IONE BRIDGE PLANNING REPORT

Prepared For:

Pend Oreille County Public Works Department

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1.0 INTRODUCTION AND SCOPE OF WORK

The Ione Bridge is an essential structure for northern Pend Oreille County. The bridge provides access from Highway 31 to LeClerc Road North and Sullivan Lake Road for residents, recreationalists, bicyclists, and commercial and logging interests. Without the bridge, drivers would be significantly impacted as a detour would be at least 31 miles long.

This report is intended to assist Pend Oreille County Public Works in planning for the future of the Ione Bridge by providing information on the background, current condition, necessary repairs, preventative maintenance, bridge retrofit, and prolonging the lifespan of the bridge.

Nicholls Kovich Engineering's scope of work for this planning report includes the following:

- Provide a summary of existing bridge deficiencies, their importance, and effect on lifespan of the bridge.
- Provide a prioritized list of repair recommendations with associated costs.
- Address preventative maintenance needs and associated funding-level costs.
- Review alternatives to the open-grid steel decking.
- Address the feasibility and cost to retrofit the bridge rail for bicycle use.
- Review bridge load rating capacity and explore options to remove "One Truck" posting by strengthening the bridge.

This report is intended to assist the County with the short and long-term planning for the bridge with the following key takeaways:

1. Key repairs, and their costs, to prolong the service life of the bridge for >10-20 years.
2. Key enhancements, and their costs, to allow the one truck requirement to be removed.
3. Concepts and costs to retrofit the bridge.

Photo 1 - Deck view looking east

2.0 BRIDGE BACKGROUND

2.1 General Description

The Ione Bridge is located just southeast of the Town of Ione in Pend Oreille County. The bridge crosses the Pend Oreille River which flows south to north. The bridge provides vital access across the river since the closest bridges are 10 miles downstream and 35 miles upstream. The bridge is an 830-ft bridge composed of a 3-span steel main truss, 7 spans of steel approach trusses with timber stringers and 5 spans composed of timber girders.

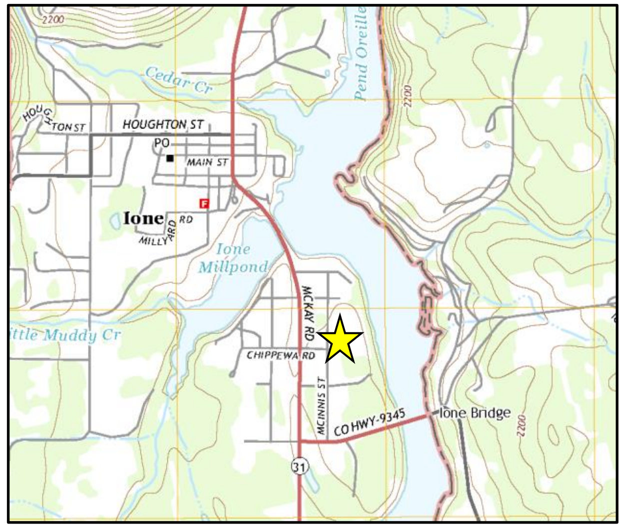


Figure 1 – Vicinity Map

The Ione Bridge has a sufficiency rating of 67.61 out of 100. The bridge is not presently categorized as Structurally Deficient.

The major bridge components are deemed to be in the following overall condition:

Deck – **6** (Satisfactory Condition)
Superstructure – **6** (Satisfactory Condition)
Substructure – **6** (Satisfactory Condition)

The bridge is posted for "One Truck at a Time". With this posting, the bridge does not need to be posted for legal loads, but Overload 2 should be restricted. The coding for WSBIS Item 1293 (Open/Closed/Posted) is "R" which indicates the bridge is posted for other load-capacity restrictions such as number of vehicles on the bridge.

2.2 History of Work on Bridge

The Ione Bridge was originally built in 1932. It consisted of a 467-ft main truss with a center drop-in span supporting a 17.67-ft wide timber deck. The original approach spans were timber trestles. The original bridge was designed by H.A. Sewell for with a design load consisting of the H-15 truck.

Photo 2 – Historical Photo, Original Construction (Metalines Community Library)

In 1967, the bridge was heavily modified. The drop-in span was fixed to the cantilever truss with pins making it continuous. Several truss members were replaced and several others were strengthened. The original deck over the main truss was replaced and widened to 26-ft with an open-grid steel decking system. The approach trestles were replaced with simple spans (timber, or steel deck trusses) supporting a lightweight concrete deck. The 1967 reconstruction was designed by Harry R. Powell & Associates for a design load consisting of the HS-15 truck.

Presently, the bridge is composed of the following spans for a total bridge length of 830 feet:

Spans 1-3: Three simple spans of timber girders (19-ft to 20-ft each) with concrete deck
Spans 4-7: Four simple spans of steel deck truss (38-ft each) with concrete deck
Spans 8-10: Main steel deck truss with open-grid steel decking. (2) 97-ft Spans and (1) 273-ft Span
Spans 11-13: Three simple spans of steel deck truss (38-ft each) with concrete deck
Spans 14-15: Two simple spans of timber girders (19-ft to 20-ft each) with concrete deck

In 2011, the bridge underwent an extensive maintenance rehabilitation, with the following scope of repairs:

- Steel was repainted.
- The deck on the approach spans was scarified and a new 1.5-inch modified concrete overlay was placed – Spans 1-7 and 11-15.
- Two sections of steel grid deck were replaced in Span 10.
- Deck joints were replaced with rapid-cure silicone sealant at Piers 4, 5, 6, 7, 12, 13, 14.
- Timber helper girders were installed at Girders 4D, 7E, 13G and 15K (Photo 3).
- Grout pads at Piers 4, 5, 6, 7, 12, 13 and 14 were reconstructed.
- Carbon fiber wrapping was installed at Concrete Piers 8, 9, 10 and 11.
- Four piles at Pier 7 were spliced (Photo 4) and two piles at Pier 13 were jacketed.
- Scour mitigation added to Piers 8 thru 12.

Prior to the 2011 rehabilitation, the bridge had a sufficiency rating of 14.38 SD (structurally deficient) with the following National Bridge Inventory (NBI) Condition Codes:

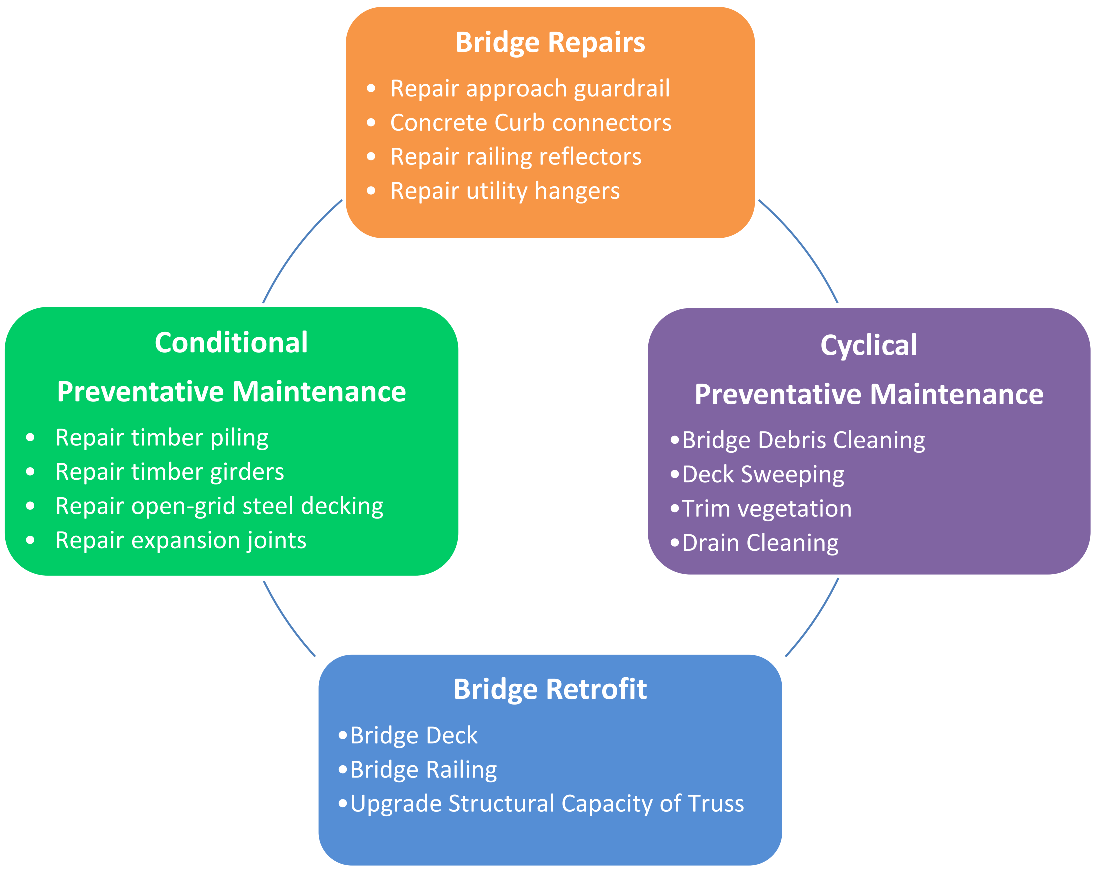
Deck – **4** (Poor Condition)
Superstructure – **5** (Fair Condition)
Substructure – **4** (Poor Condition)

Photo 3 – Helper beam at Girder 13G

Photo 4 – Spliced timber piles at Pier 7

3.0 PLANNING OVERVIEW

To assist Pend Oreille County with planning for the future of the Ione Bridge, this report will be divided into four areas: Bridge Repairs, Conditional Preventative Maintenance, Cyclical Preventative Maintenance and Bridge Retrofit.



Bridge Repairs – This includes components of the bridge that are in need of repair. These repairs are not structural in nature, nor do they affect the structural capacity of the bridge. However, they may affect the serviceability or safety measures on the bridge, so these repairs should be addressed in a timely manner.

Conditional Preventative Maintenance –This includes components on the bridge that are in need of repair for a conditional issue. These repairs have a higher importance and may affect the structural capacity of the bridge. Performing these repairs will extend the service life of the bridge.

Cyclical Preventative Maintenance – These are recommended maintenance measures that if performed on a cyclical basis will extend the service life of the bridge and/or aid in bridge inspection measures.

Bridge Retrofit – This includes components of the bridge that if retrofitted would benefit the County in the long-term or upgrade the bridge to current design standards.

4.0 RECOMMENDED BRIDGE REPAIRS

Several bridge elements are in need of repair. These recommended repairs are not structural in nature, but they may affect the serviceability of the bridge. They are listed in order of importance:

4.1 Repair East Approach Guardrail

The approach guardrail transitions at the northeast and southeast corners both have impact damage. There is damage to both the W-beam railing and some timber posts. The northeast guardrail is flattened and likely has reduced strength. Both guardrail transition sections should be repaired or replaced to bring them back to full strength. The transitions could be repaired to the existing configuration or upgraded to meet current design standards. The following are two options to repair the approach guardrail at the east end:

Option 1: Upgrade the transitions to a thrie-beam system.
Option 2: Replace the W-beam railing and timber posts that are damaged.

4.2 Replace Missing Nuts at Concrete Curb

There are three locations where a 1-inch hex nut is missing from the bolt connecting the concrete curb to the steel floor beams (Photo 5). These missing nuts are located on the north side at truss points U1, U2, and U3 (Span 8). Though a relatively simple repair to install, it would require special access, such as with a UBIT or a climber. Estimated costs assume that this work can be accomplished during the next routine bridge inspection if materials are provided by the County.

Photo 5 - Missing Nut

4.3 Replace Damaged Reflectors

The bridge railing posts have L-shaped reflectors attached to them at a 38-ft spacing. In 2019, there were (15) missing or broken reflectors. These damaged reflectors, attached with adhesive, should be repaired to improve nighttime visibility on the bridge. This repair can be performed by County crews with some traffic control. This will likely be an ongoing repair given these reflectors are susceptible to being hit and broken off.

4.4 Repair Utility Hangers

The Ione Bridge carries one utility line on each side of the bridge and both lines are suspended from the bottom of the steel rail posts. Both conduits are 4-inch PVC and carry communication lines. The south side conduit has separated in two locations exposing the interior cables. In addition, multiple utility hangers are broken on both sides of the bridge. The separated conduit and broken utility hangers should be repair and paid for by the associated utility company. This work could be coordinated while there is traffic control during the next bridge inspection. The conduit hangers that are broken are Anvil Fig. 67 or similar.

5.0 CONDITIONAL PREVENTATIVE MAINTENANCE

The following sections summarize the bridge's conditional deficiencies along with a discussion of the recommended repair methods to increase the service life of the bridge element:

5.1 Timber Piling

The approach piers (Piers 2-7, 12, 13, and 15) are each supported by treated timber piling that was installed in 1967. There are 63 total piles in the Ione bridge. Pile size will taper with maximum size at the top of pile.

Six piles were repaired in the 2011 major rehabilitation project. Two piles within Pier 13 received a Fiber Reinforced Polymer (FRP) jacket and four piles within Pier 7 were spliced near the groundline due to heavy decay. Repairs made in 2011 are performing well.

The majority of timber piles have checking up to 1-inch wide and up to 5-inch deep. Piling at Piers 7 and 12 nearest to the river have checking up to 2-inch wide and up to 5.5-inch deep (Photo 6). There are currently 12 piles in the bridge that are considered to have the most severe checking.

Photo 6 – Pile 7D up to 2-inch wide checks

Piles with deep checking will deteriorate more quickly as the internal portion of the piling is exposed to oxygen, organisms, and moisture. Additionally, the severe checking of piling has the potential to jeopardize the stability of the piles (buckling) if advanced section loss occurs. Also, wide checking could advance into a through split which would significantly reduce pile capacity.

Potential repairs for checking depend on severity and can range from preservative treatment to steel banding to crack filling and then pile jacketing for the most severe cases. FRP pile jackets are suitable for repairing piling that needs an increase in strength, but do not require total replacement. The space between the pile and the jacket is filled with a marine epoxy which completely fills cracks and voids. The FRP pile jacket system protects the pile from the elements and it cuts out oxygen access to the wood, thereby eliminating the potential for decay. Cost estimating in this planning report assumes twelve piles would be repaired with pile jacketing.

An analysis of the tallest piling in the Ione Bridge indicates that structural capacity will start to be affected when approximately 15% of the pile section is lost. A split through the pile would indicate a serious structural deficiency.

Prior to design and installation of permanent repairs, piles should undergo non-destructive testing for decay at multiple locations near ground level. If any decay is found, pile splicing may be required to eliminate any unsound material. A Resistograph machine may be used.

5.2 Timber Girders

There are 19 spans of timber girders with 12 lines of girders in each span. The treated girders are 6-inch wide x 18-inch deep. The girders are mostly in good condition, however there are some which exhibit heavy checking and splitting (Photos 7 and 8). 89-feet, or 2% of total length of girders, is categorized in Condition State 3 which indicates the member has a defect, but it is not yet serious enough to affect structural capacity.

Checking in timber girders is a natural process that occurs due to separation of the wood fibers. The outer surface of the girder loses moisture to the atmosphere and begins to shrink while the interior of the girder loses moisture at a much slower rate. This differential shrinkage results in checking. Checking is not a structural concern, unless it is very severe and affects a significant portion of the girder. The checking in the timber girders of the Ione Bridge is not extensive enough to be a structural concern.

Photo 7 – Heavy Checking in Girder 11H

Photo 8 – Split in Girder 4I

Splitting in timber girders differs from checking in that a split extends through the member from face to face. Splits are prone to propagate and often increase with time. Splits can be caused by normal seasoning or due to a stress riser from a notch or defect in the timber. Sometimes splitting can be stress related. Severe splitting can have an effect on both the shear and flexural strength. Severe splitting can be taken as any split that exceeds 25% of the member length, according to the Montana *Timber Bridge Inspection Guide.* Therefore, it is important to repair any splitting that has become severe. A full length longitudinal split in one of the Ione timber girders could reduce the flexural capacity between 10-50%.

There are presently 12 timber girders which have splitting. The splitting ranges in length from several feet to full length (19-ft). Girders which have splitting have been yellow-tagged. The Washington State Bridge Inspection Manual (WSBIM) defines this as members with structural defects which do not significantly affect structural capacity. WSBIM recommends inspecting yellow-tagged timbers at least every 12 months.

Table 1 lists the yellow-tagged members along with the recommended repair action:

Table 1. *Summary of timber girders needing repair.*

YT Timber Member	Splitting Length (ft.)	% of Member Length	Recommended Action
3D	4	21%	Local Repair
4J	19	100%	Install Helper
4I	12.67	67%	Install Helper
5D	11.67	61%	Install Helper
5E	19	100%	Install Helper
7G	2.33	12%	Local Repair
7B	2.75	14%	Local Repair
12C	2.58	14%	Local Repair
12G	8.5	45%	Install Helper
12K	3 - Impact damage	16%	Local Repair
14F	3	16%	Local Repair
15I	19	100%	Install Helper

There are steel shims below timber girders at Piers 8 and 11 in addition to some girders at other piers. The steel shims are walking out from under girders at 7 locations and missing at 5 locations. Missing shims could negatively affect the condition of the concrete deck due to settlement of timber girders. It would be beneficial to reposition and replace missing shims at the same time when helper beams are installed.

We recommend installing helper beams at the 6 timber girders which have splitting along at least half the girder length. Helper beams should be slightly shallower than the existing girders to facilitate installation. Steel shims should then be used to bring the girders into contact with the concrete deck. The helper beams should be securely attached to the existing girders with bolts at the ends.

If this repair is not performed, there is possibility that the splitting in the girders could deteriorate further, requiring a reduction to the load rating. Performing this preventative maintenance will ensure that there is reserve capacity in the compromised girders, avoiding the need to reduce the bridge's load capacity.

5.3 Open-Grid Steel Decking

Spans 8, 9 and 10 (main truss spans) have an open-grid steel deck system which is composed of the following members:

- Main bearing bars are 5-inch deep at 6-inch spacing and span perpendicular to traffic.
- Cross Bars are 1.5-inch deep at 3-inch spacing and run parallel to traffic.
- Supplementary Bars are 3/4-inch deep at 3-inch spacing and span perpendicular to traffic.

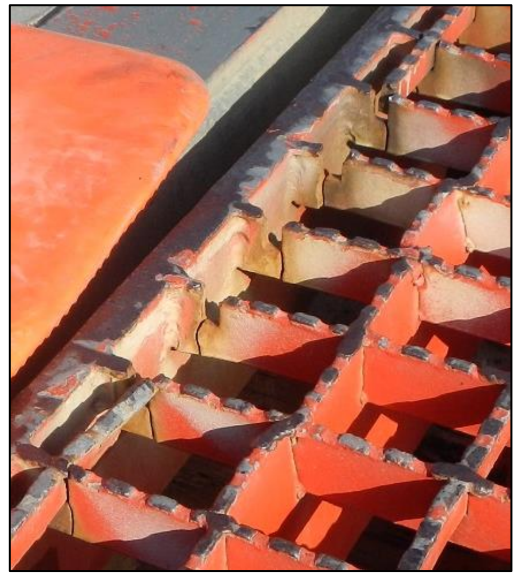


Photo 9 – Missing Supplemental Bars and Cracking of Cross Bars at West end.

The steel bars are welded at each intersection to form a grid pattern. The main bearing bars are welded to each supporting steel stringer. The top of the bars are serrated to provide slip resistance.

Overall the open-grid steel decking is in good condition. There are some isolated defects which include cracked bars and welds (Photo 9). Additionally, some of the bars are bent or have fractures likely from vehicle impact damage. The total area of defects in the open-grid decking is 254 square feet or 3% of the deck area. The steel decking is more prone to defects near the ends where there is an abrupt change in deck type from concrete to steel.

In 2011, two areas of grid decking (120 total square feet) were replaced in Span 10 due to heavy damage. Also during the rehabilitation work, the full deck was repainted. The new deck pieces were first bolted to the stringers, but due to multiple broken bolts, they were welded to the stringers after the 2017 routine inspection.

The lifespan of open-grid decking is based upon several factors including orientation and spacing of main bars, fatigue resistance, applied stress range, and the corrosion protection system. Open-grid decks are more prone to fatigue if the main bars are not parallel to traffic, which is the case on the Ione Bridge where braking forces can cause extra stress in the cross bars.

Key defects to watch for and repair include cracked welds that propagate down into bars and areas with damaged or missing bars that could cause overstress in adjacent bars. Other defects to watch for include loss of corrosion protection and loss of serrations on top of the deck due to wear.

To extend the lifespan of the existing open-grid steel deck, it is important to fix the cracked welds and bars. Any bent and fractured bars should be repaired and rewelded. Fractures propagating into the distribution bars should be arrested by welding as well.

The open-grid steel decking is a good solution when a lightweight deck is required. It generally provides a strong and durable deck. However, it does have some drawbacks. One issue is that it allows road debris to fall through and build up on the supporting truss members. Additionally, the open grid decking system is vulnerable to damage from improperly secured loads – items or vehicle parts striking the steel bars. There are a number of areas on the Ione Bridge where a vehicle has dragged an item or part of vehicle across the bridge causing a line of damage.

5.4 Deck Expansion Joints

Photo 10 – Failed Deck Joint

There are expansion joints at Piers 4, 5, 6, 7, 12, 13, 14. These were originally designed as compression seals in the approach spans that were added during the 1967 Reconstruction. The compression seals were replaced with rapid-cure silicone (RCS) sealant joints in 2011. However, these joints have not performed well and were noted to have issues such as debonding as early as 2015. The 2019 inspection report notes that 60-ft is debonded and 38-ft has dropped or is filled with debris. Every joint has debonding for a length between 5-ft and 17-ft. The total length of RCS sealant is 182-ft. Locations where the RCS sealant joints are debonded will allow water and debris to get down to the superstructure and substructure, potentially causing issues due to moisture.

Multiple expansion joint alternatives have been researched for this report, including the alternative to do nothing (see Table 2). Each type of joint has its strengths and weaknesses, and there is no perfect system. The success or failure of each type of joint system depends on multiple factors, including quality of installation, quality of surface preparation, adherence to manufacturer recommendations such as temperature and time windows, maintenance, and environmental conditions.

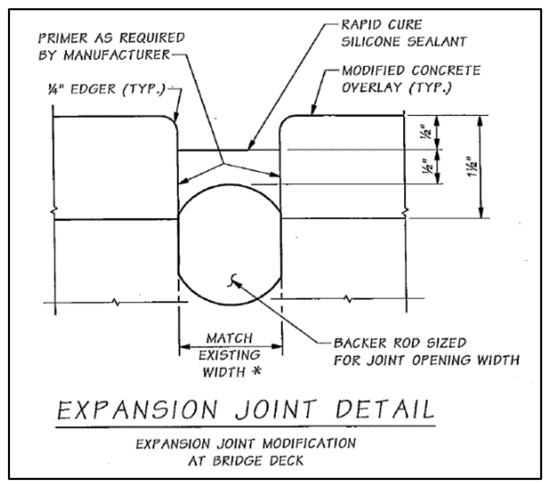


Figure 2: Rapid Cure Silicone Sealant (2011 Maintenance)

The currently installed type of expansion joint is the Rapid-Cure Silicone (RCS) joint. As mentioned previously, all joints at the Ione Bridge have at least some debonding. Since it is not realistic to replace just the failed portion of a joint, we recommend full replacement of all RCS joints at the Ione Bridge.

We recommend replacing the existing RCS joints with compression seals since the RCS joint system has proven to be short-lived on both the Ione and Usk bridges. Since this bridge originally had compression seal expansion joints from 1967, it is possible that the original ledge seats for compression seals still exist. If that is the case, the compression seal could be installed immediately following removal of RCS joint material with minimal prep work. This could greatly speed up the installation process as well as bring down cost. Unfortunately, the condition of the ledges and edge surfaces would not be known until the RCS joint is removed. If the ledge is damaged or the concrete surface is very rough, sawcutting may be required. The preliminary cost estimate for compression seals includes sawcutting since it may be required.

After installation of the compression seal material, we recommend applying a bead of silicone along the edges of the joints. This will help seal up any gaps due to uneven concrete surfaces.

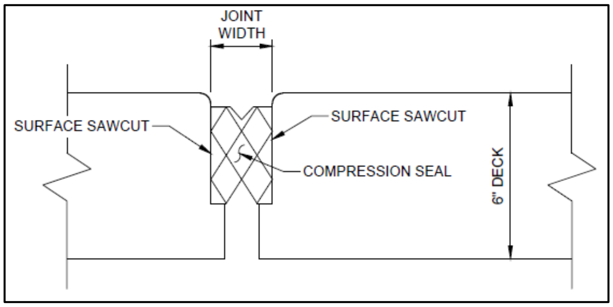


Figure 3 - Compression seal with sawcut

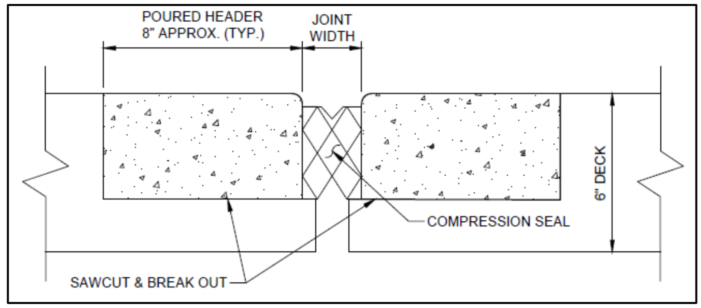


Figure 4 - Compression seal with headers

Table 2. Summary of joint options for the Ione Bridge.

Alternative	Estimated Life Span	Description	Approx. Cost*	Benefit/ Cost Ratio	Pros/Cons
1 Do Nothing	0 years	Do nothing. Joints will continue to fail. Moisture and debris will accelerate bearing seat and substructure deterioration.	**$0**	**$0 per year**	***Pro*** *+ No immediate cost* ***Con*** *- Bridge will be more vulnerable to deterioration* *- May result in future costly repairs or rehabilitation*
2 Rapid-Cure Silicone (RCS) Joints	4-8 years	Replace failed RCS joints with new RCS joints. This includes new backer rod and poured joint.	**$30K**	**$4K to $8K per year**	***Pro*** *+ Lower initial cost* ***Con*** *- Shorter-term solution* *- Poor past performance, especially wider joints.* *- Requires more maintenance.*
3 Compression Seal (Rubber)	8-20 years	Sawcut (if needed) along edge of deck to create vertical surface and ledge for support. Install properly sized compression seal (rubber).	**$51K**	**$3K to $6K per year**	**Pro** *+ Reasonable joint lifespan* *+ Joint restrained from falling through by ledge* **Con** *- Higher cost* *- Sawcut deck edge may not be perfectly smooth.*
4 Compression Seal (Open-Cell Foam)	8-20 years	Sawcut (if needed) along edge of deck to create vertical surface and ledge for support. Install properly sized compression seal (open-cell foam).	**$53K**	**$3K to $7K per year**	**Pro** *+ Reasonable joint lifespan* *+ Joint restrained from falling through by ledge* **Con** *- Higher cost* *- Sawcut deck edge may not be perfectly smooth.*
5 Compression Seal with New Concrete Headers	10-20 years	Remove top portion of concrete deck. Pour new headers with elastomeric concrete. Install properly sized compression seal.	**$106K**	**$5K to $11K per year**	**Pro** *+ Reasonable joint lifespan* *+ Joint restrained from falling through by ledge* *+ Smooth edge of new headers will provide better seal.* **Con** *- Highest cost*

**Costs in the table are today's dollars (labor and materials only).*

6.0 CYCLICAL PREVENTATIVE MAINTENANCE

These following recommended maintenance measures will extend the service life of the bridge and aid in bridge inspection measures. They are listed in order of importance.

6.1 Bridge Debris

Photo 11 – Heavy debris accumulation at beginning of steel decking.

The open-grid steel decking over the main truss is a lightweight and durable deck; however, the openings in the grid do allow roadway debris to fall through and build up on bridge members (Photo 11). Debris accumulation has been a continuous maintenance concern on the Ione bridge due to the openings in the steel deck portion. The majority of the debris buildup occurs at 1) the beginning and end of the open-grid decking where impact is the highest and 2) in the top chord where members are close to the deck and can "hold" debris and water due to their shape. Members which experience lengthy periods of debris and moisture exposure, especially if salts are present, could experience an accelerated rate of corrosion.

The rate of corrosion of steel bridges depends on many factors. One of the most significant factors which increases corrosion rate is the presence of salt. For inland bridges, the main source of salt comes from the application of deicing salts onto roadways during the winter. The quantity of salt present on and around a bridge depends heavily on the practices of the controlling Agency. If salt or deicing chemicals are applied on or near the bridge, this salt can find its way onto the bridge surfaces. Even grit application can be a source of salt since it is common to add salt to prevent grit stockpiles from freezing solid. We understand that Pend Oreille County does not deice their roads, but does treat their roadway sand with salt to minimize clumping. It unknown what amount of roadway sand is applied to the bridge.

In an ideal world, bridges would receive regular debris removal and washing. However, there are factors that can make this difficult or impractical. These factors include environmental concerns, permitting requirements, access limitations and/or prohibitive costs. Bridge cleaning practices are highly variable between states. Some states have intensive bridge washing programs, while others don't maintain a bridge cleaning program at all due to the prohibitive costs involved in meeting the state's environmental requirements. It is therefore up to the owning Agency to weigh the costs and expected benefits of cleaning their bridges.

Beginning in January 2014, the Washington Department of Transportation (WSDOT) began a statewide program to clean large steel State-owned bridges prior to fracture critical inspections. WSDOT's Study "*Determining the Cost/Benefit of Routine Maintenance Cleaning on Steel Bridges to Prevent Structural Deterioration*" indicates:

Studies have demonstrated that washing is effective in removing chloride ions from bridge surfaces which should slow corrosion. (2013)

WSDOT also began a long-term study of bridge washing and its effectiveness and impact on bridge paint condition.

While it is not fully known the extent of corrosion in the Ione Bridge that can be attributed to debris buildup, there is evidence that debris and associated moisture is breaking down the protective paint coating and may have contributed to past pitting. Photo 12 shows an outline of pitting corrosion in the top chord of the truss in an area where debris can build up. This is of notable concern since the majority of top chord members are fracture critical and currently hold debris. If a member is covered with debris, it makes it difficult to fully inspect for defects. Therefore, it is highly recommended to pursue a regular washing program for the Ione Bridge. Frequency is recommended every two years (prior to the fracture critical inspection), but at least every four years if cost becomes a factor. It is our engineering opinion that based upon observed defects in the Ione Bridge, cyclical cleanings will be an important step for preventative maintenance to extend the life of the bridge.

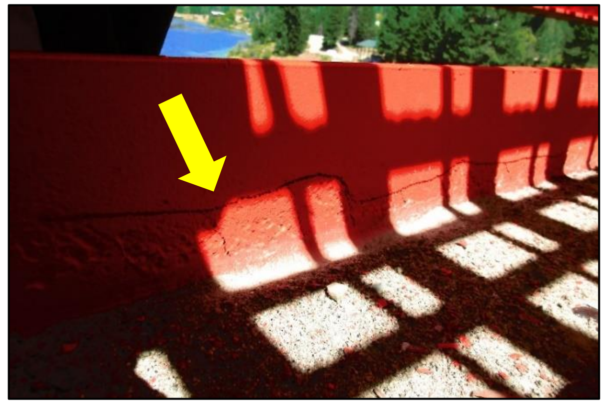


Photo 12. - Pitting corrosion in top chord where debris can build up.

Potential for Inter-Agency Agreement with WSDOT to Perform Cleaning Maintenance

WSDOT's Local Agency Bridge Engineer, Sonia Lowry, indicated that the Ione Bridge could be added to the washing scheduled of the South Central Region for 2022. Logistics and a cost estimate for this effort are forthcoming and will be communicated with Pend Oreille County in the near future.

WSDOT has a Bridge and Ferry Terminal Washing General Permit. If WSDOT's Permit does not cover the Ione Bridge, these are the typical steps taken by an Agency to obtain coverage:

1. Apply for permit with online application through Washington State Department of Ecology's Water Quality Permitting Portal, Permit Coverage Notice of Intent (NOI).

    a. Must be done 60 days prior to discharging wash water.
    b. Submit on or before the date of first public notice.
    c. 30-day public comment period begins on date of second public notice.
    d. Public Notice of Application (PNOA) must be published once a week for two consecutive weeks in a local newspaper of general circulation.

2. Contact Washington State Department of Fish & Wildlife for hydraulic project approval and to comply with any other fish habitat protection requirements.

3. Compliance with Standards – discharges must be in compliance with Surface Water Quality Standards, Ground Water Standards, Sediment Quality Standards or the National Toxics Rule.
4. Follow discharge limits – prevent damage to vegetation, use of clean water only (no detergents or other cleaning agents). There are special methods for cleaning creosote or treated wood fibers if applicable.
5. Minimize scour impact from discharge.
6. Grease removal done by hand, such material cannot enter water.
7. Dry cleaning methods (scraping, sweeping, vacuuming) should be done before pressure washing to lessen debris and substances from entering water.
8. Must wash with the minimum water pressure necessary to accomplish the work.

6.2 Deck Sweeping

We understand that Pend Oreille County performs annual sweeping of the concrete bridge deck. This is beneficial to the longevity of the concrete deck and to vehicular traffic that crosses the bridge. This should continue as a preventative maintenance practice.

6.3 Trim Vegetation

This is a straightforward maintenance item to clear out tree and brush vegetation that encroaches on the steel truss at the west end (Photo 13). This maintenance item could be performed by County crews and could be completed in one day or less. This is important step to keep moisture and debris away from painted steel members.

Photo 13 - Vegetation encroaching on truss

6.4 Clean Truss Drains

In the bottom chord of Span 12 of the east approach truss, there is typically water that accumulates within the member. There are small drain holes at the ends of these members that should be cleared periodically to drain the accumulated water. This location should be possible to reach with a tall ladder. Routinely clearing the water will help maintain the paint condition in that member.

7.0 BRIDGE RETROFIT

7.1 Alternatives to Open-Grid Steel Decking

While the open-grid steel decking on the Ione Bridge has generally performed well for over 50 years, it has seen areas with higher rates of damage, particularly at the transitions from steel deck to concrete. Additionally, the open decking will be a continual maintenance issue with buildup on the truss members. The County is interested in learning about alternatives to the open-grid decking and if any are a feasible replacement option for a solid, lightweight, and durable deck alternative. Table 3 provides a summary of the alternatives studied followed by a discussion of each deck type. Replacement deck weight will need to be limited to 23 pounds per square foot (psf) given the current load capacity and posting on the bridge. If an increased deck weight or railing weight is necessary, strengthening of the steel truss would be required.

Table 3. *Summary of open-grid steel deck alternatives*

Deck Type	Weight (psf)	Pros	Cons	Estimated Costs	Lifespan
Open-Grid Steel *(Existing)*	16	+Proven durability +No joints +Most cost effective.	-Open design allows for debris -Noise may be an issue -Damage is not easily repaired	$90/SF $2.52 million Total	75+ years
Aluminum *(5-inch depth, plus wearing surface)*	19-21	+Rigid (Low Deflections) +High strength-to-weight ratio +Excellent corrosion resistance	-Joints required between each member -High material costs -Lack of in-service use to confirm lifespan.	$135/SF $3.42 million Total	75-100 years 15-20 years wearing surface
Fiber Reinforced Polymer *(6 to 8 inches)*	20 - 25	+High strength-to-weight ratio +Non-destructive properties	-High material costs. -Susceptible to deflection issues. -Lack of widespread use and no design specifications.	$250/SF $5.74 million Total	75 years projected 15-20 years wearing surface
Ultra High-Performance Concrete Waffle Deck *(5 inches)*	29 - 35	+Very high compressive strength +Excellent permeability and durability +No Joints	-High material costs -Not adopted as a standard bridge material yet. -New technology -Highest unit weight	$180/SF $4.33 million Total	75 years projected

Other deck types reviewed, but deemed too heavy, include corrugated metal decking with asphalt overlay and SPS (Sandwich Plate System) panels which consist of steel plates with internal elastomer.

7.1.1 Aluminum Decking

Aluminum orthotropic decks are an extruded product fabricated with aluminum alloys. They consist of a solid top and bottom flange with vertical and diagonal webs. Aluminum has been used for over 80 years in various forms of bridge construction and is more recently being used for bridge decks for spans up to 6-feet. The tops of the decks are typically overlaid with a wearing course consisting of at least two layers of ¼-inch epoxy polymer with flint rock aggregate for skid resistance. This overlay service life is estimated at 15-20 years. Joints between adjacent members would have to be sealed.

Aluminum orthotropic decking is typically bolted to supporting members. To prohibit corrosion issues if placed on steel, a zinc-rich primer paint would be necessary. Aluminum structures and decks are covered under AASHTO LRFD Design Specifications, Sections 7 and 9.8.4.

Advantages of aluminum decking include being the most lightweight option to replace open-grid steel decks, high strength-to-weight ratio, excellent corrosion resistance, and low maintenance as compared to steel. Disadvantages include high initial cost of material as compared to steel and there is not a history of long-term in-service performance to verify lifespan.

In 2013, the Florida Department of Transportation conducted a study of replacement options for open-grid steel decks for bascule bridges. Aluminum orthotropic decking was the clear frontrunner and the company AlumaBridge® is in production for deck replacement projects.

7.1.2 Fiber Reinforced Polymer

Fiber Reinforced Polymer (FRP) bridge decks are a comparatively new technology in lightweight bridge deck options. FRP's are commonly used in the aerospace industry as well as in bridges to strengthen existing components. They were first introduced in the U.S. bridge deck market in the 1990's. They are an engineered material consisting of fiber reinforcement surrounded by polymer resins. FRP composites may also contain fillers and additives to enhance the final project. The fibers (typically made from fiberglass) provide the mechanical strength while the polymer resin provides protection.

The top of the deck surface is typically finished with a thin polymer overlay (approximately ½-inch thick) with aggregate added for a skid resistant, durable surface. For FRP decking, there are two common deck types that have different manufacturing processes:

1. **Pultruded decks** – Consists of a top and bottom layer with vertical webs created from a continuous manufacturing process. Requires a constant cross-sectional thickness.

2. **Sandwiched decks** – Consists of a top and bottom layer, shear webs, and a closed cell inner core layer. Cross sections can be customized such as for variable thickness, curbs, and cross slopes, etc.

The advantages of FRP decks include a high strength-to-weight ratio, the material is corrosion resistant, and they can be installed quickly due to their light weight. Static testing of FRP decks has demonstrated that performance requirements can be met with high factors of safety. Disadvantages to FRP decking include high initial cost as compared to conventional deck materials, lack of design specifications, brittle failure, and the joint behavior is emerging and being tested. A disadvantage specifically for the Ione Bridge site, is that deck depths would be in the range of 6 to 8-inches, which could pose challenges in connecting to the adjacent concrete deck.

The challenges in designing an FRP decking system is that it is a newer technology without widespread use, and therefore does not have a history of in-service use to confirm long-term performance. Additionally, there are currently no AASHTO Design specifications for use in vehicular bridges. Design is based upon finite element analysis and is often controlled by deflections. FRP decks are typically designed by a specialty fabricator to a performance specification.

Photo 14 - Example FRP Decking

The Chief Joseph Dam Bridge in Washington State (Douglas County) had an FRP deck installed to save weight on a truss in 2003 (Photo 14). The FRP deck was generally in good structural condition, but it did have some serviceability issues, such as leaking and there was not uniform bearing over the supporting girders. The full bridge was replaced in 2016, so long-term performance of the FRP was not established.

7.1.3 Ultra-high Performance Concrete Waffle Deck

An ultra-high performance concrete (UHPC) waffle deck is a lighter and stronger alternative to a conventional concrete deck. Waffle decks consists of a solid top slab and “ribs” which run both transversely and longitudinally. The first full-bridge waffle deck was installed in Wapello County, Iowa in 2011 after full-scale testing. Waffle decks are typically made composite with the supporting bridge member, whether it be concrete or steel.

UHPC decking is fabricated using ultra-high performance concrete which is a proprietary material by LaFarge North America (trademark name Ductal®). UHPC is an engineered material and consists of Portland cement, fine aggregate, silica fume, crushed quartz, steel fibers, water, and superplasticizers. Its main material difference from conventional concrete is that it does not have coarse aggregate and has a very low water-to-cement ratio. UHPC can reach compressive strengths of 18 to 24 ksi, which is 3 to 4 times the strength of conventional deck concrete.

The advantages of UHPC waffle decks include a high compressive strength, excellent permeability, and superior durability. These characteristics would likely contribute to increased service life and reduced maintenance costs for a bridge deck, as compared to conventional concrete. Disadvantages to UHPC decking include very high costs (approximately $2K to $3K per cubic yard) and lack of adopted design specifications. Because material cost is so high, many bridge projects have limited the use of UHPC to only the joints between precast members.

7.2 Retrofit for Bicycle Traffic

The Ione Bridge is on the U.S. Bicycle Route System (USBR10) from Colville to Newport. As such, the bridge sees bicycle traffic during the warmer months. The existing bridge rail does not meet current height or opening standards per the Washington State Department of Transportation. The County has expressed interest in studying options to upgrade the bridge rail to meet current bicycle rail standards.

History of Bicycle Railing Height Requirements

Bicycle railing height requirements have changed over the years. In 1974, the American Association of State Highway and Transportation Officials (AASHTO) adopted a 54-inch minimum height standard. Per NCHRP Report 20-07 (168):

> *In the absence of scientific study, empirical data, and actual or simulated crash data, the first AASHTO guideline for the height of a bicycle railing was based solely on the theory that a railing should be equal to or higher than a bicyclist's center of gravity (COG) to prevent the bicyclist from vaulting or falling over the railing. A conservative estimate of an additional 12 inches was applied to the 1.1-meter (42-inch) pedestrian railing height, and a 1.4-meter (54-inch) high bicycle railing height was established.*

In 1999, the AASHTO Task Force on Geometric Design recommended a reduction to a 42-inch height due to aesthetics and a lack of adverse crash test data. It was not until 2007 that AASHTO formally lowered the requirement to 42-inch minimum rail height for both pedestrians and cyclists. As it currently stands, states are free to establish any height of rail at or above 42-inches. Washington State has opted to stay with the minimum height of 54-inches based upon RCW 46.61.755(2) which allows bicyclists to ride on a sidewalk. This height is also characteristic of standard bicycle railing design in Washington's bridge inventory.

Table 4 provides a summary of rail height and spacing requirements for bicycle rail in Washington State and how the Ione Bridge compares:

Table 4. *Comparison of Ione Bridge Rail to WSDOT and AASHTO Requirements.*

Requirement	Ione Status
54-inch minimum height for bicyclists (WSDOT)	*Does not meet at 39.5-inches*
Openings in lower 27-inch of rail sized such that a 6-inch sphere could not pass. (AASHTO)	*Does not meet opening requirement at 10 inches*
Openings above 27-inch sized such that an 8-inch sphere could not pass. (AASHTO)	*Does not meet opening requirement at 11.5 inches*
Rail must have safety toe or curb. (AASHTO)	*Meets requirement*

The rail at the Ione Bridge consists of 6-inch steel rail posts spaced at 6'-4" mounted on the outside edge of the concrete curbs (Photo 15). The horizontal rails consists of two 4x3 steel tubes. The rail height above the driving surface is 39.5-inches which is 2.5-inches short of the current AASHTO requirements and 14.5-inches short of the Washington State requirement. The current weight of the steel railing is 40 lbs. per linear foot.

Photo 15 - Ione Bridge Railing

Any retrofit to the bridge rail would require an increase in weight (dead load) applied to the bridge. To retrofit the bridge for bicycle requirements, the bridge rail would require both an increase in height and adding horizontal members to reduce opening size.

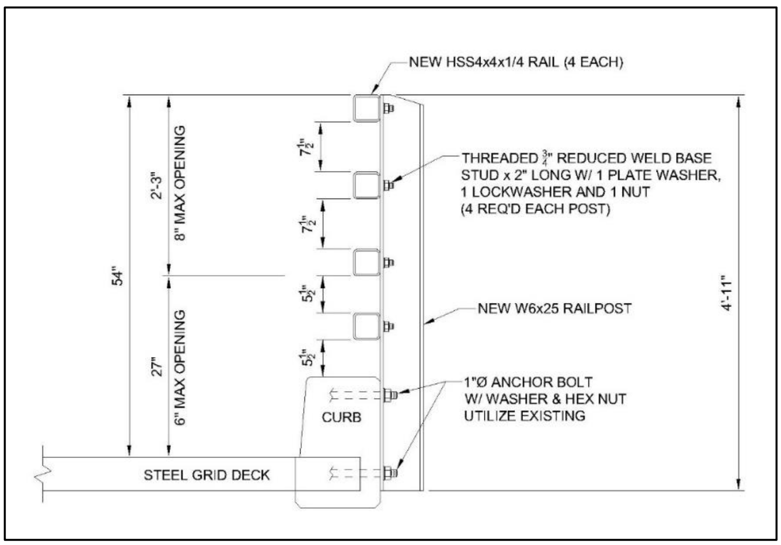


Figure 5: Rail Retrofit Detail

Furthermore, a retrofit would require consideration of the railing's adequacy for vehicular loading. The rail at Ione is not a crash-tested system, nor does it meet any present-day railing standards. Per the WSDOT Bridge Design Manual, for systems constructed prior to the year 2000, a retrofit would need to resist a 10-kip barrier impact design load. In a review of the existing bridge rail, both the rail posts and the attachment bolts <u>do meet</u> the 10-kip barrier load. Therefore, a retrofit is feasible to meet both bicycle and vehicular loading for existing bridges.

For the purpose of this planning report, Nicholls Kovich Engineering reviewed several rail retrofit concepts with the recommended concept shown in Figure 5. This rail retrofit design provides for the following:

1. Meets all WSDOT and AAASHTO Design Criteria.
2. Would require no major change to current load posting. For the one truck at a time condition, the lowest rating factor is 1.06. This rail retrofit would lower the rating factor to 1.04 which is still acceptable.
3. Could utilize existing curb bolts for installation.
4. Would be aesthetically pleasing and provide similar design concept as the existing rail.

Other alternatives studied are presented in the Appendix along with cost estimates.

7.3 Retrofit to Upgrade Structural Capacity

The Ione Bridge is presently posted for "*One Truck At a Time.*" The bridge load rating was performed in 2016 to reflect current bridge conditions and to include load rating factors for Single Unit Vehicles (SHV's) with 4 to 7 axles per FHWA requirements. The results of the load rating indicated that the bridge would require load restrictions for unrestricted truck use. If the bridge is limited to one truck at a time, the posting for legal loads is not required. Table 5 provides a summary of rating factors for standard legal loads for both two typical lanes and then for one truck at a time. Note that a rating factor less than 1.00 indicates that the bridge cannot safely handle the given fully loaded truck. Presently, the load rating is being controlled by truss members in compression and the timber girders.

Table 5. *Rating results for two lanes versus one truck at a time on the bridge.*

Legal Load Configuration	Rating Factor Two Lanes	Rating Factor One Truck	Controlling Member
TYPE 3 (Truck)	1.29	1.29	Timber Girders - Moment
TYPE 3-S2 (Semi-Truck)	1.20	1.41	Steel Truss L10-L11 - Compression
TYPE 3-3 (Truck & Trailer)	0.88	1.06	Steel Truss L9-L10 - Compression
Single Unit SHV (SU4)	1.11	1.11	Timber Girders - Moment
Single Unit SHV (SU5)	1.07	1.07	Timber Girders - Moment
Single Unit SHV (SU6)	1.03	1.03	Timber Girders - Moment
Single Unit SHV (SU7)	1.03	1.03	Timber Girders - Moment

The insufficient rating factor of 0.88 for the Type 3-3 Truck Configuration is based upon a legal truck train (Figure 6 below). This configuration shows (2) truck plus trailer configurations (at 75% capacity) in one line separated by 30-feet. This rating configuration is required to be analyzed for continuous structures.

The County is interested to know if anything can be done to strengthen the bridge to remove the load posting restriction of one truck at a time on the bridge. A bridge's load rating (or capability of the bridge to handle moving loads) is based upon three main factors: the dead weight of bridge components, bridge condition, and bridge member capacity. Since it is not feasible to significantly reduce the dead weight on the Ione Bridge, the Owner may have control over 1) bridge condition and 2) bridge member capacity.

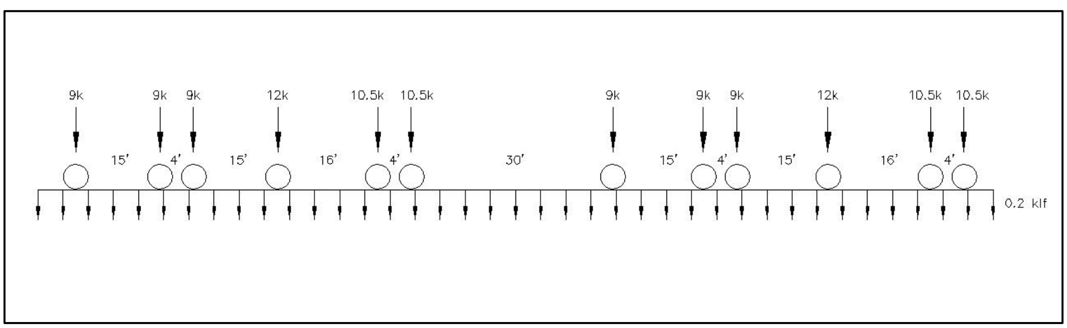


Figure 6 - Controlling truck configuration (Type 3-3)

7.3.1 Bridge Condition

Preventative maintenance measures as outlined in this report will go a long way to prevent deterioration of the bridge's existing condition. Of particular importance is debris removal on the steel truss and recommended repairs to damaged or split timber girders. Additionally, impact is also a consideration. An impact factor of 20% is applied in the load rating. If deck conditions deteriorated to poor condition, the impact would increase to 30%. Therefore, it is also important to make any recommended deck repairs.

7.3.2 Bridge Member Capacity

To increase structural capacity of members that are controlling the load rating, the following alternatives were studied:

Alternative 1 - Strengthen controlling members by adding steel plates to existing truss members.
Alternative 2 - Replace controlling members with stronger section.

The most economically feasible is Alternative 1. This would include, at a minimum, modifications to Truss Members L9-L10, L10-L11, L13-L14, and L14-L15 on each side of the truss (highlighted in Figure 7). This work would require the following steps:

1. Set up traffic control and close down one lane of bridge for work access.
2. Build work platform below Span 9 main truss.
3. Intermittently close bridge to ALL traffic while steel members are strengthened.
4. Strengthen steel members (156 linear feet).
5. Paint new steel plates and disturbed areas
6. Remove work platform and open to two lanes of traffic.

General details and a cost estimate are provided in Appendices A & B.

Prior to any truss strengthening work, it would be recommended to fully clean the bridge and re-inspect to ensure there have been no major conditional changes in truss members.

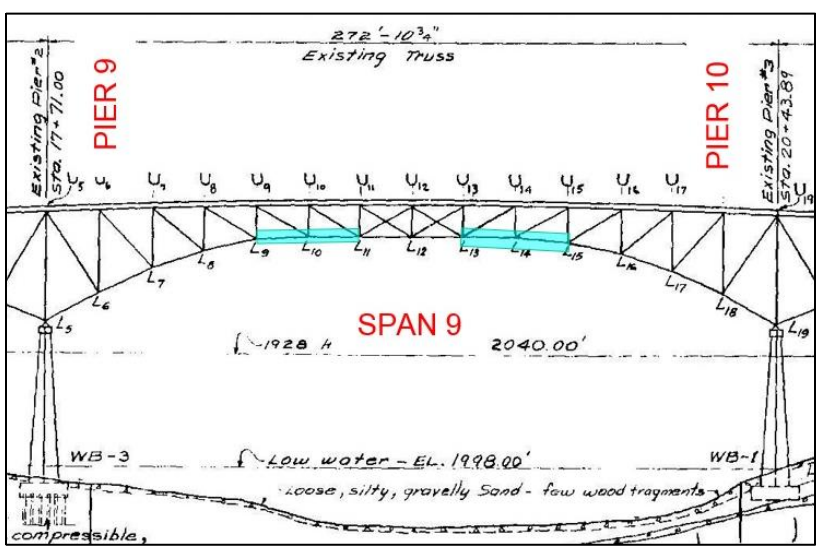


Figure 7 – Bridge member strengthening

8.0 FEDERAL BRIDGE FUNDING

The Washington State Department of Transportation had a recent Call for Projects for the Federal Local Bridge Program to improve the condition of bridges through replacement, rehabilitation, and preventative maintenance. The eligibility requirements for replacement and rehabilitation are as follows:

Replacement – Structurally Deficient Bridges with a sufficiency rating less than 40
Rehabilitation – Structurally Deficient Bridges with a sufficiency rating less than 80.

While the Ione Bridge is not eligible for replacement or rehabilitation at this time (does not meet structurally deficient category), the Bridge does qualify under the Preventative Maintenance category which seeks to maximize the life expectancy of an existing bridge. The following are areas eligible for preventative maintenance funding due to condition:

1. Expansion Joint Replacement for Elements in Condition State 3
   - *38-ft of joint length is in Condition State 3 due to joint failure = 21% of total length*

2. Steel Deck Repair for Elements in Condition State 3
   - *140 sq. feet in Condition State 3 due to damage and broken bars = 1% of total area*

3. Timber Girder Repair
   - *89-ft in Condition State 3 due to splitting = 1% of total length*

4. Timber Pile Repair for timber elements in Condition State 3.
   - *12 piles recommended repairing due to severe checking = 20% of total pile quantity*

Preventative maintenance projects would require a 13.5% local match for the design phase. For projects authorized for construction prior to December 2024, 100% of construction costs are eligible for federal funding. After December 2024, a 13.5% local match would be required for construction costs.

Per WSDOT Local Programs, if a bridge project is selected to receive federal funding, that bridge becomes ineligible to obtain subsequent funding in the Federal Bridge Program for the next 10 years.

To extend the life expectancy of the Ione Bridge, it was recommended to submit a funding application to repair the bridge elements that are eligible: expansion joints, steel grid deck, timber girders, and timber piles. The Ione Bridge was bundled with the Usk Bridge since there are some similar repairs to be made (joint replacement and pile repair).

Additionally, it is recommended in BridgeWorks to move 100% of the expansion joint quantity into Condition State 3 since the majority of joints have at least debonded or are partially failed and any level of joint failure would require full joint replacement.

9.0 PLANNING SUMMARY

The Ione Bridge Planning Table 6 (below) summarizes repair, preventative maintenance, and retrofit recommendations contained in this report. Additionally, it provides the required resources and estimated costs (including engineering) to perform the work. Of particular note in the near-term are rows marked "Federal Funding". These items qualified to be included in an application for the 2021 WSDOT Call for Bridge Projects in the Bridge Preventative Maintenance category. WSDOT will review projects this spring and summer with project awards intended for Fall 2021.

The Ione Bridge Planning Table is intended to provide a comprehensive overview of the actions and their associated costs that will keep the Ione Bridge in service to Pend Oreille County for at least the next 10-20 years, and beyond.

Table 6. *Ione Bridge Planning Table*

		County Resources	Engineering	Bid Project	Estimated Cost*	Federal Funding
Bridge Repairs	Approach Guardrail	✓		✓	$7K - $50K	
	Curb Connection	✓			$800	
	Railing Reflectors	✓			$1,400	
	Utility Hangers				Utility Co.	
Conditional Preventative Maintenance	Repair Timber Piling		✓	✓	$308,000	✓
	Repair Timber Girders		✓	✓	$145,000	✓
	Repair Steel Decking		✓	✓	$113,000	✓
	Repair Exp. Joints		✓	✓	$111,000	✓
Cyclical Preventative Maintenance	Bridge Washing			WSDOT	TBD	
	Bridge Sweeping			✓	-	
	Trim Vegetation	✓			-	
	Truss Drains	✓			-	
Bridge Retrofit	Bridge Deck		✓	✓	$3,420,000	
	Bridge Railing		✓	✓	$937,000	
	Bridge Strengthening		✓	✓	$918,000	

**Total Cost, including engineering.*

10.0 IONE BRIDGE – WHERE TO START

With this information, Pend Oreille County will need to know where to start to address the bridge's most critical needs and plan for funding. The following are the recommended areas to address first to extend the service life of the bridge and maintain load-carrying capacity for vehicular and truck traffic:

1. *Bridge Washing*
2. *Repair Timber Girders*
3. *Repair Steel Bridge Deck*
4. *Repair Timber Piling*
5. *Repair Expansion Joints*
6. *Repair Approach Guardrail*

11.0 REFERENCES

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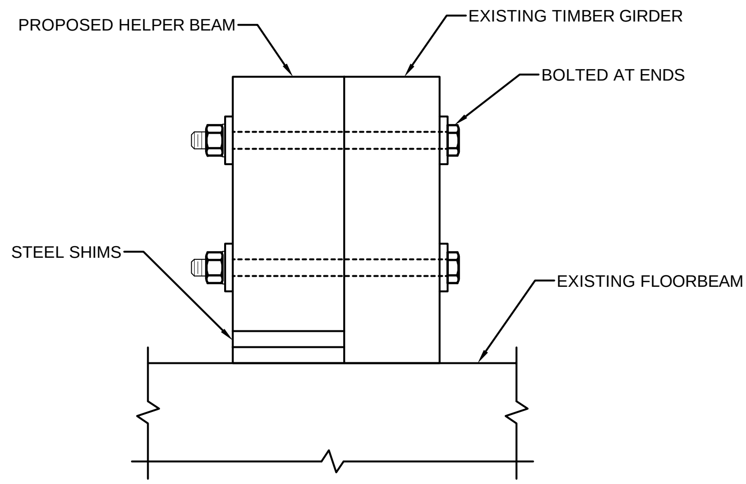
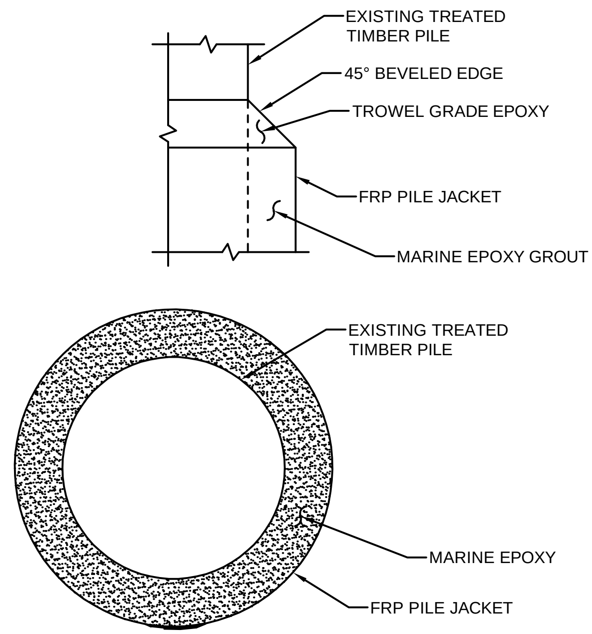
APPENDIX A

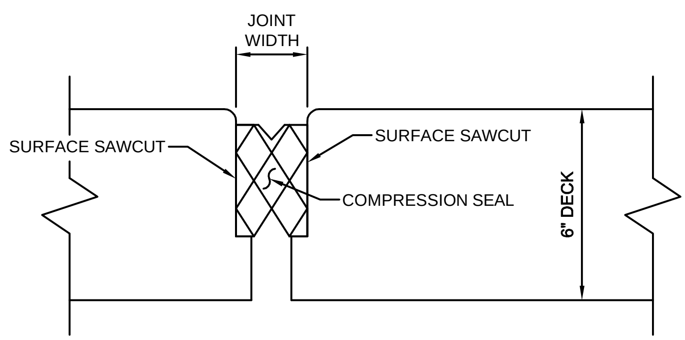
DETAILS



TIMBER GIRDER REPAIR



TIMBER PILE REPAIR



EXPANSION JOINT REPAIR

Nicholls Kovich Engineering, PLLC
P.O. Box 1050 Veradale WA 99037-1050
Phone: (509) 921-6747 Fax: (509) 242-8777
E-mail: info@nichollskovich.com

Designed By:	Date:
-	-
Checked By: SMK	Date: 2/21
Drawn By: AVK	Date: 2/21

Pend Oreille County Road Department

P.O. Box 5040 Newport, WA 99156
Phone: (509) 447-4513

SCALE
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VERTICAL:

IONE BRIDGE PLANNING REPORT
REPAIR DETAILS

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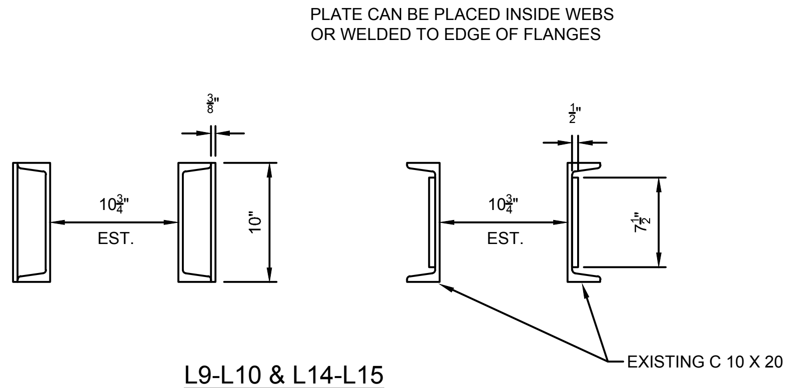
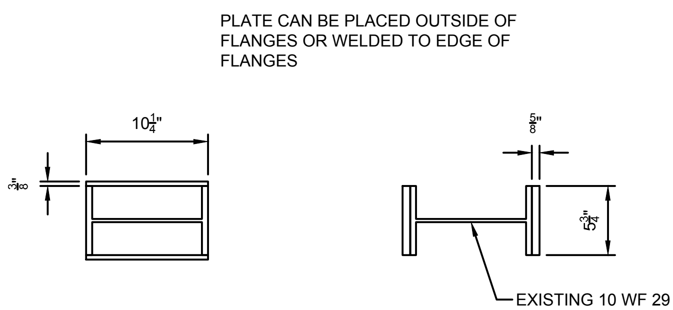


L9-L10 & L14-L15

ADD PLATES TO EXISTING CHANNELS



L10-L11 & L13-L14

ADD PLATES TO EXISTING WIDE FLANGE

NOTES:

1. WORK PLATFORM WILL BE REQUIRED
2. BRIDGE SHALL BE CLOSED TO ALL TRAFFIC TO INSTALL PLATES
3. ALL MEMBERS TO BE PAINTED AFTER RETROFIT

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Designed By: -	Date: -
Checked By: SMK	Date: 2/21
Drawn By: AVK	Date: 2/21

Pend Oreille County Road Department

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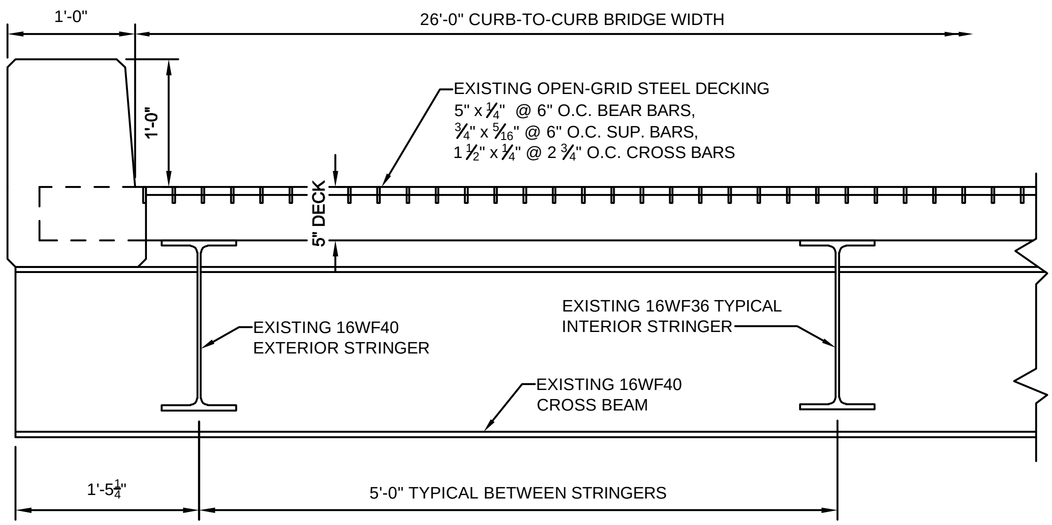
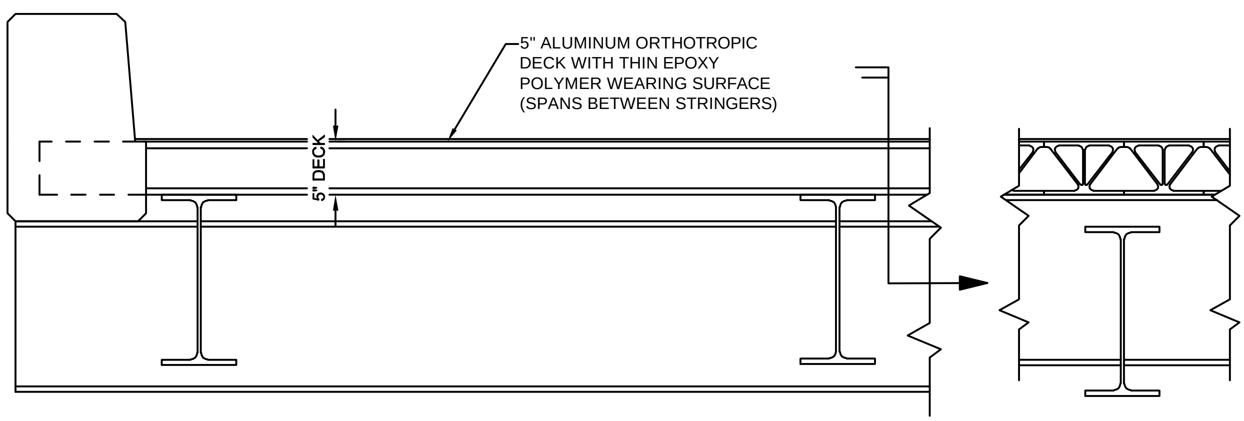
STRENGTHENING TO INCREASE LOAD CAPACITY



EXISTING BRIDGE DECK CROSS SECTION



ALUMINUM BRIDGE DECK CROSS SECTION

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Designed By:	Date:
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Checked By: SMK	Date: 2/21
Drawn By: AVK	Date: 2/21

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SCALE
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VERTICAL:

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DECKING OPTIONS 1

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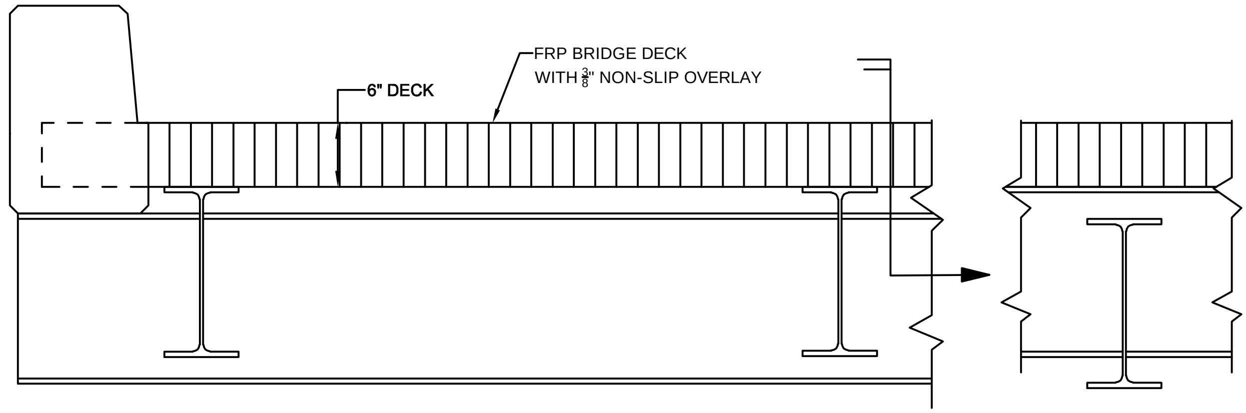
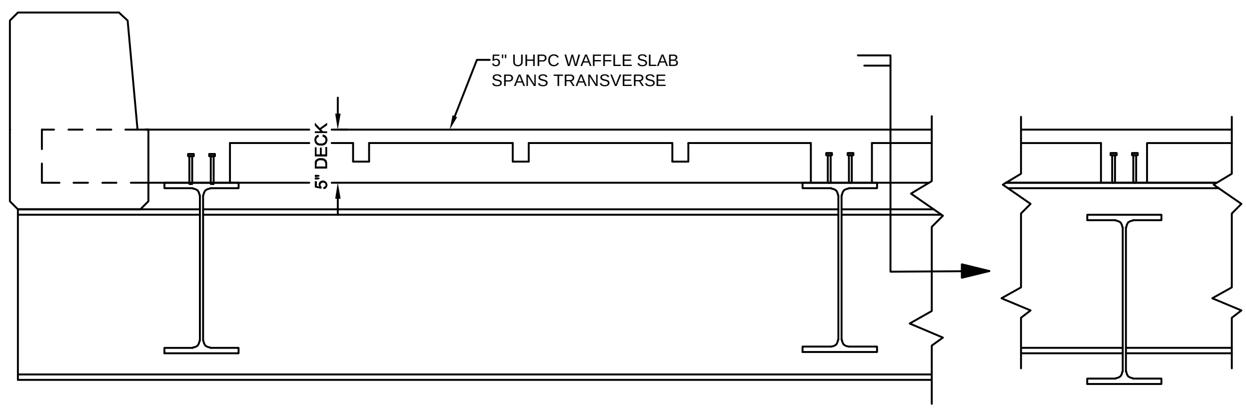


FRP BRIDGE DECK CROSS SECTION



UHPC BRIDGE DECK CROSS SECTION

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Designed By:	Date:
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Checked By: SMK	Date: 2/21
Drawn By: AVK	Date: 2/21

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DECKING OPTIONS 2

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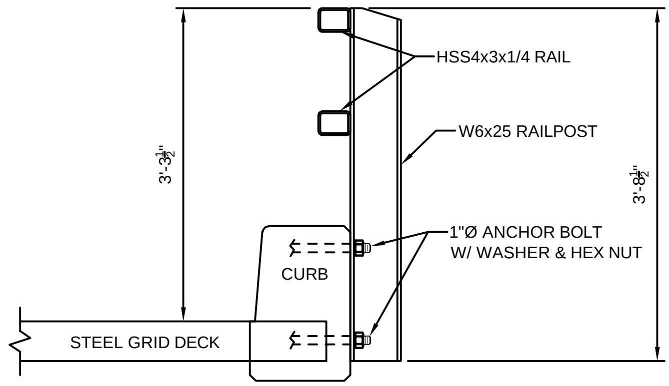
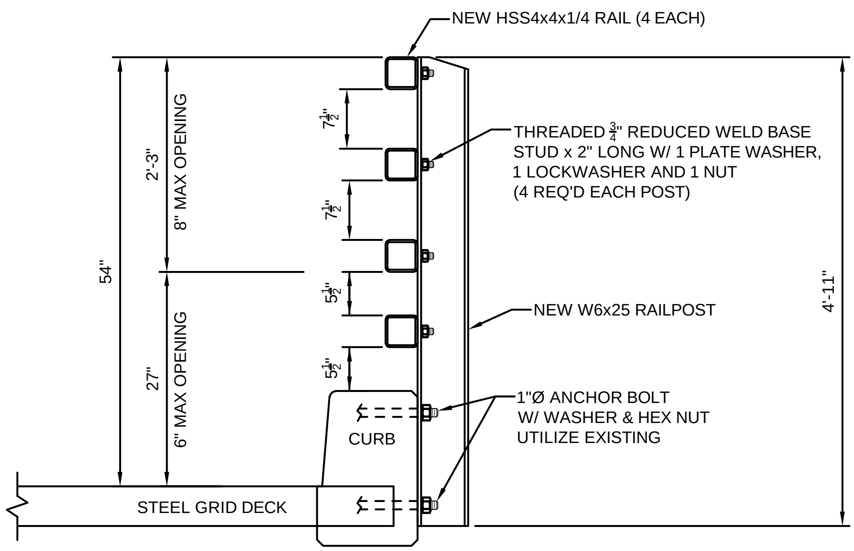


EXISTING RAIL

WEIGHT = 40 LB/FT



RAIL RETROFIT CONCEPT

RAIL WOULD MEET ALL WSDOT & AASHTO REQUIREMENTS FOR BICYCLE RAIL

WEIGHT = 70 LB/FT

Nicholls Kovich Engineering, PLLC
P.O. Box 1050 Veradale WA 99037-1050
Phone: (509) 921-6747 Fax: (509) 242-8777
E-mail: info@nichollskovich.com

Designed By:	Date:
-	-
Checked By: SMK	Date: 2/21
Drawn By: AVK	Date: 2/21

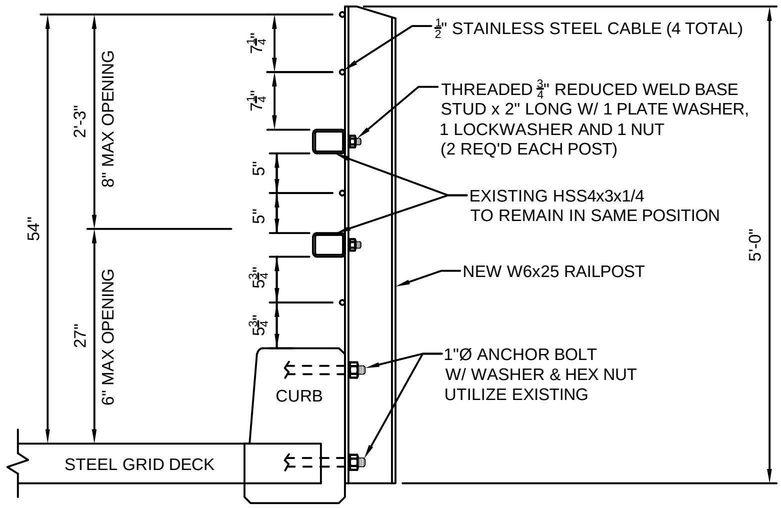
Pend Oreille County Road Department

P.O. Box 5040 Newport, WA 99156
Phone: (509) 447-4513

SCALE
HORIZONTAL: ____
VERTICAL: ____

IONE BRIDGE PLANNING REPORT
54-IN BICYCLE RAIL RETROFIT

SHEET A5 of A6

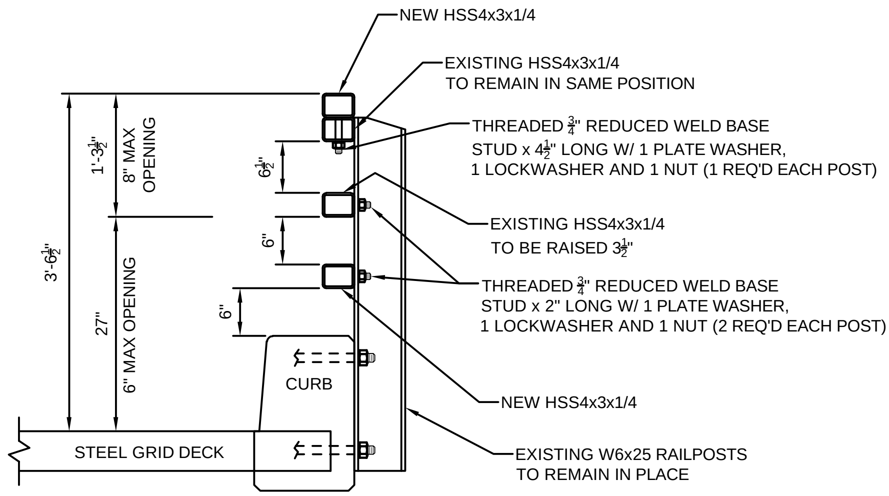


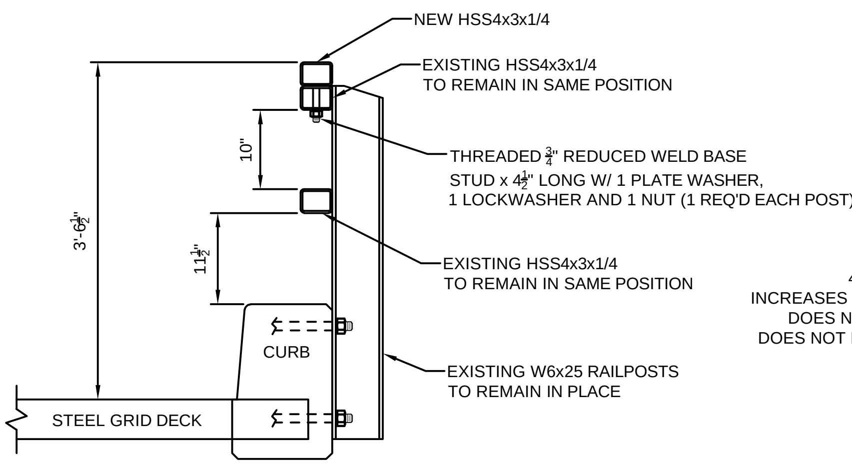
ALTERNATIVE 1

RAIL MEETS ALL WSDOT & AASHTO REQUIREMENTS FOR BICYCLE RAIL
WEIGHT = 44 PLF

ALTERNATIVE 2

42-IN RAIL WITH HSS TUBES
MEETS AASHTO REQUIREMENTS
DOES NOT MEET WSDOT HEIGHT REQUIREMENTS
WEIGHT = 58 PLF





ALTERNATIVE 3

42-IN RAIL WITH MINIMAL CHANGES
INCREASES RAIL HEIGHT TO MEET AASHTO REQUIREMENT
DOES NOT MEET WSDOT HEIGHT REQUIREMENTS
DOES NOT MEET AASHTO RAIL SPACING REQUIREMENTS
WEIGHT = 48 PLF

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Designed By: -	Date: -
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SCALE
HORIZONTAL: ____
VERTICAL: ____

IONE BRIDGE PLANNING REPORT
BICYCLE RAIL ALTERNATIVES

SHEET
A6 of A6

APPENDIX B

COST ESTIMATES

COST ESTIMATE
BRIDGE REPAIRS

BRIDGE REPAIR				
Repair Impact-Damaged Approach Rail (Option 1 - upgrade transitions)				$ 0.095
MOBILIZATION	1	LS	$ 2,800.00	$ 2,800.00
BEAM GUARDRAIL TRANSITION SECTION TYPE 24	2	EA.	$ 3,500.00	$ 7,000.00
BEAM GUARDRAIL TYPE 31	220	L.F.	$ 30.00	$ 6,600.00
BEAM GUARDRAIL ANCHOR	2	EACH	$ 1,500.00	$ 3,000.00
TRAFFIC CONTROL	1	LS	$ 10,000.00	$ 10,000.00
DESIGN	1	LS	$ 12,000.00	$ 12,000.00
			Contingency	20%
			Total Approach Rail (Max)	**$ 49,700.00**
Repair Impact-Damaged Approach Rail (Option 2 - replace only guardrail)				
LABOR & MATERIALS	1	L.S.	$ 3,830.00	$ 3,830.00
TRAFFIC CONTROL	1	LS	$ 2,000.00	$ 2,000.00
			Contingency	20%
			Total Approach Rail (Min)	**$ 7,000.00**
Replace missing nuts - curb to floorbeam connection				
LABOR & MATERIALS	1	L.S.	$ 660.00	$ 660.00
				$ -
			Contingency	20%
			Total Missing Nuts	**$ 800.00**
Replace Reflectors				
LABOR & MATERIALS	1	L.S.	$ 750.00	$ 750.00
TRAFFIC CONTROL	1	LS	$ 500.00	$ 500.00
			Contingency	10%
			Total Reflectors	**$ 1,400.00**
Utility Hangers (By Others)				

COST ESTIMATE
CONDITIONAL PREVENTATIVE MAINTENANCE

CONDITIONAL PREVENTATIVE MAINTANENCE

Scope: Repair timber piling, timber girders, steel deck, and expansion joints to increase bridge lifespan.

	Percent	Calculated		Application Input
PE Costs	15%	$61,462.50		**$70,000**
Right of Way Costs (Temporary Easement)		$0.00		**$0**
Construction Costs (Calculated Below)		$409,750		**$410,000**
Construction Engineering	18%	$73,755		**$73,800**
Contingency	15%	$61,463		**$61,500**
Mobilization	10%	$40,975		**$41,000**
Inflation Factor per Year	5%	$20,488		**$20,500**
			GRAND TOTAL	**$676,800**

ELEMENTS OF CONSTRUCTION

Item #	Std. #	Description	Quantity	Units	Unit Price	Extended
1		Install Timber Helpers	1	LS	$ 69,000.00	$ 69,000.00
2		Install FRP Pile Jacket System	1	LS	$ 147,000.00	$ 147,000.00
3		Compression Seal	1	LS	$ 53,000.00	$ 53,000.00
4		Steel Deck Repair	1	LS	$ 54,000.00	$ 54,000.00
5	6488	Erosion Control & Water Pollution Prevention	1	LS	$ 5,000.00	$ 5,000.00
6	6913	Portable Temporary Traffic Control Signal	1	LS	$ 20,000.00	$ 20,000.00
7	6971	Project Temporary Traffic Control	1	LS	$ 10,000.00	$ 10,000.00
8	6982	Construction Signs Class A	1170	SF	$ 30.00	$ 35,100.00
9	6993	Portable Changeable Message Sign	1152	HR	$ 10.00	$ 11,520.00
10		Traffic Safety Drum	33	EA	$ 20.00	$ 660.00
11		Tubular Markers	42	EA	$ 35.00	$ 1,470.00
12	7480	Roadside Cleanup	1	EST.	$ 1,000.00	$ 1,000.00
13	7736	SPCC Plan	1	LS	$ 2,000.00	$ 2,000.00
					Total Construction Costs	**$ 409,750.00**

Total Breakdown Per Element (Including Engineering)	
$308,000	Timber Piling - FRP Pile Jackets (12)
$145,000	Timber Girders - Install Helper Beams (8)
$113,000	Steel Deck Repair (140 SF)
$111,000	Expansion Joint Repair (Compression Seal = 182 LF)

COST ESTIMATE
CYCLICAL PREVENTATIVE MAINTENANCE

CYCLICAL PREVENTATIVE MAINTENANCE				
BRIDGE WASHING (PER WSDOT INTER-AGENCY AGREEMENT)				TBD

COST ESTIMATE
BRIDGE RETROFIT - DECK

BRIDGE DECKING RETROFIT					
Scope: Replace open-grid steel decking (requires new curb). Railing not included - See Rail Retrofit.					
Aluminum orthotropic shown. See other deck types below.					
			Percent	**Calculated**	**Total Costs**
PE Costs			10%	$228,164	**$230,000**
Right of Way Costs				$0.00	**$0**
Construction Costs (Calculated Below)				$2,281,637	**$2,282,000**
	Construction Engineering		10%	$228,164	**$228,200**
	Contingency		15%	$342,246	**$342,300**
	Mobilization		10%	$228,164	**$228,200**
	Inflation Factor per Year		5%	$114,082	**$114,100**
				GRAND TOTAL	**$3,420,000**

Standard Item #	Description	Quantity	Units	Unit Price	Extended
	PREPARATION				
0071	REMOVING PORTION OF EXISTING BRIDGE	12142	SF	$ 25	$ 303,550
	STRUCTURE				
4149	ST. REINF. BAR FOR BRIDGE	5000	LB.	$ 3.00	$ 15,000
	ALUMINUM ORTHOTROPIC DECK	12142	SF	$ 148.50	$ 1,803,087
	CONCRETE CLASS 4000 (CURB)	57	C.Y.	$ 1,000.00	$ 57,000
	TRAFFIC				
6971	PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	$ 100,000	$ 100,000
	OTHER ITEMS				
7736	SPCC PLAN	1	L.S.	$ 3,000	$ 3,000
				Total Construction	**$ 2,281,637**

TOTAL PROJECT COSTS - ALL DECK TYPES

	Unit Costs	Installed	**Total Project**
OPEN-GRID DECKING	$ 90	$ 99.0	$ 2,520,000
ALUMINUM ORTHOTROPIC	$ 135	$ 148.5	$ 3,420,000
FRP DECKING	$ 250	$ 275.0	$ 5,740,000
UHPC WAFFLE DECKING	$ 180	$ 198.0	$ 4,330,000

COST ESTIMATE
BRIDGE RETROFIT - RAILING

BRIDGE RAILING RETROFIT						
Scope: Replace existing bridge railing to meet WSDOT Standards						
			Percent	**Calculated**	**Total Costs**	
PE Costs			10%	$61,830.00	**$70,000**	
Right of Way Costs				$0.00	**$0**	
Construction Costs (Calculated Below)				$618,300	**$619,000**	
	Construction Engineering		10%	$61,830	**$61,900**	
	Contingency		15%	$92,745	**$92,800**	
	Mobilization		10%	$61,830	**$61,900**	
	Inflation Factor per Year		5%	$30,915	**$31,000**	
				GRAND TOTAL	**$937,000**	

Standard Item #	Description	Quantity	Units	Unit Price	Extended
	PREPARATION				
0071	REMOVING PORTION OF EXISTING BRIDGE	1	L.S.	$ 71,000	$ 71,000
	STRUCTURE				
4149	ST. REINF. BAR FOR BRIDGE	100	LB.	$ 3.00	$ 300
4322	CONC. CLASS 4000 FOR BRIDGE (PARAPET)	2	C.Y.	$ 3,000.00	$ 6,000
4410	BRIDGE RAILING TYPE - 54-INCH BICYCLE	1660	L.F.	$ 300.00	$ 498,000
	TRAFFIC				
6971	PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	$ 40,000	$ 40,000
	OTHER ITEMS				
7736	SPCC PLAN	1	L.S.	$ 3,000	$ 3,000
				Total Construction	**$ 618,300**

		WT (plf)	RATIO
4410	BRIDGE RAILING 54-inch	70	1

PROJECT COSTS FOR ALTERNATIVES

					Railing Cost	**Total Construction**
4410	ALTERNATIVE 1 (54-INCH)	44	0.629	$ 210	$ 348,600	$ 468,900
4410	ALTERNATIVE 2 (42-INCH)	58	0.829	$ 260	$ 431,600	$ 551,900
4410	ALTERNATIVE 3 (42.5-INCH)	48	0.686	$ 230	$ 381,800	$ 502,100

COST ESTIMATE
BRIDGE RETROFIT - TRUSS STRENGTHENING

TRUSS STRENGTHENING RETROFIT					
Scope: Strengthening truss members to remove posting requirements.					
			Percent	**Calculated**	**Total Costs**
PE Costs			25%	$128,625	**$130,000**
Right of Way Costs				$0.00	**$0**
Construction Costs (Calculated Below)				$514,500	**$515,000**
	Construction Engineering		18%	$92,610	**$92,700**
	Contingency		20%	$102,900	**$102,900**
	Mobilization		10%	$51,450	**$51,500**
	Inflation Factor per Year		5%	$25,725	**$25,800**
				GRAND TOTAL	**$918,000**

Standard Item #	Description	Quantity	Units	Unit Price	Extended
	STRUCTURE				
	WORK ACCESS	1	LS	$ 150,000.00	$ 150,000
	TRUSS STRENGTHENING	1	LS	$ 115,000.00	$ 115,000
4471	CLEANING AND PAINTING	1	LS	$ 60,000.00	$ 60,000
4469	CONTAINMENT OF ABRASIVES	1	LS	$ 75,000.00	$ 75,000
	TRAFFIC				
6971	PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	$ 100,000	$ 100,000
	OTHER ITEMS				
6403	ESC LEAD	15	DAY	$ 100	$ 1,500
6490	EROSION/WATER POLLUTION CONTROL	1	EST.	$ 10,000	$ 10,000
7736	SPCC PLAN	1	L.S.	$ 3,000	$ 3,000
				Total Construction	**$ 514,500**