CONFIDENTIAL

February 4, 2013

Our Reference: 45607
Parks Canada Reference: 20029741

Parks Canada Agency
Jasper National Park
Box 10
Jasper, AB. T0E 1E0

Attention: Bhuwahn Devkota, P.Eng. PMP
Project Manager

Reference: Maligne River Fifth Bridge Engineering Assessment
Jasper National Park

Introduction

In response to a request for consulting services contained with the Terms of Reference for the above noted project, please find the following recommendations for the rehabilitation of the Maligne River Fifth Bridge.

Background

The Maligne Canyon Fifth Pedestrian Bridge was originally built in 1964. A reinforced concrete wing wall, located at the front of the river right bank, was added in late 1990's to protect the foundation from erosion. The bridge was rehabilitated in 2005 by replacing wood towers, walkway, decking, fencing and modifications to the approaches.

The river experienced a record high flood water condition for the period of June through August 2012 and has resulted in substantial damage to the bridge and supporting structure complete with erosion of the banks in the area. As a result of the flood event, Parks Canada closed the bridge to use due to public safety concerns. Observations of the flood event by Parks Canada staff resulted in a request for an engineering assessment of the bridge and surrounding stream with respect to mitigation of the damages and restoring a stream crossing to service at the current location. A preference for the restoration of a cable suspension bridge was expressed and the re-use of existing materials is preferred when viewed from an aesthetic and cost of construction perspective.

Scope of Work

The overall scope of the project is intended to comprise the assessment, design and construction of a replacement river crossing. Through discussions with Parks, it was decided that the scope should be categorized in two phases in order to expedite the work and to fit the work into budgetary constraints. Phase One of the work is the assessment of the existing bridge and channel. Phase Two would be comprised of engineering design and construction administration services.

The tasks required for the phase one scope are as follows:

- Coordinate a site visit to coincide with project start-up meeting with Parks Canada

- Discuss the Parks functional and aesthetic requirements of the river crossing, the associated trails and temporary crossings
- Discuss structural, hydro-technical and surveying requirements
- Discuss regulatory requirements
- Collect field data to assess the current condition of the bridge superstructure with respect to its potential for re-use.
- Collect data to assess the current foundation conditions.
- Conduct a survey of the existing conditions including:
  - Channel profiles at bridge and up and downstream identifying high water marks, debris potential, and ice scars.
  - A visual assessment of general and local scour potential.
  - A visual assessment of existing and potential bank erosion upstream and downstream of the structure.
  - A visual assessment of the hydraulic conditions that caused failure of the existing bridge.
- Assess the hydrology of the Malign River and determine the magnitude of the design flood.
- Address seasonal flow statistics for use in construction planning.
- Assess the existing hydraulics at the site and build a 1-dimensional HEC-RAS model including insights into the 2012 failure.
- Develop hydro-technical design recommendations.
- Provide recommendations for bank protection including scour depth and armouring requirements
- Provide recommendations regarding the refurbishment of the existing bridge or replacement with a new structure.
- Provide order of magnitude budget cost estimates for the above

River and Channel Assessment

Matrix Solutions Incorporated, a hydrology and hydrotechnical engineering specialist consultancy was retained to provide input for the following tasks:

- Assess the river hydrology and determine the magnitude of the design flood
- Address the seasonal flow statistics for use in construction planning
- Assess the existing hydraulics at the site and build a 1-dimensional HEC-RAS model including insights into the 2012 failure
- Develop hydro-technical recommendations
- Provide recommendations regarding bank protection including scour depth and armouring requirements.

Matrix solutions have provided a report from the findings of this assessment. The Matrix report is appended herein.

Field Investigation

On November 22, 2012, the undersigned along with Matt Wood of Matrix Solutions Inc. travelled to Jasper to undertake the field investigation of the assessment. A short meeting with Parks Canada staff was held at the Jasper Field Office to discuss process, safety and the desires of Parks with respect to the aesthetics and operational characteristics of the crossing.

The team then proceeded to the site where ISL's survey staff, led by Dave West P. Eng. and having travelled to the site the previous day, was conducting the stream profile survey.

The bridge was observed in its closed position with the watercourse levels being well below what would have been present at the time of the flood event. The existing structure consists of a cable suspended wood structure supported by concrete abutments. A buried concrete dead man is located adjacent to the pathway on each bank which anchors the suspension cables. A drawing, purported to be that of the existing structure, was reviewed for general compliance with the built conditions. This drawing is appended for completeness. The general arrangement and sizing's from the existing drawing appeared to closely match the built conditions.

The Maligne River runs west at this location with the south bank being defined as on the 'left' as one observes the bridge structure from an upstream position. It follows that the north bank is defined as the 'right' bank for the purposes of discussion within this report.

The left bank abutment appeared to be in good condition with only minor scour of the foundation at the downstream edge. The right bank displayed considerable damage and the bridge superstructure had undergone some rotation in the clockwise direction when observed from the right bank. Deformation and damage to the right bank approaches and handrails was also observed.

At the crossing site the bed is comprised of large cobble material with some boulders. The bed is well armoured and gravels were not readily visible but proved the base for the surficial bed material. The bed substrate suggests that the potential for general scour is low and local scour is only present where there are abrupt constrictions. This is evident at the upstream of the bridge where the deposition on the left side of the channel has forced the thalweg to deepen and run along the right bank. It is also apparent at the downstream of the bridge site where the channel narrows and a 1.5 m deep pool has formed. This pool has the potential to migrate upstream and its migration would trend towards the right (north abutment). It is believed that the upstream migration of the pool and its impending connection to the thalweg on the right side of the channel has contributed to the undermining of the right abutment.

Hydrological Assessment

The review by Matrix solutions has yielded existing and post-rehabilitation design 100-year flood water levels as well as design freeboard recommendations. Protection of the right and left abutments and protection for the right bank is included in their report.

In-stream construction recommendations for placement of protection of the banks and abutments are included. The report suggests the windows of opportunity for in-stream work and the required approvals that will need to be obtained as a function of the procurement of a new crossing.

The Matrix report is appended for perusal when detailed information with respect to the stream work is required.

Structural Assessment

Based on the observed condition of the existing bridge and the limits to access of the site, ISL is proposing two possible options to re-establish this crossing. The first and most desirable option is the refurbishment of the existing bridge. The second is the replacement of the bridge in its entirety. Both options require the mitigation and repair to the stream banks in order to ensure the longevity the service of the crossing. As a sub-set of the replacement option we recommend considering two options; a pre-engineered structural steel superstructure and; a wood structure, primarily from glue-laminated beam sections.

Option A: Bridge Rehabilitation

This option is predicated on extending the span of the suspension bridge by relocating the right bank abutment 3.0m to 4.5m inland from its present position. The location is a function of the 1.5m spacing of the existing suspension cables. The minimum required setback to satisfy the hydrological concerns is 2.0m.

It would be necessary to remove and reconstruct the right-bank concrete abutment and amour it with class 1 rock rip rap. The existing dead man on both banks would likely be re-used. The bridge span extension is required to accommodate the channel migration. The south abutment will require class 1 rock rip rap slope protection due to potential future erosion. The low chord of the existing bridge is required to be raised by 0.31m from its current elevation due to its susceptibility to damage from debris during the 1:100 year flood.

The primary driver behind the selection of this option is the combined desire of having the same aesthetic experience as the original bridge coupled with the construction cost savings realized by the re-use of some of the existing concrete foundation and cabling. The estimated construction costs for this scenario are less than a replacement of the bridge.

The suspended elements of the existing bridge are likely best replaced with new material due to their age and condition. The wood tower at each bank will likely require replacement due to the profile of the new bridge not being compatible with the existing geometry of the towers. The existing left bank abutment and the cabling for the bridge could be re-used however the cables would likely require extensions.

Option B: Bridge Replacement

The existing bridge can be replaced with a new foundation and superstructure. Using the minimum additional setback of 2.0m noted in the hydrological report would define this bridge span. Options for the superstructure of the new crossing include prefabricated steel or wood glue laminated beams. The aforementioned span extension to the right bank would also be required by this option.

The south abutment, pending the structural analysis required by design, would probably be removed, redesigned and replaced to accommodate the forces induced by the new bridge superstructure. Class 1 rock riprap slope protection on both abutments is also required to avoid potential future erosion.

Estimated Capitol Construction Costs

The following is an estimate for the construction cost of the potential solutions. It should be considered only for guidance with respect to the type of construction considered. The cost of the removal of the existing bridge and foundations is estimated as $30k for the refurbishment of the existing bridge and $40K for the case of a complete replacement (Option B). The above numbers are included in the following estimates.

Option A: Refurbishment of Existing	$315,000
Option B: Bridge Replacement	
Steel Superstructure	$365,000
Wood Superstructure	$425,000

Closing Remarks

We propose that the rehabilitation of the existing bridge be pursued as the most desirable and viable solution to re-establishing this crossing. Additional constraints may be discovered as part of seeking approvals by the various regulatory agencies. Risk is involved in pursuing this option in that the additional capacity required of the existing foundations and cabling may prove to be unattainable with significant refurbishment or augmentation of the existing materials. It is recommended that these questions be placed at the forefront of the commencement of Phase Two portion of the work.

We trust the above is satisfactory, please do not hesitate to call should you have any questions or comments about this report. Thank you for the opportunity to provide our services to Parks Canada.

Sincerely,

Reid Costley, P.Eng.
ISL Engineering and Land Services

Encl.:
Existing Design Drawing; Fifth Bridge Maligne River circa 1964
Matrix Solutions Draft Report

February 4, 2013

Reid Costley, P.Eng. – Buildings Discipline Manager **Matrix 16815-522**
ISL ENGINEERING AND LAND SERVICES LTD.
#1, 6325 12th Street SE
Calgary, Alberta T2H 2K1

Re: Hydrotechnical Assessment and Conceptual Design for the Maligne Canyon Fifth Bridge over the Maligne River at 06-36-045-01-W6M

Dear Mr. Costley:

Matrix Solutions Inc. (Matrix) is pleased to provide ISL Engineering and Land Services Ltd. (ISL) with the hydrotechnical assessment and conceptual design recommendations for the rehabilitation of the Maligne Canyon Fifth Bridge crossing over the Maligne River near Jasper, Alberta (Figure 1).

1.0 BACKGROUND

The 5th Bridge over the Maligne River is a timber suspension bridge located approximately 6 km northeast of the Jasper Townsite. This area of the park is regularly visited by park guests and the bridge is used by visitors and tour groups accessing the canyon trails. In the summer of 2012 the bridge was compromised when flood waters eroded the right bank, undermined the concrete wall and washed out the fill within its north abutment (Photos 1 and 3, Figure 2). Because winter access to the site is important, a temporary bridge was constructed 40 m upstream of the compromised pedestrian bridge to provide winter access to the north side of the river. It is expected that the temporary bridge will be removed prior to freshet or risk washing out. It is recommended that the temporary bridge stay in no later than April 30th.

Matrix was retained by ISL to assess the hydraulics and river morphology at the bridge site; and, to provide hydrotechnical design recommendations as part of the Phase I conceptual design for the rehabilitation.

2.0 BASIS

Our assessment and design recommendations are based on:

- a site reconnaissance conducted by Matt Wood, P.Eng., CPESC, on November 22, 2012 to document crossing site conditions;
- 1:50,000 NTS site mapping;
- hydrometric data recorded at Water Survey Canada (WSC) Gauge 07AA004 – Maligne River near Jasper;
- general arrangement drawings of the existing bridge, provided by ISL;
- site Specific Mitigations J12-059 Parks Canada 5th Bridge Temporary Replacement; and,
- site survey data collected on November 21, 2012 and November 22, 2012 by ISL.

3.0 SITE DESCRIPTION

The Maligne River, at this location, flows west for approximately 2.0 km before reaching its confluence with the Athabasca River. It has a defined channel with an irregular meander pattern and transitions from partially confined to fully confined in its glacial cut valley. The channel section at the crossing is 24 m wide and slopes at approximately 1.5%. A pool is located immediately downstream of the crossing site and transitions to a deep run along the right side, upstream of the bridge. This run was formed by the development of a point bar on the left side of the channel (Photo 6, Figure 2) which transitions to a riffle before reaching the confluence of the flow split at the upstream island.

The bank material is comprised of loose, cobbley till and has little to no cohesive properties. Where exposed this material is highly erodible, but cobble material from the till provides some natural armour as erosion progresses.

The left (south) bank is 4 m high and slopes at 1:1 H:V. It is well vegetated with only minor localized erosion. This local erosion is most apparent at the trimline and around portions of the south abutment. The left bank does not overtop during flood. The erosion on the left bank has not compromised the south abutment but any future erosion likely would.

The right bank is 2.0 m high and vertical to undercut due to the thalweg's position along its toe. The undercutting has likely become more pronounced as recent erosion has washed out approximately 2 m of the bank in 2012. It is believed that the progression of this erosion is driven by deposition on the left side of the channel as shown in Photo 6 of Figure 2. The root structure of the mature conifers in the right overbank provides some degree of resistance to the erosion. This erosion will continue to progress at a slow rate with future development of the point bar. Hydraulic modelling (described later in this report) suggests that the right bank just barely overtops during the 100-year flood. Though the bank is low, the overbank flood depths estimated using the hydraulic model, and the presence of the slightly elevated pathway that runs back into the floodplain, suggests that the potential for full scale channel switching to the north side is low.

At the crossing site the bed is comprised of large cobble material with some boulders. The bed is well armoured and gravels were not readily visible but proved the base for the surficial bed material. The bed substrate suggests that the potential for general scour is low and local scour is only present where there are abrupt constrictions. This is evident at the upstream of the bridge where the deposition on the left side of the channel has forced the thalweg to deepen and run along the right bank. It is also apparent downstream of the bridge site where the channel narrows and a 1.5 m deep pool has formed. This pool has the potential to migrate upstream and its migration would trend towards the right (north abutment). It is believed that the upstream migration of the pool and its impending connection to the thalweg on the right side of the channel has contributed to the undermining of the right abutment.

The bed substrate is pre-dominantly composed of cobbles, but also contains gravels, boulders, and some non-cohesive fines. The bank substrate is composed of fines, gravels, and organic matter. The banks have dense cover with mature conifers and shrubs located with 0.5 m of the edge of the bank. Overbank flooding is expected to be minimal due to the dense vegetation and large channel conveyance.

3.1 Hydrology

The bridge crossing is approximately 2 km upstream of the confluence with the Athabasca River near the sub-alpine canyon on the face of the Maligne mountain range. At the site, the river drains 903 km^2 of alpine and, sub-alpine areas classified as the Rocky Mountain Montane Ecoregion (Natural Regions Committee 2006). The area is characterized by mountainous alpine terrain containing steep, exposed rock faces and glaciated areas and alpine meadows. The sub-alpine vegetation is dominated by lodgepole pine, white spruce, trembling aspen, and Douglas-fir. There are scattered grasslands interspersed within the heavily vegetated, mature forests.

There is a Water Survey Canada Gauge located 1 km downstream of the crossing site (WSC station 07AA004 – Maligne River near Jasper). This station has a record period from 1916 to 1997. Hydrologic estimates for flood frequency and monthly flow statistics were prepared using the recorded data from the gauge. Figure 3 shows the results of the hydrologic analysis.

Based on the flood frequency estimates the design flood, with a 100-year return period has a magnitude of 127 m^3/s. The 2-year flood is deemed to be representative of maximum flood conditions for navigation freeboard design and has a magnitude of 53 m^3/s.

3.2 Existing Condition Hydraulics

A 1-dimensional hydraulic model was built in HEC-RAS using the survey data collected by ISL. The model was not calibrated due to the lack of high water marks and corresponding flood estimates. Instead the model was developed using representative parameters from the literature with a trending to more conservative parameter estimates for design. The water surface profiles were estimated for the 2-year and 100-year design discharges and are shown with the estimated average channel velocities in Table 1:

Table 1: Existing Condition Hydraulics

Return Period	Flood Magnitude [m^3/s]	Water Level Upstream of the Bridge [m]	Mean Channel Velocity [m/s]
100-year Design Flood	127	1033.37	3.18
2-year Flood for Safe Navigation Design	53	1032.56	2.28

Mean channel velocities during the 100-year design flood are expected to be 3.0 m/s through the bridge opening. Local velocities may be greater.

Figure 3 also shows the results of the monthly flow data for January through December for construction planning purposes.

3.3 Geomorphology

A geomorphic assessment was conducted using aerial photography of the site taken in 1949 and 1997. The aerial photographs used in the analysis are provided in Figure 4. The resolution of the photographs does not allow for accurate measurement of past erosion. The photos do show that there was widespread channel movement at the bend that is located 200 m downstream of the crossing site that has since vegetated and stabilized. There is potential for future erosion and channel movement at the downstream; but, this should not impact the crossing location.

The crossing is located just far enough upstream of the bend that the potential for channel switching from overtopping the right bank at the crossing location is minimal. Hydraulic modelling also suggests that the right bank does not overtop during the 100-year flood event. Should a debris jam occur immediately downstream of the bridge, or within the bridge, then the potential for flood flows to jump the right bank, upstream of the bridge, is present. Because the potential for this to occur is low, and measures to prevent this would be extensive, costly and would have a significant environmental impact, it is recommended that measures to prevent channel switching not be implemented as part of this restoration.

The progressive erosion of the right bank had begun by 1997 and continues to the present. Reports from Parks Canada suggest that erosion accelerated during the 2012 flood. Based on the channel alignment shown in the aerial photography, and the future growth of the point bar on the left, upstream side of the bridge, it is likely that this erosion will continue. To halt this erosion completely would require riprap armouring of approximately 60 m of bank upstream of the bridge. This would be a costly endeavour and would come with significant environmental impacts. Because the erosion is progressing slowly, and there is still a substantial root structure in the right floodplain terrace, it is expected that a single large flood event, or a reasonable number of sequential large flood events will not cause the erosion to progress such that it will impact the bridge. This assumption is with the expectation that adequate armouring is provided at the right abutments; and, that the armouring is designed such that it considers the future upstream erosion. It is recommended that extensive armouring and river training on the upstream side of the bridge not be conducted as part of the bridge restoration.

The right bank upstream of the bridge should be monitored following each freshet to determine the degree at which the erosion is progressing. If large scale erosion is observed then the site should be re-evaluated by a river engineer to determine if remedial measures need to be implemented.

A scour assessment was conducted at the bridge site and resulted in an estimated 1.5 m of scour potential. This scour potential is evident in the 1.5 m deep scour hole downstream and suggests the hole has the potential to migrate upstream.

4.0 HYDROTECHNCIAL DESIGN RECOMMENDATIONS

The proposed rehabilitation involves salvaging as much of the existing bridge infrastructure as practical and extending its span to set the right (north) tower back from the top of bank. The rehabilitation also involves stabilizing the right bank and providing some additional erosion protection around the left abutment. The following hydrotechnical recommendations are to be used in the conceptual and detailed design of the rehabilitation. The specifications are also provided in Figure 5.

4.1 Post-Rehabilitation Hydraulics

The rehabilitation involves moving the right bridge abutment back into the bank and maintaining a low chord elevation that is at least the same as the existing bridge. The bridge itself therefore will not have an impact on the existing hydraulics; but the minor encroachment of the proposed armouring may have a slight impact. The armouring encroachment (described in Section 4.4) was modeled in HEC-RAS and the post rehabilitation hydraulics were assessed. The results of the assessment are provided in Table 2.

Table 2: Post Rehabilitation Hydraulics

Return Period	Existing Water Level Upstream of the Bridge [m]	Post Rehabilitation Water Level Upstream of the Bridge [m]	Change in Water Level [m]	Change in Velocity [m/s]
100-year Design Flood	1033.37	1033.41	+ 0.04	+0.04
2-year Flood for Safe Navigation Design	1032.56	1032.58	+ 0.02	+0.10

4.2 Design Freeboard and Minimum Low Chord Elevation

Based on the modeled hydraulics, the existing bridge design provides 0.69 m of freeboard over the 100-year water level. This freeboard is just adequate to safely convey small debris loads during the 100-year event. When restored, the minimum low chord elevation at the abutments of the bridge will need to be at, or above, the existing low chord elevation of 1034.0 m. The proposed minimum low chord elevation is shown in the context of the existing bridge in Figure 5.

Because of the type of bridge and its susceptibility to damage if struck by debris, we recommend that ISL consider raising the low chord of the bridge 0.31 m above its existing elevation to provide 1 m of freeboard over the 100-year design flood level. This recommendation, and the feasibility of raising the bridge elevation, would have to be considered in the context of costs and what can be salvaged from the existing bridge.

4.2.1 Safe Navigation Freeboard

The proposed minimum low chord elevation provides 1.42 m of freeboard over the computed 2-year water level. This freeboard does not meet typical freeboard requirements of 2 m freeboard over the 2-year flood level for safe navigation; but, may be deemed acceptable in the context of navigation on the Maligne River, which has other, more serious navigation hazards both upstream and downstream of the crossing site.

4.3 Abutment Setback

The south (left) abutment is appropriately positioned and does not need to move.

The north abutment (right) was compromised and should move back a minimum of 2.0 m from the current top of bank, into more stable ground. This is required to accommodate the proposed abutment armouring and to provide some buffer against future erosion. ISL may choose to set the abutment town back further. Doing so would reduce the armour protrusion into the river channel and would provide additional protection against future erosion.

4.4 Armouring

Armouring recommendations are based on the modeled velocities directly upstream of the existing bridge. The details of the proposed armouring are provided in Figure 5. It is recommended that the existing concrete wall at the right abutment be removed to allow for proper placement of the armouring while minimizing the encroachment into the channel.

On the north (right) side of the channel, a class I rock armoured revetment is proposed around the abutment. The armouring is to extend 4 m upstream of the bridge and 4 m downstream as shown in Figure 5. A 2 m wide riprap key shall extend 4 m back into the bank to protect the abutment from any future erosion of the upstream right bank. Should monitoring reveal that future erosion progressed such that this key becomes exposed, then remedial measures on the upstream right bank will be necessary.

All riprap above the trimline can have its voids filled with loam, planted with willow cuttings and seeded at the request of Parks Canada.

5.0 IN-STREAM CONSTRUCTION

The existing bridge is to be removed without entering the watercourse with the exception of the removal of the concrete abutment wall on the north side of the channel. The bridge can be replaced without entering the watercourse with the exception of the placement of the rock armour.

5.1 Bank Grading and Armour Placement

The armour has been designed so that it can be placed on the existing bed without the need to excavate the bed for a foundation. This eliminates the need for full isolation or dewatering. Minor isolation will be required at the toe of the right bank to prevent sediment from entering the watercourse during grading activities around the compromised abutment. This can be achieved using a silt or turbidity curtain placed at the water's edge.

5.2 Transportation of the Armour for the Right Bank

There is no vehicle access to the north side of the river; therefore, there are two feasible options for transportation of the rock armour to the right bank. Option 1 uses a crane to deposit the armour on the far side of the river. Option 2 uses rock trucks entering the channel to transport the rock to the other side. The travel routes and lay down areas for the two options are shown in Figure 6. The preferred option will be dependent on the assessment of the potential environmental impacts as determined by Parks Canada in consultation with Fisheries and Oceans Canada.

5.2.1 Armour Transportation Option 1 – Rock Truck Fording the River

The quickest way to deliver the armour is by having rock trucks reverse down the south bank, ford the river in reverse and dump their load at the right abutment. Based on the estimated volumes of riprap, we anticipate 4 loads of rock which will require a total of 8 fordings.

We believe that the clean, natural, surficial bed armour and its clean gravel base at this location of the Maligne River will limit the mobilization of sediment from the disturbance; and thus, disruption to aquatic life will be minimal. While fording, environmental monitors would be monitoring turbidity downstream as described in Section 5.4.

Fording methods such as this has been successfully used by Matrix in July 2012 on the Lower Cascade

River in Banff National Park. Such methods were also proposed by Matrix for Boulder Cluster installation on the Miette River in Jasper National Park though construction took advantage of iced conditions and avoided entering flowing water. Both projects had similar challenges where access limited options for the installation.

5.2.2 Armour Transportation Option 2 – Crane

The second option for rock delivery to the north side is to have a crane position itself on the left overbank, reach across the channel and deliver rock to the opposing side. The feasibility of this option will be assessed during detailed design and will be dependent on the capacity and limitations of available cranes.

With this option, the existing concrete abutment wall can be removed by the crane.

Note that this method will still require one fording each way by the excavator as described in Section 5.3.

5.3 Placement of the Armour for the Right Bank

A tracked excavator will be required to grade the existing bank and for arrangement of the riprap once delivered to the north side and therefore both options will require the excavator to ford the river. For both options the excavator's fording should be limited to one traverse each way. To start, the excavator would wait until some of the rock armour has been delivered to the north side (via Option 1 or Option 2). The excavator would then use the rock pile to climb the bank to its work platform in the right overbank as shown in Figure 6. The excavator should not have to return across the river or descend into the channel until the armour placement and arrangement is complete. The excavator would then use the placed armour the re-enter the channel then cross the river back to the south side. Access and egress routes for the excavator fording are provided in Figure 6.

5.4 Timing

According to J12-059 Parks Canada 5th Bridge Temporary Replacement, the fish species found in the Maligne River below the canyon include: Bull Trout, Brook Trout, Rainbow Trout, Rocky Mountain Whitefish and Burbot. As such, the instream work window is defined as April 5 to April 15 and August 15 to September 1.

The instream work is expected to take no longer than 10 days. Based on the monthly flow analysis it is recommended that the work take place in the April window to take advantage of low flows. It is not recommended that this work be done in August due to the high flows. If work cannot be done in April then an alternate construction period, outside of the designated work windows will be necessary.

5.5 Monitoring During Construction

An environmental monitoring plan will be developed as part of detailed design and construction planning, and with input from Parks Canada following their review of the proposed restoration work and installation plans. The monitoring plan will include turbidity monitoring with appropriate shut down triggers for exceedences.

6.0 REGULATORY REQUIREMENTS

6.1 Transport Canada

The Maligne River may be deemed navigable by Transport Canada however there are severe natural hazards to navigation both upstream and downstream of the crossing site. Parks Canada shall consult with Transport Canada on whether or not approval under the Navigable Water's Protection Act will be required for this rehabilitation and whether the freeboards proposed in this report are adequate for this site.

6.2 Fisheries and Oceans Canada

Clear-span bridges are normally covered under Fisheries and Oceans Canada (DFO) Operational Statements (OPs) for clear-span bridges (DFO 2008); however, this rehabilitation will require in-stream work, fordings and riprap placement in the channel. The project will therefore require authorization from DFO. It is expected that DFO will be consulted on this project throughout the construction planning and environmental assessment process.

6.3 Alberta Environment and Sustainable Resource Development

Since this project is within a National Park the Alberta *Water Act* does not apply. Regardless, the rehabilitation does meet Environment and Sustainable Resource Development requirements of the *Water Act* for hydraulic impacts as the proposed works have no significant effect on upstream flood levels or on hydraulics through the reach and meets Code of Practice Requirements for Watercourse crossings (AENV 2007).

7.0 CLOSURE

We believe that if the proposed pedestrian bridge rehabilitation is designed and constructed as recommended herein, it will: not have any major impact on the overall hydraulic behaviour of the Maligne River; maintain overall natural drainage patterns; allow for safe navigation; minimize fish habitat impact as much as practical; and, will remain serviceable up to the 100-year flood.

We trust that this letter report suits your present requirements. If you have any questions or comments, please call either of the undersigned at 403.237.0606.

Yours truly,

MATRIX SOLUTIONS INC.

PROFESSIONAL ENGINEER MATT WOOD ALBERTA

Feb 4/2013

Matt Wood, P.Eng., CPESC
Senior Hydrotechnical Engineer

Reviewed by

Dave Cooper, P.Eng.
Principal Engineer

REFERENCES

Alberta Environment (AENV). 2007. *Code of Practice for Watercourse Crossings, Water Act - Water (Ministerial) Regulation*. Queen's Printer. Edmonton, Alberta.

Fisheries and Oceans Canada (DFO). 2008. *Alberta Operational Statements- Clear Span Bridges*. http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/ab/os-eo05-eng.htm

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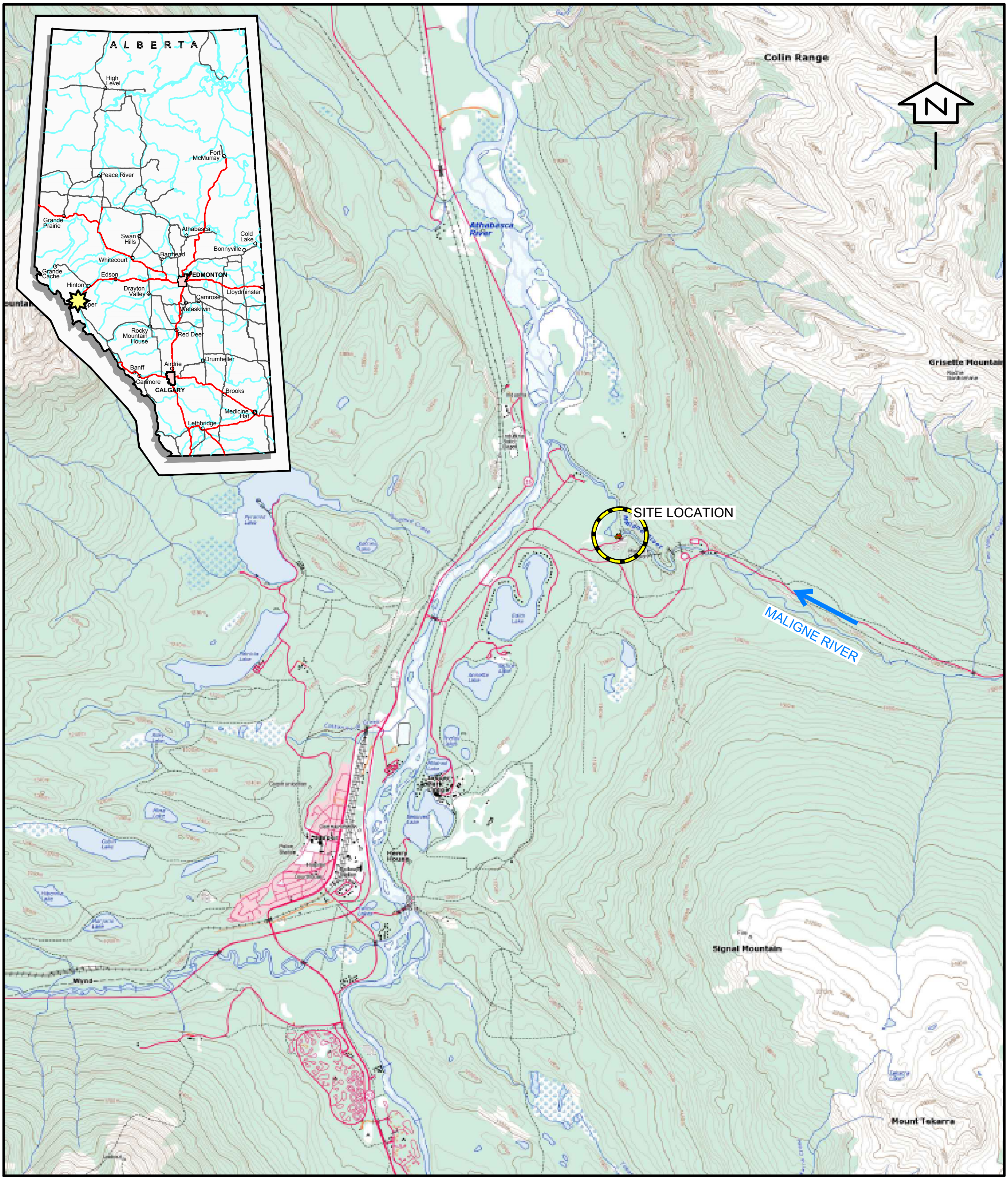
DISCLAIMER

We certify that we supervised and carried out the work as described in this letter report. The letter report is based on and limited by circumstances and conditions referred to throughout the letter report and on information available at the time of the site investigation. Matrix Solutions Inc. has exercised reasonable skill, care and diligence to assess the information acquired during the preparation of this letter report. Matrix Solutions Inc. believes this information is accurate but cannot guarantee or warrant its accuracy or completeness. Information provided by others was believed to be accurate but cannot be guaranteed. This letter report is prepared for the sole benefit of ISL Engineering and Land Services Ltd. and Parks Canada The letter report may not be relied upon by any other person or entity without the express written consent of Matrix Solutions Inc. and ISL Engineering and Land Services Ltd. and Parks Canada. Any uses which a third party makes of this letter report, or any reliance on decisions made based on it, are the responsibility of such third parties. Matrix Solutions Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this letter report.



SCALE 1: 80000 metres

800 0 800 1600

REFERENCE: 83C13 (Medicine Lake), 83D16 (Jasper), Edition 7, UTM Zone 11, NAD83.

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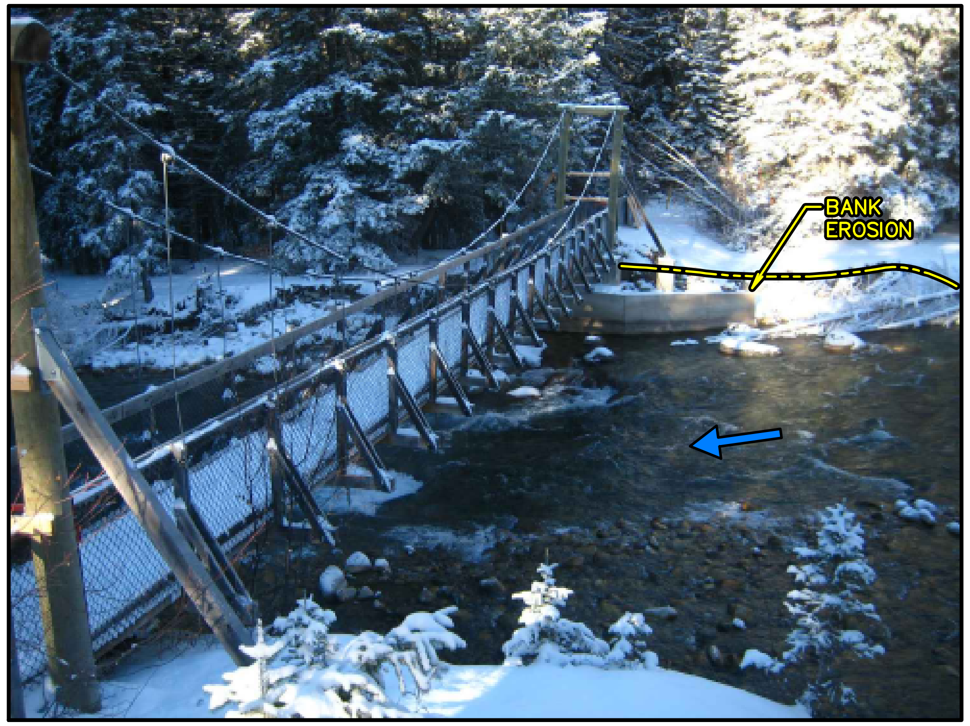
Matrix Solutions Inc.

ISL ENGINEERING AND LAND SERVICES LTD.

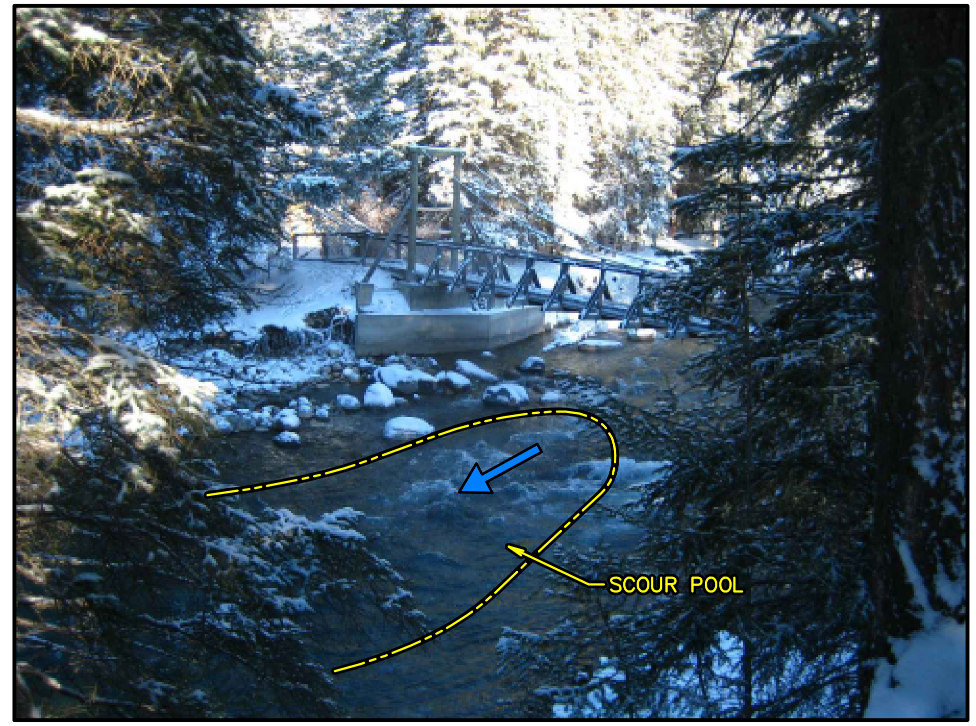
LOCATION PLAN

MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

DATE: FEBRUARY 2013	DESIGN: M. WOOD	DRAWN: N. DYER	FIGURE 1
FILE: 16815-SP-12.DWG	CHECK: D. COOPER	DATUM: UTM NAD83-Z11	



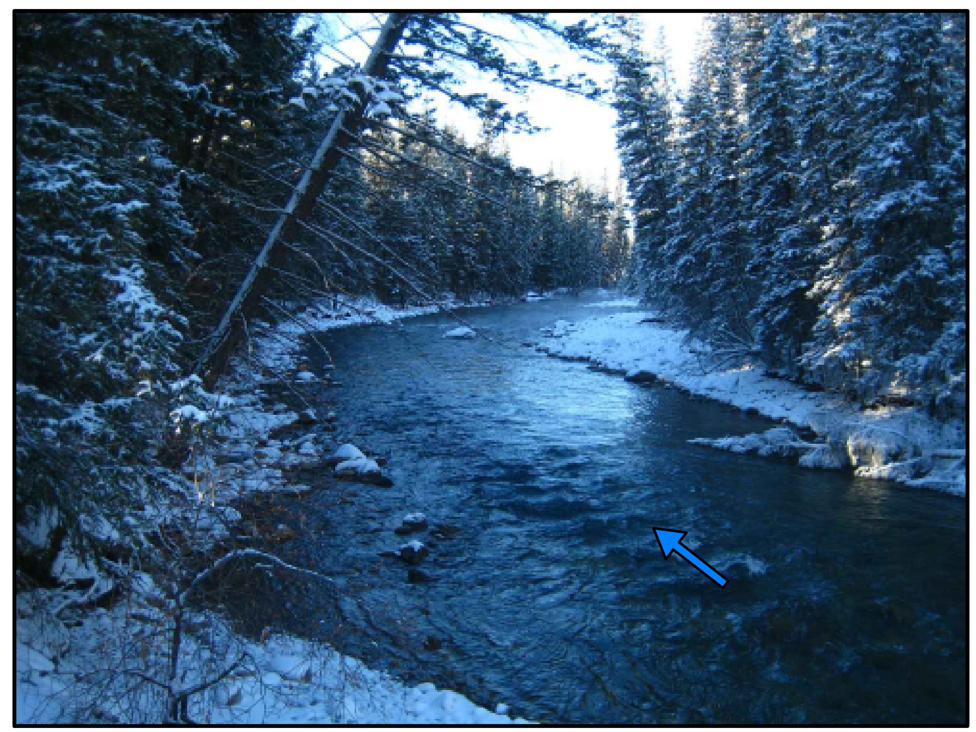
1. View of Existing Pedestrian Bridge (Looking Northwest).



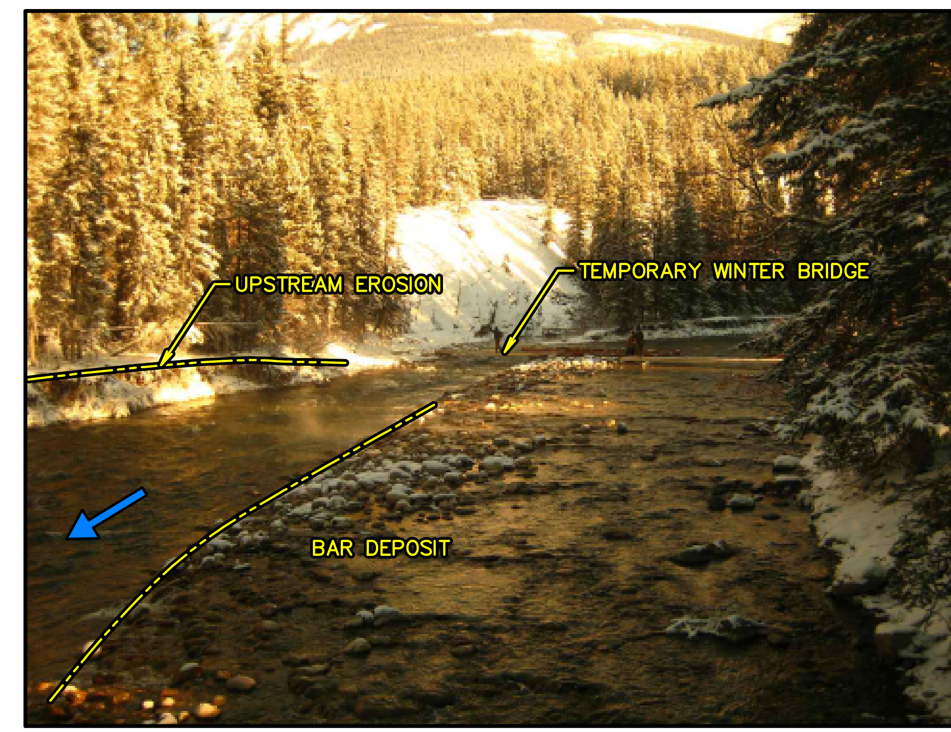
2. Upstream View of Existing Pedestrian Bridge (Looking Northwest).

3. View of Existing Right Abutment. Note Fill Loss Behind Abutment Wall.

4. Minor Erosion on Downstream Side of Left Abutment.



5. Downstream View of Maligne River (Looking East from Left Abutment).



6. Upstream View of Maligne River (Looking from East).

Photos by M. Wood, P.Eng., CPESC, Matrix Solutions Inc., November 22, 2012.

REVISION			
0	04/02/2013	ISSUED AS CONCEPTUAL	MW
No.	DATE	DESCRIPTION	BY

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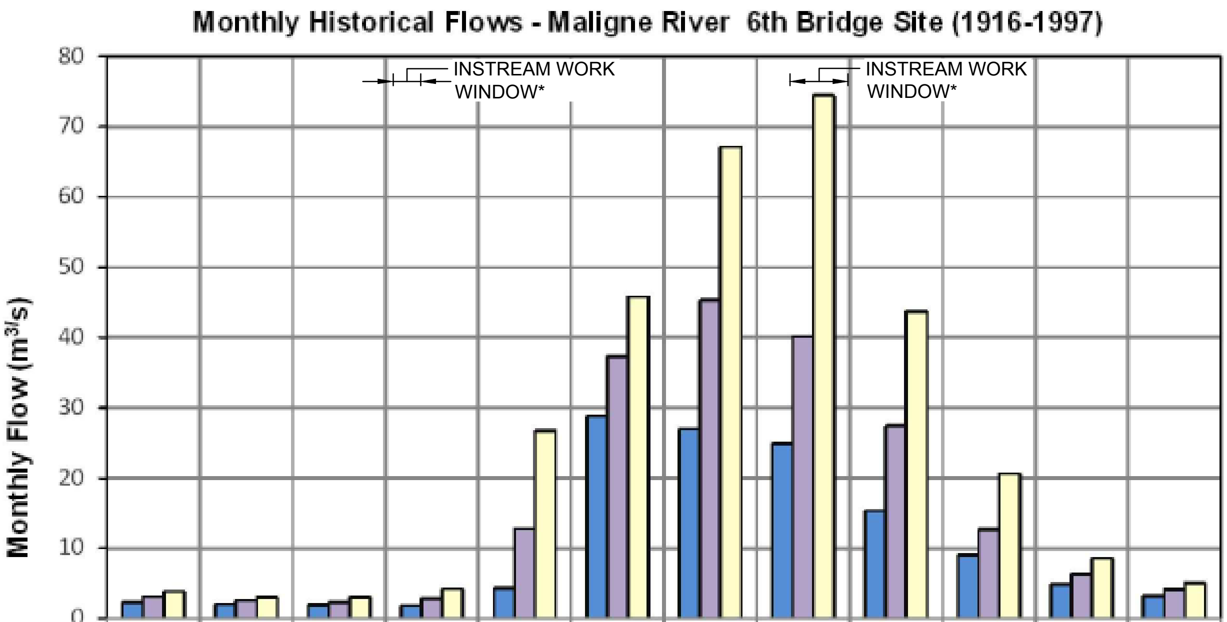
SITE PHOTOGRAPHS

MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

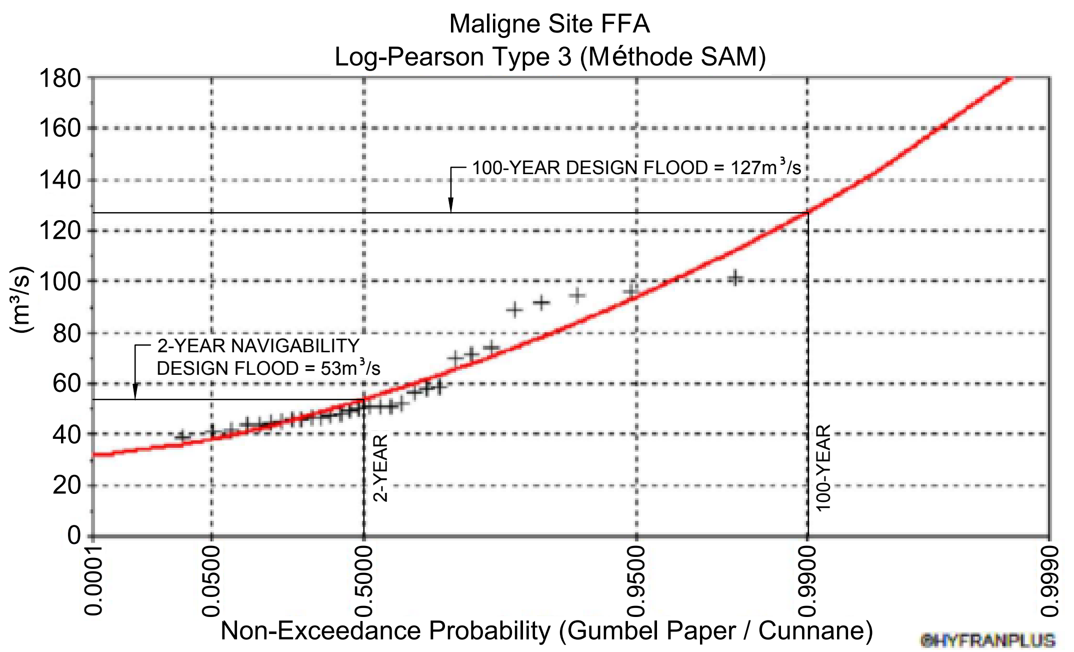
DATE: FEBRUARY 2013	DESIGN: M. WOOD	DRAWN: N. DYER	FIGURE 2
FILE: 16815-SP-12.DWG	CHECK: D. COOPER	DATUM: UTM NAD83-Z11	

*PLOT 1:1 = Tabloid (L)
F:\16815\Drafting\2012\16815-SP-12.dwg - PH - Monday, February 04, 2013 3:12:56 PM - Barry Juneau



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	2.30	2.06	1.91	1.85	4.27	28.8	27.1	24.9	15.3	9.03	4.84	3.20
Mean	3.09	2.56	2.28	2.87	12.8	37.3	45.3	40.1	27.4	12.7	6.30	4.16
Max	3.81	3.06	3.01	4.24	26.8	45.8	67.1	74.5	43.7	20.6	8.57	5.10

* Instream Work Windows Identified in J12-059 Site Specific Mitigations for 5th Temporary Bridge



Notes:

1. Graphs are estimated for the Maligne River fifth bridge site, based on the Water Survey of Canada Station (WSC) 07AA004 Maligne River near Jasper (1916-1997).
2. Flows are transferred to the site using the following relation:

$$Q_{SITE} = Q_{WSC} \times (DA_{SITE}/DA_{WSC})^{1.0}$$

Where DA_{SITE} = 903 km² and DA_{WSC} = 908 km²

Peak Flow Summary (m³/s)	
1:100 Year	127
1:50 Year	112
1:25 Year	98
1:2 Year	53

REFERENCE:

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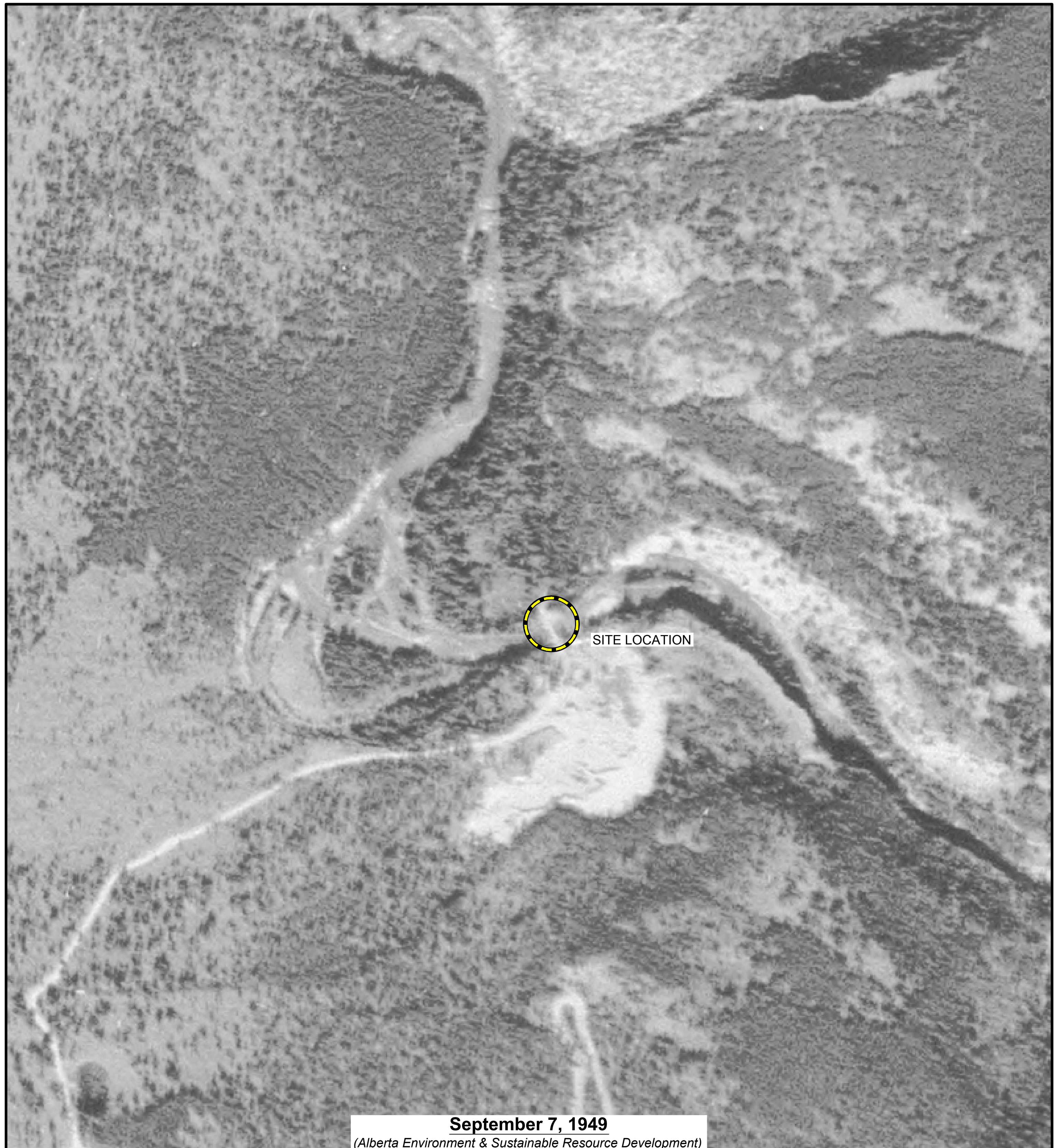
SITE HYDROLOGY

MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

DATE: FEBRUARY 2013	DESIGN: M. WOOD	DRAWN: N. DYER	FIGURE 3
FILE: 16815-SP-12.DWG	CHECK: D. COOPER	DATUM: UTM NAD83-Z11	

*PLOT 1:1 = Letter (P)

F:\16815\Drafting\2012\16815-SP-12.dwg - HYD - Monday, February 04, 2013 3:12:56 PM - Barry Juneau



September 7, 1949
(Alberta Environment & Sustainable Resource Development)

September 1, 1997
(Alberta Environment & Sustainable Resource Development)

N

SCALE 1:5000 metres
50 0 50 100

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REFERENCE:

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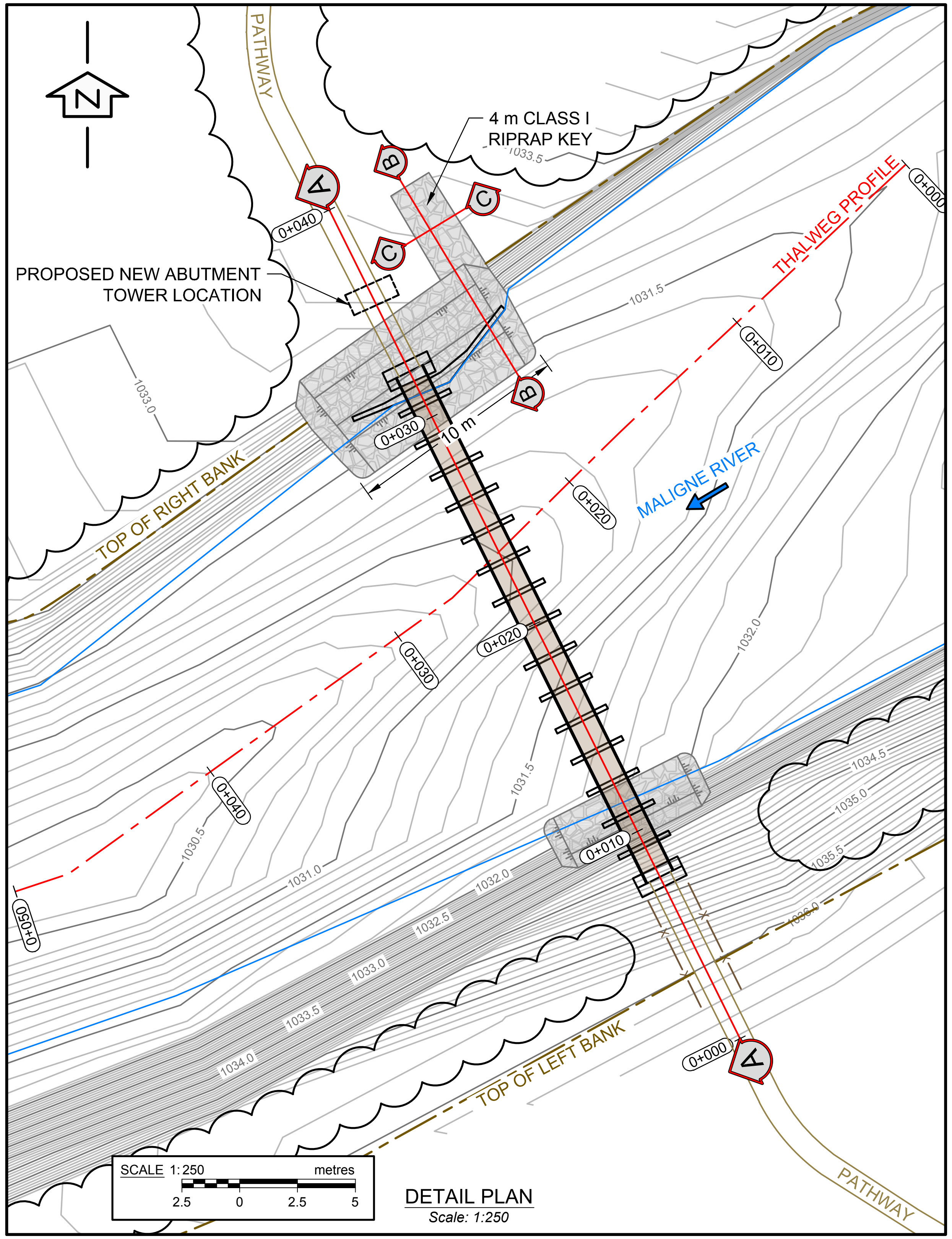
MALIGNE RIVER HISTORICAL AIRPHOTO COMPARISON

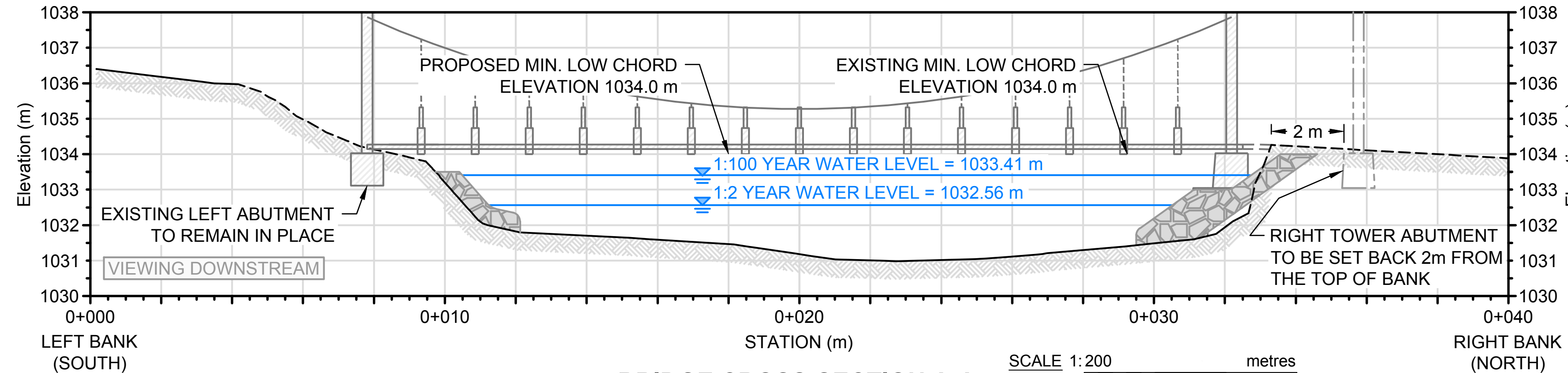
MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

DATE: FEBRUARY 2013	DESIGN: M. WOOD	DRAWN: N. DYER	FIGURE 4
FILE: 16815-SP-12.DWG	CHECK: D. COOPER	DATUM: UTM NAD83-Z11	



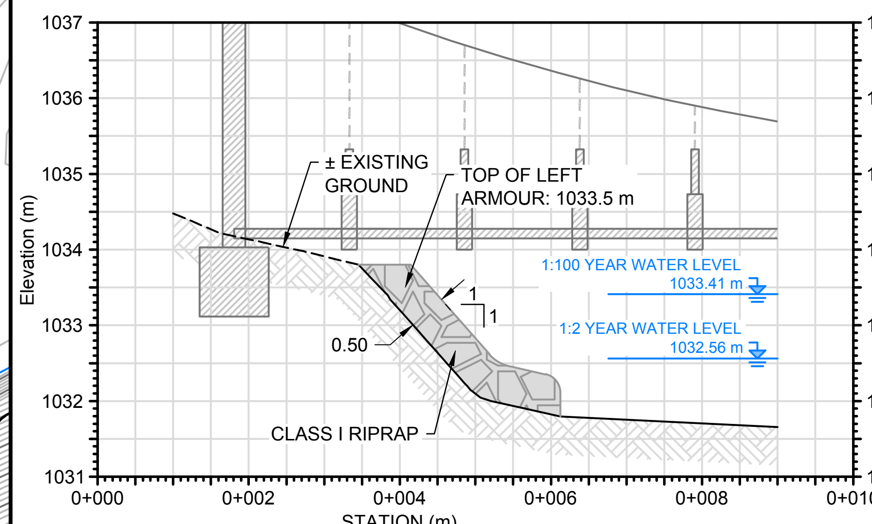
DETAIL PLAN

Scale: 1:250



BRIDGE CROSS-SECTION A-A

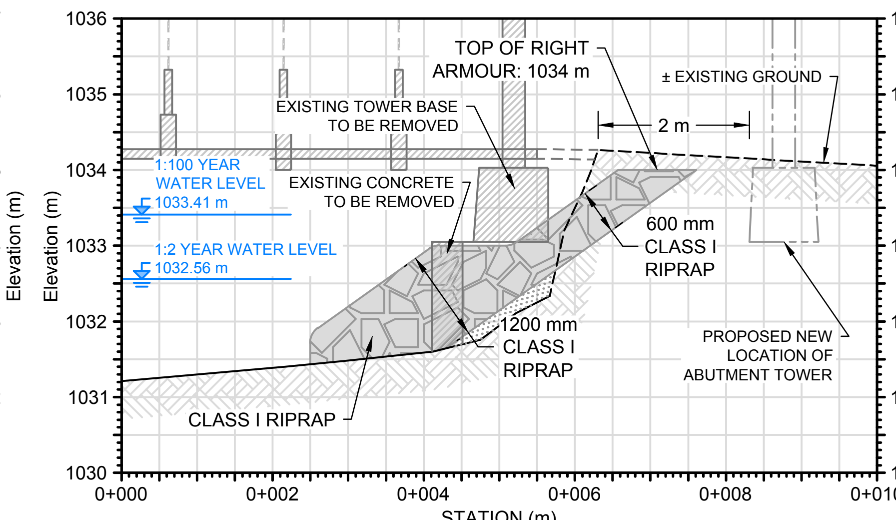
Scale: 1:200



LEFT BANK DETAIL

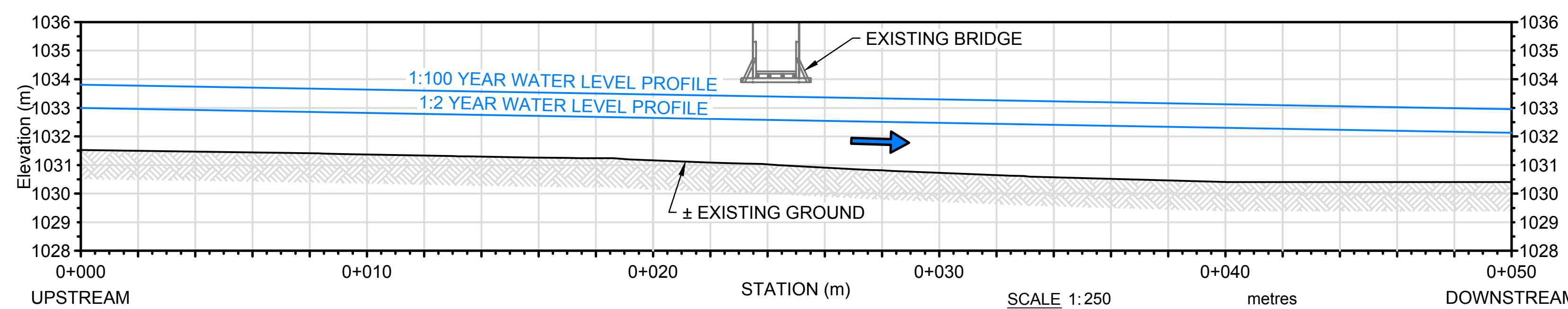
Scale: 1:100

SCALE 1:100 metres
1 0 1 2



RIGHT BANK DETAIL

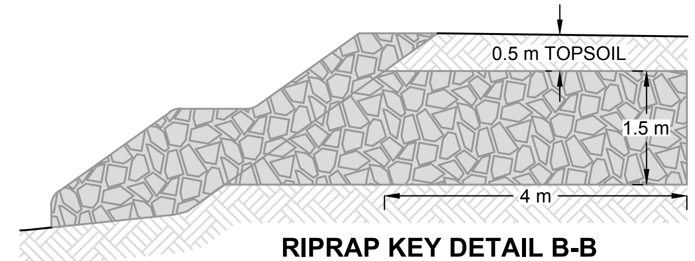
Scale: 1:100



THALWEG PROFILE

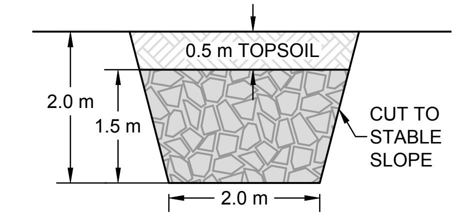
Scale: 1:200

SCALE 1:250 metres
2.5 0 2.5 5



RIPRAP KEY DETAIL B-B

Scale: 1:100



RIPRAP KEY DETAIL C-C

Scale: 1:100

Gradation of Class I Riprap

Percent Passing	Stone Size Diameter (mm)	Stone Size Mass (kg)
100	500	130
30-80	350	70
20-50	300	40
5-20	200	10

STAMP: PROFESSIONAL ENGINEER MATT WOOD ALBERTA Feb 4/2013

PERMIT: PERMIT TO PRACTICE No.: P5540

REVISION

No.	DATE	DESCRIPTION	BY
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REFERENCE:

Matrix Solutions Inc.

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HYDROTECHNICAL DESIGN SPECIFICATIONS

MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

DATE: FEBRUARY 2013 | DESIGN: M. WOOD | DRAWN: N. DYER | FIGURE 5

FILE: 16815-SP-12.DWG | CHECK: D. COOPER | DATUM: UTM NAD83-Z11

*PLOT 1:1 = Tabloid (L)

NOTES:

1.0 General

1.1 This plan has been developed as part of the conceptual design of the rehabilitation of the Maligne Fifth Bridge. The actual construction plan will be detailed in consultation with Parks Canada and as part of the detailed design phase.

1.2 It is recommended that the riprap placement be field engineered during construction to ensure optimum arrangement while minimizing disturbance to the watercourse.

2.0 Timing

2.1 J12-059 Parks Canada 5th Bridge Temporary Replacement indicates potential presence of: Bull Trout, Brook Trout, Rainbow Trout, Rocky Mountain Whitefish and Burbot.

2.2 The instream work window is defined as April 5 to April 15 and August 15 to September 1.

2.3 The instream work is expected to take no longer than 10 days.

2.4 It is recommended that the work take place in the April window to take advantage of low flows.

2.4.1 It is not recommended that this work be done in August due to the high flows.

2.4.2 If work cannot be done in April then an alternate construction period, outside of the designated work windows will be necessary.

3.0 Removal of existing bridge

3.1 The existing bridge is to be removed without entering the watercourse.

3.2 Removal of the concrete abutment wall on the north side of the channel shall be done using either a crane or via loading it in a rock truck.

4.0 Transportation of the Armour for the Right Bank

4.1 There are two options for transportation of the rock armour to the right bank.

4.1.1 Option 1 uses a crane to deposit the armour on the far side of the river.

4.1.1.1 Potential crane laydown area is shown in the figure.

4.1.1.2 Feasibility of Option 1 will be dependent on size, capacity and availability of crane.

4.1.2 Option 2 uses rock trucks entering the channel to transport the rock to the other side.

4.1.2.1 Trucks reverse down the south bank, ford the river in reverse and dump their load at the right abutment.

4.1.2.2 Estimated 4 loads of rock which will require a total of 8 fordings.

4.1.2.3 Clean, natural, surficial bed armour and its clean gravel base will limit the mobilization of sediment from the disturbance.

4.1.2.4 Turbidity shall be monitored during fordings.

5.0 Placement of the Armour for the Right Bank

5.1 A tracked excavator will need to ford the river to work on the north (right side).

5.2 Excavator's fording should be limited to one traverse each way.

5.3 Some rock armour is to be delivered to the north side (via Option 1 or Option 2) prior to the excavator entering the channel. The excavator will use the rock pile to climb the bank to its work platform in the right overbank as shown.

5.4 Once armour placement is complete the excavator shall use the placed armor to re-enter the channel and return to the south side.

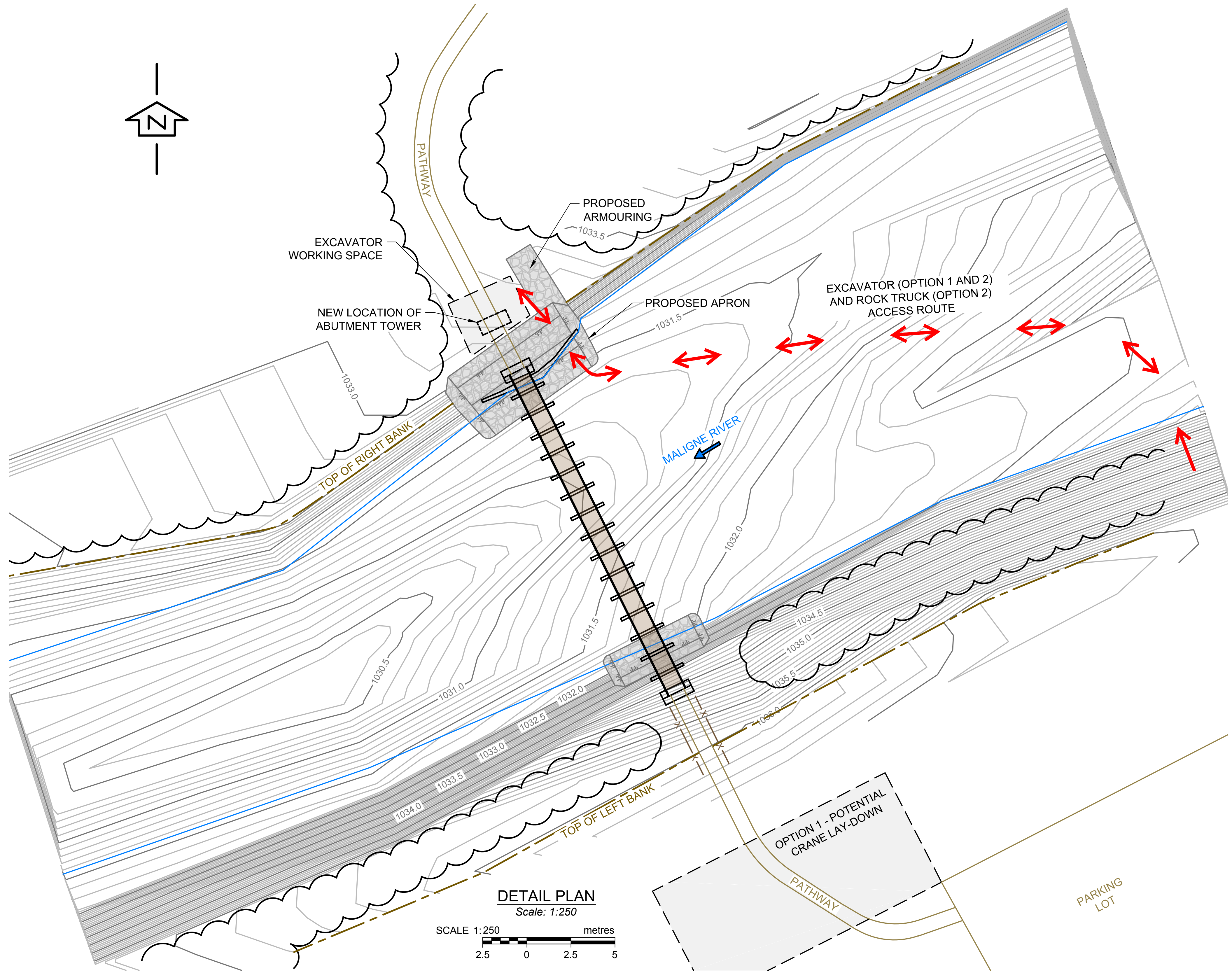
6.0 Bank Grading and Armour Placement

6.1 Bank grading is to be done under isolation using a silt or turbidity curtain at the toe of the bank.

6.2 Bed excavation is not required for armour placement.

7.0 Monitoring During Construction

7.1 An environmental monitoring plan will be developed as part of detailed design and construction planning, and with input from Parks Canada.



DETAIL PLAN
Scale: 1:250

SCALE 1:250 metres
2.5 0 2.5 5

STAMP	PERMIT	REVISION			
PROFESSIONAL ENGINEER MATT WOOD ALBERTA Feb 4/2013	PERMIT TO PRACTICE No.: P5540	0	04/02/2013	ISSUED AS CONCEPTUAL	MW
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CONSTRUCTION PLAN

MALIGNE RIVER 5TH BRIDGE (SW-36-045-01-W6M)

DATE: FEBRUARY 2013	DESIGN: M. WOOD	DRAWN: N. DYER	FIGURE 6
FILE: 16815-SP-12.DWG	CHECK: D. COOPER	DATUM: UTM NAD83-Z11	

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DEPT. NORTHERN AFFAIRS AND NATIONAL RESOURCES
NATIONAL PARKS BRANCH
ENGINEERING SERVICES DIVISION
JASPER NATIONAL PARK
SUSPENSION BRIDGE
MALIGNE RIVER FIFTH BRIDGE
Scale: As shown
Date: Dec. 1964
Drawn / Traced N. Balony
Chk'd
File
Sheet 1/1
Prepared in Resident Engineer's Office Jasper, Alberta
FENCE DETAIL
(Frost chain link industrial fence wire)
SUSPENSION ROD CLIP
(5/16" Steel plate)
CABLE CLAMP & SUSPENSION ROD
1" Cable
1/2" φ Steel suspension rods
STRAP IRON for POST & CABLE TIE
BRACE PLATE TO UPRIGHT SADDLES
1/4" Thick hot dip galvanized
BRACE PLATE
1/4" Thick hot dip galvanized
Bend 90° up
"A-A" SECTION
Suspension rod clips
1/2" φ Suspension rod
5" Decking
Rope deflection
Length of cable from C-C post = 82'-4"
Cable to turn buckle = 40'-1"
Cable to turn buckle = 23'-2"
Turn buckle
Elev. 3408.00
Elev. 3406.00
Elev. 3402.00
Elev. 3410.53
Crush fill to grade
Deck elevations on top of 4"x6"
80'-0"
ELEVATION
Similar to south end
Cable
ANCHOR
JASPER NATIONAL PARK
TITLE
BRIDGE PLANS
5th BRIDGE MALIGNE RIVER
Maligne Highway
Scale 1/4" = 1' - 1/2" = 1'
Plan Dated 1964
Prepared By Eng. Office - Jasper
E-18
Red
N.W.J./64/P
DWJ 71/R25