
Preliminary Design Report

Bridge 7800 (MP P10.07)

Rehabilitation

Maine Northern Railway – Presque Isle Subdivision

MaineDOT WIN 23458.00

PREPARED FOR



PREPARED BY



March 15, 2021

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Existing Bridge Description

Bridge 7800 is a 40'-6" long, single span, deck plate girder bridge with an open timber deck built in 1909. It carries the Presque Isle Subdivision of the Maine Northern Railway over the West Inlet to Scopan Lake in T11-R4. The girders are supported on built-up steel rail grillages atop two reinforced concrete abutments. According to the 2019 inspection report the superstructure and channel elements are both in "satisfactory" condition. The deck and substructure are both in "fair" and "poor" conditions, respectively.

The Presque Isle Subdivision runs from Masardis to the south to Presque Isle to the North. For the purposes of this report, the abutments will be referenced as Track North and Track South in conjunction with cardinal directions for clarification.

Both abutments are approximately 16 feet tall, the majority of which is underwater. Under normal conditions, there is only two to three feet of freeboard between the waterline and bottom of girder. The concrete coping along the face of both bridge seats and the wingwalls on the East (Track North) Abutment are in particularly poor condition. The girders are in satisfactory condition and have a load rating factor of 1.05 (286k car at 25mph).

No utilities are located near the project site and therefore no utility impacts are anticipated. All permanent construction impacts will be within the existing right-of-way therefore, no right-of-way impacts are anticipated. During final design, the bridge will be further optimized to reduce cost and improve constructability, hydraulic performance, and serviceability.

This report will evaluate alternatives for both rehabilitation of the existing structure and full replacement.



Elevation View of Bridge Looking North

Alternative 1 - Rehabilitation

Replace Bearings and Pedestals

The steel rail grillages supporting the bearings are loose and falling apart. Additionally, the anchor bolts at three of the four bearings have failed and can be removed by hand. As a result, the girders on the East (Track North) Abutment have shifted laterally approximately three inches to the south. See photo on next page.

The proposed rehabilitation work consists of removing the existing built-up steel rail grillages and replacing them with new precast concrete pedestals and new anchor bolts. Minor concrete repairs will be required to level out the bridge seat prior to setting the new concrete pedestals.

Anticipated Construction Cost: \$40,000 East (Track North) Abutment and \$40,000 West (Track South) Abutment



Girder Shifted Three Inches Laterally at the Northeast Bearing Due to Failed Anchor Bolts

Encase Abutments and Wingwalls.

The concrete coping along the entire face of the East (Track North) bridge seat and half of the West (Track South) bridge seat is heavily deteriorated and spalled. Additionally, the tops and sides of all four wingwalls have large areas of deterioration and spalling.

Bridge 7800 (MP P10.07) – West Inlet to Scopan Lake

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations

The Southeast Wingwall has a full depth hole up to two feet wide and three feet deep at the bridge seat and wingwall interface. A large crack runs down from the hole along the face of the wingwall. The Northeast Wingwall has a fully separated crack up to two inches wide running down at the bridge seat and wingwall interface. Additionally, at both ends of the East (Track North) bridge seat there is separation between the backwall and bridge seat and the backwall and wingwalls. See photo on next page and in the attached "Additional Photos" section.

The proposed rehabilitation work consists of removing the existing unsound concrete and encasing the entire face of both abutments and all four wingwalls with approximately 6" of concrete and reinforcing steel. At the abutments, the encasement will extend over the top of the bridge seats and tie into the backwalls with drilled and grouted dowels. Similarly, at the wingwalls, the encasement will extend over and tie into the top of the wingwalls with drilled and grouted dowels.

The depth of water (approximately 12-feet) and low clearance between the waterline and bottom of girders will make construction access and installation of cofferdams difficult at this location. Traditionally, cofferdams would be installed parallel to and along the face of each abutment. At this location, it would be proposed to install cofferdams parallel to the girders between opposite wingwalls. A bypass pipe would be installed through the causeway under the track to allow water to flow/equalize while the cofferdam is in place.

There are also concerns with keeping the work area detwatered within the cofferdam. Water will likely seep through the ballast and other material used to construct the causeway, posing a significant risk to the contractor. Additionally, the stability of the existing abutments due to unbalanced forces becomes a concern once the cofferdam is dewatered.

Anticipated Construction Cost: \$545,000 Total (\$135,000 East (Track North) Abutment, \$135,000 West (Track South) Abutment, \$250,000 Cofferdam, and \$25,000 Bypass Pipe)



Heavy Deterioration and Large Hole at Southeast Corner of Bridge Seat and Wingwall

Bridge 7800 (MP P10.07) – West Inlet to Scopan Lake

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations

Install Riprap Slope Protection (One Location)

The slope protection behind the Southeast Wingwall has failed and the bank has eroded. The erosion is up to three feet deep for a length of approximately 30 feet. See photo on next page.

The proposed work behind the Southeast wingwall consists of excavating the approach to remove the existing failed slope protection and installing new riprap to re-establish and protect the slope.

Anticipated Construction Cost: \$30,000



Failed Slope Protection Behind Southeast Wingwall

Rehabilitation Alternative - Summary of Anticipated Construction Costs (Year 2021 Costs):

Replace Bearings and Pedestals:	\$80,000
Encase Abutments and Wingwalls:	\$545,000
Install Riprap Slope Protection:	\$30,000
Subtotal:	\$655,000
Mobilization:	\$70,000
15% Contingency:	\$100,000
Total Anticipated Construction Cost:	\$830,000

Replacement Alternatives

Due to the extensive nature and high cost of the rehabilitation/repair work described above, several replacement alternatives were also explored. The proposed replacement alternatives were developed based on constructability, durability, maintenance requirements, meeting strength/service requirements, and cost.

The following criteria was used to develop the proposed alternatives for a new bridge:

- Eliminating the need for expensive cofferdams by limiting in-water work.
- Maintaining or providing a shallower superstructure depth than the existing thereby increasing freeboard.
- Using accelerated construction methods that can accommodate a short railroad shutdown window.
- Maximizing the service life and meeting Cooper E-80 live load requirements.
- Minimizing construction cost and minimizing future maintenance costs.

Superstructure - Based on the criteria listed above, several superstructure alternatives (all with an open timber deck) were considered:

- **Alternative 1** – rehabilitation option described above
- **Alternative 2** – Three span steel deck plate girder on two steel pile bents
- **Alternative 3** – Two span steel deck plate girder on one steel pile bent
- **Alternative 4** – Single span through-plate girder

Galvanized steel is proposed for each alternative due to the proximity of water. Each alternative will be described in more detail later in subsequent sections.

Substructure – A steel H-pile bent with a steel bent cap is proposed for both abutment and pier locations (as applicable). This is the only system that will meet all the criteria noted above, particularly reducing in-water work and eliminating the need for cofferdams and is therefore proposed for use with each of the superstructure alternatives. A photo of a similar project is shown below.



2017 Construction: Steel Girders on Steel Pile Bents on Wisconsin Southern Railroad (WSOR)- Madison WI

The interior piers located in the channel will be sleeved with a PVC storm drain round pipe. The PVC pipe will be embedded one foot below grade and extend up near the top of the pile. The void around the H-pile will be filled with concrete for further protection. The piles will be structurally designed based on the steel section alone (i.e. no contribution from the concrete encasement).

The new end pile bents will be installed approximately 25 feet behind each existing abutment to create new spill-through type abutments which will allow the bents to be placed completely in the dry. This configuration will also allow for the existing abutments to be fully removed if needed in the future. The existing abutments will only be removed down to the water line as a part of this project (again -to limit the amount of in-water work required). The partial removal of the abutments will allow for air flow under the superstructure and help prevent a damp environment from occurring.

As the original plan was to rehabilitate the existing abutments, no geotechnical analysis has been completed at this stage. For the purposes of this evaluation and initial cost comparison, pile sizes and lengths were assumed. A complete geotechnical analysis, including borings, is recommended during final design to confirm assumptions.

Benefits of Replacement - All proposed replacement alternatives offer several benefits as compared to the rehabilitation alternative including ease of construction, reduced impacts, and increased design life.

Ease of Construction – The driven piles will be located so that the existing bridge can remain in service while the piles are being driven, reducing railroad shutdowns. Using pile bents in lieu of traditional concrete substructure elements will also limit the required excavation and in-water work. The piles can be driven from track mounted equipment, no specialty equipment or barge mounted equipment will be required unless preferred by the Contractor. Steel pile bents caps can be welding to the driven piles during a short railroad shutdown providing a level of tolerance during construction. The steel bent caps also reduce construction time by eliminating the need for curing of a cast-in-place concrete cap alternative. Finally, cofferdams will not be required, resulting in a significant cost savings, and greatly reducing the associated risk on the State and the contractor.

Reduced impacts – The new pile bent substructures with steel bent caps will allow for much of the work to be done above the waterline with no cofferdam. Aside from limited demolition required to remove the existing abutments down to the waterline, and minor work on adjacent slopes, there will be no in-water work.

Increased Design Life – Each of the replacement alternatives provides a new bridge with a design life of 75+ years for an incremental increase in cost over the rehabilitation option which would only serve to extend the life of the bridge for another 25 – 40 years or so.

Alternative 2 – Three span steel deck girder

Alternative 2 consists of a three span, steel deck girder superstructure with an open timber deck. As described above, the new superstructure will be supported on steel pile bents each with a steel bent cap. In addition to the two abutment pile bents placed approximately 25 feet behind the existing abutments, an interior pile bent will be placed in front of each existing abutment in order to keep the span lengths short and in turn provide a shallow girder superstructure to increase the freeboard. This creates a span layout of 30'–20'–30' for a total out-to-out bridge length of 80 feet.

All spans are anticipated to be fixed allowing the entire bridge to engage during a longitudinal braking/traction event. The piles can take a small portion of the longitudinal force in bending, but most of the large braking/traction force will be resisted by passive earth pressure on the backwalls. A precast concrete backwall will be designed to resist this force and will be installed at each abutment.

The new superstructure would be comprised of a cross section of four girders with a depth of approximately 25 inches. When compared to the existing girder depth of approximately 53 inches, this provides an additional 28 inches of freeboard. This will provide plenty of access for the steel bent cap to be welded to the piles above water. The increased freeboard will reduce the risk of inundating the bridge during a flood, increase air flow under the bridge, and provide better access for future maintenance. The short, shallow girders will be relatively light, with an individual pick weight of only 7-8 kips per girder.

Anticipated Construction Cost: \$1,070,000

Alternative 3 – Two span steel deck girder

Alternative 3 is very similar to Alternative 2, but with only one interior pile bent in the center of the channel. This creates a two-span layout of 40 feet each for a total out-to-out bridge length of 80 feet.

The new superstructure would be comprised of a cross section of four girders with a depth of approximately 34 inches. When compared to the existing girder depth of approximately 53 inches, this provides an additional 19 inches of freeboard. While deeper than Alternative 2, this will still provide enough access for the steel bent cap to be welded to the piles above water. Like Alternative 2, the increased freeboard will reduce the risk of inundating the bridge during a flood, increase air flow under the bridge, and provide better access for future maintenance. These girders will still be relatively light, with an individual pick weight of only 10-11 kips per girder.

Like Alternative 2, both spans are anticipated to be fixed allowing the entire bridge to engage during a longitudinal braking/traction event. The piles can take a small portion of the longitudinal force in bending, but most of the large braking/traction force will be resisted by passive earth pressure on the backwalls. A precast concrete backwall will be designed to resist this force and will be installed at each abutment.

Anticipated Construction Cost: \$1,080,000

Alternative 4 – Single span through plate girder

Alternative 4 is a single span replacement option consisting of an 80-foot through-plate girder bridge. The main benefit of this alternative is the elimination of pile bents in the channel. Although feasible from a structure depth perspective, there are several drawbacks to this alternative including increased fabrication and erection costs due to more complex nature of the structure (i.e. a stringer and floorbeam system, as well as fabrication of a large through-plate girder), which will increase complexity of the fabrication, delivery, and erection of the structure. Furthermore, the more complex structure, when compared to the simplicity of Alternatives 2 and 3, will increase the construction duration.

Increased cost – the longer girder lengths would increase the cost of delivery as they would likely have to be shipped by rail or barge to reach this site. The larger girder lengths would also increase the pick weights which would require larger cranes to erect. An optional field splice could be added to help mitigate this additional cost but would also complicate erection. Additionally, unless a splice is used, the girders would



be too long to galvanize, and a more expensive metalizing process would be required. The complexity of the floor system framing would increase the cost of design as well as for the fabrication and installation. Even through a row of piles would be removed from the channel, the cost to fabricate and install a much heavier, complex superstructure would far outweigh the savings in pile installation (pile mobilization would still be required for the abutments).

Increased construction time – The complexity of the framing would increase installation time. Stick building in place would be difficult, if not impossible, during the allotted shutdown time of one week provided by the railroad. Therefore, either impacts to the railroad or a more complex constructions sequence would be required.

Approximate Anticipated Construction Cost: \$2,000,000

For these reasons, a through-plate girder was eliminated from the list of potential superstructure alternatives.

Recommended Alternative

Alternative 3, a bridge replacement consisting of a two-span deck girder bridge supported on steel H-pile substructure, is the recommended alternative.

Significant concerns over the constructibility risk, and cost, associated with the cofferdam was one of the primary reasons for not selecting the rehabilitation alternative. The depth of water around the bridge is 10 to 12 feet deep. This would require a robust cofferdam with sheet piling driven to a significant depth. Based on the required equipment, constructing this cofferdam from the track would not be feasible. Barge mounted cranes would likely be required. Based on the location of the bridge and the limited access to the lake, the cost of mobilizing this type of equipment would have significant costs.

While Alternative 2 and 3 provide a similar product at a similar cost, the benefits of having only one pier in the water is the main reason for choosing the two-span option. Based on information from the 2019 underwater inspection, there are potential obstructions directly in front of the existing abutments in the form of an existing timber bulkhead and timber piles cut off a few feet above the mud-line. The two-span option with only a single pier in the middle of channel mitigates the risk to encountering these potential pile driving obstructions. Additionally, construction time will generally be less for a 2 span vs. a 3 span bridge – with fewer piles to drive, less welding to the pile cap, etc. The girders are deeper with the two span option, but still significantly shallower than the existing superstructure.

Constructibility, design life, reduced future maintenance, and cost were the primary reasons for selecting the full replacement alternative. Although the replacement option is approximately \$250,000 (35%) more expensive than rehabilitation, the anticipated service life is significantly higher. The full replacement provides an overall better product, that is easier to construct, and has less in-water impact for an incremental increase in additional cost.

Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost (2021 Dollars): \$1,080,000



Additional Photos:



Separation Between Backwall and Bridge Seat/Wingwall at Northeast Corner of Bridge



Heavy Deterioration and Cracking at Northeast Corner of Bridge Seat and Wingwall



Heavy Deterioration on the Southwest Corner of Bridge Seat and Wingwall

Preliminary Design Report

Bridge 7801 (MP P14.03)

Rehabilitation

Maine Northern Railway – Presque Isle Subdivision

MaineDOT WIN 23460.00

PREPARED FOR



PREPARED BY



March 15, 2021

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Existing Bridge Description

Bridge 7801 is a 28'-8" long, three-span, "rail-top" bridge with an open steel beam deck built in 1953. It carries the Presque Isle subdivision of the Maine Northern Railway over the Small Brook in T11-R4. The girders are supported on two reinforced concrete abutments and two reinforced concrete piers. According to the 2019 inspection report the deck and channel elements are both in "fair" condition and the superstructure is in "satisfactory" condition. The substructure is in "serious" condition with the following major deficiencies noted. See photos in Additional Photos section:

- Northeast Wingwall is completely detached from the breastwall and is tipping outward.
- Northeast and Northwest Wingwalls both have large areas of spalling, deteriorated concrete, and exposed/deboned reinforcing.
- North Abutment breastwall has extensive cracking, spalling, delamination and is tipping forward.
- Invert slab in north span is 90% missing and deteriorated with only the reinforcing remaining.
- Spalling, cracking and deterioration is noted sporadically throughout the other substructure elements.

Additionally, the existing bridge is hydraulically constrained (tailwater controlled) as can be seen in Table 1 below. Also, evidence suggests that the brook has migrated towards the North Abutment. This has left the flow concentrated within the north span, leaving the middle and south spans dry most of the year and filled with silt, vegetation, and other debris.

Table 1: Existing Hydraulic Conditions (Tailwater Controlled)

Existing Low Chord Elev.	Q50	
	Water Surface Elev. (ft)	Freeboard (ft)
576.2	575.60	0.60



View on Centerline of Bridge Looking Northeast



View of Northeast Wingwall, North Abutment and Pier Looking West

Based on the serious condition of the substructure and the numerous deficiencies, a full bridge replacement was selected as the most prudent rehabilitation option.

Replacement Alternatives

In addition to cost, constructability, and meeting strength/service requirements; maintaining and improving the existing hydraulic condition of the bridge played a key role in developing the proposed alternatives. Due to the shallow profile of the existing superstructure and close proximity of the Q50 elevation to the existing superstructure, the depth of the proposed superstructure is limited considerably. Additionally, widening the existing hydraulic opening is also desired to improve the overall hydraulic function.

The following criteria was used to develop the proposed alternatives for a new bridge:

- Balancing a shallow superstructure depth (increasing freeboard) with an increased hydraulic opening. See Hydrologic and Hydraulic Memorandum in Appendix C for additional background on hydraulic criteria and performance.
- Minimizing construction cost and minimizing future maintenance costs.
- Accelerated construction methods that can accommodate a short railroad shutdown window.
- Maximizing service life and meeting Cooper E-80 live loads requirements.

Bridge 7801 (MP P14.03) – Small Brook

Based on the criteria listed above, the following replacement alternatives were considered:

- **Alternative 1** – Three Cell Precast Concrete Box Culvert
- **Alternative 2** – Three Span “Rail-Top” Superstructure on Precast Substructure Units
- **Alternative 3A** – Single Span Steel Girders on Precast Substructure Units (16’ Hydraulic Opening)
- **Alternative 3B** – Single Span Steel Girders on Precast Substructure Units (21’ Hydraulic Opening)

Alternative 1 – Three Cell Precast Concrete Box Culvert

Using a box culvert would typically require a desired 12 inches of ballast between top of culvert and bottom of tie. Assuming a 12-inch culvert top slab and six-inch timber ties the total depth would be approximately 30-inches. The existing superstructure depth is 15 inches. See Table 2 below for hydraulic comparison. See Hydrologic and Hydraulic Memo in Appendix C for more information. Additionally, a 12-inch top slab may not be sufficient to meet the requirements of E-80 live loads.

Table 2: Alt. 1 Hydraulic Comparison (Tailwater Controlled)

Option	Low Chord Elev.	Q50	
		Water Surface Elev. (ft)	Freeboard (ft)
<i>Existing</i>	<i>576.2</i>	<i>575.60</i>	<i>0.60</i>
Alt. 1	574.8	575.17	-0.37

Notes: 1. Existing values provided in ITALICS for comparison purposes
2. Negative freeboard value indicates headwater above low chord

Based on the hydraulics and potential structural issues presented above, a precast concrete box culvert was eliminated from the list of potential alternatives.

Alternative 2 – Three Span “Rail-Top” Superstructure on Precast Substructure Units

Similar to the existing structure, the proposed “rail-top” alternative would utilize a group of nested rails as girders. A photo of a similar replacement located in Fort Kent on the Madawaska Subdivision is shown below. Assuming a minimum dapped tie depth of seven and a half inches, the total superstructure depth would be approximately 15 inches which matches the existing superstructure. See Table 3 below for hydraulic comparison. See Hydrologic and Hydraulic Memo in Appendix C for more information.

Table 3: Alt. 2 Hydraulic Comparison (Tailwater Controlled)

Option	Low Chord Elev.	Q50	
		Water Surface Elev. (ft)	Freeboard (ft)
<i>Existing</i>	<i>576.2</i>	<i>575.60</i>	<i>0.49</i>
Alt. 2	576.2	575.19	1.01

Notes: 1. Existing values provided in ITALICS for comparison purposes





2014 Replacement "Rail-top" Superstructure on Madawaska Subdivision (Br. 7791 MP251.75)

The girders would sit on two precast concrete abutments and two precast concrete piers. The piers and abutments would all share a single precast concrete slab/footing. Precast concrete substructure units were selected to minimize construction time and to increase the service life of the proposed structure compared to timber piers as shown in the above paragraph.

While this alternative meets several of the hydraulic design criteria, the piers could potentially block and trap debris leading to future maintenance and hydraulic issues. Additionally, the piers would increase flow velocity and scour depth compared to a single span alternative (discussed below). See Hydrological and Hydraulics Memo in Appendix C for more information.

Since this alternative meets most of the hydraulic requirements, utilizes accelerated construction methods, and meets strength and service requirements; it was selected for further evaluation and an anticipated construction cost estimate was developed.

Anticipated Construction Cost: \$740,000

Alternative 3A – Single Span Steel Girders on Precast Substructure Units (16-Foot Hydraulic Opening)

This alternative consists of steel girders set on precast concrete abutments supported on a single (common) precast concrete slab/footing. There would be a 16-foot hydraulic opening between the faces of the abutments, which approximates the typical bank width upstream and downstream. A photo of a single span steel replacement bridge located in Dorset Vermont on the Vermont Railway is shown below.



2014 Replacement Steel Girder on Precast Concrete Substructure on Vermont Railway (VTR) – Dorset, VT

A six-girder configuration was selected to reduce the required beam depth to approximately 15 inches. Assuming a minimum dapped tie depth of seven and a half inches, the total superstructure depth would be approximately 23 inches. The existing superstructure depth is 15 inches. See Table 4 below for hydraulic comparison. Additionally, the 16-foot hydraulic opening provides a best fit to the existing channel, reduces velocities, and removes obstructions in the channel. See Hydrologic and Hydraulic Memo in Appendix C for more information. If selected, the rail profile and superstructure depth will be optimized during final design to further increase the hydraulic performance.

Table 4: Alt. 3A Hydraulic Comparison (Tailwater Controlled)

Option	Low Chord Elev.	Q50	
		Water Surface Elev. (ft)	Freeboard (ft)
<i>Existing</i>	<i>576.2</i>	<i>575.60</i>	<i>0.49</i>
Alt. 3A	575.4	575.26	0.14

Notes: 1. Existing values provided in ITALICS for comparison purposes
 2. Negative freeboard value indicates headwater above low chord

This alternative provides improved hydraulic performance, improved waterway opening, and realigns the center of the bridge with the channel. It also utilizes accelerated construction methods and meets the strength and service requirements. Therefore, it was selected for further evaluation and an anticipated construction cost was developed.

Anticipated Construction Cost: \$700,000

Alternative 3B – Single Span Steel Girders on Precast Substructure Units (21-Foot Hydraulic Opening)

This alternative would be identical to Alternative 3A, except there would be a 21-foot hydraulic opening between the faces of the abutment. This alternative was used to determine if additional clear distance between abutments would improve the hydraulic performance. See Table 5 below. See Hydrologic and Hydraulic Memo in Appendix C for more information.

Table 5: Alt. 3B Hydraulic Comparison (Tailwater Controlled)

Option	Low Chord Elev.	Q50	
		Water Surface Elev. (ft)	Freeboard (ft)
<i>Existing</i>	576.2	575.60	0.49
Alt. 3B	575.0	575.15	-0.15

Notes: 1. Existing values provided in ITALICS for comparison purposes
 2. Negative freeboard value indicates headwater above low chord

Based on the hydraulic analysis it was determined that there was no significant advantage compared to Alternative 3A. Additionally, this alternative would have deeper girders and heavier substructure units making it harder to construct and more expensive. Based on this, Alternative 3B was eliminated from the list of potential alternatives.

Recommended Replacement Alternative

Alternative 3A, a **single span with 16-foot hydraulic opening** is the recommended replacement alternative.

Out of the two alternatives that were selected for further evaluation, it is anticipated that Alternative 3A will be easier to construct for the following reasons:

- Fewer substructure units to install and maintain
- Smaller bridge "footprint" requires less excavation and minimizes impacts

In addition to ease of construction, Alternative 3A offers the following advantages:

- A single span offers better hydraulic performance and require less riprap
- A single span is less likely to trap debris and reduces future maintenance
- A single span is anticipated to have a lower construction cost

No utilities are located near the project site and therefore no utility impacts are anticipated. All permanent construction impacts will be within the existing right-of-way therefore, no right-of way impacts are anticipated. During final design, the bridge will be further optimized to reduce cost and improve constructability, hydraulic performance, and serviceability.

Anticipated Construction Cost (2020 Dollars): \$700,000



3Additional Photos:



Northeast Wingwall Completely Detached From Breastwall and Tipping Forward



Northwest Wingwall Heavily Deteriorated and Cracked, North Abutment Tipping Forward



Invert Slab of North Span Completely Deteriorated



South Span Heavily Silted, Filled With Debris and Dry

Preliminary Design Report

Bridge 7804 (MP P21.26)

Rehabilitation

Maine Northern Railway – Presque Isle Subdivision

MaineDOT WIN 23456.00

PREPARED FOR



PREPARED BY



March 15, 2021

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Existing Bridge Description

Bridge 7804 is a 40'-0" long, single span, deck plate girder bridge with an open timber deck built in 1909. It carries the Presque Isle Subdivision of the Maine Northern Railway over the North Branch Presque Isle Stream in Mapleton. The girders are supported on built-up, concrete encased, steel rail grillages atop two unreinforced concrete abutments. According to the 2019 inspection report the superstructure and channel elements are both in "satisfactory" condition. The deck and substructure are both in "poor" condition.

Both abutments are approximately 18 feet tall and were previously covered with a superficial layer of shotcrete. This layer of shotcrete has hairline cracks throughout with rust staining, efflorescence, and large areas of delaminations and spalling on both abutments. The concrete coping along the face of both bridge seats and the backwalls are in particularly poor condition. Because the girders are in satisfactory condition and have a rating factor of 1.26 (normal rating - 286k car at 25mph), the proposed work for this bridge will focus on rehabilitation of the substructure.

No utilities are located near the project site therefore no utility impacts are anticipated. It is expected that all work can be completed within the existing right-of-way, which extends 49.5' in either direction from centerline of track. Therefore, no right-of-way impacts are anticipated.



Elevation View of Bridge Looking East

Existing Condition and Proposed Repairs – Abutments

Replace Backwalls

The backwalls at both abutments have hairline map cracking and delaminations throughout. Both backwalls have multiple full-height cracks ranging from 1/4" inch to two inches wide. The backwall on the East Abutment is in particularly poor condition, with a two-inch wide full height crack that has fully separated, and ballast is spilling through. Additionally, the backwall at this location has shifted forward one to one and a half inches. See photo below and in the attached "Additional Photos" section.

The proposed work to the backwalls consists of completely removing the existing backwalls and replacing them with new precast backwalls. The precast backwalls will tie into the adjacent wingwalls with cast in place concrete. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost: \$45,000 East Abutment and \$45,000 West Abutment



Full-Height Crack with Ballast Spilling Thru and Backwall Tipping Forward on the East Abutment

Rehabilitate Bridge Seats

The concrete coping along the face of both bridge seats is in serious condition. Three out of the four corners are heavily deteriorated. At these locations, the concrete encased, steel rail grillages supporting the girders are undermined and at risk of failing. See photo below and in the attached “Additional Photos” section.

The proposed work to the bridge seats consists of removing the grillages and existing concrete from the upper portion of the bridge seat and directly below the bearings. New steel support bolsters will be installed under each girder. The steel bolsters and the upper portion of the bridge seats will then be encased with new concrete and reinforcing steel. These repairs will restore the original shape of and improve the ductility of the unreinforced bridge seats. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost: \$100,000 East Abutment and \$100,000 West Abutment



Coping Along Face of Bridge Seat Heavily Deteriorated at East Isle Abutment

Abutment Footings

Previous inspection reports noted potential scour/undermining at the base of the East Abutment. During the 2019 inspection the base of both abutments and the channel were probed. Along the bottom of the East Abutment there is a construction line or “lip” where the shotcrete ends and transitions back to the original abutment concrete. Although this may appear to be undermining or deterioration from a

distance, the original abutment concrete is not actually undermined and appears to be in satisfactory condition.

No work is proposed at the base of either abutment.

Existing Condition and Proposed Repairs – Wingwalls

Rehabilitate Wingwall (One Location)

There is a 16-inch square hole surrounded by deteriorated concrete on the Northeast Wingwall.

The proposed work to the wingwall consists of lightly removing existing unsound concrete, filling the hole with grout, and encasing the last nine feet of the wingwall with six inches of reinforced concrete. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost: \$15,000



Deteriorated Concrete and Hole in the Northeast Wingwall

Replace Timber Ballast Retainers (Four Locations)

The timber ballast retainers behind three of four wingwalls are falling apart with ballast spilling over and down the adjacent slope. See photo on next page and in the attached "Additional Photos" section.

The proposed work consists of completely removing the existing timber ballast retainers and replacing them in kind, at all four wingwalls.

Anticipated Construction Cost: \$35,000 (\$8,750 per location)



Failed Ballast Retainer behind the East Abutment

Existing Condition and Proposed Repairs – Bridge Deck

Replace Selected Bridge Timbers

The majority of the bridge timbers are in fair condition however, eight bridge timber are in poor condition. See photo the attached "Additional Photos" section.

The proposed work on the bridge deck consists of replacing the eight bridge timbers that are in poor condition.

Anticipated Construction Cost: \$20,000

Summary of Anticipated Construction Costs (Year 2021 Costs):

East Abutment:

Replace Backwall: \$45,000
Rehabilitate Bridge Seat: \$100,000

West Abutment:

Replace Backwall: \$45,000
Rehabilitate Bridge Seat: \$100,000

Wingwalls:

Rehabilitate Wingwall (Northeast Only): \$15,000
Install Four New Ballast Retainers: \$35,000

Bridge Deck:

Replace Selected Bridge Timbers \$20,000

Subtotal: \$360,000

Mobilization: \$40,000

15% Contingency: \$55,000

Total Anticipated Construction Cost: \$455,000



Additional Photos:



Half Inch Full-Height Crack in Backwall of East Abutment



Coping Along Face of Bridge Seat Heavily Deteriorated at West Abutment



Failed Ballast Retainer Behind the West Abutment



Bridge Timbers in Poor Condition

Preliminary Design Report

Bridge 7805 (MP P24.91)

Rehabilitation

Maine Northern Railway – Presque Isle Subdivision

MaineDOT WIN 23454.00

PREPARED FOR



PREPARED BY



March 15, 2021

Bridge 7805 (MP P24.91) – Presque Isle Stream

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations

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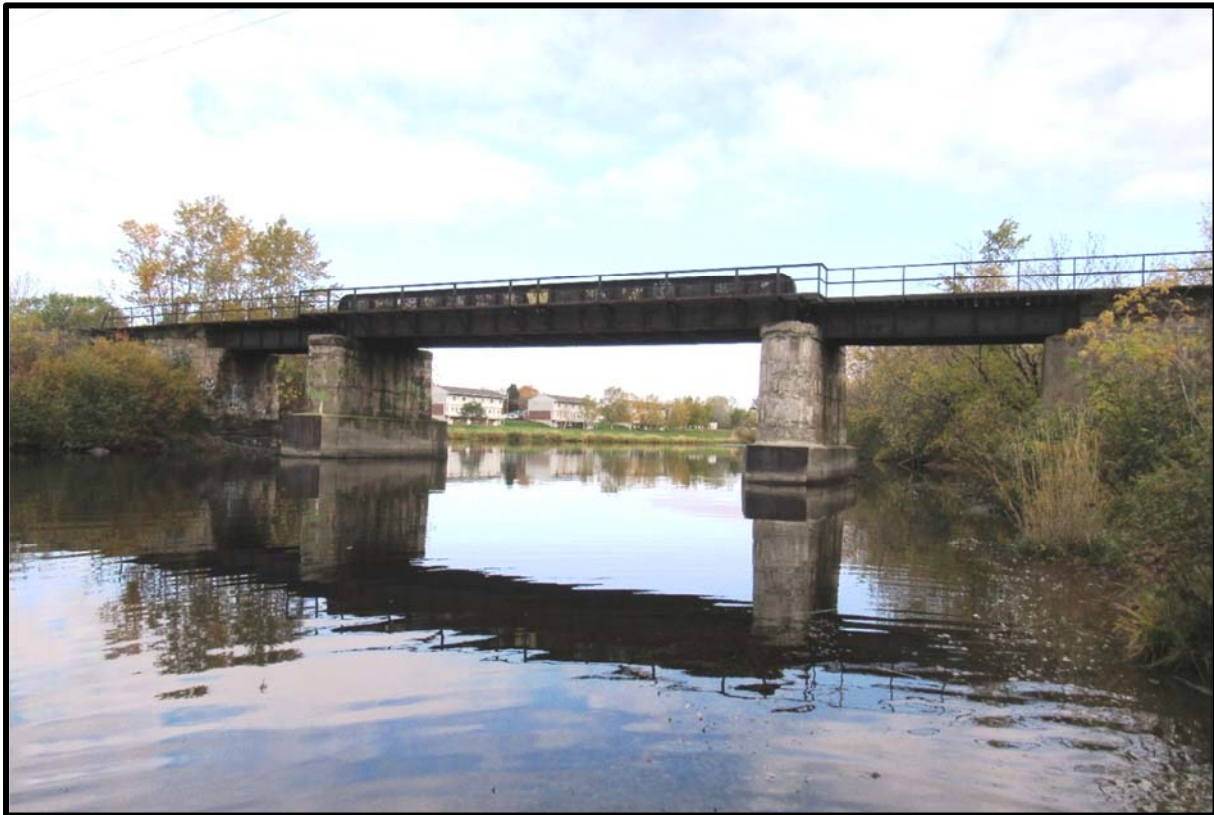
Existing Bridge Description

Bridge 7805 is a 130-foot long, three-span, deck plate and thru girder bridge with an open timber deck built in 1909. It carries the Presque Isle subdivision of the Maine Northern Railway over the Presque Isle Stream in Presque Isle. The girders are supported on two concrete abutments and two concrete piers, which are assumed to only be lightly reinforced. According to the 2019 inspection report the superstructure and deck elements are in “fair” and “satisfactory” condition, respectively. The channel and substructure are in “poor” and “critical” condition, respectively.

The Presque Isle Subdivision runs from Masardis to the south to Presque Isle to the north. For the purposes of this report the abutments and piers will be referred to Track North and Track South in conjunction with cardinal directions.

The concrete abutments and piers are approximately 20 to 25-feet tall and have large areas of spalling, delaminations, abrasion, and cracking throughout. Additionally, there are signs of scour and undermining at the East (Track North) Abutment and under both piers. Because the superstructure is in fair condition and load rates at 1.0 (normal rating - 286k car at 25mph), the proposed work for this bridge will focus on rehabilitation of the substructure.

There are powerlines that run parallel to the bridge approximately 40-feet off the south fascia. Based on their location, the powerlines are not anticipated to interfere with any of the proposed work and therefore no utility impacts are anticipated. Temporary right-of-way impacts are anticipated for a 20-foot wide path on the east end of the bridge to access the East (Track North) Abutment



Elevation View of South Fascia of Bridge

Existing Condition and Proposed Repairs – Abutments

Replace Backwalls

The backwalls at both abutments have map cracking and delaminations throughout. Both backwalls have multiple full-height cracks ranging from 1/8 inch to two inches wide. The backwall on the East (Track North) Abutment has a two-inch wide full-height crack that has fully separated and the backwall is tilting forward two to three inches. Additionally, there is cracking and spalling at the interface between the wingwalls and the bottom of the backwall. The backwall on the West (Track South) Abutment is tilting forward approximately 1/2 inch. See photo below and in the attached Additional Photos section.

The proposed work to the backwalls consists of completely removing the existing backwalls and replacing them with new precast backwalls. The precast backwalls will tie-into the adjacent wingwalls with cast-in-place concrete. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

*Anticipated Construction Cost: \$40,000 East (Track North) Abutment
\$40,000 West (Track South) Abutment*



Full-Height Crack and Backwall Tipping Forward at East (Track North) Abutment

Rehabilitate Abutment Bridge Seats

The concrete along and below both bridge seats have map cracking, rust staining and delaminations throughout. The bridge seat on the West (Track South) Abutment is in critical condition. At this location, the West corner of the bridge seat has a 45-degree shear crack up to one inch wide running from the bearing down to the edge of the abutment. The concrete surrounding this crack is soft and heavily deteriorated. Additionally, the anchor bolts on both abutments are corroded, bent, or sheared and the masonry plates have shifted. See photo below and in Additional Photos section.

The proposed work to the bridge seats consists of removal of the existing concrete from the upper portion of the bridge seat and directly below the bearings. New steel support bolsters and anchor bolts will be installed under each girder. The steel bolsters and the upper portion of the bridge seats will then be encased with new concrete and reinforcing steel. These repairs will restore the original shape of and improve the ductility of the bridge seats. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost: \$90,000 East (Track North) Abutment

\$90,000 West (Track South) Abutment



Shear Crack in Bridge Seat Under South Girder on West (Track South) Abutment

Rehabilitate Base of Abutments

Along the entire base of the East (Track North) Abutment, the concrete has deteriorated/abraded and is currently undermining the abutment footing. This section of missing concrete is approximately 18 inches high and 30 inches deep. On the West (Track South) Abutment the lower five feet of the abutment is heavily abraded, spalled, and delaminated. Abrasions are up to 18 inches high and six inches deep along this location. See photo on next page and in the attached Additional Photos section.

The proposed work consists of lightly removing existing unsound concrete and encasing the base of both abutments with concrete and reinforcing steel. In order to limit the amount of concrete removal, both encasements will extend six inches beyond the original face of the abutments. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

*Anticipated Construction Cost: \$40,000 East (Track North) Abutment
\$20,000 West (Track South) Abutment*



Abraded and Deteriorated Concrete Along the Base of the East (Track North) Abutment

Existing Condition and Proposed Repairs – Wingwalls

Rehabilitate Wingwalls

The concrete along the upper portion of the Southeast and Southwest Wingwalls have large sections of deterioration, delaminations and spalling. Additionally, several of the wingwalls appear to be tipping outward. See photo on next page and in the attached Additional Photos section.

Bridge 7805 (MP P24.91) – Presque Isle Stream

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations

The proposed work to the wingwalls consists of lightly removing the existing unsound concrete and encasing the upper portions of the Southeast and Southwest Wingwalls with concrete and reinforcing steel. At all four wingwalls vertical reinforcement will be drilled and grouted to “pin” the tops of the wingwalls and prevent a potential failure plane and further tipping. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

*Anticipated Construction Cost: \$15,000 Southeast Wingwall and \$15,000 Southwest Wingwall
\$10,000 Northeast Wingwall and \$10,000 Northwest Wingwall*



Deteriorated and Delaminated Concrete Along the Upper Portion of the Southwest Wingwall

Replace Timber Ballast Retainer (One Location)

The timber ballast retainer behind the southwest wingwall is rotting and falling apart with ballast is spilling through adjacent to the wingwall. The timber ballast retainers behind the other wingwall are either in fair or satisfactory condition. See photo in the attached Additional Photos section.

The proposed work consists of completely removing the existing timber ballast retainer and replacing it in-kind. Only the ballast retainer behind the southwest wingwall will be replaced. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.

Anticipated Construction Cost: \$20,000

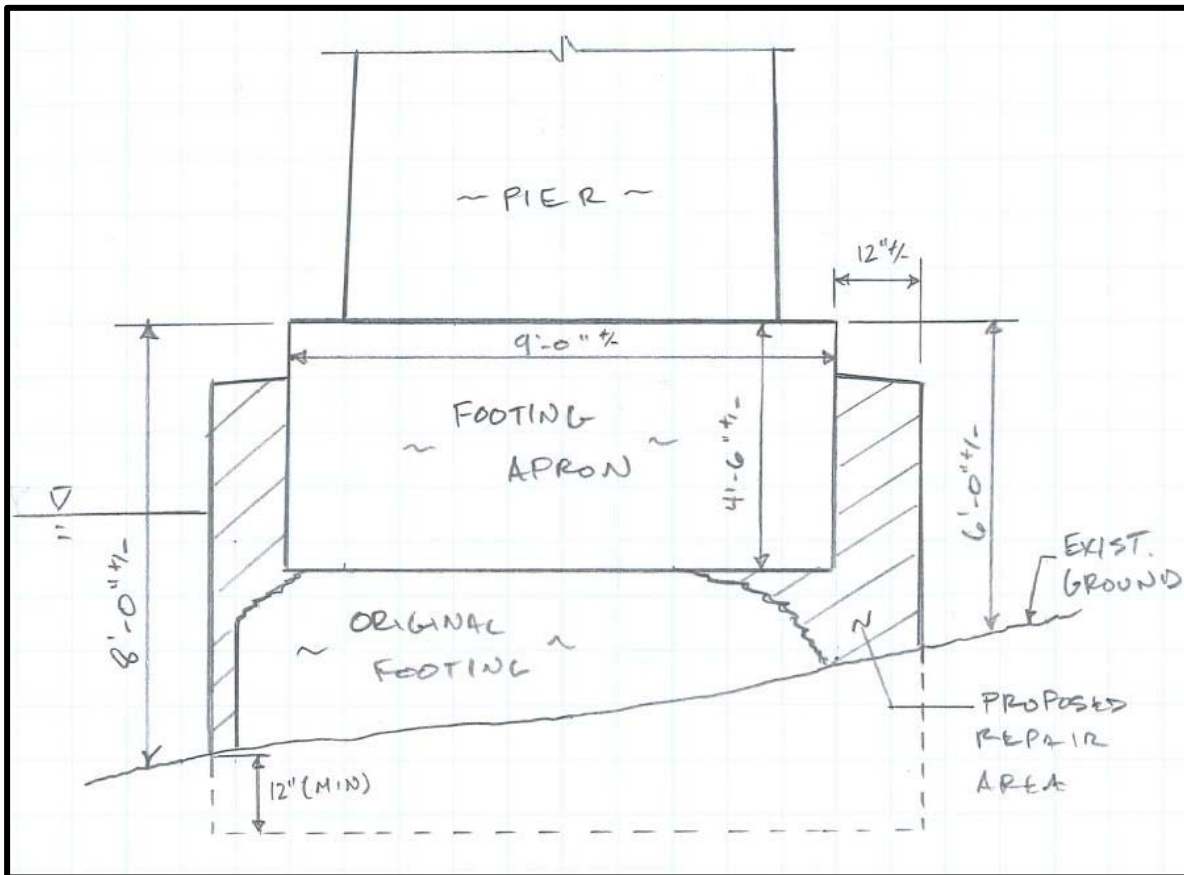
Existing Condition and Proposed Repairs – Piers

Rehabilitate Footing Aprons

The lower portion of both piers consists of a large footing aprons which sit partially on top of what is believed to be the original pier footings. The tops of the original pier footings have been abraded and deteriorated leaving sections of the footing aprons undermined. The undermining is particularly heavy on the upstream sides of both piers. The undermining includes a 24 inch x 36 inch and a 16 inch by 48 inch area under the upstream corners of the East (Track North) and West (Track South) Piers, respectively. See sketch below.

The proposed work to the base of both piers consists of encasing the footing aprons and the original pier footings. The encasements will restore connectivity between the base of the piers and the original footings and prevent future scour and abrasion. Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans and shown below.

Anticipated Construction Cost: \$180,000 East (Track North) Pier and \$150,000 West (Track South) Pier



Sketch Showing Undermining of Footing Apron at Upstream End of East (Track North) Pier

Rehabilitate Pier Faces and Strength Bridge Seats

A large portion of the concrete on the face of the both piers is spalled and delaminated with cracking, rust staining, and effloresce throughout. The spalling and delaminations are particularly heavy on the upstream and downstream faces of the East (Track North) Pier. Additionally, the East (Track North) Pier exhibits heavy spalling up to three inches deep along the horizontal cracks assumed to be cold joints. Cracks on the East (Track North) Pier are up to one inch wide. The West (Track South) Pier is in better condition with spalls typically less than one inch deep and cracks less than 1/2 inch wide. See photo below and in Additional Photos section.

The existing concrete directly under the bearings on both piers is cracked with localized areas of spalling, and delamination. The concrete coping on top of both piers have large areas of delaminations, spalls and cracking throughout. Additionally, the anchor bolts on the piers are all either corroded, bent, or both. See photo below and in Additional Photos section.



Heavy Spalling and Delaminations on Upstream End of the East (Track North) Pier

Several rehabilitation alternatives were developed to address the faces and bridge seats of the piers:

- **Alternative 1** – Installing Post Tensioned Channels and Selected Patching
- **Alternative 2** – Installing Steel Bolsters, Encasing the Bridge Seats, and Selected Patching
- **Alternative 3** – Installing Steel Bolsters and Full Encasement of the Entire Pier



Bent/Corroded Anchor Bolts and Deteriorated Concrete on Bridge Seat of East (Track North) Pier

Alternative 1 – Installing Post Tensioned Channels and Selected Patching

The proposed work for this alternative would include:

- Drilling through the tops of both piers and installing steel channels and post tensioning rods under the bearings.
- Partial depth repairs/patching selected areas that are in particularly poor condition. These locations include on the tops of both piers and on the upstream and downstream face of the East (Track North) Pier.
- This alternative aims to limit any jacking and temporary support of the superstructure. As such, no work to the bearings or anchor bolts are proposed as part of this alternative. Since the bridge seats are not in “poor” condition at this time, and the bearings are not heavily corroded, more extensive repairs may not be necessary. However, if the project budget allows, additional work would be beneficial, but can be eliminated to save cost, at this time.

Anticipated Construction Cost: \$115,000 East (Track North) Pier and \$80,000 West (Track South) Pier (\$195,000 Both Piers)

Alternative 2 – Installing Steel Bolsters, Encasing the Bridge Seats, and Selected Patching

The proposed work for this alternative would include:

- Removing existing concrete from the upper portions of each pier and directly below the bearings and installing steel support bolsters under each girder.
- The steel bolsters and the upper portion of the bridge seats would then be encased with new concrete and reinforcing steel.

- The expansion bearings for the center span would be replaced with new fabric pad bearings with a PTFE sliding surface. All other bearings would be removed and reset with new masonry plates and anchor bolts.
- Partial depth repairs/patching on the upstream and downstream face of the East (Track North) Pier.
- This alternative aims to make improvements to the bridge seats while only making necessary patch repairs to the piers. This is a “middle of the road” approach if budget allows, at this time.

Anticipated Construction Cost: \$200,000 East (Track North) Pier and \$140,000 West (Track South) Pier (\$340,000 Both Piers)

Alternative 3 – Installing Steel Bolsters and Full Encasement of the Entire Pier

The proposed work for this alternative would include:

- Removing existing concrete from the upper portions of each pier and directly below the bearings and installing steel support bolsters under each girder.
- The steel bolsters and the upper portion of the bridge seats would then be encased with new concrete and reinforcing steel.
- The expansion bearings for the center span would be replaced with new fabric pad bearings with a PTFE sliding surface. All other bearings would be removed and reset with new masonry plates and anchor bolts.
- The remaining portion of the pier stems would be fully encased with six-inch-thick layer of new concrete and reinforcing steel.
- This alternative aims to fully restore the piers as close to their original condition as possible, if the project budget allows.

Anticipated Construction Cost: \$245,000 East (Track North) Pier and \$225,000 West (Track South) Pier (\$470,000 Both Piers)

Recommended Alternative

Alternative 2, **Installing Steel Bolsters, Encasing the Bridge Seats, and Selected Patching** is the recommended replacement alternative.

This alternative provides the best balance of cost and value by targeting the most critical areas of the piers. The bolsters and bridge seat encasements will restore the original shape of and improve the ductility of the bridge seats which are likely to be unreinforced. This will greatly reduce the chance of a sudden non-ductile failure in the bridge seat concrete. Additionally, this option allows for the replacement of the bearings and anchor bolts which will improve the overall serviceability of the bridge.

Alternatively, the faces of the piers are less critical for repair and only the areas that are heavily deteriorated will be addressed. Since the pier is a “wall type” pier, there is a large concrete mass over which the loads are distributed. Beyond the delaminations and spalling on the outer layer of concrete, the majority of the concrete mass is in satisfactory condition and will be adequate to transfer the loads down to the footing.

Conceptual details of these repairs are shown in the attached Preliminary Repair Concepts Plans.



Summary of Anticipated Construction Costs (Year 2021 Costs):

East (Track North) Abutment:

Replace Backwall:	\$40,000
Rehabilitate Bridge Seat:	\$95,000
Rehabilitate Base of Abutment:	\$40,000
Rehabilitate Wingwalls:	\$25,000

West (Track South) Abutment:

Rehabilitate Backwall:	\$40,000
Rehabilitate Bridge Seat:	\$95,000
Rehabilitate Base of Abutment:	\$20,000
Rehabilitate Wingwalls:	\$25,000
Replace Timber Ballast Retainer:	\$20,000

East (Track North) Pier:

Bolsters, Partial Encasement, and Patching:	\$200,000	(Alternative 2 – See Below)
Rehabilitate Footing Apron:	\$180,000	

West (Track South) Pier:

Bolsters and Partial Encasement:	\$140,000	(Alternative 2 – See Below)
Rehabilitate Footing Apron:	\$150,000	

Subtotal:	\$1,070,000
Mobilization:	\$110,000
15% Contingency:	\$170,000
Total Anticipated Construction Cost:	\$1,350,000

The cost summary above assumed that Alternative 2 – Installing Steel Bolsters, Encasing the Bridge Seats, and Selected Patching is selected for the piers. Depending on the total project budget, the Department may elect to use Alternative 1 or Alternative 3 for the pier rehabilitations.

- If Alternative 1 – Installing Post Tensioned Channels and Selected Patching is selected the total anticipated construction cost would be \$1,160,000 (\$190,000 reduction).
- If Alternative 3 – Installing Steel Bolsters and Full Encasement of the Entire Pier is selected the total anticipated construction cost would be \$1,500,000 (\$150,000 increase).

See Appendix B – Construction Cost Backup for more information.



Additional Photos:



Cracking at Backwall and Wingwall Interface on East (Track North) Abutment

Bridge 7805 (MP P24.91) – Presque Isle Stream

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations



Heavy Deterioration and Abrasion on the Base of the West (Track South) Abutment



Failed Ballast Retainer behind the Southwest Wingwall

Preliminary Design Report

Bridge 7750 (MP H17.16)

Rehabilitation

Maine Northern Railway – Houlton Subdivision

MaineDOT WIN 24345.00

PREPARED FOR



PREPARED BY



March 15, 2021

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Existing Bridge Description

Bridge 7750 is a 410-foot long, five-span, deck plate girder bridge with an open timber deck. It carries the Houlton Subdivision of the Maine Northern Railway over the Meduxnekeag River in Houlton. The girders are supported on two granite masonry abutments and four granite masonry piers. The superstructure was built and erected on the existing piers and abutments in 1931. The abutment and piers were constructed in the late 1800s. According to the 2019 inspection report the superstructure and deck are in “satisfactory” and “serious” condition, respectively. While, the channel and substructure are both in “poor” condition.

Both abutments are approximately seven feet tall (portions above ground) and the piers are 30 to 40-feet tall. There is a noticeable dip in the approach track, at South Abutment. Additionally, the concrete apron around the base of Pier 3 is heavily deteriorated. Because the girders are in satisfactory condition and have a rating factor of 1.34 (normal rating - 286k car at 25mph), the proposed work for this bridge will focus on rehabilitation of the substructure, where applicable.

There are powerlines that run parallel to the bridge approximately 50-feet off the west fascia. Based on their location, the powerlines are not anticipated to interfere with any of the proposed work and thus no utility impacts are anticipated. Temporary right-of-way impacts are anticipated for a 25-foot wide path on the north end of the bridge to access Pier 3.

At this location, the track runs south to north with the bridge located on the north end of the Houlton Yard. For the purposes of this report the spans and piers will be number starting south (Pier 1/Span 1) and working north (Pier 4/Span 5).



Elevation View of Bridge Looking South

Existing Condition and Proposed Repairs – South Abutment

Reestablish Track Alignment and Profile

The following deficiencies have been observed at the South Abutment and Span 1:

- The approach track at the South Abutment has visually settled approximately four to five inches. See photo below.
- The approach track at the South Abutment appears to be out of alignment horizontally three inches to the west.
- At the South Abutment the anchor bolts are bent towards the backwall and the bearing plates are all overextended towards the backwall. See photo in attached Additional Photos section.
- At Pier 1 the anchor bolts are bent away for the South Abutment and the bearing plates have shifted away from the South Abutment. The ends of the girder are touching the notch in the pier cap at this location. See photo in attached Additional Photos section.



Settlement in Approach Track Just Prior to South Abutment (Looking North)

Based on the observations listed above, it appears that the South Abutment is shifting forward and slightly to the west. This has caused the superstructure to shift towards Pier 1 and caused the approach track to settle at the abutment. There is no evidence of differential settlement within the abutment, as there are no shifted, misaligned or cracked masonry blocks. However, it's possible the abutment could be settling uniformly downward, in addition to shifting forward. Unfortunately, there is no information on when the movement/settlement happened, how fast it happened, or if the abutment is still actively moving/settling.

Bridge 7750 (MP H17.16) – Meduxnekeag River

Preliminary Design Report

MNR Subdivision Bridge Rehabilitations

In January of 2020 a boring was drilled through the abutment to determine the depth of the abutment and the strata below. Based on the boring, the granite block abutment is approximately 34 feet tall, the majority of which is below the existing ground line (embankment). The abutment sits on what is currently a four-inch-thick timber mat which exhibits signs of rot. Below the timber mat there is approximately 32 feet of glacial till down to bedrock. See Appendix C for Draft GZA Boring Logs.

A 34-foot-tall abutment is consistent with a historic photo found on the “Maine Memory Network” website. The photo, taken in 1895, shows the abutment previously had a timber trestle approach to the south. See photo below. During this era of construction, trains were the most effective means of moving and placing large quantities of fill material. It is likely that the timber trestle was used to facilitate the placement of the embankment material that the approach track currently sits on. Based on the size and shape of the abutment, compared to the piers, it’s likely the abutments were designed to resist the surcharge loads created by the embankment.



Photo from 1895 Showing Timber Trestle Leading Up to Bridge in Lieu of Embankment in Place Today
(North Abutment Shown, South Abutment Similar)

Several rehabilitation alternatives were developed for the South Abutment:

- **Alternative 1** – Reestablish Track Alignment/Profile and Monitor Future Settlement and Movement (Shim and Monitor)
- **Alternative 2** – Reestablish Track Alignment/Profile and Stabilize the Abutment Against Future Lateral Movement (Tie-Back)
- **Alternative 3** – Reestablish Track Alignment/Profile and Stabilize Against Future Lateral Movement and Vertical Settlement (New Abutment)

Since there are no signs of settlement or movement at the North abutment, this repair is only proposed at the South Abutment.

Alternative 1 – Reestablish Track Alignment/Profile and Monitor Future Settlement and Movement (Shim and Monitor)

This alternative would include very limited work on the abutment itself. The proposed work for this alternative would include:

- Jacking the girders in Span 1 to establish the correct track elevation. Resetting the girder in Span 1 on new steel shims, masonry plates, and anchor bolts.
- Resetting the approach track to establish the correct alignment and profile.
- Setting up control points and a monitoring plan to monitor and track future movement.

Anticipated Construction Cost: \$50,000

Alternative 2 – Reestablish Track Alignment/Profile and Stabilize the Abutment Against Future Lateral Movement (Tie-Back)

In addition to resetting the girders and approach track, this alternative would prevent future lateral movement of the abutment. The proposed work for this alternative would include:

- Excavating behind the abutment to a depth of 10 to 15 feet and a length 40 to 50 feet.
- Drilling through the abutment approximately three feet below the bridge seat and installing tie back rods extending from the front face of the abutment back to a concrete deadman. The deadman will be installed 25 feet behind the abutment. The tie back rods will be fastened to the front of the abutment using a cast in place concrete beam.
- Installing a 20-foot-long approach slab on the back of South Abutment after backfilling above the tie back rods. The approach slab will have vertical wings which will act as ballast retainers.
- Backfilling over the approach slab and resetting the approach track.
- Jacking the girders in Span 1 to establish the correct track elevation. Resetting the girder in Span 1 on new steel shims, masonry plates, and anchor bolts.

The approach slab will transfer much of the railroad surcharge load vertically through the abutment, reducing the lateral load on the abutment. The tie back and deadman system will be designed to reduce any further movement due to residual lateral loads on the abutment. See Appendix D for more information and conceptual details of these repairs in the Draft GZA Geotechnical Report.

Anticipated Construction Cost: \$230,000

Alternative 3 – Reestablish Track Alignment/Profile and Stabilize the Abutment Against Future Lateral Movement and Vertical Settlement (New Abutment)

Due to the abutment's depth and stacked stone masonry construction, there are limited rehabilitation options to prevent future vertical settlement. Using driven or drilled pile retrofits to support the existing abutment would be difficult. Additionally, the abutment would still need to be stabilized against lateral movement with a system similar to Alternative 2 and the track and approach would need to be reset similar to Alternative 1.

Stabilizing this abutment against future lateral movement and vertical settlement would require a full replacement of the abutment. Alternatively, a new steel end bent could be built behind the existing abutment and Span 1 could be replaced or modified to "jump" over the existing abutment.



The risk of catastrophic failure due to lateral movement or vertical settlement is extremely low. Additionally, it is not known when the movement/settlement has occurred, if it is still occurring, or how much it will continue in the future. One likely source of the movement/settlement is the rotting of the timber layer directly below the abutment. What now is a four-inch-thick layer of timber could have originally been a 12 or 16-inch-thick timber mat. This was a common practice for stone masonry construction of this era and region. If this is the case, there is limited amount (four inches) of settlement that could happen in the future.

Since any alternatives that address both future lateral movement and vertical settlement would have significant cost and impact implications, and the risk of catastrophic failure is extremely low, they have been deemed unwarranted at this time.

Anticipated Construction Cost: Over \$400,000

Recommended Alternative

Alternative 1, **Reestablish Track Alignment/Profile and Monitor Future Settlement and Movement (Shim and Monitor)** is the recommended replacement alternative.

The track and superstructure will be reset to establish its original alignment and profile. Any future movement of the abutment can be monitored and further addressed in the future, if needed.

Existing Condition and Proposed Repairs – Pier 3

Rehabilitate Pier 3 Footing Apron

The concrete apron around the base of Pier 3 is heavily abraded and deteriorated. These abrasions have led to the apron being undermined up to five deep and four feet high. The undermining is particularly heavy on the upstream end of the pier, where the apron has a “flat” end. This is unlike a traditional apron which is “pointed” on the upstream end. See photo on next page and in additional photos section. Additionally, there is a scour hole in the bottom of channel directly adjacent to the upstream end of the pier. This hole is about three feet deeper than the rest of the channel and extends five to ten feet in front of the pier.



Heavy Deterioration and Undermining on South End of Pier 3 Footing Apron

The proposed work to the base of the pier consists of removing concrete at the upstream side of the pier apron to form a pointed shape. Other loose and deteriorated concrete will be removed, and the entire pier apron will be encased with reinforced concrete. This repair will prevent further abrasion, deterioration, and undermining. The pointed upstream end of the new footing apron will better direct the flow of water and debris around the pier. A "steel plated" repair option similar to what was used on the Sheridan Truss rehabilitation project (Ashland WIN 22812.00) will be provided as an option to the contractor, in lieu of traditional concrete encasement. See photo in additional photos section. Finally, riprap or other suitable material will be installed in the scour hole upstream of the apron to prevent further undermining.

Anticipated Construction Cost: \$245,000

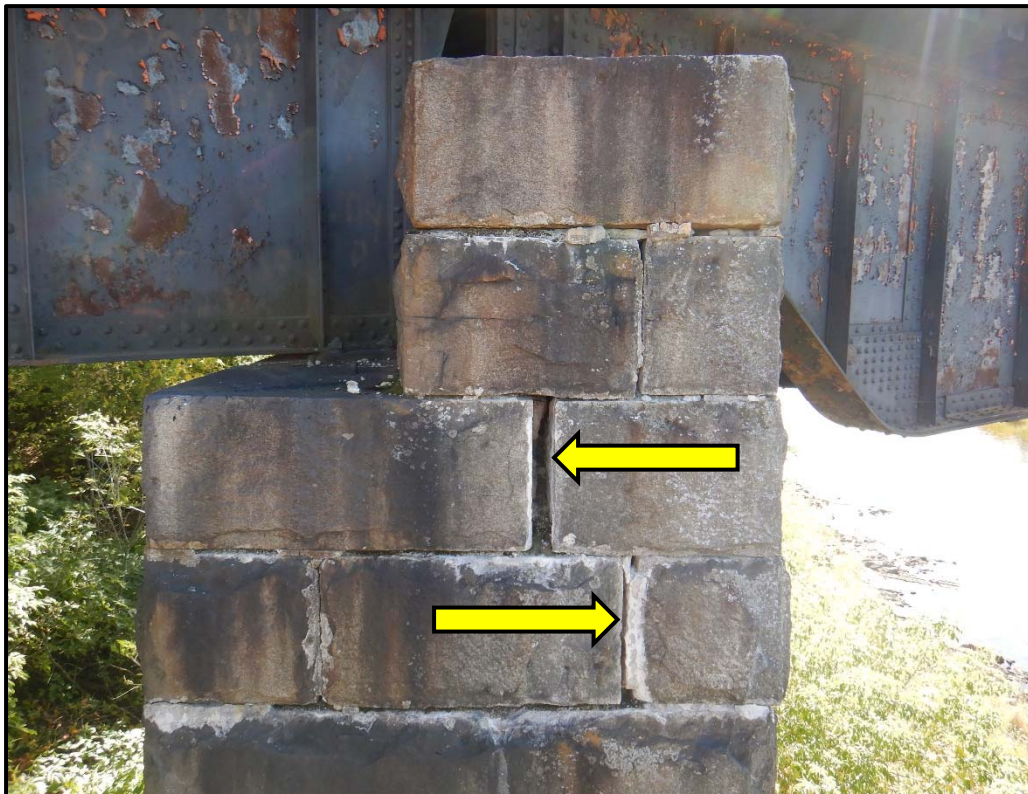
Existing Condition and Proposed Repairs – Pier 4

Stabilize Blocks in Top at Pier 4

The stone masonry blocks in the top 4 courses of Pier 4 have shifted. At multiple locations, the pointing has fallen out and the vertical joints have opened, up to three inches. This occurs on all four faces of the pier, on vertical joints running both longitudinally and transversely. See photo below and in the additional photos section.

The proposed work to the top of Pier 4 consists of repointing and pumping grout into the upper four courses of stone masonry. Channels and tension rods will be used secure the blocks and prevent future movement.

Anticipated Construction Cost: \$45,000



Blocks Shifting and Joints Open Up to 3 Inches on the West Face of Pier 4

Existing Condition and Proposed Repairs – Bridge Deck and Walkway

Replace Selected Bridge Timbers

The majority of the 406 bridge timbers are in poor condition with approximately 45 bridge timbers in serious condition. Additionally, there is fire damage to several timbers in Span 2. See photo below.

The proposed work on the bridge deck consists of replacing the timbers that are damaged and in serious condition.

Anticipated Construction Cost: \$70,000



Bridge Timber in Serious Condition, Multiple Other Timbers in Similar Condition

Repair Walkway

The walkway at the north end of the bridge has been damaged and the grate is missing. Additionally, there are several locations where the grate is bent up or the handrail is broken. See photo on next page.

The proposed work on the walkway consists of repairing the walkway and replacing the missing grate at the north end of the bridge. Additionally, a contingency will be provided for spot repairs of the walkway as directed by the Resident.

Anticipated Construction Cost: \$15,000



Damaged Walkway Section at North End of Bridge

Summary of Anticipated Construction Costs (Year 2021 Costs):

Shim Superstr. and Monitor Abutment:	\$50,000
Rehabilitate Pier 3 Footing Apron:	\$250,000
Stabilize Blocks in Top of Pier 4:	\$45,000
Replace Selected Bridge Timbers:	\$100,000
Repair Walkway:	\$15,000
Subtotal:	\$460,000
Mobilization:	\$50,000
15% Contingency:	\$70,000
Total Anticipated Construction Cost:	\$580,000

Additional Photos:



East End of South Abutment



At South Abutment, Anchor Bolts Bent and Bearing Plates Overextended Towards Backwall



At Pier 1, Anchor Bolts Bent and Bearing Plates Overextended Away from the South Abutment



Heavy Deterioration and Undermining on South End of Pier 3 Footing Apron



Sample – Steel Plated Footing Apron Repair on Sheridan Truss in Ashland on Madawaska Subdivision



Blocks Shifting and Joints Open Up on the East Corner of the North Face of Pier 4



Blocks Shifting and Joint Opened on Top of Pier 4 on the West End