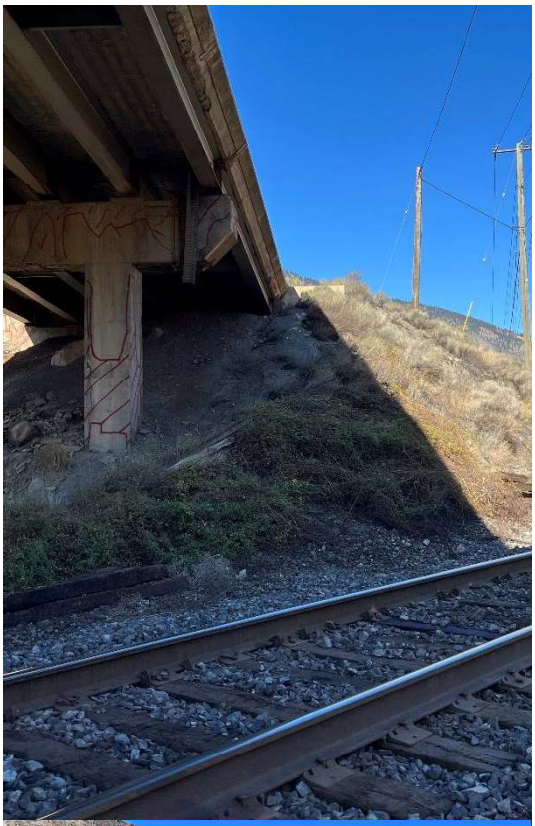

CONSTRUCTABIILTY REPORT

PROJECT NO. 23040-0000
SACKUM OVERHEAD NO. 1491 REPLACEMENT AND APPROACHES

Stantec

Prepared for:

Ministry of Transportation and Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T3
Attn: Mark DiDonato, P.Eng., Highway Design Engineer
Attn: Michaela Horner, P.Eng., Structural Liaison Engineer

Prepared by:

Stantec Consulting Ltd.
300-175 2nd Avenue
Kamloops, BC
V2C 5W1

November 7, 2024

Sign-off Sheet

Prepared by:  _____

(signature)

Shannon Quarterman P.Eng.

Prepared by:  _____

(signature)

Paul Dudzinski, P.Eng., Struct. Eng., MI Struct E

Reviewed by:  2024-11-07

(signature)

Grant Irvine, P.Eng.

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1.0 INTRODUCTION

The Ministry of Transportation and Infrastructure (BC MOTI) is replacing the existing Sackum Overhead No. 1491, which is located approximately 22.4 km north of Lytton on Highway 1. The existing bridge was constructed in 1958 and has reached the end of its useful service life. The existing overhead is a road-rail grade separated structure that carries highway traffic over the Canadian Pacific Kansas City (CPKC) rail line. The existing structure is a 73.8m, six-span steel girder bridge with a single lane of traffic in each direction on a clear deck width of 8.23m.

To assist with this assignment, MOTI has engaged Stantec Inc. (Stantec) to provide structural, and highway services and coordination for the design of a new replacement structure. Stantec will also provide engineering support services during the tendering and construction of the new structure, which is anticipated to begin in 2025. Figure 1, below, shows the location of Sackum Overhead.

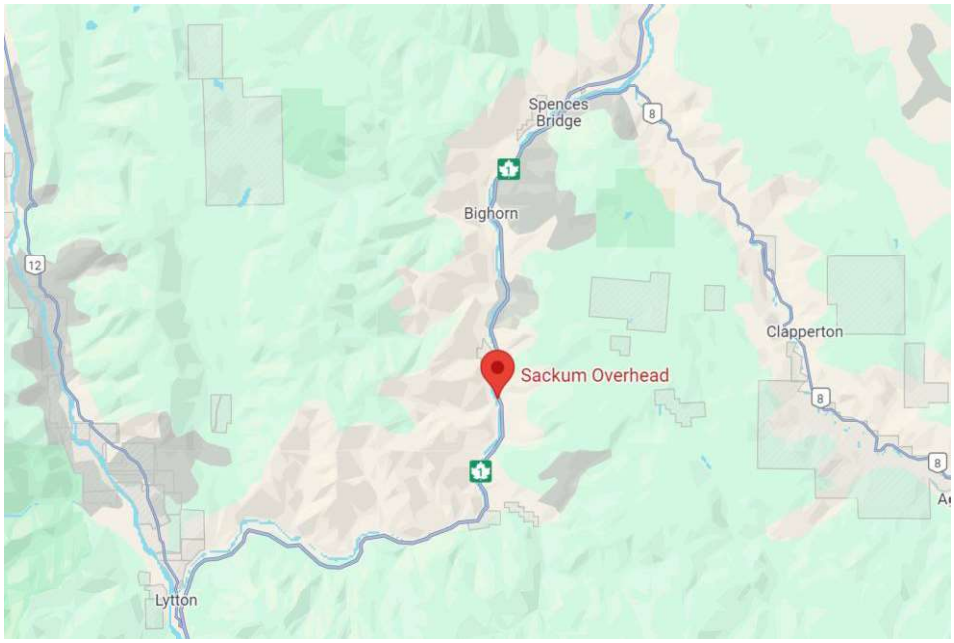

Figure 1 – Sackum Overhead Location (key map)

2.0 NEW SACKUM OVERHEAD STRUCTURE

The new Sackum Overhead is a 101.4m long, two-span steel I-girder bridge. The structure is located on a new off-line highway alignment to the east of the existing structure. The alignment has been designed to meet the required railway clearances, span arrangement, and structure depth. The new structure provides an efficient steel bridge on the revised highway alignment. The General Arrangement of the proposed structure can be seen in Figure 2.

The new superstructure consists of five 2000 mm deep, Steel I-Girders. The girders are made continuous over the central pier to improve the girder efficiency. The new superstructure will carry a 11.98 m wide deck. The concrete deck width is set to carry two 3.6 m traffic lanes with a 2.0 m shoulder with Ministry Standard

10 High (TL-4) concrete parapets and steel cyclist railings.

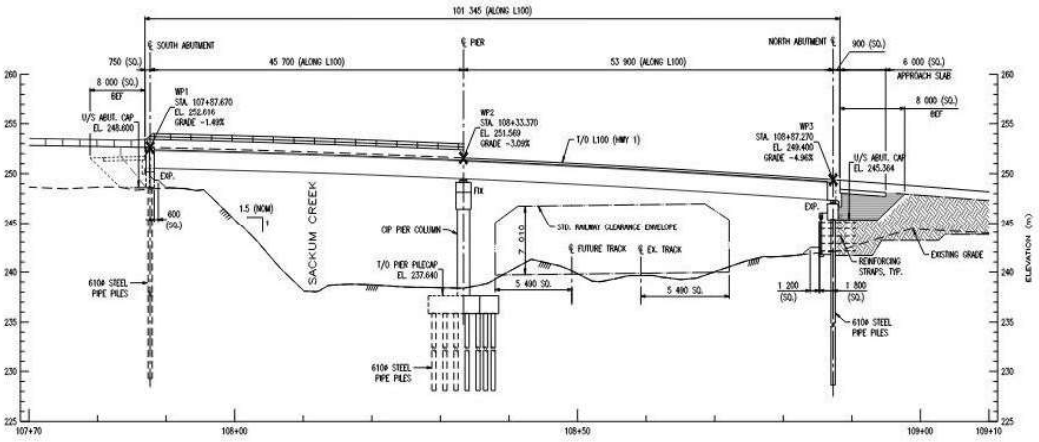

Figure 2 - Sackum Overhead General Arrangement

Due to the proposed kinked configuration of the I-girders, the deck overhang length will vary slightly from a nominal 775 mm over the west edge and a nominal 775 mm over the east edge.

A cast-in-place concrete deck will allow the deck and cast-in-place parapet to follow the road curvature. Use of partial depth concrete deck planks was reviewed but was found to be not applicable due to the negative moment region at the pier requiring extra rebar placement within the deck to achieve the required moment capacity. The size of the rebar required precluded use of a partial depth plank as the final achievable cover to the rebar would be below specification.

The substructure consists of conventional cast-in-place concrete elements including an intermediate hammerhead type pier and beam seat type cast-in-place concrete abutments. Both abutments will be placed over 610mm diameter steel pipe piles advanced to a minimum estimated depth of -15m from existing grade. Cast-in-place concrete wingwalls will be integrally connected to the ends of each abutment cap beams at the outside edge of the bridge deck to retain the bridge end fills and roadway embankments at the ends of the bridge.

The intermediate pier will be placed on a piled footing. The piers will be composed of a 2200mm deep (max) hammerhead pier cap supported on a single 1900mm diameter column supported on a 7600mm x 8500mm x1800mm deep pile cap and a piled foundation. As required by CPKC Rail, a crash wall will be incorporated to the north abutment construction and extend 2.50m above the top of rail and run along the face of the MSE wall construction with a thickness of 750mm.

2.1 TRAFFIC MANAGEMENT

The existing bridge is located along Highway 1, which connects the Lower Mainland to Highway 97 North, acting as:

- A major truck route which is important to the provincial economy;
- A popular route for tourists;
- An alternative route from Highway 5 (Coquihalla);
- An important route for Fraser Canyon communities.

The Sackum Overhead provides an essential connection across the CPKC railway and maintaining this vital connection during the bridge replacement will be essential. The traffic management strategy for the Project requires that normal two-lane traffic operations be maintained, as much as possible, on Highway 1 during construction. The proposed Sackum Overhead will be built on a new alignment, however the proposed south abutment will be directly adjacent to the existing south abutment, which necessitates a careful strategy to maintain two lanes of traffic during the construction period. The traffic management approach for the replacement of the Sackum Overhead is intended to minimize the use of SLAT, as much as possible.

2.2 CPKC RAIL IMPACT

Similar to the current Highway 1 alignment, the current preferred off-line alignment crosses over the CPKC mainline at a highly skewed angle. The existing (and proposed) structure passes over a single track with an allowance made for the addition of a track to the south of the existing. The new overhead has been designed to comply with all required railway clearance requirements based on previous discussions with CPKC, Transport Canada Publication TC E-05, Diagram 1, and the Ministry's Bridge Standards and Procedures Manual, Volume 2, Section 5.3.

Standard track clearance, with curvature allowance and crash walls for the two-track envelope are as follows:

- Minimum Vertical Clearance: 7.01 m (23'-0") from top of rail;
- Minimum Horizontal Clearance: 5.50 m (18'-0") from centerline of track;
- Allowance for track curvature at each side of the rail tracks is 25.4mm (1 inch) per degree of curvature.

Geotechnical and regulatory review with the railway will be required well in advance of construction.

Pile cap excavations and pile driving for the center pier will be in the general vicinity to the existing track requiring close coordination with train operations. If work windows are required for the construction of the center pier, they will require coordination and approval of the railway. Access to the center pier can be gained from road access on the south side of the track, thus avoiding track crossings. Flagging requirements (if required) will need to be submitted to the railway several months in advance by the Contractor and the railway will be given a notice of construction/flagging requirement expectations ahead of Contract tendering.

Additionally, the Contractor will need to provide means such as netting or other barriers to ensure that no construction or demolition debris enters the CPKC right of way and should have contingency protocols in place in the event that some does. Work will be coordinated with train schedules to ensure railway safety standards are met and to reduce risk.

2.3 CONSTRUCTION ACCESS

There is readily available access to the bridge site from both the North and South approaches to the existing Sackum Overhead. The new offline alignment of the replacement structure will provide sufficient laydown and staging area east of the current highway.

Current Temporary License to Construct Area (TLCA) drawings can be found in Appendix A.

Space available for crane setup and boom swing east of the new alignment and to the north and south of the CPKC track.

Considerations for Railway ROW: Staging areas and crane points must remain clear of the rail clearance box. Coordination with CPKC will be required to obtain 'track possessions' where materials and assemblages can be passed through and over the clearance box without rail traffic interference. Track possessions are normally limited by time, subject to CPKC operational requirements.

2.4 MATERIALS

Concrete

Cast-in-place concrete will be required for the deck, bridge parapets, abutment pile caps, wingwalls, center pier column, pile cap and pile infill, and crash walls.

Cast-in-place concrete with type GU cement and the addition of Fly Ash and Hydration Stabilizer Admixture to limits as allowed by MOTI Standard Specifications could be delivered to site and placed within the time of placement requirements, however depending on the time of year the heat of hydration should be monitored such that early construction related compressive strengths are attained prior to the concrete falling below freezing.

Steel I-Girders

The Sackum Overhead girders will be 2000 mm deep structural steel I-girders. Girders of the size and weight proposed for the new overhead are easy to procure, transport and erect by using smaller conventional cranes.

The two-span arrangement of the proposed bridge requires the longest individual girder section to be approximately 32m long. Most individual girder sections are of a length and weight that should not require any special permitting for transportation to the site by conventional means and afford easy handling for loading and off loading. The longest segment may require a steerable dolly.

2.5 GIRDER ERECTION

The total weight of a single girder is estimated to be 67 tonnes. Individual girder sections are of a length and weight that should be conducive to erection by cranes on the ground or by preassembling and incrementally launching. Current splice locations divide a girder into four segments with an estimated weight (not including rigging, etc.,) calculated as follows:

- South Abutment Segment: 17900kg
- Pier Segment: 20600kg
- North Middle Segment: 18700kg
- North Abutment Segment: 9310kg

2.5.1 Erection by Cranes on the Ground

Suitable space to set a crane is available at each approach to the crossing, however overhead power lines will require review and possible relocation prior to construction of the new structure.

Conventional (lattice boom) cranes are assumed for this discussion. The erection sequence is described assuming full coordination and cooperation with the railway. Track possessions (available time blocks) and clearance requirements for crane positioning will require careful review and likely revision of this idealized plan.

The most efficient erection sequence would be to erect the segment over the pier, followed by drop in segments of the north and south spans. Sequencing is anticipated as follows:

- Erect pier segment using a crane located to the south and east of the pier. Although symmetric, the pier segments will require stabilizing by means of temporary struts to one side of the pier or tie-downs to both sides;
- Assemble (splice) the north span abutment and drop in spans;
- Erect the spliced segment, using a crane located north of the CPKC track;
- Splice the assembled segment to the pier segment;
- Remove struts and/or tie downs;
- Erect the south span abutment segment using the crane located south and east of the pier;
- This procedure would be repeated for each of the five girders. Vertical and horizontal bracing can be installed to the first girder pair with subsequent segments braced off this pair as erection proceeds.

2.5.2 Incremental Launching

Techniques for incremental launching of steel plate girders is well established in BC. Recent launches of curved and kinked girders have been made on Highway 1 at Park Bridge in Kicking Horse Canyon and Quartz Bridge on the approach to Rogers Pass. Compared to erection off the ground, a higher degree of preparation is required, typically consisting of erection engineering, custom fabrications and possible modifications to the girders. These costs need to be compared against an anticipated multi-crane conventional erection, which may require geotechnical improvements in addition to mobilization and demobilization costs. The launch system is anticipated as follows:

- Launch from the north abutment towards the south (uphill). The abutment pile cap beam would be utilized to support rollers and temporary supports related to the launch. Approach fills would have to be completed to an elevation that would allow for assembly of the girders behind the north abutment and also access the launch supports and rollers.

- A launch nose will likely be required. This will provide a lightweight extension to the girder to account for deflection during launch and provide an early touchdown point when approaching the pier. The nose would engage lateral guides at the pier providing initial stability to the girder assembly as the launch proceeds.

- Vertical and horizontal rollers would be required, providing support and guidance to the bottom flanges of the girders.

- Girder assemblies would be pushed (or winched) uphill by means of heavy equipment (bulldozer / excavator) or a purpose-built winch system.

Anticipated sequencing would be:

- Assemble girders in pairs, threes or all five, with all bracing installed.

- Advance to the pier and then ‘tie-off’. Extents of individual moves will be dependent on available track possessions and CPKC guidance as to acceptability of partially completed work over (but clear of the clearance box) their track.

- Assemble the remainder of the girder (if not done already) and advance to the south abutment. Complete any bracing and set on permanent bearings.

Launch Considerations:

- Girders have been designed for the permanent condition. During the launch, flanges and webs may be overstressed due to the addition of the launch nose and cantilever condition during advancement. The Contractor and Erection Engineer would be responsible for determining if additional material is required and seeing that it is added during fabrication.

- In order to facilitate the roller/girder interface, the bottom flange will be detailed flush (web height varies) and the flange width will be constant. Also, flange splice plates to the bottom flange will be split, to allow for rollers to be centered under the girder.

- As the roadway is curved and the girders are fabricated with kinks to follow the curve, multiple locations will be required for positioning lateral rollers. This would essentially be at the pier, north abutment and a temporary support (concrete grade beam) positioned behind the north abutment. As the girders leave the north abutment, they will be guided by horizontal rollers at the north abutment and temporary support. The rollers would be adjusted so that the girder assembly is aimed such that the launch nose will arrive at the center of the pier bearings. Due to the effects of the kinks, it is anticipated that the girder webs will deviate up to 120 mm from the nominal center of the vertical rollers. As a roller is typically 100mm wide, this deviation would have to be considered when devising an erection scheme.

2.6 DECK CONSTRUCTION

The conventional cast-in-place deck would utilize typical temporary plywood and dimensional lumber formwork. Protection to rail operations below can be achieved by construction of a temporary plywood and dimensional lumber continuous work platform between the girders and supported on the bottom flanges.

Consideration to the employment of partial depth precast concrete deck panels was reviewed but ruled out, as noted in Section 2.0.

2.7 PIER EXCAVATION

Bridge pier configurations have been designed to keep the spread footings outside the Zone of Potential Track Loading (ZPTL). In addition, as per CPKC requirements:

- Foundations located within a 1.5:1 slope from a point 0.6m out from top of end of tie will be required to accommodate railway loading/vibration and shall be avoided.

- Excavations located 2:1 slope from 0.6m out from top of end of tie will require close coordination and shoring designs approved by the railway. In poor soils this excavation line could be extended out further.

Hence, we have evaluated these conditions to assure we are complying with these requirements.

Additionally, care will still be required to safely excavate adjacent to the rail track and the existing bridge piers without undermining the existing foundations. If the excavations encroach into the horizontal clearance zone, coordination will be required with CPKC prior to proceeding. Additionally, should site conditions require deeper or wider excavations, additional shoring or slope support may be required.

2.8 BRIDGE REMOVAL

The existing bridge is to be removed as part of the contract. It is anticipated that deck removal will commence initially (requiring coordination with CPKC when working over the track), followed by removal of the piers. The piers are founded on spread footing and at this time it is anticipated that the piers would be removed to existing grade. Complete removal of the footings is to be confirmed and may be subject to geotechnical considerations before doing so to ensure their removal does not cause any slope destabilization. Abutment structural elements would also be completely removed, and regrading of the approach fills is to be determined in conjunction with the highway designer, geotechnical consultant, MOTI and Nicomen First Nation.

3.0 CONSTRUCTION STAGING

As noted in Section 2.1 the key consideration for highway construction on this project is the ability to maintain existing two (2) lanes of highway traffic as much as possible during construction while minimizing the use of SLAT. Construction Detour Staging Drawings with relevant typical cross sections are shown in Appendix B. Recommended construction speed zone, posted speeds during active and inactive work, for each of these stages, would be confirmed in the Construction Contract Provisions.

The Stage 1 detour would utilize the existing overhead (bridge) and two (2) highway lanes. Construction during Stage 1 would include the new north abutment, return walls, and the highway embankment for the new north approach, which, between Sta. 109+00 through Sta. 111+40. The new L400 (Railway) access, can be built entirely offline and will not require any lane closures.

The Stage 1A detour would involve shifting traffic lanes to the west, but still within highway right of way, to facilitate two (2) lanes of traffic during construction. The temporary detour will require a small embankment fill to be built, see Section C-C and Section C1-C1 on Sheet 1 in Appendix B. The temporary detour would involve two 3.5 m lanes, and two 0.5 m shoulders to accommodate two-lanes of traffic, with concrete roadside barrier on either side as protection for active construction work, and/or other hazards. Construction during Stage 1A would include the new south abutment, return walls, the MSE wall, the central pier, and complete the new bridge construction, off-line. Some temporary, and localized SLAT may be required to complete construction of the new MSE wall component. During Stage 1A, a portion of the highway embankment for the right hand (east) side of the south approach and tie-ins at the limits of construction, as well as the driveway access to the cemetery area could be completed. This would facilitate the Stage 2 detour.

The Stage 2 detour would involve shifting the northbound traffic to the new partially constructed south approach embankment, while maintaining southbound traffic on the Stage 1A detour alignment. During Stage 2, there will be sufficient lateral space to complete further widening of the new south approach, leading to the Stage 2A detour arrangement where both the northbound and southbound traffic lanes will be placed on the new alignment.

During Stage 2A, the remainder of the new south approach embankment, the new L800 access could be constructed, removal of the existing bridge and abutments, any other final grading and paving requirements, and removal of any remaining temporary detour works can be completed.

APPENDIX A - TEMPORARY LICENSE TO CONSTRUCT AREA

APPENDIX B - CONSTRUCTION STAGING PLAN & CROSS SECTIONS