# Report

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## Ministry of Transportation and Infrastructure

### Bridge Inspection and Assessment - E&N Railway, Vancouver Island, BC, Canada

### Phase 2 - Evaluation Report
### Bridge from Mile 1.30 to Mile 65.1 and two Bridges on Wellcox Spur (28 Bridges) and Executive Summary

**February 2012**

ASSOCIATED ENGINEERING

QUALITY MANAGEMENT SIGN-OFF

Signature .....

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# 1 E & N Railway – Bridge Inspection and Assessment – Summary for Executive Overview

The E & N Railway on Vancouver Island, British Columbia, Canada between Victoria and Courtenay is owned by the Island Corridor Foundation (ICF) and is operated under contract by Southern Railway of Vancouver Island (SVI).

There are 48 railway bridges on the line, consisting of 46 railway bridge structures between Mile 1.3 (Victoria) and Mile 135.1 (Courtenay) on the Victoria Subdivision and two railway bridges on the Wellcox Spur. The Wellcox Spur is a 3.2 mile connection between SVI's main freight rail classification yard, Wellcox Yard, and the Victoria Subdivision at Stockett Station in Nanaimo. The railway bridge structures range in date of construction between 1906 and 2010. Fibre optics are located on all bridge structures between Victoria and Qualicum Beach. South of Duncan, there is no train service currently. Freight between Duncan and Courtenay is generally conducted by one train four days per week dependent on customer service.

The Ministry of Transportation and Infrastructure (MoTI) engaged a consultant, Associated Engineering (B.C.) Ltd. on September 19, 2011, to carry out inspections and assessment of all bridges on the line in order to do the following:

- Assess the load carrying capacity of the bridges.
- Estimate potential rehabilitation/replacement costs required to the bridges to support rail operations to the end of year 2021, with further estimates of bridge rehabilitation/replacement costs to the years 2031 and 2041.

The load carrying capacity was assessed for the following three railway load ratings: 132,000 lb. (passenger cars), 263,000 lb. (freight cars), and 286,000 lb. (freight cars), with loading diagrams supplied by SVI. The Ministry allocated $500,000 for this consultant assignment.

## *Inspection and Assessment Process*

The inspection was carried out by several crews working simultaneously performing visual inspections, with the addition of a rail-based snooper truck for additional access as required. Non-Destructive Testing (NDT - ultrasound and magnetic particle testing which does not damage the component) was carried out on selected steel components of major structures to identify potential problems such as cracks. Transportation to the bridge locations, railway flagging and track protection during the assignment was provided by SVI. By going to extended work days, including weekends, inspections were completed in early November, 2011. Assessment of the load carrying capacity proceeded on bridges as soon as inspection reports and any required additional measurements of bridge elements were available. Costing of potential repairs and strengthening followed.

Reporting was broken into five phases as listed below:

- **Phase 1** - Inspection Report – Bridges from Bridge at Mileage 1.30 to Bridge at Mileage 65.10 and 2 Bridges on the Wellcox Spur (28 bridges).
- **Phase 2** – Assessment Report - Bridges from Bridge at Mileage 1.30 to Bridge at Mileage 65.10 and 2 Bridges on the Wellcox Spur (28 bridges).
- **Phase 3** - Inspection Report – Bridges from Bridge at Mileage 79.10 to Bridge at Mileage 135.10 (20 bridges).
- **Phase 4** – Assessment Report – Bridges from Bridge at Mileage 79.10 to Bridge at Mileage 135.10 (20 bridges).
- **Phase 5** – Additional Inspection and Testing and Final Report.

The additional testing and inspection work in Phase 5 was originally envisaged to take place after completion of reporting of Phases 1 to 4 (targeted for February 15, 2012) and to be complete by May 15, 2012. However, by carrying out additional testing, inspection, and assessment work in early phases, partly to take advantage of the availability of the snooper vehicle, the time lines were compressed. All reporting is now expected to be complete by February 15, 2012.

### *Inspection and Assessment Results*

Ministry executive require information in a format which will allow an informed decision on potential funding of targeted repairs on the railway line. To enable this, projected repairs and the projected costs were divided into the following four categories:

- ***Maintenance***
  - Inspection, cleaning and other routine actions which ensure the bridge is safe for traffic, excluding any structural repairs. These repairs would normally be done by the operating entity as part of their normal operations.

- ***Essential Repairs (Immediate)****
  - High priority repair of deficiencies identified in the Inspection Report required to safely operate the bridge under the train loadings and modified design speeds specified as a result of the structural assessment and load ratings. Bridge load ratings shown in this report are based on the assumption that the essential repairs are completed.

- ***Projected Repairs***
  - Expected repairs to or replacement of existing bridge components over the ten year period necessitated by deterioration but not increasing design bridge load carrying capacity. The projected repairs listed in this report are based on the Phase 1 and Phase 3 Inspection Reports conducted in 2011 and on historical information available to the evaluators. Examples could include replacement or reinforcement of the corroded and damaged components (normally like for like) or

major rehabilitation of deteriorated components in timber structures to extend the life of the structure.

- ***Strengthening***
  - Increasing the size or adding to components of bridges to strengthen the bridge to carry the train of the loading being assessed. Strengthening recommendations may include replacement of the entire structure, plating steel members, adding stringers, rod stiffening mechanisms or similar strengthening processes, to timber spans

A clarifying footnote was added to the Essential Repairs (Immediate) classification as follows:

- It may be possible, through additional testing, analysis, monitoring, and/or modified operating procedures, to modify and/or defer the repairs identified as Essential Repairs (Immediate), while still ensuring safe passage of trains. Modified operating procedures could include elevated bridge inspection frequencies, reduced maximum permissible operating speed, reduced train loading by marshalling with idlers (empty cars) between loaded cars, etc. These items are outside the scope of the current contract.

## *Costing*

Costing was projected for three time periods for repairs indicated by the assessments for each of the three loadings as below:

- Present to 2021
- 2021 to 2031
- 2031 to 2041

Totals of the costs for each of the time periods, for each of the loadings, are contained in the two tables below, one for Victoria to Nanaimo (Phase 1 and 3 reports) and one for Nanaimo to Courtenay (Phase 2 and 4 reports). Note that if the track is upgraded to carry a given loading, it can automatically carry any lower loadings assessed. The cost of replacing ties on the structures has been excluded from these costs as they will be included in SVI's program for re-ballasting and tie rehabilitation over the full length of the rail line.

In addition to the specific repairs defined in the report, a Unallocated Rehabilitation Allowance of $2.5m was added to each portion of the line (Southern and Northern) for each of the 2021 to 2031 and 2031 to 2041 time periods. This Unallocated Rehabilitation Allowance is defined as a likely cost for repairs and replacements of the bridges to address deficiencies that have not been observed during the 2011 inspection, but can reasonably be expected in the future. This allowance is not allocated to particular structures but applies to all the bridges on the line. Considering the age and condition of the structures, future deficiencies may occur on several bridges. The

allowance does not include the costs of repairs and replacements of timber ties nor trestles. A sample of the bridges and projected repairs which had a major contribution to the costs in the tables are described below.

| Southern Section - Mile 0 to Mile 65.1 Including Wellcox Spur (Victoria to Nanaimo) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time Frame | Train Loading | Category of Work | | | | Sub-Total Defined Repairs | Unallocated Rehabilitation Allowance | Total Cost for Bridges (Defined + Unallocated Rehabilitation Allowance) |
| | | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Streng-thening | | | |
| Present until 2021 | Passenger Loading | $296,500 | $337,500 | $483,800 | $2,000 | $1,119,800 | $0 | $1,119,800 |
| | 263 kip Freight | $291,500 | $337,500 | $447,300 | $2,851,000 | $3,927,300 | $0 | $3,927,300 |
| | 286 kip Freight | $291,500 | $337,500 | $447,300 | $2,953,000 | $4,029,300 | $0 | $4,029,300 |
| | | | | | | | | |
| 2021 to 2031 | Passenger Loading | $452,000 | $0 | $490,000 | $0 | $942,000 | $2,500,000 | $3,442,000 |
| | 263 kip Freight | $452,000 | $0 | $490,000 | $0 | $942,000 | $2,500,000 | $3,442,000 |
| | 286 kip Freight | $452,000 | $0 | $490,000 | $0 | $942,000 | $2,500,000 | $3,442,000 |
| | | | | | | | | |
| 2031 to 2041 | Passenger Loading | $432,000 | $0 | $468,000 | $0 | $900,000 | $2,500,000 | $3,400,000 |
| | 263 kip Freight | $432,000 | $0 | $468,000 | $0 | $900,000 | $2,500,000 | $3,400,000 |
| | 286 kip Freight | $432,000 | $0 | $468,000 | $0 | $900,000 | $2,500,000 | $3,400,000 |
| Total to 2041 | Passenger (incl. Allowance) | $1,180,500 | $337,500 | $1,441,800 | $2,000 | | | $7,961,800 |
| Total to 2041 | 263 kip Freight (incl. Allowance) | $1,175,500 | $337,500 | $1,405,300 | $2,851,000 | | | $10,769,300 |
| Total to 2041 | 286 kip Freight (incl. Allowance) | $1,175,500 | $337,500 | $1,405,300 | $2,953,000 | | | $10,871,300 |

**Note**: Costs in Repair Categories are discrete costs for the indicated Train Loading and are not cumulative within a ten year time frame. The Total Cost in the far right column is the total for the indicated time period and Train Loading, for all repairs including the Risk Allowance). Repairs made to sustain 286 kip Freight loading would also sustain 263 kip Freight and Passenger loadings.

| Northern Section - Mile 65.1 to Mile 135.1 (Nanaimo to Courtenay) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time Frame | Train Loading | Category of Work | | | | Sub-Total Defined Repairs | Unallocated Rehabilitation Allowance | Total Cost for Bridges (Defined + Unallocated Rehabilitation Allowance) |
| | | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Streng-thening | | | |
| Present until 2021 | Passenger Loading | $162,000 | $308,000 | $820,500 | $0 | $1,290,500 | | $1,290,500 |
| | 263 kip Freight | $162,000 | $252,000 | $808,500 | $3,170,000 | $4,392,500 | | $4,392,500 |
| | 286 kip Freight | $162,000 | $252,000 | $808,500 | $3,460,000 | $4,682,500 | | $4,682,500 |
| | | | | | | | | |
| 2021 to 2031 | Passenger Loading | $186,000 | $0 | $4,500,000 | $0 | $4,686,000 | $2,500,000 | $7,186,000 |
| | 263 kip Freight | $186,000 | $0 | $4,500,000 | $0 | $4,686,000 | $2,500,000 | $7,186,000 |
| | 286 kip Freight | $186,000 | $0 | $4,500,000 | $0 | $4,686,000 | $2,500,000 | $7,186,000 |
| | | | | | | | | |
| 2031 to 2041 | Passenger Loading | $186,000 | $0 | $3,420,000 | $0 | $3,606,000 | $2,500,000 | $6,106,000 |
| | 263 kip Freight | $186,000 | $0 | $3,420,000 | $0 | $3,606,000 | $2,500,000 | $6,106,000 |
| | 286 kip Freight | $186,000 | $0 | $3,420,000 | $0 | $3,606,000 | $2,500,000 | $6,106,000 |
| Total to 2041 | Passenger (incl. Allowance) | $534,000 | $308,000 | $8,740,500 | $0 | | | $14,582,500 |
| Total to 2041 | 263 kip Freight (incl. Allowance) | $534,000 | $252,000 | $8,728,500 | $3,170,000 | | | $17,684,500 |
| Total to 2041 | 286 kip Freight (incl. Allowance) | $534,000 | $252,000 | $8,728,500 | $3,460,000 | $12,974,500 | | $17,974,500 |

Note: Costs in Repair Categories are discrete costs for the indicated Train Loading and are not cumulative within a ten year time frame. The Total Cost in the far right column is the total for the indicated time period and Train Loading, for all repairs including the Risk Allowance). Repairs made to sustain 286 kip Freight loading would also sustain 263 kip Freight and Passenger loadings.

These bridges and repairs listed provide a major contribution (over $100,000) to the Essential Repairs (Immediate) costs or involve replacements of entire steel structures or major rehabilitation to the long timber trestles. Maintenance costs are not described in this section. The repair type selected for a given bridge may fall into any of the three time periods.

## *A) Southern Section – Mile 0 to Mile 65.1 Including Wellcox Spur (Victoria to Nanaimo)*

### Bridge Mile 14.00 Niagara

Bridge 14.00 Niagara is a 525' cantilever pin-connected deck truss on a tangent alignment. The bridge was originally constructed on the CPR mainline to cross the the Fraser River at Cisco, BC. The bridge was disassembled, moved and re-constructed at Mile 14.0 in 1912.

The costs for Essential Repairs (Immediate) for all three loading types in the Present to 2021 time period total $158,500. The repairs comprise:

- Replace abutment bearing links with a detail that does not allow movement under loading.
- Replace top 4" pin in the NE corner of north abutment.
- Replace cracked turnbuckle in span 3, panel 3 east exterior truss.
- Replace or tighten loose diagonals of east truss (U25-L24 & U26-L25).

### Bridge Mile 39.3 – Cowichan River

Bridge 39.3 is a single span open deck bridge over the Cowichan River. The superstructure consists of a 219 ft. wrought iron double through truss (two trusses on each side of the rail line), with steel floor beams and stringers. The bridge in its present configuration was erected 1909, with trusses fabricated in 1876, previously used at another location. The bridge is supported by stone masonry block abutments with concrete footings built in 1892.
The costs for Essential Repairs (Immediate) for all three loading types in the Present to 2021 time period total $165,000. The repairs consist of:

- Replace all bridge counters (because of cracked eye nuts).
- Replace or repair bridge South expansion bearings.

### Bridge Mile 47.9 - Chemainus

Bridge 47.9 is a single span open deck bridge over the Chemainus River. The superstructure consists of a 155'-6" ft. steel through truss, with steel floor beams and stringers. The truss was previously used on a different location. The bridge is on a tangent alignment. The bridge was reinforced in the 1940's; bridge stringers were reinforced by queen posts (4 rows of adjustable eye bars). The bridge is supported by stone masonry block abutment with concrete wing walls and ballast wall. There is a reinforced concrete jacket constructed at South abutment. The north abutment is bearing on natural rock; the south abutment is supported by timber piles.

The cost for Strengthening for 263kip loading (and 286kip loading) is estimated at $2,400,000 for a complete replacement in the Present to 2021 time period. Considering the overall poor condition of the bridge and the fact that the strengthening of the truss required for the freight trains would be expensive and complex, it is recommended that the bridge be replaced if it is to facilitate 263kip and 268kip freight trains. The bridge replacement is not required if the bridge will be used only for the specified passenger trains.

## *B) Northern Section – Mile 65.1 to Mile 135.1 (Nanaimo to Courtenay)*

### Bridge Mile 79.9 Green Lake

Bridge 79.9 is a 14-span open deck bridge over Green Lake. The superstructure consists of a 15 ft treated timber trestle, with stringer spans supported on timber bents. The bridge is on a tangent alignment. The bridge in present configuration was built in the year 1974. This bridge caught fire in 2005 (or 2006), causing damage to the timber. The components that suffered the worst damaged were subsequently replaced.

The costs for Projected Repairs for Passenger Loading (and 263kip loading and 286kip loading) is estimated at $1,250,000 for a complete replacement in the 2021 to 2031 time period because the fire damage will shorten the expected life span of the timber elements.

### Bridge Mile 98.6 – French Creek

Bridge 98.6 is a 63 ft span open deck bridge over French Creek. The superstructure consists of 56 – 15 ft timber stringer spans supported on timber trestle bents, 2 – 45 ft DPG spans, 1 – 75 ft DPG span and 4 – 15 ft timber stringer transition spans. The steel DPG spans and towers were constructed in the year 1913. The timber trestle approaches were built in 1977.

The timber trestle side spans are 35 years old. Bridge replacement may be required around the year 2030; however with maintenance repairs, the trestle may last until 2041. Estimated replacement for the 898 ft long timber trestle is in the order of $6,000,000; this replacement cost is distributed equally in three $2,000,000 increments in the 2021 to 2031 and each of the next two subsequent 10 year periods as timber trestles are normally repaired with major rehabilitations to extend their lifespan. The third $2,000,000 increment falls in the 2041 to 2051 time frame, which is outside the time frame covered by this study.

### Bridge Mile 125.5 – Tsable River

Bridge 125.50 is a twenty-five span open deck bridge over Tsable River. The superstructure consists of twenty-three 15 ft timber stringer spans, a 154'-6" steel deck truss span and a 100'-8" steel deck plate girder span. The steel spans carry timber structural ties and the timber spans carry timber bearing ties. The bridge is on a tangent alignment and is supported by closed concrete abutments, intermediate timber frame bents and two concrete piers. The bridge was originally built in 1914. In 1977 the timber trestle on the south approach was replaced in kind and the timber trestle on the north approach was replaced with an existing deck plate girder span.

The steel deck truss span was erected at 125.5 in 1914; fabrication was an unknown time prior to 1914. The truss is likely over 100 years old. Multiple members in the truss are either overstressed or nearly overstressed for freight trains, based on the calculation results presented above. Field inspection and NDT revealed cracks in various members and an overall poor condition of the truss members. Based on these items, we recommend that this bridge be replaced if it is to facilitate 263kip and 286kip freight trains. An estimated replacement cost for the steel truss span is $2,850,000, provided the existing concrete piers are adequate to support freight traffic (a pier investigation is recommended). The bridge replacement is not expected if the bridge will be used only for the specified passenger trains, provided the repairs and maintenance discussed in this report are completed.

The timber trestle approach span is already 35 years old. It is likely that replacement will be required in the next 10-20 years. An estimated replacement cost for the 343' timber trestle is $2,900,000, including substructure elements; this replacement cost is distributed equally in three $970,000 increments in the 2021 to 2031 and each of the next two subsequent 10 year periods as timber trestles are normally repaired with major rehabilitations to extend their lifespan. The third $970,000 increment falls in the 2041 to 2051 time frame, which is outside the time frame covered by this study.

### Bridge Mile 135.1 Trent River

Bridge 135.10 is a five-span open deck bridge over Trent River. The superstructure consists of two 73'-1" steel deck plate girder spans, two 43 ft steel deck plate girder spans and a 48 ft steel deck plate girder span. All spans carry timber structural ties. The bridge is on a tangent alignment and is supported by spill-through concrete abutments and steel bent towers. The bridge was originally built in 1913. The steel deck plate girders in the end spans were replaced in 1928.

The costs for Essential Repairs (Immediate) for all three loading types in the Present to 2021 time period total $110,000. The repairs consist of:

- Repair undermined footing of SE leg at Tower 1.
- Investigate Scour.

# 2 Introduction

The following comprises the Phase 2 Evaluation Report for the E&N Railway bridges, along Victoria and Wellcox Subdivisions of the E&N Railway, owned by the Island Corridor Foundation (ICF), currently operated by Southern Railway of Vancouver Island (SVI). This report covers 28 bridges in the southern portion of the line, 26 bridges in the Victoria Subdivision between Milepost 1.30 and 65.1, and two Wellcox Spur bridges, Mile 0.69 and 1.02. The remaining E&N Railway bridges are evaluated in the Phase 4 Report. A detailed list of structures is shown in **Appendix A** of this report.

This evaluation takes into account the Bridge Inspection findings, outlined in our Phase 1 and 3 Inspection Report.

# 3 Evaluation Scope

We have conducted the engineering inspection and structural evaluation of the bridges on the E&N line to evaluate the potential for the bridges to support projected future train loads, and to estimate costs of future maintenance and repairs to maintain function of the bridges until the year 2041. Our investigation is limited to the structural aspects of the bridges. We have not investigated the rail operation and work safety issues such as rails, Jordan rails, walkways, escape platforms and handrails.

For the purposes of this report, repair activities have been split into the following major groupings:

- **Maintenance (in 10 year increments) through 2041**: Inspection, cleaning and other routine actions which ensure the bridge is safe for traffic, excluding any structural repairs.
- **Essential Repairs (Immediate)** [1]: Repair of deficiencies identified in the Inspection Report required to safely operate the bridge under the current train loadings and under modified design speeds specified as a result of the structural assessment and load ratings. Bridge load ratings shown in this report are based on the assumption that these essential repairs are completed.

  Note: [1] It may be possible, through additional testing, analysis, monitoring, and modified operating procedures to modify or defer the repairs identified as Essential Repairs (Immediate) included in this report, while still allowing the passage of trains. Modified operating procedures could include elevated bridge inspection frequencies, reduced maximum permissible operating speed, reduced train loading by marshaling with idlers between loads, etc. to allow the passage of trains pending completion of required Essential Repairs. These items are outside the scope of the current contract.
- **Projected Repairs**: Expected repairs of components required to provide future stability of a bridge and adequacy to support the train load through 2041. The projected repairs listed in this report are based on the Phase 1 and Phase 3 Inspection Reports we conducted in 2011, and on historical information available to our evaluators.

Requirements for projected repairs may need to be adjusted as a result of findings from future inspections. Examples could include replacing or reinforcing of the corroded and damaged components, or major rehabilitation of deteriorated components in timber structures to extend the life of the structure. Repair or partial replacement costs of timber structures that will have reached their life expectancy are included in the Projected Repair costs for each bridge. We are assuming that repair or partial replacement cost for a timber structure is in the order of one third of the complete replacement cost for each 10 year period after the structure reaches its expected lifespan. Estimated repair costs for steel structures, to address deficiencies that have not been observed during the 2011 inspection but can be expected in the future, are included in the **Unallocated Rehabilitation Allowance** shown in the summary table and as described in **Section 5**.

- **Strengthening**: Structural improvements to bridges that address insufficient capacities for specific assessment train loadings that were identified by the structural assessment. Strengthening recommendations may include plating steel members, adding stringers, Dywidag rod stiffening mechanisms or similar strengthening processes, to timber spans and more, with a focus on improving the capacity of the structures.

## 3.1 Assessment of Bridges

Assessment of each bridge focuses on the strength rating of the following:

- **Steel Trusses**: Evaluation of all primary members (i.e. chords, hangers and diagonals) for maximum axial tension/compression.
- **Steel Flexural Members (i.e. TPG, DPG, HDPG bridges)**: Evaluation of girders, floor beams and stringers for midspan moment and end shear, with consideration of stability of flanges in compression.
- **Timber/glulam Flexural Members**: CP Rail standard plans for appropriate Cooper loading used where applicable.

Assessment of the bridges excludes:

- Maximum rating.
- Fatigue rating.
- Substructure members.(such as abutments, piers, wingwalls).
- Connections between structural members, except as discussed in this Report.
- Lateral bracing members.
- Determination of the “actual” bridge capacity as a preparation of Cooper loading for every component of every bridge.

# 4 Design Criteria

## 4.1 Design Code

- 2010 AREMA Manual for Railway Engineering (Manual), modified to address site specific issues, outlined in this report.
- Transport Canada's Guideline for Bridge Safety Management (TCG).

## 4.2 Assessment Loads

### 4.2.1 Train Load

The structures are evaluated for the following three Assessment Trains (AT):

- AT1: 4 - GP-9 locomotives and 286 kip, 55 ft. long cars
- AT2: 2 - GP-9 locomotives and 263 kip, 55 ft. long cars
- AT3: 3 - RDC-1 Passenger Vehicles, 130 kip each

Locomotives and cars are as shown on the drawing "*Typical Rail Car Loading on Victoria Subdivision, Vancouver Island, BC"*, rev01, dated 18 August 2011, shown in **Appendix B**. For evaluation purposes, these trains shall be compared against normal capacities.

***Train speed***: The bridges are evaluated for the desired track speed, equal to 30 mph for all the bridges except Bridges Mile 1.30, Wellcox 0.69 and 1.02 where the desired speed is 15 mph, and Mile 28.2 Bridge where the speed is 20 mph. In the case of a negative load rating for the desired speed, a reduced speed of 20 mph or 10 mph is considered.

All the structures are evaluated for trains (including the passenger train) traveling at a speed of 30 mph or less. In case that the passenger trains operate at the speed of 40 mph instead of 30 mph, the stress demands will increase by approximately 4% (based on a sample calculation conducted for a 100 ft steel span; note this demand varies depending on the span length). Although the passenger train is not typically a governing load, and the impact of passenger train speed from 30 mph to 40 mph is relatively small, we needed to complete the stress analysis and checking to be able to confirm that the structures can safely support the passenger train traveling at the speed of 40 mph.

### 4.2.2 Dynamic Impact

The dynamic impact (effective, instantaneous increase in train loading due to dynamic effects) is calculated in accordance with Section 15-1.3.5 of the AREMA Manual.

### 4.2.3 Dead Load

Dead loads (self weight) are calculated in accordance with Section 7-2.5.2 of the AREMA Manual for timber structures and Section 15-1.3.2 for steel structures. Dead loads specified on the available design drawings are used wherever possible.

### 4.2.4 Wind Load

Considering the low traffic volume on the railway, the structures are evaluated for Train Loads, excluding wind load, in accordance with standard industry practice. On tall and slender bridges, where stress due to wind load, or a combination of both wind load and train load, may cause stresses to exceed the allowable limits, the passage of trains will be limited to periods when the wind velocity is not significant**.** Limitations for specific structures are shown in the "Rating Recommendation" for each structure, shown in the detailed evaluation report.

### 4.2.5 Centrifugal Forces

On curved bridges, centrifugal force shall be calculated in accordance with Section 7- 2.5.4 of the AREMA Manual for timber structures and Section 15-1.3.6 for steel structures.

### 4.2.6 Nosing of the Locomotive

Forces due to nosing of the locomotives and cars are disregarded in the evaluation of primary load carrying members, in accordance with standard industry practice. These forces primarily affect the evaluation of secondary bracing members that are not included in the scope of this report.

### 4.2.7 Longitudinal Forces

Longitudinal forces from train loading are disregarded in the evaluation of primary load carrying members, in accordance with standard industry practice. These forces primarily affect the evaluation of bearings and substructure members that are not included in the scope of this report.

## 4.3 Scour

Scour is a possible concern with several crossings along the E&N Rail Line. A complete investigation of scour risks requires hydrological and hydraulic inputs and potentially underwater inspections; neither was in the scope of work for this project. Inspection of scour is normally conducted in the period of low water flows (August and September); however scour holes formed during high flows can partially or completely fill as high water abates making detection difficult.

We have identified several crossings with scour potential under bridge piers. We recommend that specific reviews be undertaken to investigate if there is a significant risk to the

stability of the structures at these crossings. Additionally, railroad personnel should inspect structures after flood events. The available record information indicates a possibility that the piers of several bridges (mile 110.7, 113.2, 122.0, 123.0, 131.1 and 135.1) susceptible to scour are founded on timber piles. However, the original plans for these substructures often include a note stating to “use piles only if necessary”, we cannot determine whether or not piles are in fact in place without more detailed investigation. Having a pier cap supported by timber piles may reduce a risk of a catastrophic pier failure in the event of scour. However, the size and number of piles is not known and the piles cannot be inspected to confirm their condition and assess their capacity to support the structure in the event of a scour. Since the piles would be 100 years old we can expect some deterioration, although under some conditions even untreated timber piles can last beyond this duration. Therefore, having a pile supported pier does not eliminate the risk of scour on a pier. We recommend that the crossings identified as susceptible to scour be investigated by an expert regardless of whether or not the piers are pile supported.

We have also identified the structures where there is the greatest likelihood that work will be required to mitigate scour damage. The repair could consist of placing rip-rap scour protection around the piers. Since access to some bridges is difficult, placing scour protection can be costly. We have included the estimated scour protection cost in the cost estimates for these structures.

We realize that future investigation may reveal that scour protection is required on structures other than those we have identified in this report. The site inspections, scour assessment and estimated protection costs we have identified are intended as estimates only, based on the deficiencies noted. These costs are subject to weather and flood event frequency in the future.

### 4.4 Life Expectancy of the Structures and Components

The majority of bridges on the E&N Rail Line were constructed in the late 19$^{th}$ and early 20$^{th}$ century. The timber structures such as trestles and timber stringers, and timber components such as timber ties, have typically been replaced over the years, however, the timber is reaching its normal life expectancy on many bridges. Many steel structures are reaching their expected service life.

The timber bridge element life span depends on the load regime, environment and maintenance effort. The load regime will differ for various elements (ties, stringers, caps, sills, posts, piles and bracing) but is likely not a major factor for timber deterioration due to historically light and infrequent loads on the E&N rail line.

The bridge timbers used on the line were usually pressure treated (between 8 and 10 lbs. /cu ft. of creosote retention) after fabrication, with timbers often incised to enhance preservative penetration into the wood. This type of preservative treatment provides a protective shell of chemically treated wood on the outside of the timber. Nevertheless, the depth of checks in the wood may occasionally exceed the treatment penetration depth, allowing rot-causing fungi access to untreated wood in the interior of the timber. Other means of fungal access past the treated outer shell include rail spike

holes, untreated fastener holes or fire damage. Wet conditions on Vancouver Island provide a good environment for fungal-induced decay in untreated timber. Wet ground conditions may precipitate decay at mudsills (timber spread footings) or exposed piles in contact with soils in fluctuating ground water levels.

Based on experience and available information, we have assumed the following life expectancies for the pressure treated timber on the E&N bridges:

- **Stringers, caps, sills, posts, piles and bracing: 50 years**. Timber bridges will require periodic maintenance to achieve this life expectancy and that is reflected in the maintenance costs we have assigned to these structures.
- **Treated timber ties (bearing and structural): 30 to 35 years**. (Track curvature greater than 3 degrees typically reduces the life span by 5 years.)

Timber tie life is very dependent on traffic loading. The existing treated timber bridge ties on the E&N Railway are typically between 30 and 40 years old.

It is evident from the age of the existing treated ties on the E&N Railway that tie life has significantly exceeded the normal tie life expectancy of 20 to 25 years for a lightly trafficked line. This is because the damage normally expected in timber ties, such as spike kill, has not occurred due to very light traffic.

- **Untreated yellow cedar ties (bearing and structural): 20 to 25 years**. (Track curvature greater than 3 degrees typically reduces life span by 5 years.)

For timber structures nearing the end of their assumed life span that are in good to fair condition, an additional 10 to 15 years is estimated with periodic maintenance of early rot elements.

When a significant percentage of timber ties on a bridge are in poor condition, those ties should be replaced to ensure the bridge is safe for traffic. Since the remaining ties on the bridge are likely reaching the end of their life span as well, we recommend that all the ties be replaced at the same time. Top surfaces of steel girders and floor beams supporting the ties are often corroded more significantly than the other elements because of dirt accumulating and trapping moisture. We recommend considering coating the top steel surfaces to reduce corrosion loss in the future. We recommend an environmentally friendly, low Volatile Organic Compound (VOC), paint, that does not require sand-blasting of steel surfaces.

When the ties are replaced, we recommend that the new ties conform to CP Rail standards for E60 loading. Although the cost of tie replacement was excluded from the scope of this contract, our estimated costs for tie replacements (including supply of pressure treated D. Fir tie with hardware and installation) are as follows:

- tie 6”x8” (ballast deck) = $ 500
- tie 8”x8” = $ 750
- tie 10”x10” = $ 800
- tie 10”x16” = $1000

The steel and iron structures have not been repainted for several decades; the existing paint has mostly fallen off the structures. Our inspections have discovered some corrosion of steel and iron structures. However there are only a few structures where the corrosion has resulted in a significant deterioration of the capacity and, even in those structures, the damage is localised to specific elements, such as top flanges of floor beams or top of bottom girder flanges where flaked paint and debris has accumulated.

Steel bridges will need to be inspected and tested in the future to investigate potential corrosion as well as mechanical damage, particularly if the railway traffic intensifies in the future. If the future bridge inspections discover possible deterioration such as cracking of critical structural components, failure of pins, scour, significant corrosion or mechanical damage of any structure, the capacity of that structure will need to be re-evaluated. In case the reduced bridge capacity is determined to be inadequate, a complete bridge replacement may be required. In this report, we have provided optional replacement costs for the steel bridges that may require replacement in the next 30 years, but since a complete replacement of steel structures may not be required on the basis of deteriorating condition, we have not included the replacement costs in the costs summary.

To increase the life span of the steel structure it may be cost-effective to paint those areas which are particularly subject to corrosion including:

- The top of the top flange of floor beams.
- The top of the bottom flanges of deck plate girders.
- The base of steel towers in contact with vegetation or dirt.

We recommend local maintenance painting using an environmentally friendly (low Volatile Organic Compound) paint, that does not require sand-blasting of the steel surfaces and is relatively economical. If this local painting work can be scheduled to coincide with other bridge repairs, the cost should not be significant.

## 4.5 Capacity Calculation

Bridge load capacity is determined as outlined in Section 3.2 of Transport Canada’s Guideline for Bridge Safety Management (TCG): http://www.tc.gc.ca/eng/railsafety/guideline-731.htm. This Guideline in turn reference current AREMA guide specifications.

Bridge load capacity is typically determined from existing design and available modification records of a bridge without additional calculation provided that the bridge substantially conforms to its recorded configuration. The Cooper design loads, obtained for the available record drawings for

each structure, are shown in **Appendix A**. This methodology was used where appropriate on a number of bridges along the E&N Line.

Otherwise, the load capacity of a bridge is determined by measurement and calculation of the properties of its individual components, or other methods as determined by the Engineer. This was done for several bridges on this project.

Where a bridge inspection reveals that the condition of a bridge or its component might adversely affect the load capacity of the bridge to carry the traffic operated, a reduced capacity is determined. Where the comparison of the effects of the bridge design loads and the Assessment Trains (AT) are negative (effects of the AT's are greater that the effects of the design load), bridge load capacity is determined from existing design and modification records of a bridge, provided that the bridge substantially conforms to its recorded configuration. Otherwise, the load capacity of a bridge is determined by measurement and calculation of the properties of its individual components.

Where a bridge inspection revealed that the condition of a bridge or its component might adversely affect the load capacity of the bridge to carry the traffic operated, a reduced capacity is determined. In cases where bridge components are damaged in a way that renders determining reduced capacity unreliable, the load evaluation is based on the assumption that the damaged components in question will be replaced. These repairs are listed as Essential Repairs for each individual bridge.

Bridge load capacity is expressed in terms of **normal** rating capacity. Per AREMA 15-7.3.1.1a, normal rating is the load level which can be carried by the existing structure for its expected service life. **Maximum** rating is not considered in this report.

The Cooper design load used for analysis is prorated from the Cooper E 80 Load, shown in Figure 15-1-2 of the AREMA Manual. Alternate live load, shown on Figure 15-1-3 of the AREMA Manual is ignored.

### 4.6 Allowable Stresses

Allowable stresses for iron and steel components, as some cases as recommended by a steel manufacturer, are used where appropriate. When the allowable stresses are not specified on the record drawings by the manufacturer we default to either:

- Fabricator's suggested allowable stresses based on the material type and era of fabrication, or
- The allowable stress table along with yield strengths as suggested in cl. 15-7.3.4.3a of the AREMA manual.

For more modern structures, where the steel yield strength ($F_y$) is known, we use the allowable stresses in steel structure as shown on Table 15-1-11 of the AREMA manual.

Effective slenderness ratio KL/r (where K is effective length factor, L is unsupported length and r is radius of gyration) is calculated for compression members in trusses. An effective length factor K equal to 7/8 is typically used for the truss diagonals and verticals as prescribed in the AREMA table. The allowable stress in tension hangers is typically based on 0.40 $F_y$. The allowable stress in any other tension members is typically based on 0.55 $F_y$. In computing the capacity of a member, the gross section area is used for compression members and net section area is used for tension members. To determine the net section properties we typically exclude the area of rivet holes in a given cross-section within the member.

For girder spans, the effective lengths of compression flanges based on cross-frame spacing are calculated. The stability of the top flanges in compression for steel HDPG spans, where there is no bracing of the top flange, is calculated in accordance with a recognized procedure, such as the procedure shown in *Guide to Stability Design Criteria for Metal Structures*, by Theodore Galambos.

# 5 Ratings

The normal ratings provided in this report are based on the assumption that the Essential Repairs (Immediate) will be complete.

The Component Cooper Rating (CCR) is defined as:

$$CCR = \frac{\text{Capacity - DL Effect}}{1 + \text{Dynamic Impact}} \times \frac{50}{\text{Effect of E50}}$$

CCR is the heaviest Cooper train that can cross the bridge before normal capacity of the critical component is exceeded.

All required ratings are provided as Equivalent Cooper Demand (ECD). Cooper Equivalent load is defined as:

$$ECD = 50 \times \frac{\text{Effect of Assessment Train}}{\text{Effect of E50}}$$

ECD is the Cooper train that produces the same force effect on the critical member as the Assessment Train.

Components having no overstress are capable of supporting the Assessment Train at the specified speed. In specific cases, overstress not exceeding 6% may be considered acceptable by the evaluator; such cases could include members in a redundant system, such as timber stringers, where sound condition of the stringers is confirmed by the inspection. No overstress is considered acceptable for non-redundant primary components or for secondary components where failure of one member may lead to a progressive collapse, such as steel floor beams.

Tables showing the rating results for trusses will not show results for all members. Only the results for the governing component of each type of component are shown. For instance, a truss has several diagonal members, each carrying different loads and having different section properties and different strengths. Tables will only show the results for the diagonal member that had the lowest CCR/ECD (capacity/demand) ratio, which is the most critical component of the diagonal component type. The critical component in a bridge may not be the same for every assessment train and this is sometimes reflected by the Component Cooper Rating for a particular member type (truss diagonal) being different for different assessment trains.

# 6 Cost Estimates

The Evaluation Report includes the cost estimates for the following groupings (see section 2 for definitions of repair types):

- **Maintenance (in 10 year increments) through 2041**: Inspection, cleaning and other routine actions which ensure the bridge is safe for traffic, excluding any structural repairs.
- **Essential Repairs (Immediate)** [1]: Repair of deficiencies identified in the Inspection Report required to safely operate the bridge under the train loadings and modified design speeds specified as a result of the structural assessment and load ratings. Bridge load ratings shown in this report are based on the assumption that the essential repairs are completed.

  Note: [1] It may be possible, through additional testing, analysis, monitoring, and/or modified operating procedures as required to modify and/or defer the repairs identified as Essential Repairs (Immediate) included in this report, still ensuring safe passage of trains. Modified operating procedures could include elevated bridge inspection frequencies, reduced maximum permissible operating speed, reduced train loading by marshaling with idlers between loads, etc. to ensure the safe passage of trains pending completion of required Essential Repairs. These items are outside the scope of the current contract.
- **Projected Repairs**: Expected repairs of components required to ensure future stability of a bridge and adequacy to support the train load through 2041. The projected repairs listed in this report are based on the Phase 1 and Phase 3 Inspection Reports conducted in 2011 and on historical information available to the evaluators. Requirements for projected repairs may need to be adjusted as a result of findings from the future inspections. Examples could include replacing or reinforcing of the corroded and damaged components, major rehabilitation of deteriorated components in timber structures to extend the life of the structure. Repair or partial replacement costs of timber structures that will have reached their life expectancy are included in the Projected Repair costs for each bridge. We are assuming that repair or partial replacement cost for a timber structure is in the order of one third of the complete replacement cost for each 10 year period after the stricter reaches its expected lifespan. Estimated repair costs for steel structures, to address deficiencies that have not been observed during the 2011 inspection but can be expected in the future, are included in the **Unallocated Rehabilitation Allowance** shown in the summary table.

- **Strengthening**: Structural improvements to bridges that address insufficient capacities for specific assessment train loadings that were identified by the structural assessment. Strengthening recommendations may include plating steel members, adding stringers, Dywidag rod stiffening mechanisms or similar strengthening processes, to timber spans and more, with a focus on improving the capacity of the structures.

In our cost estimates we have assumed that the existing bridges will be repaired 'like-for-like'. The bridges to be replaced will be replaced by new structures meeting all the relevant operational and work-safety regulations. The repairs and replacement costs shown in this report are estimated costs to safely operate the line through each of the 10 year periods, until the year of 2041; we have not considered residual value of the structures and repair and replacement needs after 2041.

**Unallocated Rehabilitation Allowance,** value specified in the summary tables represents a potential value or repairs and replacements of the bridges, addressing deficiencies that have not been observed during the 2011 inspection, but can reasonably be expected in the future. The Unallocated Rehabilitation Allowance is not allocated to particular structures but applies to all the bridges on the line. Considering age and condition of the structures, future deficiencies may occur on several bridges. The Unallocated Rehabilitation Allowance does not include the costs of repairs and replacements of timber ties nor trestles.

The following inspection and repair costs are EXCLUDED from the cost summary:

- Costs for replacement of deteriorated timber ties.
- Regular visual inspections of bridges conducted by SVI forces (Employees of the Southern Railway of Vancouver Island Limited, performing routine inspection and maintenance of the track).

The cost estimates for the maintenance, repair and strengthening for the bridges included in Phase 4 are summarized in the following tables. Detailed descriptions of the repair needs follow on a bridge by bridge basis.

## Phase 2 - Projected Cost Summary to Operate Bridges from Present until the Year 2021, Passenger Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $4,500 | $0 | $5,500 | $0 | $10,000 |
| 4.00 | $3,000 | $0 | $9,000 | $0 | $12,000 |
| 4.50 | $3,000 | $0 | $4,200 | $0 | $7,200 |
| 5.20 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.34 | $4,000 | $0 | $0 | $0 | $4,000 |
| 5.45 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 14.00 | $205,000 | $128,500 | $60,000 | $0 | $393,500 |
| 14.90 | $7,000 | $5,000 | $161,000 | $0 | $173,000 |
| 18.20 | $1,000 | $0 | $4,000 | $0 | $5,000 |
| 26.80 | $2,500 | $0 | $0 | $0 | $2,500 |
| 28.20 | $2,000 | $0 | $17,000 | $0 | $19,000 |
| 28.40 | $2,000 | $0 | $16,000 | $0 | $18,000 |
| 28.60 | $2,000 | $0 | $11,400 | $0 | $13,400 |
| 29.80 | $2,000 | $0 | $0 | $0 | $2,000 |
| 35.60 | $2,000 | $0 | $8,700 | $0 | $10,700 |
| 37.60 | $12,000 | $3,000 | $18,500 | $0 | $33,500 |
| 37.80 | $5,000 | $0 | $20,000 | $0 | $25,000 |
| 39.30 | $5,000 | $165,000 | $58,000 | $1,000 | $229,000 |
| 40.60 | $3,000 | $0 | $0 | $0 | $3,000 |
| 46.60 | $1,000 | $10,000 | $2,000 | $0 | $13,000 |
| 46.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 47.90 | $5,000 | $0 | $36,500 | $0 | $41,500 |
| 60.70 | $3,000 | $0 | $0 | $1,000 | $4,000 |
| 64.40 | $3,000 | $0 | $0 | $0 | $3,000 |
| 65.10 | $1,500 | $20,000 | $20,000 | $0 | $41,500 |
| 0.69 (Wellcox) | $3,000 | $0 | $32,000 | $0 | $35,000 |
| 1.02 (Wellcox) | $3,000 | $6,000 | $0 | $0 | $9,000 |
| Total (no allowance *) | **$296,500** | **$337,500** | **$483,800** | **$2,000** | **$1,119,800** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$0** | **$0** | **$0** |
| Total with Unallocated Rehabilitation Allowances | **$296,500** | **$337,500** | **$483,800** | **$2,000** | **$1,119,800** |

Notes:
1. All of the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges from Present until the Year 2021, 263kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $4,500 | $0 | $5,500 | $0 | $10,000 |
| 4.00 | $3,000 | $0 | $9,000 | $0 | 12,000 |
| 4.50 | $3,000 | $0 | $4,200 | $0 | $7,200 |
| 5.20 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.34 | $4,000 | $0 | $0 | $0 | $4,000 |
| 5.45 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 14.00 | $205,000 | $128,500 | $60,000 | $200,000 | $593,500 |
| 14.90 | $7,000 | $5,000 | $161,000 | $0 | $173,000 |
| 18.20 | $1,000 | $0 | $4,000 | $0 | $5,000 |
| 26.80 | $2,500 | $0 | $0 | $0 | $2,500 |
| 28.20 | $2,000 | $0 | $17,000 | $0 | $19,000 |
| 28.40 | $2,000 | $0 | $16,000 | $0 | $18,000 |
| 28.60 | $2,000 | $0 | $11,400 | $0 | $13,400 |
| 29.80 | $2,000 | $0 | $0 | $0 | $2,000 |
| 35.60 | $2,000 | $0 | $8,700 | $0 | $10,700 |
| 37.60 | $12,000 | $3,000 | $18,500 | $0 | $33,500 |
| 37.80 | $5,000 | $0 | $20,000 | $0 | $25,000 |
| 39.30 | $5,000 | $165,000 | $58,000 | $151,000 | $379,000 |
| 40.60 | $3,000 | $0 | $0 | $0 | $3,000 |
| 46.60 | $1,000 | $10,000 | $2,000 | $0 | $13,000 |
| 46.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 47.90 | $0 | $0 | $0 | $2,400,000 | $2,400,000 |
| 60.70 | $3,000 | $0 | $0 | $25,000 | $28,000 |
| 64.40 | $3,000 | $0 | $0 | $0 | $3,000 |
| 65.10 | $1,500 | $20,000 | $20,000 | $75,000 | $116,500 |
| 0.69 (Wellcox) | $3,000 | $0 | $32,000 | $0 | $35,000 |
| 1.02 (Wellcox) | $3,000 | $6,000 | $0 | $0 | $9,000 |
| Total (no allowance *) | **$291,500** | **$337,500** | **$447,300** | **$2,851,000** | **$3,927,300** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$0** | **$0** | **$0** |
| Total with Unallocated Rehabilitation Allowances | **$291,500** | **$337,500** | **$447,300** | **$2,851,000** | **$3,927,300** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges from Present until the Year 2021, 286kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $4,500 | $0 | $5,500 | $0 | $10,000 |
| 4.00 | $3,000 | $0 | $9,000 | $0 | 12,000 |
| 4.50 | $3,000 | $0 | $4,200 | $0 | $7,200 |
| 5.20 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.34 | $4,000 | $0 | $0 | $0 | $4,000 |
| 5.45 | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 14.00 | $205,000 | $128,500 | $60,000 | $200,000 | $593,500 |
| 14.90 | $7,000 | $5,000 | $161,000 | $50,000 | $223,000 |
| 18.20 | $1,000 | $0 | $4,000 | $0 | $5,000 |
| 26.80 | $2,500 | $0 | $0 | $0 | $2,500 |
| 28.20 | $2,000 | $0 | $17,000 | $0 | $19,000 |
| 28.40 | $2,000 | $0 | $16,000 | $0 | $18,000 |
| 28.60 | $2,000 | $0 | $11,400 | $0 | $13,400 |
| 29.80 | $2,000 | $0 | $0 | $0 | $2,000 |
| 35.60 | $2,000 | $0 | $8,700 | $25,000 | $35,700 |
| 37.60 | $12,000 | $3,000 | $18,500 | $12,000 | $45,500 |
| 37.80 | $5,000 | $0 | $20,000 | $0 | $25,000 |
| 39.30 | $5,000 | $165,000 | $58,000 | $151,000 | $379,000 |
| 40.60 | $3,000 | $0 | $0 | $0 | $3,000 |
| 46.60 | $1,000 | $10,000 | $2,000 | $5,000 | $18,000 |
| 46.80 | $3,000 | $0 | $0 | $0 | $3,000 |
| 47.90 | $0 | $0 | $0 | $2,400,000 | $2,400,000 |
| 60.70 | $3,000 | $0 | $0 | $25,000 | $28,000 |
| 64.40 | $3,000 | $0 | $0 | $0 | $3,000 |
| 65.10 | $1,500 | $20,000 | $20,000 | $75,000 | $116,500 |
| 0.69 (Wellcox) | $3,000 | $0 | $32,000 | $5,000 | $40,000 |
| 1.02 (Wellcox) | $3,000 | $6,000 | $0 | $5,000 | $14,000 |
| Total (no allowance *) | **$291,500** | **$337,500** | **$447,300** | **$2,953,000** | **$4,029,300** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$0** | **$0** | **$0** |
| Total with Unallocated Rehabilitation Allowances | **$291,500** | **$337,500** | **$447,300** | **$2,953,000** | **$4,029,300** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2021 - 2031, Passenger Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $24,000 | $0 | $0 | $0 | $24,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $22,000 | $0 | $30,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$452,000** | **$0** | **$490,000** | **$0** | **$942,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$452,000** | **$0** | **$2,990,000** | **$0** | **$3,442,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2021 - 2031, 263kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $24,000 | $0 | $0 | $0 | $24,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $22,000 | $0 | $30,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$452,000** | **$0** | **$490,000** | **$0** | **$942,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$452,000** | **$0** | **$2,990,000** | **$0** | **$3,442,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2021 - 2031, 286kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $24,000 | $0 | $0 | $0 | $24,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $22,000 | $0 | $30,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$452,000** | **$0** | **$490,000** | **$0** | **$942,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$452,000** | **$0** | **$2,990,000** | **$0** | **$3,442,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2031 - 2041, Passenger Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $0 | $0 | $8,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$432,000** | **$0** | **$468,000** | **$0** | **$900,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$432,000** | **$0** | **$2,968,000** | **$0** | **$3,400,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies. .
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2031 - 2041, 263kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $0 | $0 | $8,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$432,000** | **$0** | **$468,000** | **$0** | **$900,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$432,000** | **$0** | **$2,968,000** | **$0** | **$3,400,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Phase 2 - Projected Cost Summary to Operate Bridges 2031 - 2041, 286kip Loading

| Bridge Mile Post | Category of Work | | | | Total Cost for Bridge |
|---|---|---|---|---|---|
| | Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | |
| 1.30 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.00 | $6,000 | $0 | $0 | $0 | $6,000 |
| 4.50 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.20 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.34 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.45 | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 14.00 | $260,000 | $0 | $0 | $0 | $260,000 |
| 14.90 | $16,000 | $0 | $0 | $0 | $16,000 |
| 18.20 | $2,000 | $0 | $30,000 | $0 | $32,000 |
| 26.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.20 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.40 | $4,000 | $0 | $0 | $0 | $4,000 |
| 28.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 29.80 | $4,000 | $0 | $0 | $0 | $4,000 |
| 35.60 | $4,000 | $0 | $0 | $0 | $4,000 |
| 37.60 | $2,000 | $0 | $133,000 | $0 | $135,000 |
| 37.80 | $10,000 | $0 | $0 | $0 | $10,000 |
| 39.30 | $15,000 | $0 | $0 | $0 | $15,000 |
| 40.60 | $6,000 | $0 | $0 | $0 | $6,000 |
| 46.60 | $3,000 | $0 | $85,000 | $0 | $88,000 |
| 46.80 | $6,000 | $0 | $0 | $0 | $6,000 |
| 47.90 | $8,000 | $0 | $0 | $0 | $8,000 |
| 60.70 | $8,000 | $0 | $0 | $0 | $8,000 |
| 64.40 | $8,000 | $0 | $0 | $0 | $8,000 |
| 65.10 | $8,000 | $0 | $0 | $0 | $8,000 |
| 0.69 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| 1.02 (Wellcox) | $7,000 | $0 | $110,000 | $0 | $117,000 |
| Total (no allowance *) | **$432,000** | **$0** | **$468,000** | **$0** | **$900,000** |
| Unallocated Rehabilitation Allowance* | **$0** | **$0** | **$2,500,000** | **$0** | **$2,500,000** |
| Total with Unallocated Rehabilitation Allowances | **$432,000** | **$0** | **$2,968,000** | **$0** | **$3,400,000** |

Notes:
1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.
3. The cost for each of the four repair types listed under Category of Work is a discreet cost which does not include work from another repair type.

## Summary of Costs to Operate Bridges
## Phase 2 until the year of 2041

| | Train Type | | |
|---|---|---|---|
| *Br. Milepost* | Passenger | 263 | 286 |
| 1.30 | $22,000 | $22,000 | $22,000 |
| 4.00 | $24,000 | $24,000 | $24,000 |
| 4.50 | $19,200 | $19,200 | $19,200 |
| 5.20 | $15,000 | $15,000 | $15,000 |
| 5.34 | $16,000 | $16,000 | $16,000 |
| 5.45 | $15,000 | $15,000 | $15,000 |
| 5.80 | $15,000 | $15,000 | $15,000 |
| 14.00 | $913,500 | $1,113,500 | $1,113,500 |
| 14.90 | $205,000 | $205,000 | $255,000 |
| 18.20 | $69,000 | $69,000 | $69,000 |
| 26.80 | $10,500 | $10,500 | $10,500 |
| 28.20 | $27,000 | $27,000 | $27,000 |
| 28.40 | $26,000 | $26,000 | $26,000 |
| 28.60 | $21,400 | $21,400 | $21,400 |
| 29.80 | $30,000 | $30,000 | $30,000 |
| 35.60 | $18,700 | $18,700 | $43,700 |
| 37.60 | $303,500 | $303,500 | $315,500 |
| 37.80 | $45,000 | $45,000 | $45,000 |
| 39.30 | $259,000 | $409,000 | $409,000 |
| 40.60 | $15,000 | $15,000 | $15,000 |
| 46.60 | $189,000 | $189,000 | $194,000 |
| 46.80 | $15,000 | $15,000 | $15,000 |
| 47.90 | $57,500 | $2,416,000 | $2,416,000 |
| 60.70 | $20,000 | $44,000 | $44,000 |
| 64.40 | $19,000 | $19,000 | $19,000 |
| 65.10 | $79,500 | $154,500 | $154,500 |
| 0.69 (Wellcox) | $269,000 | $269,000 | $274,000 |
| 1.02 (Wellcox) | $243,000 | $243,000 | $248,000 |
| **Total for phase 2** | $2,961,800 | $5,769,300 | $5,871,300 |
| **Unallocated Rehabilitation Allowance *** | $5,000,000 | $5,000,000 | $5,000,000 |
| Total with Unallocated Rehabilitation Allowances | $7,961,800 | $10,769,300 | $10,871,300 |

Notes: 1. All the costs are shown in 2011 Canadian Dollars.
2. Unallocated Rehabilitation Allowance (*) is estimated cost of future repairs and replacements of steel bridge structures to address possible future deficiencies.

# 7 Mile 1.30 – Hereward Road


## 7.1 Mile 1.30 – Description

Bridge 1.30 is a single span open deck bridge over Hereward Road. The superstructure consists of a 47 ft steel half deck plate girder with timber structural ties. The bridge is on a skew with a tangent alignment.

The bridge was erected in 1914. The bridge is supported by concrete closed abutments.

**Bridge Design Load:** E-50 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 15 mph
**Desired Speed:** 15 mph

### 7.2 Mile 1.30 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed minor corrosion in the steel girders, but no structurally significant damage.

Inspection also revealed the following:

- Spalled edge of abutment seat in front of bearings.
- Poor backwall ties.
- Soil accumulation beneath ties at ends of bridge.
- Corroded anchor bolts.
- Several poor bridge ties and overall fair-poor tie condition.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 7.3 Mile 1.30 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the SVI design load (design load also unconfirmed). In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 15mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | >E70 | E54 | - | Bending |
| Deck Plate Girder (Steel) | E66 | E54 | - | Shear |
| Timber Structural Tie | >E80 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 15mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 15mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 15mph | N / A |

### 7.4 Mile 1.30 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in 20 years to maintain railway traffic. An estimated replacement cost for this bridge is $1,060,000, including removal/erection of substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

### 7.5 Mile 1.30 – Cost Summary Table: Present to year 2021

**Bridge 1.30 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Remove soil from beneath ties at ends of bridge. | $1,500 |
| | | X | | Repair spalled edge of abutment seat in front of bearings. | $2,500 |
| | | X | | Replace backwall ties. | $2,000 |
| | | X | | Replace anchor bolts. | $1,000 |
| | | X | | Replace all bridge ties (46-10"x18" ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$10,000** |

### 7.6 Mile 1.30 – Cost Summary Table: Years 2021 to 2031

**Bridge 1.30 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

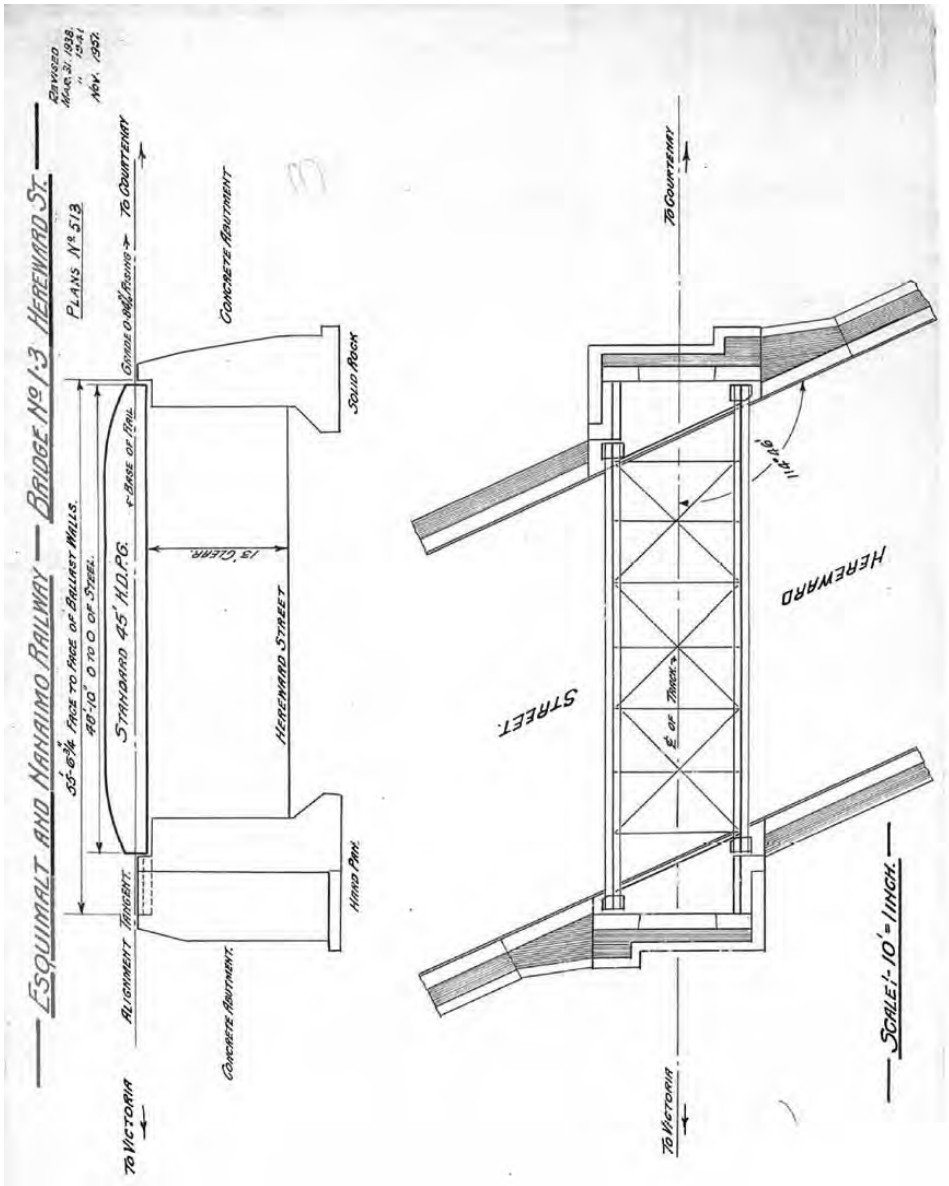
### 7.7 Mile 1.30 – Cost Summary Table: Years 2031 to 2041

**Bridge 1.30 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 1.30 – Victoria Subdivision – Hereward Road

## Bridge General Arrangement:



# 8 Mile 4.00 – Highway 1A

## 8.1 Mile 4.00 – Description

Bridge 4.00 is a single span ballasted deck bridge over Highway 1A. The superstructure consists of 74 ft (22.5 m) steel thru plate girders with steel floor beams and a steel floor plate supporting the ballast deck. The bridge is on a tangent alignment.

The bridge was originally constructed in 1911. The majority of the structure (all of superstructure, most of abutments) was replaced in 2010.

**Bridge Design Load:** E-80 (shown on the record drawings)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

## 8.2 Mile 4.00 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

Inspection also revealed the following:

- Timber backwall leaning against girder span.
- End floor beam flanges in contact with anchor bolts.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 8.3 Mile 4.00 – Load Rating

Detailed load rating was not performed because load effects of the Assessment Trains are less than the design load. This is summarized in the 286kip table below.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Thru Plate Girder (Steel) | E80* | E56 | - | Bending |
| Thru Plate Girder (Steel) | E80* | E57 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

## 8.4 Mile 4.00 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

## 8.5 Mile 4.00 – Cost Summary Table: Present to Year 2021

**Bridge 4.00 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Repair timber backwall leaning against girder span. | $8,000 |
| | | X | | Notch end floor beams to prevent contact with anchor bolts. | $1,000 |
| | | | | **Subtotal All Loadings** | **$12,000** |

## 8.6 Mile 4.00 – Cost Summary Table: Years 2021 to 2031

**Bridge 4.00 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

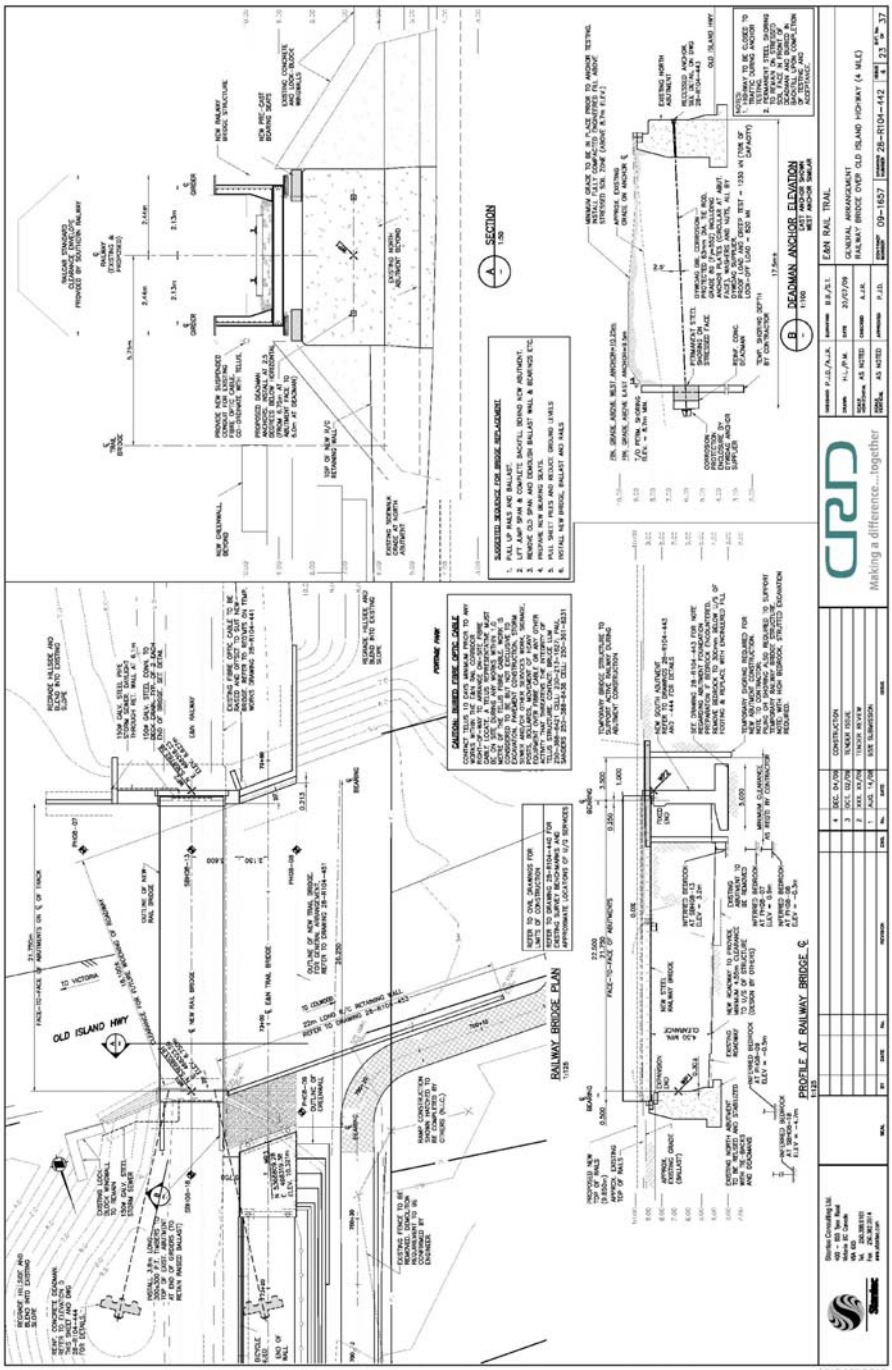
## 8.7 Mile 4.00 – Cost Summary Table: Years 2031 to 2041

**Bridge 4.00 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| X | | | | Replace all bridge ties (40' of 8" x 8" ballast ties, cost excluded) | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 4.00 – Victoria Subdivision – Highway 1A

## Bridge General Arrangement:



# 9 Mile 4.50 – Helmcken Road

## 9.1 Mile 4.50 – Description

Bridge 4.50 is a single span concrete ballasted deck bridge over Helmcken Road. The superstructure consists of a 42'-10" steel thru plate girder with steel floor beams encased in concrete. The bridge is on a tangent alignment.

The bridge was originally constructed in 1961. The structure is supported by concrete closed abutments.

**Bridge Design Load:** E-50
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

## 9.2 Mile 4.50 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to have minor surface corrosion, with no structurally significant damage.

Inspection also revealed the following:

- Cracks in abutments under both bearings.
- Missing anchor bolts at south abutment bearings.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 9.3 Mile 4.50 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear. We have also evaluated the floorbeams compositely for maximum moment and shear.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Thru Plate Girder (Steel) | E60 | E55 | - | Bending |
| Thru Plate Girder (Steel) | >E70 | E56 | - | Shear |
| Steel Floor beam (encased in concrete) | >E80 | E72 | - | Bending |
| Steel Floor beam (encased in concrete) | >E80 | E72 | - | Shear |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 9.4 Mile 4.50 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 9.5 Mile 4.50 – Cost Summary Table: Present to Year 2021

**Bridge 4.50 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Repair cracks in abutments under both bearings. | $3,200 |
| | | X | | Replace missing anchor bolts at south abutment bearings. | $1,000 |
| | | | | **Subtotal All Loadings** | **$7,200** |

### 9.6 Mile 4.50 – Cost Summary Table: Years 2021 to 2031

**Bridge 4.50 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

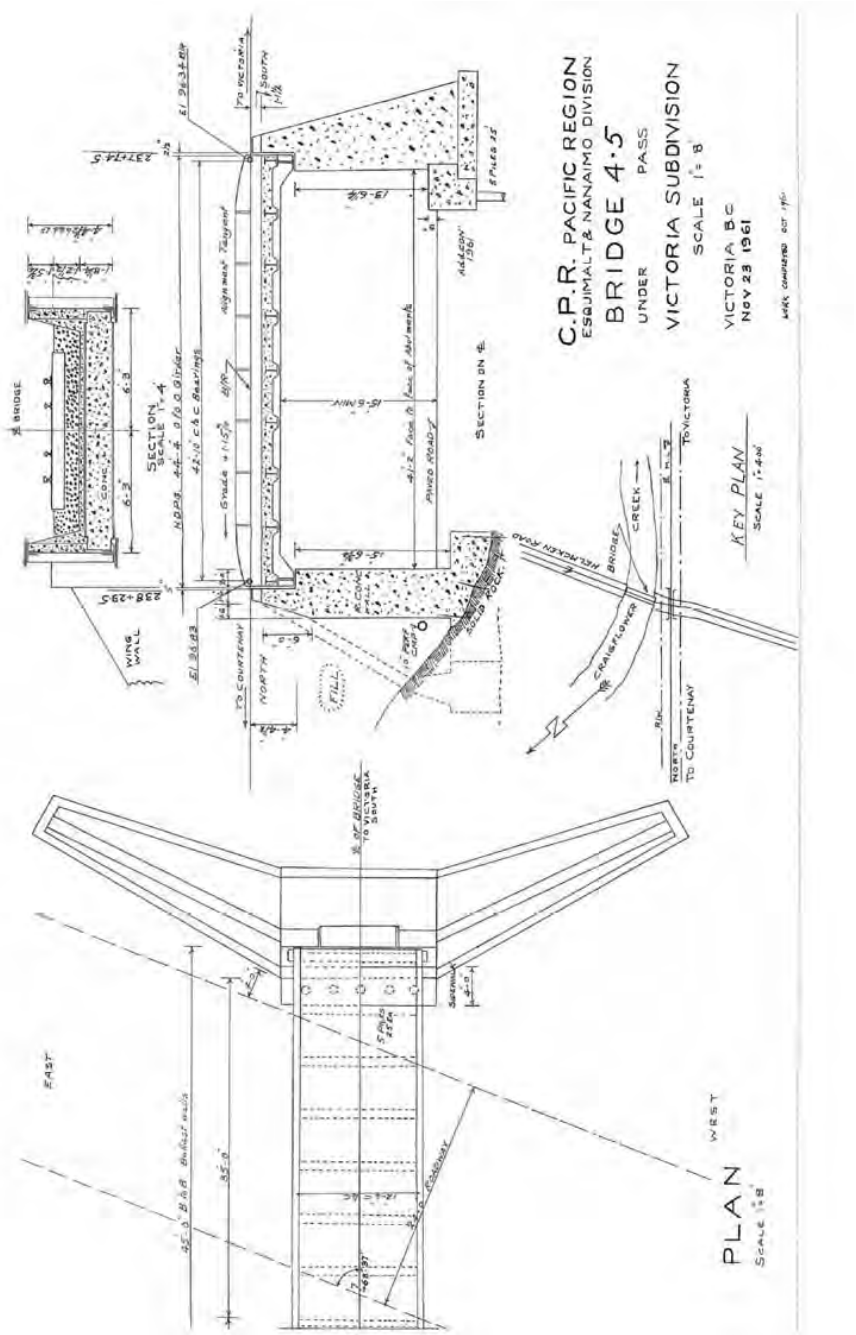
## 9.7 Mile 4.50 – Cost Summary Table: Years 2031 to 2041

**Bridge 4.50 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 4.50 – Victoria Subdivision – Helmcken Road

## Bridge General Arrangement:



# 10 Mile 5.20 – Adams Place

## 10.1 Mile 5.20 – Description

Bridge 5.20 is a single span ballasted deck bridge over Adams Place. The superstructure consists of a 65 ft steel thru plate girder with steel floor beams and a steel floor plate supporting the ballast. The bridge is on a tangent alignment.

The bridge was originally constructed in 1997. The superstructure is supported by concrete open abutments with slope walls.

**Bridge Design Load:** E-80
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 10.2 Mile 5.20 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

For detailed inspection results refer to the Inspection Report dated February 2012. Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 10.3 Mile 5.20 – Load Rating

Detailed load rating was not performed because load effects of the Assessment Trains are less than the design load. This is summarized in the 286kip table below.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Thru Plate Girder (Steel) | E80* | E48 | - | Bending |
| Thru Plate Girder (Steel) | E80* | E50 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 10.4 Mile 5.20 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 10.5 Mile 5.20 – Cost Summary Table: Present to 2021

**Bridge 5.20 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

### 10.6 Mile 5.20 – Cost Summary Table: Years 2021 to 2031

**Bridge 5.20 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

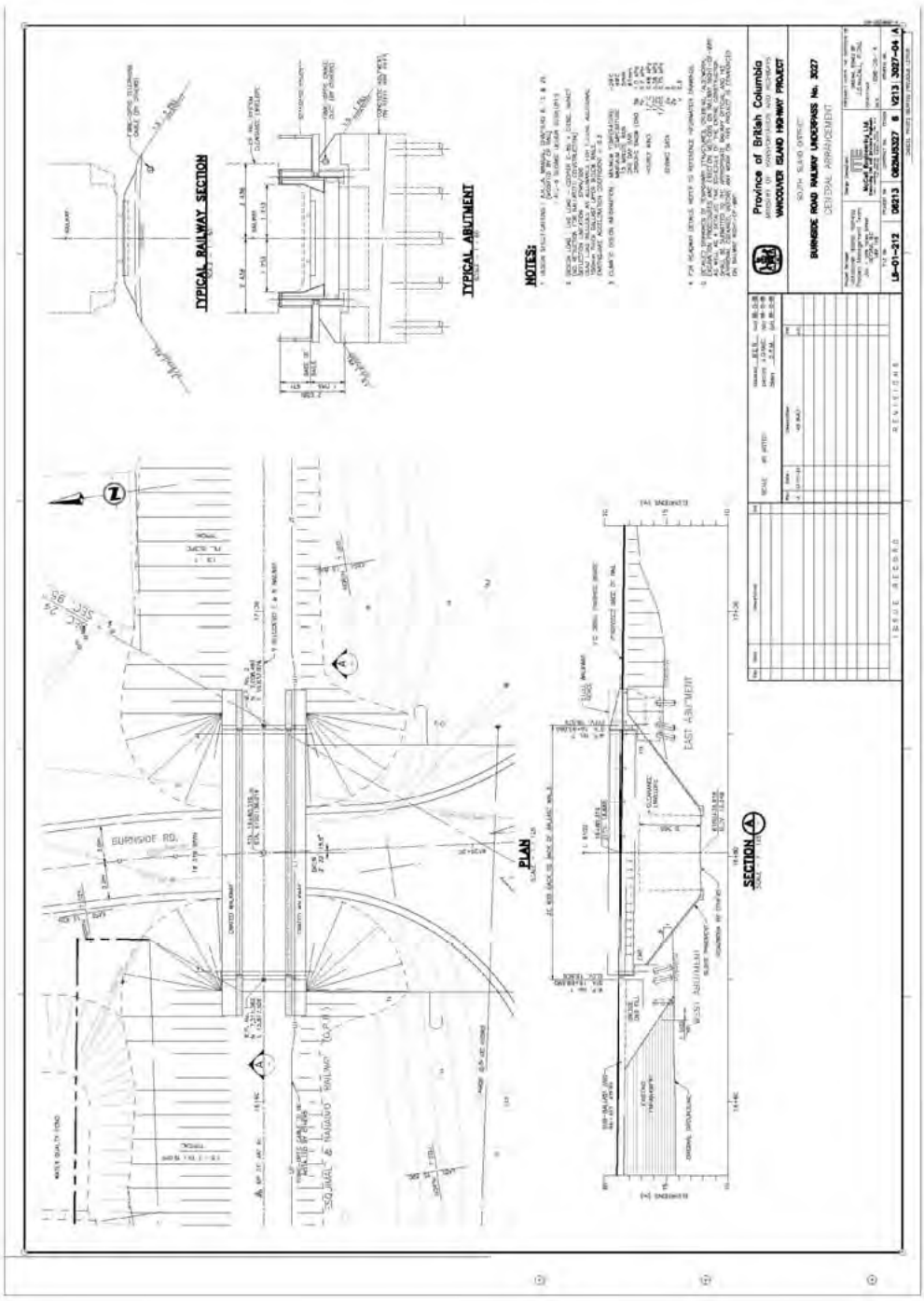
## 10.7 Mile 5.20 – Cost Summary Table: Years 2031 to 2041

**Bridge 5.20 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| X | | | | Replace all bridge ties (65' of ballast ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 5.20 – Victoria Subdivision – Adams Place

## Bridge General Arrangement:



# 11 Mile 5.34 – Island Highway

## 11.1 Mile 5.34 – Description

Bridge 5.34 is a three span ballasted deck bridge over Island Highway. The superstructure consists of 83', 126' and 116' steel thru plate girders with steel floor beams and a steel floor plate supporting the ballast. The bridge is on a curved alignment.

The bridge was originally constructed in 1998. The superstructure is supported by concrete closed abutments and concrete hammerhead piers.

**Bridge Design Load:** E-80
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 11.2 Mile 5.34 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 11.3 Mile 5.34 – Load Rating

Detailed load rating was not performed because load effects of the Assessment Trains are less than the design load. This is summarized in the 286kip table below.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 89' Thru Plate Girder (Steel) | E80* | E42 | - | Bending |
| 89' Thru Plate Girder (Steel) | E80* | E49 | - | Shear |
| 118' Thru Plate Girder (Steel) | E80* | E42 | - | Bending |
| 118' Thru Plate Girder (Steel) | E80* | E46 | - | Shear |
| 126' Thru Plate Girder (Steel) | E80* | E42 | - | Bending |
| 126' Thru Plate Girder (Steel) | E80* | E46 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 11.4 Mile 5.34 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 11.5 Mile 5.34 – Cost Summary Table: Present to Year 2021

**Bridge 5.34 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Top girder flanges at Pier 1 are touching; this should be monitored. | $1,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

### 11.6 Mile 5.34 – Cost Summary Table: Years 2021 to 2031

**Bridge 5.34 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

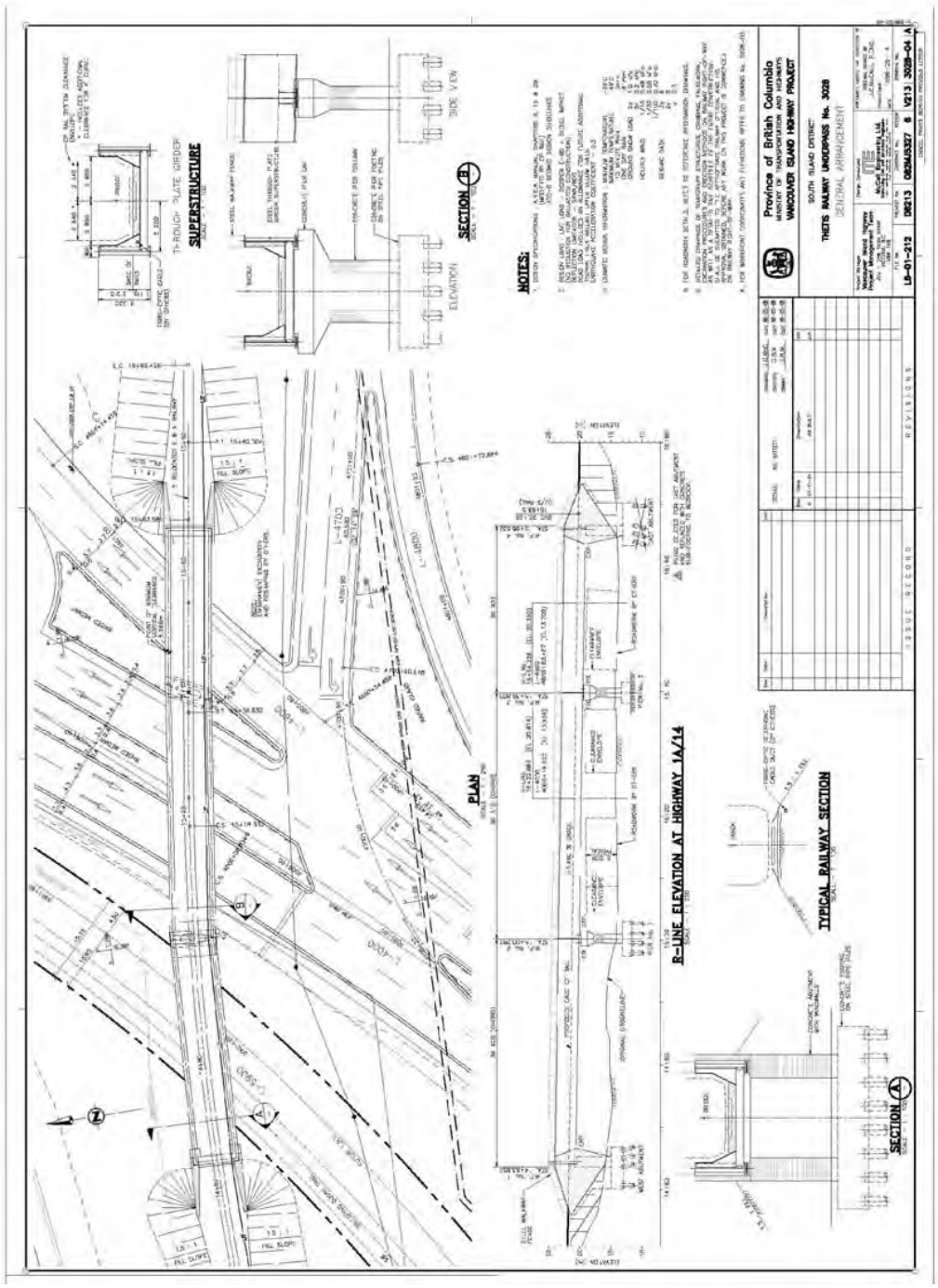
## 11.7 Mile 5.34 – Cost Summary Table: Years 2031 to 2041

**Bridge 5.34 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| X | | | | Replace all bridge ties (333' of ballast ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 5.34 – Victoria Subdivision – Island Highway

## Bridge General Arrangement:



# 12 Mile 5.45 – Brydon Road

## 12.1 Mile 5.45 – Description

Bridge 5.45 is a single span ballasted deck bridge over Brydon Road. The superstructure consists of a 63'-5" steel thru plate girder with steel floor beams and a steel floor plate supporting the ballast. The bridge is on a tangent alignment.

The bridge was originally constructed in 1998. The superstructure is supported by concrete closed abutments.

**Bridge Design Load:** E-80
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 12.2 Mile 5.45 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 12.3 Mile 5.45 – Load Rating

Detailed load rating was not performed because load effects of the Assessment Trains are less than the design load. This is summarized in the 286kip table below.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Thru Plate Girder (Steel) | E80* | E48 | - | Bending |
| Thru Plate Girder (Steel) | E80* | E50 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 12.4 Mile 5.45 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 12.5 Mile 5.45 – Cost Summary Table: Present to Year 2021

**Bridge 5.45 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

### 12.6 Mile 5.45 – Cost Summary Table: Years 2021 to 2031

**Bridge 5.45 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

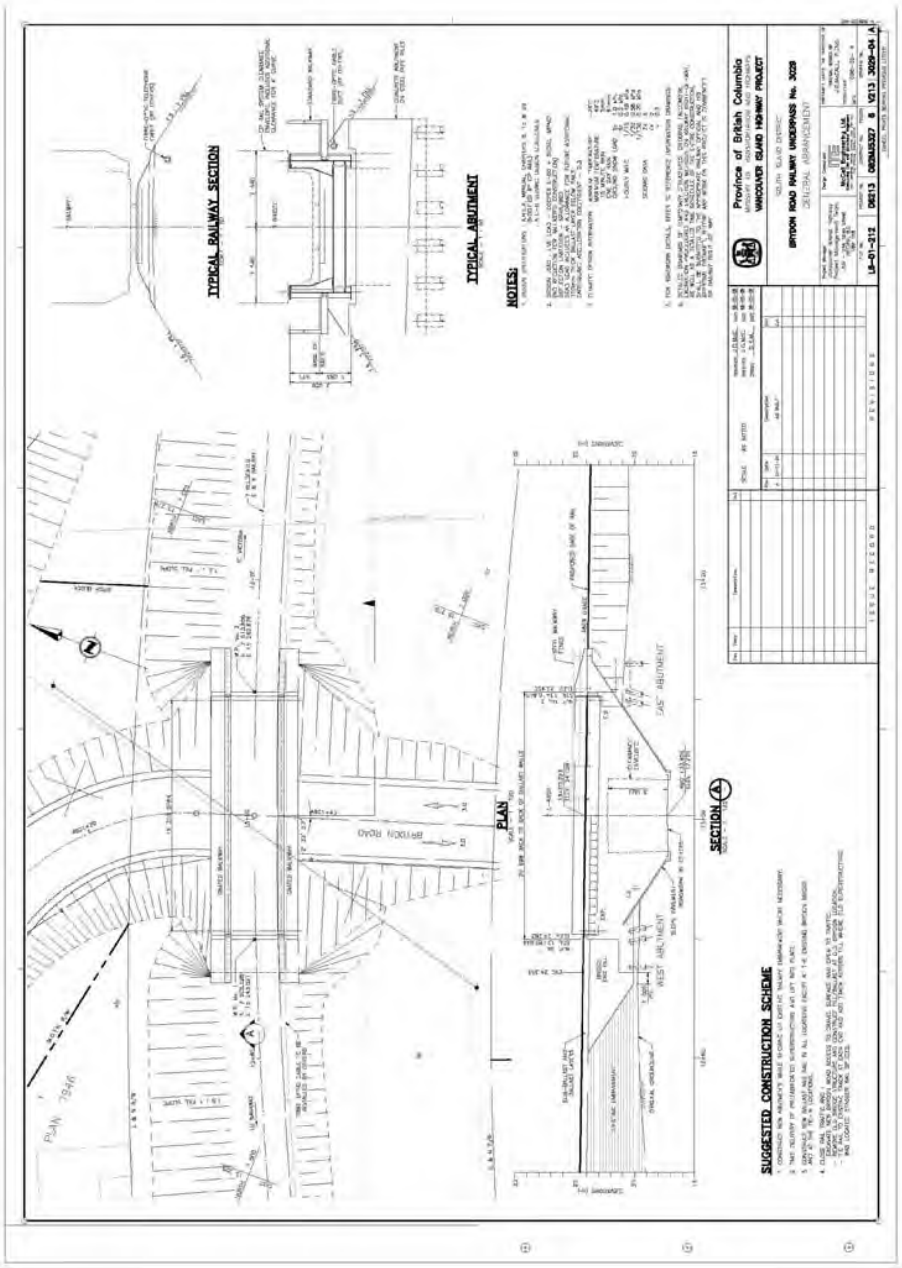
## 12.7 Mile 5.45 – Cost Summary Table: Years 2031 to 2041

**Bridge 5.45 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| X | | | | Replace all bridge ties (65' of ballast ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 5.45 – Victoria Subdivision – Brydon Road

**Bridge General Arrangement:**



# 13 Mile 5.80 – Six Mile Road

## 13.1 Mile 5.80 – Description

Bridge 5.80 is a single span ballasted deck bridge over Six Mile Road. The superstructure consists of a 104' steel thru plate girder with steel floor beams and a steel floor plate supporting the ballast. The bridge is on a slight curve.

The bridge was originally constructed in 1998.

**Bridge Design Load:** E-80
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 13.2 Mile 5.80 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed the steel members to be in good condition with no loss.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 13.3 Mile 5.80 – Load Rating

Detailed load rating was not performed because load effects of the Assessment Trains are less than the design load. This is summarized in the 286kip table below.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Thru Plate Girder (Steel) | E80* | E42 | - | Bending |
| Thru Plate Girder (Steel) | E80* | E47 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 13.4 Mile 5.80 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 13.5 Mile 5.80 – Cost Summary Table: Present to Year 2021

**Bridge 5.80 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

### 13.6 Mile 5.80 – Cost Summary Table: Years 2021 to 2031

**Bridge 5.80 – Projected Cost Summary to Operate Bridges Years 2021 to 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $3,000 |
| | | | | **Subtotal All Loadings** | **$6,000** |

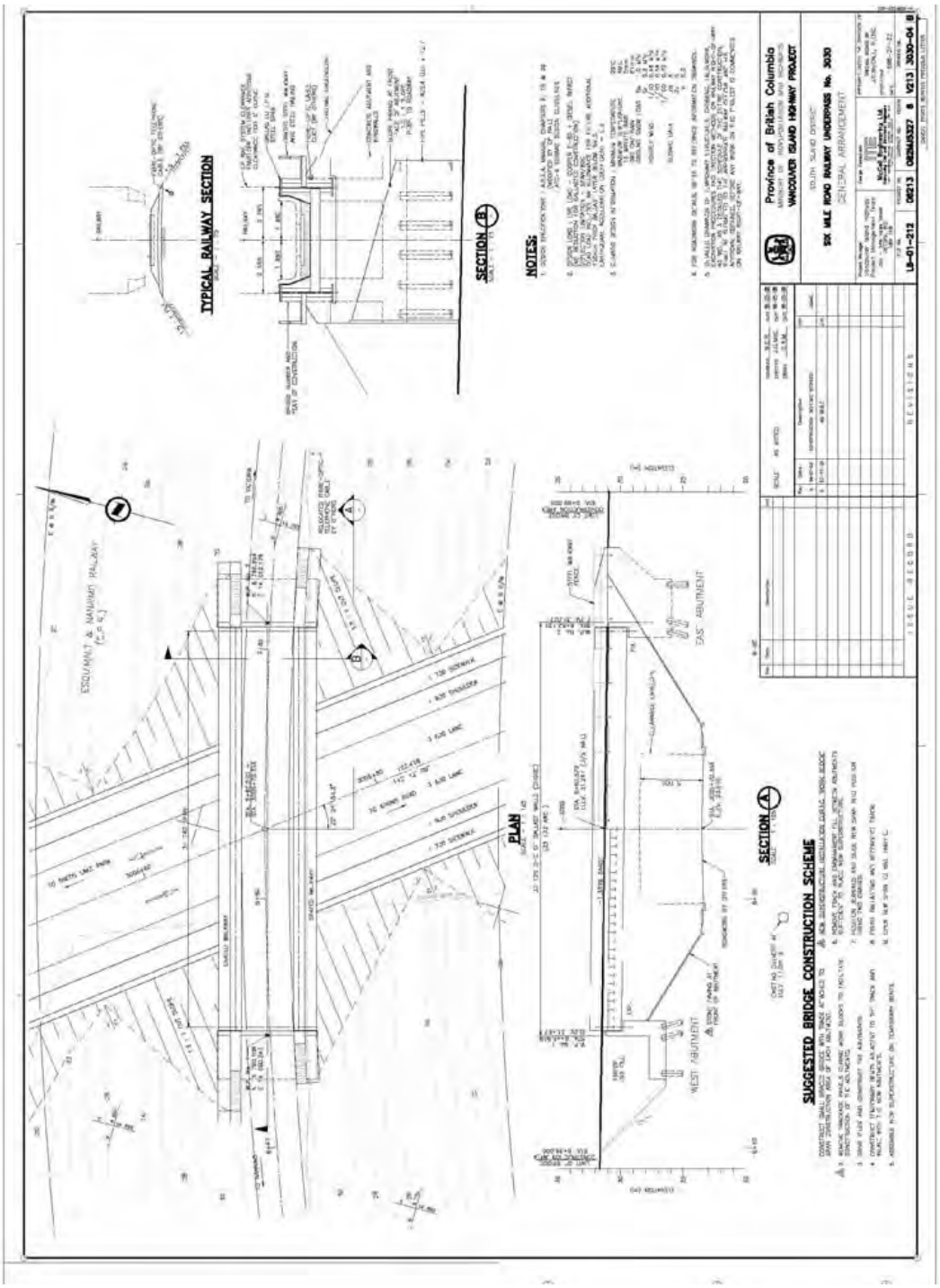
### 13.7 Mile 5.80 – Cost Summary Table: Years 2031 to 2041

**Bridge 5.80 – Projected Cost Summary to Operate Bridges Years 2031 to 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $3,000 |
| X | | | | Replace all bridge ties (100' of ballast ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 5.80 – Victoria Subdivision – Six Mile Road

**Bridge General Arrangement:**



# 14 Mile 14.00 – Niagara Canyon

## 14.1 Mile 14.00 – Description

Bridge 14.00 is a 525' cantilever pin-connected deck truss on a tangent alignment. The bridge was originally constructed on the CPR mainline to cross the Fraser River at Cisco, B.C. The bridge was disassembled, moved and re-constructed at Mile 14.0 in 1912.

The bridge is supported on two piers and two abutments all constructed of masonry block pointed with mortar and backfilled with rubble.

**Bridge Design Load:** E-50
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 14.2 Mile 14.00 – Inspection

Detailed bridge inspection, including non-destructive testing, was conducted in 2011. The inspection revealed the following immediate concerns:

- Poor bridge ties.
- Abutment bearing links worn and moving under load.
- Cracked turnbuckle in Span 3, Panel 3 of east truss.
- Loose diagonals in east truss (U25-L24 & U26-L25).
- Pin LU7-Right and LU28-Left did not have acceptable NDT testing results.
- Top 4” pin in northeast corner of north abutment has slackened by approximately 3/8” and the top hole in the end post/hanger plate at this location has elongated approximately 1/16”.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection also revealed the following:

- Cracks on top of pier caps near bearings.
- Loose transverse diagonal bracing members in all spans.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 14.3 Mile 14.00 Load Rating

In the 1940s, the Niagara Canyon bridge structure was upgraded to meet E50 loading demands on the railway. Included in the plans was a detailed rating sheet created in 1939 to assess the existing capacity of the structure along with a revised rating based on specified upgrades. The upgrades were made to reach an E50 load rating for all primary members.

In the current assessment, a 3D model was created to determine the forces in primary truss members under dead load combined with vertical moving train loads. This model was used as the foundation for an independent assessment of both member capacities and stresses based on current AREMA code standards. The existing plans (supplemented by the field inspections) were used to determine the most current section properties of the primary members. Whenever relevant data could not be confirmed, the section properties shown in the 1939 rating table were used (One example: all primary member material is rated as steel and not wrought iron; the plans provided suggest steel has replaced wrought iron in primary member components, however this cannot be confirmed for all members. The 1939 assessment appears to be based solely on steel material).

The assessment determined that multiple members rate below E50 despite the upgrades made in the 1940s. The following differences exist between the 1939 rating method and current AREMA code requirements:

- Impact Factors: The original rating assumed an impact factor of 50% (likely based on steam locomotives); current diesel impact factors for this truss at operational speeds are significantly lower.
- Allowable Stress – Tension: The current AREMA manual limits allowable stresses to 0.55Fy for axial tension members in normal rating. The allowable stresses used to evaluate tensile members in the 1939 rating varied from 20 – 24 ksi. An ASCE transaction paper written in 1917 by Othmar Ammann states that unit stresses for steel materials were often taken from 0.625-0.75Fy. It seems likely this logic was applied to the 1939 rating; a steel yield strength of 32 ksi would correlate to an allowable stress range from 20 – 24 ksi as was used. The current rating thus assumed a 32 ksi yield strength, but applied current code allowable stress requirements.
- Allowable Stress – Hanger w/ Riveted Ends: The current AREMA manual limits allowable stresses to 0.40Fy for floorbeam hangers with riveted end connections. This significantly reduces the rating capacity of riveted hanger members compared to the original analysis where 20 ksi was used as the allowable stress.
- Allowable Stress – Compression: The current AREMA manual limits allowable stresses to a maximum of 0.55Fy for non-slender compression members. The allowable stresses used to evaluate compression members in the 1939 rating used a 20 ksi maximum value, likely correlating to 0.625Fy.

For most members, the improved rating capacity from a reduction in impact tends to balance out the reduced rating capacity from more conservative allowable stresses. However, in the case of vertical hangers with riveted end connections in particular, the reduction in allowable stresses outweighs the impact reduction and action is required to improve the member capacity.

As noted in **Section 4.5** of this report, wind loads were excluded from the truss rating. As this bridge is a tall and slender structure that could potentially be sensitive to the combined effects of wind load and freight trains, we recommend that the freight trains are not operated on the bridge during the periods of significant wind.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Bridge Component | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode | |
|---|---|---|---|---|---|
| Top Chord (U4U5)* | E50 | E43 | - | Tension | Anchor Arm |
| Vertical Post (U0L0)* | E53 | E48 | - | Compression | |
| Bottom Chord (L6L7)* | E47 | E44 | - | Compression | |
| Diagonal (L2U3) | E48 | E49 | 2% | Tension | |
| Diagonal (L3U4) | E47 | E52 | 11% | Tension | |
| Diagonal (L0U1) | E46 | E43 | - | Tension | |
| Counter (U0L1)* | E64 | E44 | - | Tension | |
| Top Chord (U12U13)* | E48 | E45 | - | Tension | Cantilever Arm |
| Vertical Post (U12L12)* | E66 | E46 | - | Compression | |
| Hanger (U14M14) | E26 | E45 | 78% | Tension | |
| Hanger (M14L14) | E42 | E47 | 11% | Tension | |
| Bottom Chord (L7L8)* | E47 | E44 | - | Compression | |
| Diagonal (U11L12)* | E52 | E46 | - | Tension | |
| Top Chord (U16U17)* | E65 | E43 | - | Compression | Suspended Span |
| Vertical Post (U16L16)* | E71 | E48 | - | Compression | |
| Hanger (U15M15) | E28 | E53 | 85% | Tension | |
| Bottom Chord (L14L15)* | E52 | E47 | - | Tension | |
| Diagonal (U15L16)* | E52 | E48 | - | Tension | |
| Counter (U17L18)* | E62 | E35 | - | Tension | |
| Interior Floor beam | E53 | E54 | 2% | Bending | Floor System |
| Interior Floor beam | E60 | E54 | - | Shear | |
| End Floor beam | E63 | E63 | - | Bending | |
| End Floor beam | >E70 | E63 | - | Shear | |
| Pier Floor beam | E52 | E54 | 4% | Bending | |
| Pier Floor beam | >E70 | E54 | - | Shear | |
| Center Stringer | E66 | E60 | - | Bending | |
| Center Stringer | >E70 | E63 | - | Shear | |
| Outer Stringer | E59 | E60 | 1% | Bending | |
| Outer Stringer | >E70 | E63 | - | Shear | |

Note: *Results shown are only for the most critical member in component group. If multiple members in a group do not rate for 286kip cars at 30 mph, each inadequate member will be listed.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 10mph)**

| Bridge Component | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode | |
|---|---|---|---|---|---|
| Diagonal (L2U3) | E53 | E49 | - | Tension | Anchor Arm |
| Diagonal (L3U4) | E52 | E52 | - | Tension | |
| Hanger (U14M14) | E30 | E45 | 50% | Tension | Cantilever Arm |
| Hanger (M14L14) | E50 | E47 | - | Tension | |
| Hanger (U15M15) | E34 | E53 | 56% | Tension | Suspended Span |
| Interior Floor beam | E63 | E54 | - | Bending | Floor System |
| Interior Floor beam | E70 | E54 | - | Shear | |
| Pier Floor beam | E61 | E54 | - | Bending | |
| Pier Floor beam | >E70 | E54 | - | Shear | |
| Outer Stringer | E67 | E60 | - | Bending | |
| Outer Stringer | >E70 | E63 | - | Shear | |

Note: Only members that did not rate for 286kip cars at 30mph shown in table.

**Ratings (2 - GP-9 locomotives and 263kip cars @ 30mph)**

| Bridge Component | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode | |
|---|---|---|---|---|---|
| Top Chord (U4U5)* | E50 | E40 | - | Tension | Anchor Arm |
| Vertical Post (U0L0)* | E53 | E44 | - | Compression | |
| Bottom Chord (L6L7)* | E47 | E40 | - | Compression | |
| Diagonal (L2U3) | E48 | E45 | - | Tension | |
| Diagonal (L3U4) | E47 | E48 | 2% | Tension | |
| Counter (U0L1)* | E64 | E41 | - | Tension | |
| Top Chord (U12U13)* | E48 | E41 | - | Tension | Cantilever Arm |
| Vertical Post (U12L12)* | E66 | E42 | - | Compression | |
| Hanger (U14M14) | E26 | E42 | 62% | Tension | |
| Hanger (M14L14) | E42 | E43 | 2% | Tension | |
| Bottom Chord (L7L8)* | E47 | E40 | - | Compression | |
| Diagonal (U11L12)* | E52 | E42 | - | Tension | |
| Top Chord (U16U17)* | E65 | E39 | - | Compression | Suspended Span |
| Vertical Post (U16L16)* | >E70 | E45 | - | Compression | |
| Hanger (U15M15) | E28 | E49 | 75% | Tension | |
| Bottom Chord (L14L15)* | E52 | E43 | - | Tension | |
| Diagonal (U15L16)* | E52 | E45 | - | Tension | |
| Counter (U17L18)* | E62 | E32 | - | Tension | |
| Interior Floor beam | E53 | E50 | - | Bending | Floor System |
| Interior Floor beam | E60 | E50 | - | Shear | |
| End Floor beam | E63 | E58 | - | Bending | |
| End Floor beam | >E80 | E58 | - | Shear | |
| Pier Floor beam | E52 | E50 | - | Bending | |
| Pier Floor beam | >E70 | E50 | - | Shear | |
| Center Stringer | E66 | E55 | - | Bending | |
| Center Stringer | >E70 | E58 | - | Shear | |
| Outer Stringer | E59 | E55 | - | Bending | |
| Outer Stringer | >E70 | E58 | - | Shear | |

Note: *Results shown are only for the most critical member in component group. If multiple members in a group do not rate for 263kip cars at 30 mph, each inadequate member will be listed.

**Ratings (2 - GP-9 locomotives and 263kip cars @ 10mph)**

| Bridge Component | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode | |
|---|---|---|---|---|---|
| Diagonal (L3U4) | E52 | E48 | - | Tension | Anchor Arm |
| Hanger (U14M14) | E30 | E42 | 40% | Tension | Cantilever Arm |
| Hanger (M14L14) | E50 | E43 | - | Tension | |
| Hanger (U15M15) | E34 | E49 | 44% | Tension | Suspended Span |

Note: Only members that did not rate for 286kip cars at 30mph shown in table.

**Ratings (3 – RDC-1 Passenger Vehicles @ 30mph)**

| Bridge Component | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode | |
|---|---|---|---|---|---|
| Top Chord (U4U5)* | E50 | E13 | - | Tension | Anchor Arm |
| Vertical Post (U0L0)* | E53 | E6 | - | Compression | |
| Bottom Chord (L6L7)* | E47 | E13 | - | Compression | |
| Diagonal (L2U3) | E48 | E14 | - | Tension | |
| Counter (U0L1)* | E64 | E13 | - | Tension | |
| Top Chord (U12U13)* | E48 | E14 | - | Tension | Cantilever Arm |
| Vertical Post (U12L12)* | E66 | E14 | - | Compression | |
| Hanger (U14M14) | E26 | E14 | - | Tension | |
| Bottom Chord (L7L8)* | E47 | E13 | - | Compression | |
| Diagonal (U11L12)* | E52 | E14 | - | Tension | |
| Top Chord (U16U17)* | E65 | E14 | - | Compression | Suspended Span |
| Vertical Post (U16L16)* | >E70 | E16 | - | Compression | |
| Hanger (U15M15) | E28 | E18 | - | Tension | |
| Bottom Chord (L14L15)* | E52 | E15 | - | Tension | |
| Diagonal (U15L16)* | E52 | E16 | - | Tension | |
| Counter (U17L18)* | E62 | E15 | - | Tension | |
| Interior Floor beam | E53 | E17 | - | Bending | Floor System |
| Interior Floor beam | E60 | E17 | - | Shear | |
| End Floor beam | E63 | E17 | - | Bending | |
| End Floor beam | >E80 | E17 | - | Shear | |
| Pier Floor beam | E52 | E17 | - | Bending | |
| Pier Floor beam | >E70 | E17 | - | Shear | |
| Center Stringer | E66 | E20 | - | Bending | |
| Center Stringer | >E70 | E23 | - | Shear | |
| Outer Stringer | E59 | E20 | - | Bending | |
| Outer Stringer | >E70 | E23 | - | Shear | |

Note: *Results shown are only for the most critical member in component group.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 10mph [4] | Hangers (see note 2) |
| 2 - GP-9 locomotives and 263kip cars | 10mph [4] | Hangers (see note 2) |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A (see note 3) |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be completed.
2. Hanger capacity at U14M14 and U15M15 insufficient to support 286kip as well as 263kip car; reinforcing or replacement of hangers is required. Note that the areas used in calculating the stresses for U14M14 (15 $in^2$) and U15M15 (5 $in^2$) were taken from the original rating sheet and could not be confirmed from the plans. If the controlling area in these members is larger, overstress will decrease.
3. Observation of the bridge under a train load was conducted for low train speed only. We recommend the observation of bridge under a passenger train traveling at 30mph be conducted prior to re-establishing passenger traffic.
4. Should not be operated under significant wind load.

### 14.4 Mile 14.00 Optional Bridge Replacement

The bridge was fabricated in 1883; its first erection was at Fraser River. It was erected in its present location in 1912 with subsequent repairs made over the years. It is a 527' long cantilever truss bridge consisting of wrought iron and steel members. In our opinion, the estimated service life remaining for heavy loads and light loads may be as low as 5 years and 10 years, respectively. However, we cannot calculate the probability of truss failure in the next 5 to 10 years. Intensifying the railway traffic over the bridge may shorten the lifespan of the structure.

The estimated replacement cost for the bridge could be in the order of $14,250,000 for superstructure and removal/construction of substructure elements.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included in the tables below. Costs have been included to create and execute a detailed inspection, rating and field monitoring program at milestone years. If the results of this program prove unfavourable at any point in the timeline, it may become necessary to replace the structure in an expedited manner. Whether span rehabilitation is feasible and cost-effective versus replacement should be evaluated in greater detail in conjunction with a higher level of bridge assessment.

## 14.5 Mile 14.00 – Cost Summary Tables: Present to Year 2021

**Bridge 14.00 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $10,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Create field monitoring program; monitor deck elevation quarterly by taking elevations on top of steel stringers ($4,000/year for first 5 years). | $20,000 |
| X | | | | Perform detailed bridge inspection in 2016. | $50,000 |
| X | | | | Advance field monitoring program in 2016 as required per results of detailed bridge inspection and initial field monitoring program. | $125,000 |
| | X | | | Further investigate unacceptable NDT test results. | $10,000 |
| | X | | | Replace all bridge ties (8" x 10" ties, cost excluded). | $0 |
| | X | | | Replace abutment bearing links with a detail that does not allow movement under loading. | $100,000 |
| | X | | | Re-tighten top 4” connection pin at northeast corner of north abutment. | $2,500 |
| | X | | | Replace cracked turnbuckle in span 3, panel 3 east exterior truss. | $1,000 |
| | X | | | Replace or tighten loose diagonals of east truss (U25-L24 & U26-L25). | $15,000 |
| | | X | | Repair cracks found on top of pier caps near bearings. | $5,000 |
| | | X | | Tighten transverse diagonal bracing members in all spans. | $55,000 |
| | | | | **Passenger Subtotal** | **$393,500** |

**Bridge 14.00 – Projected Cost Summary to Operate Bridges until Year 2021 – 263kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $10,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Create field monitoring program; monitor deck elevation quarterly by taking elevations on top of steel stringers ($4,000/year for first 5 years). | $20,000 |
| X | | | | Perform detailed bridge inspection in 2016. | $50,000 |
| X | | | | Advance field monitoring program in 2016 as required per results of detailed bridge inspection and initial field monitoring program. | $125,000 |
| | X | | | Further investigate unacceptable NDT test results. | $10,000 |
| | X | | | Replace all bridge ties (8" x 10" ties, cost excluded). | $0 |
| | X | | | Replace abutment bearing links with a detail that does not allow movement under loading. | $100,000 |
| | X | | | Re-tighten top 4” connection pin at northeast corner of north abutment. | $2,500 |
| | X | | | Replace cracked turnbuckle in span 3, panel 3 east exterior truss. | $1,000 |
| | X | | | Replace or tighten loose diagonals of east truss (U25-L24 & U26-L25). | $15,000 |
| | | | X | Reinforce or replace the existing hangers at U14M14 / U21M21 and U15M15 / U20M20. | $200,000 |
| | | X | | Repair cracks found on top of pier caps near bearings. | $5,000 |
| | | X | | Tighten transverse diagonal bracing members in all spans. | $55,000 |
| | | | | **263kip Subtotal** | **$593,500** |

## Bridge 14.00 – Projected Cost Summary to Operate Bridges until Year 2021 – 286kip Loading

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $10,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Create field monitoring program; monitor deck elevation quarterly by taking elevations on top of steel stringers ($4,000/year for first 5 years). | $20,000 |
| X | | | | Perform detailed bridge inspection in 2016. | $50,000 |
| X | | | | Advance field monitoring program in 2016 as required per results of detailed bridge inspection and initial field monitoring program. | $125,000 |
| | X | | | Further investigate unacceptable NDT test results. | $10,000 |
| | X | | | Replace all bridge ties (8" x 10" ties, cost excluded). | $0 |
| | X | | | Replace abutment bearing links with a detail that does not allow movement under loading. | $100,000 |
| | X | | | Re-tighten top 4” connection pin at northeast corner of north abutment. | $2,500 |
| | X | | | Replace cracked turnbuckle in span 3, panel 3 east exterior truss. | $1,000 |
| | X | | | Replace or tighten loose diagonals of east truss (U25-L24 & U26-L25). | $15,000 |
| | | | X | Reinforce or replace the existing hangers at U14M14 / U21M21 and U15M15 / U20M20. | $200,000 |
| | | X | | Repair cracks found on top of pier caps near bearings. | $5,000 |
| | | X | | Tighten transverse diagonal bracing members in all spans. | $55,000 |
| | | | | **286kip Subtotal** | **$593,500** |

### 14.6 Mile 14.00 – Cost Summary Table: Years 2021 to 2031

**Bridge 14.00 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $10,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection/rating in 2021 and 2026. | $100,000 |
| X | | | | Continue field monitoring program as required. | $150,000 |
| | | | | **Subtotal All Loadings** | **$260,000** |

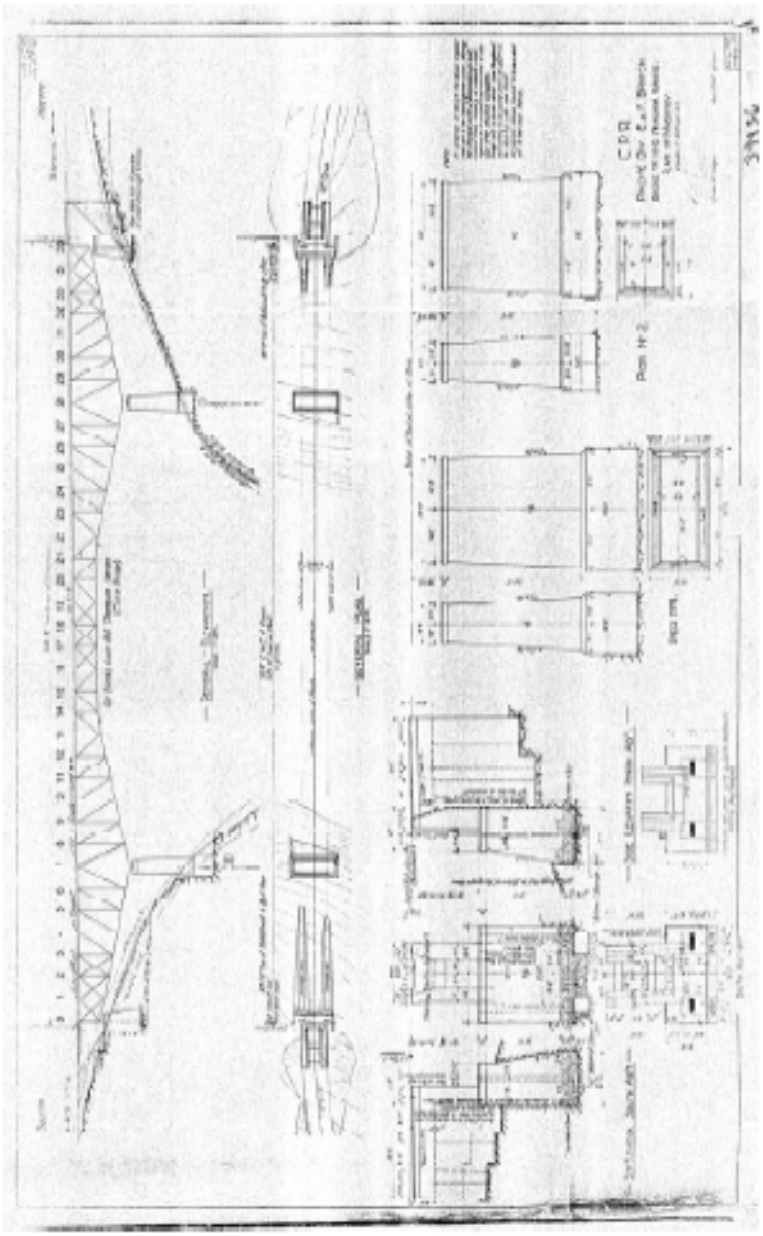
### 14.7 Mile 14.00 – Cost Summary Table: Years 2031 to 2041

**Bridge 14.00 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $10,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection/rating in 2031 and 2036. | $100,000 |
| X | | | | Continue field monitoring program as required. | $150,000 |
| | | | | **Subtotal All Loadings** | **$260,000** |

# 14.00 – Victoria Subdivision – Niagra Canyon

## Bridge General Arrangement:



# 15 Mile 14.90 – Arbutus Canyon

## 15.1 Mile 14.90 – Description

Bridge 14.90 is a six span open deck bridge over Arbutus Canyon. The superstructure consists of steel deck plate girders supporting timber structural ties. The bridge is on a tangent-spiral-curve alignment.

The bridge is supported on concrete abutments and steel tower piers (3). Two of the steel towers have four legs; the other steel tower has two legs.

**Bridge Design Load:** E-50 (per SVI inventory, could not be confirmed)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

## 15.2 Mile 14.90 – Inspection

Detailed bridge inspection was conducted in 2011. The inspection revealed the following immediate concerns:

- West girder bearing at south abutment offset with bent anchor bolt.
- Broken anchor bolts at north abutment.
- 3 rotten ties next to a fractured tie near north end of structure.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection also revealed the following:

- Steel at base of Tower 2 heavily corroded.
- Bridge ties in fair condition, aged.
- Corroded girder stiffeners.
- Corroded bottom lateral gusset plates in Span 1.
- Corroded top lateral gusset plates in Span 1.
- Bottom angles in top chord horizontal bracing have holes in Span 1.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 15.3 Mile 14.90 – Load Rating

Detailed load rating is provided for the 50’ spans because load effects of the Assessment Trains are greater than the effects of the design load. Detailed load ratings are not provided for the 75’ and 106’ spans because load effects of the Assessment Trains are less than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component’s load rating is shown to be adequate for a heavier assessment train.

### Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 106’ Deck Plate Girder | E50* | E42 | - | Bending |
| 106’ Deck Plate Girder | E50* | E47 | - | Shear |
| 75’ Deck Plate Girder | E50* | E45 | - | Bending |
| 75’ Deck Plate Girder | E50* | E49 | - | Shear |
| 50’ Deck Plate Girder (Tangent) | >E70 | E54 | - | Bending |
| 50’ Deck Plate Girder (Tangent) | >E70 | E53 | - | Shear |
| 50’ Deck Plate Girder (Curve) | E67 | E54 | - | Bending |
| 50’ Deck Plate Girder (Curve) | >E70 | E53 | - | Shear |
| Timber Structural Tie (Dap >= 1.5”) | >E80 | E72 | - | Bending |
| Timber Structural Tie (Dap >= 1.5”) | E69 | E72 | 4% ** | Horizontal Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Additional analysis and refined evaluation may support positive evaluation for ties in good condition.

### Ratings (2 - GP-9 locomotives and 263kip cars @ 30mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 106’ Deck Plate Girder | Rating not required, see 286kip car results | | | |
| 106’ Deck Plate Girder | Rating not required, see 286kip car results | | | |
| 75’ Deck Plate Girder | Rating not required, see 286kip car results | | | |
| 75’ Deck Plate Girder | Rating not required, see 286kip car results | | | |
| 50’ Deck Plate Girder (Tangent) | Rating not required, see 286kip car results | | | |
| 50’ Deck Plate Girder (Tangent) | Rating not required, see 286kip car results | | | |
| 50’ Deck Plate Girder (Curve) | Rating not required, see 286kip car results | | | |
| 50’ Deck Plate Girder (Curve) | Rating not required, see 286kip car results | | | |
| Timber Structural Tie (1.5” dap) | >E80 | E66 | - | Bending |
| Timber Structural Tie (1.5” dap) | E69 | E66 | - | Horizontal Shear |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph [3] | Structural ties (note 2) |
| 2 - GP-9 locomotives and 263kip cars | 30mph [3] | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be completed.
2. Structural ties (10" wide x 13.5" deep) with dap greater than or equal to 1.5" have insufficient capacity for 286kip cars as analyzed.
3. Should not be operated under significant wind load.

### 15.4 Mile 14.90 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in the next 30 years to maintain railway traffic. An estimated replacement cost for this bridge is $7,900,000, including substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

## 15.5 Mile 14.90 – Cost Summary Tables: Present to Year 2021

**Bridge 14.90 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger/263kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $6,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Reset bearing at south abutment (west girder) with the bent anchor bolt. | $1,000 |
| | X | | | Replace broken anchor bolts at north abutment. | $1,000 |
| | X | | | Replace three ties rotting next to a broken tie near the north end. | $3,000 |
| X | | | | Close proximity inspection of bases of Towers 1 & 3 (inaccessible in 2011). | $1,000 |
| X | | | | Replace all bridge ties (10" x 14" ties, cost excluded.) | $0 |
| | | X | | Clean and paint steel at base of Tower 2. | $25,000 |
| | | X | | Replace or repair corroded girder stiffeners. | $6,000 |
| | | X | | Replace all corroded bottom lateral gusset plates in Span 1. | $60,000 |
| | | X | | Replace all remaining corroded top lateral gusset plates in Span 1. | $60,000 |
| | | X | | Replace bottom angles in top chord horizontal bracing that have holes in Span 1. | $10,000 |
| | | | | **Passenger / 263kip Subtotal** | **$173,000** |

## Bridge 14.90 – Projected Cost Summary to Operate Bridges until Year 2021 – 286kip Loading

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $6,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Reset bearing at south abutment (west girder) with the bent anchor bolt. | $1,000 |
| | X | | | Replace broken anchor bolts at north abutment. | $1,000 |
| | X | | | Replace three ties rotting next to a broken tie near the north end. | $3,000 |
| | | | X | Replace structural ties (10" x 14") with dap at girder support equal to or exceeding 1.5". Note: a more refined inspection and analysis may reveal the ties to have adequate capacity if in good condition. Due to their general fair condition, replacement is advised. | $50,000 |
| X | | | | Close proximity inspection of bases of Towers 1 & 3 (inaccessible in 2011). | $1,000 |
| X | | | | Replace all bridge ties (10" x 14" ties, cost excluded.) | $0 |
| | | X | | Clean and paint steel at base of Tower 2. | $25,000 |
| | | X | | Replace or repair corroded girder stiffeners. | $6,000 |
| | | X | | Replace all corroded bottom lateral gusset plates in Span 1. | $60,000 |
| | | X | | Replace all remaining corroded top lateral gusset plates in Span 1. | $60,000 |
| | | X | | Replace bottom angles in top chord horizontal bracing that have holes in Span 1. | $10,000 |
| | | | | **286kip Subtotal** | **$223,000** |

### 15.6 Mile 14.90 – Cost Summary Table: Years 2021 to 2031

**Bridge 14.90 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $6,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $10,000 |
| | | | | **Subtotal All Loadings** | **$16,000** |

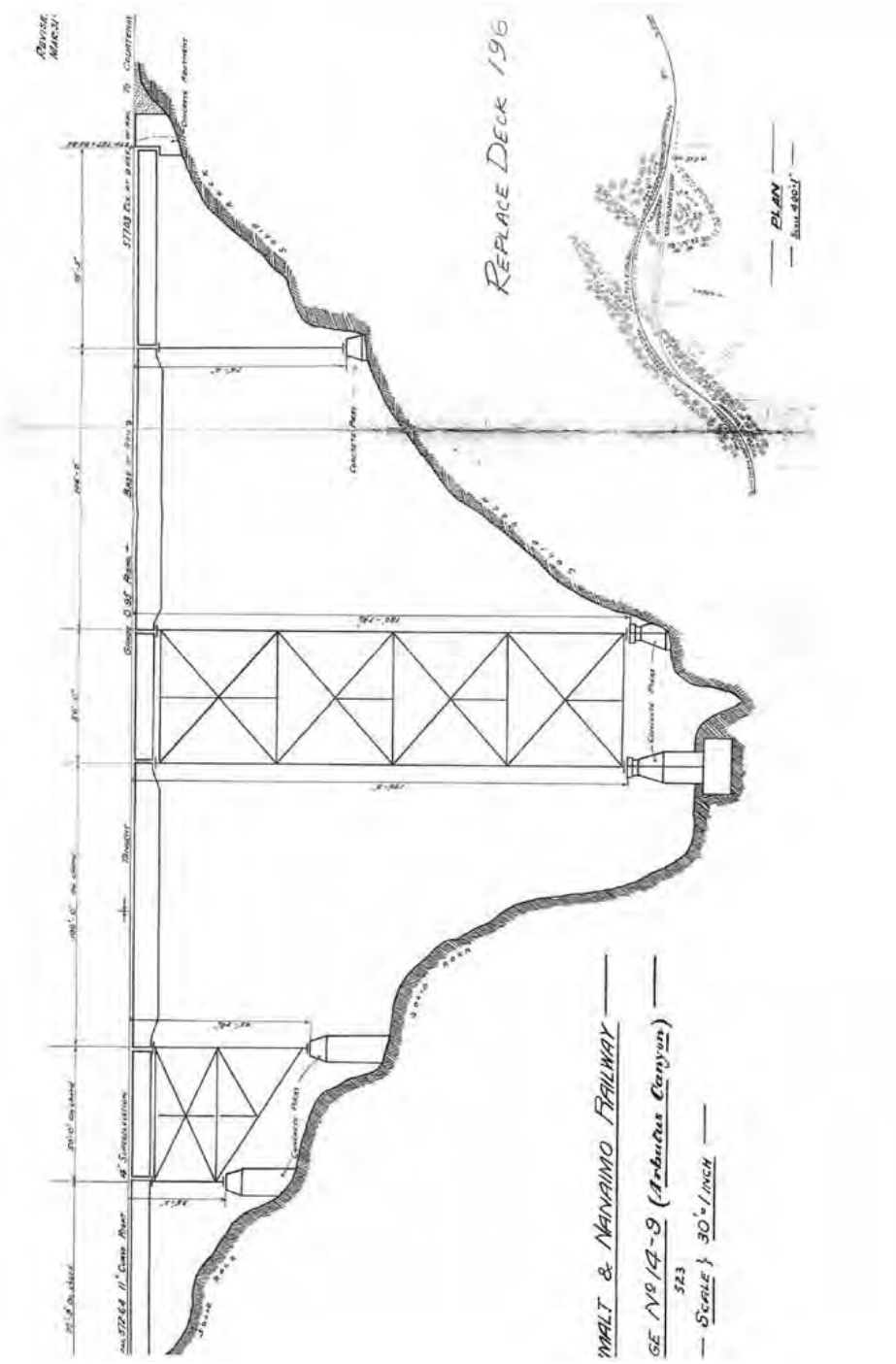
### 15.7 Mile 14.90 – Cost Summary Table: Years 2031 to 2041

**Bridge 14.90 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $6,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $10,000 |
| | | | | **Subtotal All Loadings** | **$16,000** |

# 14.90 – Victoria Subdivision – Arbutus Canyon

## Bridge General Arrangement:



# 16 Mile 18.20 – Unnamed Waterway

## 16.1 Mile 18.20 – Description

Bridge 18.20 is a single span open deck bridge over an unnamed waterway. The superstructure consists of timber stringers sitting on timber sills. The bridge is on a tangent alignment.

The bridge was originally constructed in 1935.

**Bridge Design Load:** E-60 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 16.2 Mile 18.20 – Inspection

Detailed bridge inspection was conducted in 2011. The inspection did not reveal any immediate concerns.

The timber stringers were generally in good condition, with no significant structural damage.

Inspection also revealed the following:

- Rotting north abutment end bent cap.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 16.3 Mile 18.20 – Load Rating

Detailed load rating is provided for the timber span because the design load could not be confirmed and load effects of the Assessment Trains may be greater than the effects of the design load. In accordance with the design criteria, we have evaluated the stringers for flexure, horizontal shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber Stringers | >E80 | E62 | - | Bending |
| Timber Stringers | >E80 | E65 | - | Horizontal Shear |
| Timber Stringers | >E80 | E63 | - | End Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 16.4 Mile 18.20 – Optional Bridge Replacement

Based on the age of the structure and limited knowledge as to when the stringers were last replaced, we estimate the bridge will likely be repaired, partially or completely replaced with a new structure in the next 15 years. The need to replace the structure shall be re-evaluated in accordance with the results of future inspections.

Based on the experience with similar structures, we estimate that the replacement cost for the bridge could be in the order of $90,000.

### 16.5 Mile 18.20 – Cost Summary Table: Present to Year 2021

**Bridge 18.20 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $1,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Replace rotting north abutment end bent cap. | $4,000 |
| | | | | **Subtotal All Loadings** | **$5,000** |

### 16.6 Mile 18.20 – Cost Summary Table: Years 2021 to 2031

**Bridge 18.20 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $1,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $1,000 |
| | | X | | Repair / Partially Replace bridge (1/3 of total replacement cost) | $30,000 |
| | | | | **Subtotal All Loadings** | **$32,000** |

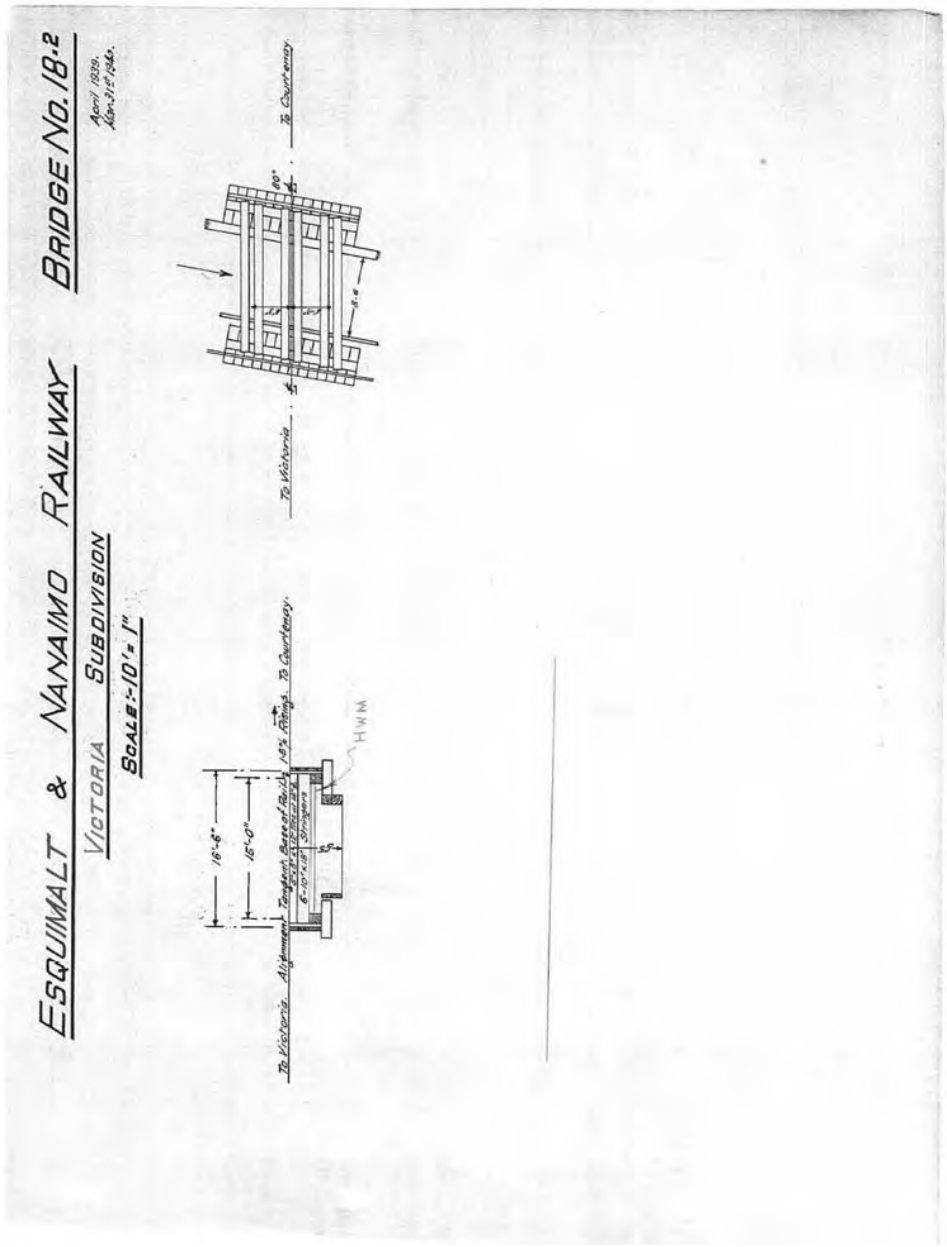
### 16.7 Mile 18.20 – Cost Summary Table: Years 2031 to 2041

**Bridge 18.20 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $1,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $1,000 |
| | | X | | Repair / Partially Replace bridge (1/3 of total replacement cost) | $30,000 |
| | | | | **Subtotal All Loadings** | **$32,000** |

# 18.20 – Victoria Subdivision – Unnamed Waterway

**Bridge General Arrangement:**



# 17 Mile 26.80 – Shawnigan Lake Road


## 17.1 Mile 26.80 - Description

Bridge 26.80 is a single span open deck bridge over Shawnigan Lake Road. The superstructure consists of 30'-6" steel rolled beams with timber structural ties sitting on the bottom flange of the beams. The bridge has a tangent alignment.

The bridge was originally constructed in 1906. Repairs were made to the abutments in 1951 and the steel superstructure appears to have been replaced around 2005.

**Bridge Design Load:** E-80 (assumed from 2005 construction)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 17.2 Mile 26.80 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed no structurally significant section loss in the steel beams.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 17.3 Mile 26.80 – Load Rating

Detailed load rating is not provided because load effects of the Assessment Trains are less than the effects of the design load.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel WF Beam | E80* | E56 | - | Bending |
| Steel WF Beam | E80* | E61 | - | Shear |
| Timber Structural Tie | >E80 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 17.4 Mile 26.80 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 17.5 Mile 26.80 – Cost Summary Table: Present to year 2021

**Bridge 26.80 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Monitor impact damage to bottom lateral cross brace. | $500 |
| | | | | **Subtotal All Loadings** | **$2,500** |

### 17.6 Mile 26.80 – Cost Summary Tables: Years 2021 to 2031

**Bridge 26.80 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

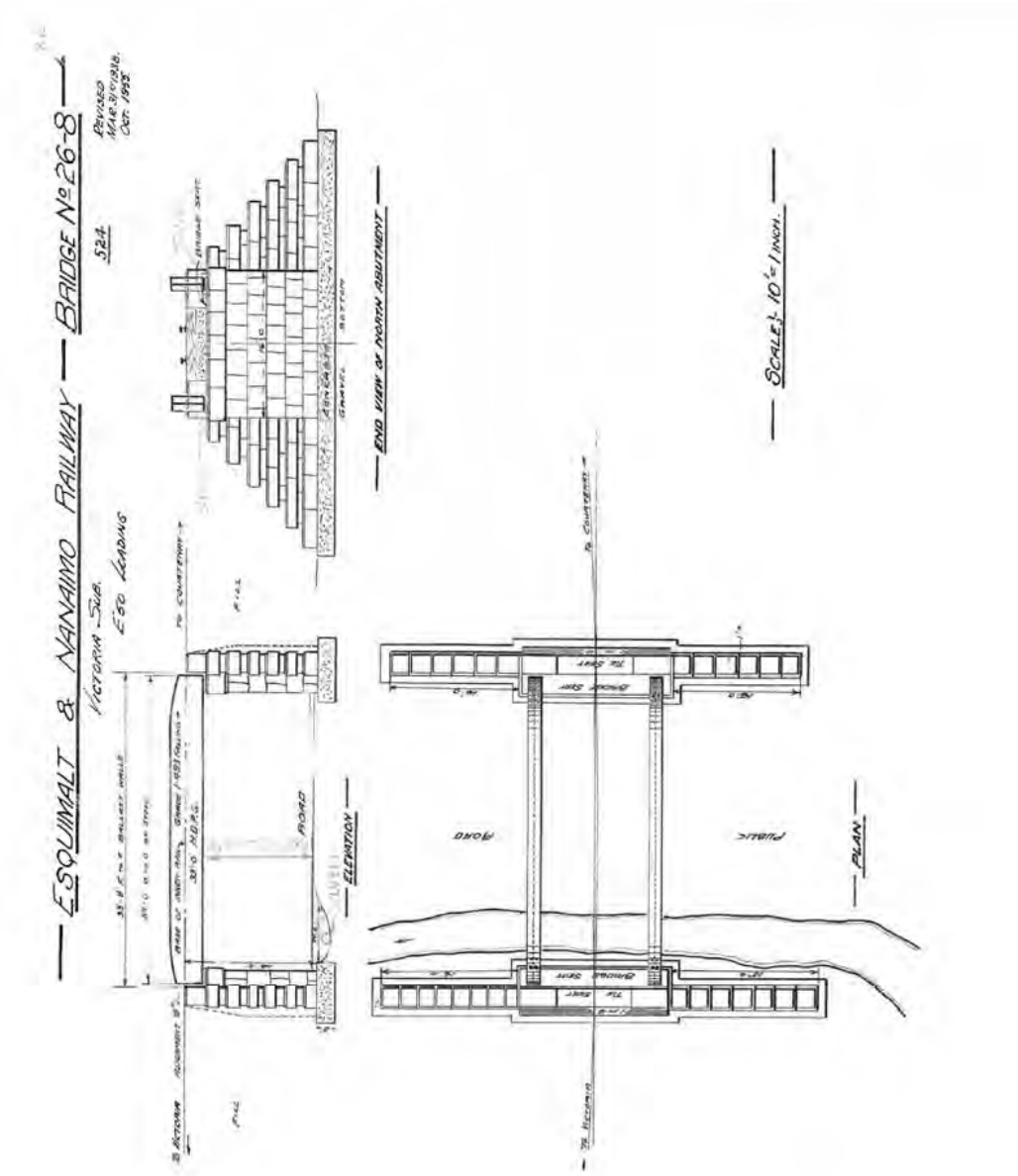
## 17.7 Mile 26.80 – Cost Summary Table: Years 2031 to 2041

**Bridge 26.80 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| X | | | | Replace all bridge ties (10" x 16" ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 26.80 – Victoria Subdivision – Shawnigan Lake Rd

**Bridge General Arrangement:**



# 18 Mile 28.20 – Shawnigan Lake Tributary


## 18.1 Mile 28.20 – Description

Bridge 28.20 is a single span open deck bridge over a tributary of Shawnigan Lake. The superstructure consists of a 42 ft steel half deck plate girder with timber structural ties. The bridge is on a tangent alignment.

The bridge was originally constructed in 1907. Some steel repairs were made in 1994 and the alignment was made tangent in 1967.

**Bridge Design Load:** E-50 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 20 mph
**Desired Speed:** 20 mph

### 18.2 Mile 28.20 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed some minor corrosion in the steel girders, but no structurally significant damage.

Inspection also revealed the following:

- Erosion at the base of abutments.
- Open joints between masonry stones in abutments.
- Swinging approach ties at abutments.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 18.3 Mile 28.20 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 20mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | >E70 | E56 | - | Bending |
| Deck Plate Girder (Steel) | E64 | E56 | - | Shear |
| Timber Structural Tie | E72 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip | 20mph | N / A |
| 2 - GP-9 locomotives and 263kip | 20mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 20mph | N / A |

### 18.4 Mile 28.20 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in 15 to 20 years to maintain railway traffic. An estimated replacement cost for this bridge is $625,000, including substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

### 18.5 Mile 28.20 – Cost Summary Table: Present to Year 2021

**Bridge 28.20 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Repair erosion at base of abutments. | $15,000 |
| | | X | | Tuck points open joints between masonry stones in abutments. | $2,000 |
| | | X | | Replace swinging approach ties at abutments (cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$19,000** |

### 18.6 Mile 28.20 – Cost Summary Table: Years 2021 to 2031

**Bridge 28.20 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

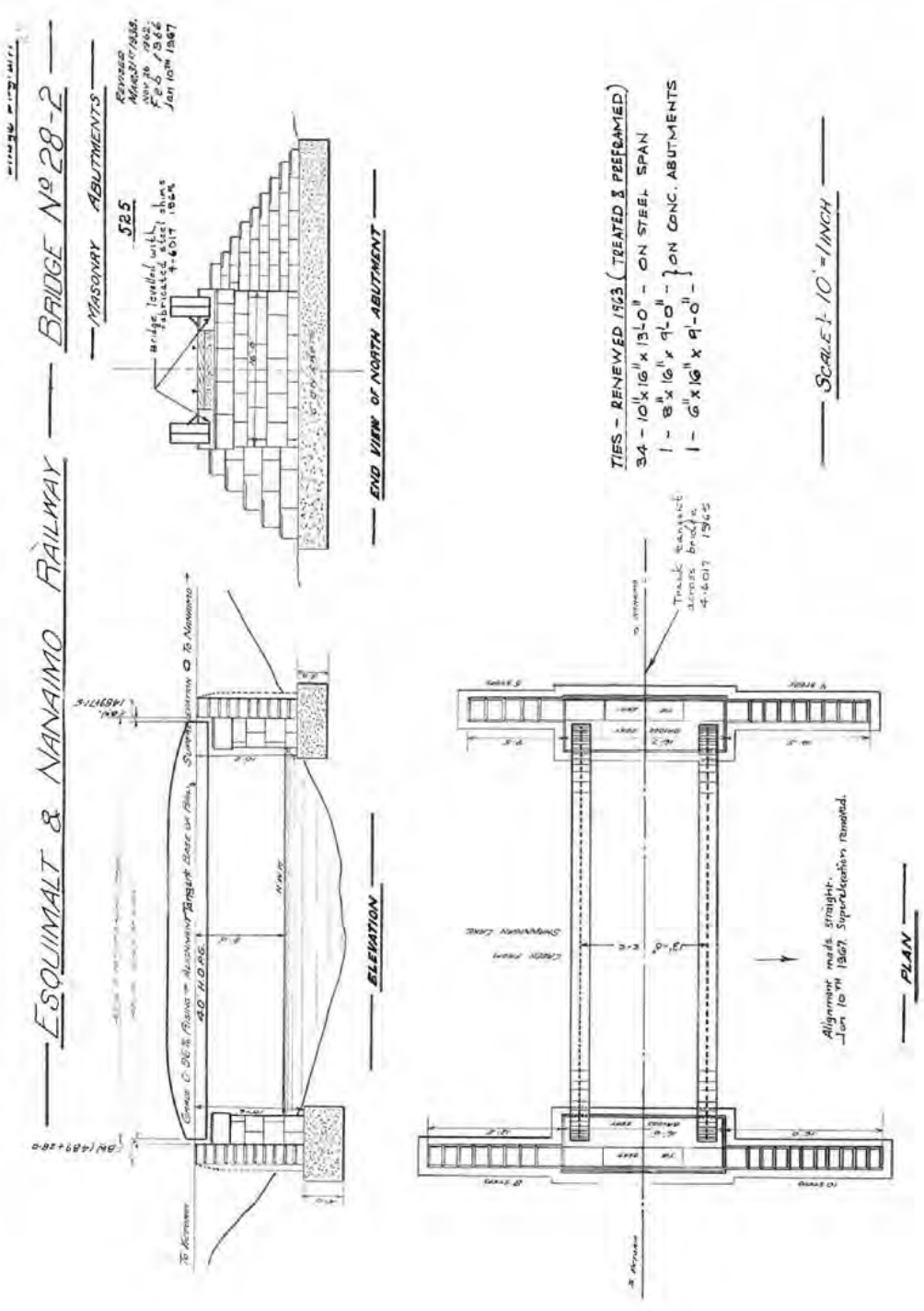
### 18.7 Mile 28.20 – Cost Summary Tables: Years 2031 to 2041

**Bridge 28.20 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 28.20 – Victoria Subdivision – Shawnigan Lk. Trib.

**Bridge General Arrangement:**



# 19 Mile 28.40 – Shawnigan Lake Tributary

## 19.1 Mile 28.40 – Description

Bridge 28.40 is a single span open deck bridge over a tributary of Shawnigan Lake. The superstructure consists of a 42 ft steel half deck plate girder with timber structural ties. The bridge is on a tangent alignment.

The bridge was originally constructed in 1907.

**Bridge Design Load:** E-50 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 19.2 Mile 28.40 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed the following immediate concerns:

- Poor bridge ties.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection revealed some minor corrosion in the steel girders, but no structurally significant damage.

Inspection also revealed the following:

- Erosion at the base of abutments.
- Cracks in north abutment.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 19.3 Mile 28.40 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E67 | E56 | - | Bending |
| Deck Plate Girder (Steel) | E52 | E56 | 8% | Shear |
| Timber Structural Tie | E72 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 20mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | >E70 | E56 | - | Bending |
| Deck Plate Girder (Steel) | E56 | E56 | - | Shear |
| Timber Structural Tie | E72 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

**Ratings (2 - GP-9 locomotives and 263kip cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E-67 | E-51 | - | Bending |
| Deck Plate Girder (Steel) | E-52 | E-52 | - | Shear |
| Timber Structural Tie | E-72 | E-72 | - | Bending |
| Timber Structural Tie | E-103 | E-72 | - | Horizontal Shear |
| Timber Structural Tie | E-96 | E-72 | - | End Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 20mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be completed.

### 19.4 Mile 28.40 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in 15 to 20 years to maintain railway traffic. An estimated replacement cost for this bridge is $750,000, including substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

### 19.5 Mile 28.40 – Cost Summary Table: Present to Year 2021

**Bridge 28.40 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Replace all bridge ties (10" x 16" ties, cost excluded). | $0 |
| | | X | | Repair erosion at base of abutments. | $15,000 |
| | | X | | Repair cracks found in north abutment. | $1,000 |
| | | | | **Subtotal All Loadings** | **$18,000** |

### 19.6 Mile 28.40 – Cost Summary Tables: Years 2021 to 2031

**Bridge 28.40 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

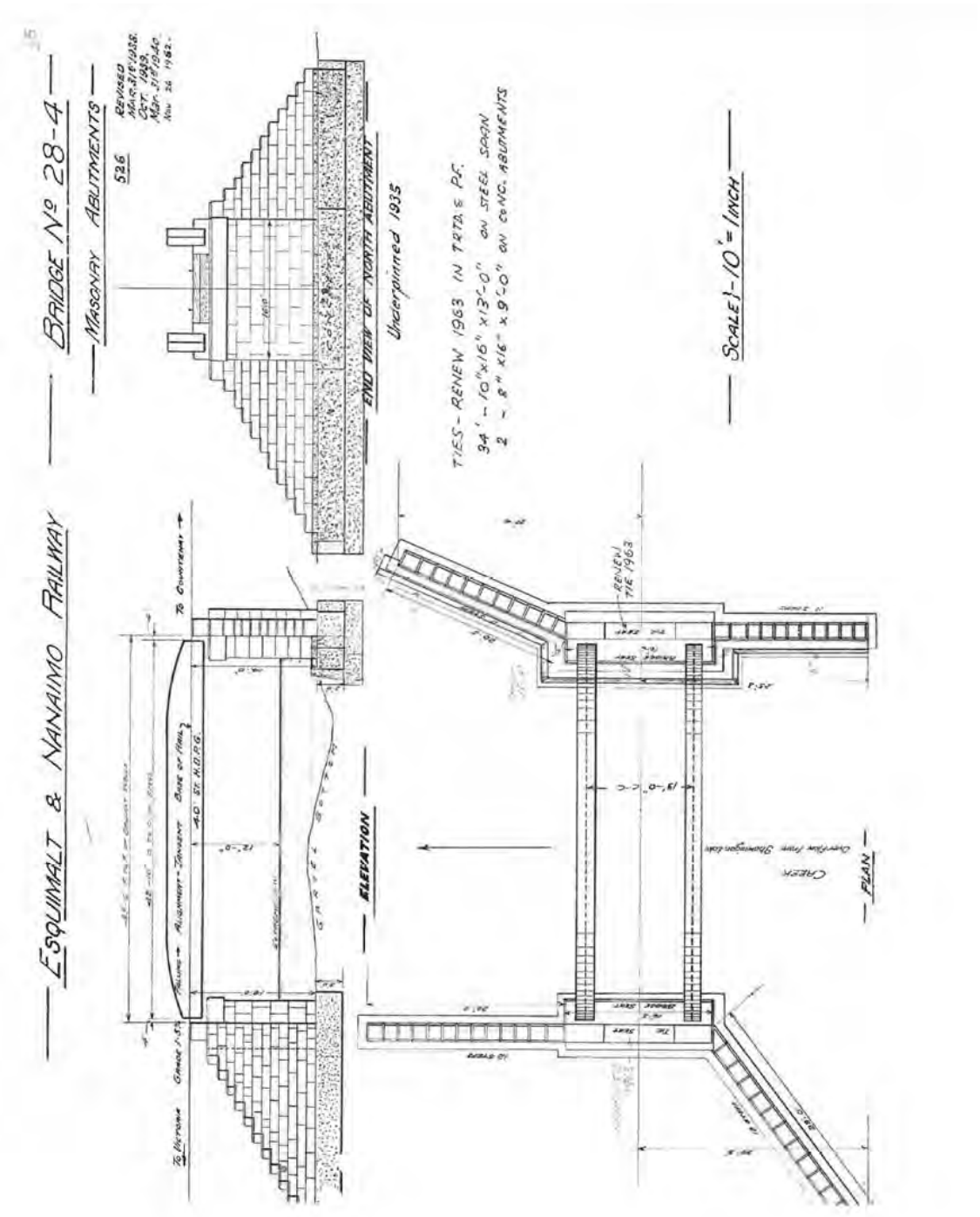
## 19.7 Mile 28.40 – Cost Summary Table: Years 2031 to 2041

**Bridge 28.40 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 28.40 – Victoria Subdivision – Shawnigan Lk. Trib.

**Bridge General Arrangement:**



# 20 Mile 28.60 – Shawnigan Lake Tributary

## 20.1 Mile 28.60 – Description

Bridge 28.60 is a single span open deck bridge over a tributary of Shawnigan Lake. The superstructure consists of a 42 ft steel half deck plate girder with timber structural ties. The bridge is on a curved alignment.

The bridge was originally constructed in 1907.

**Bridge Design Load:** E-50 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

## 20.2 Mile 28.60 - Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed the following immediate concerns:

- Poor bridge ties.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection revealed some minor corrosion in the steel girders, but no structurally significant damage.

Inspection also revealed the following:

- Cracked masonry blocks under bearings at both abutments.
- Fractured masonry blocks in both abutments.
- Open joints between masonry stones in wingwalls.
- Stiffeners have 100% section loss near bottom flange angles.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 20.3 Mile 28.60 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E63 | E56 | - | Bending |
| Deck Plate Girder (Steel) | E57 | E56 | - | Shear |
| Timber Structural Tie | E-72 | E72 | - | Bending |
| Timber Structural Tie | >E80 | E72 | - | Horizontal Shear |
| Timber Structural Tie | >E80 | E72 | - | End Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be completed.

### 20.4 Mile 28.60 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in 15 to 20 years to maintain railway traffic. An estimated replacement cost for this bridge is $580,000, including substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

## 20.5 Mile 28.60 – Cost Summary Table: Present to Year 2021

**Bridge 28.60 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Replace all bridge ties (10" x 16" ties, cost excluded). | $0 |
| | | X | | Repair cracked masonry blocks under bearings at both abutments. | $3,200 |
| | | X | | Repair blocks in both abutments that are fractured. | $3,200 |
| | | X | | Tuck point open joints between masonry stones in wingwalls. | $2,000 |
| | | X | | Replace stiffeners with 100% section loss near bottom flange angles. | $3,000 |
| | | | | **Subtotal All Loadings** | **$13,400** |

### 20.6 Mile 28.60 – Cost Summary Table: Years 2021 to 2031

**Bridge 28.60 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

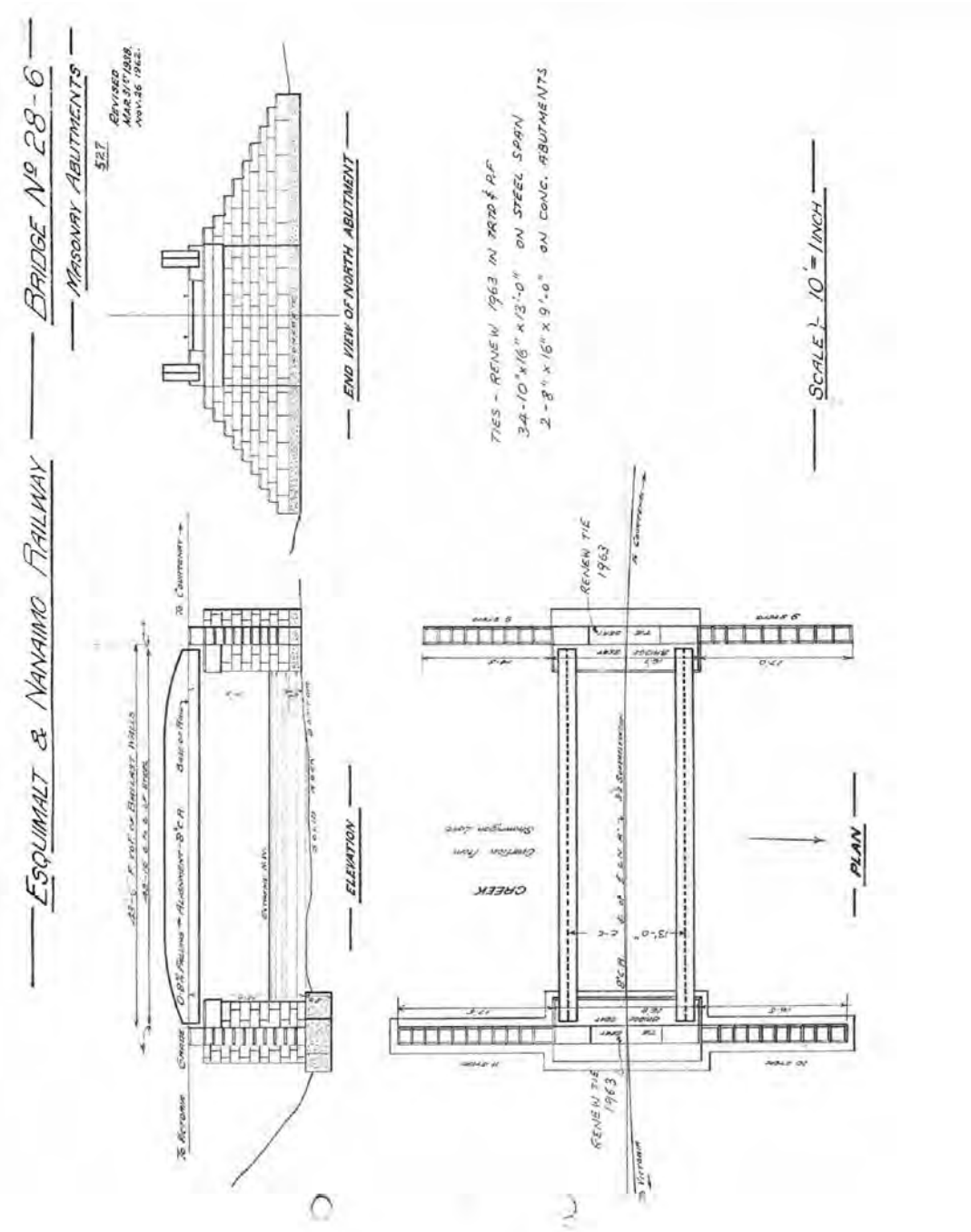
### 20.7 Mile 28.60 – Cost Summary Table: Years 2031 to 2041

**Bridge 28.60 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 28.60 – Victoria Subdivision –Shawnigan Lake Trib.

## Bridge General Arrangement:



# 21 Mile 29.80 – Northgate Road

## 21.1 Mile 29.80 – Description

Bridge 29.80 is a single span ballasted deck bridge over Northgate Road. The superstructure consists of 45'-4" steel wide flange beams. The bridge is on a curved alignment.

The bridge was originally constructed in 1908. The abutments are masonry blocks that were raised 6" in 1978 when new deck plate girders were installed.

**Bridge Design Load:** E-70
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 21.2 Mile 29.80 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed some minor corrosion in the steel girders, but no structurally significant damage.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 21.3 Mile 29.80 – Load Rating

Detailed load rating is not provided because load effects of the Assessment Trains are less than the effects of the design load.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel WF Beam | E70* | E55 | - | Bending |
| Steel WF Beam | E70* | E55 | - | Shear |

Note: *CCR not calculated, value based on bridge design loads.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

### 21.4 Mile 29.80 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

## 21.5 Mile 29.80 – Cost Summary Table: Present to Year 2021

**Bridge 29.80 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | | | **Subtotal All Loadings** | **$2,000** |

## 21.6 Mile 29.80 – Cost Summary Tables: Years 2021 to 2031

**Bridge 29.80 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| X | | | | Replace all bridge ties (47' of ballast ties, cost excluded). | $0 |
| | | | | **Subtotal All Loadings** | **$4,000** |

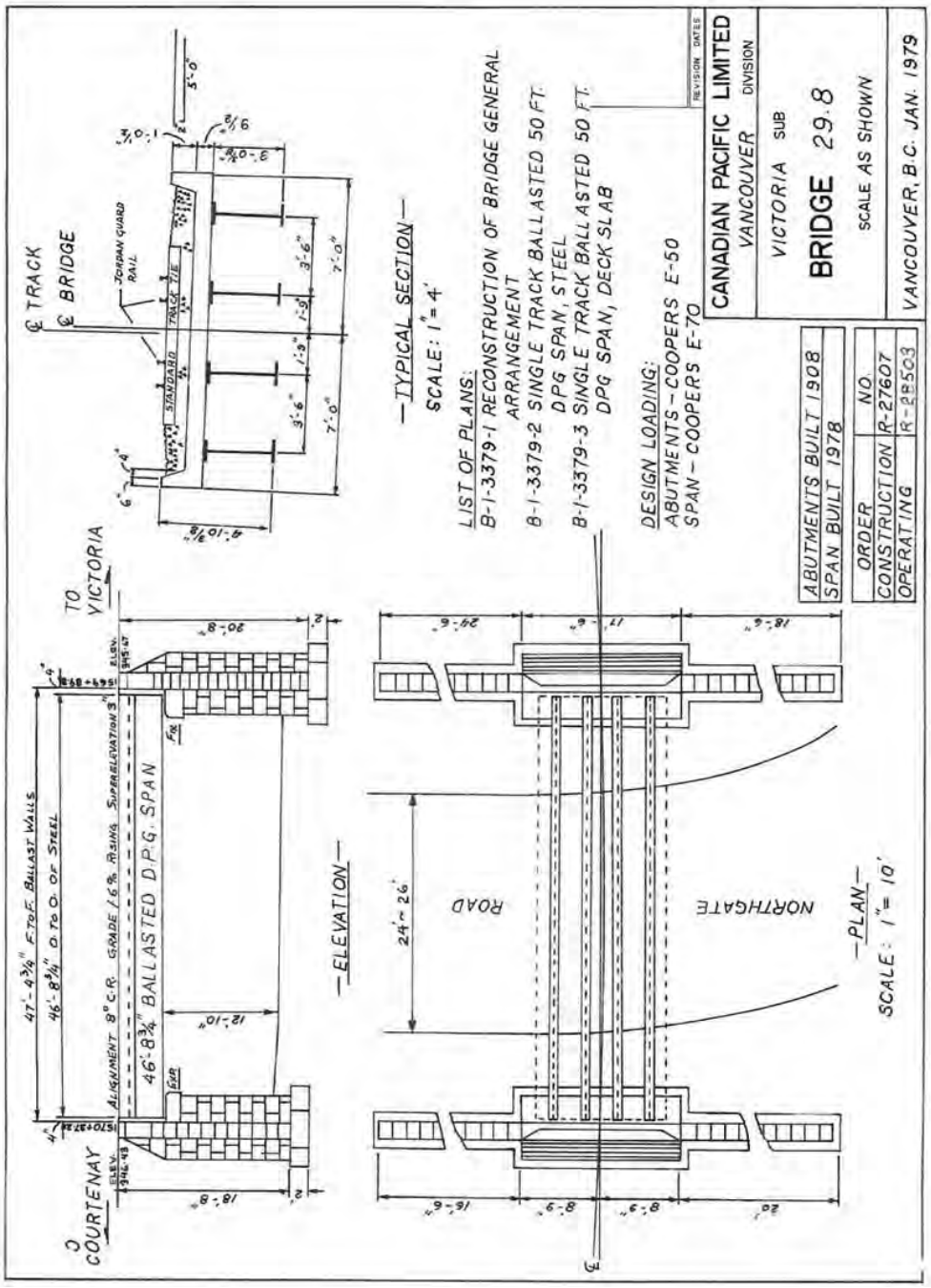
## 21.7 Mile 29.80 – Cost Summary Table: Years 2031 to 2041

**Bridge 29.80 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 29.80 – Victoria Subdivision – Northgate Road

## Bridge General Arrangement:



# 22 Mile 35.60 – Koksilah Road

## 22.1 Mile 35.60 – Description

Bridge 35.60 is a single span open deck bridge over Koksilah Road. The superstructure consists of a 27 ft steel half deck plate girder with timber structural ties. The bridge is on a tangent alignment.

The bridge was erected in 1911. The bridge is supported by masonry block abutments.

**Bridge Design Load:** E-50 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

## 22.2 Mile 35.60 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed minor corrosion in the steel girders, but no structurally significant damage.

Inspection also revealed the following:

- Cracks in masonry abutment blocks.
- Corroded bottom lateral bracing system elements.
- Fair-poor bridge ties.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 22.3 Mile 35.60 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater than the effects of the design load. In accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in flexure, shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E55 | E55 | - | Bending |
| Deck Plate Girder (Steel) | E53 | E61 | 15% | Shear |
| Timber Structural Tie | E79 | E72 | - | Bending |
| Timber Structural Tie (Side Notch) | E78 | E72 | - | Horizontal Shear |
| Timber Structural Tie (Side Notch) | E67 | E72 | 6% * | End Bearing |

Note: *Additional analysis and detailed inspection may support positive evaluation for ties in good condition.

### Ratings (4 - GP-9 locomotives and 286kip Cars @ 10mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E64 | E55 | - | Bending |
| Deck Plate Girder (Steel) | E63 | E61 | - | Shear |
| Timber Structural Tie | See results at 30 mph | | | |
| Timber Structural Tie (Side Notch) | See results at 30 mph | | | |
| Timber Structural Tie (Side Notch) | See results at 30 mph | | | |

### Ratings (2 - GP-9 locomotives and 263kip cars @ 30mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E55 | E51 | - | Bending |
| Deck Plate Girder (Steel) | E53 | E56 | 6% | Shear |
| Timber Structural Tie | E79 | E66 | - | Bending |
| Timber Structural Tie (Side Notch) | E78 | E66 | - | Horizontal Shear |
| Timber Structural Tie (Side Notch) | E67 | E66 | - | End Bearing |

### Ratings (2 - GP-9 locomotives and 263kip cars @ 10mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E64 | E-51 | - | Bending |
| Deck Plate Girder (Steel) | E63 | E-56 | - | Shear |
| Timber Structural Tie | See results at 30 mph | | | |
| Timber Structural Tie (Side Notch) | See results at 30 mph | | | |
| Timber Structural Tie (Side Notch) | See results at 30 mph | | | |

### Ratings (3 - RDC-1 Passenger Vehicles, 130kip each @ 30mph)

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Deck Plate Girder (Steel) | E55 | E18 | - | Bending |
| Deck Plate Girder (Steel) | E53 | E19 | - | Shear |
| Timber Structural Tie | No rating required, see 263kip car results | | | |
| Timber Structural Tie (Side Notch) | No rating required, see 263kip car results | | | |
| Timber Structural Tie (Side Notch) | No rating required, see 263kip car results | | | |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 10mph | Structural ties w/ side notch (note 1) |
| 2 - GP-9 locomotives and 263kip cars | 10mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

Notes:

1. Multiple structural ties on the bridge have notches cut into their sides at the tie bearing location on the girder. Where a side notch greater than 1.5" exists at the tie bearing location, capacity is insufficient for 286kip cars as analyzed.

### 22.4 Mile 35.60 – Optional Bridge Replacement

Based on the age and expected service life of the structure, there is a possibility that this bridge will need to be replaced in 20 years to maintain railway traffic. An estimated replacement cost for this bridge is $610,000, including substructure elements. It is also possible that replacement will not be required before 2041, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. The potential cost for replacement is captured within the steel bridge replacement allowance in the project summary tables.

## 22.5 Mile 35.60 – Cost Summary Tables: Present to Year 2021

### Bridge 35.60 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Replace all bridge ties (10" x 18" ties, cost excluded). | $0 |
| | | X | | Repair cracks in masonry abutment blocks. | $3,200 |
| | | X | | Replace corroded bottom lateral bracing system elements. | $5,500 |
| | | | | **Passenger / 263kip Subtotal** | **$10,700** |

### Bridge 35.60 – Projected Cost Summary to Operate Bridges until Year 2021 – 286kip Loading

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | | X | Replace structural ties (10" x 18") with side notch exceeding 1.5". Note: a more refined inspection and analysis may reveal the ties to have adequate capacity if in good condition. Due to their general fair-poor condition, replacement is advised. | $25,000 |
| | | X | | Repair cracks in masonry abutment blocks. | $3,200 |
| | | X | | Replace corroded bottom lateral bracing system elements. | $5,500 |
| | | | | **286kip Subtotal** | **$35,700** |

### 22.6 Mile 35.60 – Cost Summary Table: Years 2021 to 2031

**Bridge 35.60 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

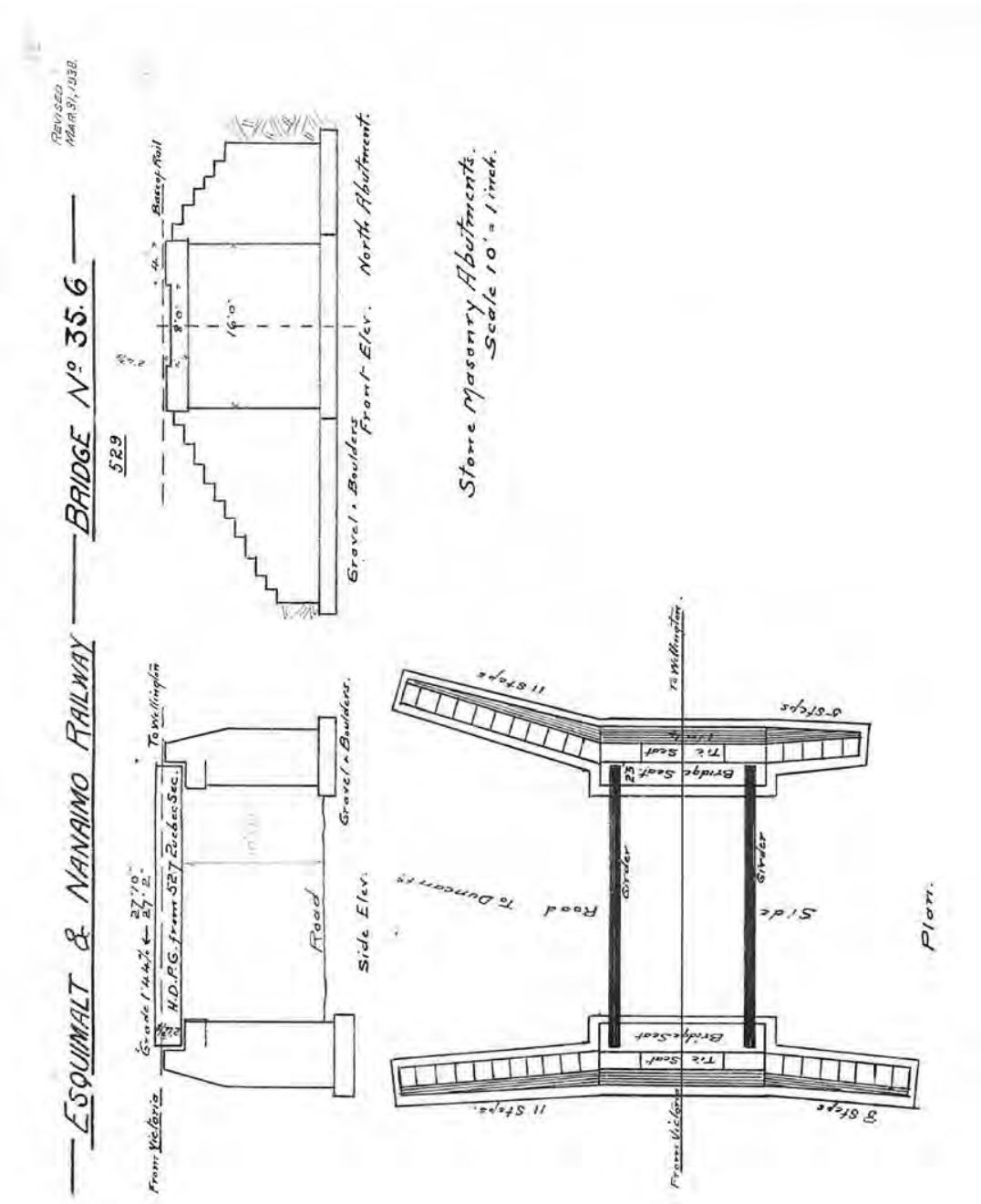
### 22.7 Mile 35.60 – Cost Summary Tables: Years 2031 to 2041

**Bridge 35.60 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $2,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

# 35.60 – Victoria Subdivision – Koksilah Road

## Bridge General Arrangement:



# 23 Mile 37.60 – Koksilah Overflow

## 23.1 Description

Bridge 37.60 is a five span open deck bridge over Koksilah Overflow. The superstructure consists of timber stringers sitting on timber pile bents. The bridge is on a curved alignment.

The bridge was originally constructed in 1965. Stringers and ties appear to have been replaced in 1993.

**Bridge Design Load:** E-60 (per SVI inventory, could not confirm)
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 23.2 Mile 37.60 – Inspection

Detailed bridge inspection was conducted in 2011. The inspection revealed the following immediate concerns:

- Broken diagonal timber bracing members in Span 4.

The immediate concerns shall be repaired to ensure stability of the bridge.

The timber stringers were generally in good condition, with no significant structural damage.

Inspection also revealed the following:

- Leaning north wingwalls.
- Erosion beneath wingwalls.
- Pile 4 of north end bent leaning inwards.
- Broken walkway boards at south end of bridge.
- Poor bridge ties.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 23.3 Mile 37.60 – Load Rating

Detailed load rating is provided for the timber spans because the design load could not be confirmed and load effects of the Assessment Trains may be greater than the effects of the design load. In accordance with the design criteria, we have evaluated the stringers for flexure, horizontal shear and end bearing.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber Stringers (Span 1,5) | E63 | E62 | - | Bending |
| Timber Stringers (Span 1,5) | >E80 | E65 | - | Horizontal Shear |
| Timber Stringers (Span 1,5) | >E80 | E62 | - | End Bearing |
| Timber Cap (Span 1,5) | >E80 | E54 | - | Bearing on piles |
| Timber Stringers (Span 2-4) | E57 | E61 | 6% * | Bending |
| Timber Stringers (Span 2-4) | E80 | E64 | - | Horizontal Shear |
| Timber Stringers (Span 2-4) | >E80 | E63 | - | End Bearing |
| Timber Cap (Span 2-4) | >E80 | E54 | - | Bearing on piles |

Note: *Detailed inspection and material evaluation required to confirm positive evaluation.

**Ratings (2 - GP-9 locomotives and 263kip cars @ 30mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber Stringers (Span 1,5) | E63 | E57 | - | Bending |
| Timber Stringers (Span 1,5) | >E80 | E60 | - | Horizontal Shear |
| Timber Stringers (Span 1,5) | >E80 | E58 | - | End Bearing |
| Timber Cap (Span 1,5) | >E80 | E51 | - | Bearing on piles |
| Timber Stringers (Span 2-4) | E57 | E56 | - | Bending |
| Timber Stringers (Span 2-4) | E80 | E59 | - | Horizontal Shear |
| Timber Stringers (Span 2-4) | >E80 | E58 | - | End Bearing |
| Timber Cap (Span 2-4) | >E80 | E50 | - | Bearing on piles |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | Stringers (note 2) |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be completed.
2. Timber stringer capacity in spans 2,3 and 4 insufficient to support 286kip cars as analyzed; a more refined analysis (material property check, etc.) may alleviate the 6% overstress and prove the stringers to be adequate.
3. Reduced speed results are not shown for overstressed members because AREMA code does not include an impact factor for timber ratings.

### 23.4 Mile 37.60 – Optional Bridge Replacement

Based on the age of the substructure, there is a possibility that this bridge will need to be replaced in 10 years to maintain railway traffic, pending a special timber assessment. An estimated replacement cost for this bridge is $400,000, including substructure elements and assuming it is replaced in-kind. It is also possible that replacement will not be required, particularly in the event that traffic is light and the maintenance and repairs suggested in this report are complete.

Based on the intent to extend the life of the railway structures to their maximum utility, the estimated replacement cost for this bridge has not been included as a singular cost in the tables below. One third of the replacement cost has been included in both the 2021-2031 and 2031-2041 time periods to account for significant repair work performed in lieu of full replacement.

## 23.5 Mile 37.60 – Cost Summary Tables: Present to Year 2021

**Bridge 37.60 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Replace broken diagonal timber bracing members in Span 4. | $3,000 |
| X | | | | Perform special timber assessment of load carrying members. | $10,000 |
| X | | | | Replace all ties (8" x 8" open deck ties, cost excluded). | $0 |
| | | X | | Repair leaning north wingwalls. | $10,000 |
| | | X | | Fill in front of wingwalls to stop erosion. | $5,000 |
| | | X | | Post Pile 4 of north end bent to obtain full bearing under cap. | $3,000 |
| | | X | | Replace broken walkway boards at south end of bridge. | $500 |
| | | | | **Passenger / 263kip Subtotal** | **$33,500** |

## Bridge 37.60 – Projected Cost Summary to Operate Bridges until Year 2021 – 286kip Loading

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | X | | | Replace broken diagonal timber bracing members in Span 4. | $3,000 |
| X | | | | Perform special timber assessment of load carrying members. | $10,000 |
| | | | X | Refined analysis/evaluation to confirm adequate stringer capacity in spans 2-4. | $12,000 |
| X | | | | Replace all ties (8" x 8" open deck ties, cost excluded). | $0 |
| | | X | | Repair leaning north wingwalls. | $10,000 |
| | | X | | Fill in front of wingwalls to stop erosion. | $5,000 |
| | | X | | Post Pile 4 of north end bent to obtain full bearing under cap. | $3,000 |
| | | X | | Replace broken walkway boards at south end of bridge. | $500 |
| | | | | **286kip Subtotal** | **$45,500** |

### 23.6 Mile 37.60 – Cost Summary Table: Years 2021 to 2031

**Bridge 37.60 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Detailed bridge inspection and timber element replacements. | $133,000 |
| | | | | **Subtotal All Loadings** | **$135,000** |

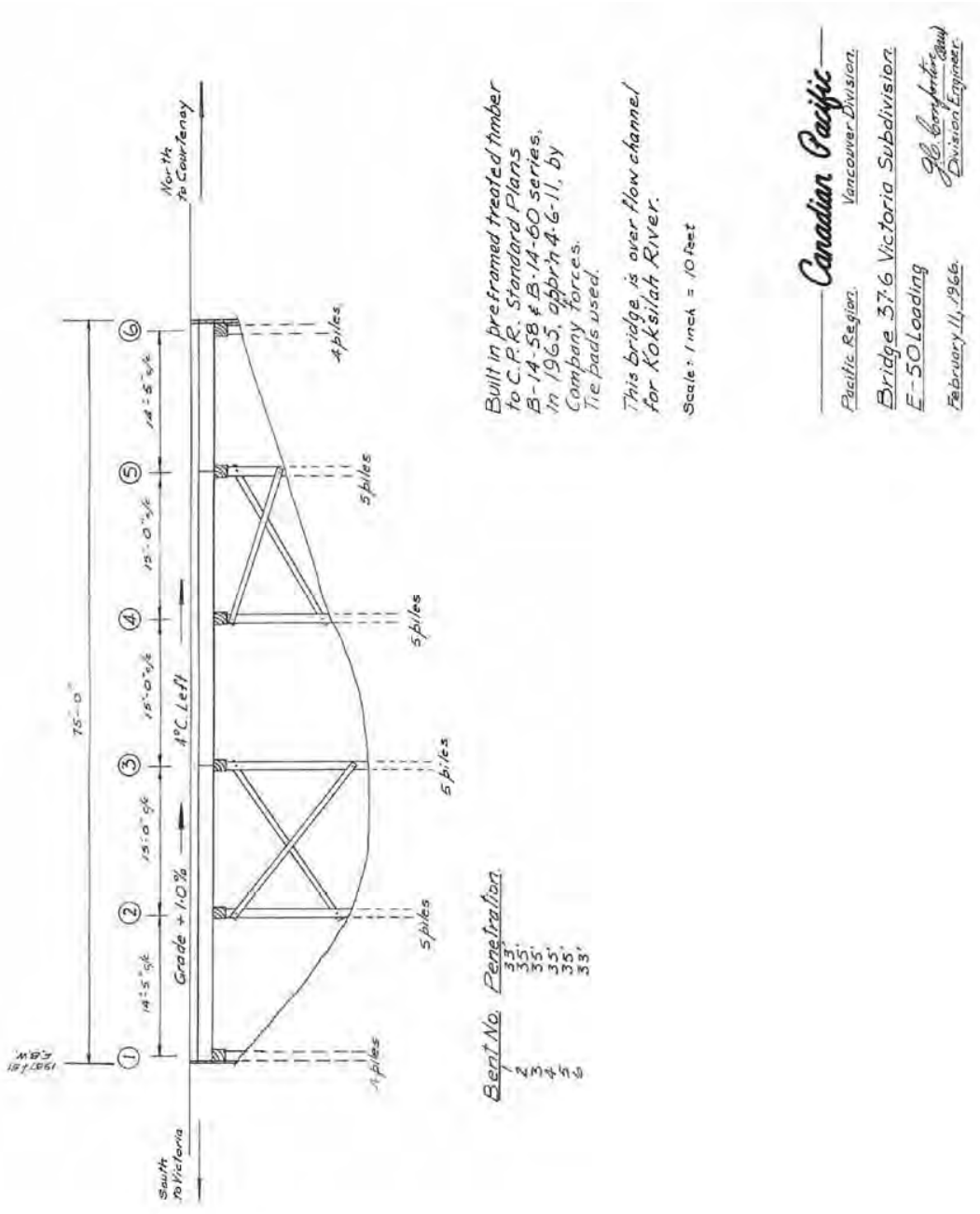
### 23.7 Mile 37.60 – Cost Summary Table: Years 2031 to 2041

**Bridge 37.60 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $2,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| | | X | | Detailed bridge inspection and timber element replacements. | $133,000 |
| | | | | **Subtotal All Loadings** | **$135,000** |

# 37.60 – Victoria Subdivision – Koksilah Overflow

## Bridge General Arrangement:



# 24 Mile 37.80 – Koksilah River

## 24.1 Mile 37.80 – Description

Bridge 37.80 is a single span open deck thru truss over Koksilah River. The floor system is composed of steel floor beams and stringers. The bridge is on a tangent alignment.

The bridge was erected in 1940 and the ties have since been replaced in 1984. The bridge is supported by concrete abutments.

**Bridge Design Load:** E-50
**Current Bridge Load:** 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit:** 30 mph
**Desired Speed:** 30 mph

### 24.2 Mile 37.80 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed no immediate concerns.

Inspection revealed minor corrosion in the steel truss members, but no structurally significant damage.

Inspection also revealed the following:

- Heavily corroded expansion bearings.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 24.3 Mile 37.80 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains in comparison with the effects of the design load cannot be determined without an analysis. In accordance with the design criteria, we have evaluated the floor system members by checking sections with maximum moment and maximum shear. We have evaluated the truss members by checking axial tension and compression.

Load rating result will not be shown for lighter assessment trains when a component's load rating is shown to be adequate for a heavier assessment train.

**Ratings (4 - GP-9 locomotives and 286kip Cars @ 30mph)**

| Bridge Component | Component Cooper Rating (CCR) | Eqv. Cooper Demand (ECD) | Overstress | Mode |
|---|---|---|---|---|
| Top Chord (U3U4)* | >E70 | E43 | - | Compression |
| End Post (L0U1) | >E70 | E45 | - | Compression |
| Interior Post (U2L2)* | E65 | E43 | - | Compression |
| End Hanger (U1L1) | E67 | E57 | - | Tension |
| Bottom Chord (L0L2)* | E54 | E45 | - | Tension |
| Diagonal (U1L2)* | E55 | E45 | - | Tension |
| Floor beam | E64 | E55 | - | Bending |
| Floor beam | >E70 | E55 | - | Shear |
| Stringer | >E70 | E57 | - | Bending |
| Stringer | >E70 | E59 | - | Shear |

Note: *Results shown for most critical member in component group.

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 30mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 30mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30mph | N / A (see note 1) |

Notes:

1. Observation of the bridge under a train load was conducted for low train speed only. We recommend the observation of bridge under a passenger train traveling at 30mph be conducted prior to re-establishing passenger traffic.

### 24.4 Mile 37.80 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore, we are not providing a cost estimate for the replacement of this bridge.

### 24.5 Mile 37.80 – Cost Summary Table: Present to Year 2021

**Bridge 37.80 – Projected Cost Summary to Operate Bridges until Year 2021 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $5,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Replace all bridge ties (126 - 10" x 14" ties, cost excluded). | $0 |
| | | X | | Replace heavily corroded expansion bearings. | $20,000 |
| | | | | **Subtotal All Loadings** | **$25,000** |

### 24.6 Mile 37.80 – Cost Summary Table: Years 2021 to 2031

**Bridge 37.80 – Projected Cost Summary to Operate Bridges Years 2021 - 2031 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $5,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2021. | $5,000 |
| | | | | **Subtotal All Loadings** | **$10,000** |

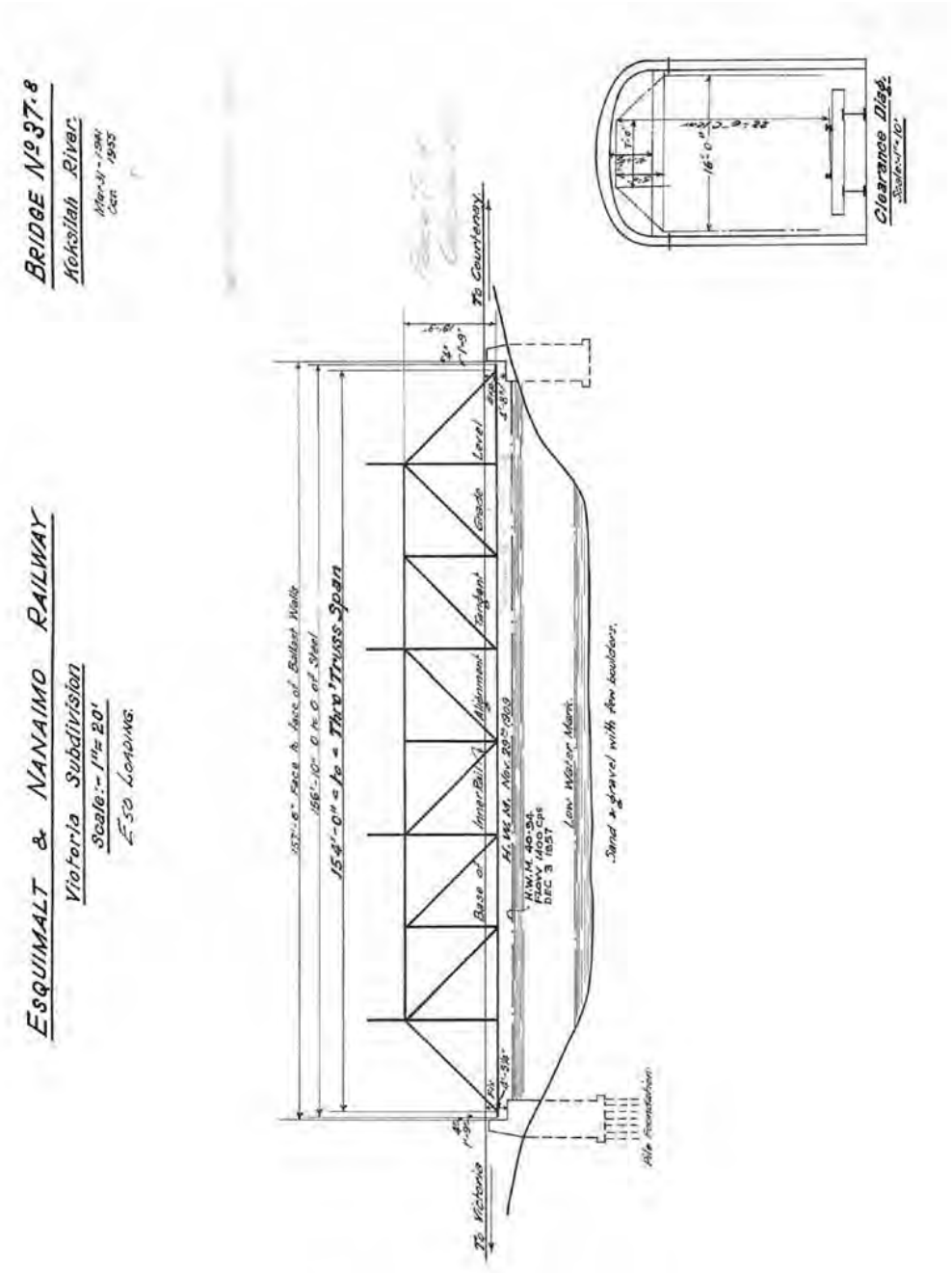
### 24.7 Mile 37.80 – Cost Summary Table: Years 2031 to 2041

**Bridge 37.80 – Projected Cost Summary to Operate Bridges Years 2031 - 2041 – Passenger Loading, 263kip Loading, 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $5,000 |
| X | | | | Regular visual inspection (by SVI forces). | $0 |
| X | | | | Detailed bridge inspection in 2031. | $5,000 |
| | | | | **Subtotal All Loadings** | **$10,000** |

# 37.80 – Victoria Subdivision – Koksilah River

## Bridge General Arrangement:



# 25 Mile 39.3 Cowichan River

## 25.1 Mile 39.3 – Description

Bridge 39.3 is a single span open deck bridge over the Cowichan River. The superstructure consists of a 219 ft. wrought iron double through truss (two trusses on each side of the rail line), with steel floor beams and stringers. The bridge is on a straight alignment.

Bridge in present configuration erected 1909, trusses fabricated in 1876, previously used at another location. The bridge is supported by stone masonry block abutments with concrete footings built in 1892.

**Bridge Design Load**: CPR 135% Engine Class D6
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 5 mph
**Desired Speed**: 30 mph

## 25.2 Mile 39.3 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011. The inspection revealed the following immediate concerns:

- Cracked eye nuts at the end of truss counters.
- Displaced truss expansion bearing.
- Heavily corroded stringer expansion bearings.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection also revealed heavy corrosion of floor beam top flanges. Based on the photograph in the inspection report we estimate section loss of 15% in floor beam top flanges; the component capacity was reduced accordingly.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 25.3 Mile 39.3 – Load Rating

Detailed load rating is provided because rating by comparison with the design loading was not possible and because of concerns that the existing components may be overstressed – raised after cracks in the counter eye nuts were discovered.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E73 | E45 | - | Compression |
| Truss vertical | E101 | E55 | - | Compression |
| Truss bottom chord | E62 | E46 | - | Tension |
| Truss diagonal | E59 | E50 | - | Tension |
| Floor beam | E49 | E55 | 13% | Bending |
| Floor beam | E65 | E38 | - | Shear |
| Stringer | E38 | E55 | 46% | Bending |
| Stringer | E52 | E58 | 12% | Shear |

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | *Rating not required, see results at 30 mph* | | | |
| Truss vertical | *Rating not required, see results at 30 mph* | | | |
| Truss bottom chord | *Rating not required, see results at 30 mph* | | | |
| Truss diagonal | *Rating not required, see results at 30 mph* | | | |
| Floor Beams | E58 | E55 | - | Bending |
| Floor Beams | E78 | E38 | - | Shear |
| Stringers | E44 | E55 | 26% | Bending |
| Stringers | E60 | E58 | - | Shear |

**Ratings (2 – GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E73 | E41 | - | Compression |
| Truss vertical | E101 | E51 | - | Compression |
| Truss bottom chord | E62 | E42 | - | Tension |
| Truss diagonal | E59 | E46 | - | Tension |
| Floor beam | E49 | E50 | 4% | Bending |
| Floor beam | E65 | E35 | - | Shear |
| Stringers | E38 | E51 | 35% | Bending |
| Stringers | E52 | E53 | 2% | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | *Rating not required, see results at 30 mph* | | | |
| Truss vertical | *Rating not required, see results at 30 mph* | | | |
| Truss bottom chord | *Rating not required, see results at 30 mph* | | | |
| Truss diagonal | *Rating not required, see results at 30 mph* | | | |
| Floor beam | E58 | E50 | - | Bending |
| Floor beam | E78 | E41 | - | Shear |
| Stringers | E44 | E51 | 16% | Bending |
| Stringers | E60 | E53 | - | Shear |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E73 | E14 | - | Compression |
| Truss vertical | E101 | E18 | - | Compression |
| Truss bottom chord | E62 | E14 | - | Tension |
| Truss diagonal | E59 | E16 | - | Tension |
| Floor beam | E49 | E16 | - | Bending |
| Floor beam | E65 | E11 | - | Shear |
| Stringers | E38 | E18 | - | Bending |
| Stringers | E52 | E21 | - | Shear |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars (286) | 10 mph [4] | Stringers (see note 2) |
| 2 - GP-9 locomotives and 263 kip cars (263) | 10 mph [4] | Stringers (see note 2) |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A (see note 3) |

Notes:

1. The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be complete.
2. Stringers capacity insufficient to support 286 kip as well as 263 kip cars, reinforcing of replacement of stringers is required.
3. Observation of the bridge under the train load conducted for low train speed only. We recommend the observation of bridge under a passenger train travelling at 30 mph be conducted prior to re-establishing passenger traffic.
4. Should not be operated under significant wind load.

### 25.4 Mile 39.3 – Optional Bridge Replacement

Wrought iron truss components of Cowichan Bridge were fabricated in 1876; they are now 135 years old. The substructure is 120 years old. In our opinion, there is a possibility that the bridge may have to be replaced in the next 30 years to maintain the railway traffic. However, we cannot calculate the probability of truss failure in the next 30 years. Intensifying the railway traffic over the bridge may shorten the lifespan of the structure.

Estimated replacement cost for the bridge could be in the order of $4,000,000. This cost is based on the estimate provided in the 2003 inspection report, adjusted 30% for inflation (3.5% annually). As the substructure probably does not comply with the modern codes, we assume that the substructure will be replaced with the superstructure.

There is also a strong possibility that the existing structure will survive another 30 years, particularly in case that the traffic is light. Therefore we do not recommend that the above replacement cost be included as a likely cost to maintain traffic to 2041.

## 25.5 Mile 39.3 – Cost Summary Tables: Present to year 2021

**Bridge 39.3 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $5,000 |
| | X | | | Replace all bridge counters (because of cracked eye nuts) | $150,000 |
| | X | | | Replace or repair bridge South expansion bearings | $15,000 |
| | | X | | Coat exposed top surface of floor beam top flanges with environmentally friendly (low VOC) paint to reduce corrosion loss | $3,000 |
| | | X | | Straighten (alternately reinforce of replace) bottom chord members with slight buckle. Includes L0-L1, East and West | $25,000 |
| | | X | | Replace mid-height transverse bracing chords that have packed rust | $20,000 |
| | | X | | Tighten bottom lateral bracing | $10,000 |
| | | | X | Observe the bridge under a passenger train traveling at 30 mph be conducted prior to re-establishing passenger traffic. SVI will provide the train. | $1,000 |
| | | | | **Passenger Subtotal** | **$229,000** |

**Bridge 39.3 – Projected Cost Summary to Operate Bridges until Year 2021**
**263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $5,000 |
| | X | | | Replace all bridge counters (because of cracked eye nuts) | $150,000 |
| | X | | | Replace or repair bridge South expansion bearings | $15,000 |
| | | X | | Coat exposed top surface of floor beam top flanges with environmentally friendly (low VOC) paint to reduce corrosion loss | $3,000 |
| | | X | | Straighten (alternately reinforce of replace) bottom chord members with slight buckle. Includes L0-L1, East and West | $25,000 |
| | | X | | Replace mid-height transverse bracing chords that have packed rust | $20,000 |
| | | X | | Tighten bottom lateral bracing | $10,000 |
| | | | X | Reinforce or replace the existing bridge stringers (required to support 286 cars as well as 263 cars traveling at 10mph) | $150,000 |
| | | | X | Observe the bridge under a passenger train traveling at 30 mph be conducted prior to re-establishing passenger traffic. SVI will provide the train. | $1,000 |
| | | | | **Subtotal All Loadings** | **$379,000** |

## 25.6 Mile 39.3 – Cost Summary Table: Years 2021 to 2031

**Bridge 39.3 – Projected Cost Summary to Operate Bridges Years 2021 to 2031**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2021, including NDT. (investigate for cracks and corrosion loss in steel members, investigate timber ties) – one required | $10,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $5,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$15,000** |

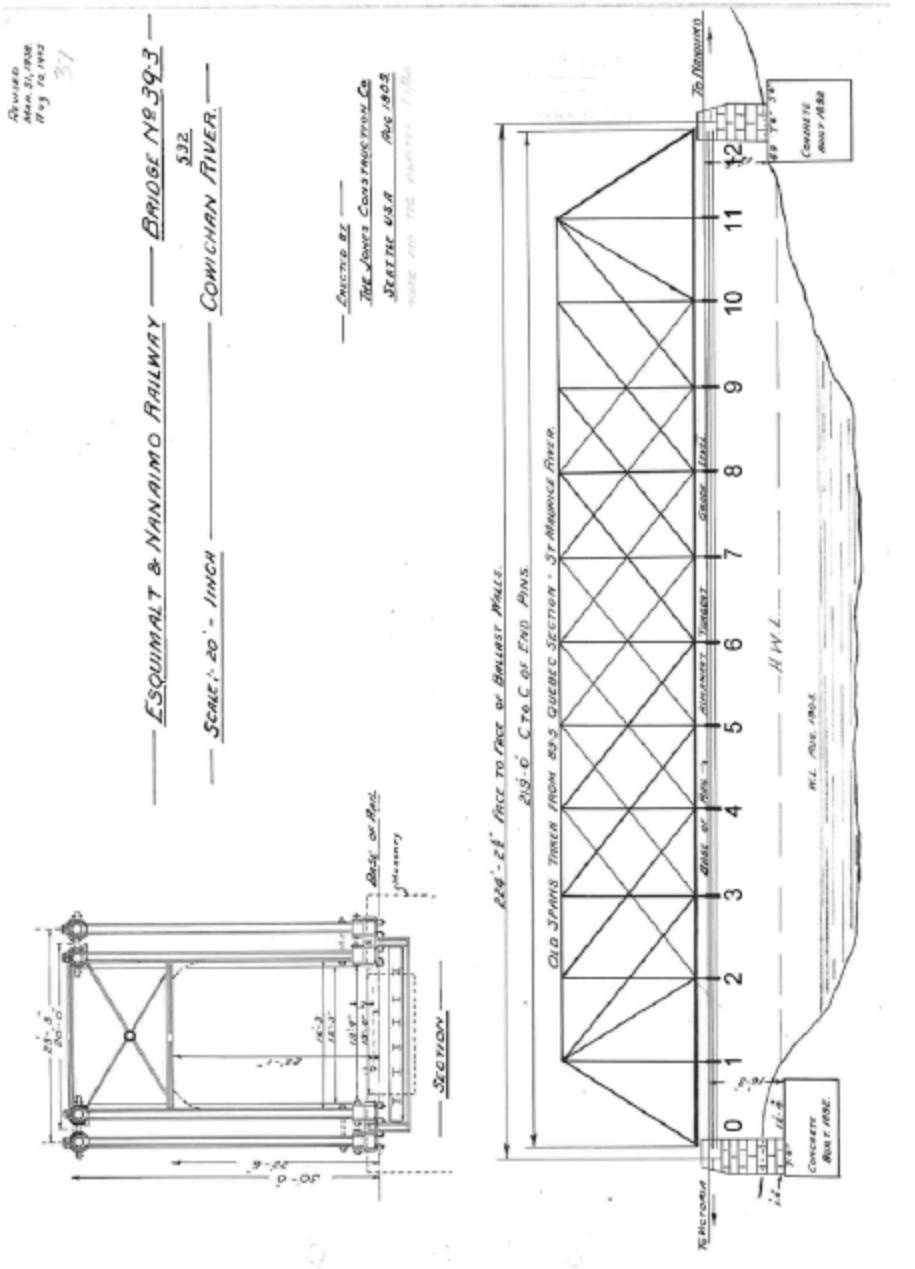
## 25.7 Mile 39.3 – Cost Summary Table: Years 2031 to 2041

**Bridge 39.3 – Projected Cost Summary to Operate Bridges – Years 2031 to 2041**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2031, including NDT. (investigate for cracks and corrosion loss in steel members, investigate timber ties) – one required | $10,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $5,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | | X | | Possible partial tie replacement (cost excluded) | $0 |
| | | | | **Subtotal All Loadings** | **$15,000** |

# 39.30 – Victoria Subdivision – Cowichan River

## Bridge General Arrangement:



# 26 Mile 40.6 – Unnamed Watercourse

## 26.1 Mile 40.6 Description

Bridge 40.6 is a single span, open deck bridge. The superstructure consists of a 38 ft. half depth steel plate girder. The bridge is on a straight alignment.

Bridge in present configuration erected 1940; steel girders were previously used at another location. The bridge is supported by concrete abutments with pile foundation built in 1917.

**Bridge Design Load**: Cooper E50
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 30 mph
**Desired Speed**: 30 mph

## 26.2 Mile 40.6 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011. The inspection revealed no immediate concerns:

Inspection also revealed minor corrosion and pitting of the steel girders, no structurally significant damage.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 26.3 Mile 40.6 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater that the effects of the design load.

**Ratings (4 - GP-9 locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Girder | E57 | E54 | - | Bending |
| Girder | E65 | E59 | - | Shear |
| Structural Ties | E72 | E72 | - | Bending |
| Structural Ties | E110 | E72 | - | Horizontal Shear |
| Structural Ties | E109 | E72 | - | Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars (286) | 30 mph | N / A |
| 2 - GP-9 locomotives and 263 kip cars (263) | 30 mph | N / A |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A |

## 26.4 Mile 40.6 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore we are not providing the cost estimate for the replacement of this bridge.

## 26.5 Mile 40.6 – Cost Summary Table: Present to Year 2021

**Bridge 40.6 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $3,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

## 26.6 Mile 40.6 – Cost Summary Table: Years 2021 to 2031

**Bridge 40.6 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspections in 2021 (investigate for cracks and corrosion loss in steel members, investigate timber ties). | $3,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $3,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | | X | | Replace bridge timber ties (cost excluded) | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

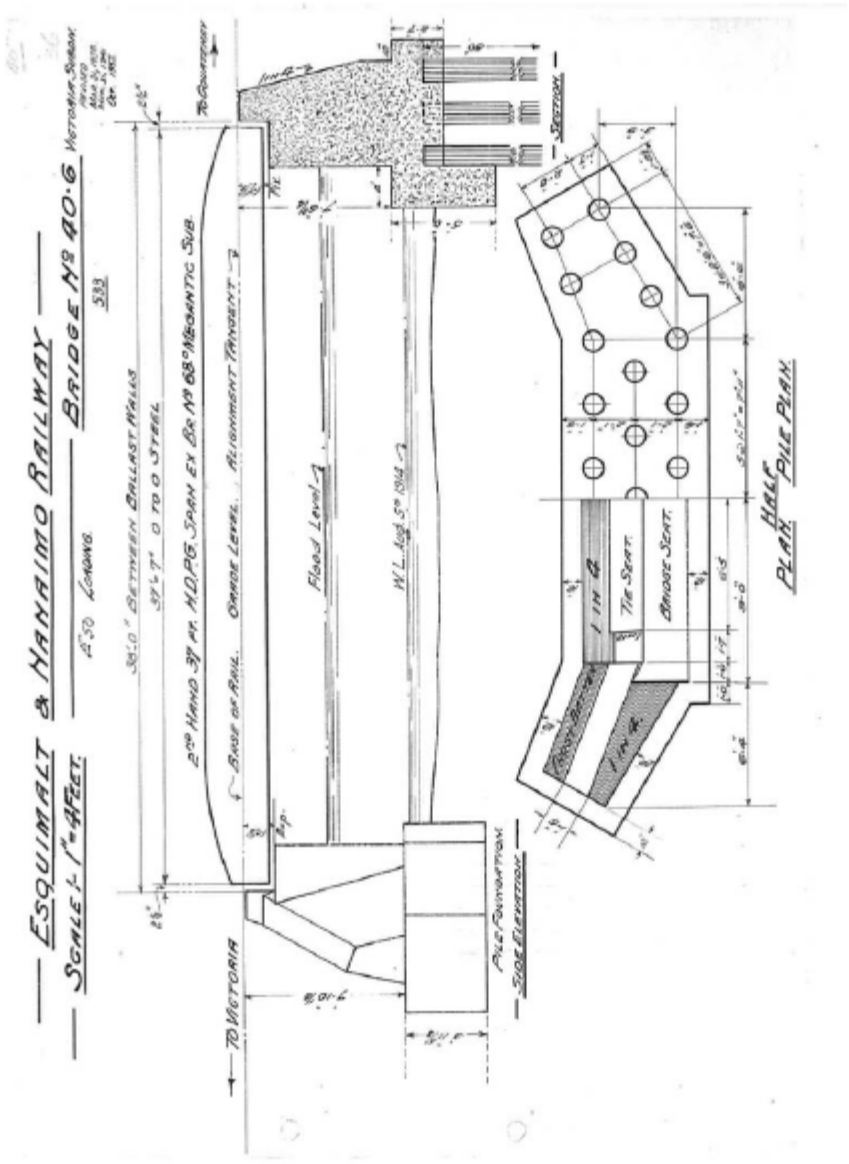
## 26.7 Mile 40.6 – Cost Summary Table: Years 2031 to 2041

**Bridge 40.6 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263kip and 286kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2031. (investigate for cracks and corrosion loss in steel members, investigate timber ties) – one required | $3,000 |
| X | | | | Clean debris on the bridge every 5 years to prevent accelerated corrosion of steel members, in particular on girder flanges | $3,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 40.60 – Victoria Subdivision – Unnamed Waterway

**Bridge General Arrangement:**



# 27 Mile 46.6 – Overflow

## 27.1 Mile 46.6 – Description

Mile 46.6 Bridge is a three-span pile trestle with span configuration: 14'-5" – 15' – 14'-5". The trestle was constructed in 1973. The bridge is constructed in accordance with CP standard plans for E60 loading.

**Bridge Design Load**: Cooper E60
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 30 mph
**Desired Speed**: 30 mph

## 27.2 Mile 46.6 - Inspection

Detailed bridge inspection, including observation of trestle under the train loading was conducted 2011. The inspection revealed the following immediate concerns:

- Significant rot in two of the six piles at Bent 2.

The immediate concerns shall be repaired to ensure stability of the bridge.

Inspection also revealed the following deficiencies:

- Timber pile bracing shown on the design drawings is missing.
- Nine (out of 45) timber ties in poor condition.

While poor ties and missing bracing may not represent an immediate safety concern, we recommend the ties are replaced at the same time with pile repairs.

The stringers are found to be in good condition, with no significant damage. Some movement observed under the train load, but not excessive.

Since the stringers are in good condition, as well as substructure, we assume that the bridge design life can be extended until 2021.

## 27.3 Mile 46.6 – Load Rating

Detailed load rating is conducted by comparing the effect of the design load with the effects of the assessment trains. The rating is based on the assumptions that the immediate concerns, listed above, are addressed.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber stringer | E-60 | E-60 | - | Bending |
| Timber stringer | E-60 | E-63 | 4% [1] | Shear[1] |

Note [1]: Additional analysis and detailed inspection required to confirm positive evaluation.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Girder | *Rating not required, see results at 30 mph* | | | |
| Girder | *Rating not required, see results at 30 mph* | | | |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber stringer | E-60 | E-55 | - | Bending |
| Timber stringer | E-60 | E-58 | - | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber stringers | *Rating not required, see results at 30 mph* | | | |
| Timber stringers | *Rating not required, see results at 30 mph* | | | |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber stringer | E-60 | E-20 | - | Bending |
| Timber stringer | E-60 | E-23 | - | Shear |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Timber stringer | *Rating not required, see results at 30 mph* | | | |
| Timber stringer | *Rating not required, see results at 30 mph* | | | |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars (286) | 30 mph | See note 2 |
| 2 - GP-9 locomotives and 263 kip cars (263) | 30 mph | N / A |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A |

Notes:

1 The rating provided in this report is based on the assumption that the Essential Repairs listed below will be complete.

2 A small overstress was identified in the timber stringers; additional analysis and detailed inspection required to confirm positive evaluation.

## 27.4 Mile 46.6 – Optional Bridge Replacement

Considering the age of the structure, we estimate that the bridge will need to be replaced between the year 2021 and 2031; estimated bridge replacement cost is in the order of $200,000.

## 27.5 Mile 46.6 – Cost Summary Table: Present to Year 2021

**Bridge 46.6 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading and 263 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Clean debris and vegetation adjacent to bridge at abutments | $1,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | X | | | Repair two rotten piles by posting – cutting off and replacing the rotten section of pile | $10,000 |
| | | X | | Replace nine ties in poor condition | $0 |
| | | X | | Install bracing on two piers | $2,000 |
| | | | | **Subtotal all Loadings** | **$13,000** |

**Bridge 46.6 – Projected Cost Summary to Operate Bridges until Year 2021**
**286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Clean debris and vegetation adjacent to bridge at abutments | $1,000 |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| | X | | | Repair two rotten piles by posting – cutting off and replacing the rotten section of pile | $10,000 |
| | | X | | Replace nine ties in poor condition | $0 |
| | | X | | Install bracing on two piers | $2,000 |
| | | | X | Additional analysis and inspection to confirm the capacity of 15 ft trestle to support 286 cars. | $5,000 |
| | | | | **Subtotal all Loadings** | **$18,000** |

## 27.6 Mile 46.6 – Cost Summary Table: Years 2021 to 2031

**Bridge 46.6 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| X | | | | Detailed bridge inspection in 2021 | $3,000 |
| | | X | | Repair/partially replace timber trestle (1/3 of 3-15ft spans) | $85,000 |
| | | | | **Subtotal All Loadings** | **$88,000** |

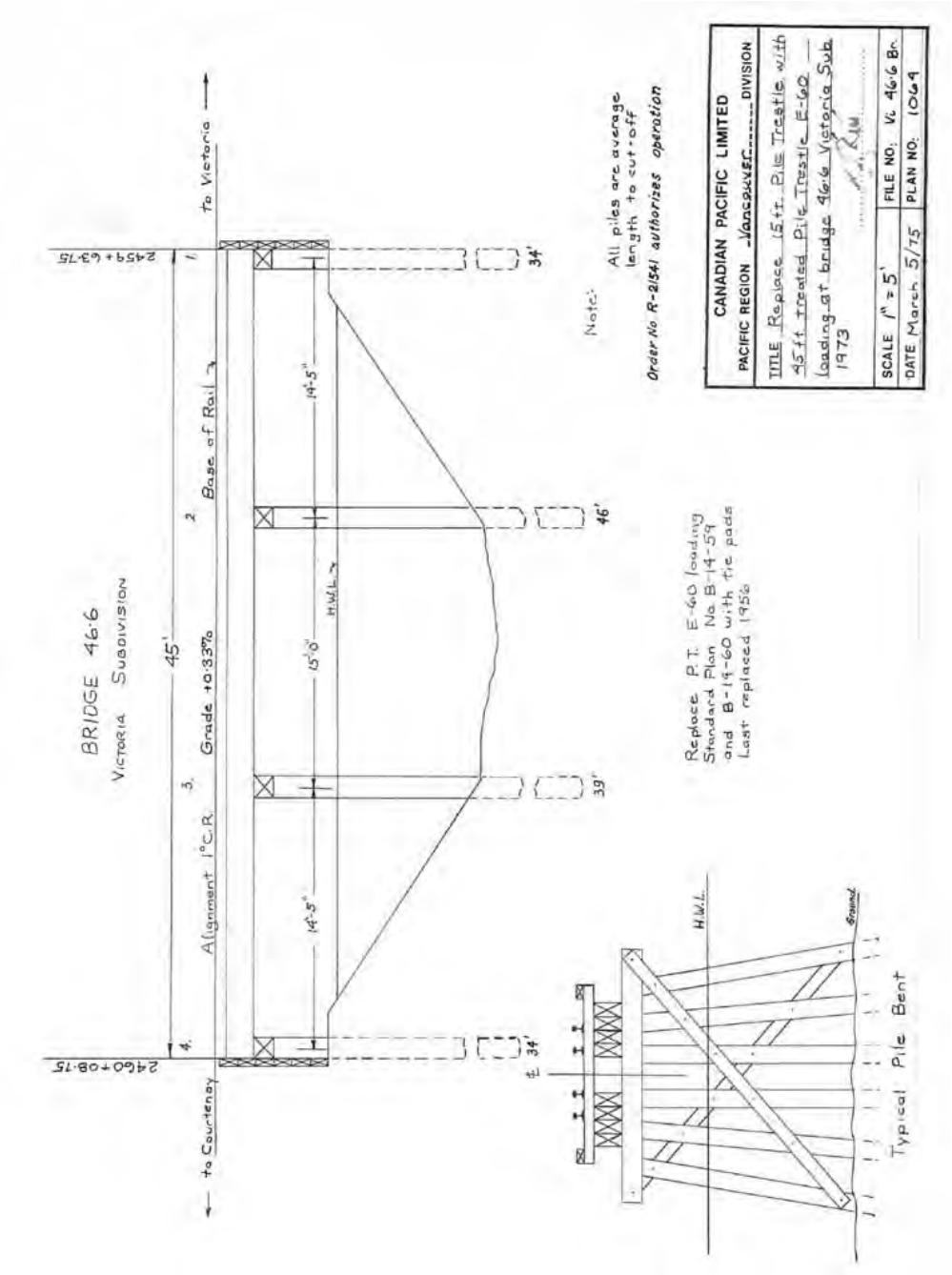
## 27.7 Mile 46.6 – Cost Summary Table: Years 2031 to 2041

**Bridge 46.6 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Bridge annual visual inspections – nine required (by SVI forces) | $0 |
| X | | | | Detailed bridge inspection in 2031 | $3,000 |
| | | X | | Repair/partially replace timber trestle (1/3 of 3-15ft spans) | $85,000 |
| | | | | **Subtotal All Loadings** | **$88,000** |

# 46.60 – Victoria Subdivision – Overflow

**Bridge General Arrangement:**



# 28 Mile 46.8 – Whitehouse Creek

## 28.1 Mile 46.8 – Description

Bridge 46.8 is a single span open deck bridge over Whitehouse Creek. The superstructure consists of a 30 ft. steel DPG span with wood structural tie deck. The bridge is on a straight alignment.

Bridge in present configuration erected 1940, girders previously used at another location. The bridge is supported by concrete abutments on pile foundations, built in 1913.

**Bridge Design Load**: Unknown
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 30 mph
**Desired Speed**: 30 mph.

## 28.2 Mile 46.8 – Inspection

Detailed bridge inspection conducted in 2011. The inspection revealed the following immediate concern:

- Ties are in poor condition and should be replaced by 16" deep ties, similar to current CP Standard ties for E60 loading. We recommend that top surfaces of girder top and bottom flanges shall be coated with environmentally friendly (low VOC) paint before new ties are installed.

The immediate concern shall be repaired to ensure stability of the bridge.

Inspection also revealed notable corrosion on the top and bottom flanges of the girders. Based on the inspection, the top and bottom flanges have 1/16" corrosion over their horizontal surfaces; the component capacity was reduced accordingly. For detailed inspection results refer to the Inspection Report dated Feb. 2012.

## 28.3 Mile 46.8 – Load Rating

Detailed load rating is provided because load effects of the Assessment Trains are greater that the effects of the design load. In the accordance with the design criteria, we have evaluated the girders by checking sections with maximum moment and maximum shear, as well as timber ties in moment, shear and end bearing.

When a component's load rating is positive for the 286 kip AT, results will not be shown for the lighter Assessment Trains.

**Ratings (4 - GP-9 locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Girders | E62 | E55 | - | Bending |
| Girders | E60 | E60 | - | Shear |
| Structural Ties | E83 | E72 | - | Bending |
| Structural Ties | E84 | E72 | - | Horizontal Shear |
| Structural Ties | E185 | E72 | - | Bearing |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars (286) | 30 mph | N / A |
| 2 - GP-9 locomotives and 263 kip cars (263) | 30 mph | N / A |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A |

## 28.4 Mile 46.8 – Optional Bridge Replacement

It is unlikely that this bridge will need to be replaced in the next 30 years; therefore we are not providing the cost estimate for the replacement of this bridge.

## 28.5 Mile 46.8 – Cost Summary Table: Present to Year 2021

**Bridge 46.8 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required. | $3,000 |
| X | | | | Bridge annual visual inspections – (by SVI forces) | $0 |
| | X | | | Replace all (23) bridge ties with 16”x10” ties (cost excluded) | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

## 28.6 Mile 46.8 – Cost Summary Table: Years 2021 to 2031

**Bridge 46.8 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2021 (investigates for cracks and corrosion loss in steel members, investigate timber ties). | $3,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $3,000 |
| X | | | | Bridge annual visual inspections (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

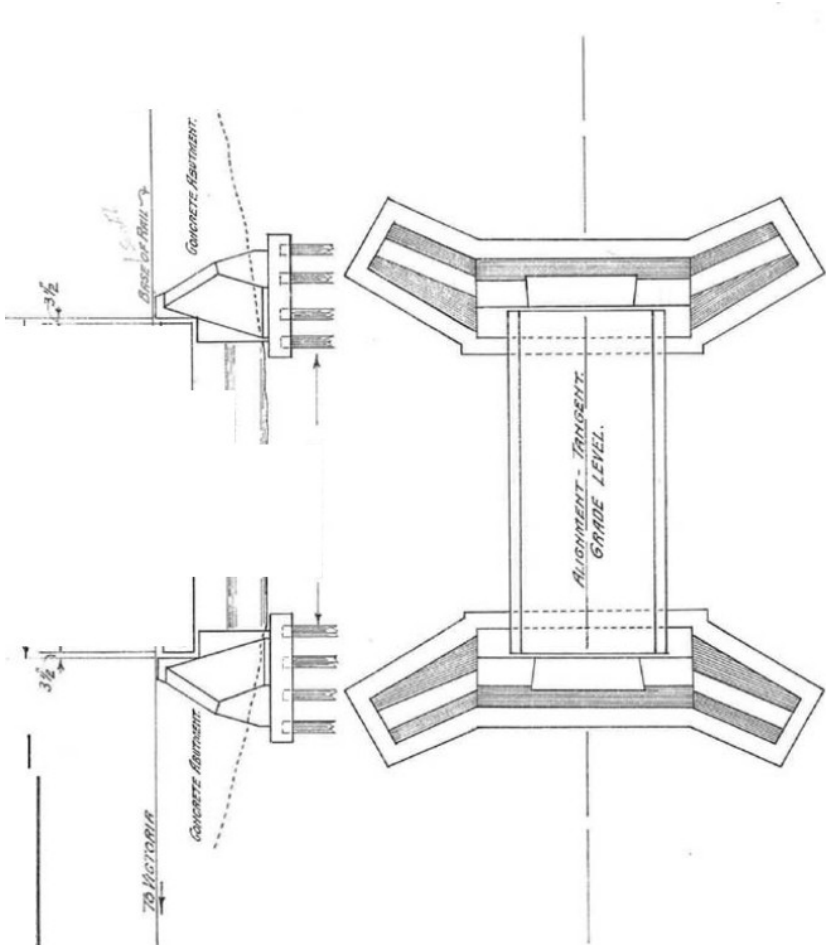
## 28.7 Mile 46.8 – Cost Summary Table: Years 2031 to 2041

**Bridge 46.8 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2031. (investigate for cracks and corrosion loss in steel members, investigate timber ties) – one required | $3,000 |
| X | | | | Clean debris on the bridge every 5 years to prevent accelerated corrosion of steel members, in particular on girder flanges | $3,000 |
| X | | | | Bridge annual visual inspections (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$6,000** |

# 46.80 – Victoria Subdivision – Whitehouse Creek

**Bridge General Arrangement**



# 29 Mile 47.9 – Chemainus River

## 29.1 Mile 47.9 – Description

Bridge 47.9 is a single span open deck bridge over the Chemainus River. The superstructure consists of a 155'-6" ft. steel through truss, with steel floor beams and stringers. The truss was previously used on a different location. The bridge is on a straight alignment. The bridge was reinforced in 1940's; bridge stringers were reinforced by queen posts (4 rows of adjustable eye bars).

The bridge is supported by stone masonry block abutment with concrete wing walls and ballast wall. Reinforced concrete jacket constructed at South abutment. North abutment is bearing on natural rock; south abutment is supported by timber piles.

**Bridge Design Load**: Unknown
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 10 mph
**Desired Speed**: 30 mph

### 29.2 Mile 47.9 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011. The inspection revealed the following immediate concerns:

- Stringer strengthening detail (Queen posts) appears not to be functioning. Inspection revealed cracks in some of the tension bars under the stringers, as well as loose bars.

The immediate concerns shall be repaired to ensure stability of the bridge.

The inspection also revealed the following:

- Ties generally in good conditions, replaced in 2006.
- Bearing rollers out of square.
- Cracked bottom lateral bracing connection L2R.
- Cracks in masonry blocks in north abutment.
- Eye bar bent at 4th bay of west truss.
- Loose rivets in floor beam to stringer connections.
- Cotter pin missing from pin at horizontal side sway member from U6L to U7R.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 29.3 Mile 47.9 – Load Rating

Detailed load rating is provided because the bridge design load is unknown, making it impossible to rate by comparison. The evaluation is conducted for representative truss components, floor beams and stringers.

The load rating results shown in the following table are based on an steel yield strength of Fy = 30 ks; based on recommendations in AREMA for the year of construction.

The evaluation is conducted for representative truss components, floor beams and stringers.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E48 | E43 | - | Compression |
| Truss vertical | E71 | E47 | - | Compression |
| Truss vertical | E102 | E56 | - | Tension |
| Truss bottom chord, Panel 1 | E57 | E44 | - | Tension |
| Truss bottom chord, Panel 2 | E57 | E45 | - | Tension |
| Truss bottom chord, Panel 3 | E38 | E44 | 15% | Tension |
| Truss bottom chord, Panel 4 | E37 | E42 | 13% | Tension |
| Truss bottom chord, Panel 5 | E36 | E43 | 19% | Tension |
| Truss diagonal, Panel 2 | E33 | E44 | 36% | Tension |
| Truss diagonal, Panel 3 | E33 | E46 | 38% | Tension |
| Truss diagonal, Panel 4+ | E41 | E48 | 16% | Tension |
| Truss diagonal, Panel 4- | E51 | E51 | 1% | Tension |
| Truss diagonal, Panel 5 | E44 | E48 | 8% | Tension |
| Floor beam | E52 | E56 | 8% | Bending |
| Floor beam | E89 | E55 | - | Shear |
| Stringer tie rod | E38 | E55 | 46% | Tension |
| Stringer | E51 | E58 | 16% | Bending+axial |
| Stringer | E111 | E59 | - | Shear |

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | No need | | - | Compression |
| Truss vertical | No need | | - | Compression |
| Truss vertical | No need | | - | Tension |
| Truss bottom chord, Panel 1 | No need | | - | Tension |
| Truss bottom chord, Panel 2 | No need | | - | Tension |
| Truss bottom chord, Panel 3 | E41 | E43 | 5% | Tension |
| Truss bottom chord, Panel 4 | E40 | E42 | 3% | Tension |
| Truss bottom chord, Panel 5 | E39 | E43 | 9% | Tension |
| Truss diagonal, Panel 2 | E36 | E44 | 24% | Tension |
| Truss diagonal, Panel 3 | E36 | E46 | 26% | Tension |
| Truss diagonal, Panel 4+ | E45 | E47 | 6% | Tension |
| Truss diagonal, Panel 4- | No need | | - | Tension |
| Truss diagonal, Panel 5 | E49 | E48 | - | Tension |
| Floor beam | E61 | E55 | - | Bending |
| Floor beam | No need | | - | Shear |

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Stringer tie rod | E44 | E55 | 26% | Tension |
| Stringer | E58 | E58 | - | Bending+axial |
| Stringer | No need | | - | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E48 | E39 | - | Compression |
| Truss vertical | E71 | E44 | - | Compression |
| Truss vertical | E102 | E51 | - | Tension |
| Truss bottom chord, Panel 1 | E57 | E41 | - | Tension |
| Truss bottom chord, Panel 2 | E57 | E41 | - | Tension |
| Truss bottom chord, Panel 3 | E38 | E40 | 6% | Tension |
| Truss bottom chord, Panel 4 | E37 | E38 | 4% | Tension |
| Truss bottom chord, Panel 5 | E36 | E39 | 10% | Tension |
| Truss diagonal, Panel 2 | E33 | E41 | 25% | Tension |
| Truss diagonal, Panel 3 | E33 | E42 | 27% | Tension |
| Truss diagonal, Panel 4+ | E41 | E44 | 7% | Tension |
| Truss diagonal, Panel 4- | E51 | E47 | - | Tension |
| Truss diagonal, Panel 5 | E44 | E44 | - | Tension |
| Floor beam | E52 | E51 | - | Bending |
| Floor beam | E89 | E51 | - | Shear |
| Stringer tie rod | E38 | E51 | 34% | Tension |
| Stringer | E51 | E54 | 7% | Bending+Axial |
| Stringer | E111 | E54 | - | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | No need | | - | Compression |
| Truss vertical | No need | | - | Compression |
| Truss vertical | No need | | - | Tension |
| Truss bottom chord, Panel 1 | No need | | - | Tension |
| Truss bottom chord, Panel 2 | No need | | - | Tension |
| Truss bottom chord, Panel 3 | E41 | E38 | - | Tension |
| Truss bottom chord, Panel 4 | E40 | E40 | - | Tension |
| Truss bottom chord, Panel 5 | E39 | E39 | 1% | Tension |

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss diagonal, Panel 2 | E36 | E41 | 14% | Tension |
| Truss diagonal, Panel 3 | E36 | E42 | 16% | Tension |
| Truss diagonal, Panel 4+ | E45 | E43 | - | Tension |
| Truss diagonal, Panel 4- | No need | | - | Tension |
| Truss diagonal, Panel 5 | No need | | - | Tension |
| Floor beam | No need | | - | Bending |
| Floor beam | No need | | - | Shear |
| Stringer tie rod | E44 | E51 | 16% | Tension |
| Stringer | E58 | E53 | - | Bending+Axial |
| Stringer | No need | | - | Shear |
| | | | | |
| | | | | |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E48 | E13 | - | Compression |
| Truss vertical | E71 | E16 | - | Compression |
| Truss vertical | E102 | E18 | - | Tension |
| Truss bottom chord | E31 | E13 | - | Tension |
| Truss diagonal | E19 | E15 | - | Tension |
| Floor beam | E52 | E18 | - | Bending |
| Floor beam | E89 | E18 | - | Shear |
| Stringer tie rod | E38 | E23 | - | Tension |
| Stringer | E51 | E25 | - | Bending+Axial |
| Stringer | E111 | E22 | - | Shear |

**Rating Recommendation**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars (286) | N / A | Replace bridge (see note 1) |
| 2 - GP-9 locomotives and 263 kip cars (263) | N ./ A | Replace bridge (see note 1) |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A |

Notes:

1. Bridge replacement is recommended for 286 and 263 trains. For detailed discussion see section titled “Mile 47.9 – Optional Bridge Replacement”.

### 29.4 Mile 47.9 – Optional Bridge Replacement

Truss components of this bridge were fabricated prior to 1909, when the pin-connected truss was installed in the present location. The bridge is over 100 years old. The truss bottom chord and diagonals are overstressed under the 263 kip and 268 kip assessment train loadings, based on the calculations described above. Considering the overall poor condition of the bridge, we recommend that this bridge be replaced if it is to facilitate 263 kip and 268 kip freight trains. While bridge strengthening to facilitate the freight trains may be technically feasible, we are not aware a similar recent example; and investigation of the possibilities for the truss reinforcement is in not in a scope of this report.

Bridge replacement is not required if the intention is to use the bridge for the specified passenger trains.

The load evaluation is conducted in accordance with AREMA code for 'normal load'. The load factors are effectively equivalent for load evaluation of existing bridges and for new bridge design. In the evaluation of highway bridges, Section 14 of the Canadian Highway Bridge Design Code S6-06 allows a substantial reduction of the load factors for evaluating bridges currently in service. The reduction of load factors for highway bridges is in the order of 25%, which is greater than the 16% overstress we have for 263 kip cars at 10mph. In addition, the amount of the overstress would be reduced slightly for 5 mph speed. There is also the potential that the use of freight trains with cars lighter than the 263 kip cars in the analysis may allow continuing operation without bridge replacement.

The estimated replacement cost for the bridge could be in the order of $2,400,000. This cost is based on the estimate provided in the 2003 inspection report, adjusted 30% for inflation (3.5% annually). As it is unlikely the substructure complies with the modern codes, we assume that the substructure will be replaced with the superstructure

## 29.5 Mike 47.9 – Cost Summary Tables: Present to Year 2021

**Bridge 47.9 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members in particular around stringer supports – two required | $5,000 |
| X | | | | Bridge annual visual inspections – ten required (by SVI forces) | $0 |
| | | X | | Replace Bearings | $25,000 |
| | | X | | Repair cracked bottom lateral bracing connection L2R. | $4,000 |
| | | X | | Straighten bent eye bar at 4th bay of west truss. | $2,000 |
| | | X | | Replace loose rivets in floor beam to stringer connections with bolts | $5,000 |
| | | X | | Install cotter pin missing from pin at horizontal side sway member from U6L to U7R. | $500 |
| | | | | **Passenger Subtotal** | **$41,500** |

**Bridge 47.9 – Projected Cost Summary to Operate Bridges until Year 2021**
**263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| | | | X | Replace the bridge | $2,400,000 |
| X | | | | Bridge annual visual inspections (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$2,400,000** |

## 29.6 Mile 47.9 – Cost Summary Table: Years 2021 to 2031

**Bridge 47.9 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2021 | $4,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $4,000 |
| X | | | | Bridge annual visual inspections – ten required (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

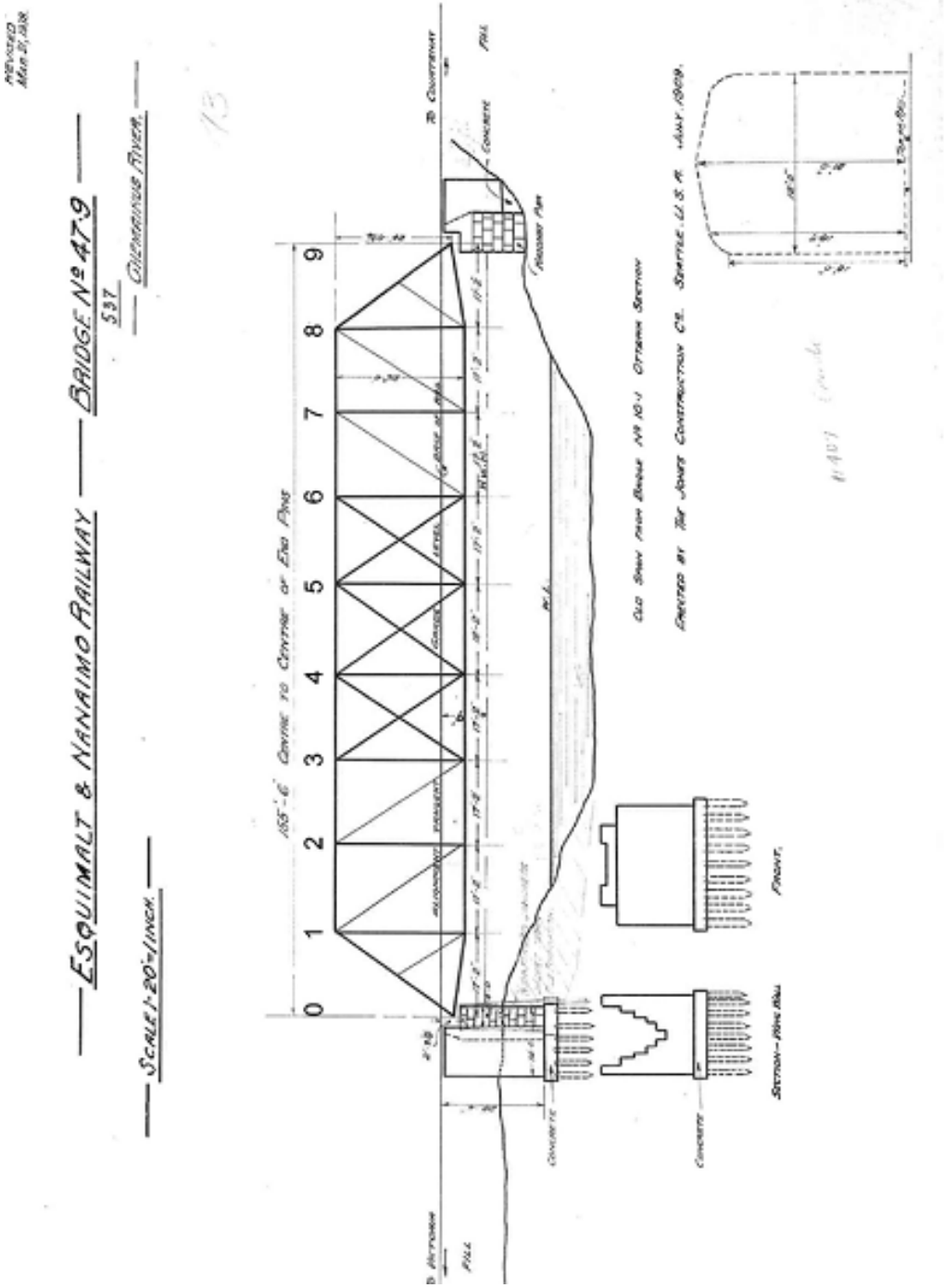
## 29.7 Mile 47.9 – Cost Summary Table: Years 2031 to 2041

**Bridge 47.9 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263 kip and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2031 | $4,000 |
| X | | | | Clean debris on the bridge every five years to prevent accelerated corrosion of steel members, in particular around stringer supports - two required | $4,000 |
| X | | | | Bridge annual visual inspections – ten required (by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

# 47.90 – Victoria Subdivision – Chemainus River

**Bridge General Arrangement:**



# 30 Mile 60.7 – Harrison Creek

## 30.1 Mile 60.7 – Description

Bridge 60.7 is a single span open deck bridge over the Harrison Creek. The superstructure consists of a 106 ft. steel (material unconfirmed) through pony truss, with steel floor beams and stringers. The bridge is on a slight horizontal curve (4 degree curve R). The rail offset form the bridge centerline is 8” at abutments and 4” in the opposite direction at the mid span. As the eccentricity is relatively low and the impact of centrifugal force is minute considering the low train speed (maximum allowable speed of 10 mph for GP-9 locomotives and 286 kip cars), the impact of horizontal curvature on the load evaluation results is negligible.

Bridge in present configuration erected 1915, trusses fabricated in 1896, previously used at another location. Flooring system strengthened in 1940 per existing plans. The bridge is supported by concrete abutments on timber piles.

**Bridge Design Load**: Unknown
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 10 mph
**Desired Speed**: 30 mph

## 30.2 Mile 60.7 – Inspection

Detailed bridge inspection, including non-destructive testing, was conducted in 2011. The inspection revealed the following immediate concerns:

- Timber ties on the truss span (10" wide x 15" deep) are in poor condition and need to be replaced. We recommend that all the ties in the girder span (10" wide x 15" deep) be replaced at the same time.

Inspection also revealed only minor corrosion of all steel elements. Based on this no allowances were made for corrosion loss when determining steel section properties.

Inspection revealed that the South abutment pot bearing or rocker bearing may be locked and not allowing movement. At this point there are no visible adverse consequences of bearing failure on the bridge structure.

For detailed inspection results refer to the Inspection Report dated February 2012.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord U5 – U6 | E-44 | E-41 | - | Compression |
| Truss top chord U3 – U5 | E-43 | E-44 | 2% | Compression |
| Truss top chord U1 – U3 | E-57 | E-46 | - | Compression |
| Truss vertical | E-147 | E-60 | - | Tension |
| Truss bottom chord L4 – L6 | E-45 | E-43 | - | Tension |
| Truss bottom chord L2 – L4 | E-49 | E-45 | - | Tension |
| Truss bottom chord L0 – L2 | E-46 | E-47 | 1% | Tension |
| Truss diagonal U5 – L6 (C) | E-64 | E-57 | - | Compression |
| Truss diagonal U5 – L6 (T) | E-72 | E-52 | - | Tension |
| Truss diagonal L4 – U5 (C) | E-66 | E-49 | - | Compression |
| Truss diagonal L4 – U5 (T) | E-274 | E-60 | - | Tension |
| Truss diagonal U3 – L4 (T) | E-53 | E-49 | - | Tension |
| Truss diagonal L2 – U3 (C) | E-48 | E-48 | - | Compression |
| Truss diagonal U1 – L2 (T) | E-42 | E-48 | 14% | Tension |
| Truss diagonal L0 – U1 (C) | E-73 | E-47 | - | Compression |
| Floor beam | E-50 | E-55 | 10% | Bending |
| Floor beam | E-55 | E-55 | - | Shear |
| Stringer “S” | E-53 | E-55 | 4% | Bending |
| Stringer “S” | E-91 | E-58 | - | Shear |
| Stringer “S1” | E-67 | E-55 | - | Bending |
| Stringer “S1” | E-136 | E-58 | - | Shear |
| Stringer “S2” | E-69 | E-72 | 4% | Bending |
| Stringer “S2” | E-92 | E-72 | - | Shear |
| Stringer “S3” | E-105 | E-72 | - | Bending |
| Stringer “S3” | E-128 | E-72 | - | Shear |

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord U5 – U6 | Rating not required, see results at 30 mph | | | |
| Truss top chord U3 – U5 | E-48 | E-44 | - | Compression |
| Truss top chord U1 – U3 | Rating not required, see results at 30 mph | | | |
| Truss vertical | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L4 – L6 | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L2 – L4 | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L0 – L2 | E-52 | E-47 | - | Tension |
| Truss diagonal U5 – L6 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U5 – L6 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L4 – U5 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L4 – U5 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U3 – L4 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L2 – U3 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U1 – L2 (T) | E-47 | E-48 | 3% | Tension |
| Truss diagonal L0 – U1 (C) | Rating not required, see results at 30 mph | | | |
| Floor beam | E-59 | E-55 | - | Bending |
| Floor beam | E-65 | E-55 | - | Shear |
| Stringer “S” | E-63 | E-55 | - | Bending |
| Stringer “S” | E-107 | E-58 | - | Shear |
| Stringer “S2” | E80 | E72 | - | Bending |
| Stringer “S2” | E107 | E72 | - | Shear |

**Ratings (2 - GP-9 locomotives and 263 kip cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord U5 – U6 | E-44 | E-38 | - | Compression |
| Truss top chord U3 – U5 | E-43 | E-41 | - | Compression |
| Truss top chord U1 – U3 | E-57 | E-42 | - | Compression |
| Truss vertical | E-147 | E-50 | - | Tension |
| Truss bottom chord L4 – L6 | E-45 | E-39 | - | Tension |
| Truss bottom chord L2 – L4 | E-49 | E-42 | - | Tension |
| Truss bottom chord L0 – L2 | E-46 | E-43 | - | Tension |
| Truss diagonal U5 – L6 (C) | E-64 | E-51 | - | Compression |
| Truss diagonal U5 – L6 (T) | E-72 | E-48 | - | Tension |
| Truss diagonal L4 – U5 (C) | E-66 | E-45 | - | Compression |
| Truss diagonal L4 – U5 (T) | E-274 | E-55 | - | Tension |
| Truss diagonal U3 – L4 (T) | E-53 | E-45 | - | Tension |
| Truss diagonal L2 – U3 (C) | E-48 | E-45 | - | Compression |
| Truss diagonal U1 – L2 (T) | E-42 | E-44 | 5% | Tension |
| Truss diagonal L0 – U1 (C) | E-73 | E-43 | - | Compression |
| Floor beam | E-50 | E-55 | 10% | Bending |
| Floor beam | E-55 | E-55 | 1% | Shear |

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Stringer “S” | E-53 | E-55 | 4% | Bending |
| Stringer “S” | E-91 | E-58 | - | Shear |
| Stringer “S2” | E-69 | E-66 | - | Bending |
| Stringer “S2” | E-92 | E-66 | - | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord U5 – U6 | Rating not required, see results at 30 mph | | | |
| Truss top chord U3 – U5 | Rating not required, see results at 30 mph | | | |
| Truss top chord U1 – U3 | Rating not required, see results at 30 mph | | | |
| Truss vertical | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L4 – L6 | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L2 – L4 | Rating not required, see results at 30 mph | | | |
| Truss bottom chord L0 – L2 | Rating not required, see results at 30 mph | | | |
| Truss diagonal U5 – L6 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U5 – L6 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L4 – U5 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L4 – U5 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U3 – L4 (T) | Rating not required, see results at 30 mph | | | |
| Truss diagonal L2 – U3 (C) | Rating not required, see results at 30 mph | | | |
| Truss diagonal U1 – L2 (T) | E-47 | E-44 | - | Tension |
| Truss diagonal L0 – U1 (C) | Rating not required, see results at 30 mph | | | |
| Floor beam | E-59 | E-50 | | Bending |
| Floor beam | E-65 | E-50 | | Shear |
| Stringer “S” | E-63 | E-50 | - | Bending |
| Stringer “S” | E-107 | E-53 | - | Shear |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord U5 – U6 | E-44 | E-14 | - | Compression |
| Truss top chord U3 – U5 | E-43 | E-14 | - | Compression |
| Truss top chord U1 – U3 | E-57 | E-14 | - | Compression |
| Truss vertical | E-147 | E-20 | - | Tension |
| Truss bottom chord L4 – L6 | E-45 | E-14 | - | Tension |
| Truss bottom chord L2 – L4 | E-49 | E-14 | - | Tension |
| Truss bottom chord L0 – L2 | E-46 | E-15 | - | Tension |
| Truss diagonal U5 – L6 (C) | E-74 | E-18 | - | Compression |
| Truss diagonal U5 – L6 (T) | E-72 | E-18 | - | Tension |
| Truss diagonal L4 – U5 (C) | E-66 | E-18 | - | Compression |
| Truss diagonal L4 – U5 (T) | E-274 | E-18 | - | Tension |
| Truss diagonal U3 – L4 (T) | E-53 | E-17 | - | Tension |

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss diagonal L2 – U3 (C) | E-48 | E-16 | - | Compression |
| Truss diagonal U1 – L2 (T) | E-42 | E-15 | - | Tension |
| Truss diagonal L0 – U1 (C) | E-73 | E-15 | - | Compression |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars | 10 mph | Truss diagonal U1 to L2 (see Note 1) |
| 2 - GP-9 locomotives and 263 kip cars | 20 mph | Truss diagonal U1 to L2 (see Note 1) |
| 3 – RDC-1 Passenger Vehicles | 30 mph | N / A (see Note 2) |

Notes:

1. Truss diagonal U1 – L2 needs to be reinforced to ensure the bridge can support the assessment trains. For location see the bridge GA drawing.
2. Observation of the bridge under the train load conducted for low train speed only. We recommend the observation of bridge under a passenger train travelling at 30 mph be conducted prior to re-establishing passenger traffic.

## 30.3 Mile 60.7 – Optional Bridge Replacement

Steel truss components of Mile 60.7 Bridge were fabricated in 1896, they are now 105 years old. In our opinion, there is a possibility that the bridge may have to be replaced in the next 30 years to maintain the railway traffic. However, we cannot calculate the probability of truss failure in the next 30 years. Intensifying the railway traffic over the bridge may shorten the lifespan of the structure.

Estimated replacement cost for the bridge could be in the order of $2,600,000. This cost is based on the estimate provided in the 2003 inspection report, adjusted 30% for inflation. As the substructure probably does not comply with the modern codes, we assume that the substructure will be replaced with the superstructure.

There is also a strong possibility that the existing structure will survive another 30 years, particularly in case that the traffic is light. Therefore we do not recommend that the above replacement cost is included as a likely cost to maintain traffic to 2041.

## 30.4 Mile 60.7 – Cost Summary Table: Present to Year 2021

**Bridge 60.7 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | X | | Replace 14 ties in poor condition (cost excluded) | $0 |
| | | | X | Observe the bridge under a passenger train traveling at 30 mph be conducted prior to re-establishing passenger traffic. SVI will provide the train. | $1,000 |
| | | | | **Subtotal All Loadings** | **$4,000** |

**Bridge 60.7 – Projected Cost Summary to Operate Bridges until Year 2021**
**263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | X | | Replace 14 ties in poor condition (cost excluded) | $0 |
| | | | X | Reinforce truss diagonal U1 – L2 (location highlighted on the Bridge GA drawing in this report). | $25,000 |
| | | | | **Subtotal All Loadings** | **$28,000** |

### 30.5 Mile 60.7 – Cost Summary Table: Years 2021 to 2031

**Bridge 60.7 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2021 | $5,000 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| X | | | | Replace remaining 66 ties in poor condition, not replaced prior to 2021 | Cost Excluded |
| | | | | **Subtotal All Loadings** | **$8,000** |

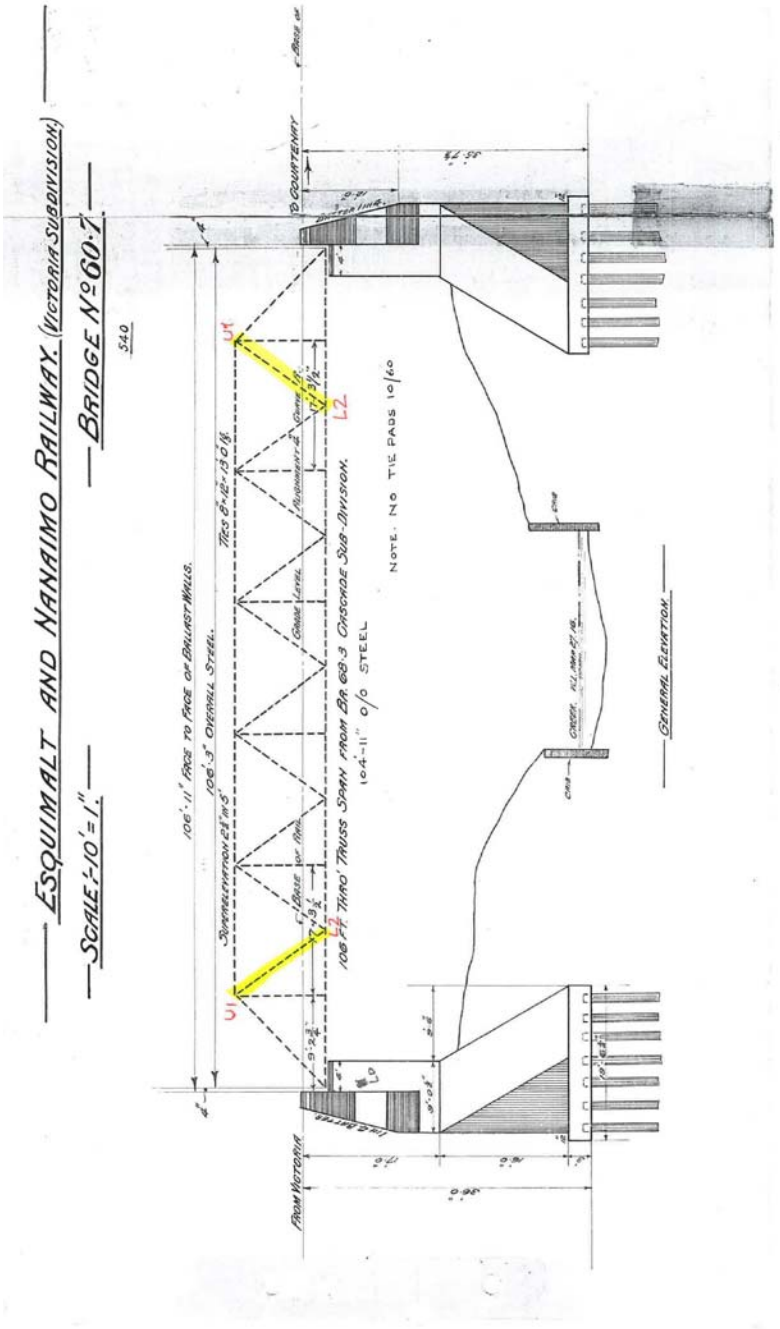
### 30.6 Mile 60.7 – Cost Summary Table: Years 2031 to 2041

**Bridge 60.7 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| X | | | | Detailed bridge inspection in 2031 | $5,000 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

# 60.70 – Victoria Subdivision – Harrison Creek

**Bridge General Arrangement:**



# 31 Mile 64.4 – Lochner Road and Haslam Creek

## 31.1 Mile 64.4 – Description

Bridge 64.4 is a two-span open deck bridge over the Haslam Creek River. The superstructure consists of one southern span of 76'-4" deck truss, with steel floor beams and stringers and a northern span of 25 ft 5-inches with steel I-Beam Stringers. The bridge is on a straight alignment.

Bridge in present configuration erected 1911; the steel members of the truss were strengthened in 1940. The bridge is supported by cast-in-place concrete abutments at outer ends and a concrete pier at the location where the truss and stringer spans meet.

**Bridge Design Load**: E-50
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars
**Current Speed Limit**: 30 mph
**Desired Speed**: 30 mph

### 31.2 Mile 64.4 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011. The inspection revealed the following immediate concerns:

- Timber ties on the truss span (10" wide x 15" deep) are in poor condition and need to be replaced. We recommend that all the ties in the girder span (10" wide x 15" deep) be replaced at the same time.

The bridge bearings have deteriorated and appear to be ineffective. The bearing condition is unchanged for several years; similar condition is described in the 2003 inspection report. Since there are no visible adverse consequences of seized beadings we recommend that the condition be monitored, we are not recommending the bearing replacement at this point.

We also recommend monitoring the following:

- Look for signs of scour at river piers (scour protection currently in place).
- Monitor top chord of east truss that is bowed up at midspan where vertical post connects.
- Monitor impact damage to bottom flange of Span 2.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 31.3 Mile 64.4 – Load Rating

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel beam | E-70 | E-57 | - | Bending |
| Steel beam | E-161 | E-61 | - | Shear |

Note: 10 mph not needed.

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel beam | E-70 | E-53 | - | Bending |
| Steel beam | E-161 | E-56 | - | Shear |

Note: 10 mph not needed.

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel beam | E-70 | E-20 | - | Bending |
| Steel beam | E-161 | E-19 | - | Shear |

Note: 10 mph not needed.

### *Span 2 Load Rating Results*

The span is designed to Cooper E-50 as shown in record drawings. Direct comparison between E-50 and all evaluation trains are positive except for top chord, verticals and some diagonals. Consequently rating is only given for these components.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E-44 | E-51 | 16% | Bending+axial |
| Truss vertical | E-128 | E-63 | - | Compression |
| Truss diagonal | E-78 | E-52 | - | Tension |
| Truss diagonal | E-52 | E-55 | 4% | Compression |

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E-50 | E-51 | 2% [1] | Bending+axial |
| Truss vertical | No need | | - | Compression |
| Truss diagonal | No need | | - | Tension |
| Truss diagonal | E-59 | E-55 | - | Compression |

Note [1]: 2% overstress is considered acceptable.

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E-44 | E-48 | 8% | Bending+axial |
| Truss vertical | E-128 | E-58 | - | Compression |
| Truss diagonal | E-78 | E-48 | - | Tension |
| Truss diagonal | E-52 | E-51 | - | Compression |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Truss top chord | E-50 | E-48 | - | Bending+axial |
| Truss vertical | No need | | - | Compression |
| Truss diagonal | No need | | - | Tension |
| Truss diagonal | No need | | - | Compression |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| **Normal Rating** | **Component Cooper Rating** | **Eqv. Cooper Demand** | **Overstress** | **Mode** |
| Truss top chord | E-44 | E-24 | - | Bending+axial |
| Truss vertical | E-128 | E-23 | - | Compression |
| Truss diagonal | E-78 | E-20 | - | Tension |
| Truss diagonal | E-52 | E-20 | - | Compression |

(Note: Rating of Passenger Vehicles, 130 KIP each @ 10 mph is not required because rating of same vehicles at 30 mph is positive.)

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars | 10 mph | N / A |
| 2 - GP-9 locomotives and 263kip cars | 10 mph | N / A |
| 3 – RDC-1 Passenger Vehicles | 30 mph | N / A |

## 31.4 Mile 64.4 – Optional Bridge Replacement

The bridge is 100 years old and needs to be monitored, but is may last another 30 years. Estimated replacement cost for the bridge could be in the order of $2,500,000. This cost is based on the estimate provided in the 2003 inspection report, adjusted 30% for inflation (3.5% annually). As the substructure probably does not comply with the modern codes, we assume that the substructure will be replaced with the superstructure.

We do not recommend that the above replacement cost be included as a likely cost to maintain traffic to 2041.

## 31.5 Mile 64.4 – Cost Summary Table: Present to Year 2021

**Bridge 64.4 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs | StrengtheningStrengthening | | |
| | X | | | Replace All Bridge Ties (cost excluded) | $0 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$3,000** |

## 31.6 Mile 64.4 – Cost Summary Table: Years 2021 to 2031

**Bridge 64.4 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs | StrengtheninStrengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2021. | $5,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

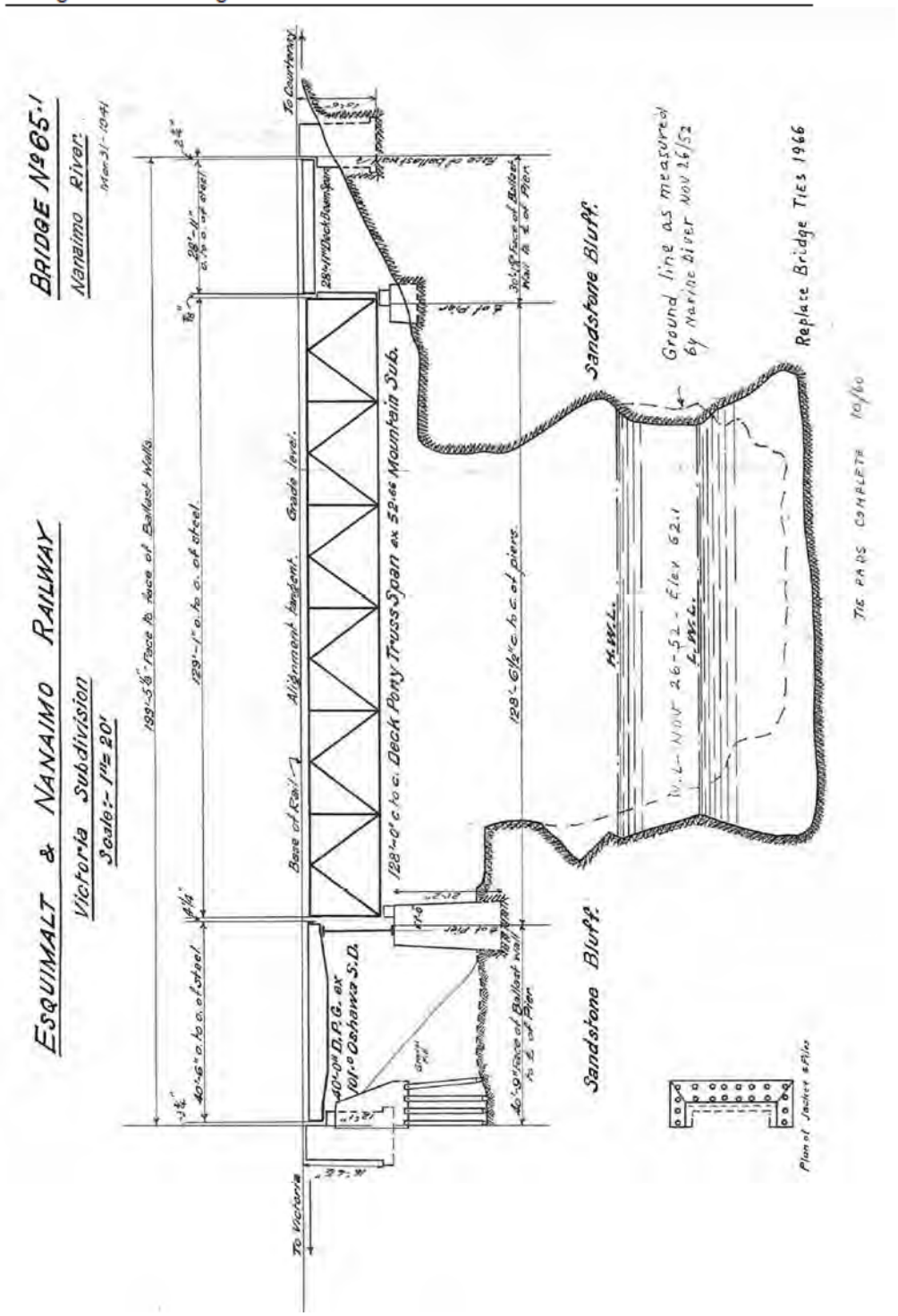
## 31.7 Mile 64.4 – Cost Summary Table: Years 2031 to 2041

**Bridge 64.4 – Projected Cost Summary to Operate Bridges - Years 2031 to 2041**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs | Strengthening Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2031. | $5,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

## 64.40 – Victoria Subdivision – Lochner Rd/Haslam Cr

**Bridge General Arrangement:**



# 32 Mile 65.1 – Nanaimo River

## 32.1 Mile 65.1 – Description

Bridge 65.1 consists of three steel spans. End spans are DPG's with spans of 40' and 28'-11". Main span is a steel deck truss with a span of 128'. The bridge is on a tangent alignment. The structure is supported on masonry block piers and abutments. The piers and one of the abutments are bearing on the natural rock (sandstone bluff) while the other abutment is supported by timber piles. The piers are situated above a deep canyon; stability of sandstone bluff supporting the piers is a concern although there is no evidence of movement of the supporting rock.

**Bridge Design Load**: E50
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars.
**Current Speed Limit**: 30 mph
**Desired Speed**: 30 mph

## 32.2 Mile 65.1 – Inspection

Detailed bridge inspection, including non-destructive testing, was conducted in 2011. The inspection revealed the following immediate concerns:

- 36 (out of 150) timber ties are in poor condition and need to be replaced.
- Refuge bay is missing, which is a safety concern; refuge bay can be installed as a part of deck replacement.

Inspection also revealed only minor corrosion of all steel elements. Based on this no allowances were made for corrosion loss when determining steel section properties. Refuge bay is missing, which is a safety concern; refuge bay can be installed as a part of deck replacement.

Previous inspection report indicates concerns with stability of sandstone bluff sporting the bridge piers.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 32.3 Mile 65.1 – Load Rating

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 129'-1" Top Chord #3 | E-50 | E-65 | 30% | Bending+ Axial |
| 129'-1" Top Chord #3 | E-50 | E-11 | - | Shear[1] |
| 40'-6" DPG | E-50 | E-40 | - | Bending |
| 40'-6" DPG | E-50 | E-59 | 17% | Shear[1] |
| 28'-5" DBG | E-50 | E-43 | - | Bending |
| 28'-5" DBG | E-50 | E-29 | - | Shear[1] |

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 129'-1" Top Chord #3 | E-50 | E-59 | 18% | Bending+ Axial |
| 129'-1" Top Chord #3 | E-50 | E-10 | - | Shear[1] |
| 40'-6" DPG | E-50 | E-35 | - | Bending |
| 40'-6" DPG | E-50 | E-50 | - | Shear[1] |
| 28'-5" DBG | Rating not required, see results at 30mph | | | |
| 28'-5" DBG | Rating not required, see results at 30mph | | | |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 129'-1" Top Chord #3 | E-50 | E-61 | 21% | Bending+ Axial |
| 129'-1" Top Chord #3 | E-50 | E-10 | - | Shear[1] |
| 40'-6" DPG | E-50 | E-37 | - | Bending |
| 40'-6" DPG | E-50 | E-54 | 7% | Shear |
| 28'-5" DBG | E-50 | E-40 | - | Bending |
| 28'-5" DBG | E-50 | E-27 | - | Shear |

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 129'-1" Top Chord #3 | E-50 | E-55 | 10% | Bending+ Axial |
| 129'-1" Top Chord #3 | E-50 | E-9 | - | Shear[1] |
| 40'-6" DPG | E-50 | E-32 | - | Bending |
| 40'-6" DPG | E-50 | E-46 | - | Shear |
| 28'-5" DBG | Rating not required, see results at 30mph | | | |
| 28'-5" DBG | Rating not required, see results at 30mph | | | |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| **Normal Rating** | **Component Cooper Rating** | **Eqv. Cooper Demand** | **Overstress** | **Mode** |
| 129'-1" Top Chord #3 | E-60 | E-30 | - | Bending |
| 129'-1" Top Chord #3 | E-60 | E-4.5 | - | Shear |
| 40'-6" DPG | E-50 | E-12 | - | Bending |
| 40'-6" DPG | E-50 | E-21 | - | Shear |
| 28'-5" DBG | E-50 | E-15 | - | Bending |
| 28'-5" DBG | E-50 | E-10 | - | Shear |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 10 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| 129'-1" Top Chord #3 | Rating not required, see results at 30 mph | | | |
| 129'-1" Top Chord #3 | Rating not required, see results at 30 mph | | | |
| 40'-6" DPG | Rating not required, see results at 30 mph | | | |
| 40'-6" DPG | Rating not required, see results at 30 mph | | | |
| 28'-5" DBG | Rating not required, see results at 30 mph | | | |
| 28'-5" DBG | Rating not required, see results at 30 mph | | | |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars (286) | 10mph | Reinforce Truss (see Note 1) |
| 2 - GP-9 locomotives and 263kip cars (263) | 10mph | Reinforce Truss (see Note 1) |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30mph | N / A |

Notes:

1: The Rating provided in this report is based on the assumption that the Essential Repairs listed below will be complete.

## 32.4 Mile 65.1 – Optional Bridge Replacement

The bridge is 102 years old and needs to be monitored, but it may last another 30 years, with repairs and strengthening described below. Estimated replacement cost for the bridge could be in the order of $2,700,000. This cost is based on the estimate provided in the 2003 inspection report, adjusted 30% for inflation (3.5% annually). As the substructure probably does not comply with the modern codes, we assume that the substructure will be replaced with the superstructure.

We do not recommend that the above replacement cost be included as a likely cost to maintain traffic to 2041.

## 32.5 Mile 65.1 – Cost Summary Tables: Present to Year 2021

**Bridge 65.1 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| | X | | | Replace 36 Ties in poor cond. (cost excluded) | $0 |
| | X | | | Investigate stability of sandstone bluff supporting bridge piers; this may require geotechnical and hydro technical expertise as well as sounding. | $20,000 |
| | | X | | Repair leaning timber wall at south end | $20,000 |
| X | | | | Clean debris from the bridge | $1,500 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal Passenger Loadings** | **$41,500** |

**Bridge 65.1 – Projected Cost Summary to Operate Bridges until Year 2021**
**263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | StrengtheningS trengthening | | |
| | X | | | Replace 36 Ties in poor cond. (cost excluded) | $0 |
| | X | | | Investigate stability of sandstone bluff supporting bridge piers; this may require geotechnical and hydro technical expertise as well as sounding. | $20,000 |
| | | | X | Reinforce truss top chord | $75,000 |
| | | X | | Repair leaning timber wall at south end | $20,000 |
| X | | | | Clean debris from the bridge | $1,500 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal 263 and 268 Loadings** | **$116,500** |

## 32.6 Mile 65.1 – Cost Summary Table: Years 2021 to 2031

**Bridge 65.1 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | StrengtheningS trengthening | | |
| | | X | | Replace Remaining Ties (cost excluded) | $0 |
| | | X | | Replace timber bearing block that is splitting at south abutment, east bearing | $10,000 |
| | | X | | Tuck point open joints between blocks in masonry wing walls at north end of bridge and masonry blocks with open joints at piers | $12,000 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2021. | $5,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$30,000** |

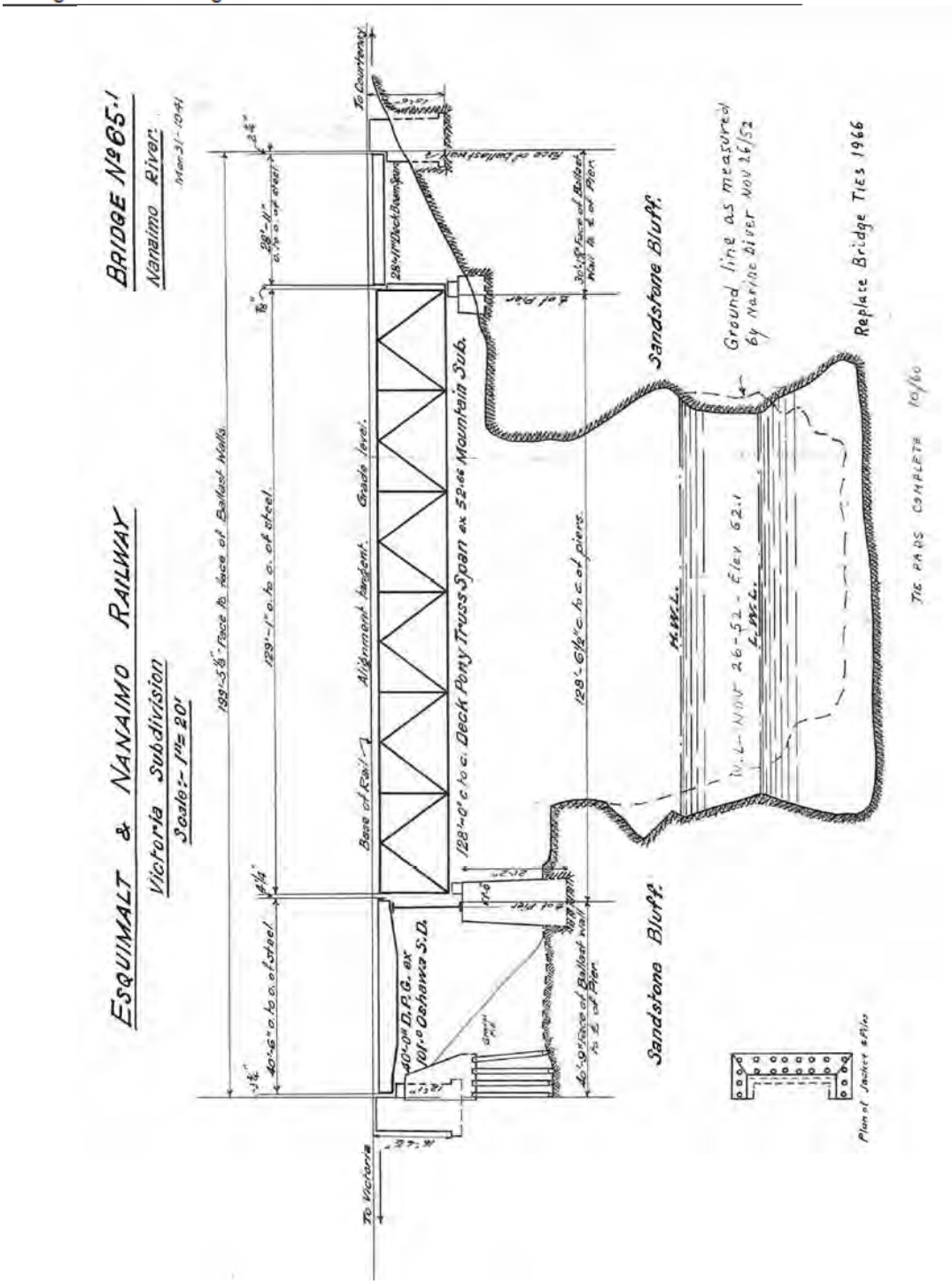
## 32.7 Mile 65.1 – Cost Summary Table: Years 2031 to 2041

**Bridge 65.1 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | StrengtheningS trengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2021. | $5,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$8,000** |

# 65.10 – Victoria Subdivision - Nanaimo River

**Bridge General Arrangement:**



# 33 Mile 0.69 – Wellcox Spur – Old Island Highway

## 33.1 Mile 0.69 – Description

Bridge 0.69 consists of two 53'-4" steel deck plate girders spanning over the highway, with 2-15' timber trestles on both sides of the bridge. One girder is riveted, constructed in 1953, while the other girder is welded plate girder, constructed in 1975, as well as timber stringers in the approach spans. Timber trestles, with two-four ply timber stringers, are conforming to CP standard design for E60 loading, supported centrally by a timber trestle. The bridge is on a straight alignment.

**Bridge Design Load**: Cooper E60
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars
**Current Speed Limit**: 10 mph
**Desired Speed**: 30 mph

### 33.2 Mile 0.69 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011.

Inspection revealed the following immediate concern:

- Vehicular impact damage of the bottom flange of riveted steel girder. Upon further inspection, this damage does not appear to compromise the stability of the bridge; the immediate repair is not required.
- 22 (approximately 50%) ties in span 4 (riveted steel girder) in poor condition.

Inspection also revealed the following deficiencies:

- 6 poor ties in approach spans 1,2,5,6.
- Five timber piles in poor condition: one in bent 2 two in bent 5, two in bent 6.

Inspection revealed no significant corrosion of the steel girders.

Timber stringers are generally in good condition, except one of the stringers in Span 2 has a 2” x 2” section loss – this section loss has no significant impact on the capacity of the stringer in flexure and shear.

For detailed inspection results refer to the Inspection Report dated February 2012.

### 33.3 Mile 0.69 – Load Rating

The bridge has six spans:

- Span 1 and 2: 15 ft timber trestle
- Span 3 and 4: 53 ft steel beam
- Span 5 and 6: 15 ft timber trestle

All spans are designed to Cooper E-60 as shown in the record drawings.

Direct comparisons between E-60 and evaluation trains are all positive and the results are given below.

### *Span 1, 2, 5 and 6 Load Rating Results*

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel girder | E-60 | E-44 | - | Bending |
| Steel girder | E-60 | E-46 | 4% [1] | Shear |
| Timber stringer | E-60 | E-58 | - | Bending |
| Timber stringer | E-60 | E-63 | 4% [1] | Shear |

Note [1]: Additional analysis and detailed inspection required to confirm positive evaluation

**Ratings (2 - GP-9 Locomotives and 263 kip Cars @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel girder | E-60 | E-40 | - | Bending |
| Steel girder | E-60 | E-43 | 1% [1] | Shear |
| Timber stringer | E-60 | E-54 | - | Bending |
| Timber stringer | E-60 | E-61 | 1% [1] | Shear |

Note [1]: Over stress of 1% is considered acceptable.

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 30 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Steel girder | E-60 | E-12 | - | Bending |
| Steel girder | E-60 | E-15 | - | Shear |
| Timber stringer | E-60 | E-20 | - | Bending |
| Timber stringer | E-60 | E-23 | - | Shear |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit |
|---|---|---|
| 4 - GP-9 locomotives and 286kip cars (286) | 30 mph | See note 1 |
| 2 - GP-9 locomotives and 263kip cars (263) | 30 mph | N / A |
| 3 – RDC-1 Passenger Vehicles (pass.) | 30 mph | N / A |

Notes:

1 A small overstress was identified in the timber stringers; additional analysis and detailed inspection required to confirm positive evaluation.

### 33.4 Mile 0.69 – Optional Bridge Replacement

As the bridge steel girders as well as substructure are in good condition, it is unlikely that the bridge replacement will be required in the next 30 years. Therefore we are not including the bridge replacement cost in our cost estimate. The replacement of the timber trestle side spans may be required; this cost is included.

### 33.5 Mile 0.69 – Cost Summary Table: Present to Year 2021

**Bridge 0.69 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading and 263 kip**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| | X | | | Replace 22 poor ties in span 4 (cost excluded) | $0 |
| | | X | | Replace 6 poor ties in sp.1,2,5,6 (cost excluded) | $0 |
| | | X | | Repair span 4 girder (bolt an extra local reinf. plate under damaged girder flange) | $7,000 |
| | | X | | Post 5 piles in Bent 6 | $25,000 |
| X | | | | Clean debris from the bridge at 5 years | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$35,000** |

**Bridge 0.69 – Projected Cost Summary to Operate Bridges until Year 2021, 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs | Strengthening | | |
| | X | | | Replace 22 poor ties in span 4 (cost excluded) | $0 |
| | | X | | Replace 6 poor ties in sp.1,2,5,6 (cost excluded) | $0 |
| | | X | | Repair span 4 girder (bolt an extra local reinf. plate under damaged girder flange) | $7,000 |
| | | X | | Post 5 piles in Bent 6 | $25,000 |
| X | | | | Clean debris from the bridge at 5 years | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | X | Additional analysis and inspection to confirm the capacity of 15 ft trestle to support 286 cars. | $5,000 |
| | | | | **Subtotal All Loadings** | **$40,000** |

## 33.6 Mile 0.69 – Cost Summary Table: Years 2021 to 2031

**Bridge 0.69 – Projected Cost Summary to Operate Bridges - Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Detailed bridge inspection in 2021 (investigate for cracks and corrosion loss in steel members, investigate timber ties and stringers). | $4,000 |
| | | X | | Replace Remaining Ties on steel span (cost excluded) | $0 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| | | X | | Repair/partially replace timber trestles (1/3 of 4-15ft spans) | $110,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$117,000** |

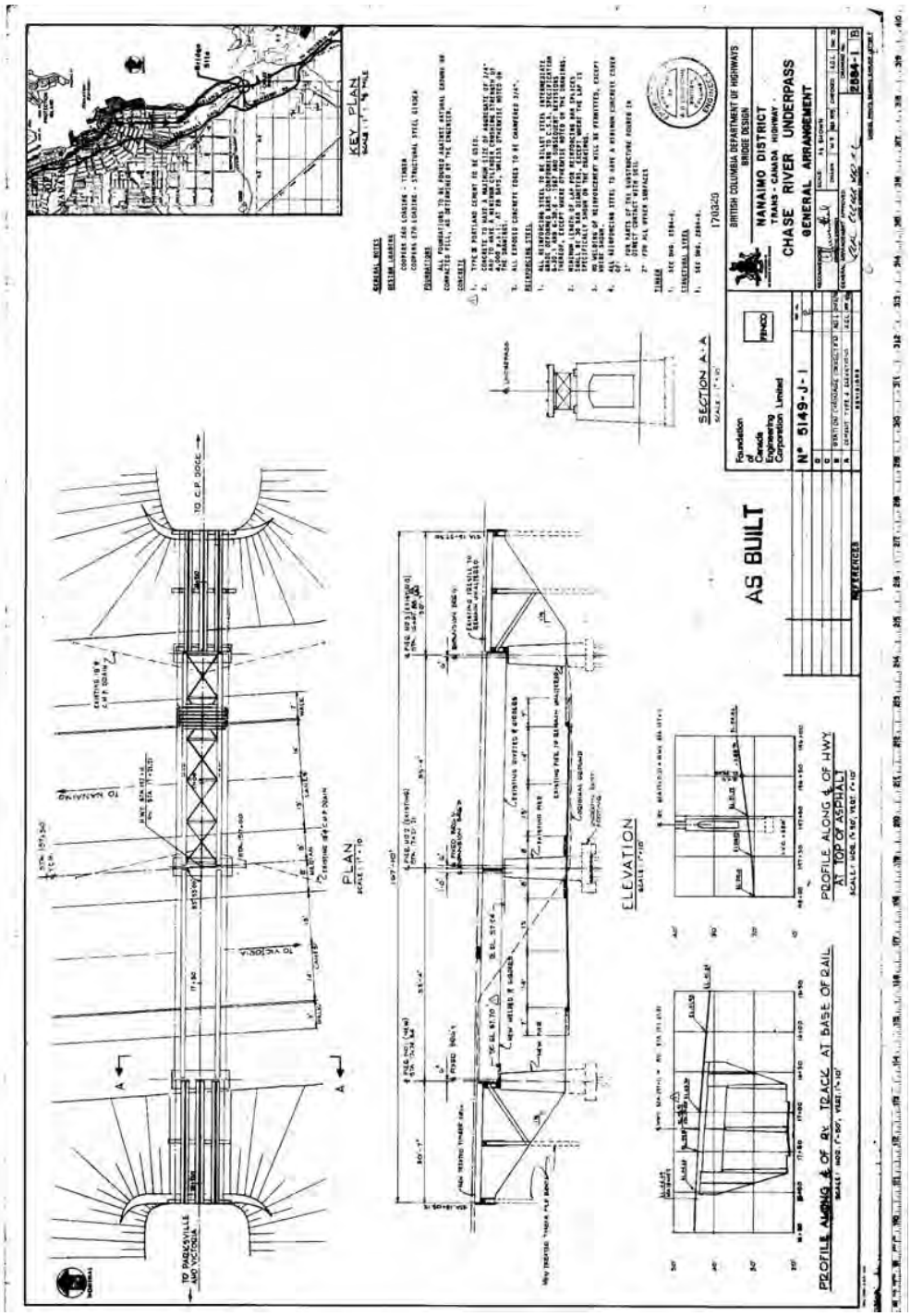
## 33.7 Mile 0.69 – Cost Summary Table: Years 2031 to 2041

**Bridge 0.69 – Projected Cost Summary to Operate Bridges - Year 2031 to 2041**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs (Immediate) | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2031. | $4,000 |
| | | X | | Repair/partially replace timber trestles (1/3 of 4-15ft spans) | $110,000 |
| X | | | | Bridge annual visual inspections–(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$117,000** |

# 0.69 – Wellcox Spur – Old Island Highway

**Bridge General Arrangement:**



# 34 Mile 1.02 – Wellcox Spur – Chase River

## 34.1 Mile 1.02 – Description

Bridge 1.02 consists of a centre span deck plate girder bridge with timber stringers on outer spans. The superstructure centre span consists of two 42 ft 10-inch wrought iron plate girders, with steel floor beams. Each outer span superstructure is a 2-15' timber structure, with two-four ply timber stringers, in conforming to CP standard design for E60 loading, supported centrally by a timber trestle. The bridge is on a straight alignment.

Bridge in present configuration erected 1953/1969. The centre span bridge is supported by cast-in-place concrete piers. The outer spans are supported by timber piles on the east side and a posted bent on the west side.

**Bridge Design Load**: Cooper E50 - steel span; E60 – timber spans
**Current Bridge Load**: 2-GP9 Locomotives and 263 kip cars
**Current Speed Limit**: 10 mph
**Desired Speed**: 15 mph

## 34.2 Mile 1.02 – Inspection

Detailed bridge inspection, including non-destructive testing, conducted 2011.

Inspection revealed the following immediate concern:

- Three square piles added recently to South end bent are not bearing on bent cap.

Bridge ties are generally in good condition, two poor ties counted on the bridge. No timber stringer damage noted.

Inspection also revealed corrosion of girder flanges. Based on the photograph in the inspection report we have conservatively assumed section loss of ¼ x ¼ inch in two top corners of the girder top flanges. This local section loss does not have a significant impact on the capacity of the girders.

For detailed inspection results refer to the Inspection Report dated February 2012.

## 34.3 Mile 1.02 – Load Rating

Detailed load rating of the steel span is provided because load effects of the Assessment Trains are greater that the effects of the assumed design load E50. Load rating by comparison with the design load (E60) conducted for the timber approach spans.

**Ratings (4 - GP-9 Locomotives and 286 kip Cars @ 15 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Plate Girder | E62 | E55 | - | Bending |
| Plate Girder | E70 | E53 | - | Shear |
| Timber Stringers | E60 | E60 | - | Bending |
| Timber Stringers | E60 | E63 | 4% [1] | Shear[1] |

Note [1]: Additional analysis and detailed inspection required to confirm positive evaluation.

**Ratings (2 - GP-9 Locomotives and 263 kip cars @ 15 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Plate Girder | E62 | E51 | - | Bending |
| Plate Girder | E70 | E49 | - | Shear |
| Timber Stringer | E60 | E55 | - | Bending |
| Timber Stringer | E60 | E58 | - | Shear |

**Ratings (3 – RDC-1 Passenger Vehicles, 130 kip each @ 15 mph)**

| Normal Rating | Component Cooper Rating | Eqv. Cooper Demand | Overstress | Mode |
|---|---|---|---|---|
| Plate Girder | E62 | E16 | - | Bending |
| Plate Girder | E70 | E18 | - | Shear |
| Timber Stringer | E60 | E20 | - | Bending |
| Stringer | E60 | E23 | - | Shear |

**Rating Recommendations**

| Train | Maximum Safe Speed | Required Retrofit (see note 1) |
|---|---|---|
| 4 - GP-9 locomotives and 286 kip cars | 15 mph | See note 2 |
| 2 - GP-9 locomotives and 263 kip cars | 15 mph | N/A |
| 3 – RDC-1 Passenger Vehicles | 15 mph | N/A |

Notes:

1 The rating provided in this report is based on the assumption that the Essential Repairs listed below will be complete.

2 A small overstress was identified in the timber stringers; additional analysis and detailed inspection required to confirm positive evaluation.

### 34.4 Mile 1.02 – Optional Bridge Replacement

As the bridge steel girders as well as substructure are in good condition, it is unlikely that the bridge replacement will be required in the next 30 years. Therefore we are not including the bridge replacement cost in our cost estimate. The replacement of the timber trestle side spans may be required; this cost is included.

## 34.5 Mile 1.02 – Cost Summary Table: Present to Year 2021

**Bridge 1.02 – Projected Cost Summary to Operate Bridges until Year 2021**
**Passenger Loading and 263 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs | Strengthening | | |
| | X | | | Shim to bear under three square piles added recently to South end bent (not bearing on bent cap) to properly distribute load | $6,000 |
| | | X | | Replace 2 Ties in poor cond. (cost excluded) | $0 |
| X | | | | Clean debris from the bridge at 5 years | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$9,000** |

**Bridge 1.02 – Projected Cost Summary to Operate Bridges until Year 2021**
**286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs | Strengthening | | |
| | X | | | Shim to bear under three square piles added recently to South end bent (not bearing on bent cap) to properly distribute load | $6,000 |
| | | X | | Replace 2 Ties in poor cond. (cost excluded) | $0 |
| X | | | | Clean debris from the bridge at 5 years | $3,000 |
| X | | | | Bridge annual visual inspections –(by SVI forces) | $0 |
| | | | X | Additional analysis and inspection to confirm the capacity of 15 ft trestle to support 286 cars. | $5,000 |
| | | | | **Subtotal All Loadings** | **$14,000** |

### 34.6 Mile 1.02 – Cost Summary Table: Years 2021 to 2031

**Bridge 1.02 – Projected Cost Summary to Operate Bridges Years 2021 to 2031**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Detailed bridge inspection in 2021 (investigate for cracks and corrosion loss in steel members, investigate timber ties and stringers). | $4,000 |
| | | X | | Replace Remaining Ties on steel span (cost excluded) | $0 |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| | | X | | Repair/partially replace timber trestles(1/3 of 4-15ft spans) | $110,000 |
| X | | | | Bridge annual visual inspections–(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$117,000** |

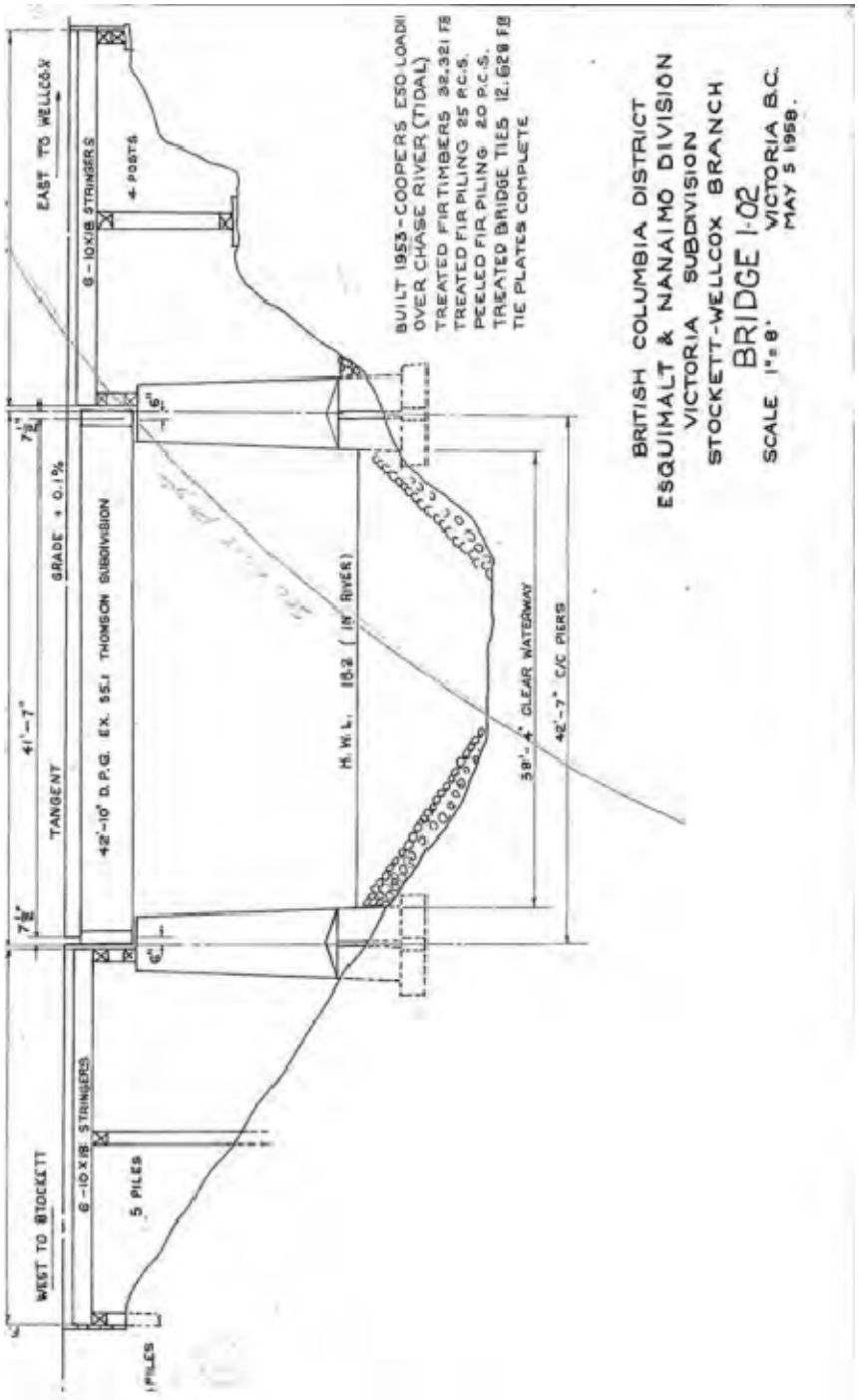
## 34.7 Mile 1.02 – Cost Summary Table: Years 2031 to 2041

**Bridge 1.02 – Projected Cost Summary to Operate Bridges Years 2031 to 2041**
**Passenger Loading, 263 kip Loading and 286 kip Loading**

| Category of Work | | | | Action Required | Estimated Cost of Action |
|---|---|---|---|---|---|
| Maintenance | Essential Repairs | Projected Repairs or Replacement | Strengthening | | |
| X | | | | Clean debris on the bridge every 5 years. | $3,000 |
| X | | | | Detailed bridge inspection in 2031 | $4,000 |
| | | X | | Repair/partially replace timber trestles(1/3 of 4-15ft spans) | $110,000 |
| X | | | | Bridge annual visual inspections–(by SVI forces) | $0 |
| | | | | **Subtotal All Loadings** | **$117,000** |

# 1.02 – Wellcox Spur – Chase River

**Bridge General Arrangement:**



# 35 Closure

The services provided by Associated Engineering and Alfred Benesch & Company in preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession practising under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Prepared by:

Michael J. O'Connor, 2/15/2012

Michael J. O'Connor, PE
Project Manager
Alfred Benesch & Company

Reviewed by:

N. Cuperlovic

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA N. CUPERLOVIC

Feb 15/2012

Nikola Cuperlovic, P.Eng.
Project Manager
Associated Engineering

Reviewed by:

D.W. Kennedy, M.Eng., P.Eng.
Manager – Bridge Engineering
Associated Engineering

NC/DWK/skn

# Appendix A - Detailed List of Structures

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E&N Railway Bridge List

| Bridge Inventory | | | | | | |
|---|---|---|---|---|---|---|
| # | Mileage | Year Built | Description of Structure Type | Length (feet) | Height (feet) | Name of Crossing |
| Victoria Subdivision | | | | | | |
| 1 | 1.30 | 1914 | 1-45' HDPG | 56 | 15 | Herewood St |
| 2 | 4.00 | 2010 | 1-40' BDHDPG | 44 | 17 | Hwy 1A |
| 3 | 4.50 | 1961 | 1-45' BDHDPG | 45 | 18 | Helmeken Road |
| 4 | 5.20 | 1998 | 1-65' BDTPG | 65 | 21 | Burnside Rd |
| 5 | 5.34 | 1998 | 3 BDTPG (1-89'; 1-118'; 1-126') | 220 | 27 | Island Hwy |
| 6 | 5.45 | 1998 | 1-65' BDTPG | 78 | 26 | Thetis Lake Rd |
| 7 | 5.80 | 1998 | 1-106' BDTPG | 90 | 21 | Six Mile Rd |
| 8 | 14.00 | 1912 | 529' Pin/Cantilever | 529 | 246 | Niagra Canyon |
| 9 | 14.90 | 1914 | 2-50'DPG; 2-75' DPG; 2-106' DPG | 463 | 183 | Arbutus Canyon |
| 10 | 18.20 | 1935 | 1-16' Posted Trestle | 17 | 7 | Unnamed Watercourse |
| 11 | 26.80 | 2002 | 1-33' HDPG | 34 | 14 | Shawnigan Lake Rd |
| 12 | 28.20 | 1907 | 1-40' HDPG | 44 | 20 | Creek from Shawnigan Lake |
| 13 | 28.40 | 1907 | 1-43' HDPG | 44 | 18 | Creek from Shawnigan Lake |
| 14 | 28.60 | 1907 | 1-43' HDPG | 44 | 17 | Creek from Shawnigan Lake |
| 15 | 29.80 | 1978 | 1-47' BDPG | 48 | 18 | Northgate Rd |
| 16 | 35.60 | 1908 | 1-28' HDPG | 28 | 46 | Koksilah Rd |
| 17 | 37.60 | 1965 | 1-75' Timber Pile Trestle | 75 | 20 | Koksilah Overfow Channel |
| 18 | 37.80 | 1940 | 1-157' Thru Truss | 158 | 22 | Koksilah River |
| 19 | 39.30 | 1908/188? | 1-219' Pin Con Truss | 224 | 32 | Cowichan River |
| 20 | 40.60 | 1940 | 1-38' HDPG | 38 | 11 | Unnamed Watercourse |
| 21 | 46.60 | 1973 | 1-45' Pile Trestle | 45 | 11 | Overflow |
| 22 | 46.80 | 1940 | 1-30' DPG | 31 | 13 | Whitehouse Creek |
| 23 | 47.90 | 1909 | 1-155' Thru Truss | 157 | 23 | Chemainus River |
| 24 | 60.70 | 1915 | 1-106' Thru Truss (Pony) | 107 | 38 | Harrison Creek |
| 25 | 64.40 | 1911 | 1-26' IB, 1-76' Deck Truss | 103 | 30 | Lochner Rd & Haslam Crk |
| 26 | 65.10 | 1909 | 1-129' DPT; 1-40' Rolled Beam | 200 | 112 | Nanaimo River |
| 27 | 79.10 | | Timber Pile Trestle | 85 | 21 | Dumont rd |
| 28 | 79.90 | | Timber Pile Trestle | 210 | 26 | Green Lake |
| 29 | 86.90 | | DPG | 66 | 20 | Bonell Creek |
| 30 | 87.20 | | Steel Girders & Beams | 46 | 22 | Hamilton Creek |
| 31 | 93.00 | | 3-TD Steel Structure | 335 | 80 | Englishman River |

E&N Railway Bridge List

| Bridge Inventory | | | | | | |
|---|---|---|---|---|---|---|
| # | Mileage | Year Built | Description of Structure Type | Length (feet) | Height (feet) | Name of Crossing |
| 32 | 98.60 | 1913 | 240' Framed Timber Trestle; 2-45'DPG/ 1-75' DPG (E50?); 570' Framed Timber Trestle | 1063 | 92 | French Creek |
| 33 | 103.70 | 1913 | 2-45' DPG; 1-60' DPG; 4-75' DPG | 450 | 132 | Little Qualicum River |
| 34 | 110.70 | 1913 | 3-75'DPG; 2-45' DPG | 316 | 97 | Big Qualicum River |
| 35 | 113.20 | 1914 | 1-54'DPG; 1-50' DPG; 1-60' DPG | 167 | 55 | Nile Creek |
| 36 | 119.20 | 1914 | 1-30' DPG | 31 | 14 | Cook Creek south fork |
| 37 | 119.50 | 1913 | 28' Glulam Stringers | 30 | 13 | Cook Creek north fork |
| 38 | 120.20 | 1914 | 1-70' HDPG | 71 | 25 | Rosewell Creek |
| 39 | 122.00 | 1928 | 1-65' HDPG | 66 | 16 | Waterloo Creek |
| 40 | 123.00 | 1914 | 1-31' DPG; 1-34' DPG; 1-50' DPG | 118 | 35 | Coal Creak |
| 41 | 124.10 | 1925 | 1-65' DPG; 1-106' DT | 173 | 40 | Mill Creek |
| 42 | 125.50 | 1914 | 1-101' DPG; 1-154' DT (E50?); 315' FT; 2-14'FT | 603 | 75 | Tsable River |
| 43 | 126.15 | 1998 | 1-65' BDPG | 66 | 25 | Buckley Bay Rd |
| 44 | 127.60 | 1974 | 21' Timber Stringer Deck | 21 | 25 | Hindoo Creek |
| 45 | 131.10 | 1914 | 1-50' DPG; 2-30' DPG | 111 | 13 | Washer Creek |
| 46 | 135.10 | 1914 | 2-45' DPG; 1-75' DPG; 1-49'DPG;1-75' DPG | 289 | 80 | Trent River |

E&N Railway Bridge List

| Bridge Inventory | | | | | | |
|---|---|---|---|---|---|---|
| # | Mileage | Year Built | Description of Structure Type | Length (feet) | Height (feet) | Name of Crossing |
| Wellcox Spur | | | | | | |
| 47 | 0.69 | 1953 | 4-15' PT; 2-53' DPG | 168 | 25 | Old Island Hwy |
| 48 | 1.02 | 1953/69 | 4-15' PT(69); 1-53' DPG (53) | 104 | 32 | Chase River |

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# Appendix B - Typical Rail Car Loading on Victoria Subdivision, Vancouver Island, BC

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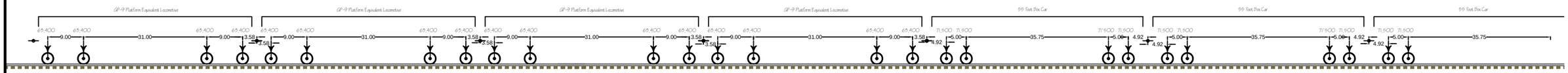
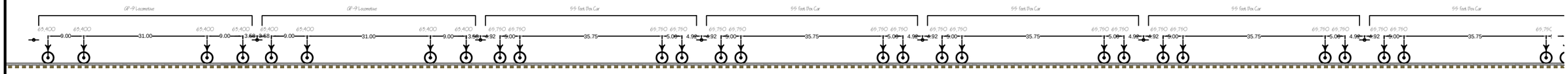
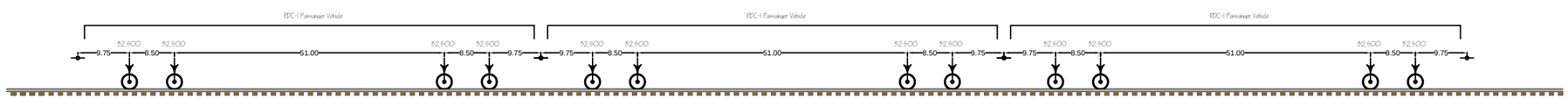



Typical 286,000 Pound Loading
- Four typical locomotives, high horsepower GP-9 platform
- Typically 50 railcars
- Locomotive Axle loading = 63,400 pounds
- Rail car Axle loading = 71,500 pounds
- Measurements in feet and tenths of feet




Typical 263,000 Pound Loading
- Two typical locomotives
- Typically 40 railcars
- Locomotive Axle loading = 63,400 pounds
- Rail car Axle loading = 65,750 pounds
- Measurements in feet and tenths of feet




Typical 130,000 Pound Loading
- Typically two passenger vehicles
- Future growth could require Third vehicle
- RDC-1 Axle loading = 32,500 pounds
- Measurements in feet and tenths of feet

| Rev. | Date | Description | By | Chk |
|---|---|---|---|---|
| 02 | 1 Dec 11 | Update 286 loading to 4 GP9 Units | GTS | GTS. |
| 01 | 18 Aug 11 | Add RDC-1 Passenger Vehicles | GTS | GTS. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Project No. | Drawing No. Plan_02 | Rev. | Mile | Subdivision | | CNSA No. |
| Cad File Railcar Loading_02.dwg | | Designed GTS | Drawn GTS | Approved 21 Sept | Date 21 Sept 11 | Scale As shown |

Project: Typical Rail Car Loading on Victoria Subdivision Vancouver Island, BC

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# Appendix C - Equivalent Cooper's E Load Diagrams

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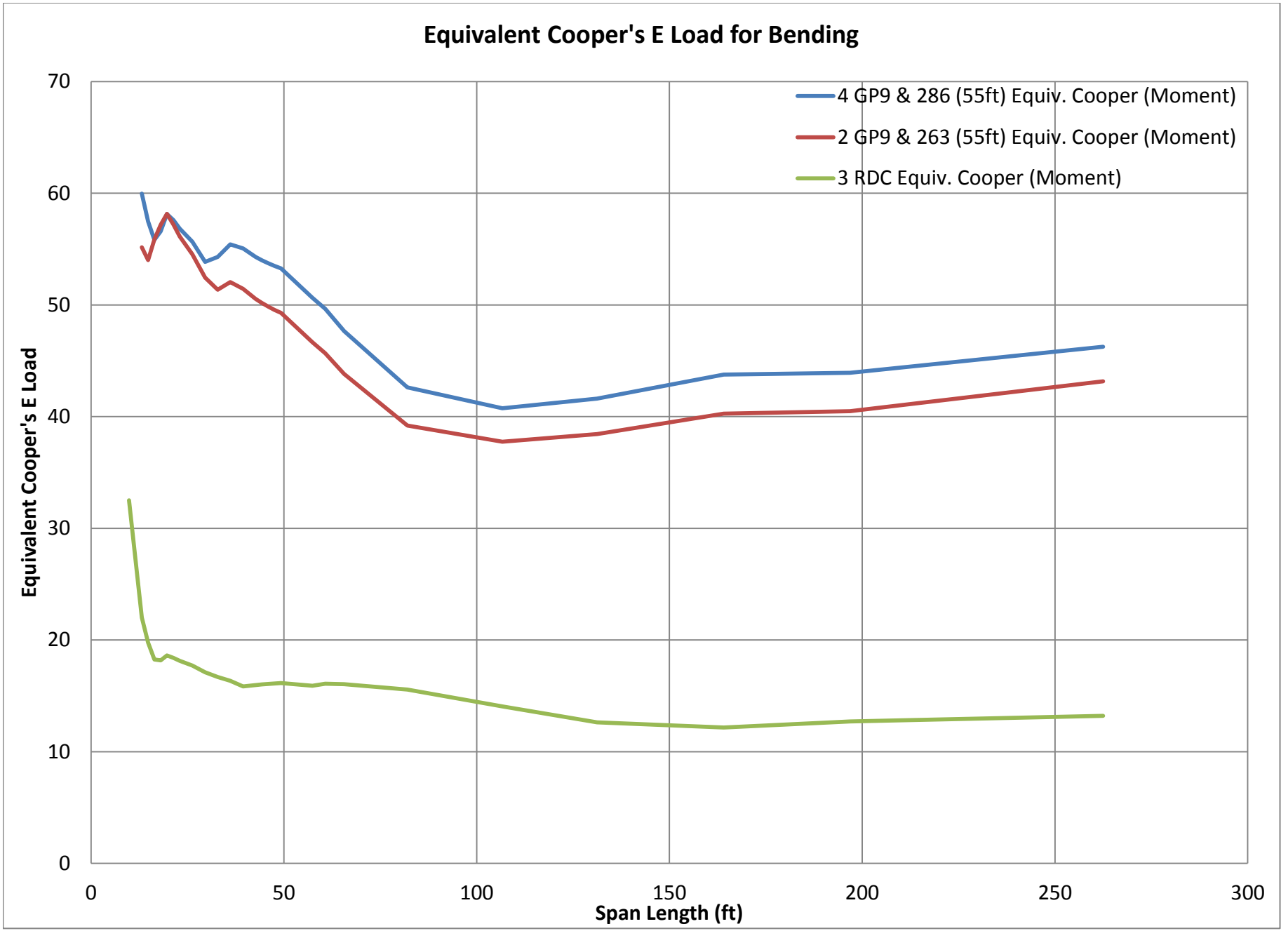
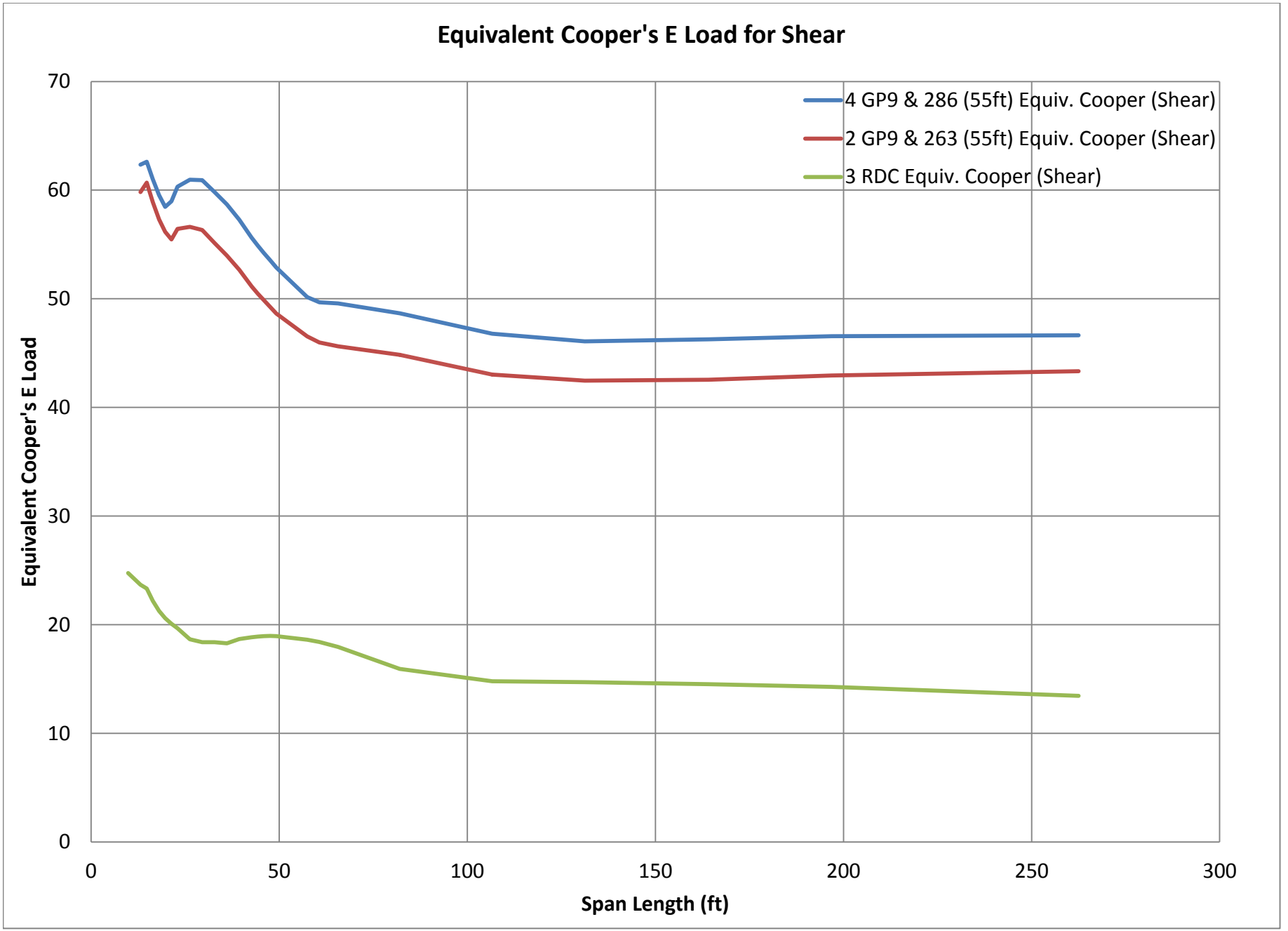

Equivalent Cooper's E Load for Bending
4 GP9 & 286 (55ft) Equiv. Cooper (Moment)
2 GP9 & 263 (55ft) Equiv. Cooper (Moment)
3 RDC Equiv. Cooper (Moment)
Equivalent Cooper's E Load
Span Length (ft)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300


Equivalent Cooper's E Load for Shear
4 GP9 & 286 (55ft) Equiv. Cooper (Shear)
2 GP9 & 263 (55ft) Equiv. Cooper (Shear)
3 RDC Equiv. Cooper (Shear)
Equivalent Cooper's E Load
Span Length (ft)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300