USK BRIDGE PLANNING REPORT

Prepared For:

Pend Oreille County Public Works Department

April 2021

Prepared By:

Susan M. Kovich, P.E.
susan@nichollskovich.com

Nicholls Kovich Engineering, PLLC

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1.0 INTRODUCTION AND SCOPE OF WORK

The 57-year old Usk Bridge, the longest County road bridge in Washington State, is a critical structure in Pend Oreille County. Residents, members of the Kalispel Tribe, school children, and many of County's largest employers rely on the bridge for transport of people and goods across the Pend Oreille River. Without the bridge, drivers would be significantly impacted as a detour would be at least 35-miles long.

This report is intended to assist Pend Oreille County Public Works in planning for the future of the Usk Bridge by providing information on the background, current condition, necessary repairs, potential enhancements, and replacement costs for 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 maintenance and repair recommendations with associated costs.
- Review bridge load rating capacity and explore options to remove load posting by strengthening the bridge.
- Address the feasibility and cost to retrofit the bridge for shared pedestrian and bicycle use.
- Address long-term bridge replacement needs and associated funding-level costs.

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 load posting to be removed.
3. Present-day cost to replace the bridge.

Photo 1 - Deck view looking east

2.0 BRIDGE BACKGROUND

2.1 General Description

The Usk Bridge is a 2,281-ft long bridge at Usk, Washington that carries Kings Lake Road over the Pend Oreille River. The bridge provides vital access to Pend Oreille County residents, particularly members of the Kalispel Tribe of Indians. The closest river crossings to the Usk Bridge are 17 miles upstream at Newport and 35 miles downstream at Ione.

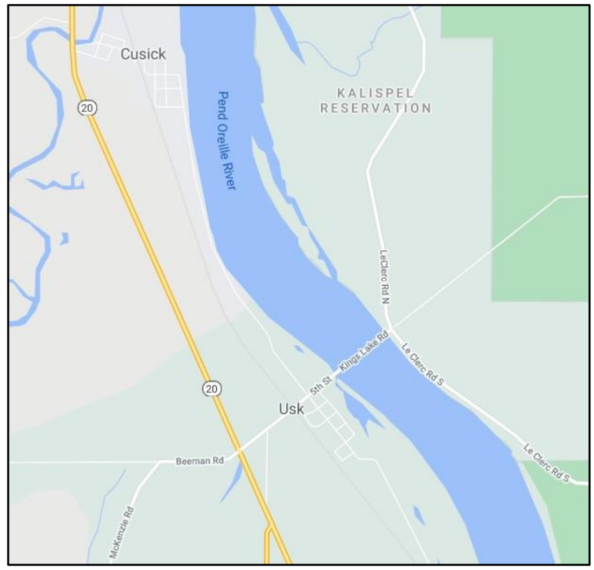


Figure 1 – VICINITY MAP *Map data ©2021, Google*

The Usk Bridge was designed by Harry R. Powell and Associates of Seattle and constructed by Paul Jarvis, Inc. in 1964 at a cost of $935,000. The bridge replaced an adjacent obsolete timber bridge that was constructed in 1915. The bridge has always been an important link within the County, originally constructed to create a link between the forests and lumber mills.

The bridge has two distinct structure types due to variation in the underlying soils that support the bridge foundations. A 600-ft length of the bridge on the west side consists of a lightweight concrete deck and (20) spans of treated timber glulam girders supported by 25-Ton timber piling. The eastern 1681-ft portion of the bridge consists of a lightweight concrete deck on (24) spans of prestressed concrete girders supported by 75-Ton precast concrete piling. Geotechnical data shows that the western third of the channel consists of soft silt underlain by sand and clay deposits of variable thickness. The eastern two-thirds of the channel consists of 30 to 50-ft of soft silt underlain by mudstone shale.

The existing bridge was designed for an H15-S12-44 live loading. This is a 27-Ton (54 kip) design truck with (3) axles (6 kip, 24 kip, and 24 kip). Average daily traffic was documented to be 1,900 in the year 2018 with 30 percent being trucks.

2.2 History of Work on Bridge

Bridge maintenance, rehabilitation, and replacement has been a topic for the Usk Bridge for several decades. In the Fall of 1996, the Bridge Replacement Advisory Committee (BRAC) listed the bridge as a candidate for replacement. In 2002, a Type, Size, and Location Study was conducted by Parson Brinckerhoff Quade & Douglas, Inc. for total bridge replacement. That Study recommended a new upstream bridge consisting of steel and concrete girders at a cost of $16.8 million. By 2008, the estimated costs were documented to be upwards of $40 million.

Due to rising replacement costs, the bridge underwent major maintanence in 2010, with repair details designed by the Washington State Department of Transportation. Prior to this major maintenance, the bridge's sufficiency rating was 23.92 and the bridge was categorized as Structurally Deficient with the following National Bridge Inventory (NBI) Condition Codes:

Deck – **6** (Satisfactory Conditon)
Superstructure – **5** (Fair Condition)
Substructure – **4** (Poor Condition)

The main elements repaired in 2010 are listed in Table 1:

Table 1.

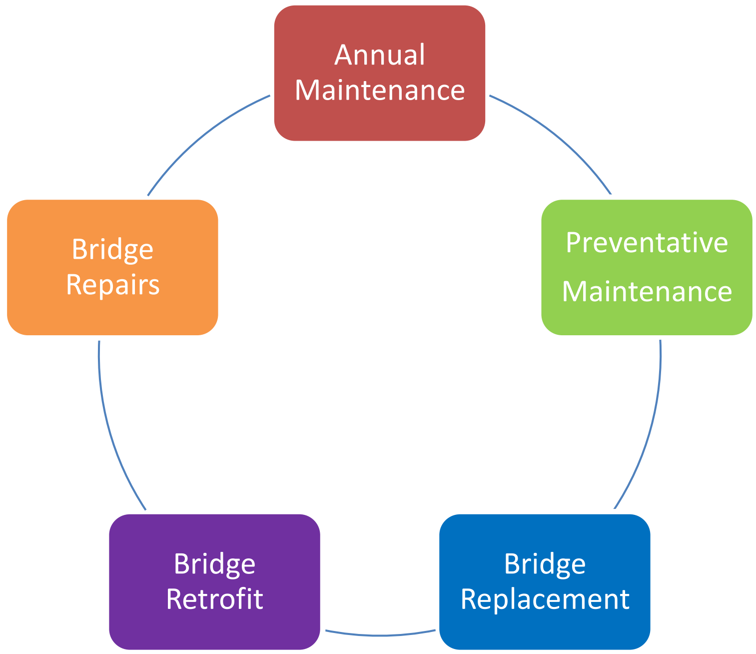
Major Maintenance Item	***Extent***
1½" Modified Overlay	Area on Bridge = 59,315 sq. ft.
Expansion Joint Modification – 44 Joints	Piers 1 - 44 (44) locations = 1210-ft
Pile Jacketing – 16 piles (282-ft) (Reference Photo 2)	Piles: 27G, 28G, 29D, 29E, 29G, 30A, 30G, 31G, 32A, 32E, 32G, 33A, 34G, 35F, 37A, 40C
Pile Section Replacement (remove and splice section), 18 feet	Pile 34A
Pier Cap Repair (Spalls, Cracking, Scaling, Exfoliation, Delaminations, and Exposed Rebar) (Reference Photo 3)	Piers: 2-5, 8-17, 19-26, 28-44 Total Area = 600 sq. ft.

Photo 2 - Timber pile jacketing (Bent 32)

Photo 3 - Pier cap spalling repair

3.0 PLANNING OVERVIEW

To assist Pend Oreille County with planning for the future of the Usk Bridge, this report will be organized into five areas: Annual Maintenance, Bridge Repairs, Preventative Maintenance, Bridge Retrofit, and Bridge Replacement.



Annual Maintenance – These are recommended maintenance measures that if performed on a yearly basis will extend the service life of the bridge and aid in bridge inspection measures.

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.

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.

Bridge Retrofit – This includes components of the bridge that if retrofitted would benefit the community or strengthen the bridge's load capacity.

Bridge Replacement – This includes an update to planning-level costs for total bridge replacement.

4.0 SUMMARY OF CURRENT DEFICIENCIES

The Usk Bridge presently has a sufficiency rating of 62.76 out of 100. The bridge is not currently categorized as Structurally Deficient. Structurally deficient bridges have at least one major component in Poor condition and/or a low inventory rating (capacity).

The major bridge components are deemed to be in the following overall condition per the 2019 Bridge Inspection Report:

Deck – **7** (Good Condition)
Superstructure – **5** (Fair Condition)
Substructure – **5** (Fair Condition)

Photo 4 - Current load posting

The bridge is currently posted for "One Truck on Bridge" as well as weight restrictions for (3) AASHTO trucks (Photo 4). Per the 2016 load rating, if there is one truck at a time within each span, 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. The weight limit sign posted reflects loads right at the legal limit.

While the bridge deck is in good condition, there are areas of the superstructure and substructure that put the bridge into the Fair Condition category. The following summarizes these structural deficiencies and their root cause:

4.1 Glulam Girders

There are (4) treated glulam girders in each 30-ft span on the western third of the bridge. The glulam girders are 11-inches wide by 32.5-inches deep and documented to be Douglas Fir select structural grade with waterproof adhesive. Glulam girders are manufactured by taking individual lumber laminations (1.5-inch thick or less) and bonding their wide faces together using a structural adhesive to fabricate a deeper member. The glulam girders are connected to the concrete deck with 4-inch diameter shear connectors; therefore, they can be analyzed as composite with the deck.


Photo 5 – Checking in glulam girders (highlighted in white)

The existing glulam girders have widespread checking on their sides (Photo 5) and 60% of the glulam girders have side checking up to 3/8-inch wide.

Checking in glulam 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 can be differentiated from delamination (inadequate glue between laminations) by observing whether or not the separation is smooth or torn along the grain. Because the separation of the wood fiber is not smooth (Photo 6), delamination is not deemed to be the main cause.

Checking is typically not a major structural concern, unless it affects a significant portion of the girder. Per the APA-Engineered Wood Associaton, checking becomes a structural concern when at least a third of the girder width is separated as well as one-third of the girder length. Because this is the case on the Usk Bridge, the load rating has taken appropriate reductions in allowable shear stresses (using 4.5-inches as the deepest check).

Photo 6 – Closeup of checking in glulam girders

During the 2010 Major Maintenance project, the glulam girders received an application of preservative treatment to all checks and cracks. The treatment material was Jasco Copper Brown Wood Preservative Treatment with a copper naphthenate solution containing 1.4% copper.

During future inspections, the glulam girders should be monitored by measuring and tracking the checking depths into the member. If the checking depth increases to 6-inches total, the girder splits, or the girders appear to deflect under traffic loading, the load rating should be re-evaluated as the glulam girders do control the load capacity of the bridge.

Since the glulam girders were originally treated with preservatives at installation and then re-treated during 2010, they appear to be well protected from the potential for decay. If the checking does not change significantly over the next 10 years, the lifespan of these glulam girders could be considered to be at least another 20 to 25 years.

Action Item: Glulam Girders

- **Monitor Glulam Girder Checking (depth greater than 6-inches should be evaluated)**
- **For Strengthening Options to Remove Load Posting – See Section 8.1 (Glulam Girder Strengthening)**

3.2 Concrete Girder Cracking & Spalling

There are four concrete girders in each of the (24) 70-ft eastern spans. The girders were fabricated by Ace Concrete in Spokane. The prestressed girders are a 70-ft Series design based upon the 1962 E-54 Standard Plans published by the Washington State Highway Commision. The I-girders are 44-inches deep with a 5-inch web. There are (10) ½" prestressed straight strands in the bottom of the girder and (12) 7/16" post-tensioned harped strands in the web. Vertical stirrups consists of (2) #4 bars at 18-inch spacing for a majority of the length. The stirrups project out of the top of the girders in order to connect with the deck for composite action.

Photo 7 – Typical spalling at end of girder

Two of the main defects in the girders include hairline web cracking and spalling at the bearing seats (Photo 7). There are at least eight girders with longitudinal cracking that follows the same path as the harped strands (Photo 8). And 30% of all girders have spalls at the bearing seats with an additional 10% that are cracked that could lead to spalling.

Web Cracking

In 2014, crack gauges were installed to monitor any changes in web cracking. Pend Oreille County indicated that when the monitors were installed, the cracking had been present for a long time. Since 2014, the crack gauges have shown zero to little change. During the 2019 bridge inspection, many of the cracked areas were sounded for delaminations and none were found.

In a review of literature and present-day design code, the possible causes of the web cracking include:

Photo 8 - Hairline cracking in girder web along path of harped strands.

1. *High intial stresses in the web due to post-tensioning details:*

The post-tensioning duct is shown to be 1¾" x 2¾" flextube in the original contract drawings, see Figure 2. Because the duct is grouted after the strands are post-tensioned, the grout imparts an outward radial pressure on the tube. Past studies have indicated that grouting can cause significant stresses in the web, particularly those post-tensioning tubes that are oval in shape as the ones in the Usk Bridge.

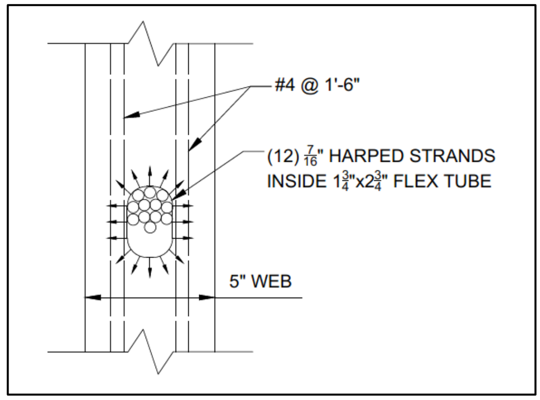


Figure 2: Post-tensioning detail - existing girder web

2. *Insufficient web thickness and web reinforcement per current design standards*

Current AASHTO LRFD design specification indicate a minimum web thickness of 6.5-inches for post-tensioned members, whereas the Usk girders have a 5-inch web. Additionally, the web reinforcement (#4 stirrups at 18-inch spacing) does not meet current minimum requirements for transverse reinforcement.

While the geometrics and reinforcing in the girders may not meet current design standards, the cracks are not significant enough to affect the load-carrying capacity of the girders. It is recommended that the web cracking continue to be monitored for any changes. Significant changes would include an increase in crack size from hairline (< 1/16") to narrow size (1/16" to 1/8").

Girder Spalling

As previously mentioned, cracking and spalling at the base of the girders near the bearing seats is presently affecting about 40% of the concrete girders. Cracking at the ends of girders within the pre-tensioned zone is not uncommon due to the amount of compressive force that is applied due to prestressing (Photo 9). Additionally, since prestressing was in its early stages of development when these girders were fabricated, there is insufficient reinforcing steel in the bottom of the girders to resist the cracking. Girders fabricated today include more confinement reinforcing to avoid this problem.


Photo 9 - Crack propogating at end of girder

Once cracking initiates, it can lead to spalling which is actively occurring in the Usk girders. It is particularly important to keep these areas as dry as possible to prevent additional deterioration. These defects should be monitored over time. They could become a concern if spalling extends into the area above the bearing pad or if the prestressing strand begins to show significant damage due to corrosion.

Action Item: Concrete Girders

- **Continue to monitor girder web cracking for any changes.**
- **Monitor spalls for extension into bearing area.**
- **Keep girder bearing seats dry - See Section 7.1: Expansion Joint Replacement**

3.3 Deck Joints

There are (44) expansion joints within the Usk Bridge. Each individual span is separated by a poured rubber joint at the deck surface that allows the girders and deck to expand and contract under thermal movements.

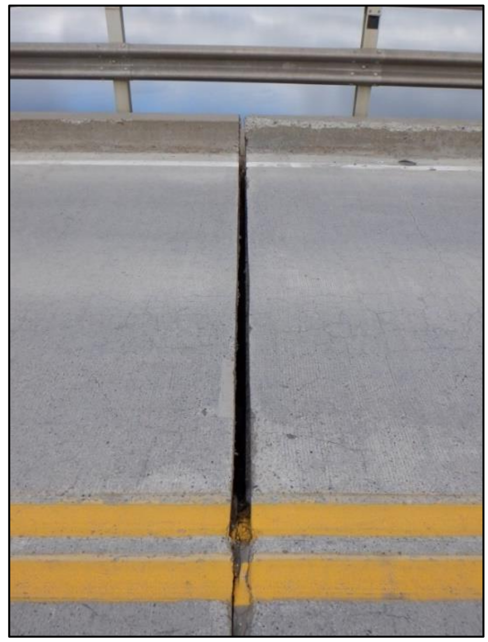


Photo 10 - Joint Failure showing open gap between girders

The current expansion joint design consists of a rapid-cure ultra-low-modulus silicone sealant that adheres to the concrete deck and is intended to expand up to 100% of the joint width and compress 50%. The expansion joint system consists of flexible backer rod material on the bottom and poured sealant above the backer rod.

The Usk Bridge was originally constructed with a 2.5-inch wide poured rubber joint. In 2010, all expansion joints were replaced with Rapid Cure Silicone (RCS) Sealant (Dow 932S per the project special provisions). Within two years of repair, the joints were noted to need maintenance and within 6 years of repair, many joints were noted to be "open".

Photo 11 – Joint failure and debris buildup on pier cap

Presently, within the concrete girder spans, there are (5) joints that have completely failed and are totally open and (13) additional joints that are more than 50% open (Photo 10). Also a significant number of joints have debonded. Damaged joints are allowing water and debris to penetrate the deck and saturate the pier cap and bearing seats (Photo 11). The moisture is accelerating deterioration of the pier caps and girder ends and the debris build-up is allowing the moisture to be retained.

Action Item: Deck Joints

- **Top Priority: Repair expansion joints – See Section 7.1: Expansion Joint Replacement**

3.4 Timber Piling

The western third of the bridge (Bents 26 to 44) is supported by timber pile foundations with (8) piles at each bent for the majority of bents. Bents 27, 29, and 33 each have additional piles. There are a total of 156 timber piles. Piles at Abutment 45 are not visible. During low to typical water levels, the majority of timber piles are on dry land. During spring runoff, the piles typically become submerged.

Photo 12: Yellow-tagged timber pile

The timber piles have various deficiencies including wide checking, wear, abrasion, and some piles sound punky, indicating potential decay. Two piles were bored (using 3/8" bit) during the previous inspection and no measurable rot was found.

Presently there are (34) piles in Condition State 3 which indicates structural defects, but they do not significantly affect structural capacity. At the next inspection cycle, it would be desirable to perform non-destructive testing, such as with resistance drilling, for a more detailed analysis which would provide valuable insight regarding the pile's internal defects. This data could then be used to determine which of the (34) piles are in most need of repair to increase their lifespan. From soundings, visual inspections, and borings, there are approximately (8) to (12) timber piles in need of repair.

Action Item: Timber Piling

- **Wrap/jacket timber piling in most severe conditions – See Section 7.2: Timber Piling Repair**

3.5 Concrete Pier Cap Spalling

There are (43) concrete pier caps that support both the timber glulam and concrete girders. The majority of the pier caps have exfoliation, spalling, cracking, and/or delaminations at the ends, corners, or bottoms of the caps (Photo 13).

A 1995 report by Erlin, Hime Associates indicated that the caps contain non-air-entrained concrete and reactive aggregate. Four core specimens were taken for the purposes of a bridge rehabilitation study at the following locations:

Core 1 (Bent 44) – Minor alkali silica distress
Core 2 (Bent 32) – Severe alkali silica distress
Core 3 (Bent 1) – Minor alkali silica distress
Core 4 (Bent 4) - Severe alkali silica distress

The 1995 report concluded:
"*From these specimens, the distress in the concrete is related to two major factors: cyclic freezing on non-air entrained concrete, and alkali-silica reactions between a siltstone component of the aggregates and the cement paste*."

Photo 13 - Exfoliation at corner of pier cap

Alkali-silica reaction (ASR) occurs due to a chemical reaction between silica aggregate and alkali hydroxides in the cement paste. The product of the reaction is alkali-silica gel that has a tendency to absorb water and swell, causing cracking and surface pop-outs. Often the first symptom of alkali-silica distress is map cracking spread across the face of the concrete. ASR concrete that is routinely exposed to moisture has a much higher chance of continued expansion. While ASR cannot be eliminated, the rate of expansion can sometimes be reduced using various mitigation meaures.

In determining the structural integrity of an ASR-affected structure, Fournier, et all (2010) recommends to focus on the following considerations:

1. Presence, or potential for formation, of major cracks that could affect the stability of the structure.
2. Potential for bearing or crushing failure of concrete where sharp changes in structural geometry occurs.
3. Potential for steel yielding, concrete/steel bond reduction, and concrete delamination.

If one or more of these considerations are present, then mitigation measures are necessary to protect the integrity/stability of the structure.

The Federal Highway Administration (FHWA) published the document "*Alkali-Aggregate Reactivity (AAR) Facts Book*" (2013) which discusses the symptoms, diagnosis, prognosis, and mitigation for concrete affect by alkali-silica reaction. The main mitigation measures to consider include:

1. Improved Drainage
2. Application of coatings/sealers
3. Application of cladding or restraint (FRP, etc).
4. Crack filling/patching
5. Application of lithium compounds

The recommended mitigation measures at this time for the Usk Bridge are No. 1 (Improved Drainage) and No. 4 (Crack filling/Patching). The rate of expansion can sometimes be reduced by taking steps to maintain the concrete in a condition that is as dry as possible. This can be accomplished by repairing and maintaining the expansion joints. Additionally, areas that are heavily delaminated or cracked should be a focus of spall repair efforts.

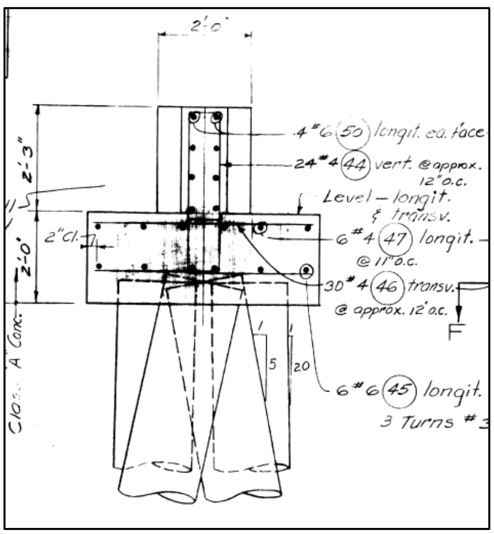


Figure 3: Detail of concrete cap at timber piles

Photo 14: ASR Damage at bottom corner of pier cap.

The degree to which reinforcing bars provide containment can affect differential ASR expansion which, in turn, can affect the integrity of the structure. Concrete that is heavily reinforced with hooked bars is preferable to minimal reinforcement with non-hooked bars. In a review of the reinforcing details for the Usk Bridge, the concrete caps at the timber piles have the least confining reinforcement (no hooked reinforcement nor reinforcement near the bottom of the cap - see Figure 3). This correlates to observed deterioration in the field with delaminations and cracking near the bottom of the timber pier caps (Photo 14).

Repairs to concrete undergoing ASR may be shorter lived. However, in some cases, making repairs that will likely be short lived are still the best alternative to doing nothing.

Action Item: Concrete Pier Caps
- **Repair spalled areas in Condition State 3 with focus on timber pier caps.**

3.6 Bridge Railing and Curb

The Usk Bridge has 4,700 linear feet of 12-inch tall concrete curbs on each side of the bridge deck. There is extensive exfoliation, spalling, and exposed rebar with 25% of the total curb length in poor condition. There are (12) joint locations where the spalling is severe enough to expose multiple reinforcing bars (Photo 15). The spallings appear to be due to freeze-thaw damage. Concrete in other portions of the structure was determined to be non-air-entrained; therefore, it is reasonable to assume that the curbs may suffer from the same mix design issues. It is recommended to repair those portions of the curb with exposed reinforcing. Once the reinforcing is exposed, there is a higher chance of corrosion and further spalling deterioration. Additionally, heavy spalling and exposed bars make the curbs more susceptible to impact damage.

There are several areas where the bridge railing has been damaged due to impact. This occurs in the steel railposts on the bridge, as well as timber posts in the approach guardrail. It is desirable to make these repairs as well, although they are not as high as a priority.

Photo 15 - Exfoliation of curb with exposed rebar

Action Item: Bridge Curb and Railing Repair
- **Repair curbs with exposed reinforcing – See Section 6.1**
- **Repair impact-damaged railing – See Section 6.2**

5.0 ANNUAL MAINTENANCE

5.1 Deck and Joint Cleaning

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 an annual maintenance practice.

Additionally, it is recommended to specifically clean the transverse bridge joints of debris as well. Over time bridge debris will build up in the joints and tire pressure may impart a force to the joints which can lead to premature failure. Hiring a Contractor to sweep the deck should also include cleaning of each joints as well.

6.0 BRIDGE REPAIRS

6.1 Concrete Curb Repair

Concrete curb repair would consist of localized repairs to heavily damaged curbs and areas with exposed reinforcing bars. There are presently (12) areas that are recommended for repairs. Repair work would consist of one lane closure, removing damaged or loose concrete, and replacing with a high-early strength repair mortar to minimize traffic disruptions. The purpose of the repair would be to protect the existing reinforcement and structural integrity of the curbs.

6.2 Bridge Railing Repair

Bridge railing repair consists of repairing impact-damaged approach rail at the southeast bridge approach (Photo 16) and replacing impact-damaged railposts and bolts in Span 5. Due to impact, there is also an open gap in the rail top longitudinal rail (Photo 17). This repair work could be contracted out directly with a Contractor specializing in bridge and approach guardrail.

Photo 16 – Approach guardrail damage

Photo 17 - Open gap at longitudinal bridge rail

7.0 PREVENTATIVE MAINTENANCE

7.1 Expansion Joint Replacement

Expansion joints are one of the smaller elements of a bridge, but they are often one of the first elements to deteriorate or even fail. The expansion joints on the Usk Bridge have a history of poor performace, particularly within the 72-ft concrete girder spans. Inspection reports within the past 25 years have all noted the joints needing maintenance or replacement. Joint repair is viewed as the No. 1 priority on the Usk Bridge as the open joints are an avenue for water and roadway debris to fall through the deck, and saturate or build-up on the supporting pier caps. This is especially important since pier caps consist of non-air entrained concrete and some have ASR damage; therefore, protection from moisture is critical.

Premature failure of expansion joints can occur for many reasons, the following being the most characteristic (of which the first three are occuring on the Usk Bridge):

1. Loss of bond with header
2. Debris Impaction
3. Seal or backer rod dropping
4. Tearing and/or cracking

The joints on the Usk Bridge are considered Small Movement Expansion Joints since their total movement is expected to be less than 4-inches. Each span in the bridge was designed to move independently; therefore the unfactored thermal movement for the 72-ft spans is anticipated to be:

$$\Delta L_{temp} = \alpha \cdot L_{trib} \cdot \delta T = 0.000006 \text{ in/in} \cdot 864 \text{ in.} \cdot 80° = 0.42 \text{ inches}$$

The expansion joints on the Usk Bridge need to be closed joints to prevent the intrusion of water and debris to the bearings seats and pier caps. Two typical types of closed expansion joints for small movements include both pourable sealants and compression seals. WSDOT's current policy is to use compression seals or rapid-cure silicone sealants almost exclusively.

The Usk Bridge was originally constructed with pourable expansion joints and in 2010, all expansion joints were replaced with Rapid Cure Silicone Sealant (see Figure 4).

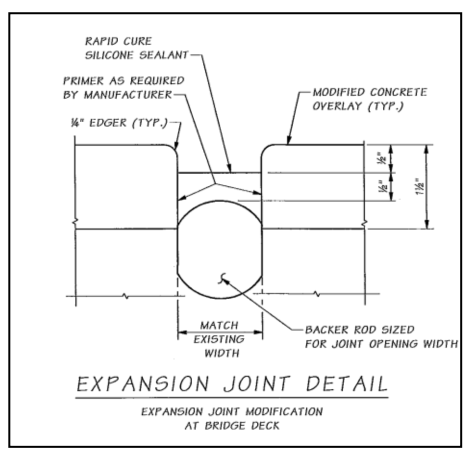


Figure 4: Rapid Cure Silicone Sealant (2010 Maintenance)

Multiple expansion joint alternatives have been researched for this report, including the alternative to do nothing (see Table 3). 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.

The currently installed type of expansion joint is the Rapid-Cure Silcone (RCS) joint. As mentioned in Section 3.3, these joints have not performed well on the Usk Bridge. Studies by the Virginia Department of Transportation (Robertson & Hale, 2008) suggest that wider RCS joints (greater than 2-inches) do not perform as well as narrower installations. However, they are less expense than some alternatives.

A longer-lived (and more expensive) type of expansion joint is the compression seal. The compression seal has the potential for a lifespan approaching 20 years under the right conditions mentioned above. However, the installation of compression seals can be more complex with regard to site preparation. A key aspect of compression seal joints is that the concrete at the installation site must have 1) smooth surfaces contacting the joint, and 2) a ledge to support the compression seal to prevent it from falling through the joint. Proper surface preparation is vital to ensure both the longevity and water-tightness of the seal. A rough contact surface could lead to leakage through the seal.

The Usk Bridge currently has rough surfaces at the joint, and no consistent support ledge. There are two methods that could be used to prepare the Usk Bridge joints for use with compression seals. For Method 1) the rough joints could be cut with a concrete saw to produce both a smooth edge and a ledge to support the compression seal (Figure 5). The feasibility of this approach was verified with a Spokane-based concrete cutting contractor. For Method 2) the top portion of the concrete deck would be removed, formed, and repoured, leaving a smooth surface and a proper ledge (Figure 6). Clearly Method 1, cutting the existing concrete, would be lower-cost and less labor-intensive than casting new concrete headers. However, Method 1 presents more of a risk that the concrete surface is not completely smooth compared to newly poured headers designed specifically for compression seals. If it is decided to install compression seals at Usk Bridge, it may be desirable to perform a trial installation of a small number of seals using Method 1 to ensure the applicability of this method for the Usk Bridge.

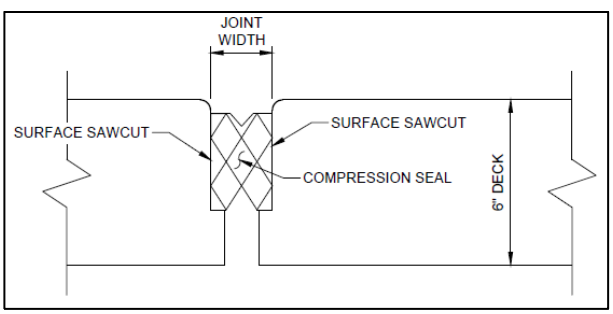


Figure 5 - Compression seal with sawcut

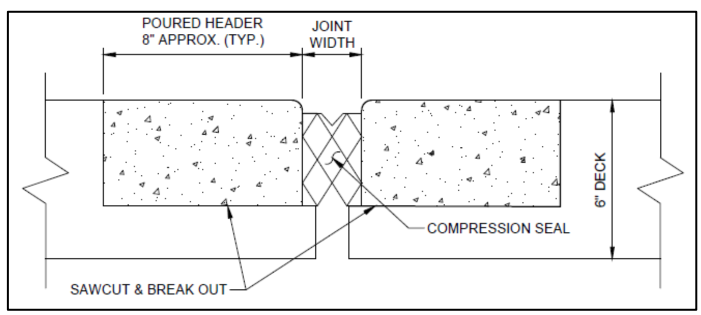


Figure 6 - Compression seal with headers

The following steps are recommended in designing, installing, and maintaining replacement expansion joints:

Step 1: Obtain measurements of each existing joint widths under hot and cold temperature extremes. This will ensure a better understanding of how the bridge is actually expanding and contracting under temperature variation.

Step 2: Develop a design for new expansion joints, with the preference being a compression seal. Use information gathered in Step 1 to determine the optimum temperature for installation.

Step 3: Given the importance of the expansion joints in preventing water leakage through the joints, as well as the prior poor performance of existing joints, it may be beneficial to perform a trial installation of the selected expansion joint type in select locations to ensure applicability on a larger scale. County involvement with a trial installation could be beneficial to familiarize County personnel with installation techniques that would aid in future joint maintenance.

Step 4: Once the type of expansion joint is confirmed to be performing succesfully, the project could be bid and installed on a larger scale to all joints. Given the sheer number of joints, and their importance on the Usk Bridge, the Contractor could be required to have a material supplier representative on site for quality control and assurance.

Step 5: Clean joints at a minimum of once per year, preferably two times (spring and late summer) to remove any embedded debris.

Table 3. Summary of joint options for the Usk 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 continue to deteriorate* *- 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.	**$140K**	**$18K to $35K per year**	***Pro*** *+ Most cost-effective* ***Con*** *- Shorter-term solution* *- Poor past performance, especially wider joints.* *- Requires more maintenance.*
3 **Compression Seal (Rubber)**	8-20 years	Sawcut along edge of deck to create vertical surface and ledge for support. Install properly sized compression seal (rubber).	**$280K**	**$14K to $35K 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 along edge of deck to create vertical surface and ledge for support. Install properly sized compression seal (open-cell foam).	**$300K**	**$15K to $38K 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.	**$650K**	**$33K to $65K 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).*

7.2 Timber Piling Repair

Potential repairs for pile 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. Fiber-reinforced polymer (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.

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.

7.3 Pier Cap Repair and Debris Removal

It is recommended to repair major spalling at pier caps in Condition State 3, with special focus on pier caps supported by timber piles. This scope of work would include removal of unsound concrete, protection of existing reinforcement, adding drilled anchors/reinforcement as necessary, and forming and pouring the damaged area with a high-strength repair mortar.

In order to facilitate pier cap repair and to reduce retention of moisture, it is highly recommended that debris buildup be removed from the concrete pier caps. Based on literature review and current state of practice, washing of decks, bearings, joints and substructure seats can elongate the usable life of those elements and delay the need for bridge replacement. Eliminating the debris removes a storage medium for water, roadway debris, and potential road salts which will deteriorate bridge elements.

WSDOT's Local Agency Bridge Engineer, Sonia Lowry, indicated that the Usk Bridge could be added to the washing scheduled of the South Central Region for 2022. Logistics and a cost estimate for this effort 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 Usk Bridge, these are the typical steps taken by an Agency to obtain coverage:

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

    - Must be done 60 days prior to discharging wash water.
    - Submit on or before the date of first public notice.
    - 30-day public comment period begins on date of second public notice.
    - 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.

8.0 BRIDGE RETROFIT

8.1 Glulam Girder Strengthening

The Usk Bridge is presently posted for load restrictions, including "*One Truck on Bridge*" as well as posted for weight limits for trucks, semi-trucks, and truck and trailers (25T, 36T, and 40T respectively). The bridge load rating was updated in 2016 to reflect current bridge conditions and to include load rating factors for Single Unit Vehicle (SHV's) with 4 to 7 axles per FHWA requirements. The results of the load rating indicated that the bridge requires posting for typical traffic of two lanes. If the bridge were limited to one truck at a time in each span, the load posting would not apply. Table 4 provides a summary of rating factors for standard legal loads. Note that rating factor less than 1.00 indicates that the bridge cannot safely handle the given fully loaded truck. Currently, the load rating is controlled by the glulam girders in Spans 25-44 in both shear and moment.

Table 4. *Rating results for one versus two lanes of traffic*

Legal Load Configuration	Rating Factor Two Lanes	Rating Factor One Lane	Controlling Member
TYPE 3 (Truck)	1.09	1.31	Glulam Girders - Shear
TYPE 3-S2 (Semi-Truck)	1.14	1.36	Glulam Girders - Shear
TYPE 3-3 (Truck & Trailer)	1.35	1.62	Glulam Girders - Shear
Single Unit SHV (SU4)	0.94	1.13	Glulam Girders - Shear
Single Unit SHV (SU5)	0.90	1.08	Glulam Girders - Shear
Single Unit SHV (SU6)	0.91	1.10	Glulam Girders - Moment
Single Unit SHV (SU7)	0.88	1.06	Glulam Girders - Moment

The County is interested to know if anything can be done to remove the load posting restriction of one truck at a time on the bridge. For a load rating to change, one of two things need to occur: either the capacity needs to be increased or the dead loading needs to be decreased. It is not feasible to significantly reduce the dead weight on the timber girders; therefore increasing the load capacity was studied.

The following Alternatives were studied:

Alternative 1 - Add girders to existing glulam spans.
Alternative 2 - Strengthen glulams with side plates and/or post-tensioning at base.
Alternative 3 - Wrap glulams with fiber-reinforced polymer (FRP) to strengthen.
Alternative 4 - Total Replacement of Glulam spans.

Of the four Alternatives studied, the most economical and structurally feasible is Alternative 3 which is to wrap the glulams with FRP to strengthen in shear and moment.

Strengthening of glulam beams can be challenging from an engineering perspective, but the growing use of fiber-reinforced polymers with structural materials such as concrete, has enabled similar applications for use on wood structures.

There are several advantages to FRP materials including low weight, high tensile strength, and ease of application. Weight is a critical factor on the west spans of the Usk Bridge given the lower geotechnical capacity of the existing soils.

The concept for strengthening would be a combination of laminated carbon strips along the bottom of the girders along with a carbon fiber wrap to restore and strengthen the glulam beams in both shear and flexural capacity (Figure 7). The following steps would need to be taken from design through construction:

1. Obtain funding for engineering and construction.
2. Advertise and select engineering team with experience designing FRP retrofits.
3. Design glulam retrofit to increase horizontal shear capacity by 40% and flexural capacity by at least 25%.
4. Verify calculations in laboratory study on similar size girders through FRP supplier.
5. Perform retrofit in the field per supplier guidelines and rigorous inspection procedures.

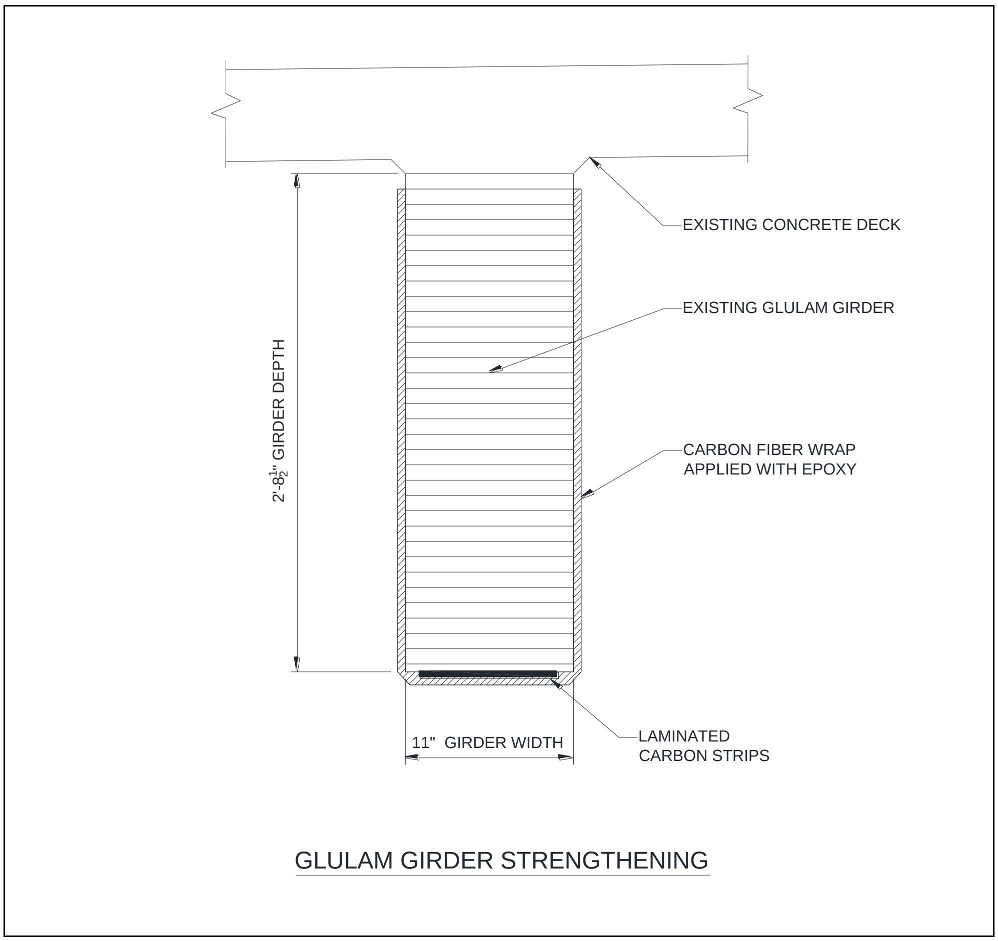


Figure 7

8.2 Bridge Retrofit for Pedestrian and Bicycle Traffic

The Usk Bridge does not currently meet standards for pedestrian or bicycle use. The 26-ft wide roadway is designed only to accommodate two lanes of traffic. We understand there has been discussion in the community for provisions for bicyle and pedestrian traffic on the bridge. Therefore, we have studied alternatives to retrofit the bridge for pedestrian and bicyclists; the concept being a shared-use pathway. Shared-use paths are designed for pedestrian and recreational purposes and could be used by pedestrian, bicyclists, equestrians, and recreationalists.

Per the WSDOT Design Manual, the minimum width for shared-use pathways is 10 feet, with a desirable width of 12 feet. A width of 12 feet would also more readily accommodate maintenance vehicles without disruption to traffic lanes. For the purpose of this study, retrofit costs only include modifications to the existing bridge structure. Construction of paved shared-pathways to connect up to the bridge would be additional and are outside of this scope of work.

Several bridge cross sections were considered to accommodate a bridge widening for a shared-use pathway. The first concept studied was widening the deck only to accommodate the additional 12-ft width. This was determined to not be feasible due to insufficient capacity of the existing 6-inch deck, as well as insufficient vertical and lateral capacity of the concrete and timber piling. Therefore, it was determined that to support a new shared-use pathway, the bridge would require significant construction work, including extending the existing pier caps, adding more piles, and adding two lines of girders. The shared-use path would be separated from traffic lanes by a concrete barrier and would provide for a 4’-6” tall exterior barrier to meet rail standards for bicycle use.

Figure 8 shows the most feasible cross section for the existing bridge to support a 12-ft wide shared-use pathway for the full length of the bridge. The planning level cost for this retrofit is $13.5 million including engineering (Appendix B3). The County must determine whether retrofitting the existing bridge given its current age and condition for a new shared-use path is economically feasible.

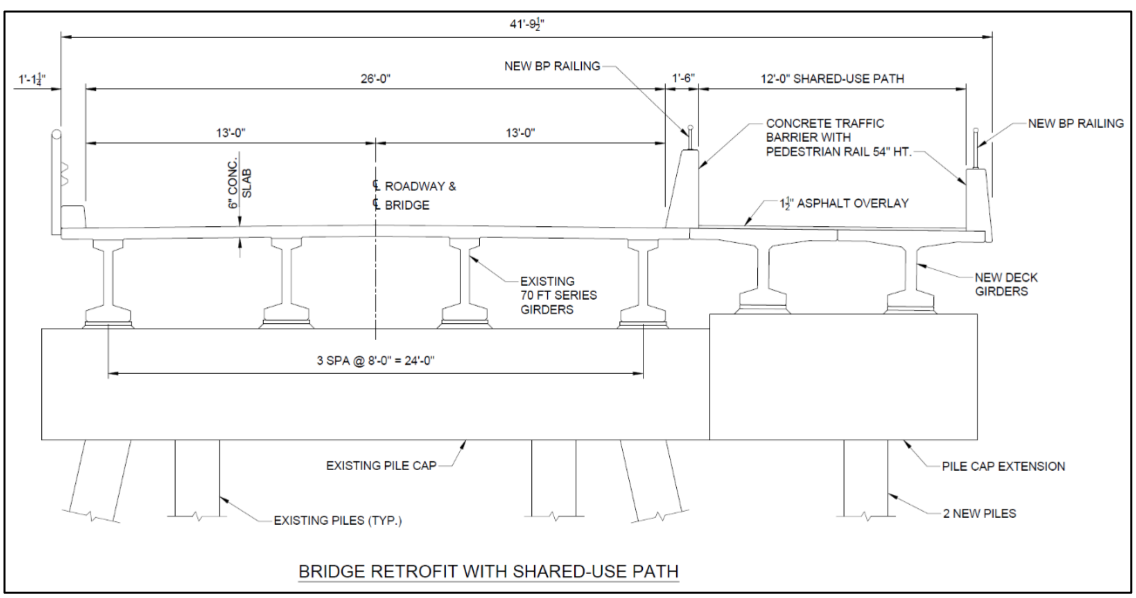


Figure 8

9.0 BRIDGE REPLACEMENT

In 2002, a Type, Size, and Location Report for a new Usk Bridge was prepared by Parsons Brinckerhoff Quade & Douglas, Inc. The goal of the project was to replace the substandard bridge with one that met current design standards, improved safety for pedestrians and bicycles, and increased the live load capacity of the bridge to HS-25. The Type, Size, and Location Report recommended the following structure types for a new bridge upstream of the existing bridge:

Spans 1-12 (East): *73.5-inch thin flange bulb-tee girders with cast-in-place concrete deck supported by a 2-column bent with drilled shafts.*

Spans 13-18 (West): *54-inch steel plate girders with cast-in-place concrete deck supported by a 2-column bent with pile cap and piles.*

The total estimated project cost per the 2002 report was $16.8 million. Subsequently, due to lack of available funding, final design was not completed. In 2008, project costs were documented to be upwards of $40 million.

This planning report includes an update of bridge replacement costs for long-range planning. The bridge type, size and location will be used from the 2002 report by with a few exceptions, such as adding concrete traffic barrier to protect pedestrians and bicyclists from traffic.

The first step in bridge replacement planning would be to perform an updated Type, Size, and Location Report. A new Type, Size, and Location report should provide for the following at a minimum:

- A review of current and future transportation needs for Pend Oreille County and the Kalispel Tribe
- A review of current and future needs for pedestrian and bicycle traffic.
- Review past design recommendations for capatibility with current design standards and specifications.
- Review past Value Engineering Study (Engineering Management Services - August 24, 2000) for all recommendations for full bridge replacement.
- Provide structure type recommendations for HL-93 design loading.
- Independent Geotechnical Study for various foundation types.

Using the concept in the previous 2002 report, modifying the concept slightly and updating the costs to 2021 dollars gives the cost for a new bridge to be $79.8 million. Planning for future costs should include a suggested inflation factor of 5% per year. Conceptual cross sections are found in Appendix A2 & A3 and a new replacement cost estimate can be found in Appendix B4.

10.0 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:

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

While the Usk 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:

1. Expansion Joint Replacement for Elements in Condition State 3
    - *642-ft of joint length in the Usk Bridge falls under Condition State 3 = 55% of total*

2. Concrete Superstructure/substructure spall repair for areas in Condition State 3
    - *46-ft of pier caps fall under Condition State 3 = 4% of total*

3. Timber Substructure Repair for timber elements in Condition State 3 and 4.
    - *34 piles each fall under Condition State 3 = 22% of total*
    - *Condition State 3 indicates a pile with structural defects, but defects do not significantly affect structural capacity.*

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 Usk Bridge, it was recommended to submit a funding application for four bridge elements: expansion joints, substructure spall repair, timber substructure repair, and timber glulam strengthening. We would also recommend that the pier caps be cleaned of debris which could be justified under the spall repair category. The Usk Bridge was bundled with the Ione Bridge for the funding application, as there were similar repairs common to both bridges.

Additionally, it is recommended during the next cycle of bridge inspection reporting to move 100% of the expansion joint quantity into Condition State 3 since all of the joints have at least debonded or are partially failed and any level of joint failure would require full joint replacement.

11.0 USK BRIDGE PLANNING SUMMARY

The Usk Bridge Planning Table 5 (below) summarizes the maintenance, repair, retrofit, and replacement recommendations contained in this report. These recommendations are generally listed in order of increasing cost and complexity, as well as decreasing feasibility for accomplishing in the next few years. Annual maintenance items can be accomplished with County resources, while others will require external resources and funding.

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 Maintence category.

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

Table 5.

		County Resources	Engineering	Bid Project	Estimated Cost*	Federal Funding
Annual Maintenance	Deck and Joint Cleaning	✓		✓	$26,000	
Recommended Bridge Repairs	Curb Repairs		✓	✓	$62,000	
	Rail Repairs			✓	$34,000	
Preventative Maintenance	Joint Replacement		✓	✓	$475,000	✓
	Pier cap repair		✓	✓	$241,000	✓
	Timber pile repair		✓	✓	$259,000	✓
Bridge Retrofit	Glulam Girder Strengthening		✓	✓	$1.32 mil	✓
	Shared-Use Pathway		✓	✓	$13.5 mil	
Bridge Replacement	New Bridge		✓	✓	$79.8 mil	

**Total Cost, including engineering.*

12.0 USK 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 existing bridge and maintain load-carrying capacity for vehicular and truck traffic:

1. *Joint Replacement*
2. *Pier Cap Repair (including debris removal)*
3. *Repair Approach Guardrail*
4. *Timber Pile Repair*
5. *Glulam Girder Strengthening*
6. *Curb Repairs*

13.0 REFERENCES

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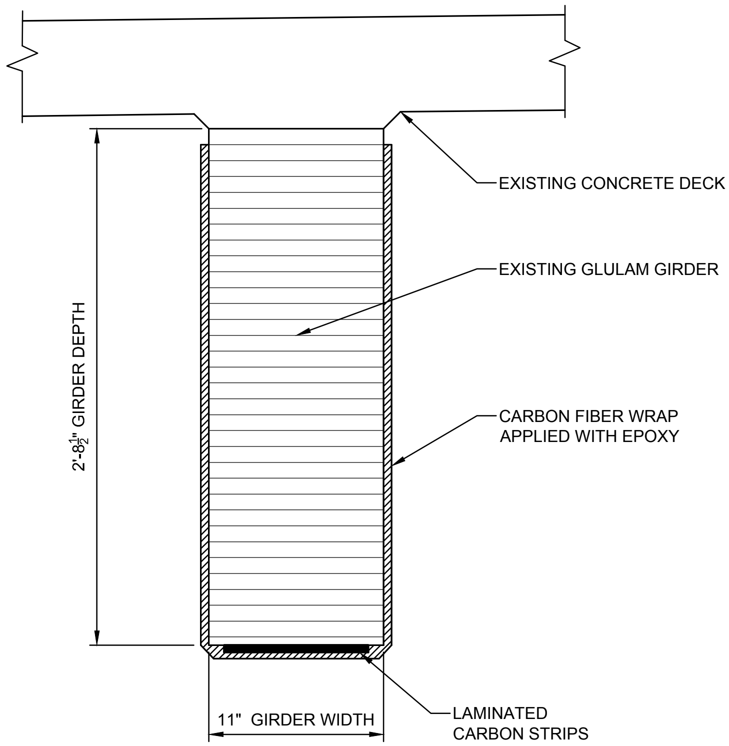
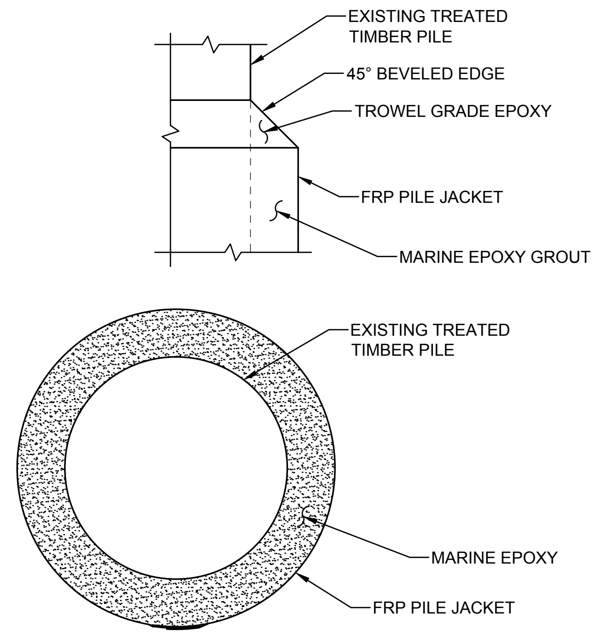
APPENDIX A

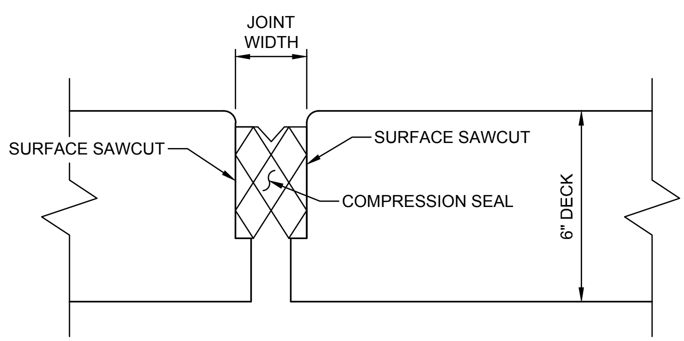
DETAILS



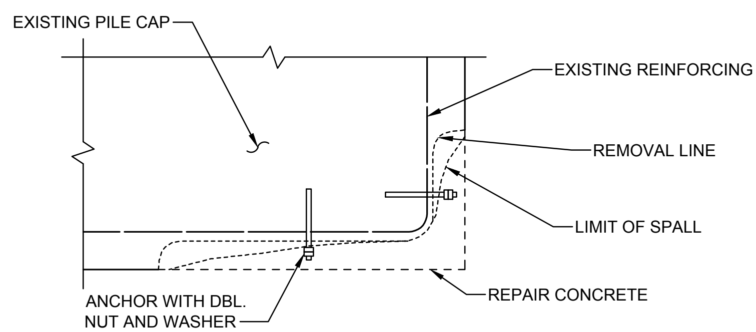
GLULAM GIRDER STRENGTHENING



TIMBER PILE REPAIR



EXPANSION JOINT REPAIR



PILE CAP SPALL 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

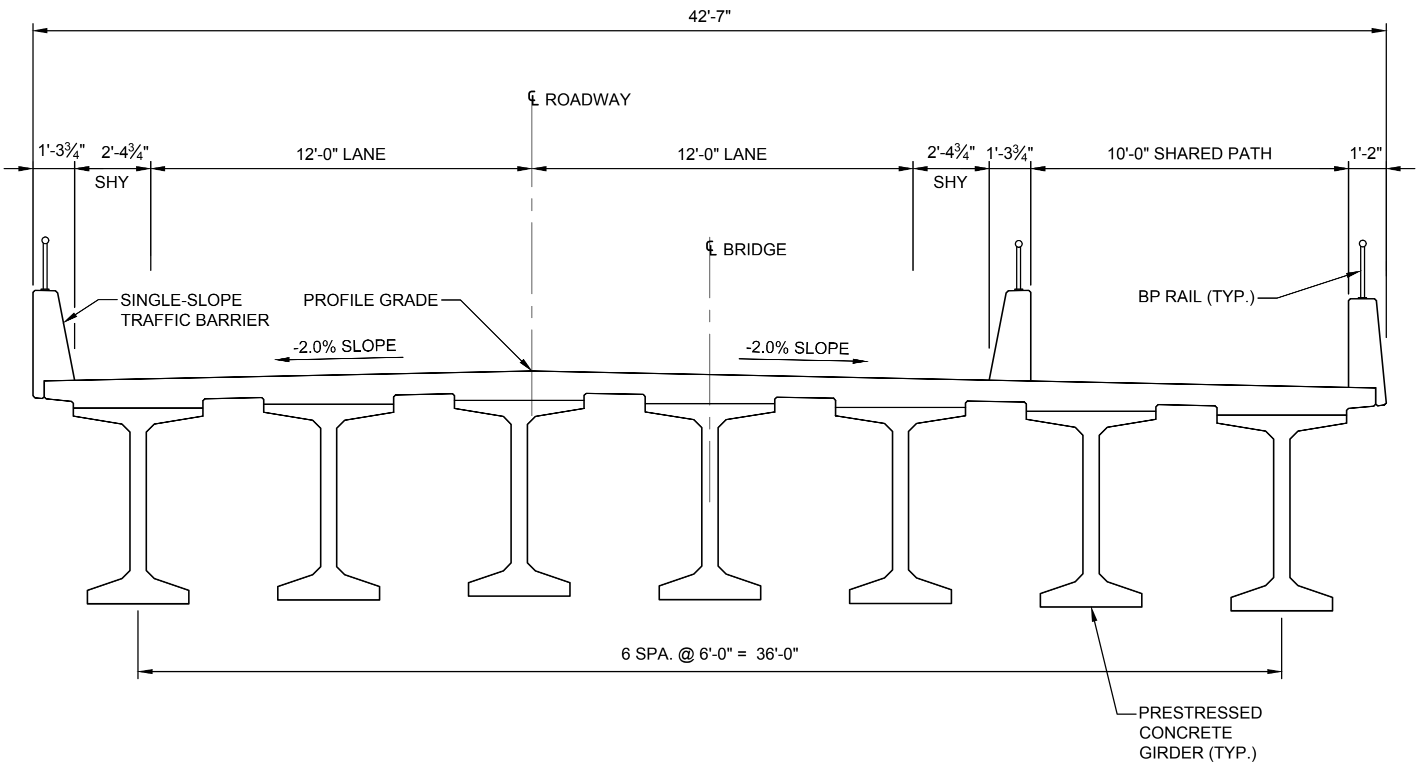
Designed By: -	Date: -
Checked By: SMK	Date: 3/21
Drawn By: SEC	Date: 2/21

Pend Oreille County Road Department
P.O. Box 5040 Newport, WA 99156
Phone: (509) 447-4513

SCALE
HORIZONTAL: ________
VERTICAL: ________

USK BRIDGE PLANNING REPORT
PREVENTATIVE AND STRENGTHENING DETAILS

SHEET
A1 of A3



CONCEPTUAL BRIDGE REPLACEMENT
EAST SPANS

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

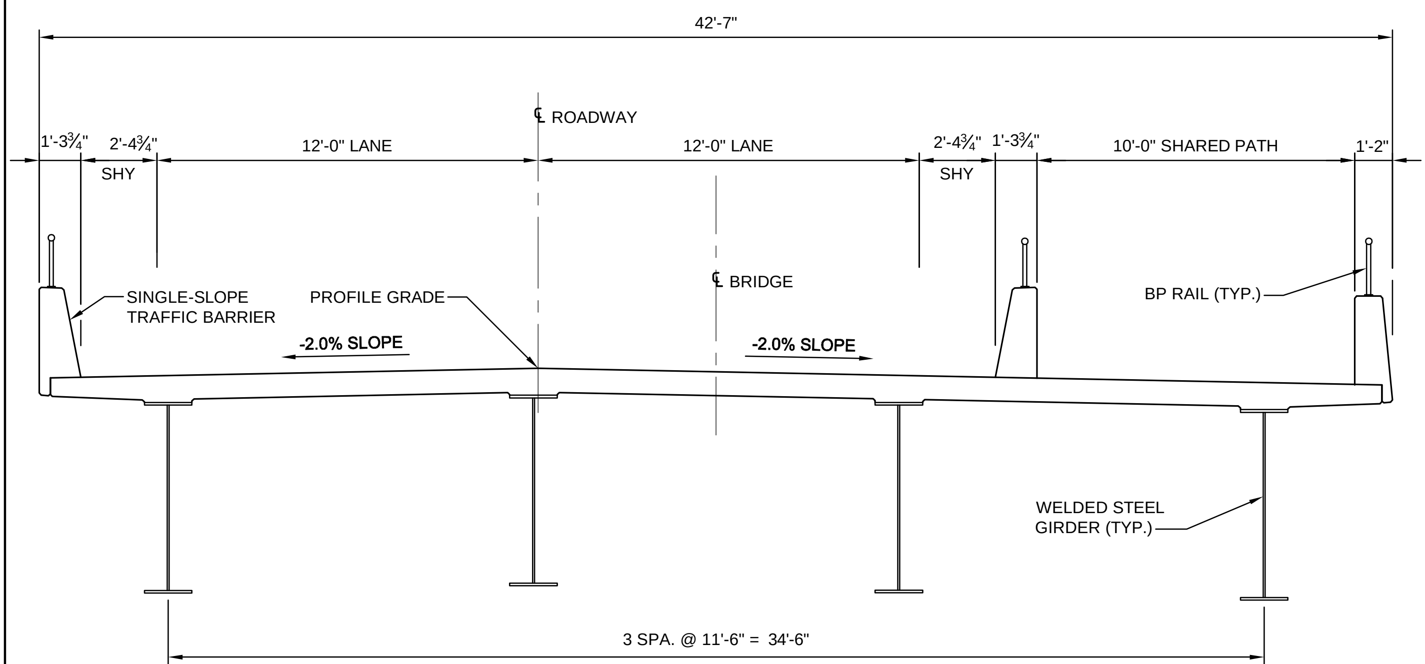
Designed By:	Date:
-	-
Checked By:	Date:
SMK	3/21
Drawn By:	Date:
SEC	2/21

Pend Oreille County Road Department
P.O. Box 5040 Newport, WA 99156
Phone: (509) 447-4513

SCALE
HORIZONTAL: ______
VERTICAL: ______

USK BRIDGE PLANNING REPORT
EAST SPAN - CONCRETE GIRDERS

SHEET
A2 of A3



CONCEPTUAL BRIDGE REPLACEMENT
WEST SPANS

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: 3/21
Drawn By: SEC	Date: 2/21

Pend Oreille County Road Department

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

SCALE
HORIZONTAL:
VERTICAL:

USK BRIDGE PLANNING REPORT

WEST SPAN - STEEL GIRDERS

APPENDIX B

COST ESTIMATES

Pend Oreille County
Usk Bridge

COST ESTIMATE
ANNUAL MAINTENANCE
AND BRIDGE REPAIRS

ANNUAL MAINTENANCE				
Annual Maintenance to Clean Deck and Joints				
DECK AND JOINT CLEANING	1	L.S.	$ 21,890.00	$ 21,890.00
			Contingency	15%
			Total	**$ 26,000.00**
BRIDGE REPAIRS				
CURB REPAIRS				
CURB REPAIR (MATERIALS AND LABOR)	1	LS	$ 27,042.30	$ 27,042.30
TRAFFIC CONTROL	1	LS	$ 16,800.00	$ 16,800.00
ENGINEERING	1	LS	$ 10,000.00	$ 10,000.00
				$ 53,842.30
			Contingency	15%
			Total Curb Repairs	**$ 62,000.00**
REPAIR APPROACH RAIL (SOUTHEAST CORNER)				
BEAM GUARDRAIL TYPE 31	102	L.F.	$ 45.00	$ 4,590.00
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	1	L.S.	$ 3,500.00	$ 3,500.00
BEAM GUARDRAIL TRANSITION SECTION TYPE 24	1	L.S.	$ 3,000.00	$ 3,000.00
TRAFFIC CONTROL	1	DAY	$ 2,500.00	$ 2,500.00
			Contingency	15%
			Total Approach Rail	**$ 16,000.00**
REPAIR DAMAGE BRIDGE RAIL				
LUMP SUM REPAIR	1	L.S.	$ 10,600.00	$ 10,600.00
TRAFFIC CONTROL	2	DAY	$ 2,500.00	$ 5,000.00
			Contingency	15%
			Total Bridge Rail	**$ 18,000.00**
			Total Rail Repairs	**$ 34,000.00**

Pend Oreille County
Usk Bridge

Cost Estimate
Preventative Maintenance
and Girder Strenthening

PREVENTATIVE MAINTENANCE

BRIDGE RETROFIT

FUNDING APPLICATION - SUBMITTED TO WSDOT 2/19/2021

	Percent	Calculated	Application Input
PE Costs	15%	$210,297.00	**$220,000**
Right of Way Costs (Temporary Easement)		$0.00	**$0**
Construction Bid Item Costs (Calculated Below)		$1,401,980	**$1,402,000**
Construction Engineering	18%	$252,356	**$252,400**
Contingency	15%	$210,297	**$210,300**
Mobilization	10%	$140,198	**$140,200**
Inflation Factor per Year	5%	$70,099	**$70,100**
		TOTAL CONSTRUCTION	**$2,075,000**
		TOTAL INCL. ENGINEERING	**$2,295,000**

ELEMENTS OF CONSTRUCTION

Item #	Std. #	Description	Quantity	Units	Unit Price	Extended	Percentage
1		Install FRP Pile Jacket System	1	LS	$ 147,100.00	$ 147,100.00	11.3%
2		Pile Cap Spalling Repair	1	LS	$ 89,900.00	$ 89,900.00	6.9%
3		Clean Top of Piers	1	LS	$ 47,500.00	$ 47,500.00	3.6%
4		Compression Seal - w/o Headers	1	LS	$ 269,900.00	$ 269,900.00	20.7%
5		FRP GluLam Girder Wrap	1	LS	$ 750,000.00	$ 750,000.00	57.5%
6	6488	Erosion Control & Water Pollution Prevention	1	LS	$ 10,000.00	$ 10,000.00	
7	6913	Portable Temporary Traffic Control Signal	1	LS	$ 30,000.00	$ 30,000.00	
8	6971	Project Temporary Traffic Control	1	LS	$ 10,000.00	$ 10,000.00	
9	6982	Construction Signs Class A	1000	SF	$ 25.00	$ 25,000.00	
10	6993	Portable Changeable Message Sign	1248	HR	$ 10.00	$ 12,480.00	
11		Traffic Safety Drum	230	EA	$ 20.00	$ 4,600.00	
12	7480	Roadside Cleanup	1	EST.	$ 3,000.00	$ 3,000.00	
13	7736	SPCC Plan	1	LS	$ 2,500.00	$ 2,500.00	
					Total Bid Items	**$ 1,401,980.00**	

Total Breakdown Per Element (incl. Engineering)

$258,810	1 - Install FRP Pile Jacket System
$241,740	2+3 - Pile Cap Spalling Repair (incl. debris removal)
$474,870	4 - Compression Seal without Headers
$1,319,570	5 - FRP Glue-Lam Girder Wrap
$ 2,295,000	**Total incl. Engineering**

Total Breakdown Per Element (Construction Only)

$234,000	1 - Install FRP Pile Jacket System
$218,600	2+3 - Pile Cap Spalling Repair (incl. debris removal)
$429,300	4 - Compression Seal without Headers
$1,193,100	5 - FRP Glue-Lam Girder Wrap
$ 2,075,000	**Total Construction Only**

COST ESTIMATE
RETROFIT FOR SHARED-USE PATH

RETROFIT - SHARED USE PATH

	Percent	Calculated		Input
PE Costs	12%	$1,153,277		**$1,160,000**
Right of Way Costs (Temporary Easement)		$0.00		**$0**
Construction Costs (Calculated Below)		$9,610,638		**$9,611,000**
Construction Engineering	8%	$768,851		**$768,900**
Contingency	10%	$961,064		**$961,100**
Mobilization	10%	$961,064		**$961,100**
			GRAND TOTAL	**$13,500,000**

Unit Costs are per WSDOT Bridge Design Manual
IN APPENDIX 12.3-A1
CURRENT YEAR 2021

UNIT RECOMMENDED CONCEPT COSTS		LOW	AVERAGE	HIGH	USE
PRESTRESSED DECK BULB TEE	PER SQU FT	220	270	320	320

A. NEW PATH (BRIDGE WIDENING)

BRIDGE LENGTH	2281.00	FT	BRIDGE SKEW =	0	DEGREES
CURB TO CURB WIDTH	12.00	FT	TAN =	0.0000	
RAILING WIDTH	1.167	FT			
TOTAL WIDTH	13.167	FT			
TOTAL SQUARE FEET	30033	SF			

NEW WIDENING COST **$9,610,638**
CONSTRUCTION ONLY

Cost Estimate
Bridge Replacement

BRIDGE REPLACEMENT

Updated cost estimate is based on bid items and quantities per the 2002 Type, Size, and Location report with the addition of traffic barriers for a shared-use path.

	Unit	Quantity		Unit Cost		Amount
1. Civil - Approaches Only						
Excavation	CY	500	$	50.00	$	25,000
Borrow	CY	4,000	$	25.00	$	100,000
Asphalt Concrete Pavement	SY	4,600	$	40.00	$	184,000
Drainage Structures	LS	1	$	20,000.00	$	20,000
Relocate Water Vault	LS	1	$	30,000.00	$	30,000
Guardrail	FT	250	$	50.00	$	12,500
North Waterline Relocation:						
8-inch Waterline	FT	240	$	88.00	$	21,120
6-inch Waterline	FT	100	$	75.00	$	7,500
Vault	EA	1	$	25,000.00	$	25,000
Fittings, Connections	LS	1	$	10,000.00	$	10,000
Pavement Removal/Replacement	SY	280	$	55.00	$	15,400
				Civil Total	*$*	*450,600*
2. Structures						
Abutments						
Concrete Class 4000 - Stem \ Wall	CY	63	$	1,000.00	$	63,000
Concrete Class 4000 - Footing	CY	111	$	1,000.00	$	111,000
Steel Reinforcing Bars - Abutments	LBS	19,170	$	2.00	$	38,340
Excavation	CY	319	$	50.00	$	15,950
				Abutment Total	$	228,300
Piers						
Concrete Class 4000 - Pier Caps	CY	1,354	$	1,000.00	$	1,354,000
Steel Reinforcing Bars - Pier Caps	LBS	267,900	$	2.00	$	535,800
Concrete Class 4000 - Columns (Form)	CY	167	$	1,000.00	$	167,000
Concrete Class 4000 - Columns (Casing)	CY	908	$	800.00	$	726,400
Steel Reinforcing Bars - Columns	LBS	380,000	$	2.00	$	760,000
Concrete Class 4000 - Pile Caps	CY	500	$	1,000.00	$	500,000
Steel Reinforcing Bars - Pile Caps	LBS	100,000	$	2.00	$	200,000
Furnishing and Driving Concrete Test Pile	EA	4	$	15,000.00	$	60,000
Furnishing Concrete Piling	FT	4,292	$	150.00	$	643,800
Driving Concrete Piles	EA	56	$	6,000.00	$	336,000
Concrete - Seal	CY	1,170	$	600.00	$	702,000
Cofferdam	SF	11,970	$	60.00	$	718,200
Excavation Class A	CY	2,470	$	40.00	$	98,800
Concrete Class 4000P - Shafts	CY	1,012	$	900.00	$	910,800
1/2" Steel Casing	LBS	808,177	$	4.00	$	3,232,708
Steel Reinforcing Bars - Shafts	LBS	354,300	$	2.00	$	708,600
Excavation for Drilled Shafts	CY	1,361	$	1,000.00	$	1,361,000
				Pier Total	$	13,015,200

Cost Estimate
Bridge Replacement

BRIDGE REPLACEMENT

Superstructure						
73.5" Prestressed Bulb Tee Girder	FT	11,865	$ 950.00	$	11,271,750
Structural Steel Plate Girders	LBS	600,000	$ 4.00	$	2,400,000
Steel Reinf. Bars - (Black & Epoxy Coated)	LBS	650,000	$ 3.50	$	2,275,000
Concrete Class 4000D - Deck East	CY	2,000	$ 1,800.00	$	3,600,000
Concrete Class 4000D - Deck West	CY	670	$ 1,800.00	$	1,206,000
Exp. Joint System Strip Seal - Superstructure	FT	128	$ 600.00	$	76,800
Bridge Drain	EA	23	$ 1,000.00	$	23,000
Traffic Barrier	FT	6,882	$ 160.00	$	1,101,120
Metal Railing Type BP	FT	6,882	$ 100.00	$	688,200
Bearing Pads	EA	21	$ 2,000.00	$	42,000
			Superstructure Total	$	22,683,900
			Structure Total	*$*	*35,927,400*

	Length	Width	Total (SF)	Cost per SF
Area =	2294	43	98,642	$ 364.22

3. Remove Existing Structure					
Concrete Deck on Concrete and Timber GluLam Girders, supported on Concrete Caps, Beams and Concrete and Timber Piles	SF	65,000	$ 65.00	$	4,225,000
			Remove Existing	*$*	*4,225,000*
4. Approach Slabs					
Concrete Class 4000	CY	85	$ 1,200.00	$	102,000
Steel Reinf. Bars - (Black & Epoxy Coated)	LBS	21,130	$ 3.50	$	73,955
Bridge Approach Slab Anchors	EA	44	$ 100.00	$	4,400
			Approach Slab	*$*	*180,400*
			New Structure	*$*	*40,783,400*
Partial Construction Access Trestle	LF	2,300	$ 2,400.00	$	5,520,000
Traffic Control / Environmental	LS	1	$ 2,000,000.00	$	2,000,000
Mobilization	10%			$	4,830,300
			Subtotal	$	53,133,700
Contingency	25%			$	13,283,500
			Total Construction	**$**	**66,417,200**
Preliminary Engineering	10%			$	6,641,800
Construction Engineering/Testing/Admin	10%			$	6,641,720
			Total Engineering	$	13,283,520
TOTAL ESTIMATED PROJECT COST (2021)				**$**	**79,800,000**