ENGINEERING CONSULTING SERVICES

VOLUME 6 - APPENDIX

SECTION 6.25 – WEMINDJI ACCESS ROAD

Feasibility Study Final Report Phase I

Consultant Reference: LGA-1-GN-F-FRN-RT-0006_01_Section6.25

Stantec ▪ DESFOR ▪ SYSTRA

with subconsultant KPMG

La Grande Alliance Feasibility Study Phase I

Feasibility study of Maquatua River crossing bridge - Wemindji.

2023/03/31

VEI Document Number: LGA-1-GN-T-TGN-RT-0006_00_6.25

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GENERAL INFORMATION

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Document
IDENTIFICATION

**La Grande Alliance
Feasibility Study Phase I**

**Feasibility study of
Maquatua River crossing
bridge - Wemindji.**

*Document Reference:
LGA-1-GN-T-TGN-RT-0006_00_6.25*

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1. MANDATE AND INTRODUCTION

1.1 SCOPE OF STUDY

The contract consists of a feasibility study to widen the bridge at km 4 on the road of Wemindji crossing the Maquatua River.

The content of the report is as follows:

1. Preliminary studies of the following three options (with the same road axis) :
    a. Symmetric widening of the bridge,
    b. One side widening of the bridge,
    c. Demolition/reconstruction.
2. Analysis of the impact of the bridge widening on approaches,
3. Summary table of solutions studied,
4. Estimation (structure side).

1.2 OUT OF SCOPE

The scope of the report does not include the study of the creation of an independent pedestrian bridge. The pedestrian way will be considered to cross the bridge on an enlarge roadway or on a path isolated from the vehicles by a barrier or sidewalk.

1.3 INTRODUCTION

This report aims to:

- Present the data and list the assumptions used,
- Evaluate the current dimensioning of the structure to evaluate the possibilities of changing the deck width by conserving existing structural elements,
- Submit widening solution and provide, for each solution:
    - The preliminary design of the wood decking,
    - The preliminary design of the wood sleepers,
    - The preliminary design of the steel beams,
- We are using the Safi software “Pont acier-bois v14.0.3” as well as Excel software for manual checking.

2. INPUT DATA AND HYPOTHESIS

2.1 INPUT DATA

2.1.1 References

[1] « Handbook of steel construction » – ninth edition 2004,

[2] CAN/CSA – S6 : 19 Canadian Highway Bridge Design Code,

[3] Manuel de conception des structures, MTQ December 2021

[4] Formulaire de rdm des techniques de l'ingénieur.

[5] Software SAFI v14.0.3,

2.1.2 Documents

[6] 776872_offre_CNG_study_bridge_Wemindji,

[7] Study 152700393_200-110-PO-R-0001-0 « Damage survey of the access road bridge over Maquatua river in Wemindji",

2.2 EXISTING CONDITION

The existing conditions have been surveyed on the site by the inspection team. Refer to report 152700393_200-110-PO-R-0001-0 for additional information regarding field conditions including number and location of braces.

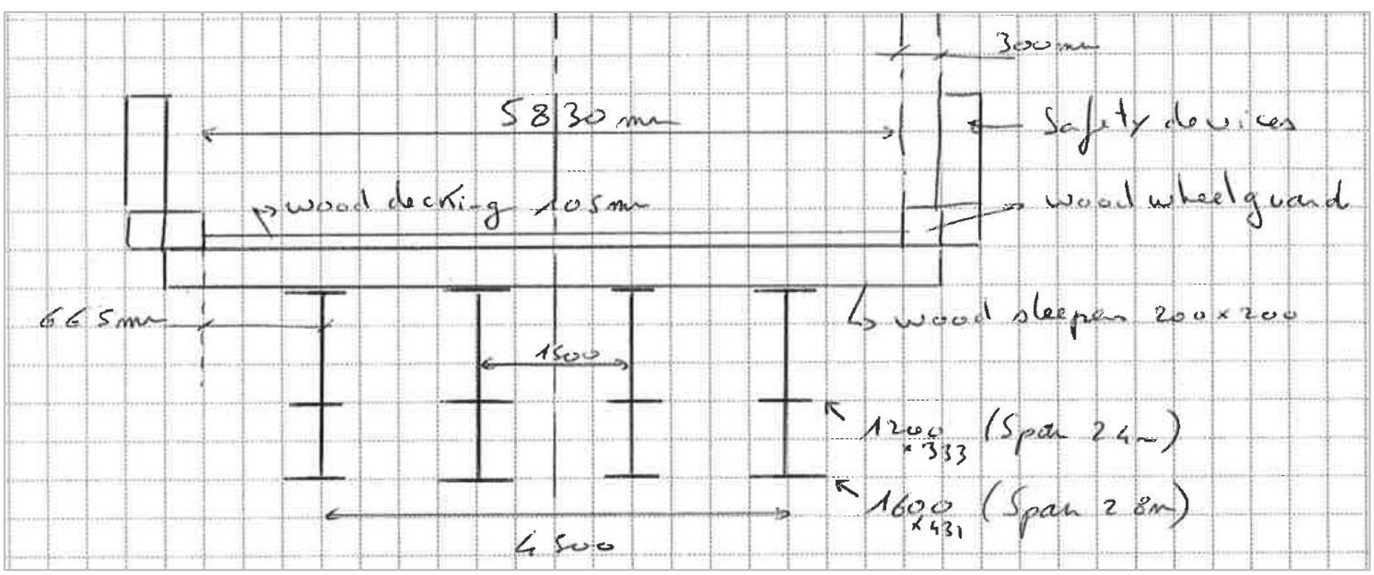

Figure 2-1 : Cross Section

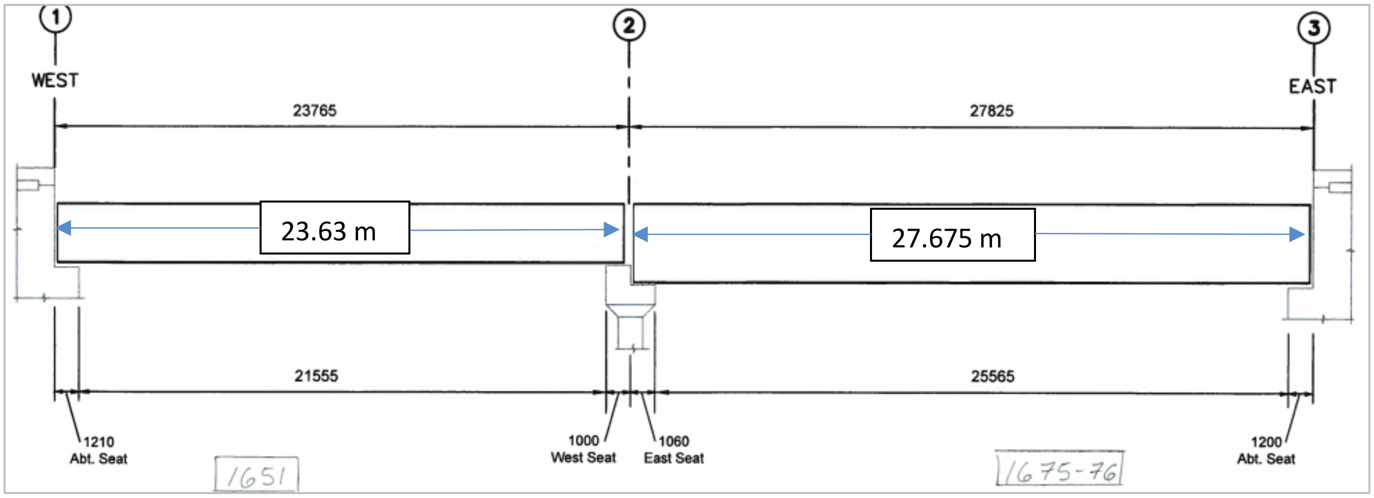

Figure 2-2: Elevation view

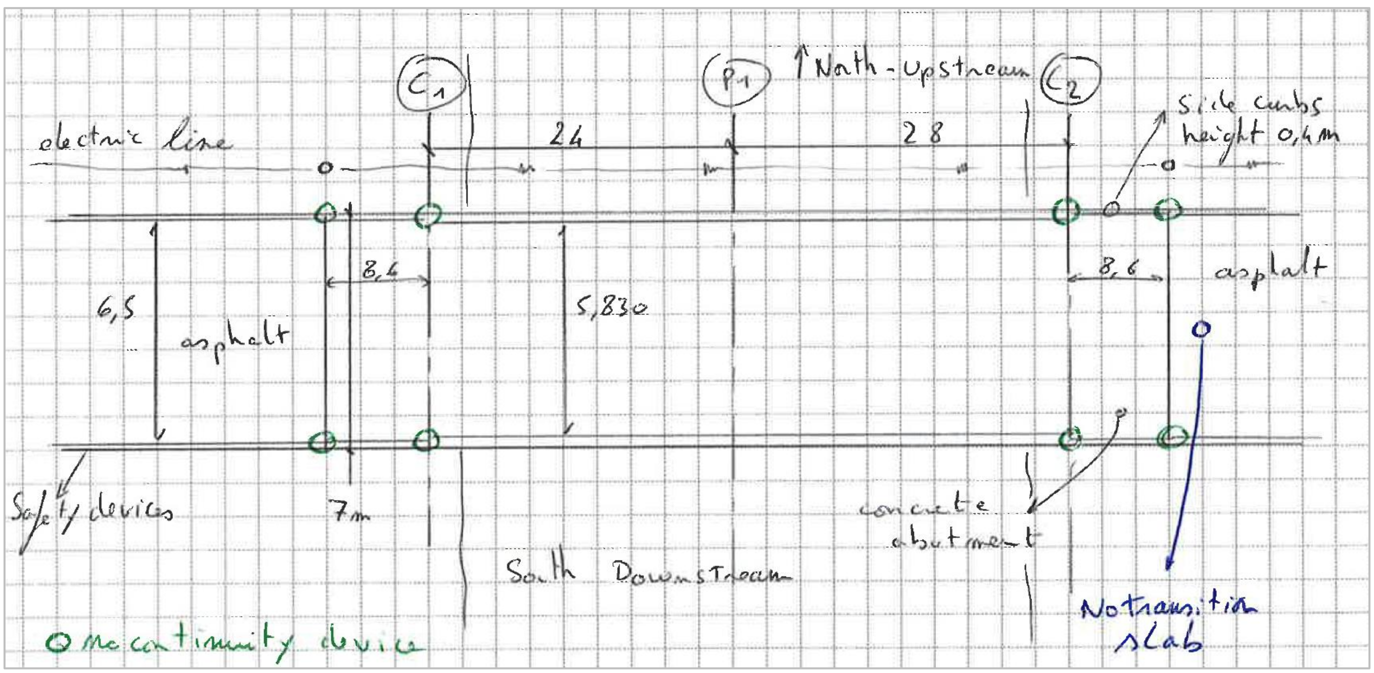

Figure 2-3 : Plan view

2.3 Missing data and hypothesis

2.3.1 Missing data

The following information was not available prior to this study :

- Dimensions of steel beams : thickness of webs and lower and upper flange of the 1600 steel beam; width of the lower flange of the 1600 steel beam,

- Geotechnical report,
- Drawings of the current bridge and site reports of the current bridge,
- Dimensions and type of bearing mechanism,
- Presence of transition slabs behind concrete abutments.

2.3.2 Hypothesis to be validated

We took those hypothesis in the study :

- Material properties :
  - Wood elements : see section 3.1.1,
  - Steel elements : see section 3.1.2
- Dimensions of the steel beams: (grade G40.21 350AT)
  - For 28 m span : 4 steel beams WWF 1600 x 431,
  - For 24 m span : 4 steel beams WWF 1200 x 333.

We assume that the beams of the structure are made of weathering steel. We also note that the vehicles circulate directly on the concrete slabs of the abutments (without any bituminous overlay). We therefore recommend not to use de-icing salt on the structure and its approaches to prevent premature deterioration of the beams and abutments.

2.3.3 Differences between Standards/Existing structure

The usable width of the structure is 5.83 m instead of 6.706 m for a MTQ standard two-way steel-wood structure. We notice a difference of 876 mm. According to MTQ standards, a structure with a usable width of 5.83 m is a one-road structure only.

The width of the road outside of the structure is about 6.5 m plus shoulders and, therefore, seems to correspond to a type D road, i.e. two lanes of 3.3 m with 2x1 m gravel shoulders. Therefore, we note a significant narrowing of the roadway, especially if two heavy vehicles arrive at the bridge at the same time or for potential pedestrians crossing the bridge while a vehicle comes across.

The barrier on the bridge and its approaches are not up to standard. There is no continuity between the guard rail along the road and the concrete barrier on the bridge abutments. Also, there is no continuity between the concrete barrier and the wood barrier on the bridge.

Currently, none of the barriers near the structure provide adequate safety for users. In the event of an accident, the owner may be deemed responsible if the barrier systems do not comply with the code requirements (lack of continuity) and is likely to face legal proceedings.

It seems there is no transition slab between concrete abutments and the road. In time, a sag of the approach embankment, or a deterioration of the abutment's concrete may occur.

In the event of an accident on the structure, the barrier must protect the users. Consequently, the barriers must have a minimum height of 0.9 m for vehicles and can go up to 1.10 m when pedestrians are allowed on the structure and 1.40 m for bicycles. However, the concrete curbs on the abutments have a height of less than 40 cm. These systems will have to be raised to ensure the safety of the users according to the vocation of the structure.

As for damages observed on the site, permanent deformations of the guard rail outside the structure have been noted (see doc ref [7]). An oblique cracking, which begins in the corner of the stair step in the southern part of the structure have also been noted on the pier cap. The crack is less than 0.8 mm wide (see doc ref [7]).

Accumulation of rubble near the abutment and pier bases are present. Regular cleaning of the structure shall be performed.

We do not observe any notable deterioration linked to the corrosion of the steel beams. However, we recommend repainting the upper flanges of the structure during the installation of the new wooden deck to ensure its protection and durability.

We do not see any cracking or delamination of the concrete that would suggest carbonation deterioration.

We will not recommend correction of the concrete related to the carbonation of it.

3. CALCULATION HYPOTHESIS

3.1 MATERIALS

3.1.1 Wood structure

Wood structures : wood decking, wood sleepers, wheel guard and safety devices. All these elements would be in “SPF” quality n°1

Wood : Spruce – Pine - Fir (SPF).

Fbu = 9,6 MPa, Fvu = 1,2 MPa, Fqu = 3,6 MPa, ρ = 0,612 t/m³ et E = 10 GPa

3.1.2 Steel beam

Span n°1 : 4 beams : WWF 1200 x 333, Fy = 350 MPa de classe W, E = 200 GPa, ρ = 7,85 t/m³.

Span n°2 : 4 beams : WWF 1600 x 431, Fy = 350 MPa de classe W, E = 200 GPa, ρ = 7,85 t/m³.

The coefficient of resistance of steel beams subjected to shear , cf chapter 10.5.7.b doc ref [2], is : Φs = 0,95.

The resistance coefficient of steel beams subjected to bending, cf 10.5.7.a doc ref [2], is : Φs = 0,95.

3.2 BRIDGE AND LOAD DESCRIPTION

3.2.1 Bridge description

Road class: C – this hypothesis remains to be validated; we will use a road class A in this document

Tableau 1.1
Classes de route
(voir l'article 1.4.2.2)

Classe de route	Débit journalier moyen (DJM) par voie (nombre de véhicules)	Débit journalier moyen de camions (DJMC) par voie (nombre de véhicules)
A	> 4000	> 1000
~~B~~	~~> 1000 à 4000~~	~~> 250 à 1000~~
C	100 à 1000	50 à 250
D	< 100	< 50

Figure 3-1 : type of road

Structure category : slender structure (table 5.2 doc ref [2]).

Structure type : wood decking on wood sleepers on steel beam, type C cf § 5.1 doc ref [2].

Road width on the bridge: Wc = 6706 mm (cf. tab 9.2.1 doc ref [3]).

The calculation width road is calculated according to chapter § 3.8.2 doc ref [2] and according to table 3.4 with n = 2 : We = Wc/n = 3,353 m

Span : $L_{span\ n°1}$ = 24 m, $L_{span\ n°2}$ = 28 m.

Type of additional load : D2

14.8.2.1 General

Dead load shall include the weight of all components of the bridge, fill, utilities, and other materials permanently on the bridge. Dead loads shall be determined from available plans and verified with field measurements in accordance with Clause 14.6.

Dead load shall be apportioned to three categories, D1, D2, and D3, as follows:

a) D1: dead load of factory-produced components and cast-in-place concrete, excluding decks;
b) D2: cast-in-place concrete decks (including voided decks and cementitious concrete overlays), wood, field-measured bituminous surfacing, and non-structural components; and
c) D3: bituminous surfacing where the nominal thickness is assumed to be 90 mm for the evaluation.

Figure 3-2 : Type of additional charges

3.2.2 Truck load

We consider the CL-625 (as defined in doc ref [2]) as the road overload. The dynamic increase coefficient is determined according to tables 3.2.4 and 3.2.5 of chapter § 3.2.2.2 doc ref [3] : CMD shear force = 0,25 and CMD bending moment = 0,25.

3.2.3 Distribution factor

We calculate the distribution factors in accordance with table 5.2 of chapter § 5.7.1.1 doc ref [2].

3.2.3.1 Longitudinal vertical shear

We calculate the shear distribution factor in accordance with the chapter § 5.7.1.4 doc ref [2], with :

- S, the spacing of the beams : 1,50 m
- n number of lanes : 2
- RL, the modifying factor cf. § 3.8.4.2 doc ref [2] : 0,9
- F, the width which characterizes the distribution of the load for a bridge cf. tab 5.7 of § 5.7.1.4.1.2 doc ref [2] : 4,60 m

$$Vg/_{V_T} = \frac{S \cdot n \cdot R_L}{F} = \frac{1{,}50 \times 2 \times 0{,}9}{4{,}6} = 0{,}587 = fec$$

3.2.3.2 Bending moment

We calculate the axle factor in accordance with chapter § 5.7.1.2 doc ref [2], with :

- With F, according to table 5.3 of § 5.7.1.2.1.2 doc ref [2] : 4,60 m.
- With Cf, the correcting factor of tab 5.3 of chapter § 5.7.1.2.1.2 doc ref [2] : 0.

$$Mg/_{M_T} = \frac{S \cdot n \cdot R_L}{F \cdot \left[1 + \frac{\mu \cdot Cf}{100}\right]} = \frac{1{,}50 \times 2 \times 0{,}9}{4{,}6\left[1 + \frac{\mu \times 0}{100}\right]} = 0{,}587 = fem$$

4. VERIFICATION OF THE EXISTING BRIDGE

Preliminary checks show that the girders of the 28 m span have a greater reserve capacity than the girders of the 24 m span. Consequently, we will only check, via the Safi software, the beams of the 24 m span.

4.1 ANALYSIS RESULTS

The software "SAFI Pont Acier-Bois v14.0.3" was used to check the capacity of the existing bridge.

The following show the input data of the software as well as the main results obtained.

4.2 INPUT DATA

Design of wood bridge :	Code: CAN-CSA/S6-19

4.2.1 General properties

Mode of work :	MTQ
Design Truck :	CL1-625A
Road class :	A

Number of roads :	**1**
Clear span :	24000 mm
Number of steel beams :	4
Road width usable by vehicles :	5830 mm
Barrier weight :	0.650 kN/m
Side supports :	L76x76x9.5
Spacing c/c of side supports :	3600 mm
Deflection criteria :	L/275
Load use for deflection :	0.9*truck*(1+CMD), distribution factor includes the "0.9" effect

4.2.2 Characteristic of the deck

width of wood sleepers :	200 mm
Thickness of wood sleepers :	200 mm
Spacing c/c between wood sleepers :	200 mm
Overlapping of wood sleepers :	No overlap
Thickness of decking :	105 mm

Wood : Spruce– Pine - Fir. (Quality No. 1)

Fbu = 9.6 MPa Fvu = 1.2 MPa Fqu = 3.6 MPa

4.2.3 Vue en coupe du modèle étudié

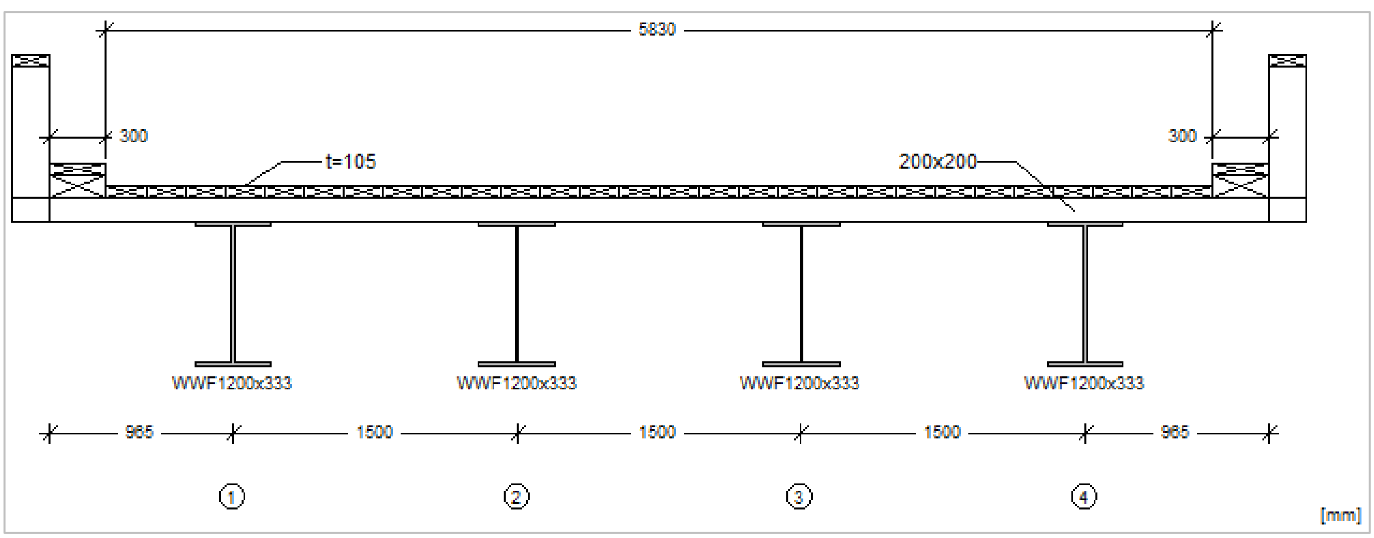

Figure 4-1 : Cross section

4.2.4 Conclusion of analysis

Facteurs de capacité de surcharge (F)

Poutres d'acier

0 4	CL1-625	CL2-625	CL3-625
Flexion	2.53	2.55	3.14
Cisaillement	5.98	6.70	8.55
Flèche	2.86	3.07	4.10
Capacité	161.0 t	123.7 t	96.0 t

Traverses de bois

0 4	CL1-625	CL2-625	CL3-625
Flexion	1.20	1.20	1.20
Cisaillement	2.02	2.02	2.02
Écrasement	3.14	3.14	3.14
Capacité	76.8 t	58.3 t	36.8 t

Affichage recommandé: D-200, D-200-P

Figure 4-2 : Conclusion of SAFI

The overload capacity factors obtained from the Safi software indicate that the current bridge, considering a single traffic lane, has sufficient resistance to support the design load without modification.

It is recommended to install a D-200 display panel indicating a one lane passage restriction, the current width being insufficient to allow 2 lanes on the bridge.

5. WIDENING SOLUTIONS

5.1 SOLUTION N°1 – WIDENING OF THE STRUCTURE TO 6.706 M ROAD WIDTH

We check the possibility of widening the structure so that it meets the standards for a two-lane structure, while keeping the existing steel beams without modifying their position.

5.1.1 Cross section studied

The software does not allow us to make a model at 6.706 m with cantilevers greater than 1.20 m (sleepers usually can't support a longer cantilever). We have therefore modified the cross-section in order to tend towards a useful width of 6.706 m; For purpose of sizing and calculation verification, we retained a width usable by vehicles of 6.500 m and curb of 0.2 m.

We present the cross section of the solution n°1

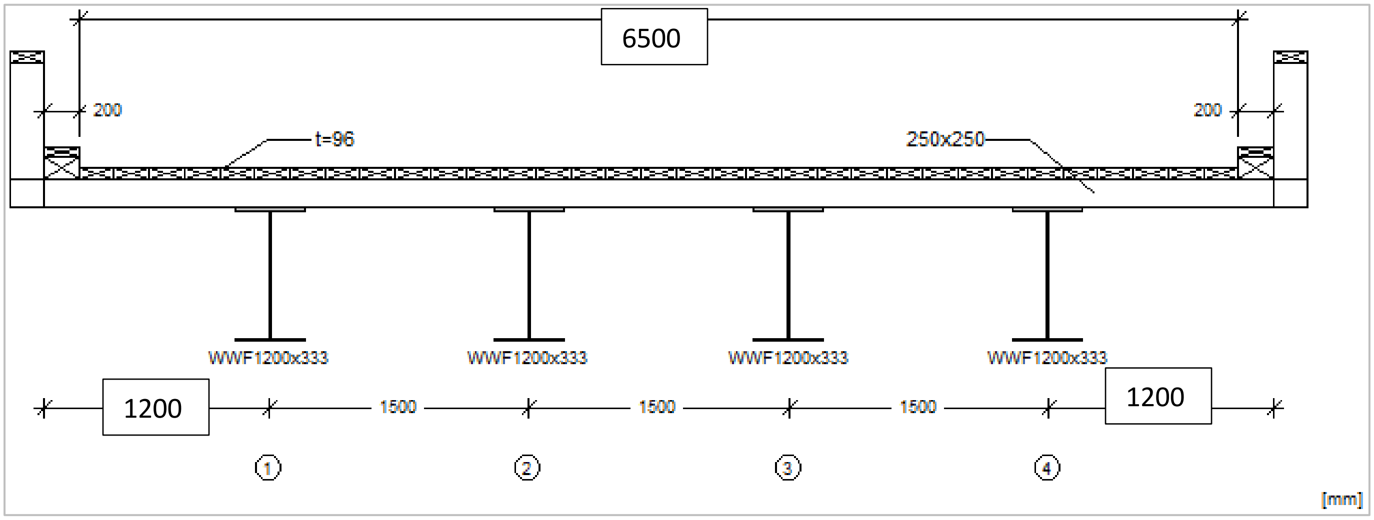

Figure 5-1 : cross section

5.1.2 Modifications between the existing bridge and the planned bridge

Below, we list modifications between the existing bridge and the planned bridge of solution n°1.

	Proposed deck	Existing deck
• usable width:	6.500 m	5.830 m,
• curb :	0.2 x 0.2	0.3 x 0.3,
• wood decking :	96 mm	105 mm,
• Wood sleepers :	250 x 250	200 x 200.

5.1.3 Conclusion of analysis

Facteurs de capacité de surcharge (F)

Poutres d'acier				Traverses de bois			
0 4	CL1-625	CL2-625	CL3-625	0 4	CL1-625	CL2-625	CL3-625
Flexion	2.45	2.48	3.04	Flexion	1.21	1.21	1.21
Cisaillement	6.37	7.15	9.11	Cisaillement	2.24	2.24	2.24
Flèche	2.10	2.25	3.01	Écrasement	3.08	3.08	3.08
Capacité	156.1 t	120.0 t	93.1 t	Capacité	77.3 t	58.8 t	37.1 t

Figure 5-2 : Conclusion

5.1.4 Consequences on concrete abutment

The widening of the structure requires a widening of the usable width on the abutment and therefore the removal of the concrete side curbs on the abutment.

The widening can be carried out using lateral corbels, as shown in the diagram below.

Keeping the beam centre lines has the advantage of minimizing the work on the supports with possible widening of piers and abutments.

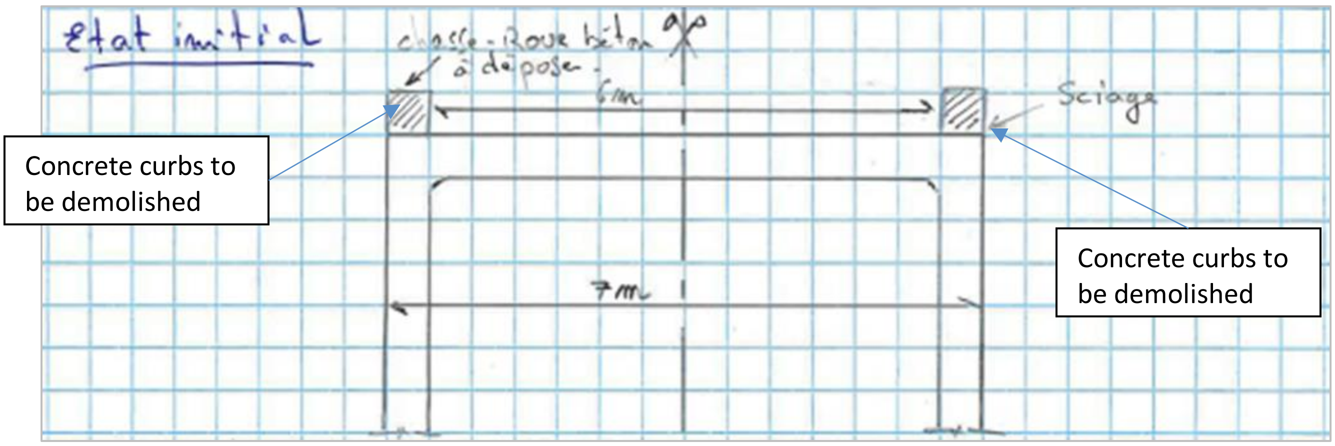

Figure 5-3 : Concrete abutment

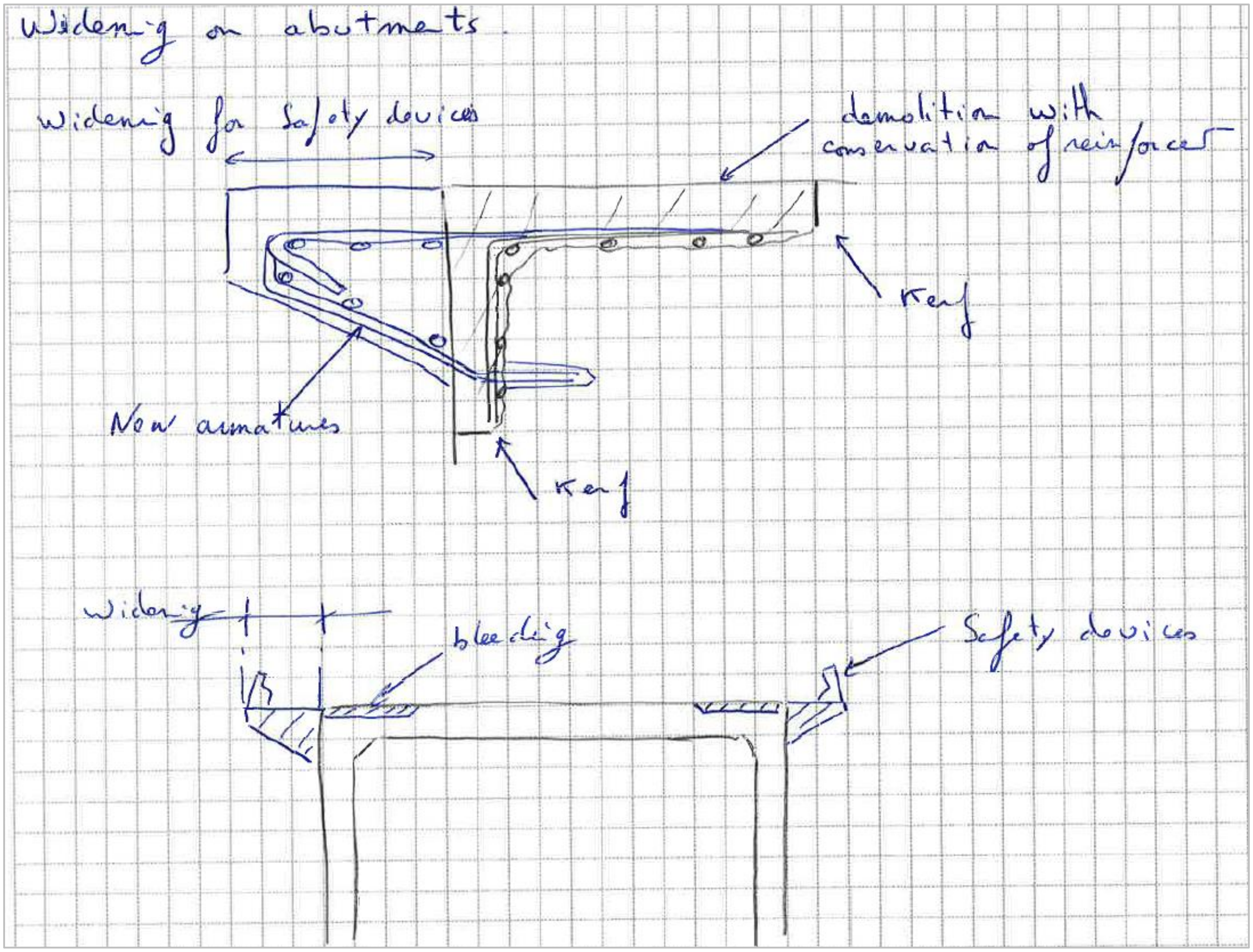

Figure 5-4 : Details

Required Work on abutments :

- The relocation of the curbs,
- Widening of the running surface according to the widening of the roadway on the structure,
- Anchorage of the reinforcement of the widening in the abutment,
- Construction of barriers on the edges of abutments with the implementation of overlapping systems to bring the safety devices into conformity on and off the structure.

5.2 SOLUTION N°2 - WIDENING OF THE STRUCTURE TO 8,206 M ROAD WIDTH

In addition to the widening of the structure to 6.706, in order to comply with the minimum standards for double road structures, we are considering the possibility of carrying out an additional widening by adding two service tracks of 0.75 m wide to give more space for pedestrians.

This widening leads to a width of 8,206 m usable by vehicles and pedestrians on the structure.

5.2.1 Cross section studied

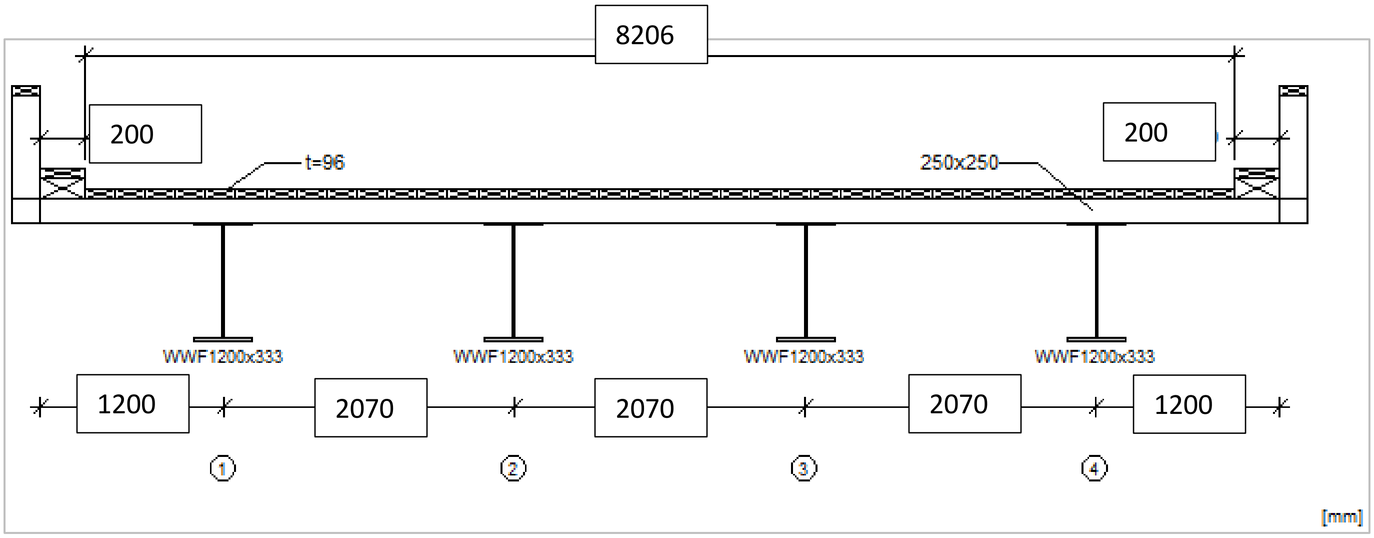

Figure 5-5 : Cross section

5.2.2 Modifications between the existing bridge and the planned bridge

Below, we list modifications between the existing bridge and the proposed bridge for solution n°2 :

	Proposed deck	Existing deck
• usable width:	8.206 m	5.830 m,
• curb :	0.2 x 0.2	0.3 x 0.3,
• wood decking :	96 mm	105 mm,
• wood sleepers :	250 x 250	200 x 200,
• Spacing between steel beams :	2.07 m	1.50 m.

5.2.3 Conclusion of analysis

Facteurs de capacité de surcharge (F)							
Poutres d'acier				Traverses de bois			
0 4	CL1-625	CL2-625	CL3-625	0 4	CL1-625	CL2-625	CL3-625
Flexion	2.12	2.14	2.63	Flexion	1.21	1.21	1.21
Cisaillement	5.54	6.21	7.91	Cisaillement	2.30	2.30	2.30
Flèche	2.14	2.30	3.07	Écrasement	3.02	3.02	3.02
Capacité	134.9 t	103.7 t	80.4 t	Capacité	77.3 t	58.8 t	37.1 t

Figure 5-6 : Conclusion of SAFI

According to the result, the load capacity is governed by the capacity of the sleepers.

5.2.4 Consequences on supports

5.2.4.1 Abutment widening

Abutments are 7 m wide overall.

The widening of the roadway to 8,206 m entails :

- Removal curbs and widening of the roadway similar to solution no.1;
- Removal of existing seats bloc and construction of new ones;
- Widening of the abutments using reinforced concrete corbel as show below.

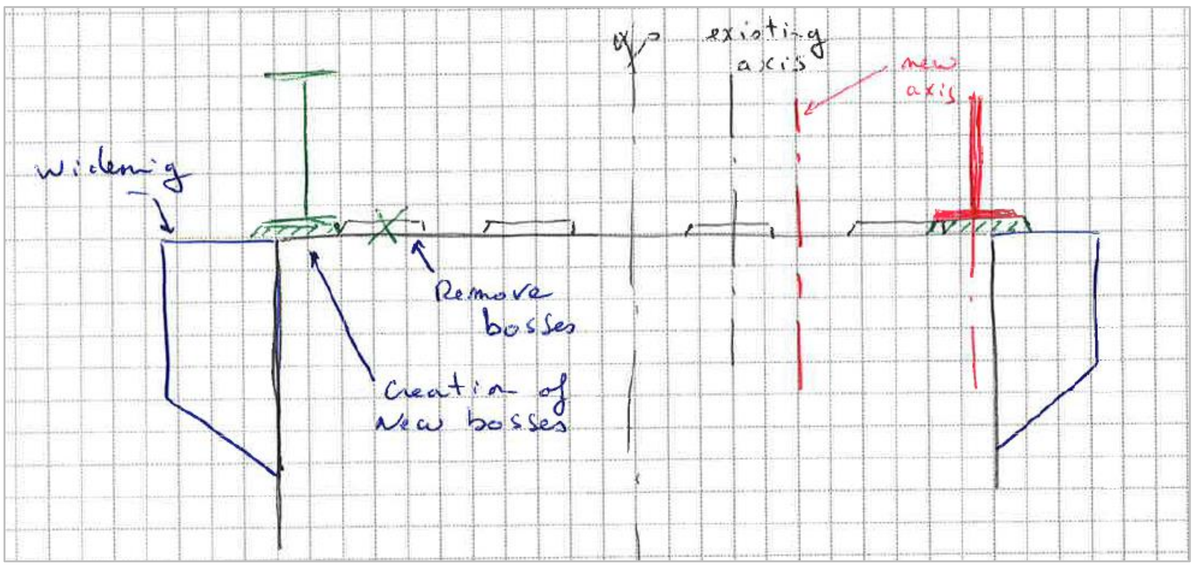

Figure 5-7 : Abutment widening

5.2.4.2 Widening of the pier

The increase in the spacing between the steel beams implies a widening of the pier cap.

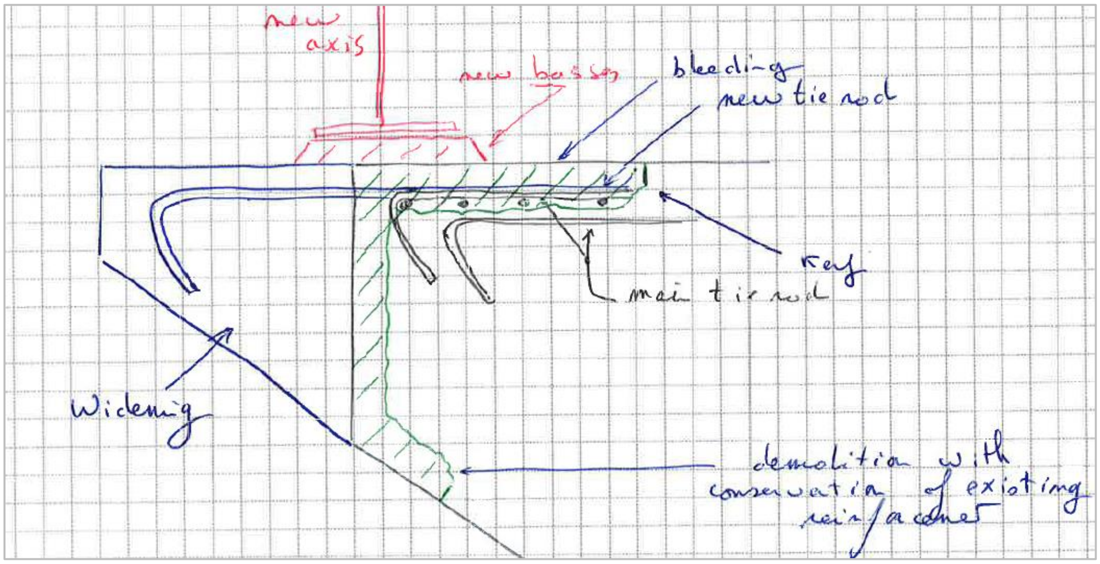

Figure 5-8 : Pier cap widening details

5.3 SOLUTION N°3 - WIDENING OF THE STRUCTURE TO 8.206 M

5.3.1 Cross section studied

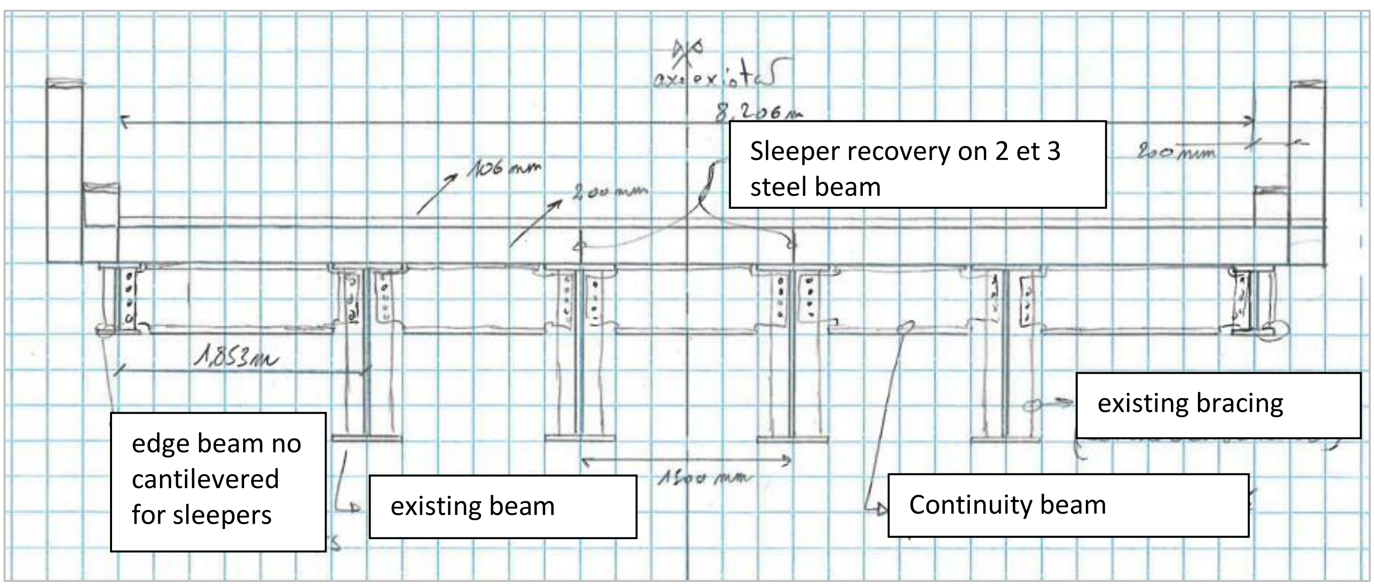

Figure 5-9 : cross section

5.3.2 Modifications between the existing bridge and the planned bridge

This solution is similar to the previous one, but there is no need to relocate the girders. Since the sleepers are the limiting elements, we add a support beam at the edge to limit the sleeper's span. Below, we list modifications between the existing bridge and the proposed bridge solution n°3 :

	Proposed deck	Existing deck
• usable width :	8.206 m	5.830 m,
• Curb :	0.2 x 0.2	0.3 x 0.3,

- Bracing : a continuity beam will be added in order to distribute the loads of the edge beams to the existing beams.
- Overhang : edge beam 1 m.

5.3.3 Sizing

The dimensioning of this solution requires a sophisticated model which will be produced in the preliminary design phase. We did a predesign of the side beam for estimation purpose.

Validation of the various previous solutions demonstrate the ability of the existing main beams to take up loads brought by this arrangement.

5.3.4 Consequences on supports

The vertical loads will be greater on the widened structure, it is therefore possible that it will be necessary to rework the seat blocks in order to avoid cracking of the existing ones.

The upper part of abutments is to be widened similar to solution no.1.

5.4 SOLUTION N°4 - WIDENING OF THE STRUCTURE TO 8.206 M

5.4.1 Cross section studied

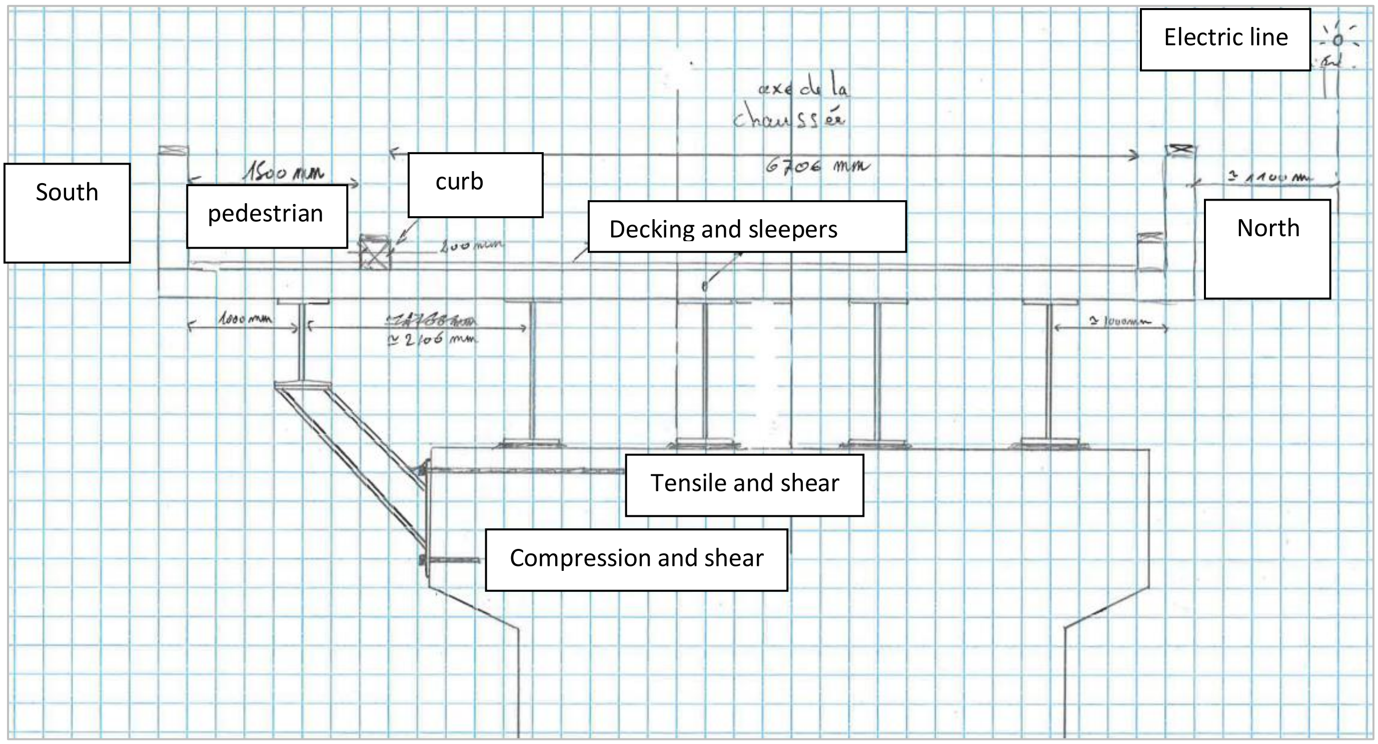

Figure 5-10 : cross section

The same principle of fixing the additional side beam will be considered on abutments.

5.4.2 Modifications between the existing bridge and the planned bridge

The road way will be widened to 6,706 m to accommodate 2 lanes of traffic, and a sidewalk will be added on one side of the structure for pedestrians. Below, we list modifications between the existing bridge and the proposed bridge for solution n°4 :

	Proposed deck	Existing deck
• usable width by vehicles :	6.706 m	5.830 m,
• usable width by pedestrians :	1,5 m	
• curb :	0.2 x 0.2	0.3 x 0.3,
• number of beams :	5	4

5.4.3 Sizing

If a barrier is installed between the road way and the sidewalk, the new edge beam can be smaller since the load on the sidewalk will be limited to pedestrians. Girders similar to the existing one can also be used for visual aspect of the bridge. But if there is no barrier, it means trucks can go on the side and the edge beam will need to be the same size as the others.

Validation of the various previous solutions demonstrate the ability of existing main beams to take up loads brought by this arrangement.

5.4.4 Consequences on supports

The removal of the concrete curbs from the abutments is still necessary even in the non-widened area.

The pier cap will not need to be widened with concrete. However the verification of the pier stability will still be necessary.

Anchor rods will be made in the pier cap as well as in front walls of abutments. In order to avoid the main reinforcements of concrete structures, it will be necessary to locate the existing reinforcement and adjust the positioning of tie rods.

5.4.5 Reasons of elimination

Solution no.4 was not retained as a viable solution. This solution consists of channelling all pedestrian traffic on one side of the structure and separating it from the roadway in order to increase pedestrian safety.

As far as we are concerned, this arrangement does not seem to be suitable for the development of the site, which does not present any differentiated pedestrian traffic from the Wemindji road path. This solution should be considered as part of a larger development in which a pedestrian path would pass through the structure. Furthermore, the solution with braces anchored in concrete structures is not very esthetic.

6. ADDITIONAL DEMAND

6.1 CONCRETE SLAB ON EXISTING BEAMS

The solution of replacing the wooden deck with a concrete slab has been considered without adding an expansion joint over the pier between the two spans. Therefore, the bridge will become semi-continuous.

Beams for steel-wood structure have no initial camber, therefore the construction of a concrete slab with the addition of dowels can produce a permanent deflection of the steel beams. Even if the resistance of the beams is adequate, it can be troubling for the user to see the deflection and can also lead to drainage problems.

The addition of a 200 mm thick concrete slab will increase the load on the support of 500 kN for the 24 m span and 580 KN on the support of the 28 m span. The load of the steel beam and wood deck on the supports is currently 166 kN for the 24 m span, and 196 kN for the 28 m span.

The load capacity of the existing beams should be sufficient. Once in place, with the addition of shear stud on the beams, the concrete slab will take part in the support of the live load on the bridge.

It will be necessary in the subsequent phases of the project to check the stability and deflection of the steel beams during the pouring of the slab.

. Abutments and the pier are laid directly on the roc. Stability and bearing capacity will need to be checked with the new slab, but capacity of that type of foundation is usually of sufficient capacity.

With the addition of a concrete slab, the beams will need to be respaced at 2 m centre to centre to accommodate the new width.

6.2 NEW BRIDGE

To better suit any needs of the community, it is also an option the build an entirely new bridge. In this case, the new bridge can be as wide as needed to accommodate vehicles and pedestrians. It could also be a great opportunity to have a signature bridge near the community. An example of bowstring type bridge is shown below. It could be made of steel or laminated wood. However the more complex the structure become, the more the cost will increase accordingly.

In the case of the construction of a structure equipped with a concrete decking, it would be possible to requalify the current structure as a pedestrian structure and to build, alongside the existing structure, a new bridge which would take up user traffic. This solution would require the modification of the road alignment in order to make a connection on the new structure.

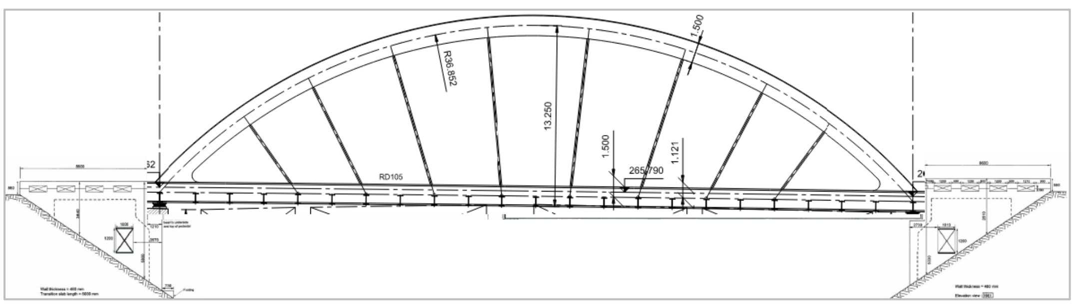

Figure 6-1 : Bowstring

7. ESTIMATION OF SOLUTIONS

In order to widen the existing bridge or to replace it, a temporary bridge and a diversion path will need to be built along the side of the existing one, or a detour, if one exists, will need to be put in place. In any case the cost for the work on the bridge does not include maintenance of service of the roadway during construction.

When needed, the work of demolition and reconstruction of seats blocks are included with the cost of the abutments head beam.

Table 7-1 : Estimation Solution no.1

Encryption Possibility n°1		Designation	unity	Quantity	PUHT		%
# 1	177 000	General prices					24,25%
	1	Mobilization and site organization	Lump		138 000	138 000	
	2	Demolition of existing bridge	Lump		39 000	39 000	
# 2	26 000	Earthworks and foundations					3,56%
	1	Excavations and filling	m3	300	40	12 000	
	3	Safety devices (type 1)	u	4	3500	14 000	
# 3	84 200	Abutment					11,53%
	1	Concrete (including grooves and formworks)	m3	21	2400	50 400	
	2	Reinforcement (including anchoring in existing)	kg	3100	8	24 800	
	3	Barriers	ml	36	250	9 000	
#4	259 600	Deck					35,56%
	1	Wood sleepers	m3	91	2000	182 000	
	2	Wood decking	m3	33	1800	59 400	
	3	Wheel guard	ml	52	100	5 200	
	4	Barriers	ml	52	250	13 000	
# 6	90 000	Various					12,33%
	1	Safety devices connection : bridge / abutment	unité	4	1500	6 000	
	2	Safety devices connection : abutment / road	unité	4	1000	4 000	
	3	Fill at approaches	m2	160	500	80 000	
	4	Wearing surface (approaches 15 m each side)	t	75	280	21 000	
# 7	72 000	Miscellaneous					9,86%
	1	Miscellaneous not detailed	Lump		72 000	72 000	
Cost per m²	2470 $/m²				Total	730 000 $	
Surface	370 m²		contingency	25%	Total (cont)	912 500 $	

Table 7-2 : Estimation Solution no.2

Encryption Possibility n°2		Designation	unity	Quantity	PUHT		%
# 1	255 000	General prices					24,24%
	1	Mobilization and site organization	Lump		199 000	199 000	
	2	Demolition of existing bridge	lump		56 000	56 000	
# 2	26 000	Earthworks and foundations					2,47%
	1	Excavations and filling	m3	300	40	12 000	
	2	Safety devices (type 1)	unit	4	3500	14 000	
# 3	122 000	Abutment and pier					11,60%
	1	Concrete (including grooves and formworks)	m3	31	2200	68 200	
	2	Reinforcement (including anchoring in existing)	kg	5600	8	44 800	
	3	Safety devices	ml	36	250	9 000	
	4	Concrete Abutment (including grooves and formwo	m3	2	2200	4 400	
	5	Reinforcement (including anchoring in existing)	kg	660	8	5 280	
	6	Head beam of abutments	m2	17	1200	20 400	
	7	Concrete pier (including grooves and formworks)	m3	2	2400	4 800	
	8	Reinforcement (including anchoring in existing)	kg	540	8	4 320	
	9	Head beam of the pier	m2	17	1200	20 400	
#4	388 645	Deck					36,94%
	1	Wood sleepers	m3	111	2000	222 000	
	2	Wood decking	m3	40	1800	72 000	
	3	Wheel guard	ml	52	100	5 200	
	4	Safety devices	ml	52	250	13 000	
	5	Painting of beams	m2	233	80	18 640	
	6	Bracings	kg	7226	8	57 805	
# 6	97 000	Various					9,22%
	1	Safety devices connection : bridge / abutment	unit	4	1500	6 000	
	2	Safety devices connection : abutment / road	unit	4	1000	4 000	
	3	Fill at approaches	m2	132	500	66 000	
	4	Wearing surface (approaches 15 m each side)	t	75	280	21 000	
# 7	104 000	Hazards					9,89%
	1	Hazards (including miscellaneous not detailed)	Lump		104 000	104 000	
Cost per m²	2940 $/m²				Total	1 052 000 $	
Surface	448 m²		contingency	25%	Total (cont)	1 315 000 $	

Table 7-3 : Estimation Solution no.3

Encryption							
Possibility n°3		Designation	unity	Quantity	PUHT		%
# 1	205 000	General prices					21,83%
	1	Mobilization and site organization	Lump		160 000	160 000	
	2	Demolition of existing bridge	Lump		45 000	45 000	
# 2	26 000	Earthworks and foundations					2,77%
	1	Excavations and filling	m3	300	40	12 000	
	2	Safety devices (type 1)	unit	4	3500	14 000	
# 3	122 000	Abutment					12,99%
	1	Concrete (including grooves and formworks)	m3	31	2200	68 200	
	2	Reinforcement (including anchoring in existing)	kg	5600	8	44 800	
	3	Safety devices	ml	36	250	9 000	
#4	393 160	Deck					41,87%
	1	Wood sleepers	m3	57	2000	114 000	
	2	Wood decking	m3	40	1800	72 000	
	3	Wheel guard	ml	52	100	5 200	
	4	Safety devices	ml	52	250	13 000	
	5	Painting of beams	m2	230	80	18 400	
	6	repartition beams	kg	6720	8	53 760	
	7	edge beams	kg	14600	8	116 800	
# 6	97 000	Various					10,33%
	1	Safety devices connection : bridge / abutment	unit	4	1500	6 000	
	2	Safety devices connection : abutment / road	unit	4	1000	4 000	
	3	Fill at approaches	m2	132	500	66 000	
	4	Wearing surface (approaches 15 m each side)	t	75	280,00 $	21 000	
# 7	96 000	Miscellaneous					10,22%
	1	Miscellaneous not detailed	Lump		96 000	96 000	
Cost per m²	2620 $/m²			round	Total HT	939 000 $	
Surface	448 m²			25%	Total TTC	1 173 750 $	

8. SYNTHESIS TABLE AND RECOMMENDATIONS

8.1 SYNTHESIS TABLE

	Solution n°1	Solution n°2	Solution n°3
Usable width	6.706 m	8.206 m	6.706 m (trucks) 1,5 m pedestrian
Deck's surface	370 m²	450 m²	450 m²
Curb	0.2 x 0.2 m	0.2 x 0.2 m	0.2 x 0.2 m
thickness of wood decking	96 mm	96 mm	105 mm
Straight sections of wood sleepers	250 x 250 mm	250 x 250 mm	197 x 203 mm
spacing between centre lines of steel beam	1.50 m	2.0 m	1.50 m
Bracing	unchanged	new	partially replaced

	Solution n°1	Solution n°2	Solution n°3
Number of steel beams	4	4	4 main girders and two edge beams
Lengh of the overhanging of wood sleepers	1.20 m	1.20 m	none
modification to the upper slab of abutments	Relocate barrier	Relocate barrier and widening the slab – more than 0,6 m	Relocate barrier and widening the slab – more than 0,6 m
Modification of abutments and pier width	unchanged	Yes widening abutment and relocation of seats blocks	unchanged
Barriers on bridge	conforming to standards	conforming to standards	conforming to standards
Barriers - approach	Not necessary	Yes – connection and widening of the roadway on the structure	Yes – connection and widening of the roadway on the structure
Safety of pedestrians	Improved like standards	Improved with increase of road way by 0,75 m per direction	Improved with increase of road way by 0,75 m per direction
Bearing mechanism	Unchanged - To be confirmed in preliminary design	Unchanged - To be confirmed in preliminary design	Unchanged - To be confirmed in preliminary design
Cost HT	912 500 \$ 2 470 \$/m²	1 315 000 \$ 2 940 \$/m²	1 173 000 \$ 2 620 \$/m²

8.2 RECOMMENDATION

Wood Deck:

For the safety of the vehicles and pedestrians, we do recommend a large widening of the bridge deck, and we recommend solution no.2.

Solution no.1 is the least expensive but offer very few additional protections for the pedestrian. However, it is possible to increase security by building a dedicated footbridge alongside the existing bridge. This could be a viable solution. But the addition of a dedicated footbridge will bring the total price of the project around 1,2 M\$ in the same range as solutions no.2 and no.3.

Concrete Deck:

The weight of the concrete deck and the absence of knowledge on the existing one leads us to recommend the construction of a new bridge. In this case we recommend building a bridge with the road and pedestrians on the same bridge. We estimated the following for a complete bridge replacement

- Slab on a girder bridge : 6,25 M\$: 50 m long * 12,5 m width * 10°000 \$/m²,
- Signature bridge : 11,25 M\$: 50 * 12.5 * 18°000 \$/m²,

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APPENDIX – INSPECTION REPORT WEMINDJI

Stantec

CREE NATION GOVERNMENT

DAMAGE SURVEY OF THE ACCESS ROAD BRIDGE OVER MAQUATUA RIVER IN WEMINDJI

2019 DAMAGE SURVEY REPORT

Final version

Damage Survey of the Access Road Bridge Over Maquatua River in Wemindji

2019 Damage Survey Report,

Wemindji, QC Canada

Project #152700393

March 3, 2020

Prepared for:

The Cree Nation Government

Prepared by:

Stantec Consulting Ltd

O/Ref.: 152700393-200-110-PO-R-0001-0

Sign-off Sheet

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OIQ #105497

Revision	Description	Author		Quality validation		Independant review	
0	Final Report	Myriame Fraser	2020-03-03	Alessandro Cirella	2020-02-25	Sylvain Bédard	2019-12-06
A	Preliminary Report	Myriame Fraser	2020-02-05	Alessandro Cirella	2019-10-01	Sylvain Bédard	2019-12-06

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1.0 SCOPE OF WORK

The present section describes the project and work plan of the Wemindji Access Road bridge and the reference documents used in the present damage survey report.

1.1 DESCRIPTION OF PROJECT AND WORK PLAN

In the early-1990's the Cree Nation of Wemindji built its first road access to the community. A 96 km long road is now linking the community to the James Bay Highway. This road is still the only access the community has to the provincial road network. A single traffic lane bridge, over the Maquatua River, is located on the access road approximately 3 km East of the community.

The Cree Nation Government has expressed its desire to validate the feasibility of enlarging the present one lane bridge on the Wemindji Access Road to a two lanes bridge. In order to do this, Stantec was mandated by the Cree Nation Government to provide engineering services for carrying out a damage survey and recommending further maintenance activities. The damage survey report is necessary prior to any feasibility studies for the road bridge enlargement. The program consists in carrying out all the activities related to conducting the detailed inventory, the damage survey and then recommending further maintenance activities keeping in mind the plan to enlarge the bridge roadway.

This report presents the defects observed by Stantec's Inspection team during the damage survey performed in august 2019. The purpose of the survey is to determine the actual bridge condition in order to present maintenance and rehabilitation options in the next phase for the road bridge enlargement. This report is also to detect any material defects that may affect the structure's components, evaluate its condition state and detect any other suspected performance deficiencies regarding public safety, comfort and convenience. Also, a complete dimensional survey was made during the damage survey.

1.2 REFERENCE DOCUMENTS

The damage survey was conducted in accordance with the following documents, published by the Quebec Ministry of Transportation or given to Stantec by the Cree Nation Government:

- Manuel d'inspection des structures, Quebec Ministry of Transportation, published in January 2017;
- Manuel d'inventaire des structures, Quebec Ministry of Transportation, published in January 2017;
- Manuel d'entretien des structures, Quebec Ministry of Transportation, published in January 2016.
- Manuel d'évaluation de la capacité portante de ponts, Quebec Ministry of Transportation, published in february 2015.
- Professional Services proposal – General Inspection and Damage surveyr of the Access Road Brdige in Wemindji, Stantec, April 2018.

2.0 BRIDGE DESCRIPTION

This section presents the Wemindji access road bridge location and its structural description.

2.1 WEMINDJI ACCESS ROAD BRIDGE LOCATION

The Wemindji Access Road Bridge is located about 3 km East from the inlet of the Cree Nation of Wemindji, above the Maquatua River. The Cree Nation of Wemindji sits at the mouth of the Maquatua River on the east coast of James Bay in the Nord-du-Québec administrative region in the province of Québec, Canada.

The purpose of the bridge is to cross the Maquatua River. One lane with shoulders allows the vehicles to enter or exit Wemindji. It is also the only road access to the community.

Figure 1 : *Bridge* Location

The Wemindji Access road bridge's is a one lane bridge on a two lane gravel road, one lane in each direction. No houses or buildings are located near the bridge approaches. Bridge is erected over the Maquatua river and its environment consists of a vast wooded forest.

Figure 2 : Bridge *Environment*

2.2 STRUCTURE DESCRIPTION

The bridge has a structure made of a timber deck on steel girders. It features two non-symmetric spans of four straight steel beams supported by a concrete pier and two concrete abutments. The abutments are hollowed. Each span is independent and simply supported.

The road deck surface (single traffic lane) is made of wood planks while the approaches on both sides are in asphalt. The rest of the access road is in gravel and is undergoing resurfacing process to be paved in 2020.

Figure 3 : North *Elevation*

Figure 4 : *Beams and wood deck*

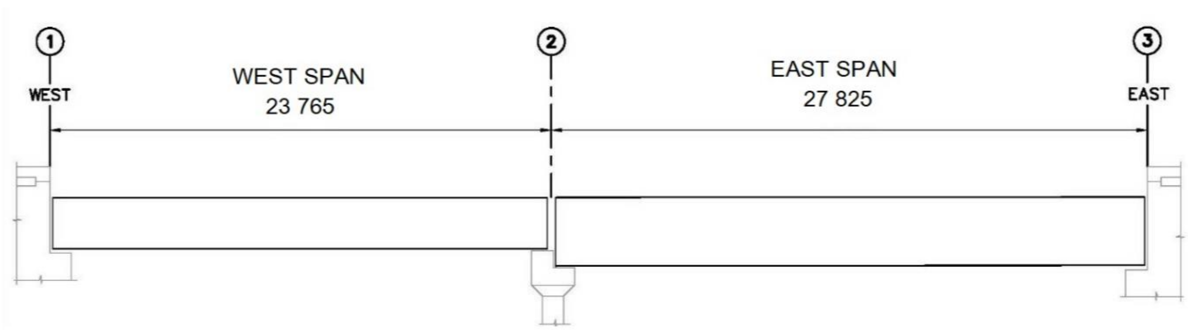
The principal dimensional characteristics are listed in the table below and the complete detailed dimensional inventory can be found in Appendix A.

Table 1 : Principal bridge dimensional characteristics

Bridge characteristics	Dimensions (m)
Bridge total length (including deck and side walls)	68,905 m
Total deck length (wood timbers)	51,32 m
Deck length (wood timbers), by span	• West span: 23,61 m • East span: 27,71 m
Spans length (pier center / abutment wall face)	• West span: 23,765 m • East span: 27,825 m
Bridge lane width	6,050 m (single lane)

Axis number “1” is located at the west side of the bridge (west to Wemindji), axis number “2” is located in the center of the pier and axis number “3” is at the east side of the bridge, (east to James bay highway), as shown on the bridge profile view below:

Figure 5 : *Bridge Profile View*



← West to Wemindji

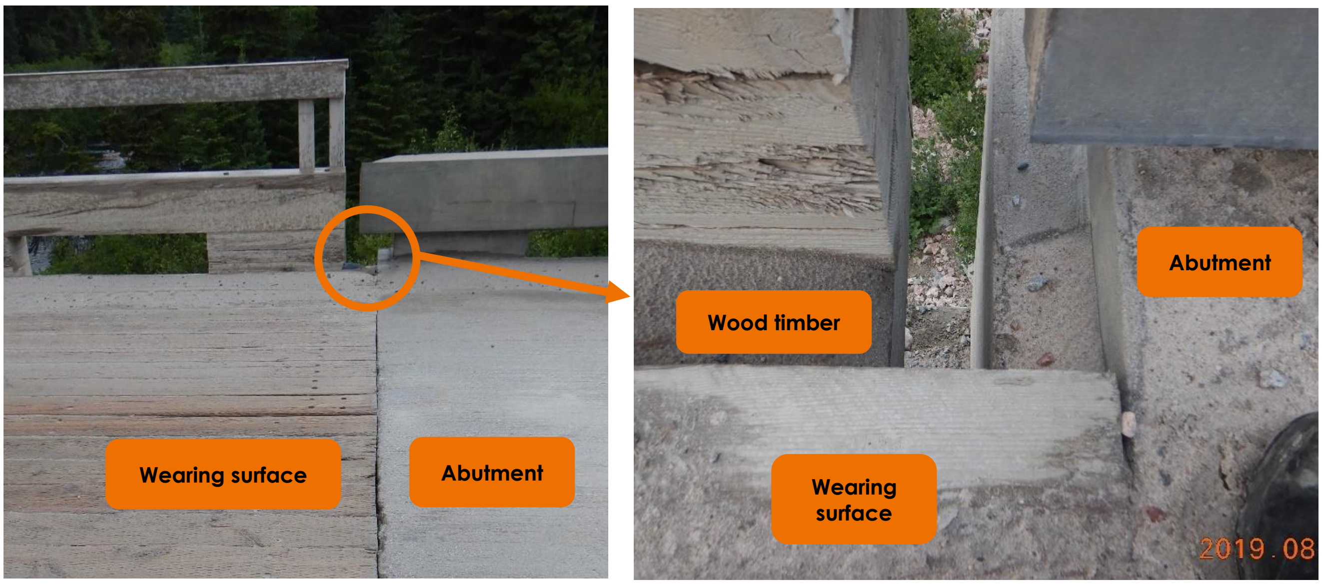
East to James Bay Hwy →

Girder number “1” is located south, and number are increasing to beam number “4”, located on the North side of the deck. Sidewalls are numbered according to cardinal points: side wall no.1 is South-West, sidewall no.2 is North-West, side wall no.3 is South-East and side wall no.4 is North-East.

2.3 STRUCTURE DIMENSIONAL PARTICULARITY

The deck of Wemindji access road bridge is made of wood timbers and the wearing surface is also made of wood planking surface. The wood planking surface is slightly longer than the deck length (wood timbers) because it sits on a ledge at the top of the abutment walls. An open joint (space) is present between the ballast wall and the first wood timber of the deck. The structural detail is shown in the picture below.

Figure 6 : Deck *detail*



3.0 INSPECTION AND INVESTIGATION ACTIVITIES

This section of the report describes the inspection team and time frame, the methodology and the access devices used for the realization of the damage survey.

3.1 INSPECTION TEAM AND TIME FRAME

The field inspection was conducted from August 6 to 7 during daytime. Inspectors on field were Ms. Myriame Fraser, eng., Mr. Simon Lefebvre, junior technician and Mr. Sébastien Daigneault, senior technician, under direct supervision of the project manager, Mr Alessandro Cirella.

The temperature varied between 13 °C to 25 °C, cloudy and rainy.

3.2 METHODOLOGY AND ACCESS DEVICES

The following methods were used to access and inspect every element of the structure at arm's length:

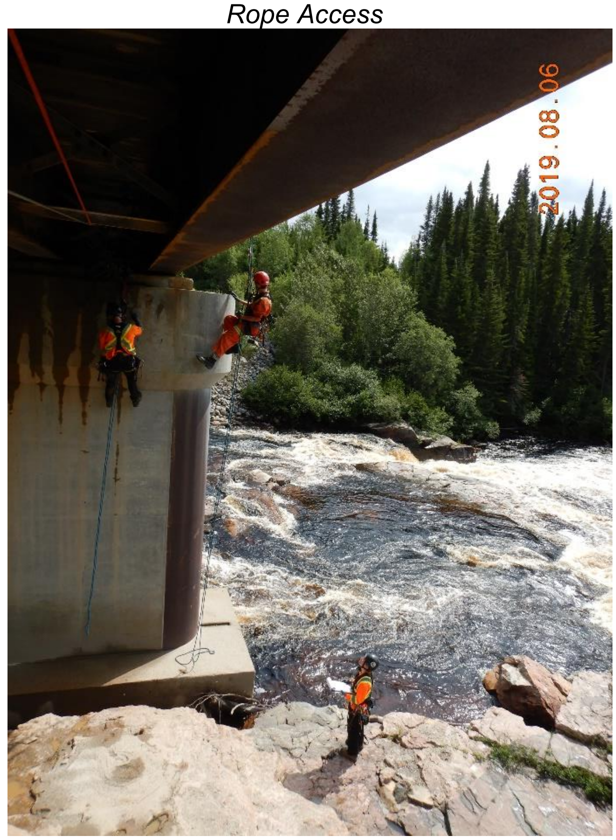
- Foot inspection on and around the bridge: abutments, deck surface, curbs and guards;
- Rope access inspection: steel beams and bracings, bearings, concrete pier, concrete abutment walls and wood deck's underside.

These items were subject to a arms length inspection as prescribed in the *Manuel d'inspection des structures*.

Figure 7 : *Foot and Rope Access* Inspection

Foot Inspection

Rope Access



4.0 INSPECTION OBSERVATIONS

This section provides a general overview of the major damage found to the structure. The defects are presented by group of elements. Photos of the main defects are presented in this report to illustrate the comments, while all the photos taken during the inspection are presented in the appendix C.

4.1 APPROACHES

This section is covering the main elements of both approaches of the structure; road pavement transition, embankments and guardrails.

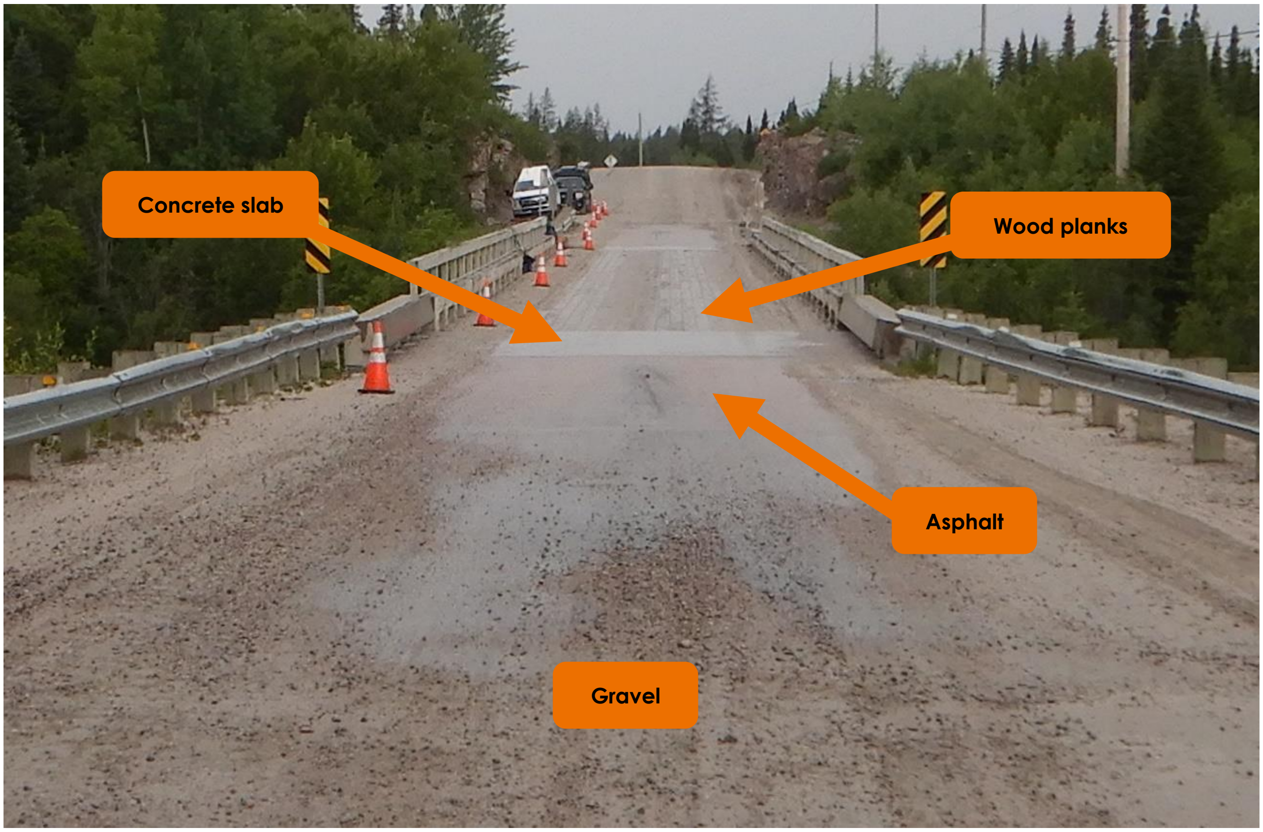
4.1.1 Road Pavement Transition

The access road leading to the bridge is entirely made of gravel except at the bridge's approaches. Two types of surface compose the approaches: asphalt and concrete.

The approaches' asphalt pavement is making the transition between the gravel and the concrete surface (concrete deck of the hollowed abutments). It is damaged by cracks and potholes that allows the water to infiltrate the infrastructure under the pavement and possibly accelerate its deterioration. A concrete slab serves as pavement transition between the asphalt approaches and the wooden planks. No expansion joint is separating the different materials.

Figure 8 : Western *approach*

Figure 9 : *Eastern* approach



A smooth transition for the vehicles is critical in order to eliminate any impact on the structure itself or any impact to the approach. West approach provides a smooth transition between the approaches' surface and the bridge; wooden planking and the asphalt of the approach are at the same level.

Figure 10 : *Western approach transition*

Eastern approach presents a slight unevenness between the concrete part and the wooden planking of the bridge deck that may cause low impact on the structure.

Figure 11 : Eastern *approach transition*

4.1.2 Embankments

The embankments are made of sand and gravel. No loss of granular material was identified at each corner of the approaches or in front of the abutment's walls. Embankments are in good condition.

Figure 12 : Embankments

4.1.3 Slope protection

The purpose of the slope protection is to prevent the erosion of the embankment material. The slope protection is made of stones of different diameters. While some plants are growing through the stones and some sliding of stones at the top of the slope protection (wingwall no. 1) was observed, its condition is good.

Figure 13 : S*lope protection, wingwall no.1*

4.1.4 Railing systems

The bridge has two types of railing systems on its approaches. The first railing system is made of wood posts and galvanized steel rails (flex beams) and is followed by a concrete barrier made of concrete posts and concrete railing, above the hollowed abutments.

At first, guardrails are the first protection device while approaching the bridge. A guardrail is a semi-rigid structure made of galvanized steel and wood. Its purpose is to slide the vehicle that might leave the road. Wood and galvanized steel guardrails are installed on both approaches. Wooden posts are in bad condition (some are broken, and some are decayed) and the galvanized steel railings are deformed by impacts. Extremities of galvanized steel railings were possibly hit by cars and are deformed and/or torn up at each end of the structure. No rigidity transition is in place between the semi-rigid wood and steel railing and concrete rigid guardrails.

Figure 14 : Wood and galvanized steel *Guardrails*

The second device is made of concrete rails and concrete posts covered with a “C” formed steel channel. Those concrete guardrails are located at the top of the four sidewalls. No material defect was noted on the concrete barriers and their condition is good.

Figure 15 : Concrete g*uardrails*

Also, no connection system is in place between the two types of railings, creating a gap between the two elements. This detail is typical and can be seen at each corner of the structure.

The deficiencies’ resume, described for each corner of the structure, can be found in the table below.

Table 2 : Railing *system’s deficiencies*

West approach		
North-West corner		
		
Permanent deformation of flex beam and torn up guardrail.	Broken wood posts offset blocks	No connection device between the wood and galvanized steel railing and the concrete barrier

West approach		
South-West corner		
		
Permanent deformation of guardrail and torn guardrail.	Permanent deformation of guardrail and torn guardrail. Two broken wood posts.	No connection device between the wood and galvanized steel railing and the concrete barrier

East approach		
North-East corner		
		
Permanent deformation of guardrail and torn guardrail extremity.	Torn guardrail.	No connection device between the wood and galvanized steel railing and the concrete barrier
East approach		
South-East corner		
		
Permanent deformation of guardrail and torn guardrail.	Permanent deformation of guardrail.	No connection device between the wood and galvanized steel railing and the concrete barrier

4.2 ABUTMENTS

This section refers to the inspection of the different elements of the abutments on both shores (axis 1 and 3). This bridge's abutments are U-shaped (Side walls perpendicular to the front wall) and hollowed (no backfill).

4.2.1 Abutment's foundation

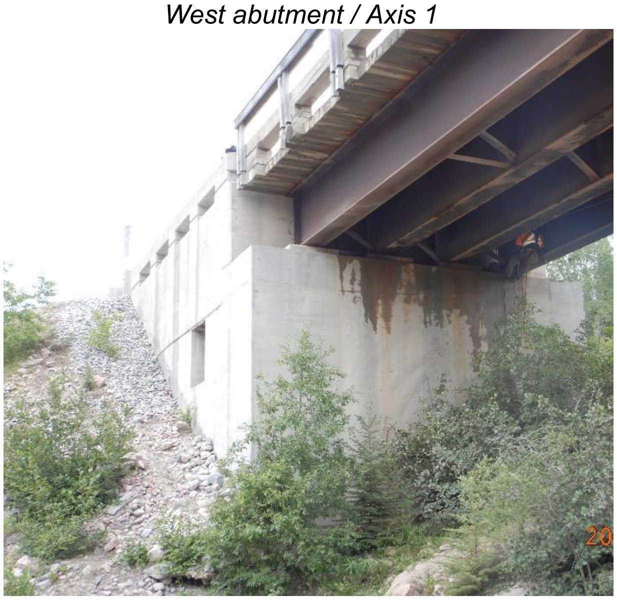
Abutment's foundations are not visible. No visible movement of the abutments was observed at the time of the damage survey; therefore, they are considered in good condition.

4.2.2 Abutment front walls

The front walls of the abutment are perpendicular to the bridge alignment. Both abutment walls are in good condition. Narrow cracks (width opening < 0,8 mm) and cold joints in concrete were identified on each front wall. General views of each front walls and typical cracks are shown in the figures below.

Figure 16 : *Front Walls general views*

West abutment / Axis 1



East abutment / Axis 3

Figure 17 : Cold joint and narrow *cracks on the East front wall*

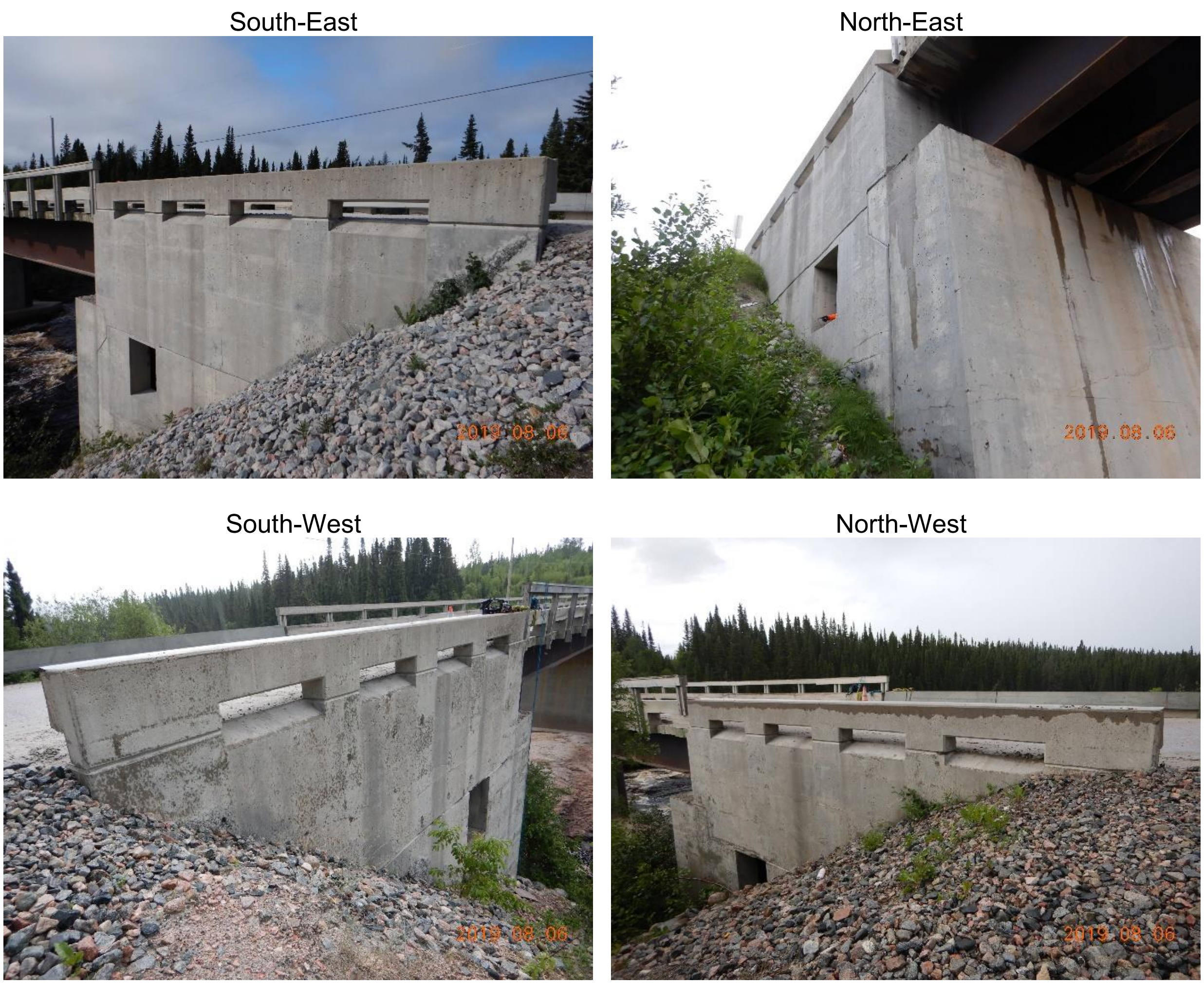
Figure 18 : Cold joint and narrow *cracks on the West front wall*

4.2.3 Sidewalls

The sidewalls of the abutment are parallel to bridge alignment. It has a hole in each sidewall (a door 1000 x 1200 mm) leading to the inside of the abutment.

No concrete deficiencies were found on the side walls, except for narrow cracks in concrete (width opening < 0,8 mm). Sidewalls are in good condition.

Figure 19 : *Sidewalls*



4.2.4 Abutments bearings

The bearing type installed on both abutments are made of steel plates and elastomeric plates. Some bent and sectioned bolts were noted on each abutment bearings. The description of the deficiencies found on the abutment bearings are listed in the table below.

Table 3 : ***Abutment bearings deficiencies***

East abutment		
Beam #1	One sectioned bolt	
Beam #2	One bent bolt	
Beam #3	One sectioned bolt	

<table>
<tr><td rowspan="2">Beam #4</td><td>One sectioned bolt (interior face)</td><td>
</td></tr>
<tr><td>One bent and loose bolt (exterior face)</td><td>
</td></tr>
<tr><td colspan="3">West abutment</td></tr>
<tr><td>Beam #1</td><td>One bent bolt</td><td></td></tr>
<tr><td>Beam #2</td><td colspan="2">No deficiencies</td></tr>
<tr><td>Beam #3</td><td colspan="2">No deficiencies</td></tr>
<tr><td>Beam #4</td><td colspan="2">No deficiencies</td></tr>
</table>

4.2.5 Abutments' bearing seat and bearings pedestals

Concrete bearing pedestals are located under each end beam on the bearing seat. Bearing pedestals' dimensions are approximately 950 mm long x 1030 mm width x 150 mm height. No concrete deficiencies such as delamination or spalling was noted on these elements. Debris are covering the most part of the bearing seat and the bearing pedestals of both abutments. Bearing seat and bearings pedestals are in good condition.

Figure 20 : Debris on the bearing pedestals (West and East)

4.2.6 Ballast Wall

Ballast walls of west and east abutments are in good condition. No concrete deficiencies were noted on these elements. Narrow cracks were observed (width opening < 0,8 mm).

Figure 21 : Ballast walls (Left: West and Right: East)

4.2.7 Hollow Abutments' interior

Both abutments' interior are accessible through an opening in the sidewalls. Walls and deck soffits of both abutments are in good condition. Narrow cracks were noted on the concrete (width opening < 0,8 mm).

Figure 22 : *West abutment's interior*

West wall

East wall (back of the front wall)

South wall

North wall

Figure 23 : *East* abutment's *interior*

West wall (back of the front wall)

East wall

South wall

North wall

East abutment: Deck soffit

West abutment: Deck soffit

4.3 PIER

The pier is the system that transfer the load from the deck to the foundations on the riverbed. It is composed of a foundation, a pier-wall and a pier cap (all made of reinforced concrete). Access road Wemindji bridge has one pier and it is located at axis no. 2.

4.3.1 Pier foundation

The foundation sits on the riverbed. The low level of water allowed the visualisation of this element, normally in the water.

The pillar foundation is in good condition. No movement of the structure and no loss of material under the foundation were observed at the time of the damage survey.

Figure 24 : *Pile foundation*

West elevation

Looking North-West

Looking South-West

4.3.2 Pier-wall

The pier-wall is the concrete element that transfers the load from the pier cap to the foundation. Both ends are shielded by a steel plate. The wall is in good condition, both concrete and steel plates. Narrow cracks were obsrved in the concrete (width opening < 0,8 mm).

Figure 25 : *Pier* faces

West face

East face

4.3.3 Pier cap and bearings' seat

The pier cap is located above the pier-wall. The cap has different height on each side. the East side is shorter than the West side due to the different beams' height for different span lengths.

The pier cap is in good condition. Narrow cracks were observed on the concrete surfaces.

The bearing seat is located at the top of the pier cap. Debris are covering some parts of the pier's bearings' seat. Bearing seats are in good condition.

Figure 26 : *Pier cap*

General views

Vertical crack width < 0.8 mm

Pier cap – South face

Figure 27 : ***Pile's bearing seat***

4.3.4 Bearings

Concrete bearings (steel plates and elastomeric plates) and pedestals are located under each beam. The bearings are in good condition. Bearing pedestals are in good condition and no defects were identified.

Figure 28 : ***Pile's bearings and pedestals***

4.4 STEEL STRUCTURE AND CONNECTORS

Steel elements are supporting each span. These elements are the beams and the bracings which are connected altogether by steel connectors, such as bolts.

4.4.1 Beams

All beams are "I" shaped plate girder and made of Atmospheric Corrosion-Resistant Notch-Tough Steel. Each span is supported by 4 beams. Since the spans are asymmetric, their dimensions vary. Detailed dimension can be found in the detailed dimensional inventory in appendix A.

Beams are in good condition. No important steel section loss was noted in the damage survey.

Figure 29 : *Beams general views*

Span 1

Span 1

Span 2

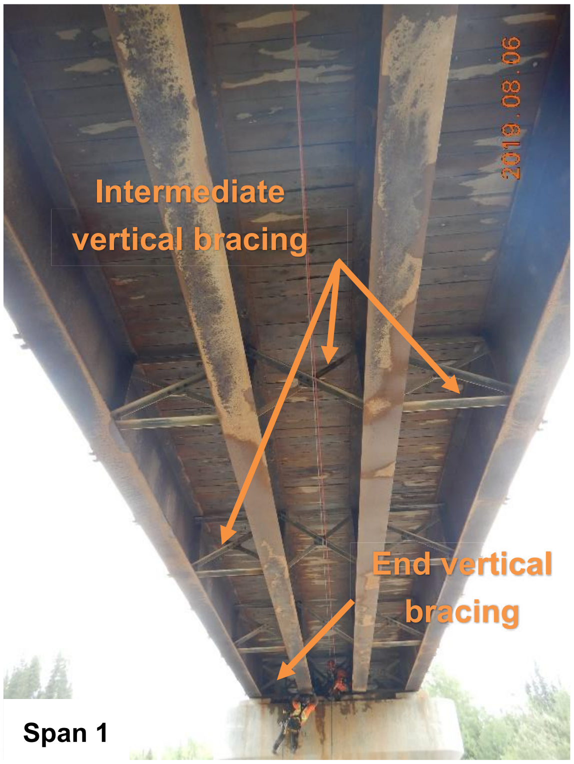
Span 2

4.4.2 Bracings

Bracings are connecting the beams together and providing lateral support. The purpose of the bracings is to transfer the lateral forces, such as the wind, to the beams. Diaphragms are located under the deck and are perpendicular to the beams.

Span 1 has four intermediate vertical transverse bracings and one end vertical transverse bracing at each end. No horizontal bracings are present between beams of span 1. All bracings of span 1 are in good condition.

Span 2 has nine intermediate vertical transverse bracings and one end vertical transverse bracing at each end. Span 2 also has ten horizontal bracings between beams 2 and 3. All bracings of span 2 are in good condition.


2019.08.06
Intermediate vertical bracing
End vertical bracing
Span 1

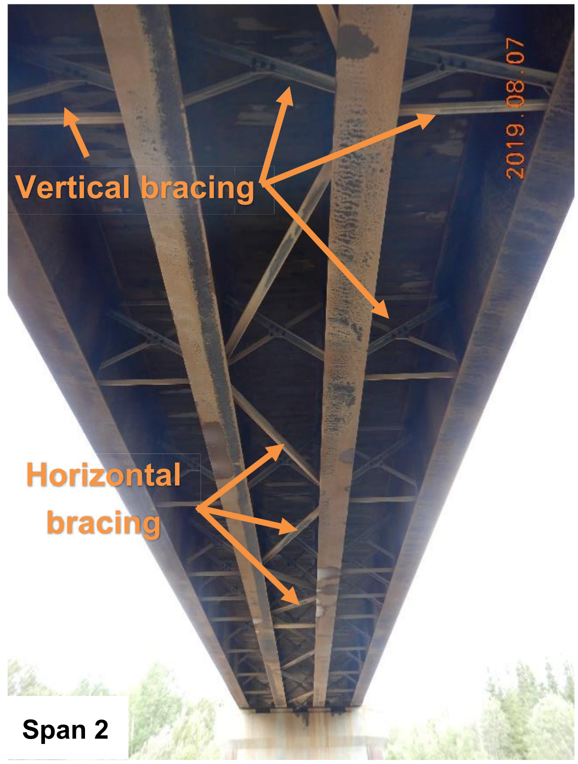
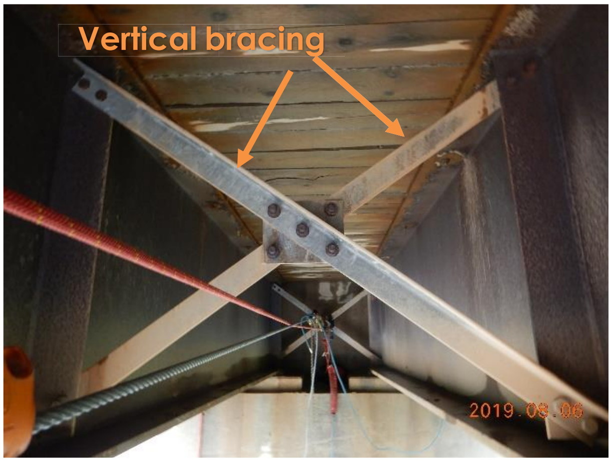
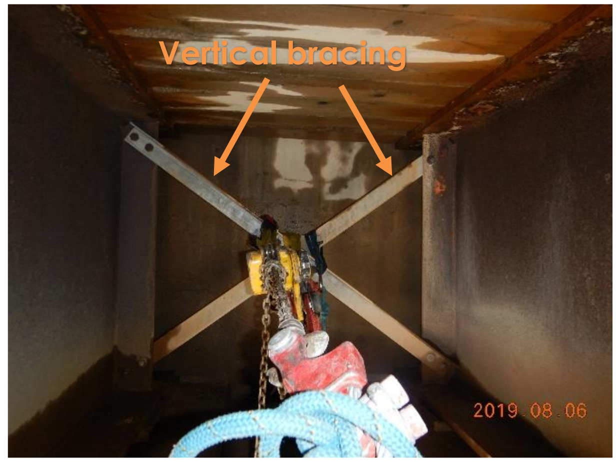

2019.08.07
Vertical bracing
Horizontal bracing
Span 2

Figure 30 : *Bracings*

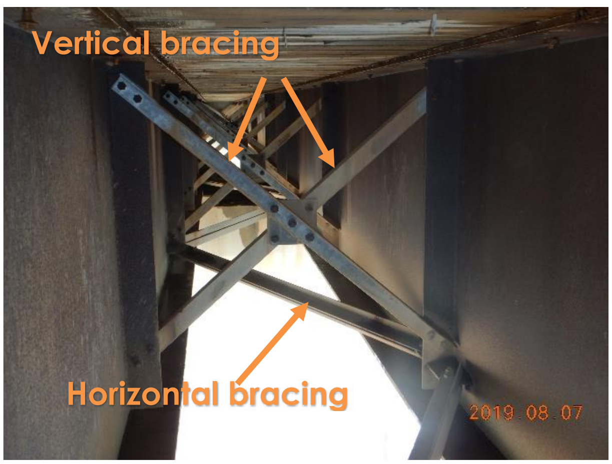
Span 1 – Intermediate vertical transverse bracings



Span 1 – End vertical transverse bracings



Span 2 – Intermediate vertical transverse bracings and horizontal bracings



Span 1 – End vertical transverse bracings (pier 2)

4.5 DECKING, BRIDGE SURFACE AND SAFETY DEVICES

This section covers all the elements forming the deck and the elements above it: the wood timbers of the deck itself, the wooden wearing surface, the wood curbs and the wooden railing system.

4.5.1 Bridge deck

The bridge deck is made of timbers. A wooden wearing surface on it make it only visible from its underside, between the beams and on the exterior sides (north and south).

Wood timbers are in good condition.

Figure 31 : *Bridge deck – wood timbers*

Span 1 – Timbers between beams

Span 1 – Timbers' extremity

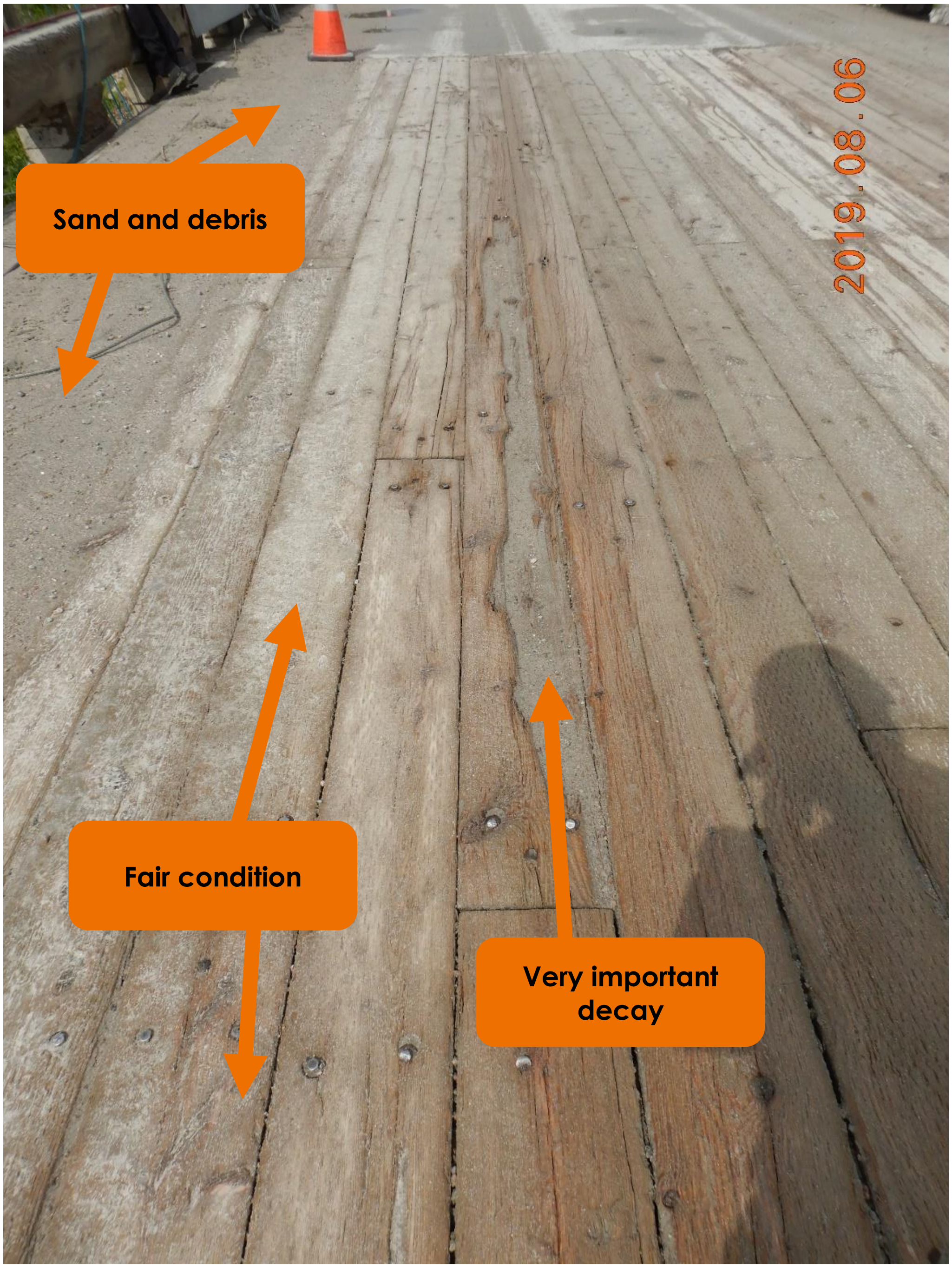
Span 2 – Timbers between beams

Span 2 – Timbers' extremity

4.5.2 Wearing surface

The wearing surface is made of wooden planks. The roadside (25% of the surface) is covered of sand and debris, which makes it not possible to inspect. The visible part of the surface (the clean part) has 5% of its wooden planks with important decay. Another 5% has very important decay. A few bolts were scattered on the surface. There is no joint on the wearing surface above the pile. The wearing surface is in a fair condition.

Figure 32 : *Wooden Plank Surface*



4.5.3 Curbs

The wood curbs are located along the guardrails, next to the road surface. They are made of 300 mm x 300 mm section wood pieces on wood anchor blocks.

The curbs are in good condition. In both spans, they present medium abrasion on its corner.

Figure 33 : *Road curb*

Typical curb and guardrails detail

Curbs – general view of abrasion

4.5.4 Guardrails

Both sides of the bridge are protected by wood guardrails. In some places, the posts of the guardrails are not fixed to the timbers, where they should be. Instead, they are fixed to the curbs or the anchor of the curbs. At some places, posts are cut. Therefore, the condition of the guardrails is judged to be poor.

Typical defects of the guardrails are shown in the pictures below.

Figure 34 : *Wood guardrails – span 1*

Figure 35 : *Wood guardrails – span 2*

5.0 CONCLUSIONS

To summarize, the bridge is in a good condition. No defects were identified on the concrete abutments, the steel beams and transverse wooden timbers are in good condition. No major repair is needed at this time. For further modifications to the structure, it is important to keep in mind the abutments are hollowed but in good condition and accessible by 2 openings.

However, the few defects and problems identified during the inspection show that maintenance has to be done on specific elements to ensure the sustainability of the structure. The wooden wearing surface is partially decayed and should be scheduled to be replaced in the next 5 to 10 years. In the eventuality where the structure enlargement project goes forward, it should be considered to use the same contract to replace the wooden wearing surface on the existing bridge. Estimation cost for the replacement of the wood surface is $45,000.

The guardrail posts on the bridge are deficient (not fixed to the transverse beams) and there is no stiffness transition and link between the flexible guard rails on the approaches and the concrete rails on the concrete slab. To ensure security of the users, corrective work is to be done in the short term. Repair of the guardrail is estimated at $24,900.

Finally, it was observed that a few anchor rods were deformed or sectioned at the bearings. Regular observations of the bridge should be conducted to make sure there is no further movement of the deck and there is no displacement of the bearings. Again, in the eventuality where the structure enlargement project goes forward, it should be considered to use the same contract to replace the damaged anchor on the existing bridge. Estimation cost for the replacement of the anchors is $18,800.

The cost estimates are based on the MTQ suggested costs per activities and include a 25% contingency. The total costs are estimated at $88,700. This estimate does not include the mobilization, demobilization and the managing costs of the construction firm which can vary from 30 to 50% given the location.

5.1 BRIDGE ENLARGEMENT

The bridge foundation elements (pier, abutments) and structural steel system are in good condition. It is acceptable to maintain this structure in good service for many more years as long as normal maintenance is done. From the state of the bridge observed during the damage survey, many options are possible to enlarge the traffic lane of the bridge: A new one lane bridge can be built parallel to the existing one, or concrete pier and abutment can be enlarged on one or both sides to add more girders and then enlarge the deck surface. Solutions and cost estimation can be discussed further in the future feasibility study.

APPENDIX A

DETAILED DIMENSIONAL INVENTORY

APPENDIX B

Damage survey sketches

APPENDIX C

Photo report

APPENDIX A

DETAILED DIMENSIONAL INVENTORY

DETAILED DIMENSIONAL INVENTORY
IDENTIFICATION

Identification

Structure	**Main road bridge**
Municipality	Wemindji
Responsibility	Cree nation Government

Location

Latitude	53,012564	Longitude	-78,77033
Site	Wemindji access road - 3km east from Wemindji		
Orientation	East-West		
Point of reference	West to Wemindji		

Obstacles

Name	Maquata River

Road

Name	Wemindji access road
Number of lanes	One lane bridge
Clear width	6,050 m

General dimensions

Total bridge length, including sidewalls	68,905 m
Deck length (wood timbers)	51,320 m
Total width	7,0 m
Bridge lane width (one lane bridge)	6,05 m
Deck area	327 m²
Deck angle	0 degree

Year

Construction	1990
Abutments and pile	1990
Structural system	1990
Deck	1990

Public services

Type	Location
Powerline	North side, 11,0 m from structure

Span

Span identification	Type of structure	Span length (mm)	End connection S/W	End connection N/E	Beam spacing (mm)	Foundation S/W	Foundation N/E
1 - West span	Wood deck on steel beams	23 765	Simply supported	Simply supported	1 500	Concrete abutment	Concrete pile
2 - East span	Wood deck on steel beams	27 825	Simply supported	Simply supported	1 500	Concrete pile	Concrete abutment

Span #	Element Group	Element	Type	Material	Reinforcement	Prot. Syst.	Ele. #	Position	Length (mm)	Width (mm)	Height (mm)	Calc. Qty	Unit	Envir.	Remarks
1	Stream and embankment	Stream													
1	Stream and embankment	Embankment	Granular					West							
1	Stream and embankment	Slope protection	Stones					West							
1	Substructure / Abutment	Foundation	Undetermined				1	West							
1	Substructure / Abutment	Abutment front wall	Reinforced concrete	Regular concrete	Steel reinforcement		1	West		7030	4800	34	m²	Moderate	
1	Substructure / Abutment	Ballast wall	Reinforced concrete	Regular concrete	Steel reinforcement		1	West		7030	1700	12	m²	Moderate	
1	Substructure / Abutment	Bearing pedestals	Reinforced concrete	Regular concrete	Steel reinforcement		1	West	1030	950	150	4	unit(s)	Moderate	Pedestals dimensions vary
1	Substructure / Abutment	Bearings	Steel plates + elastomer plates				1	West				4	unit(s)	Moderate	
1	Substructure / Abutment	Sidewall	Reinforced concrete	Regular concrete	Steel reinforcement		1	South-West	8600		3330	29	m²	Moderate	Height varies from 860 to 5800 mm
1	Substructure / Abutment	Sidewall	Reinforced concrete	Regular concrete	Steel reinforcement		2	North-West	8600		2790	24	m²	Moderate	Height varies from 550 to 5030 mm
1	Substructure / Abutment	Bearing seat	Reinforced concrete	Regular concrete	Steel reinforcement		1	West	1210	7030		9	m²	Moderate	
1	Substructure / Pier	Foundation	Undetermined				2								
1	Substructure / Pier	Pier cap	Reinforced concrete	Regular concrete	Steel reinforcement		2		2060	7080	1570	25	m²	Moderate	Height varies from 1200 to 1570 mm
1	Substructure / Pier	Pier - wall	Reinforced concrete	Regular concrete	Steel reinforcement		2		1400	6380	5690	89	m²		Width varies from 5010 to 6380 mm
1	Substructure / Pier	Bearing pedestals	Reinforced concrete	Regular concrete	Steel reinforcement		2		925	935	165	4	unit(s)	Moderate	Pedestals dimensions vary
1	Substructure / Pier	Bearing pedestals	Reinforced concrete	Regular concrete	Steel reinforcement		3		935	920	165	4	unit(s)	Moderate	Pedestals dimensions vary
1	Substructure / Pier	Bearings	Steel plates + elastomer plates				2					4	unit(s)	Moderate	

DETAILED DIMENSIONAL INVENTORY
Element list
Main road bridge to Wemindji

Span #	Element Group	Element	Type	Material	Reinforcement	Prot. Syst.	Ele. #	Position	Length (mm)	Width (mm)	Height (mm)	Calc. Qty	Unit	Envir.	Remarks
1	Substructure / Pier	Bearings	Steel plates + elastomer plates				3					4	unit(s)	Moderate	
1	Substructure / Pier	Bearing seat	Reinforced concrete	Regular concrete	Steel reinforcement		2		2060	7080		15	m²	Moderate	West part of the bearing seat: 1000 mm width East part of the bearing seat: 1060 mm width
1	Deck	Deck	Wood deck	Wood					23610	6380		151	m²	Severe	Timber length = 6380 mm
1	Deck	Wearing surface	Wood planking wearing surface	Wood					23815	5830		139	m²	Severe	Carriageway = 5830 mm and the space bertween the curbs = 6050 mm
1	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel			1		23630	410	1200	86	m²	Moderate	
1	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel			2		23630	410	1200	86	m²	Moderate	
1	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel			3		23630	410	1200	86	m²	Moderate	
1	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel		Other	4		23630	410	1200	86	m²	Moderate	
1	Bracings	Vertical bracing	Transverse	Galvanized steel		Other		End				2	unit(s)	Moderate	
1	Bracings	Vertical bracing	Transverse	Galvanized steel		Other		Intermediate				4	unit(s)	Moderate	
1	Curbs and sidewalks	Curb	Wood curb	Wood		Treated wood		North	23610	300	600	24	m	Severe	Wood curb: 300 mm width x 300 mm height on anchor wood block 300 mm width x 300 mm height
1	Curbs and sidewalks	Curb	Wood curb	Wood		Treated wood		South	23610	300	600	24	m	Severe	Wood curb: 300 mm width x 300 mm height on anchor wood block 300 mm width x 300 mm height
1	Guard rail	Railing system	Wood railing	Wood		Treated wood		North	23610			24	m	Severe	
1	Guard rail	Railing system	Wood railing	Wood		Treated wood		South	23610			24	m	Severe	
1	Approaches	Transition						West							
1	Approaches	Railing system	Wood and steel	Wood and steel				West	26880			27	m	Severe	
2	Stream and embankment	Embankment	Granular					East							

DETAILED DIMENSIONAL INVENTORY
Element list
Main road bridge to Wemindji

Span #	Element Group	Element	Type	Material	Reinforcement	Prot. Syst.	Ele. #	Position	Length (mm)	Width (mm)	Height (mm)	Calc. Qty	Unit	Envir.	Remarks
2	Stream and embankment	Slope protection	Stones					East							
2	Substructure / Abutment	Foundation	Undetermined				3	East							
2	Substructure / Abutment	Abutment front wall	Reinforced concrete	Regular concrete	Steel reinforcement		3	East		7000	4285	30	m²	Moderate	
2	Substructure / Abutment	Ballast wall	Reinforced concrete	Regular concrete	Steel reinforcement		3	East		7000	2010	14	m²	Moderate	
2	Substructure / Abutment	Bearing pedestals	Reinforced concrete	Regular concrete	Steel reinforcement		4	East	1040	950	160	4	unit(s)	Moderate	Pedestals dimensions vary
2	Substructure / Abutment	Bearings	Steel plates + elastomer plates				4	East				4	unit(s)	Moderate	
2	Substructure / Abutment	Sidewall	Reinforced concrete	Regular concrete	Steel reinforcement		3	South-East	8600		4050	35	m²	Moderate	Heignt varies from 1300 to 6800 mm
2	Substructure / Abutment	Sidewall	Reinforced concrete	Regular concrete	Steel reinforcement		4	North-East	8600		3190	27	m²	Moderate	Heignt varies from 630 to 5750 mm
2	Substructure / Abutment	Bearing seat	Reinforced concrete	Regular concrete	Steel reinforcement		3	East	1200	7000		8	m²	Moderate	
2	Deck	Deck	Wood deck	Wood					27710	6380		177	m²	Severe	Timber length = 6380 mm
2	Deck	Wearing surface	Wood planking wearing surface	Wood					27890	5830		163	m²	Severe	Carriageway = 5830 mm and the space bertween the curbs = 6050 mm
2	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel		Other	1		27675	450	1600	126	m²	Moderate	
2	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel		Other	2		27675	450	1600	126	m²	Moderate	
2	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel		Other	3		27675	450	1600	126	m²	Moderate	
2	Superstructure / Beams	Beam	Welded beam	Atmospheric corrosion resistant notch tough steel		Other	4		27675	450	1600	126	m²	Moderate	
2	Bracings	Vertical bracing	Transverse	Galvanized steel		Other		End				2	unit(s)	Moderate	
2	Bracings	Vertical bracing	Transverse	Galvanized steel		Other		Intermediate				9	unit(s)	Moderate	

DETAILED DIMENSIONAL INVENTORY
Element list
Main road bridge to Wemindji

Span #	Element Group	Element	Type	Material	Reinforcement	Prot. Syst.	Ele. #	Position	Length (mm)	Width (mm)	Height (mm)	Calc. Qty	Unit	Envir.	Remarks
2	Bracings	Horizontal bracing	Horizontal	Galvanized steel		Other		Inferior				10	unit(s)	Moderate	
2	Curbs and sidewalks	Curb	Wood curb	Wood		Treated wood		North	27710	300	600	28	m	Severe	Wood curb: 300 mm width x 300 mm height on anchor wood block 300 mm width x 300 mm height
2	Curbs and sidewalks	Curb	Wood curb	Wood		Treated wood		South	27710	300	600	28	m	Severe	Wood curb: 300 mm width x 300 mm height on anchor wood block 300 mm width x 300 mm height
2	Guard rail	Railing system	Wood railing	Wood		Treated wood		North	27710			28	m	Severe	
2	Guard rail	Railing system	Wood railing	Wood		Treated wood		South	27710			28	m	Severe	
2	Approaches	Transition						East							
2	Approaches	Railing system	Wood and steel	Wood and steel				East	26930			27	m	Severe	

APPENDIX B

Damage survey sketches

Stantec

DAMAGE SURVEY

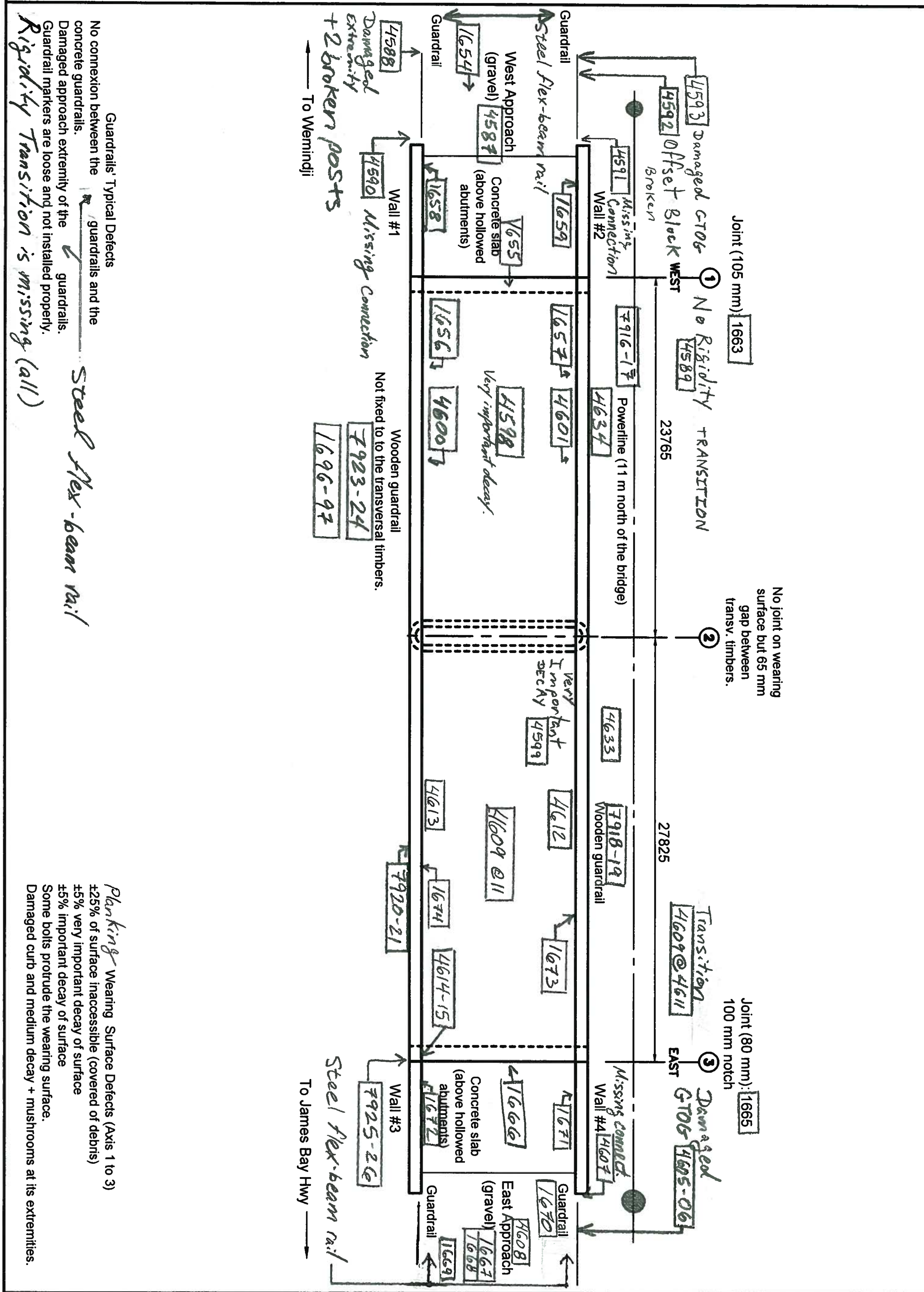
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

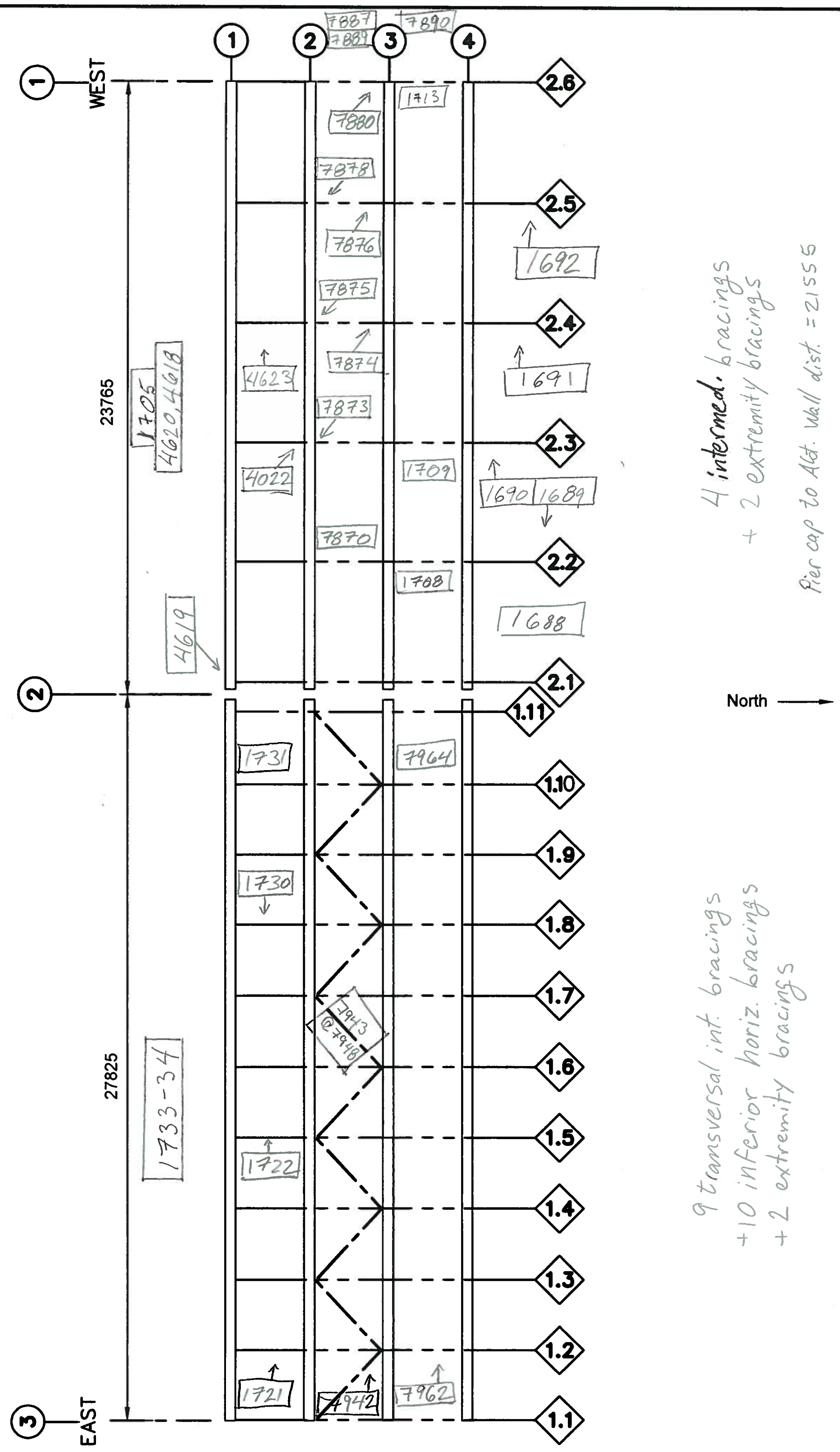
INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

GENERAL PLAN VIEW



Stantec DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

PLAN VIEW
VERTICAL AND HORIZONTAL BRACINGS



Stantec

DAMAGE SURVEY

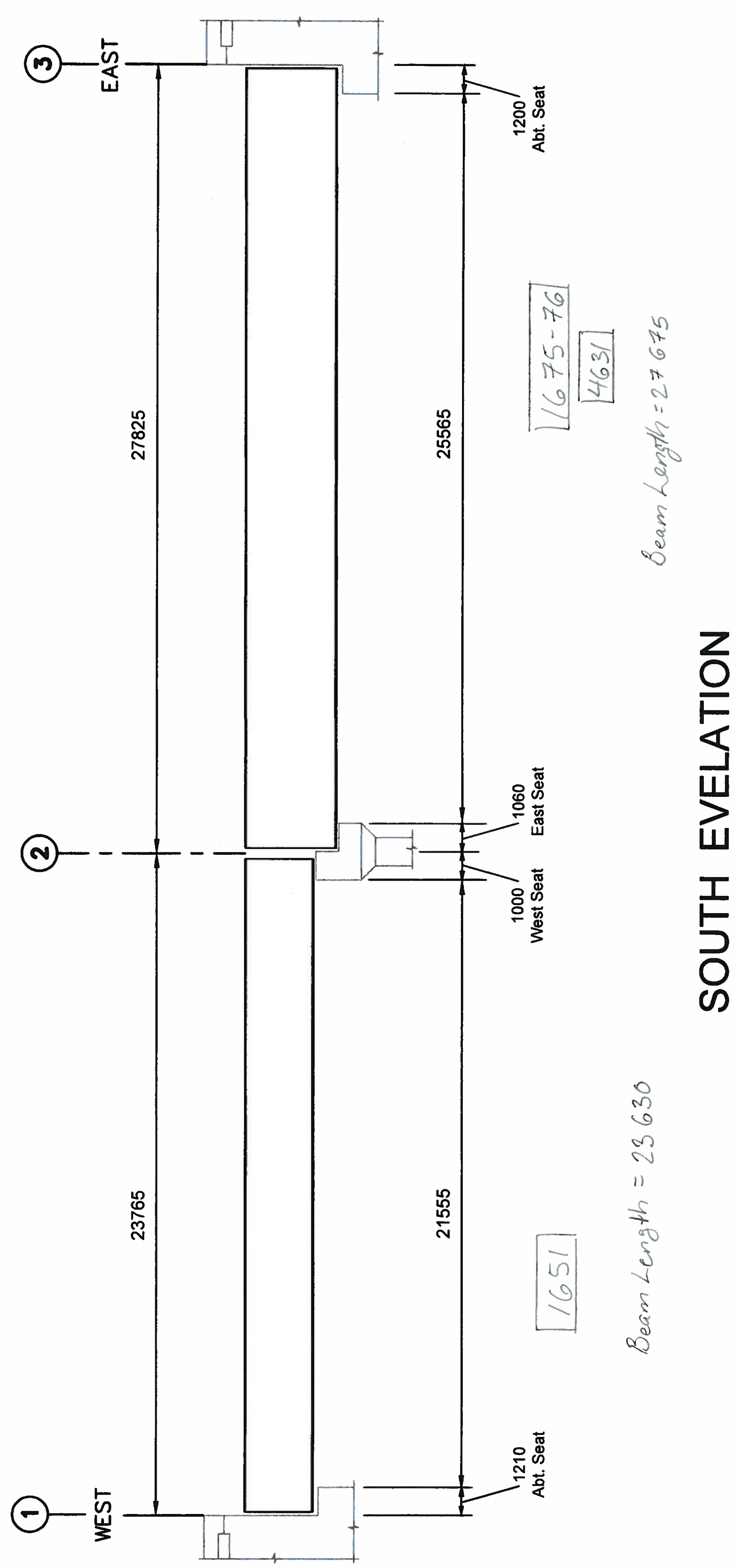
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

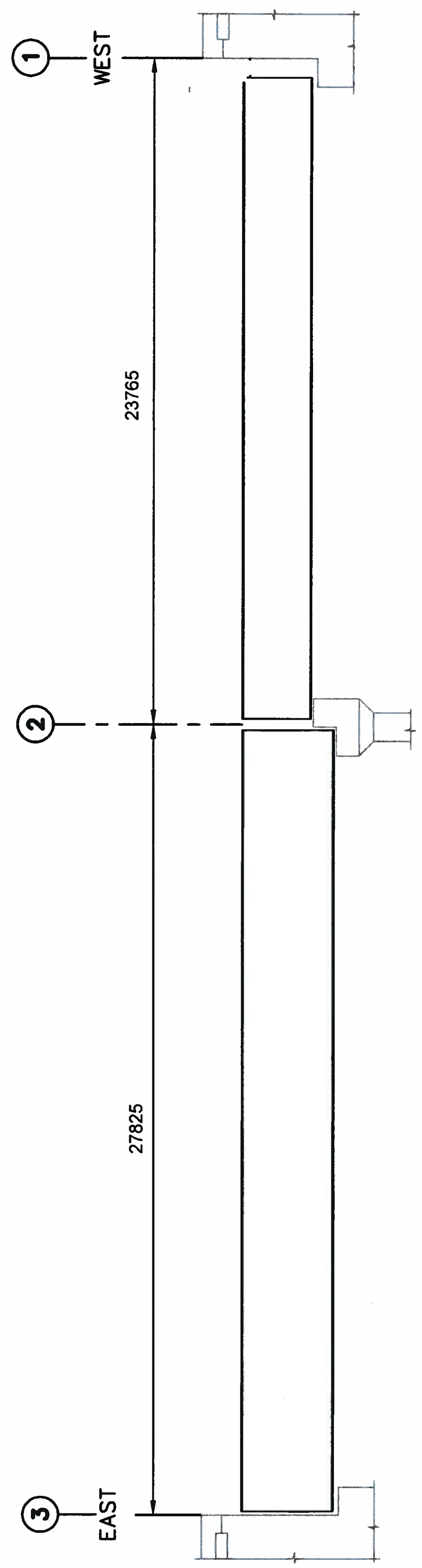
INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

SOUTH EVELATION



Stantec DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

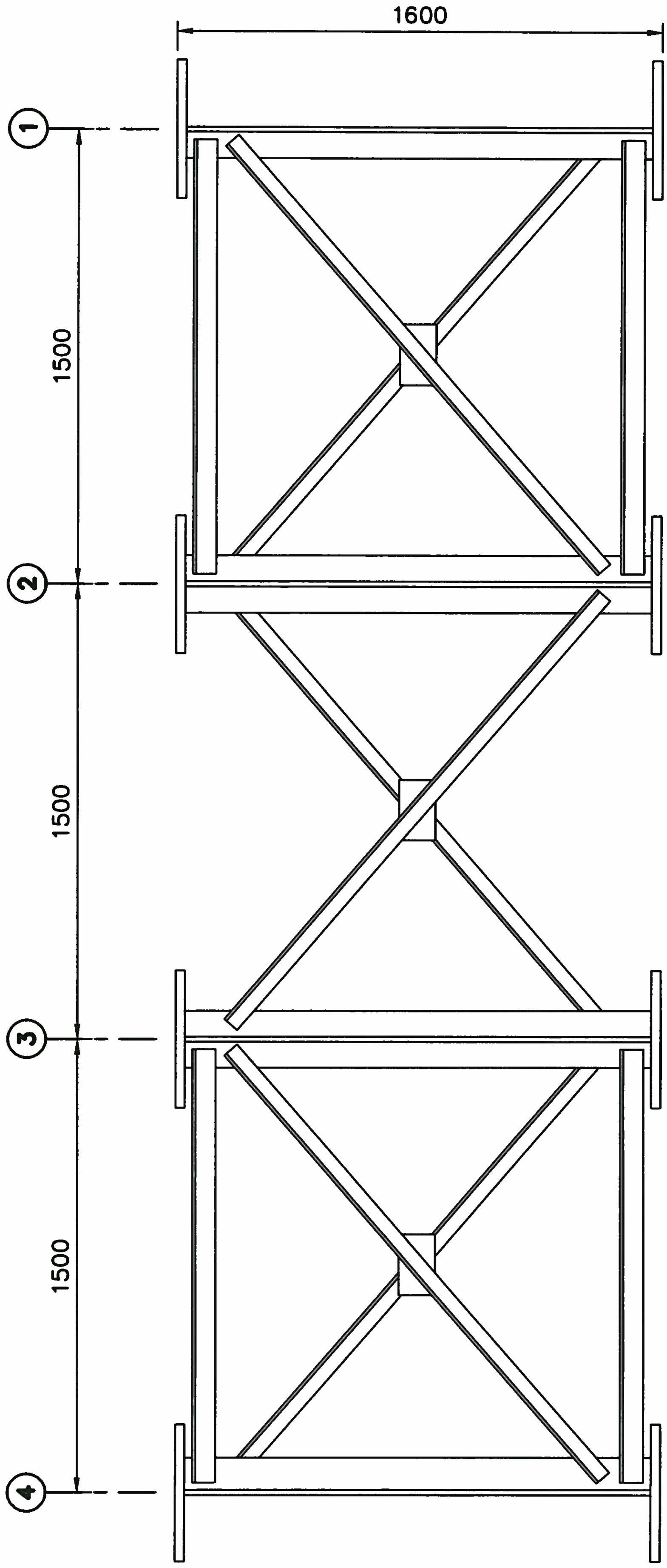
NORTH EVELATION



NORTH EVELATION

Stantec DAMAGE SURVEY	
	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

EAST SPAN TYPICAL CROSS-SECTION (H=1600mm)



Notes
Steel Angle (L-shaped) 76 x 76 (Typ.)
19 mm bolts (Typ.)

Stantec

DAMAGE SURVEY

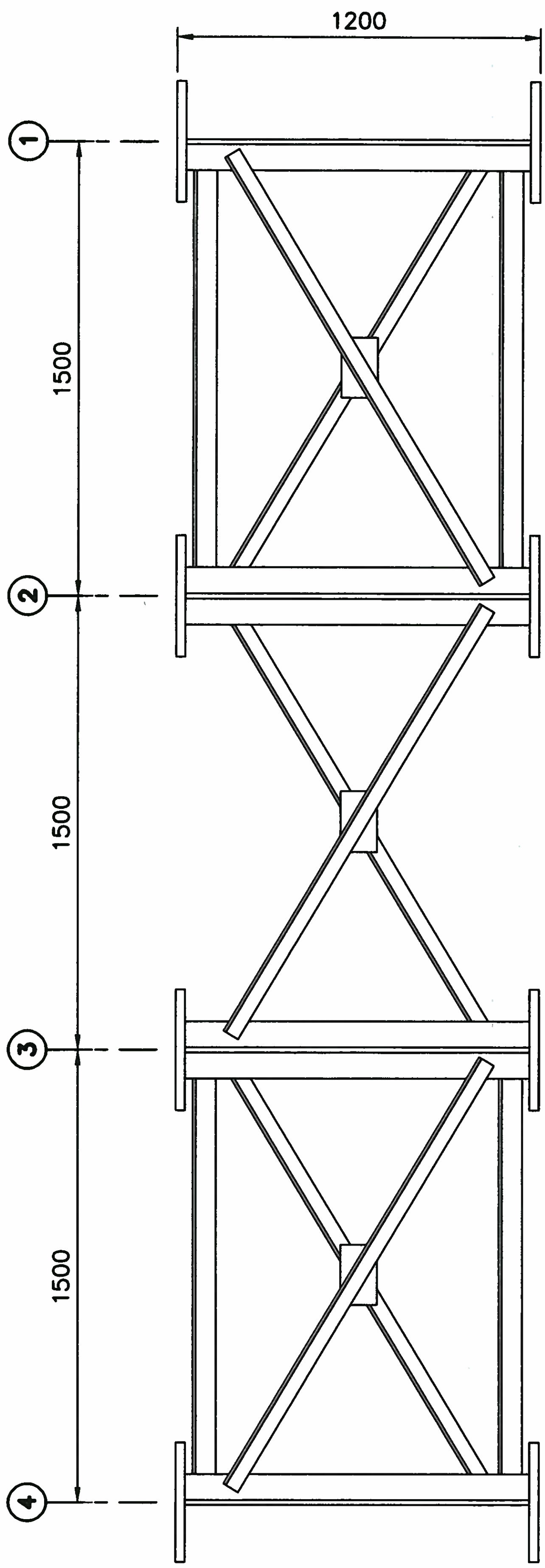
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

WEST SPAN TYPICAL CROSS-SECTION (H=1200mm)



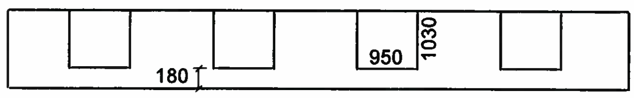
Notes
Steel Angle (L-shaped) 76 x 76 (Typ.)
19 mm bolts (Typ.)

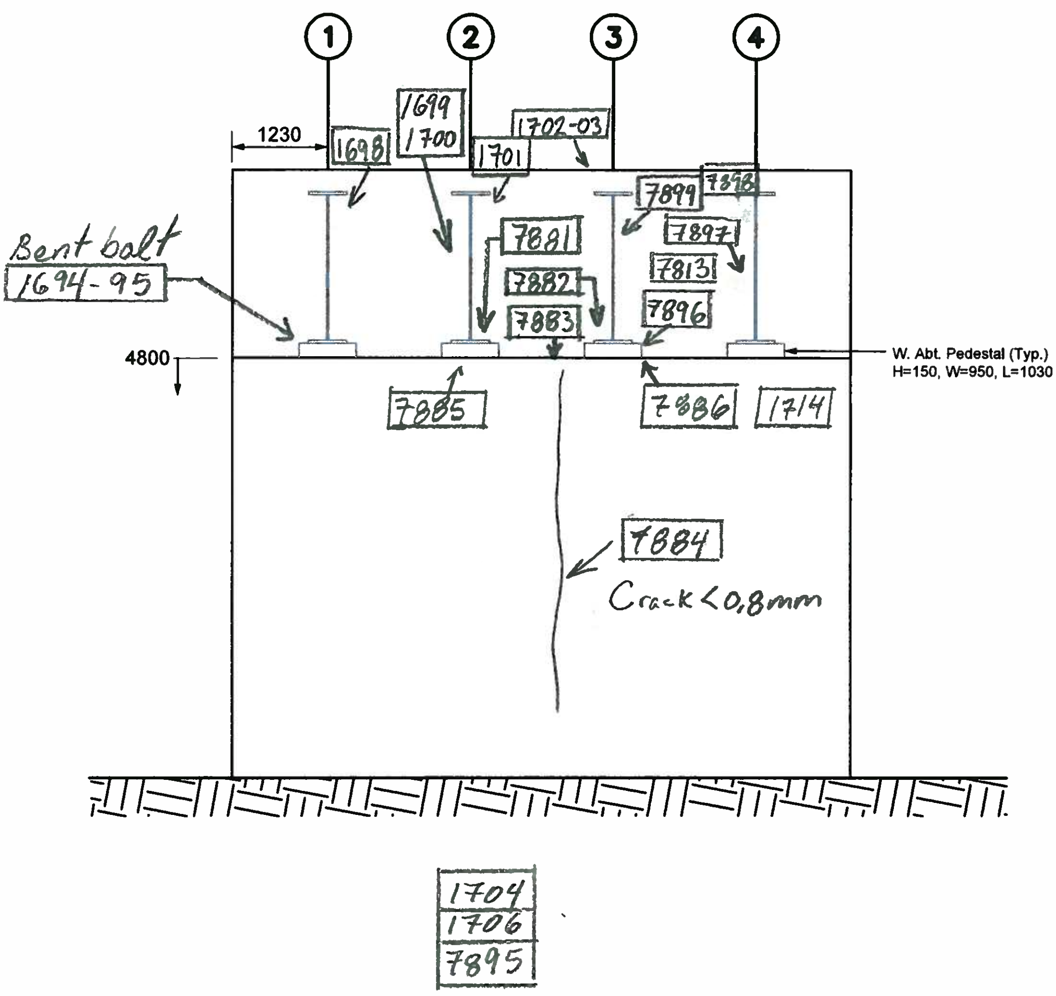
Stantec

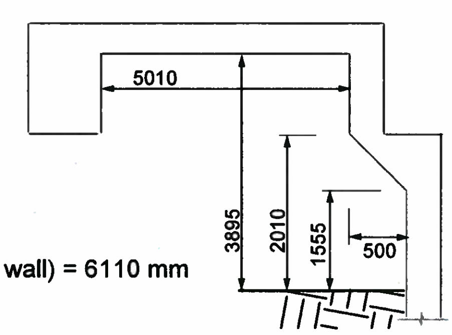
DAMAGE SURVEY

CLIENT:	CREE NATION OF WEMINDJI
STRUCTURE:	ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
DATE:	2019/08/06
INSPECTORS:	Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

WEST ABUTMENT
EAST ELEVATION







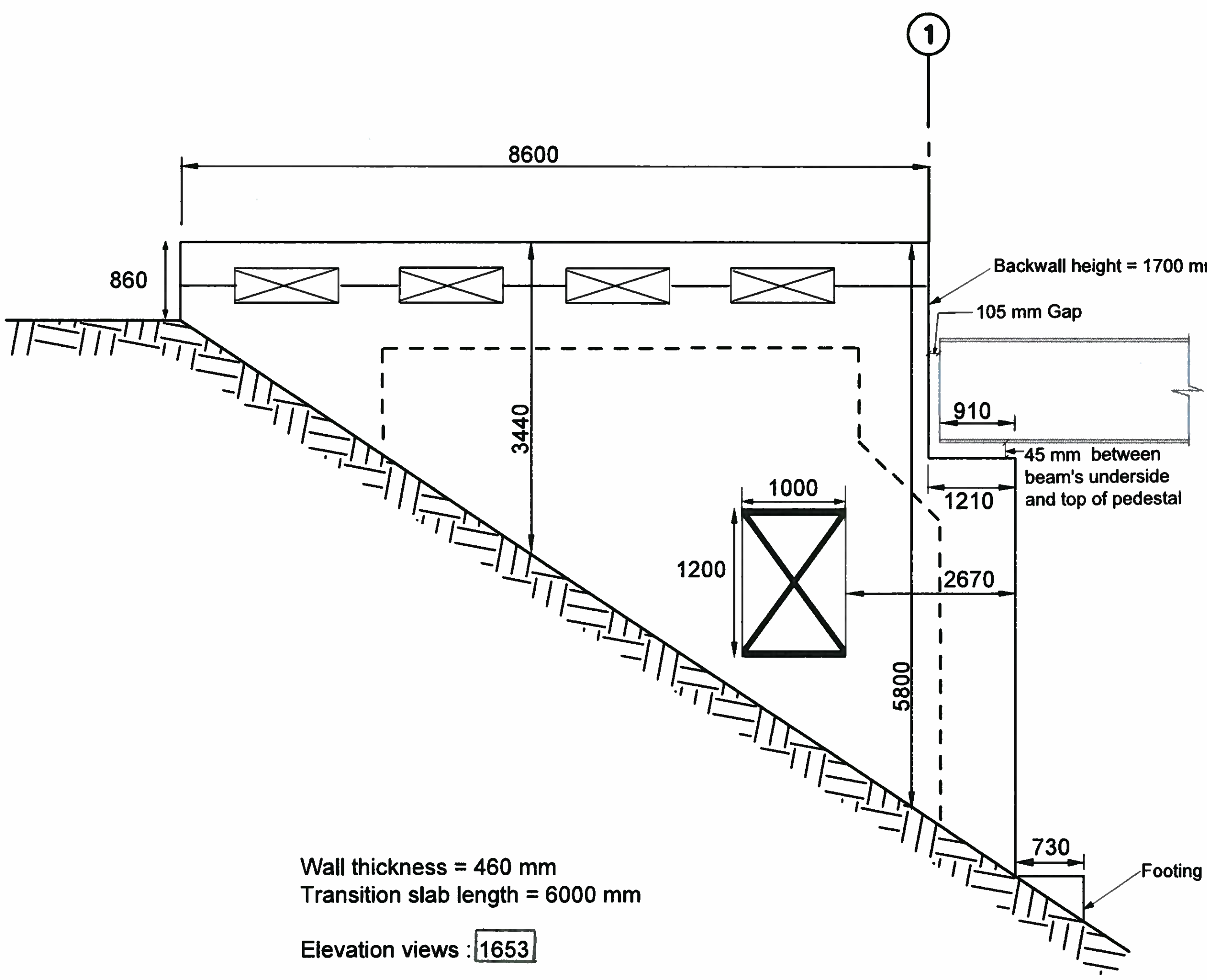
Width (South wall to North wall) = 6110 mm

Pictures
Backwall : 7900
North wall : 7903
Back side of abutment front wall : 7902
South wall : 7901
Slab : 7904-05

Stantec DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

WEST ABUTMENT SOUTH ELEVATION

(Wall #1)



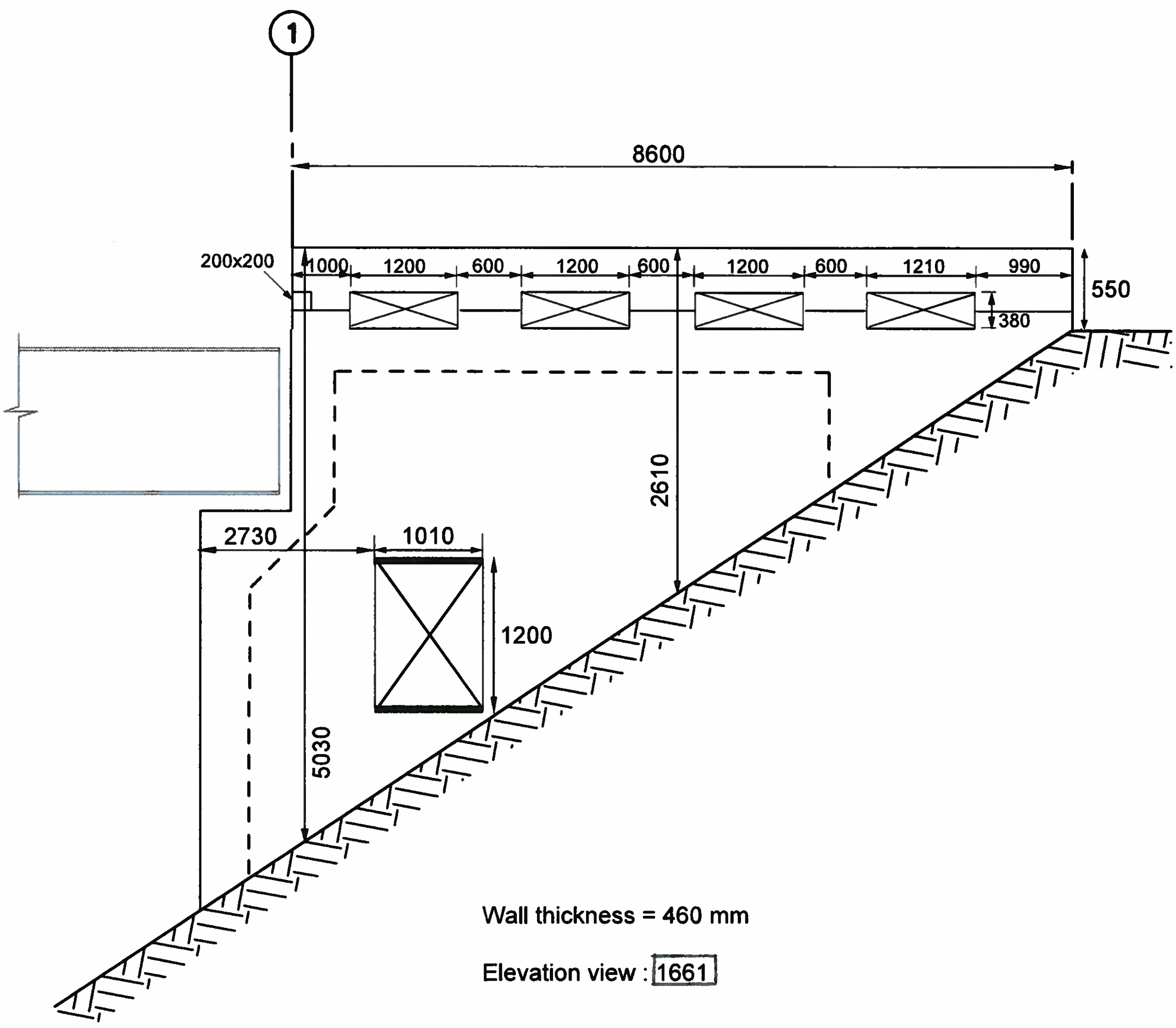
Wall thickness = 460 mm
Transition slab length = 6000 mm

Elevation views : 1653

Stantec DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

WEST ABUTMENT NORTH ELEVATION

(Wall #2)

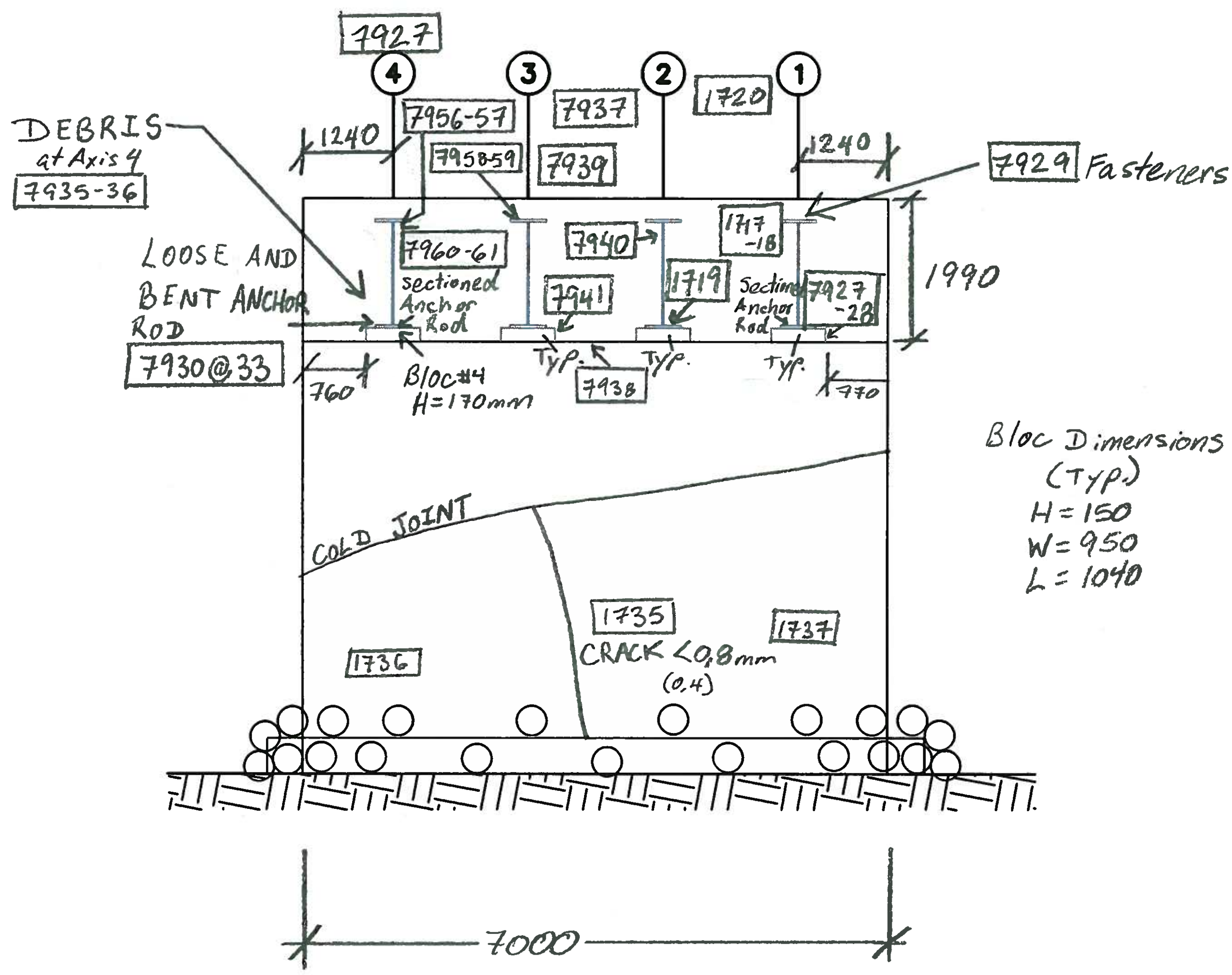


Wall thickness = 460 mm

Elevation view : 1661

DAMAGE SURVEY	
	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

EAST ABUTMENT
WEST ELEVATION



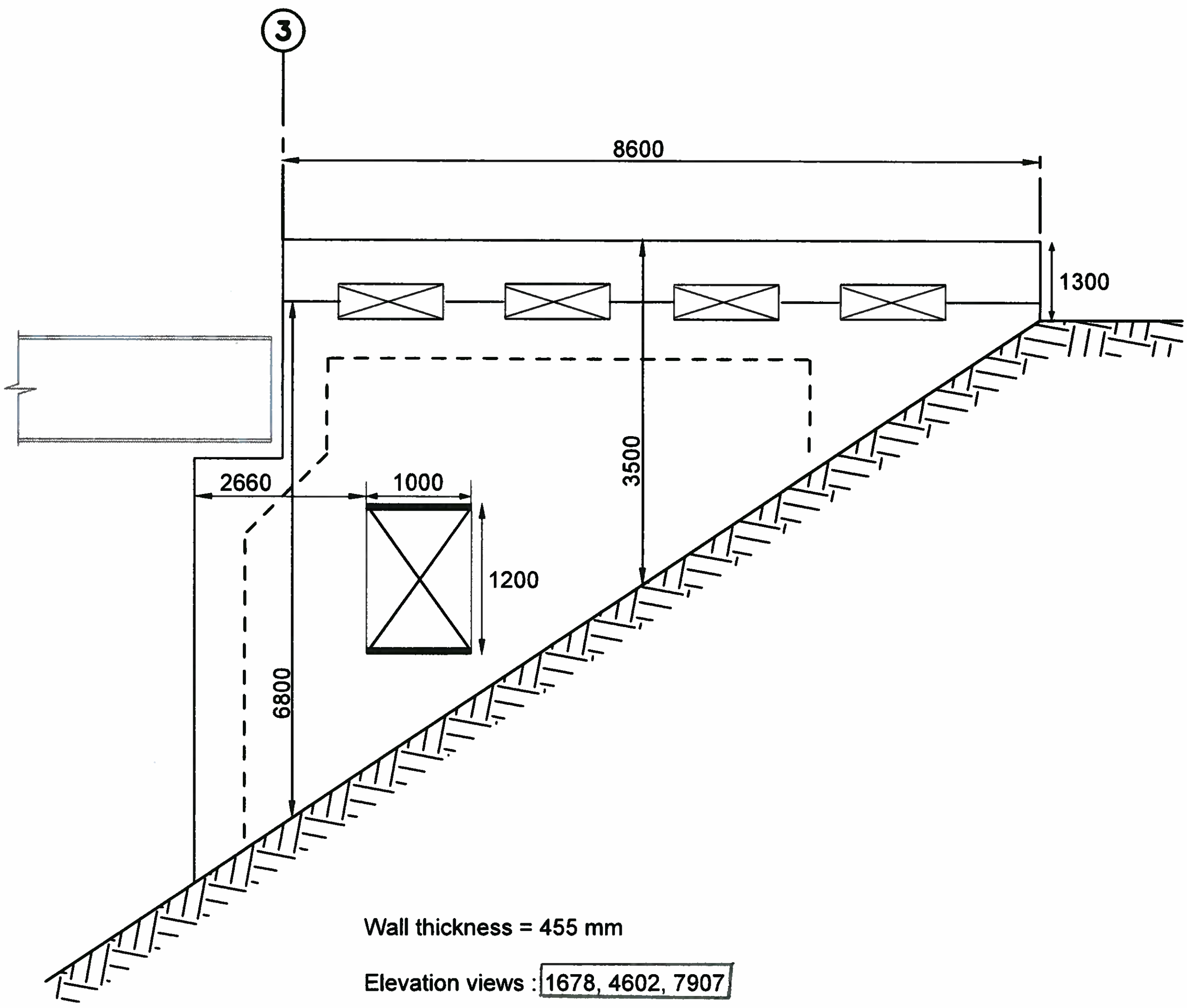
7907

Notes:
Seat lenght : 1200 mm
Spacing between the girders and the abutment backwall is 110 mm at Axis 1 and 120 mm at Axis 4.
Footing width : 750 mm

DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

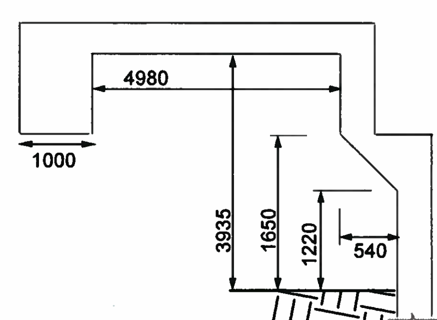
EAST ABUTMENT
SOUTH ELEVATION

(Wall #3)



Wall thickness = 455 mm

Elevation views : 1678, 4602, 7907

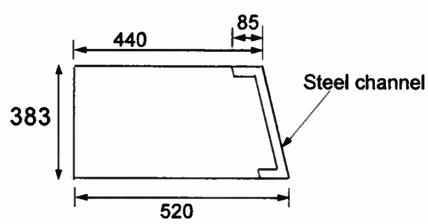


Pictures
Backwall : 7908
North wall : 7909 & 7914
Back side of abutment front wall : 7910
South wall : 7911
Slab : 7912-13

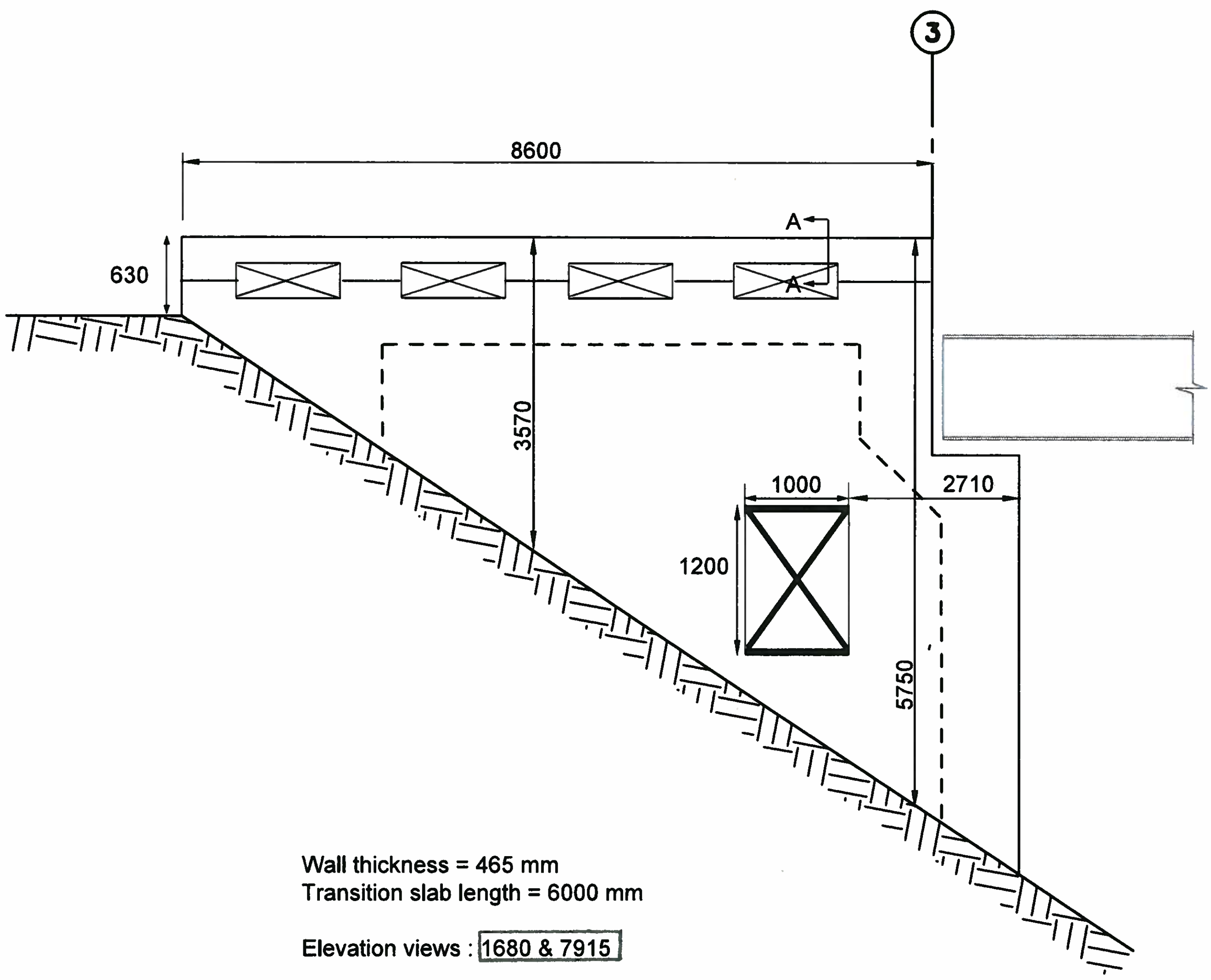
Stantec DAMAGE SURVEY	CLIENT: CREE NATION OF WEMINDJI
	STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER
	DATE: 2019/08/06
	INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

EAST ABUTMENT NORTH ELEVATION

(Wall #4)



Cross-section A-A



Wall thickness = 465 mm
Transition slab length = 6000 mm

Elevation views : 1680 & 7915

Stantec

DAMAGE SURVEY

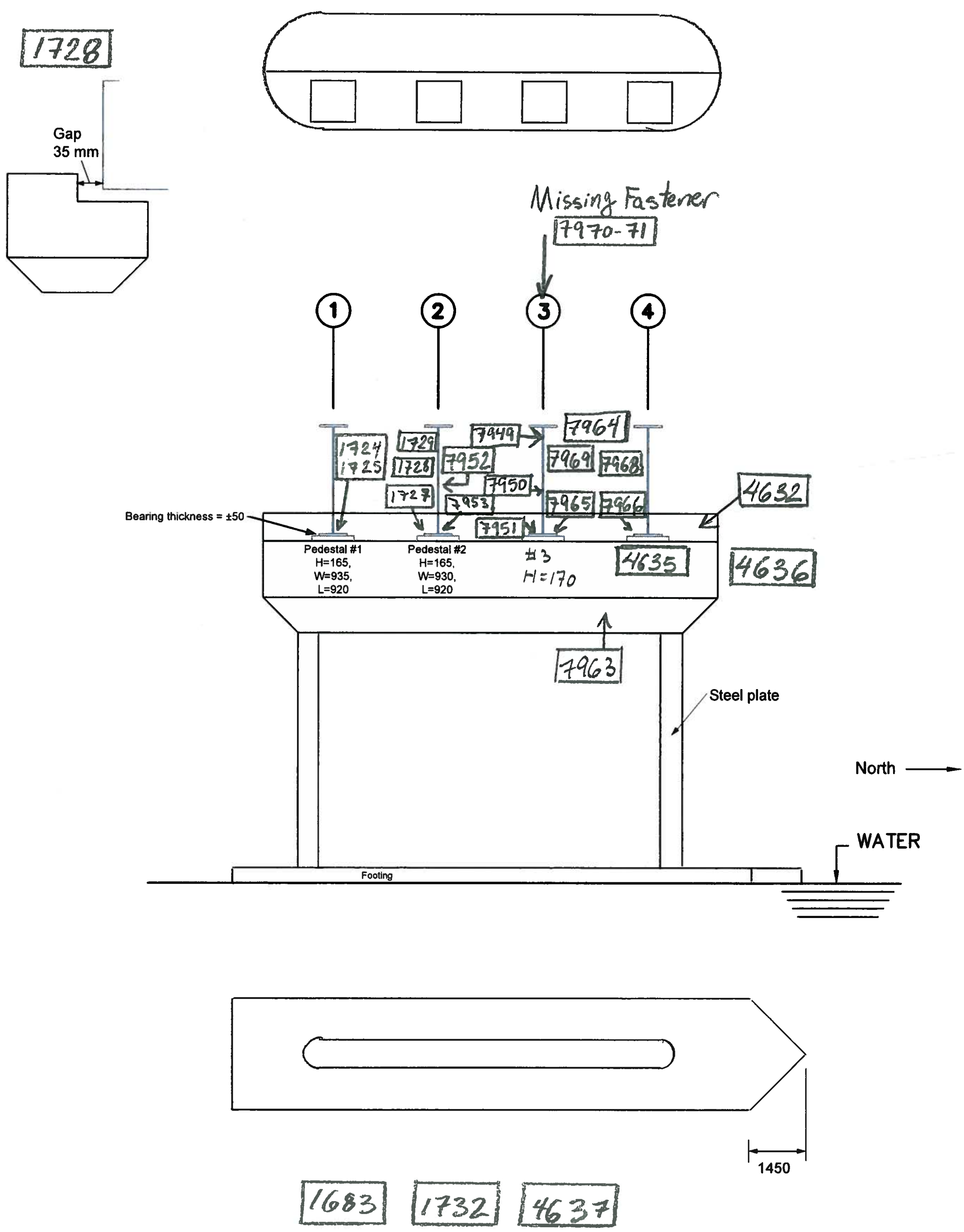
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

PIER (Axis 2)
EAST ELEVATION



Stantec

DAMAGE SURVEY

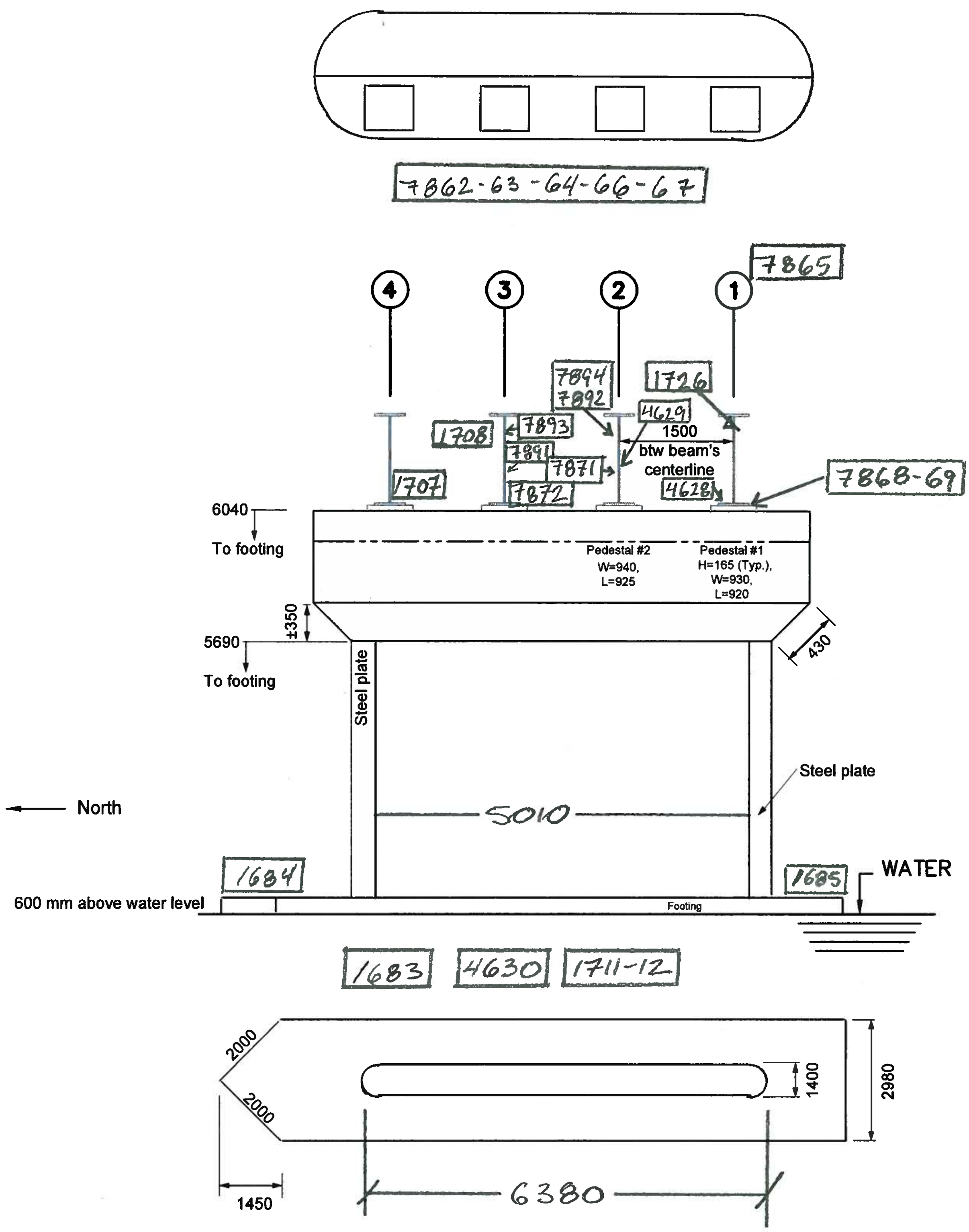
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

PIER (Axis 2)
WEST ELEVATION



Notes
Bracings : steel angle (L-shaped) 76x76 with 19 mm bolts.
45 mm between pedestals and beam's undersides.
Support length : 970 mm (all beams).
Steel beams: H = 1200 mm, flange thickness = 32 mm, flange width = 410 mm.

CLIENT: CREE NATION OF WEMINDJI

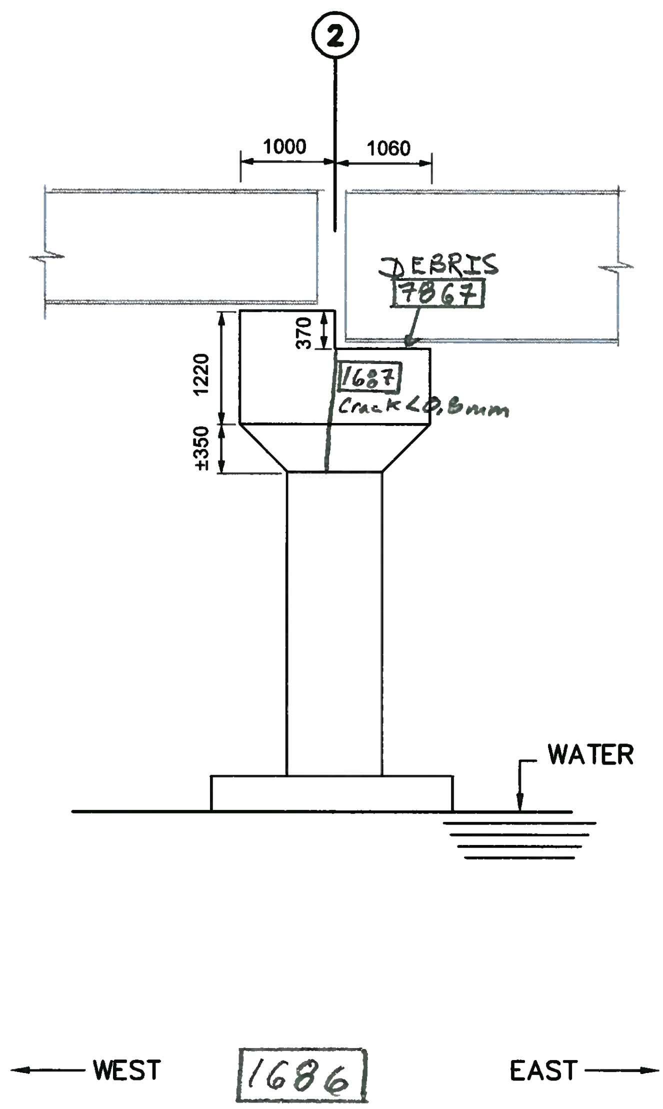
STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

DAMAGE SURVEY

PIER
SOUTH ELEVATION



Stantec

DAMAGE SURVEY

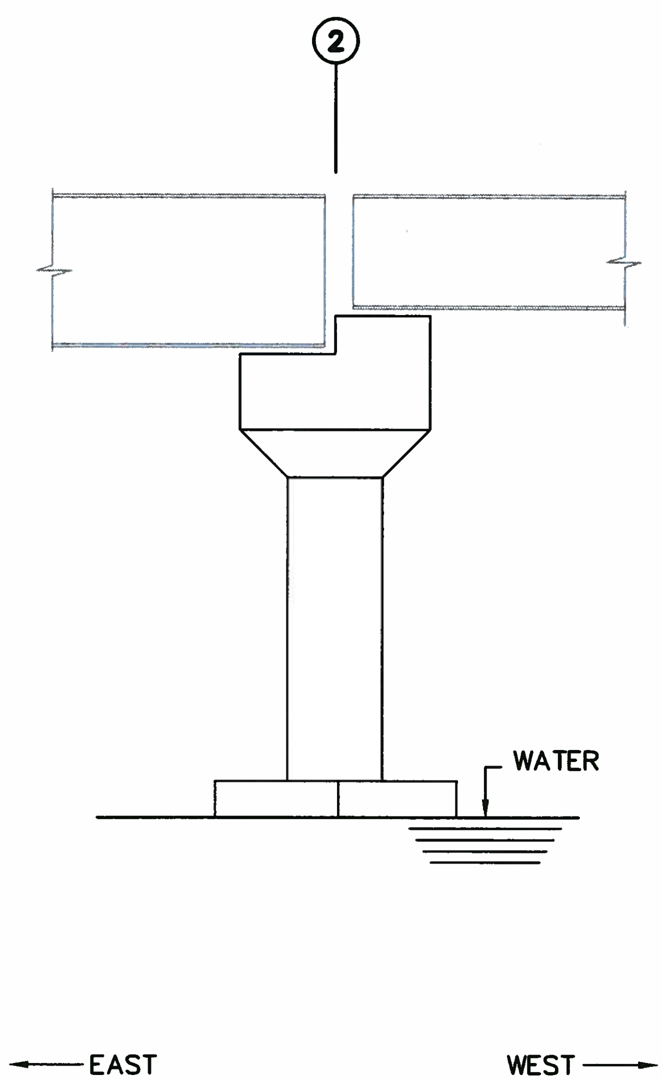
CLIENT: CREE NATION OF WEMINDJI

STRUCTURE: ACCESS ROAD BRIDGE OVER THE MAQUATA RIVER

DATE: 2019/08/06

INSPECTORS: Myriame Fraser, eng. ; Sebastien Daigneault, tech ; Simon Lefebvre, tech

PIER
NORTH ELEVATION



APPENDIX C

Photo report

Photo report

Wemindji_4587

Wemindji_4588

Wemindji_4589

Wemindji_4590

Wemindji_4591

Wemindji_4592

Wemindji_4593

Wemindji_1651

Photo report

Wemindji_4594

Wemindji_1653

Wemindji_4595

Wemindji_4596

Wemindji_1654

Wemindji_1655

Wemindji_1656

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Wemindji_1676

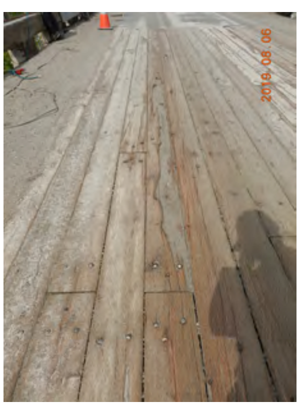
Wemindji_1678

Wemindji_1680

Wemindji_1681

Wemindji_1682


Wemindji_4597


Wemindji_4598

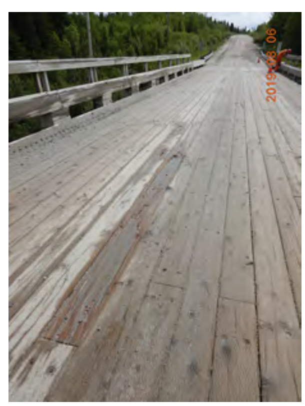

Wemindji_4599

Photo report

Wemindji_4600


Wemindji_4601

Wemindji_4602


Wemindji_4603


Wemindji_4604


Wemindji_4605


Wemindji_4606


Wemindji_4607

Wemindji_4608

Wemindji_4609

Wemindji_4610

Wemindji_4611

Wemindji_4612

Wemindji_4613

Wemindji_4614

Wemindji_4615

Photo report

Wemindji_1683

Wemindji_1684

Wemindji_1685

Wemindji_4616

Wemindji_4617

Wemindji_4618

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Wemindji_1689

Wemindji_1690

Wemindji_7862

Wemindji_7863

Wemindji_1691

Wemindji_1692


Wemindji_4624

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Wemindji_4631

Wemindji_1694

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Wemindji_1697

Wemindji_7870

Wemindji_7871

Photo report

Wemindji_7872

Wemindji_7873

Wemindji_7874

Wemindji_7875

Wemindji_7876

Wemindji_7877

Wemindji_7878

Wemindji_7879

Wemindji_7880

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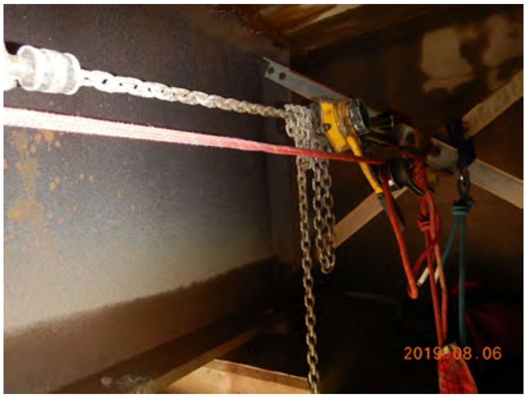
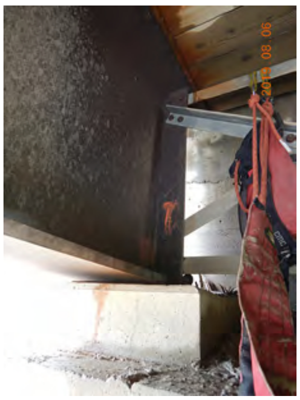
Wemindji_7887


Wemindji_7888


Wemindji_7889


Wemindji_1698


Wemindji_1699

Wemindji_7890

Wemindji_1700


Wemindji_7891

Wemindji_7892

Photo report

Wemindji_1701

Wemindji_1702

Wemindji_1703

Wemindji_7893

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Wemindji_7909

Wemindji_7910

Photo report

Wemindji_7911

Wemindji_7912

Wemindji_7913

Wemindji_7914

Wemindji_7915

Wemindji_7916

Wemindji_7917

Wemindji_7918

Photo report

Wemindji_7919

Wemindji_7920

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Wemindji_4632

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Wemindji_4635

Wemindji_4636

Photo report

Wemindji_4637

Wemindji_7930

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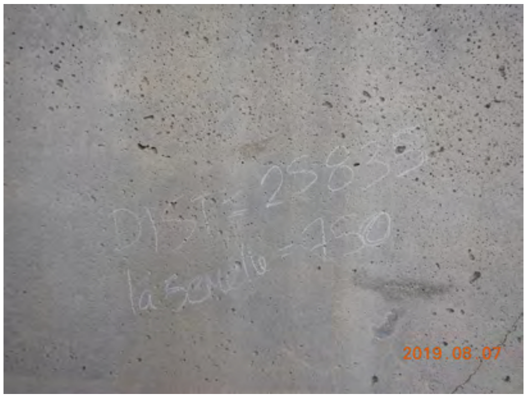
Wemindji_7935

Wemindji_7936

Wemindji_1715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Wemindji_1721

Photo report

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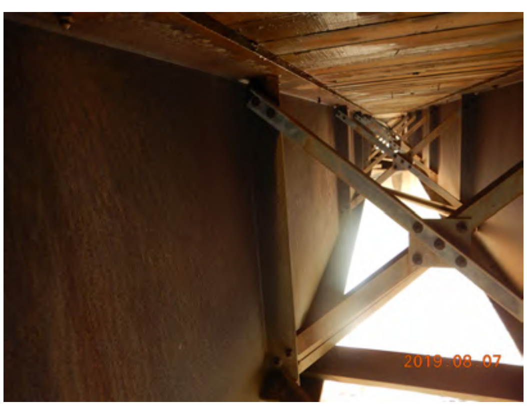
Wemindji_7942

Wemindji_1722

Wemindji_7943



Wemindji_7944

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Photo report

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Photo report

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Photo report


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Photo report

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Design with community in mind

CREE
DEVELOPMENT
CORPORATION

Respect · Collaboration · Strength

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