans utilizing precast prestressed concrete channel (PPCC) girders topped with asphalt pavement. Bridge railing consists of MTI-standard TL-2 steel tubes, side-mounted to the fascia girders. To accommodate Manning Canal's skew angle, the substructure was oriented on a 30-degree skew and utilized steel H-pile bents. MTI has successfully designed and constructed PPCC girder bridges with 30-degree skews. While skews up to 45 degrees have been built, they remain uncommon. Based on this experience, the bridge skew for this project was limited to 30 degrees, creating a differential skew angle relative to the canal. This skew difference generates excessive ice loading due to pier bent projected width. The abutments were designed utilizing precast concrete (PC) backwalls and wingwalls.

Figure 4. Alternative 1 - Elevation View



Source: Dillon Consulting Ltd.

Figure 5. Alternative 1 - Typical Section

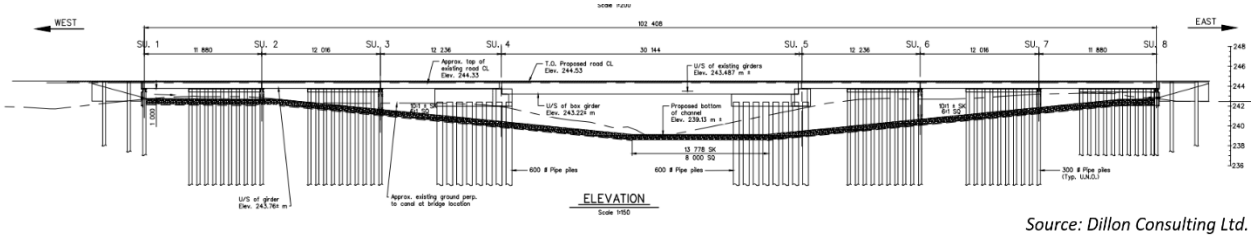


Source: Dillon Consulting Ltd.

Alternative 2 - Hybrid PPCC Grider and Precast Concrete (PC) Box Girder Bridge

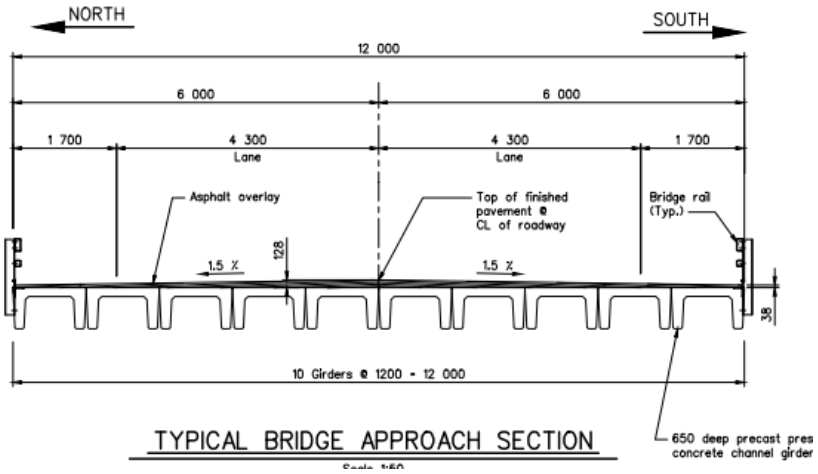
Alternative 2 shown in figures 6 through 8, incorporates a 102.5-meter hybrid MTI standard configuration designed to optimize the crossing's hydraulic opening. This layout integrates six (6) 12 m PPCC approach spans with a central 30 m PC box girder span. Like Alternative 1, the girders are topped with asphalt pavement. Bridge railing consists of MTI-standard TL-2 steel tubes, side-mounted to the fascia girders. The central span is supported by pipe pile bents topped with a concrete pile cap, while the approach spans utilize steel H-pile bents oriented on a 30-degree skew. While the central span significantly improves the hydraulic opening, the 12 m approach spans remain a critical constraint for overall hydraulic performance.

Figure 6. Alternative 2 - Elevation View



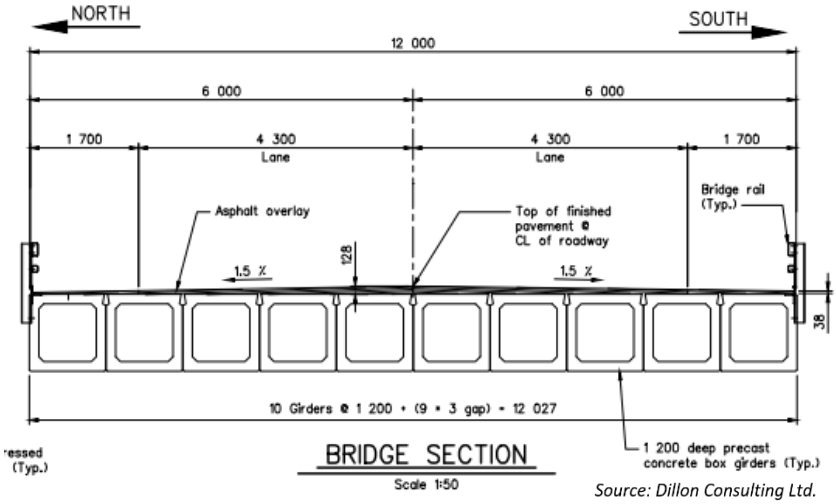
Source: Dillon Consulting Ltd.

Figure 7. Alternative 2 - Typical Approach Section



Source: Dillon Consulting Ltd.

Figure 8. Alternative 2 - Typical Central Span Section

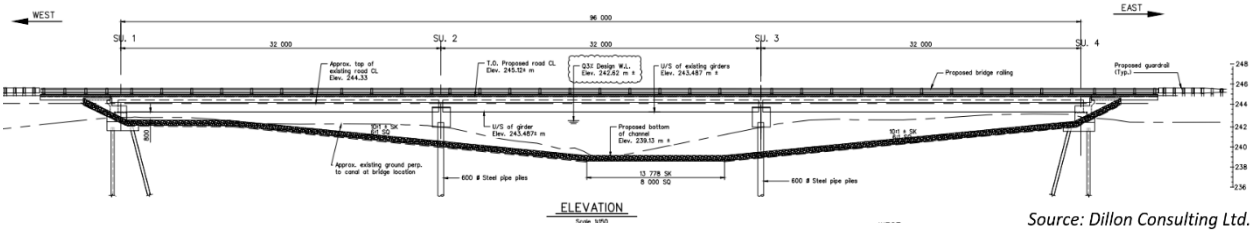


Source: Dillon Consulting Ltd.

Alternative 3 – Three (3) Span PC Box Girder Bridge

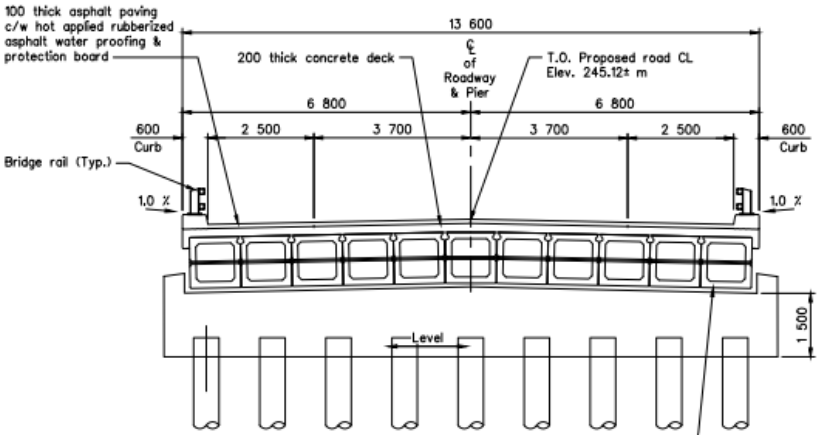
Alternative 3 shown in figures 9 through 11, details a 96 m long structure featuring three (3) continuous 30 m PC Box Girder spans. The girders were made composite with a reinforced concrete deck, supported by pipe pile bents on a 30-degree skew and cast-in-place concrete abutments founded on steel H-piles. TL-4 Alaska Multi-state bridge railing mounted on top of concrete curb was recommended. While PPCC girder alternatives offer limited overload capacity, the proposed high-performance bridge alternative provides the capacity necessary to support the long-term load improvement goals for PR 311. Furthermore, the use of a continuous structure eliminates expansion joints over the piers, significantly enhancing the bridge's long-term durability and reducing maintenance requirements.

Figure 9. Alternative 3 - Elevation View



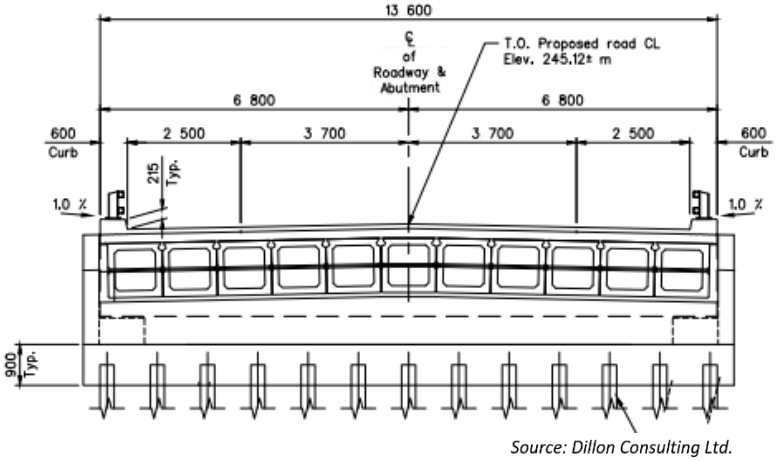
Source: Dillon Consulting Ltd.

Figure 10. Alternative 3 - Typical Pier Section



Source: Dillon Consulting Ltd.

Figure 11. Alternative 3 - Typical Abutment Section



Source: Dillon Consulting Ltd.

Evaluation and Selection of The Recommended Design

A structural evaluation of these alternatives revealed critical deficiencies in the second-class options. The 12 m PPCC spans proposed in Alternative 1 (PPCC Girder Bridge), when applied across the 54-degree channel skew, resulted in a severely restricted hydraulic opening that would likely induce ice jamming and subject the steel H-pile bents to immense lateral static and dynamic ice loads. The PPCC superstructure lacked a cast-in-place concrete deck and a waterproofing membrane, and it is non-continuous over the piers. Based on MTI's observations, the actual service life of these structures is

reduced relative to the generally mandated 75-year predicted service life. Additionally, the PPCC channel girders are not designed to provide the necessary overload capacity required for the RTAC upgrade (equivalent to AASHTO HS 30 design loading).

While Alternative 2 (Hybrid – PPCC and Box Girder Bridge) improved mid-channel ice passage, its PPCC approach spans remained structurally limited and economically inefficient over a lifecycle horizon. Ultimately, the decision-making process prioritized long-term structural capacity, hydraulic resilience, and schedule-driven delivery, leading to the selection of Alternative 3 (3 Span PC Box Girder Bridge) as the preferred alternative. The three-span PC box girder design provided a sufficient hydraulic opening that eliminated the risk of ice jamming on the approach bents, while its composite concrete deck and hot-applied rubberized asphalt waterproofing membrane supported a 75-year service life with full RTAC overload capacity. Crucially, the selection of precast concrete girders over a steel superstructure was heavily influenced by supply chain realities; steel fabrication lead times of 8 to 10 months posed an undesirable schedule risk at that time. By leveraging regionally available precast concrete and daily inter-agency collaboration, the team ensured the accelerated restoration of this vital economic corridor was viable.

4.0 Phase II Environmental Site Assessment (ESA)

A Phase II Environmental Site Assessment (ESA) was undertaken to evaluate the environmental impacts resulting from the field fire at the PR 311 crossing. The primary objective of the investigation was to determine the presence and extent of contaminants leached from the burnt remnants of the treated-timber abutments and embedded piles.

The field program involved the advancement of six (6) hand-augered boreholes to a depth of 1.0 meters below ground surface (mbgs) in the immediate vicinity of the former abutments. The team recovered twelve (12) soil samples, along with two (2) sediment samples and two (2) surface water samples extracted upstream and downstream of the crossing within the Manning Canal. These samples were subjected to rigorous laboratory analysis for Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), Petroleum Hydrocarbon (PHC) fractions F1 to F4, Polycyclic Aromatic Hydrocarbons (PAHs), heavy metals, and phenols. Analytical results were benchmarked against the Canadian Council of Ministers of the Environment (CCME) guidelines[2] for fine-grained soils under Agricultural Land Use and the Protection of Aquatic Life.

Key Environmental Findings

The analytical data collected confirmed the contamination was isolated to shallow stratigraphy, primarily driven by legacy wood treatment preservatives. Soil analytical results revealed exceedances in multiple PAHs, including Naphthalene, Phenanthrene, Pyrene, and Benzo(a)pyrene, alongside heavy metals such as arsenic, boron, copper, nickel, and tin. Sediment sampling identified elevated PAHs and heavy metals. Notably, the upstream sample (SS1) exhibited an arsenic concentration of 82 mg/kg, which significantly exceeds the CCME guideline of 17 mg/kg. The engineering team directly attributed these severe localized arsenic spikes, along with the PAH exceedances, to the chemical preservatives utilized in the original timber piles and abutments.

While surface water testing indicated exceedances for metals including arsenic, boron, total chromium, and iron, the comparative analysis of upstream and downstream data suggested that parameters like

chromium were likely migrating from off-site sources. Furthermore, boron and copper are common agricultural micronutrients in southern Manitoba, suggesting these specific exceedances were largely naturally occurring or linked to surrounding land use.

Project Impacts and Construction Mitigation Strategy

The findings of the Phase II ESA impacted the construction methodology and earthworks strategy for the new structure. As the contaminant exceedances were shallow, localized, and generally within one order of magnitude of the CCME Agricultural guidelines, the engineering team determined that a costly, carbon-intensive mass-excavation and off-site disposal program was unnecessary. To mitigate project schedule delays and control capital costs, the team recommended the strategic reuse of the impacted soils as on-site fill for the new bridge embankments. To execute this safely and maintain the accelerated delivery schedule, the project team was required to develop and submit a formal remedial action plan (RAP) / risk management plan (RMP) to Manitoba Environment and Climate Change (MECC) to secure regulatory approval for sequestering the potentially impacted material as fill during bridge construction.

To protect the local aquatic ecosystem and human health during the demolition and reconstruction phases, a rigorous soil management plan (SMP) was mandated. This plan dictated strict contractor protocols for stockpiling excavated soils on-site and conducting further verification sampling for PAHs and metals to confirm whether localized soils required specialized treatment, standard landfilling, or could be safely reused as structural cover. Ultimately, the Phase II ESA transformed a severe environmental and geotechnical risk into an engineered, sustainable material management framework. By isolating the contamination and securing a pathway for on-site material reuse, the environmental strategy ensured the project delivery timeline was not compromised by the site's contaminated legacy.

Detailed Design (DD) Phase

The DD phase of the PR 311 Manning Canal bridge replacement was an accelerated engineering effort executed between September to November 2023. Following the preliminary selection of the First-Class PC Box Girder alternative, the DD phase translated the conceptual parameters into a set of construction documents and tender packages. The design was completed in accordance with 9th Edition of AASHTO LRFD Bridge Design Specifications[3] to meet a 75-year predicted service life and accommodate modern RTAC (heavy truck) loading, specifically modeled as the modified AASHTO HSS 30 and HL-93 loading.

The detailed design phase consisted of structural and roadway design, followed by tender preparation to facilitate the project delivery schedule.

Structural Design & Detailing

The structural engineering scope focused on finalizing the design of the new three-span continuous bridge and engineering for the safe demolition of the fire-damaged timber remnants. The finalized design shown in figure 12 and figure 13 below features a 96.65 m structure comprising three (3) continuous spans of 32 m, 32.65 m, and 32 m respectively. The superstructure utilizes eleven (11) adjusted precast prestressed concrete box girders, 1,300 mm deep. The girders were designed to be composite with a 200 mm nominal cast-in-place (CIP) reinforced concrete deck. To achieve a 75-year service life, the design detailed a comprehensive protection system consisting of a hot-poured rubberized asphalt waterproofing membrane, a 10 mm protection board, and a 90 mm asphalt wearing

surface. The substructure was designed to realign the crossing to a more hydraulically favorable 30-degree skew. The abutments were detailed as reinforced concrete stub abutments founded on HP 310x110 steel H-piles driven to practical refusal on glacial till. The pier bents were detailed using robust 610 mm O.D. steel pipe piles filled with reinforced concrete, interconnected by a concrete pile cap.

Figure 12. Final Alternative Elevation View

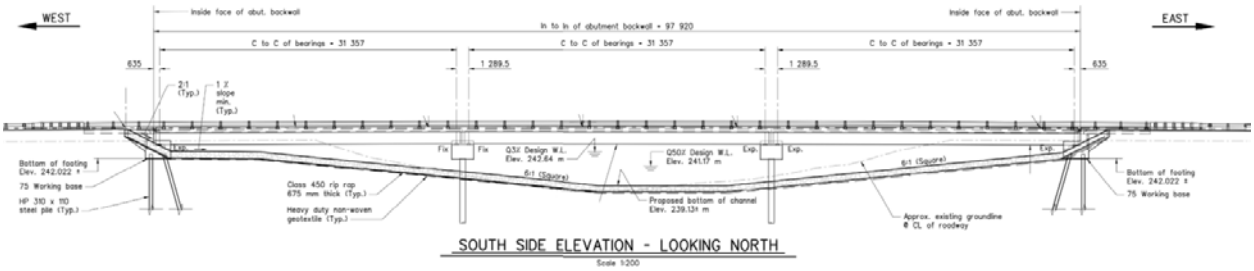
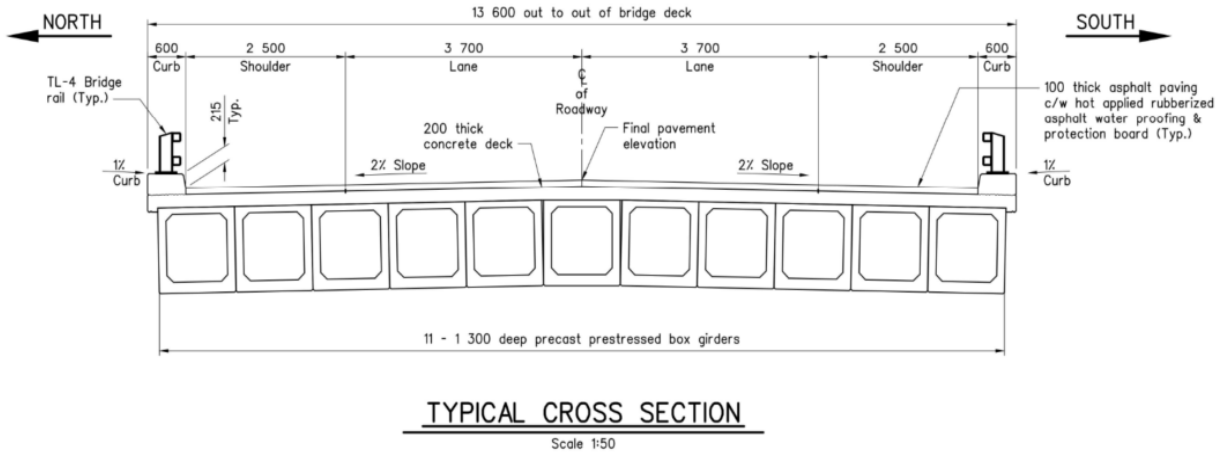


Figure 13. Final Alternative - Section View



Roadway Design & Geometric Alignments

Parallel to the structural design, the roadway team finalized the geometric alignments, and approach works to integrate the new structure into the existing PR 311 corridor. Due to the increased depth of the concrete box girders (1.3 m) and the requirement for a 0.3 m clearance above the Q3% design water level, an approximately 1.30 m roadway grade raise was required. The final vertical alignment features a 240 m crest curve with a K value of 123 and grades of approximately 0.97%. Designed as a rural collector with a 120 km/h design speed, the roadway cross-section was expanded to a 12.4 m clear width to accommodate two (2) 3.7 m travel lanes and 2.5 m shoulders. Safety infrastructure included TL-4 open tube Alaska bridge rails transitioning into nested thrie-beam and strong-post W-beam approach barriers to shield the 4:1 to 6:1 foreslopes.

Construction

Following the detailed design phase, the project was strategically split into two (2) tender packages: Tender 1 for the fabrication of the box girders, and Tender 2 for the general construction contract, which included the bridge, approach roadways, and demolition of the burnt timber remnants. This divided approach allowed the project to be tendered and awarded by December 22, 2023, with the general contractor officially mobilizing on-site on January 22, 2024. The general contract was awarded to Graham Construction & Engineering Inc. for a contract value of approximately $10.5 million.

A major logistical hurdle in bridge construction is maintaining traffic flow. However, the RM of Hanover supported the closing of the PR 311 crossing during construction, willingly absorbing the detoured commuter and commercial traffic into their municipal road network with support provided by MTI for maintenance. By eliminating the need to design, permit, and build a temporary onsite "shoo-fly" detour bridge, the contractor was able to focus all their efforts on the critical path of the structure, saving significant time and capital.

Construction progressed remarkably without major challenges as structural systems were specifically selected based on the local contracting industry's familiarity. The contractor executed the substructure by driving the steel H-piles to practical refusal for the cast-in-place concrete stub abutments, shown in figure 14 below.

Figure 14. Abutment formwork and Reinforcing



Source: Manitoba Transportation and Infrastructure

The pier bents were constructed using 610 mm O.D. steel pipe piles driven to refusal and subsequently filled with reinforced concrete and topped with a concrete pier cap, shown in figure 15 below.

Figure 15. Pier Bent Piles and Pile Cap formwork



Source: Manitoba Transportation and Infrastructure

The superstructure erection utilized 1,300 mm deep Precast Prestressed Concrete Box Girders, shown in figure 16 This system was chosen deliberately to avoid the severe fabrication lead times associated with steel girders at that time. To further protect the schedule from supply chain delays, MTI proactively pre-ordered the pipe piles and steel reinforcing bars under a separate advance contract. Driven by an integrated team approach, the construction phase met its aggressive milestones. The superstructure and approach roadways were finalized by the fall, and the new bridge officially opened to traffic on November 12, 2024.

Figure 16. Erection of PPCB Girders



Source: Manitoba Transportation and Infrastructure

Conclusion

The successful replacement of the PR 311 bridge over the Manning Canal stands as a testament to the power of integrated project delivery and stakeholder collaboration. Following the destruction of the timber structure in May 2023, the project team bypassed traditional, sequential procurement processes to fast-track the bridge's design and construction. This accelerated delivery was heavily reliant on strategic, schedule driven decisions, such as selecting precast concrete box girders to avoid severe supply chain delays associated with steel fabrication and advanced procurement of materials like pipe piles. Furthermore, the RM of Hanover provided a critical schedule advantage by supporting the complete closure of the crossing, absorbing detoured traffic into the local municipal network, and eliminating the need to build a temporary onsite detour. Through daily coordination and focus on execution, the project team successfully delivered the completed bridge in less than eighteen months, officially opening the crossing to traffic on November 12, 2024.

Ultimately, this rapid 18-month restoration project perfectly encapsulates the Transportation Association of Canada's conference theme, "Transportation for a Strong Canada." By rejecting a simple like-for-like replacement in favor of a modern, first-class structure, the project team upgraded a vulnerable, heavily skewed crossing into a resilient corridor capable of accommodating modern RTAC heavy truck loading. The new bridge not only resolves historical hydraulic inadequacies and ice-jamming risks, but it also rapidly restores the uninterrupted movement of agricultural goods, local commuters, and emergency services. The PR 311 project proves that when rigid procurement barriers are removed in favor of agile, trust-based collaboration among provincial agencies, municipal governments, and engineering consultants, Canada's critical transportation infrastructure can be hardened and modernized at an efficient and accelerated pace.

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[2] **Canadian Council of Ministers of the Environment.** “Canadian Environmental Quality Guidelines.” *CCME Publications.* Winnipeg: CCME. p. 1-12. (1999)
[3] **American Association of State Highway and Transportation Officials.** “AASHTO LRFD Bridge Design Specifications.” *9th Edition.* Washington, D.C.: AASHTO. (2020)