PORT OF HOOD RIVER COMMISSION
Tuesday, February 7, 2017
Marina Center Boardroom
5:00 P.M.

Regular Session Agenda

1. Call to Order
   a. Modifications, Additions to Agenda

2. Public Comment (5 minutes per person per subject; 30 minute limit)

3. Consent Agenda
   a. Approve Minutes of January 24, 2017 Regular Session *(Laurie Borton – Page 3)*

4. Reports, Presentations and Discussion Items
   a. Stafford Bandlow Engineers Final Report on Lift Span Mechanics *(Paul Bandlow, Gareth Rees, SBE – Page 9)*
   b. HDR Bridge Seismic Vulnerability Study Report *(Michael McElwee, David McCurry – Page 93)*
   c. HRYC Management of South Basin Dock *(Brian Douglass, Commodore – Page 137)*

5. Director's Report *(Michael McElwee – Page 139)*

6. Commissioner, Committee Reports
   a. Airport Advisory Committe – *Hoby Streich (January 26)*

7. Action Items
   a. Approve Contract with Schott & Associates for Wetland Delineation and Permitting Services at the Lower Mill Site in the Amount of $11,500 *(Anne Medenbach – Page 151)*
   b. Approve Contract with Vista GeoEnvironmental for Wetland Design, Engineering Services at the Lower MIll Site and Airport in the Amount of $36,900 *(Anne Medenbach – Page 155)*
   c. Approve Contract with Kevin Cooley for Jensen Building Roof Design Services in the Amount of $10,900 *(Anne Medenbach – Page 163)*

8. Commission Call

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9. Executive Session under ORS 192.660(2)(e) Real Estate Negotiations

10. Possible Action

11. Adjourn

If you have a disability that requires any special materials, services, or assistance, please contact us at 541-386-1645 so we may arrange for appropriate accommodations.

*The chair reserves the opportunity to change the order of the items if unforeseen circumstances arise. The Commission welcomes public comment on issues not on the agenda during the public comment period. With the exception of factual questions, the Commission does not immediately discuss issues raised during public comment. The Commission will either refer concerns raised during public comment to the Executive Director for a response or will request that the issue be placed on a future meeting agenda. People distributing copies of materials as part of their testimony should bring **10 copies**. Written comment on issues of concern may be submitted to the Port Office at any time.*

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Port of Hood River Commission
Meeting Minutes of January 24, 2017Regular Session
Marina Center Boardroom
4:00 P.M.

THESE MINUTES ARE NOT OFFICIAL until approved by the Port Commission at the next regular meeting.

Present: Commissioners Jon Davies, Brian Shortt, and Hoby Streich; Legal Counsel Jerry Jaques; from staff, Michael McElwee, Fred Kowell, Anne Medenbach, Genevieve Scholl, and Laurie Borton

Absent: Commissioners Fred Duckwall, and Rich McBride (available by phone from 5:05 to 5:17 p.m.)
Media: None

President Shortt called the January 24, 2017 meeting to order at 4:00 p.m. and the Commission was immediately called into Executive Session under ORS 192.660(2)(e) Real Estate Negotiations. The Commission was called back into Regular Session at 5:00 p.m. No action was taken as a result of Executive Session.

1. CALL TO ORDER: President Shortt called the Regular Session meeting to order at 5:05 p.m.

a. Modifications, Additions to Agenda: Shortt commented that public testimony on the Waterfront Parking Plan would remain open until the end of Regular Session. Commission Davies cited a conflict of interest with Action Items pertaining to insurance policy renewals. These items were moved ahead on the agenda to accommodate Commissioner McBride's availability by phone for a vote. Commissioner Davies then recused himself from the discussion and vote.

7. ACTION ITEMS:

b. Approve Property and Liability Insurance Policy with SDIS in the Amount of $76,644: Fred Kowell, Chief Financial Officer, introduced Scott Reynier with Columbia River Insurance, who was available to answer questions regarding the policy renewal items. Reynier stated the Port continues to operate at a high level. With regard to the property and liability policy, one incident was reported this past year which as yet is unresolved but the insurer remains in contact with the claimant. Regarding the bridge policy, the lift span deductible has been reduced to $500,000 from $1M and is attributable to the continued work and inspection efforts accomplished by the Port over the last year. Reynier stated the Port's work plan may surpass the insurer's expectations and a further reduction of the deductible may occur mid-stream during the policy period. Reynier also said he would be happy to attend another meeting when more Commissioners were in attendance.

Motion: Move to approve annual property and liability insurance policy with SDIS and authorize payment of insurance premium in the amount of $76,644.
Move: Streich
Second: McBride
Vote: **Aye:** McBride, Shortt, and Streich
Recusal: Davies
Absent: Duckwall
MOTION CARRIED

c. Approve Bridge Insurance Policy with Durham & Bates in the Amount of $249,759:

Motion: Move to approve bridge insurance policy underwritten by ACE USA and brokered by Durham & Bates in the amount of $249,759.
Move: Streich
Second: McBride
Vote: **Aye:** McBride, Shortt, and Streich
Recusal: Davies
Absent: Duckwall

MOTION CARRIED

Commissioner Davies rejoined the meeting at 5:17 p.m.

2. PUBLIC COMMENT: Executive Director Michael McElwee informed guests they were welcome to speak on the Waterfront Parking Plan at this point in the agenda if they were unable to wait until after the staff presentation. There was no public comment at this time.

3. CONSENT AGENDA:

a. Approve Minutes of November 15, 2016 Fall Planning Work Session and December 13, 2016 Regular Session
b. Approve Accounts Payable to Jaques Sharp Attorneys at Law in the amount of $5,460

Motion: Move to approve Consent Agenda.
Move: Davies
Second: Streich
Discussion: Davies cited a potential conflict of interest due to a client relationship with Jaques Sharp Attorneys at Law
Vote: **Aye:** Davies, Shortt, and Streich
Absent: Duckwall and McBride
MOTION CARRIED

4. REPORTS, PRESENTATIONS AND DISCUSSION ITEMS:

a. FY 15/16 Audit: Kowell introduced Tara Kamp, auditor and partner with Pauly, Rogers and Co. P.C. Kamp reviewed the "Communication to the Governing Body" and summarized the audit was conducted using generally accepted accounting principles and auditing standards and the Oregon Municipal Audit Law and related administrative Rules. As a result, an unmodified opinion on the basic financial statements was issued, meaning Paul, Rogers had given a "clean" opinion with no reservations; no exceptions or issues requiring comments were found; and a separate management letter would not be issued. Kamp stated results of the audit were excellent and she thanked Kowell and McElwee for the responsive and good working relationship.

b. Waterfront Parking Plan Update: A final draft of the Port's Waterfront Parking Management Plan dated January 10, 2017 was provided that included changes to the proposed Plan based on feedback from the Port's December 15, 2016 public meeting; i.e. eliminating metering at the Marina Park boat launch ramp. Public testimony was also received by City Council on January 9 and an online petition expressing opposition to parking fees on the Waterfront is circulating and delivered to City Council. At last count about 700 people had signed the letter. As a result Council deferred a decision and authorized the Mayor to organize an ad hoc committee representing City, Port, and business interests to evaluate the issue. This committee met on January 17 and January 24. No resolution or recommendations have been reached and further meetings will be held. McElwee commented if the City does not proceed then implementation of meters just on Port property would be problematic because of the need for City help with enforcement through an Intergovernmental Agreement. And although unlikely, staff will continue to explore the possibility of hiring private parties to enforce meters. McElwee stated the implementation schedule as laid out in the January 10 draft Plan will not happen. Davies, a member of the ad hoc committee, stated his belief that parking on the waterfront is a legitimate problem; however, he does not believe a plan would be implemented this summer and the Port needs to decide what can be done to help alleviate the problem. Davies also said private businesses need to be a component of the plan as he foresees limited parking will drive people into private lots from the street resulting in further problems.

Public comment received to date and submitted by email to porthr@gorge.net was provided to the Commission and these comments will be included as a part of the public record as an attachment to bound minutes.

Public Comment: Kristi Chapman thanked the Port and City for involving businesses and asked how the businesses could help the Port in establishing revenue generation with parking on Lot 1 in order to protect employee parking lots from recreational users. Chapman stated it was worth the due diligence to do the right thing. Linda Maddox encourage consideration of a "resident" or "landlord" parking pass using automobile registration or tax bill for verification of a lower cost pass and a "visitor" pass should be a higher rate. Maddox stated that locals who cannot afford the cost of a parking pass should not be excluded from using the Port's or City's waterfront properties. She also inquired why trailers are allowed to park on the west end of Portway Avenue when this could be used for overflow parking.

Shortt commented this has become 'social engineering' parking issue and that way-finding signage is another component that needs to be included in conversations. The 90-120 day high use period should be a foundation on how the Port moves forward and reiterated past comments about the use of a trolley system to move people between the waterfront and downtown. Shortt suggested asking parking consultant Rick Williams how social engineering can be accomplished, and that meeting agendas include a series of objectives. Streich inquired about permitting and paving requirements if Lot 1 were used for parking. Davies commented that all parties need to get in front of the parking issue as more development occurs. He also stated that parking meters help create turnover and use; and he inquired if a parking pass would exempt payment of a meter. Regarding truck parking on west Portway Avenue, McElwee stated this is challenging. With the suggestion of overflow parking use, he questioned where trucks would go—trucks that provide supplies and a critical need to this multi-use, industrial area. McElwee did, however, comment that the Port needs to follow through with trucking companies who do not have a parking agreement nor pay for parking on the waterfront. *There was Commission consensus to participate in the ad hoc committee and offer to pay Rick Williams for his consulting services.*

c. Lower Mill Development Update and Design Guidelines Review: Anne Medenbach, Property & Development Manager, revisited the Lower Mill Design Guidelines that previously promoted industrial activity but retained some control of the overall look of the final development. Medenbach reported that in the end, this is a site that will have many iterations of industrial use and the Port will want to limit restrictions while maintaining design integrity. Medenbach noted the Guidelines have been discussed with potential clients but that copies have not been distributed. She also reviewed three outstanding items, with completion timelines and estimated costs, that impact site development: waterline expansion and extension (for further discussion in Executive Session); wetland permitting and mitigation (action that will be brought to the Commission in February); and dirt pile relocation (possible relocation to the airport).

d. Port of Hood River Tolling Partnership with Port of Cascade Locks: Kowell reported the Port of Cascade Locks (POCL), led by their bridge engineer (HDR), has requested to open discussions on the use of one tolling system for both entities. One preliminary discussion has taken place and Kowell stated that conceptually this can be accomplished but it was discussed that POCL would need to adhere to the same business rules used by the Port of Hood River to keep programming costs from escalating and to assist in troubleshooting that occurs. Kowell said that while it is possible to have different business rules the programming costs would far exceed any benefit. With bridge replacement efforts underway, Shortt inquired if a partnership would be a short term agreement. Streich inquired about a fair compensation for sharing the tolling system with POCL and commented that we would want to maintain control. Davies recommended having further discussion on the order of magnitude for a tolling partnership with a comprehensive look at the variable components. *There was Commission consensus to keep the dialogue open and inform POCL there would be a cost associated with a partnership and the requirement to abide by our business rules.*

5. DIRECTOR'S REPORT: McElwee acknowledged the significant daytime and overnight efforts of the Facilities staff to ensure Port properties were in good shape during this winter's snow and ice events. With regard to highway closures during the latest storm, McElwee applauded ODOT's responsiveness in stopping truck traffic in The Dalles and contracting snow removal on Lot 1 that allowed for more truck parking in Hood River. Commissioners were asked to contact the office if they had an interest in attending the Special Districts Association of Oregon annual conference in Portland February 10-12. Waterfront Coordinator Liz Whitmore will be leaving the Port on January 27 for another opportunity and she was thanked for her accomplishments over the past five years. Stu Watson, an initial applicant for the position, has agreed to fill in on an interim basis. McElwee reported there is an opportunity to create more parking west of the Jensen Building with paving and landscaping improvements; however, some objections have been raised. McElwee said he would meet with City and Waterfront Park committee members to understand their opposition. February 15 is the OneGorge-sponsored "Gorge-ous Nights" capitol reception in Olympia and the Salem event is tentatively scheduled for March 9. The Commission was asked to contact Genevieve Scholl if they were interested in attending. Upon the recommendation from a marine electrical engineer the North C Dock power outages have been temporarily resolved by disconnecting the GFCI from the main panel. Pedestal breakers are providing some GFCI protection and power has held since early January. McElwee reported he attended the January 23 County Commission meeting to present the airport North Ramp project and requested an amendment to the Windmaster Urban Renewal Plan that would provide up to $20,000 to help meet the local match for the Connect VI grant. Stafford Bandlow's two reports related to their work on the liftspan are being reviewed and highlights from these reports will be brought to a February Commission meeting. Scholl and Facilities Manager John Mann were thanked for providing Senator Merkley's Field Representative, Phil Chang, a bridge tour and discussion of the Port's FASTLane application. McElwee reported that three FASTLane applications were submitted from Oregon (two from ODOT and the Port's); the review timeline and award decision are unknown at this time.

6. COMMISSIONER, COMMITTEE REPORTS: None.

7. ACTION ITEMS:

a. Approve Audit for Fiscal Year Ending June 30, 2016:

Motion: Move to approve audit for fiscal year ending June 30, 2016.
Move: Davies
Second: Streich
Vote: **Aye:** Davies, Shortt, and Streich
Absent: Duckwall and McBride
MOTION CARRIED

d. Approve Lower Mill Design Guidelines:

Motion: Move to approve Lower Mill Design Guidelines.
Move: Streich
Second: Davies
Vote: **Aye:** Davies, Shortt, and Streich
Absent: Duckwall and McBride
MOTION CARRIED

e. Authorize Acceptance of Oregon Department of Transportation *Connect*Oregon VI Grant in the Amount of $1,364,900 and Approve Execution of Grant Agreement for the Aviation Technology and Emergency Response Center at the Ken Jernstedt Airfield:

Motion: Move to authorize acceptance of Oregon Department of Transportation *Connect*Oregon VI Grant in the amount of $1,364,900 and approve execution of Grant Agreement for the Aviation Technology and Emergency Response Center at the Ken Jernstedt Airfield.
Move: Davies
Second: Streich
Vote: **Aye:** Davies, Shortt, and Streich
Absent: Duckwall and McBride
MOTION CARRIED

f. Approve Resolution 2016-17-4 Adopting Resolution Recommending Restoring Recreational Immunity: As a result of the recent Johnson v. Gibson Oregon Supreme Court case, special districts could face diminished legal protection from lawsuits regarding injuries or damages from recreational users of district properties. Recreational immunity extends immunity from liability to landowners providing recreational access on their lands to the public free of charge. Since public employers are statutorily required to represent and indemnify their employees, agents, and volunteers it exposes them to an increased risk of liability. Genevieve Scholl, Communications & Special Projects Manager, noted adoption of a resolution, as recommended by SDAO, formally supports a legislative fix.

Motion: Move to adopt Port Resolution 2016-17-4 recommending restoration of recreational immunity by the 2017 Oregon legislature.
Move: Streich
Second: Davies
Vote: **Aye:** Davies, Shortt, and Streich
Absent: Duckwall and McBride
MOTION CARRIED

Public Comment: Shortt asked for final comment on the Waterfront Parking Plan. Maddox said there needs to be an option for purchasing a day pass, possibly charging more. Shortt then closed public comment at 7:00 p.m.

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8. COMMISSION CALL: None.

9. EXECUTIVE SESSION: Regular Session was recessed at 7:00 p.m. and the Commission was called into Executive Session under ORS 192.660(2)(e) Real Property Transactions and ORS 192.660(2)(f) Consideration of Information Exempt from Public Records.

10. POSSIBLE ACTION: The Commission was called back into Regular Session at 8:35 p.m. The Executive Director then read a Waterfront Parking Plan email into the record that was received late in the day from Gary Bushman: "…Referencing back to Port Overlay Committee work, a majority agreed that having meters on Port property provided for a level playing field between the Port and Historic District. Just as important, it provided the Port with a revenue stream for green belt maintenance. I trust the Port and City will stand together and honor this commitment."

The following action was then taken as a result of Executive Session.

Motion: Move to approve Lease Termination Agreement with John Herron, effective January 31, 2017 [700 E. Port Marina Drive, Suite 100].
Move: Streich

Second: Davies
Vote: **AYE:** Davies, Shortt, and Streich
ABSENT: Duckwall and McBride
MOTION CARRIED

11. ADJOURN: The meeting was adjourned at 9:16 p.m.

Respectfully submitted,

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Laurie Borton

ATTEST:

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Brian Shortt, President, Port Commission

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Jon Davies, Secretary, Port Commission

Commission Memo

Prepared by: Michael McElwee
Date: February 7, 2017
Re: Bridge Mechanical & Electrical Analyses

Stafford Bandlow Engineering, Inc. ("SBE") completed the attached studies of the bridge lift span's mechanical and electrical systems late last year. These efforts were outcomes of the investigation of the suspected allision and subsequent claim.

The studies demonstrate the need for the Port to consider significant upgrades to components of the span drive motors and machinery and skew system in the next few years.

Paul Bandlow, P.E. and Gareth Rees, P.E. both principals at SBE will provide an overview of their analyses and associated findings via conference call and answer questions from the Commission.

RECOMMENDATION: Informational.

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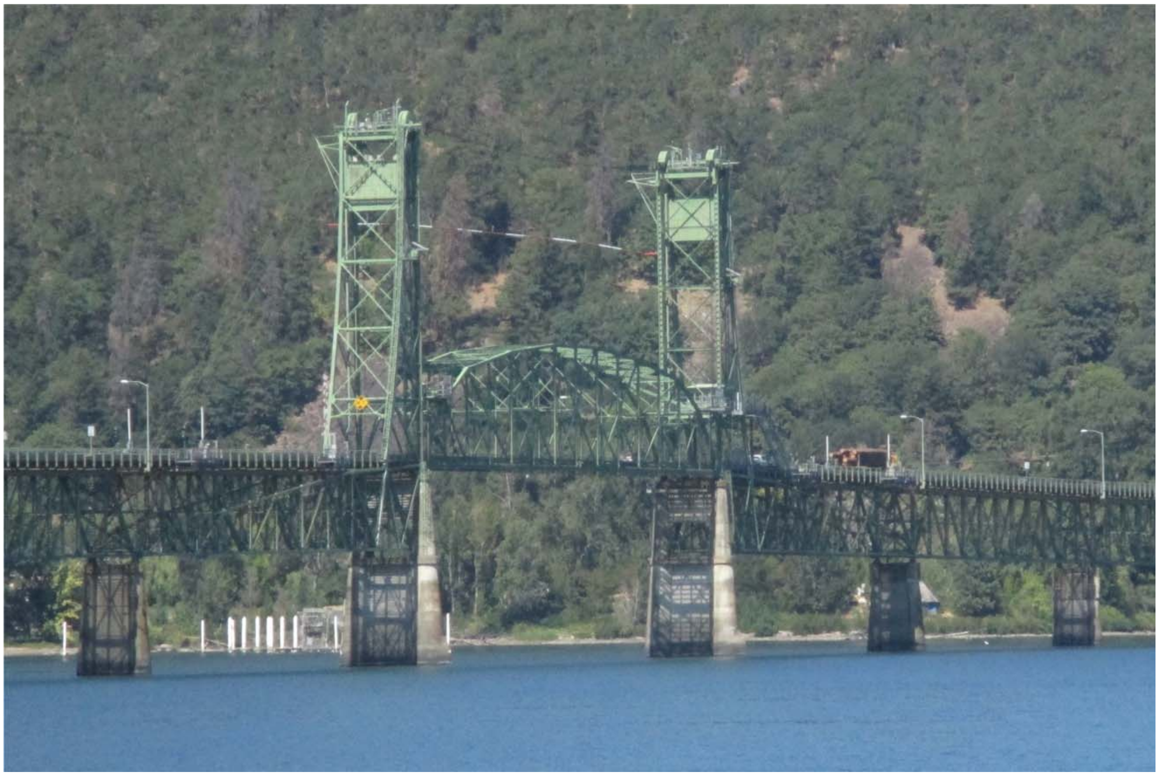
NON-DESTRUCTIVE TESTING OF TRUNNIONS, INVESTIGATION OF STICK-SLIP BEHAVIOR DURING OPERATION, AND SPAN DRIVE EVALUATION



HOOD RIVER LIFT BRIDGE
PORT OF HOOD RIVER
HOOD RIVER, OREGON

Submitted to:
Mr. Michael S. McElwee
Port of Hood River

Submitted by:

Stafford Bandlow
Engineering, Inc.
Doylestown, Pennsylvania

Submitted: January 5, 2017

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INTRODUCTION

The purpose of this report is to document additional investigation of the Hood River Vertical Lift Bridge in Hood River, Oregon. Stafford Bandlow Engineering, Inc. (SBE) and sub-consultant Wiss Janney Elstner Associates (WJE) were on site on October 27th, 28th, and 29th, 2016 to continue the investigation of critical mechanical systems for the bridge operation. The field work addressed several recommended action items from SBE's September investigation which is summarized in SBE's October 3rd, 2016 report titled *Investigation of Critical Mechanical Systems for Bridge Operation*. This field work included non-destructive testing (NDT) of the counterweight sheave trunnions, inspection of the sheave trunnion bearings, inspection of the rack pinion bearings, inspection of the span drive primary reducer gearing, and strain gage testing to monitor loads during bridge operation. In addition to the field work, SBE has reviewed the capacity of the span drive machinery components as the current motor and high speed reducer combination provides significantly greater torque than the original installation.

A schematic of the span drive machinery with component designations used throughout this report is presented in Appendix C.

TRUNNION AND TRUNNION BEARINGS

The lift span and the counterweights are supported by sheave assemblies located at the top of the towers. Two sheave assemblies are provided at each tower for a total of four for the bridge. Each sheave assembly is supported by two trunnion bearings.

The trunnion journals and the bearings were subjected to an in-depth inspection to continue an investigation into high trunnion friction and to provide NDT of the trunnions due to fatigue concerns based on prior calculations by SBE. Bridge maintenance personnel removed the trunnion bearing caps at each of the eight bearings to provide access for the inspection. This detailed inspection included a visual inspection of the trunnion journals and NDT of the trunnions.

As part of the original fatigue analysis, SBE included an estimation of the tensile strength of the existing trunnions, as the provided drawings do not fully describe the trunnion material. The tensile strength of steel correlates linearly with the hardness of the material. As part of the current field work, SBE used a portable hardness tester (Phase II, Model PHT-1700) to measure the trunnion material hardness. The average hardness recording was 215 Brinnel Hardness Number (BHN). As an estimate of the tensile strength, SBE used the convention of 490 multiplied by BHN for a tensile strength of 105 ksi. This is a lower value than the previously estimated 120 ksi tensile strength and reduces the calculated fatigue strength and fatigue life. Revised fatigue calculations are provided in Appendix D.

Although the fatigue calculations have been updated to reflect the trunnion material, the remaining life of the trunnions is based on the number of total cycles (due to bridge operations) to which the trunnions have been subjected over time since the original installation. The number of cycles remains an unknown and thus NDT of the trunnions is critical.

The NDT of the trunnions was performed by Rob Gessel of WJE. The testing at each trunnion included the following:

- Ultrasonic testing (UT) from both ends of the trunnions. This test would identify cracks or other internal defects that are of a significant depth but may not identify small surface cracks.
- Through-the-bore UT of the interface between the trunnion and the sheave at the outboard side. This is a location of high bending stress and there is a significant stress concentration factor associated with the press-fit of the sheave on the shaft.
- Wet magnetic particle testing of the fillets where the trunnion shaft diameter changes; these areas are critical for evaluation as their geometry results in significant stress concentration factors and this is the location of documented trunnion failures on other bridges.

No cracks or other indications of concern were identified as part of the NDT. A detailed report of the NDT performed is included in Appendix E. Based on these findings, trunnion fatigue is not a threat to the near-term operation of the bridge and additional corrective action is not necessary at this time. Given that the integrity of the sheave trunnions is critical for the safe operation of the bridge, it is recommended that the NDT be repeated in approximately five years.

SBE also provided a visual inspection of the visible portion of the sheave trunnions. The journals were inspected with the bridge in the closed position and with the lift span partially raised to allow for inspection of the portion of the journals that are not visible when the bridge is in the closed position. The journals were found to be in fair condition with the following notes.

- At each bearing, the portion of the journal that is visible with the bridge in the closed position was found to be well-polished and in good condition with only minor scoring and light bronze embedment on some journals. See Photo 1 in Appendix A.
- The portion of the journal that is not visible with the bridge in the closed position had light scoring and light bronze embedment. In addition, these areas had minor corrosion and dried lubricant. The corrosion was found to be limited and both the dried lubricant and corrosion were removed at the time of the inspection using emery cloth and Scotch-Brite pads. See Photos 2 and 3 in Appendix A.
- From the WJE sheave trunnion inspection, minor damage observed in the transitional fillet radius at the southwest trunnion outboard journal appears to be the result of impact from an unknown source. See Appendix E for the complete report.

Due to finding dried lubricant and corrosion on the journal surface, the field work on October 29, 2016 included flushing each trunnion journal multiple times as the journal rotated during operation with diesel fuel to breakdown and remove dried lubricant and corrosion. The flushing was done in combination with polishing with emery cloth and Scotch-Brite pads. At the completion of the field work, the trunnion bearing caps remained off to facilitate additional flushing of the bearings using a penetrating lubricant (Sea Foam Deep Creep or similar). See Appendix C for strip charts demonstrating the before and after operational loading.

Note that the current lubricant (SWEPCO 101 Moly) has a clay based thickener that may be a contributor to the dried lubricant and high friction. It is recommended that the lubricant be changed to an NLGI Grade 2 lubricant with a lithium, lithium complex, or similar thickener. Note that these lubricants are typically not compatible with clay based lubricants; it is critical that the old lubricant be completely flushed from the bearings.

In addition to the field inspection, SBE evaluated the loading of the trunnion bearings in accordance with AASHTO. Based on these calculations, which are provided in Appendix D, the trunnion bearings are overstressed. The inboard trunnion bearings have 61% of the required capacity and the outboard bearings have 89% of the required capacity. However, based on the inspection there are no significant issues, there is little wear, and therefore corrective action is not recommended.

RACK PINION SHAFT BEARINGS

In addition to the trunnion bearings, the condition of the rack pinion bearings is a potential contributor to friction problems. A clogged lubrication fitting was previously noted at the northwest rack pinion bearing cap. There are four rack pinion shaft bearings with one bearing at the inboard side of each rack pinion. As part of this inspection, the northwest, southwest, and southeast bearing caps were removed by maintenance personnel to permit an in-depth inspection. Note that maintenance personnel were not able to remove the northeast bearing cap due to corroded fasteners.

The condition of the inspected rack pinion bearings varied from fair to poor. The southeast bearing was found in fair condition with ample lubrication and only minor deficiencies. The northwest and southwest bearings were found in poor condition with moderate to heavy corrosion and dried lubrication deposits on the journal. The bearing caps at these locations had evidence of fretting corrosion (due to inadequate lubricant), dried lubrication deposits, and clogged lubrication ports. The northwest and southwest bearings were cleaned to the extent possible with the bridge in the closed position using penetrating lubricant and emery cloth to remove lubricant deposits and corrosion around the circumference of the journal. The depth of corrosive pitting at the journals was significant as the pits could not be removed by hand polishing. After cleaning, the journals were lubricated by hand and the bearings caps were installed prior to operating the bridge. See Photos 4 through 8 in Appendix A.

The field effort to remove the corrosion at the rack pinion journals (and the trunnion bearings) provided an improvement to the operation of the span by significantly reducing the previously noted oscillations. However, the overall system friction remained high and additional maintenance efforts are recommended.

It is recommended that the northeast rack pinion shaft bearing cap be removed and the journal and cap be cleaned up in a similar manner as at the other three bearings. Apart from the work at the northeast rack pinion bearing, maintenance personnel should provide further flushing of the bearings using a penetrating lubricant (Sea Foam Deep Creep or similar). As discussed for the sheave trunnion bearings, the current lubricant (SWEPCO 101 Moly) has a clay based thickener that may be a contributor to the clogging of the lubrication ports and high friction. It is recommended that the lubricant be changed to an NLGI Grade 2 lubricant with a lithium, lithium complex, or similar thickener. Again, because these lubricants are typically not compatible with clay based lubricants, it is critical that the old lubricant be completely flushed from the bearings.

Note that it is critical to provide appropriate lubrication and to operate the bridge as part of routine maintenance. SBE is currently working on a lubrication chart for guidance for future maintenance.

SPAN DRIVE PRIMARY REDUCERS

As noted in the October report, the primary reducers have less capacity than recommended by AASHTO and other authoritative sources based on the torque provided by the current motor and high speed reducer combination. For this reason, the primary reducer internal gearing was inspected.

The primary reducer does not include an inspection cover to allow for internal inspection of the gearing. A borescope (RF System Lab, Model VJ-ADV 6.9mm) was used to provide a limited inspection of the gear teeth through a ¾" diameter breather hole on top of the reducer housing.

The borescope inspection shows that the gear contact is generally good, but damage was noted at several gears in the form of pitting. At the north primary reducer, pitting was noted above the pitch line at the low speed output gears and below the pitch line on the northeast high speed pinion. At the south primary reducer, isolated pits were noted on the west low speed output gear and at the high speed pinions. The worst damage noted was at the south primary reducer west high speed pinion, where destructive pitting was noted across the teeth. See Photos 9 through 12 in Appendix A.

Oil samples were taken from both primary reducers for analysis of contaminants and/or wear particles. The sample from the north primary reducer was found to be almost entirely water and was not analyzed given that it clearly required replacement. The south primary reducer oil sample was analyzed by Southwest Spectro-Chem Labs. Their analysis considers this sample to be in "critical" condition due to contamination with wear particles, corrosion particles, and water. See Appendix B for the oil analysis report.

Based on the borescope inspection and the oil analysis it is recommended that the reducer housings be opened to provide an in-depth inspection of the internal gearing. For each reducer, all of the existing oil should be replaced and, while the cover is removed, the interior of the housing should be thoroughly cleaned to remove old oil, water, sludge, etc. In addition, each reducer should be provided with a desiccant breather to try to mitigate moisture contamination.

SPAN OPERATION OBSERVATIONS AND STRAIN GAGE TESTING

As documented in SBE's October 3rd, 2016 report titled *Investigation of Critical Mechanical Systems for Bridge Operation*, periods of irregular lift span movement (oscillations) had been noted during operation. It was theorized that the irregular movement may be due to trunnion bearing friction. During the current inspection, SBE witnessed operations and recorded strain gage measurements during operations as part of the trunnion bearing work.

Although not completely eliminated, the work at the trunnion bearings (corrosion removal, flushing, and lubrication) led to a significant reduction in the duration and magnitude of span oscillations; the oscillations were eliminated during raising of the span and were reduced during lowering of the span. See the strip charts in Appendix C. This improvement in the operational behavior appears to confirm that trunnion bearing friction is a significant contributor or the cause of the span oscillations. Continued efforts to flush the bearings of old lubricant and replenish with new lubricant should continue to improve span operation.

As part of the current work, SBE analyzed the strain gage data to determine the balance condition for the bridge. The balance analysis was previously performed and documented in the September 29, 2016 *Span Balance Analysis Report.* The following table provides a comparison of the current results with those from September.

Hood River Lift Bridge North Tower						
Test Result	**Seated Imbalance (lb.)**			**Average Friction (lb.)**		
	NW Corner	**NE Corner**	**North End**	**NW Corner**	**NE Corner**	**North End**
September 7, 2016 Average	-75	+3,636	+3,561	+6,331	+1,175	+7,507
October 29, 2016 Run 3-6	+4,478	+1,878	+6,356	+3,746	+4,807	+8,552

Hood River Lift Bridge South Tower						
Test Result	**Seated Imbalance (lb.)**			**Average Friction (lb.)**		
	SW Corner	**SE Corner**	**South End**	**SW Corner**	**SE Corner**	**South End**
September 7, 2016 Average	+6,049	-724	+5,326	+2,449	+4,483	+6,933
October 29, 2016 Run 3-6	+1,343	+4,757	+6,101	+5,069	+5,837	+10,905

Note the following comparisons between the tests:

1. There is a significant change in the total imbalance for the two ends. SBE believes that this is most likely due to two issues. The first issue is possible strain gage zeroing errors. From our analysis of the two balance efforts, it appears that the zero calibrations at the instrumented shafts may be affected due to residual friction at the rack pinion shaft bearings. The second issue is that the measurement of imbalance is based on the assumption that friction is equal and constant when raising and lowering the lift span. The accuracy of imbalance measurements can be affected at bridges with friction issues such as this one.

2. The average friction measurement has increased at both towers. This change may seem surprising given the efforts to hand-dress and re-lubricate the bearings during the inspection. However, predicting and estimating friction is difficult to do with precision as it is dependent upon many variables. It is possible, for example, that the oscillatory loading of the machinery affected the average friction values. The reduction in lift span oscillations during operation is a clear improvement and continued lubrication efforts are recommended.

3. An apparent transverse imbalance remains at each tower though it is less severe than what was noted in September. However, as discussed in the September report, cross-indexing at the two rack pinion shafts at each tower affect these measurements. The poor load sharing shown in the strip charts in Appendix C may be partially or entirely due to this indexing issue. Transverse imbalance adjustments are not recommended at this time.

The strain gage recordings were compared to 100% of full load torque (FLT) of the motor from the original machinery design (20 hp at 870 rpm; this does not represent the current capacity with the new motor and additional high speed reducer combination). We would expect that the running loads would be less than 100% FLT. This comparison shows the shaft loads being approximately 150% FLT of the original motor. This indicates that the original motor was not adequately sized for the applied loads.

MOTOR (PRIME MOVER) CAPACITY REVIEW

AASHTO prime mover requirements for the Hood River Lift Bridge were calculated (includes wind, ice, Inertia, friction, and imbalance loading) and compared to the existing and original motor installation. To provide a common reference point for comparison, the motor HP and speed is calculated as an equivalent torque value at the original primary reducer input shaft and is presented in the following table.

PRIME MOVER COMPARISON TORQUE AT THE PRIMARY REDUCER INPUT SHAFT		
AASHTO Requirement	Existing Motor Installation	Original Motor Installation
189 ft. lb.	243 ft. lb.	121 ft. lb.

The original motor installation does not meet the current AASHTO prime mover requirement. The existing motor installation is sized to provide more capacity than required to meet the AASHTO prime mover requirement.

SPAN DRIVE MACHINERY COMPONENT CAPACITY REVIEW

AASHTO LRFD, Section 5.7.1, requires that movable bridge span drive machinery be designed for 150% full load torque of the prime mover. SBE evaluated the condition of the machinery based on three different conditions:

1. The original motor installation.
2. The existing drive arrangement (replacement motor and high speed reducer circa 2000).
3. The impact of the existing brake loading on the drive machinery.

The evaluation included assumptions due to the limited information available for some of the components. See Appendix D for the calculations, including a summary of assumptions.

Original Motor Installation

The open gearing and rack pinion shaft bearing (Bearing B1) are the only components that rate for the original motor installation. The following are the rating of the remaining span drive machinery components.

- The primary reducer has 60% of the required capacity.
- The rack pinion shaft has 76% of the required capacity. The rack pinion shaft design also violates the angular strain limit provided by AASHTO.
- The keys for the C1 couplings may be overstressed depending on their material (the key material is not provided on the available drawings). Assuming AASHTO's recommended material for keys (ASTM A668 Class D) the C1 coupling keys have 57% of the required capacity.
- C1 coupling (rack pinion shaft coupling) manufacturer data is not available. Based on data from a similar coupling and, depending on the size of the installed coupling, the coupling may be overstressed. Note that the elastomeric sleeves at the coupling fasteners are deformed, which could indicate an overload condition, though it's possible that the damage is from degradation over time. See Photo 13. Although the damage to the elastomeric sleeves is a concern, their failure would not result in loss of control of the lift span as torque would still be transmitted through the fasteners.

Existing Motor / High Speed Reducer Installation

SBE's evaluation included the existing drive arrangement with the motor operating at 600 rpm. The current machinery installation provides additional torque due to the added ratio from the high speed reducer; it provides a factor of 1.96 times the original motor torque. The pinion gear, rack pinion shaft bearing (Bearing B1), High Speed Reducer, Coupling

C2 and Coupling C3 are the components that rate for the existing motor installation. The following are the ratings of the remaining span drive machinery components.

- The ring gear has 89% of the required capacity.
- The primary reducer has 31% of the required capacity.
- The high speed reducer has 93% of the required capacity.
- The rack pinion shaft has 40% of the required capacity. The rack pinion shaft design also violates the angular strain limit provided by AASHTO.
- The keys for the C1 couplings *and* for the rack pinion are likely overstressed depending on their material (the key material is not provided on the available drawings). Assuming AASHTO's recommended material for keys (ASTM A668 Class D) the C1 coupling keys have 29% and the rack pinion keys have 52% of the required capacity.
- Again, C1 coupling (rack pinion shaft coupling) manufacturer data is not available, but depending on the size of the installed coupling, they may be overstressed. This is especially true with the higher torque provided by the existing span drive configuration. Although the manufacturer data is unknown, a review of current coupling literature shows that it is unlikely that the couplings have sufficient capacity.

<u>Existing Motor Brake</u>
The motor brake is a solenoid actuated disc brake with a torque rating of 75 ft. lb. This torque is less than the existing motor torque of 88 ft. lb. used in condition 2 of the span drive machinery evaluation. Therefore, the motor brake torque does not govern when evaluating the loading on the span drive machinery, however, the use of solenoid brakes as part of span operating machinery is not in accordance with the AASHTO because they do not have an adjustable time delay feature. The motor brake is applied instantly when the motor is de-energized. Without a time delay feature, the span drive machinery will be subject to shock loading. The effect of the shock loading is difficult to quantify, but the disc brakes adds significant risk of damage to the undersized machinery components described above.

Any change made to the control system or motor should consider replacement of the brake with a spring set thrustor released drum brake in accordance with AASHTO.

CONCLUSIONS

The results of this additional investigation and analysis of the Hood River Vertical Lift Bridge mechanical systems is as follows:

The original span drive machinery was not designed to meet AASHTO requirements. The additional span drive motor and high speed reducer installed circa 2000 was sized to meet the AASHTO prime mover requirements, however, the additional capacity that the motor and high speed reducer combination provided results in the original machinery being severely undersized. The components that are of concern due to being undersized are the primary reducers, rack pinion shafts and C1 couplings and keys.

The span drive motor brake is a solenoid actuated disc brake which is not in accordance with the AASHTO because it does not have an adjustable time delay feature.

The field effort to remove the corrosion at the rack pinion journals (and the trunnion bearings) provided an improvement to the operation of the span by substantially reducing the previously noted oscillations. However, the overall system friction remained high and additional maintenance efforts are recommended. In addition, the operational loads are generally high, with the operating loads at approximately 150%FLT of the original motor installation.

The trunnion fatigue calculations have been modified to reflect the trunnion material based on field measurements of the trunnion hardness. Fatigue life remains finite, though the number of operations over the life of the bridge is unknown. Because the NDT did not note any cracks, near term operation is not at risk. Given that the integrity of the sheave trunnions is critical for the safe operation of the bridge, it is recommended that the NDT be repeated in approximately five years.

The trunnion bearing journals were found to be in fair condition with minor corrosion and dried lubricant that was cleaned as part of the field investigation.

Three of the four rack pinion shaft bearings were opened for inspection and found to be in poor condition due to corrosion and dried lubricant. Loose corrosion material and the lubricant was replaced, though corrosive pitting remains. Additional maintenance efforts are recommended.

The borescope inspection of the north and south span drive primary reducers shows damage on some of the gearing, with the worst noted at the west high speed pinion at the south reducer. The oil for both reducers was found to be contaminated. Additional maintenance is recommended to clean out the reducers and to minimize water intrusion in the future.

RECOMMENDATIONS AND COST ESTIMATES

The following recommendations are based on the findings of this inspection and one outstanding recommendation from prior inspection work by SBE. Cost estimates are provided for recommendations that require additional engineering prior to implementation and/or constitute major repairs that would likely be performed by a Contractor. Costs are presented in 2017 dollars.

Item	Recommendations	Cost Estimate
1	Rehabilitate or completely replace span drive motors and control system, while still providing operating capacity in accordance with AASHTO design guidelines. See separate electrical modifications summary for additional details.	$ 240,000 to $ 750,000
2	Replace the span drive machinery primary reducer, rack pinion shaft, C1 couplings, and span drive machinery brakes to meet the AASHTO design guidelines.	$750,000
3	Repeat the counterweight sheave trunnion NDT in approximately five years. Field measure the trunnion transitional fillet radius at this time.	$ 40,000
4	Perform a biennial mechanical and electrical inspection of the machinery components. Tailor the scope of each inspection based on ongoing findings and operational conditions.	$55,000
5	Provide an in-depth inspection of the internal gearing of both span drive primary reducers. This will involve removing the top half of the housing for access. As part of this work, the existing oil should be replaced and the interior of the housing should be thoroughly cleaned to remove old oil, water, sludge, etc.	$ 50,000
6	Perform strain gage testing to evaluate the imbalance and span operation loading after further flushing of the bearings (recommendation #10). Consider coordinating this operational testing with the recommended in-depth inspection of the span drive machinery primary reducers (recommendation #5). Note that the calibration for future strain gage testing may require additional support effort from maintenance personnel to obtain a zero torque condition at the instrumented shafts.	
7	Investigate possible improvements to the rack pinion shaft indexing to more equally share load. It may be possible that a live load adjustment could be made (either temporary or permanent) could be made to improve load sharing between the rack pinion shafts.	

Item	Recommendations (continued)	Cost Estimate
8	Hand dress to blend the noted high points at the southwest trunnion outboard journal in the transitional fillet radius.	Maintenance
9	Remove the cap for the northeast rack pinion shaft bearing. Clean and lubricate the bearing journal and the cap.	Maintenance
10	Provide further flushing of the trunnion and rack pinion bearings using a penetrating lubricant (Sea Foam Deep Creep or similar). In addition, the current lubricant (SWEPCO 101 Moly) has a clay based thickener that may be a contributor to the clogging of the lubrication ports. It is recommended that the lubricant for all bearings be changed to an NLGI Grade 2 lubricant with a lithium, lithium complex, or similar thickener. Note that because these lubricants are typically not compatible with clay based lubricants; it is critical that the old lubricant be completely flushed from the bearings.	Maintenance
11	Provide a desiccant breather for each span drive primary reducer to try to mitigate moisture contamination.	Maintenance
12	Replace the sheared motor scoop mounting bolt at each motor. (This recommendation is outstanding from the October 3, 2016 report)	Maintenance

APPENDIX A

PHOTOGRAPHS

Photo 1 TB-NW-OB Journal. View with bearing cap removed and with the bridge in the seated position.

Photo 2 TB-NW-IB Journal. View with bearing cap removed and with the bridge raised for access to the portion of journal that is not visible with the bridge seated. Note the minor corrosion and dried lubricant.

Photo 3 TB-NW-IB Journal. View of with bearing cap removed and with the bridge raised for access to the portion of the journal normally not accessible. This is a view after the removal of minor corrosion and dried lubricant.

Photo 4 B1-NW Journal. View with bearing cap removed. The journal is in poor condition with heavy corrosion and minimal lubricant.

Photo 5 B1-NW Journal. Close-up view of Photo 4. Note the corrosive pitting on the journal.

Photo 6 B1-NW Journal. View prior to re-assembly. The journal has been hand-dressed with emery cloth and fresh lubricant has been applied.

Photo 7 B1-SW Cap. View of cap prior to cleaning. Note the fretting corrosion and the clogged lubrication ports.

Photo 8 B1-NW Cap. View of cap after cleaning. The lubrication ports have been cleared and fretting and old lubricant have been removed.

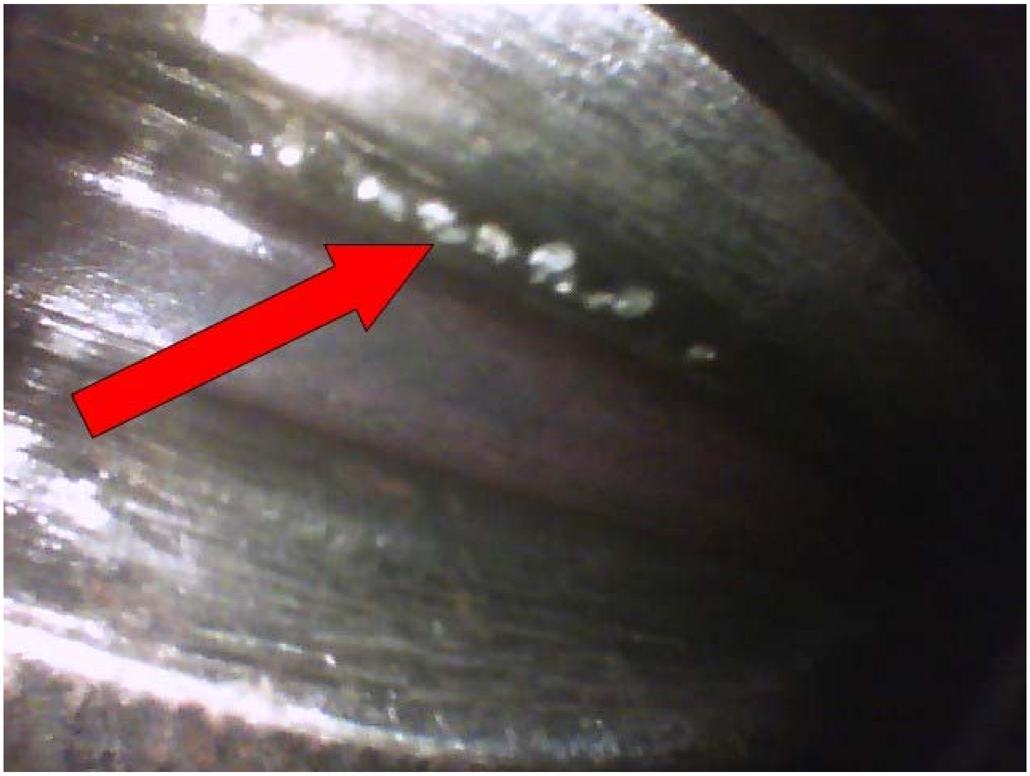


Photo 9 North Primary Reducer Gearing through Borescope. Note the pitting (arrow).

Photo 10 North Primary Reducer Gearing. Note the pitting (arrow) in the dedendum of the tooth.

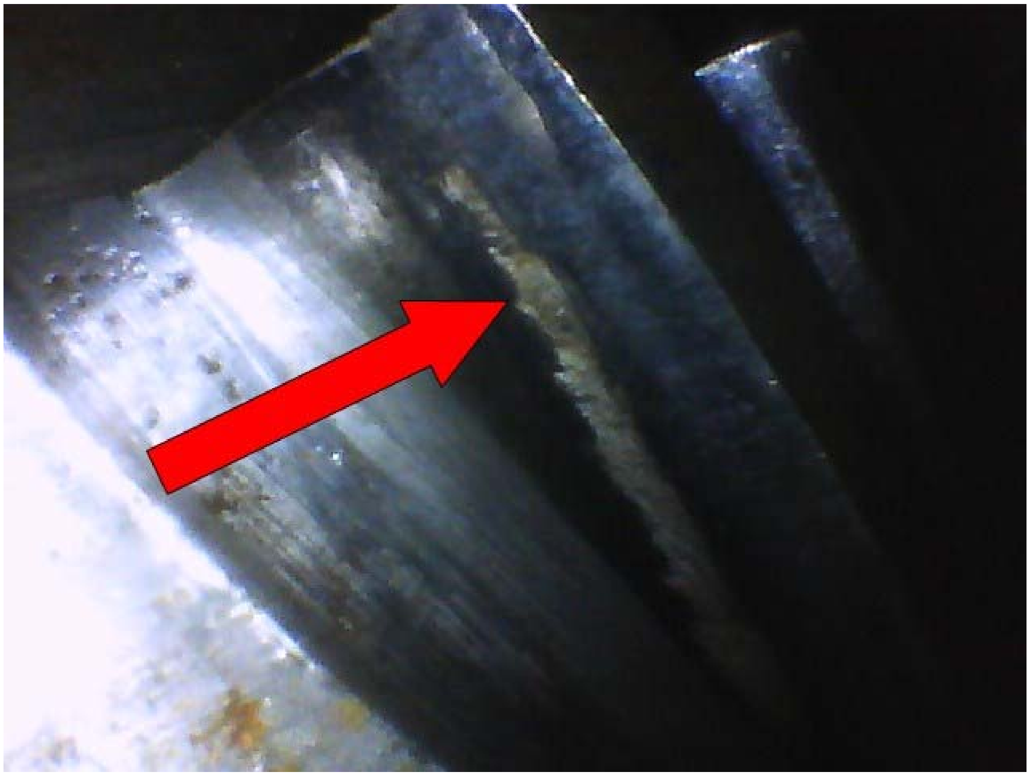


Photo 11 South Primary Reducer Gearing. View of west high speed pinion tooth. Destructive pitting extends across the width of the tooth at the pitch line.

Photo 12 South Primary Reducer Gearing. Note the pitting (arrow).

Photo 13 Rack Pinion Shaft Coupling. The coupling transmits torque via a bolt/pin installed with an elastomeric material through the coupling hubs. The elastomeric material is deformed and degraded.

APPENDIX B

SOUTH SPAN DRIVE PRIMARY REDUCER OIL SAMPLE ANALYSIS

Southwest Spectro-Chem Labs
1009 Louisiana St South Houston, TX 77587
(P)713.944.3694 (F)713.944.9881
www.weanalyzeoil.com

OVERALL WEA
JUDGEMEN
4-Critical

Analytical Ferrograph Report

SAMPLE INFORMATION			
CUSTOMER #:	234565	LAB SAMPLE #:	K0162
CUSTOMER:	STAFFORD BANDLOW ENG	OIL USED:	UNKNOWN
LOCATION:	SB796	TIME ON OIL:	N/A
UNIT:	SOUTH PRIMARY	SAMPLE DATE:	10/31/16
DESCRIPTION:	REDUCER	REPORT DATE:	11/07/16
SERIAL #:	N/A	ANALYST:	TC
EQUIP NO:	0133		

PARTICLE ANALYSIS

1 - Normal; 2 - Watch; 3 - Alert; 4 - Critical

FERROUS METAL WEAR	SEVERITY
RUBBING	3
SEVERE WEAR	3
CUTTING	
LAMINAR PARTICLES	3
SPHERES	
CHUNKS	4
RED OXIDES	4
DARK OXIDES	2
ADHESION WEAR	
ABRASION WEAR	
SLIDING	3
COPPER/COPPER ALLOY WEAR	**SEVERITY**
RUBBING	
SEVERE WEAR	
CUTTING	
LAMINAR PARTICLES	
SPHERES	
FATIGUE CHUNKS	
ABRASION WEAR	
SLIDING	
OTHER NON-MAGNETIC PARTICLES	**SEVERITY**
INORGANIC/BIREFRINGENT	
WHITE METAL	
MOLYBDENUM DISULFIDE	
OTHER NON-METALLIC PARTICLES	**SEVERITY**
ORGANIC/BIREFRINGENT	
SILICEOUS	4
FRICTION POLYMER	4
FIBERS	
LACQUER	4
AMORPHOUS	
CARBONACEOUS	

METAL CONTENT, ppm by Emission Spectroscopy

NOTE: Particles greater than 10-microns will probably not be measured in the emission spectrometer.

WEAR			
Iron	129	Tin	0
Copper	0	Nickel	1
Aluminum	1	Titanium	0
Chromium	0	Silver	0
Lead	1	Vanadium	0

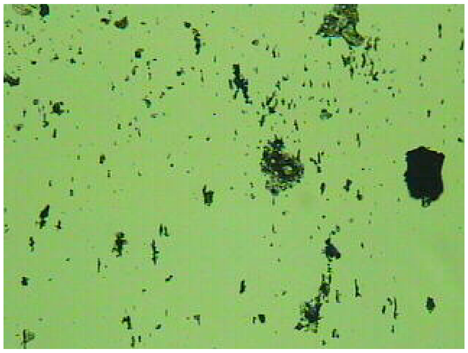
ADDITIVE	
Magnesium	0
Calcium	1
Barium	0
Phosphorous	630
Zinc	1

MULTI-SOURCE	
Molybdenum	1
Antimony	0
Boron	21

CONTAMINANT	
Silicon	5
Sodium	2
Potassium	3

PHYSICAL PROPERTIES		
Ferro D.R, Small	74.6	
Ferro D.R, Large	117.7	
KF Water	2%	ppm
TAN	0.63	mg/g

SAMPLE #: K0162



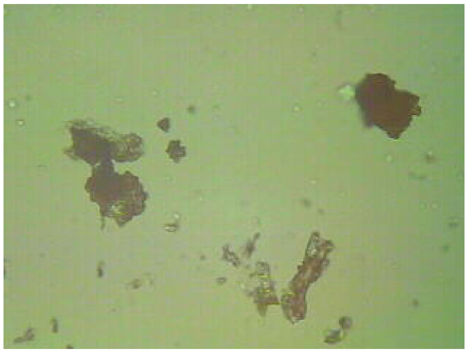
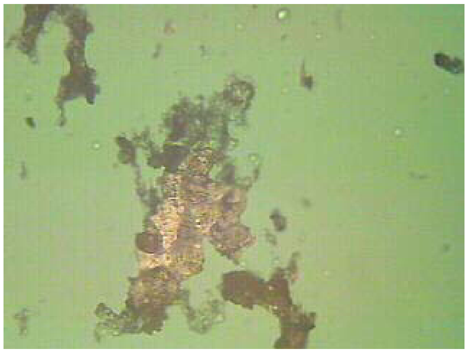


PHOTO-MICROGRAPH A @ 100 X	PHOTO-MICROGRAPH B @ 400 X
Overview of the slide entrance. This slide appears predominantly occupied with large siliceous debris, friction polymers, lacquers and various chunks of red oxides.	Red oxide chunks at different sizes are embedded with friction polymers.



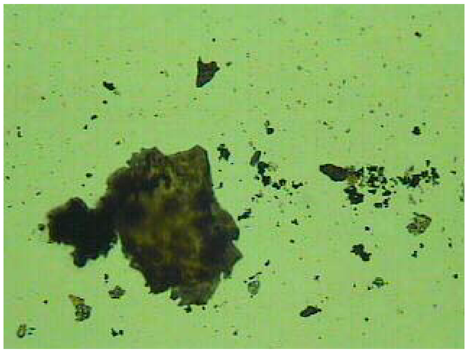


PHOTO-MICROGRAPH C @ 100 X	PHOTO-MICROGRAPH D @ 100 X
This bright yellow metal platelet appears to resemble a 3-body gear wear particle with undefined circumference, rough edges and striated marks. It is at least 20 microns large.	Lacquer platelets and friction polymers are commonly found this ferrography slide.

SUMMARY:

This sample contains various different types of wear as observed on the ferrography slide prepared when diluting the grease sample with an appropriate solvent. Rubbing wear, red oxide chunks, siliceous debris, lacquer platelets and friction polymers are typically observed on the ferrogram. The amount of particles, their large sizes and severe wear types consequentially result in its CRITICAL wear state. Also note that the current moisture content in this sample appears alarming at 2%, high content in Iron and particle count reading.

APPENDIX C

FIGURE
AND
OPERATION STRIP CHARTS

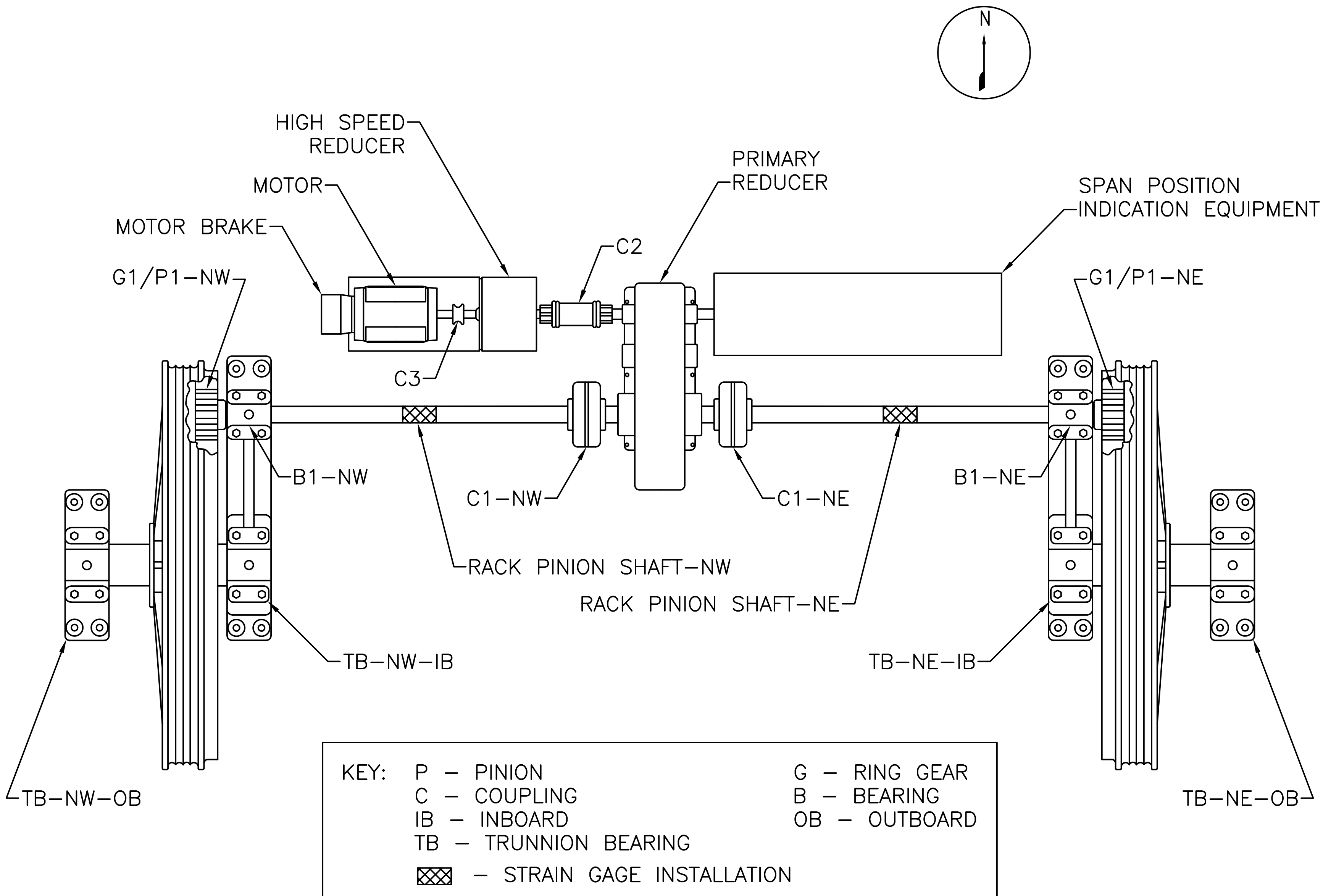
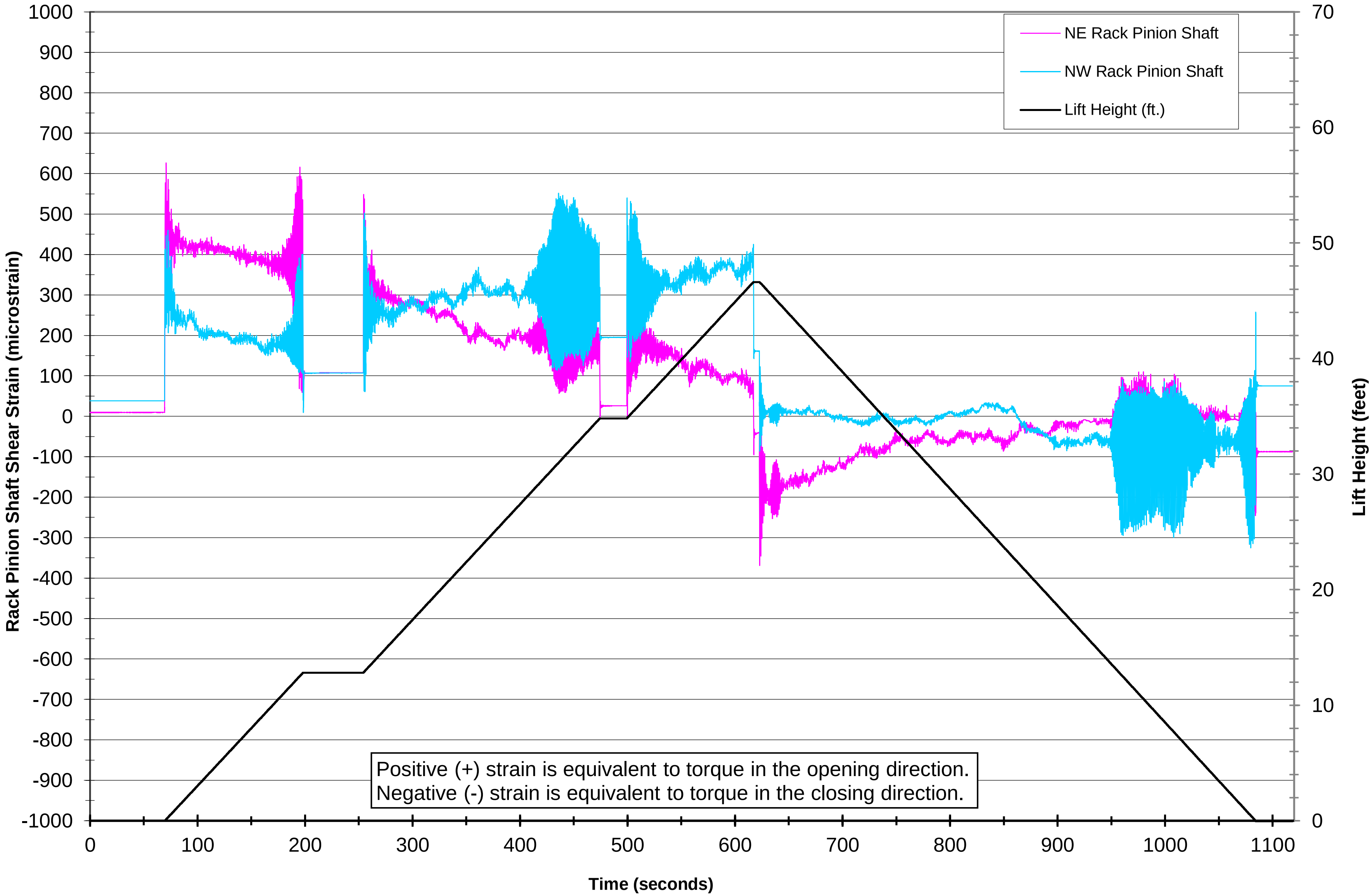


Figure 1. Span Drive Machinery Layout
North Tower Shown, South Tower Similar.

Project:
Hood River Vertical Lift Bridge
Hood River, OR

Prepared by:
Stafford Bandlow Engineering,

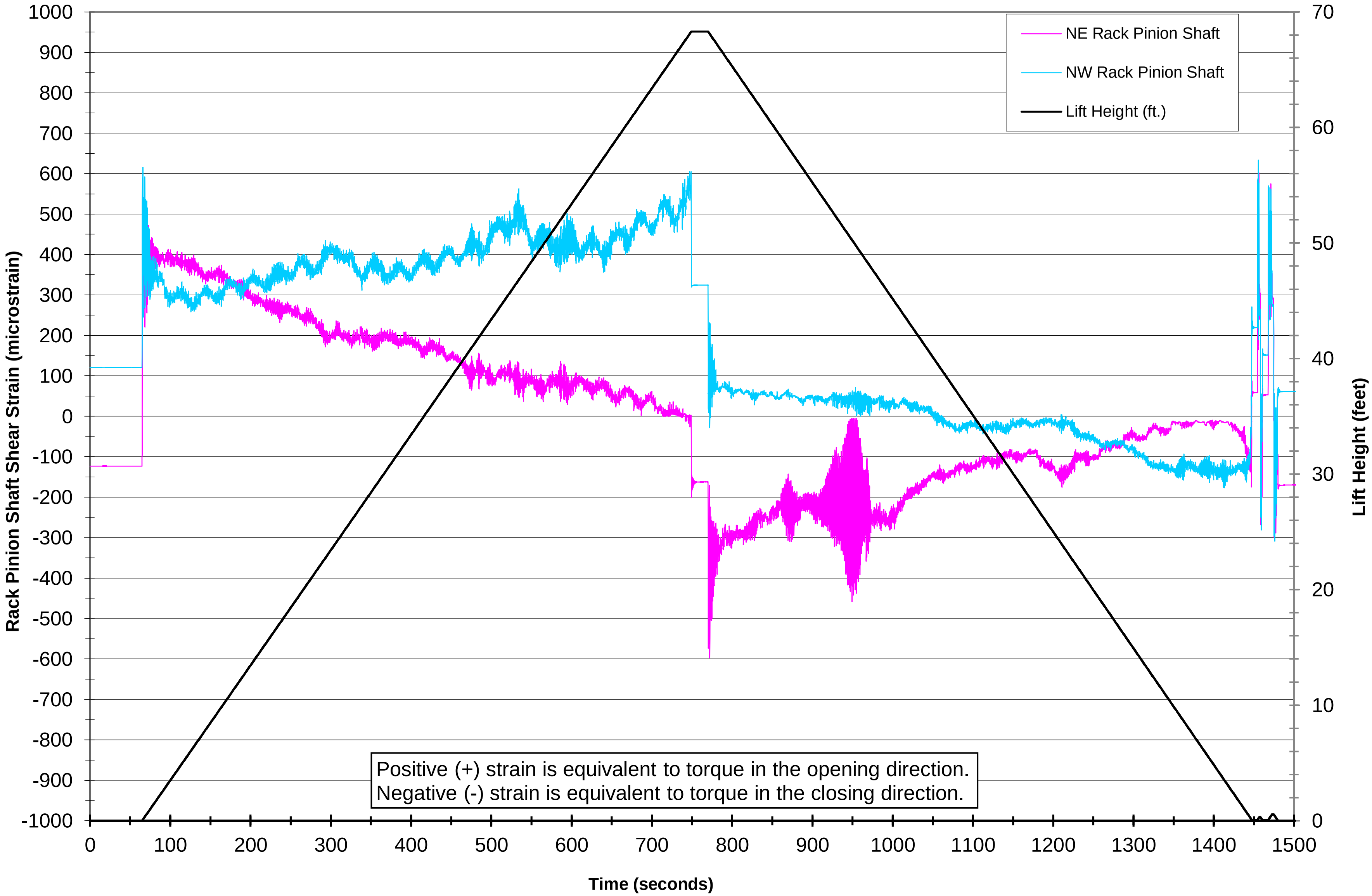
Hood River Vertical Lift Bridge
North Tower Shaft Strain Run 2-1
Before Cleanup Work



Prepared By: Stafford Bandlow Engineering, Inc.
Prepared For: Port of Hood River

Test Date: October 28, 201

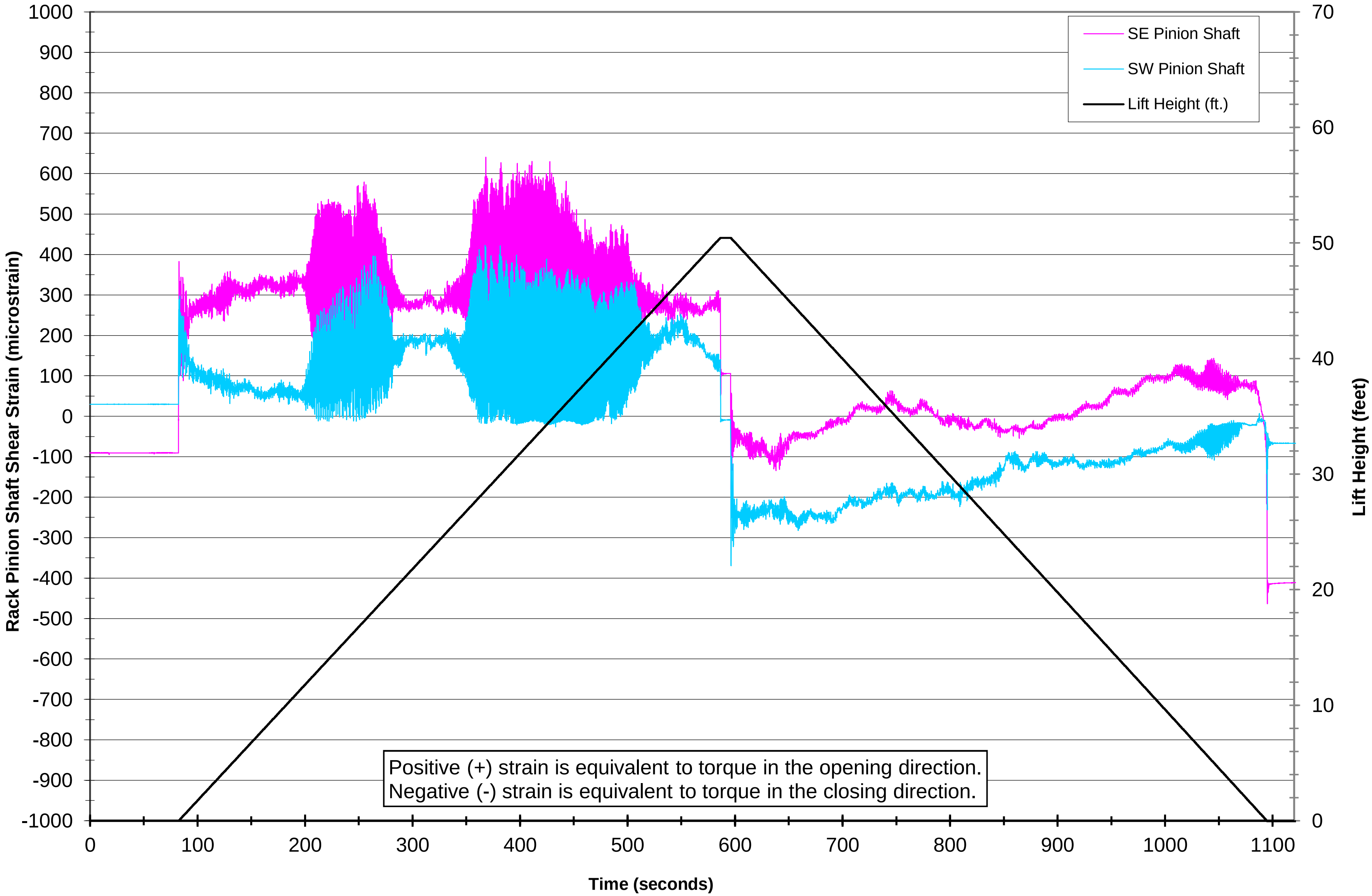
Hood River Vertical Lift Bridge
North Tower Shaft Strain Run 3-6
After Cleanup Work



Prepared By: Stafford Bandlow Engineering, Inc.
Prepared For: Port of Hood River

Test Date: October 29, 201

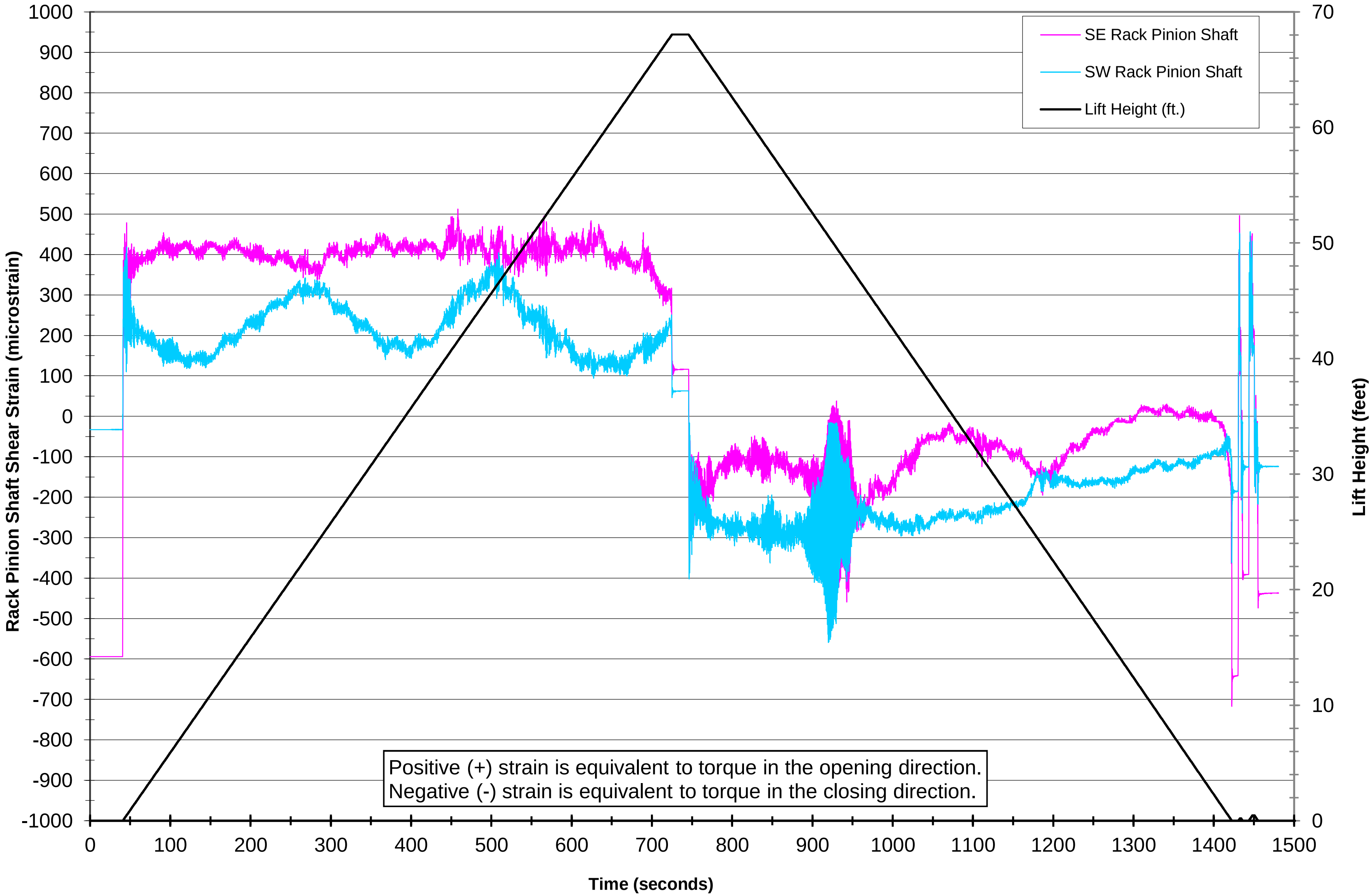
Hood River Vertical Lift Bridge
South Tower Shaft Strain Run 2-1
Before Cleanup Work



Prepared By: Stafford Bandlow Engineering, Inc.
Prepared For: Port of Hood River

Test Date: October 28, 201

Hood River Vertical Lift Bridge
South Tower Shaft Strain Run 3-6
After Cleanup Work



Prepared By: Stafford Bandlow Engineering, Inc.
Prepared For: Port of Hood River

Test Date: October 29, 201

APPENDIX D

CALCULATIONS

Purpose: Determine the capacity of the drive train components relative to AASHTO allowable from the output torque of the motor.
Three operating conditions are considered:
Condition 1 - 1.5 times full load torque of the original motor (20 hp at 870 rpm). ORIGINAL DESIGN REQUIREMENT
Note that condition 1 does not include the motor reducer currently installed.
Condition 2 - 1.5 times full load torque of the current motor (6.67 hp at 600 rpm). CURRENT DESIGN REQUIREMENT
NOTES:
1. Cells highlighted "RED" indicates an overloaded condition for the component .
2. Cells highlighted "GREEN" indicates that the capacity of the component meets or exceeds the design loading requirement.

	Condition 1	Condition 2	
Motor Power	20.00 hp	6.67 hp	
Motor Speed	870 rpm	600 rpm	
Torque @ 100%	121 ft-lbf	58 ft-lbf	
AASHTO Design Factor	1.5	1.5	
Design Torque at Motor	181 ft-lbf	88 ft-lbf	
Brake Torque at Motor	NA	75 ft-lbf	
Load Sharing	50%	50%	Assumes equal load sharing (50/50 split) after the primary reducer.
Equivalent Rack Pinion Shaft Strain Value	509	996	See strain charts for comparison of strain values during operation.
Motor Reducer Ratio	1	4.13	
Primary Reducer Ratio	70.50	70.50	
Total Ratio	70.50	291.17	
Efficiency 1	1	0.98	Enclosed Motor Reducer (AASHTO 5.8.4.2.1)
Efficiency 2	0.96	0.96	Enclosed Primary Reducer (AASHTO 5.8.4.2.1)
Total Efficiency	0.96	0.94	
Reducer Output Torque	6,129 ft-lbf	11,989 ft-lbf	
B1 Bearing Efficiency	0.95	0.95	(AASHTO 5.8.2)
Torque at Rack Pinion	5,822 ft-lbf	11,389 ft-lbf	
Rack Pinion Shaft Speed	12.34 rpm	2.06 rpm	

Gear Data

	Face Width (f)	Unit Stress (S)	Teeth (n)	diametral pitch (dp)	circular pitch (cp)	Pitch Dia.	
Ring Gear	5.00 in.	16,000 psi	126	1.50 in.	2.09 in.	7.00 ft.	S value for sheave ring gear (rack) is for cast steel.
Pinion Gear	5.50 in.	40,000 psi	15	1.50 in.	2.09 in.	0.83 ft.	S value is 1/3 of the strength (120 ksi strength based on a design Brinell hardness of 245)

Open Gearing - Lewis Capacity				
	Ring Gear		Pinion Gear	
Parameters	Condition 1	Condition 2	Condition 1	Condition 2
Velocity of Pitch Circle	32.31 fpm	5.39 fpm	32.31 fpm	5.39 fpm
Lewis Capacity (Full Depth)	23,334 lbf	24,371 lbf	40,749 lbf	42,561 lbf
Design Tangential Tooth Load	13,973 lbf	27,335 lbf	13,973 lbf	27,335 lbf
Capacity (Full Depth)/Design Load	167%	89%	292%	156%

Note: Tooth profile is assumed to be full depth with a 20 degree pressure angle.
Lewis capacity is calculated based on the gearing being in a common frame.

Reducers								
	Rating				Condition 1		Condition 2	
Reducer	Power	Speed	Service Factor	Rated Torque Capacity	Required Design Torque	Rated Capacity/ Required Design Torque	Required Design Torque	Rated Capacity/ Required Design Torque
Primary Reducer	18 hp	870 rpm	1	109 ft-lbf	181 ft-lbf	60%	354 ft-lbf	31%
Motor Reducer	20 hp	1,800 rpm	1.4	82 ft-lbf	NA		88 ft-lbf	93%

Rack Pinion Shaft									
Shaft material ultimate strength is estimated based on a field measured Brinell hardness of 220, using a portable hardness tester, multiplied by 490.									
				Principal Shaft Stress					
				Condition 1		Condition 2			
Shaft Principal Stress Design Considerations	Ultimate Strength	Allowable Normal Stress	Allowable Shear Stress	Design Normal Stress	Design Shear Stress	Design Normal Stress	Design Shear Stress		
	107,718 psi	21,544 psi	10,772 psi	26,910 psi	14,157 psi	51,176 psi	26,923 psi		
	Allowable Stress/Design Stress			80%	76%	42%	40%		
				Angular Strain					
					Condition 1		Condition 2		
Angular Strain Design Consideration	G, Shear Modulus	Shaft Diameter	J, Polar Moment of Inertia	Allowable Strain	Design Torque	Strain at Design Torque	Design Torque	Strain at Design Torque	
	11,500,000 psi	4 in	25.13 in^4	0.15 deg./ft	6,129 ft-lbf	0.175 deg./ft	11,989 ft-lbf	0.342 deg./ft	
	Allowable Shaft Strain/ Strain at Design Torque				86%		44%		

Key Forces							
				Key Shear Force		Key Bearing Force	
		Condition 1	Condition 2	Condition 1	Condition 2	Condition 1	Condition 2
Shaft Key Location	Shaft Diameter	Torque	Torque	Force	Force	Force	Force
Rack Pinion	4 in	5,822 ft-lbf	11,389 ft-lbf	34,933 lbf	68,337 lbf	38,546 lbf	75,406 lbf
C1 Coupling	4 in	6,129 ft-lbf	11,989 ft-lbf	36,771 lbf	71,934 lbf	39,223 lbf	76,729 lbf
C2 Coupling [1]	2.125 in	181 ft-lbf	354 ft-lbf	2,045 lbf	4,001 lbf	2,318 lbf	4,535 lbf
C3 Coupling [2]	1.875 in	NA	88 ft-lbf	NA	1,120 lbf	NA	1,293 lbf

Note 1: Assume original primary reducer input shaft diameter per 1937 reconstruction drawings.
Note 2: Assume NEMA 326U frame dimensions, per motor nameplate data of existing motor.

Bearing Stress at Shaft Keys								
Key material is assumed to be ASTM A668 Class D.								
	Key Data				Condition 1		Condition 2	
Shaft Key Location	Length	Height	Area	Allowable Stress	Design Stress	Allowable Stress/ Design Stress	Design Stress	Allowable Stress/ Design Stress
Rack Pinion	7.000 in	0.750 in	2.63 in^2	15,000 psi	14,684 psi	102%	28,726 psi	52%
C1 Coupling	6.000 in	0.500 in	1.50 in^2	15,000 psi	26,148 psi	57%	51,153 psi	29%
C2 Coupling	3.000 in	0.500 in	0.75 in^2	15,000 psi	3,091 psi	485%	6,046 psi	248%
C3 Coupling	2.380 in	0.500 in	0.60 in^2	15,000 psi	NA		2,173 psi	690%

Shear Stress at Shaft Keys								
Key material is assumed to be ASTM A668 Class D.								
	Key Data				Condition 1		Condition 2	
Shaft Key Location	Length	Width	Area	Allowable Stress	Design Stress	Allowable Stress/ Design Stress	Design Stress	Allowable Stress/ Design Stress
Rack Pinion	7.000 in	0.750 in	5.25 in^2	7,500 psi	6,654 psi	113%	13,017 psi	58%
C1 Coupling	6.000 in	0.750 in	4.50 in^2	7,500 psi	8,171 psi	92%	15,985 psi	47%
C2 Coupling	3.000 in	0.500 in	1.50 in^2	7,500 psi	1,364 psi	550%	2,668 psi	281%
C3 Coupling	2.380 in	0.500 in	1.19 in^2	7,500 psi	NA		942 psi	797%

Couplings						
1. Coupling capacity of the existing C1 coupling (primary reducer output shaft coupling to the rack pinion shaft) is not available. Similar style coupling selected for comparison based on the shaft bore diameter of 4". 2. Design Torque for the coupling is based on a factor of 2 instead of 1.5 per standard coupling design recommendations.						
		Condition 1		Condition 2		
Coupling	Coupling Capacity	Design Torque	Coupling Capacity/Design Torque	Design Torque	Coupling Capacity/Design Torque	
C1 (Rack Pinion Shaft) Coupling						
Renold Type 4s	3,892 ft-lbf	8,171 ft-lbf	48%	15,985 ft-lbf	24%	
Renold Type 4PB	3,250 ft-lbf	8,171 ft-lbf	40%	15,985 ft-lbf	20%	
Siemens Type 320RWN	4,057 ft-lbf	8,171 ft-lbf	50%	15,985 ft-lbf	25%	Coupling selected based on max bore of 4".
Siemens Type 400RWN	9,220 ft-lbf	8,171 ft-lbf	113%	15,985 ft-lbf	58%	Coupling based on equivalent elastomeric sleeve layout.
C2 (Motor Reducer Output) Coupling						
Falk 1070T10B	733 ft-lbf	NA		472 ft-lbf	155%	
C3 (Motor) Coupling						
Falk 1050T10B	321 ft-lbf	NA		117 ft-lbf	275%	

Bearing Stresses						
		Condition 1		Condition 2		
Bearing	Allowable Stress	Design Stress	Allowable Stress/ Design Stress	Design Stress	Allowable Stress/ Design Stress	References
TB1[1]	1,500 psi	1,694 psi	89%	NA		Refer to trunnion bearing stress calculation
TB2[1]	1,500 psi	2,474 psi	61%	NA		Refer to trunnion bearing stress calculation
B1[2]	1,000 psi	442 psi	226%	864 psi	116%	Refer to cross shaft stress calculation

Notes:
1. Neglect operating loadings, assume reactions at the bearings are due to loading conditions used in the trunnion fatigue analysis.
2. Neglect weight of the pinion and shaft.

Stafford Bandlow Engineering
Calculation Sheet

Made By: LAB 10/1?

Checked By: RGG 12/8/2016

Bridge: Hood River Lift Bridge

Job No.: SB796

Revision Notes

PURPOSE:

Determine the maximum fiber and shear stresses in the cross shaft (i.e. pinion shaft) and B1 bearing stress at 150% FLT of the original motor (condition 1).

Inputs:

$HP_{Motor} := 20hp$	Motor horsepower.
$speed_{Motor} := 870rpm$	Motor speed.
$Factor := 1.5$	Percentage of Full Load Torque (FLT) used in the analysis (Per AASHTO 5.7.1)
$Ratio_{Motor\_Reducer} := 1$	Gearbox ratio between the motor and primary reducer.
$\eta_{Motor\_Reducer} := 1$	Efficiency of the gearbox ratio between the motor and primary reducer.
$Ratio_{Reducer} := 70.5$	Ratio of the primary reducer. Ref. Page 40 of the design drawings.
$\eta_{Reducer} := .96$	Efficiency of the primary reducer.
$Split := .5$	Load sharing between reducer output shafts. Assume a 50/50 split of the output torque. between the two output shafts.
$\eta_{B1\_Bearing} := .95$	Efficiency loss due to the B1 bearings.
$\phi_{Rack\_Pinion\_Shaft} := 4in$	Ref. Page 43 of the design drawings.
$PD_{Rack\_Pinion} := 10in$	Ref. Page 43 of the design drawings.

<u>Calculate Tangential Tooth Load and Resultant Force at the Rack and Pinion Gears / 150% FLT of the Motors for AASHTO sizing requirements.</u>

$T_{Motor} := Factor \cdot HP_{Motor} \div speed_{Motor}$	$T_{Motor} = 2173.3 \cdot lbf \cdot in$
$Ratio := Ratio_{Motor\_Reducer} \cdot Ratio_{Reducer}$	$Ratio = 70.5$
$\eta := \eta_{Motor\_Reducer} \cdot \eta_{Reducer} \cdot \eta_{B1\_Bearing}$	$\eta = 0.91$
$T_{Rack\_Pinion\_Shaft} := (T_{Motor} \cdot Ratio \cdot \eta) \cdot Split$	$T_{Rack\_Pinion\_Shaft} = 69866.9 \cdot lbf \cdot in$
$TTL := T_{Rack\_Pinion\_Shaft} \div (.5PD_{Rack\_Pinion})$	$TTL = 13973.4 \cdot lbf$
$F_{Resultant} := TTL \div \cos(20deg)$	$F_{Resultant} = 14870.2 \cdot lbf$

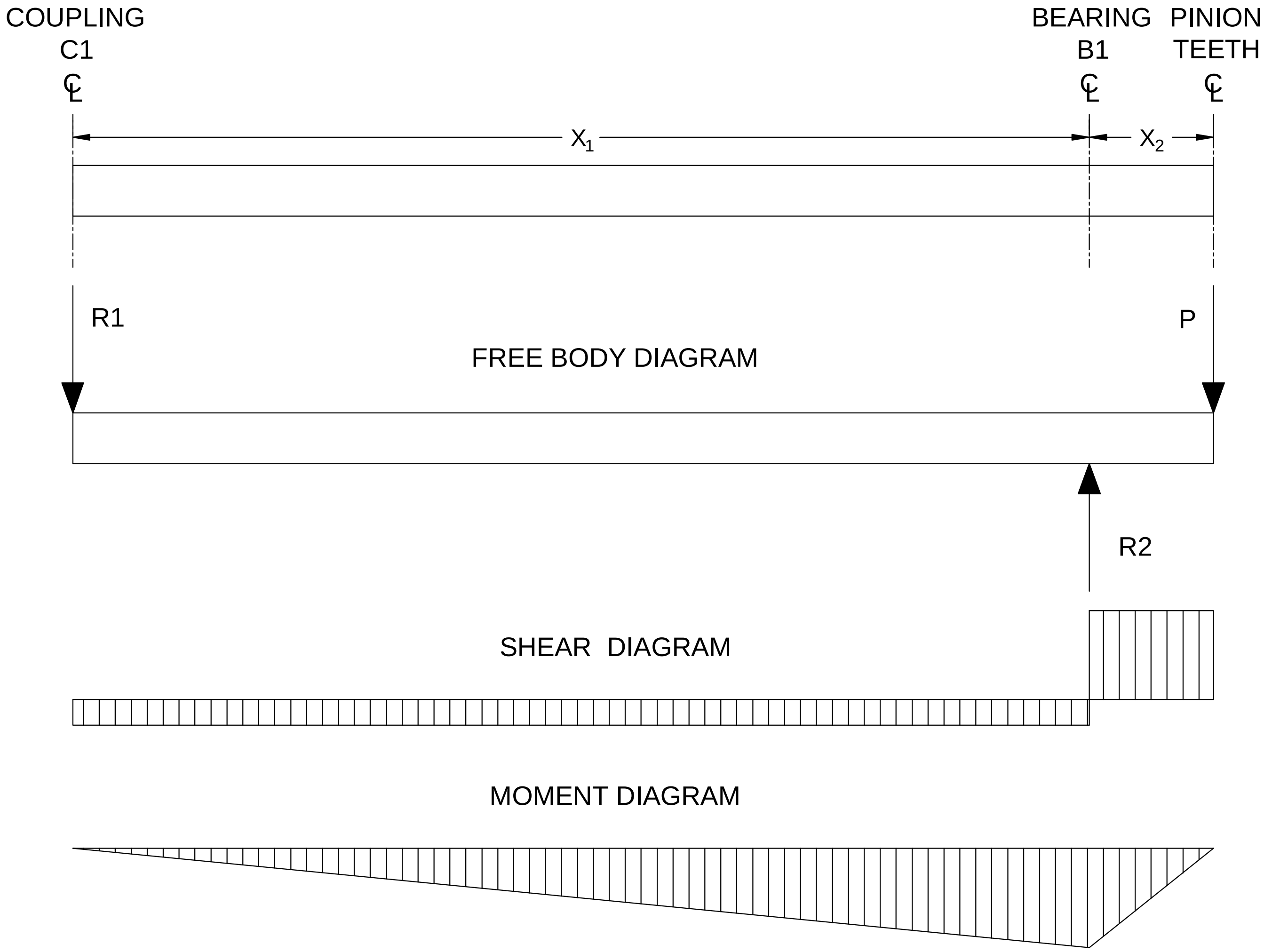


Figure 1: Free Body Diagram of Rack Pinion Shaft

Determine Stresses at the Rack Pinion Shafts (S1) at 150% FLT:

Assumptions:

1. Neglect weight of the pinion and shaft.
2. Combined stress due to bending moment and torsional shear.
3. Treat shaft as a simply supported beam in bending treating the resultant tooth load and reactions as point loads acting at the centerlines of the pinion teeth and shaft bearing and C1 coupling centerlines.

Calculate the reactions and maximum internal moments. Refer to Figure 1 for identification of the following variables.

$P := F_{Resultant}$ $\qquad P = 14870.2 \cdot lbf$

$x_1 := (85.25 + 1.5 + .5 \cdot 5.5)in - 9.75in$ $\qquad x_1 = 79.7 \cdot in$

$x_2 := 9.75in$ $\qquad x_2 = 9.8 \cdot in$

$R_2 := P \cdot (x_1 + x_2) \div x_1$ $\qquad R_2 = 16688.1 \cdot lbf$

$R_1 := P \cdot x_2 \div x_1$ $\qquad R_1 = 1818 \cdot lbf$

Check the S1 shaft per AASHTO requirements

1. Check the S1 shaft at bearing B1 where the maximum moment occurs. Neglect other locations since there are no changes to shaft geometery.

Inputs

$M_{S1} := R_1 \cdot x_1 = 144984 \cdot lbf \cdot in$ $\qquad$ Find max moment at this location

$n_{S1} := speed_{Motor} \div Ratio = 12.34 \cdot rpm$ $\qquad$ Speed of shaft

$Ø_{S1} := 4in$

Outputs

$$K_{S1} := 1 + 0.03 \cdot \sqrt{\frac{n_{S1}}{rpm}} = 1.11$$

$$\sigma_{S1} := \frac{16 \cdot K_{S1}}{\pi \cdot Ø_{S1}^{\ 3}} \cdot \left(M_{S1} + \sqrt{M_{S1}^{\ 2} + T_{Rack\_Pinion\_Shaft}^{\ 2}}\right) = 26910.3 \cdot psi$$

Normal stress due to combined moment and torsion

$$\tau_{S1} := \frac{16 \cdot K_{S1}}{\pi \cdot Ø_{S1}^{\ 3}} \cdot \left(\sqrt{M_{S1}^{\ 2} + T_{Rack\_Pinion\_Shaft}^{\ 2}}\right) = 14156.9 \cdot psi$$

Shear stress due to combined moment and torsion

Determine Bearing Stresses at B1 Bearings at 150% FLT of the Motor:

Note that material information is not available. Assume a maximum allowable pressure of 1,000 psi per Table 6.7.7.1.2-1 in 2008 AASHTO LRFD.

$A_{Bearing} := (10.5in \cdot 4in) \cdot .9$ (subtract 10% for grease grooves) $\qquad A_{Bearing} = 37.8 \cdot in^2$

$P_{Bearing} := R_2$ $\qquad P_{Bearing} = 16688.1 \cdot lbf$

$\sigma_{Bearing} := P_{Bearing} \div A_{Bearing}$ $\qquad \sigma_{Bearing} = 441.5 \cdot psi$

Bridge: Hood River Lift Bridge

Job No.: SB796

Revision Notes

PURPOSE:

Determine the maximum fiber and shear stresses in the cross shaft (i.e. pinion shaft) and B1 bearing stress at 150% FLT of the existing motor (condition 2). The horsepower output of the motor under condition 2 is 6.67 horsepower at 600rpm, which is the current motor operating speed.

Inputs:

$HP_{Motor} := \frac{20}{3} hp$ — Motor horsepower for conditon 2.

$speed_{Motor\_Condition\_2} := 600rpm$ ` — Motor speed for condition 2.

$Factor := 1.5$ — Percentage of Full Load Torque (FLT) used in the analysis (Per AASHTO 5.7.1)

$Ratio_{Motor\_Reducer} := 4.13$ — Gearbox ratio between the motor and primary reducer.

$\eta_{Motor\_Reducer} := .98$ — Efficiency of the gearbox ratio between the motor and primary reducer.

$Ratio_{Reducer} := 70.5$ — Ratio of the primary reducer. Ref. Page 40 of the design drawings.

$\eta_{Reducer} := .96$ — Efficiency of the primary reducer.

$Split := .5$ — Load sharing between reducer output shafts. Assume a 50/50 split of the output torque. between the two output shafts.

$\eta_{B1\_Bearing} := .95$ — Efficiency loss due to the B1 bearings.

$\phi_{Rack\_Pinion\_Shaft} := 4in$ — Ref. Page 43 of the design drawings.

$PD_{Rack\_Pinion} := 10in$ — Ref. Page 43 of the design drawings.

Calculate Tangential Tooth Load and Resultant Force at the Rack and Pinion Gears / 150% FLT of the Motors for AASHTO sizing requirements.

$T_{Motor} := Factor \cdot HP_{Motor} \div speed_{Motor\_Condition\_2}$ — $T_{Motor} = 1050.4 \cdot lbf \cdot in$

$Ratio := Ratio_{Motor\_Reducer} \cdot Ratio_{Reducer}$ — $Ratio = 291.2$

$\eta := \eta_{Motor\_Reducer} \cdot \eta_{Reducer} \cdot \eta_{B1\_Bearing}$ — $\eta = 0.89$

$T_{Rack\_Pinion\_Shaft} := (T_{Motor} \cdot Ratio \cdot \eta) \cdot Split$ — $T_{Rack\_Pinion\_Shaft} = 136676.6 \cdot lbf \cdot in$

$TTL := T_{Rack\_Pinion\_Shaft} \div (.5PD_{Rack\_Pinion})$ — $TTL = 27335.3 \cdot lbf$

$F_{Resultant} := TTL \div \cos(20deg)$ — $F_{Resultant} = 29089.6 \cdot lbf$

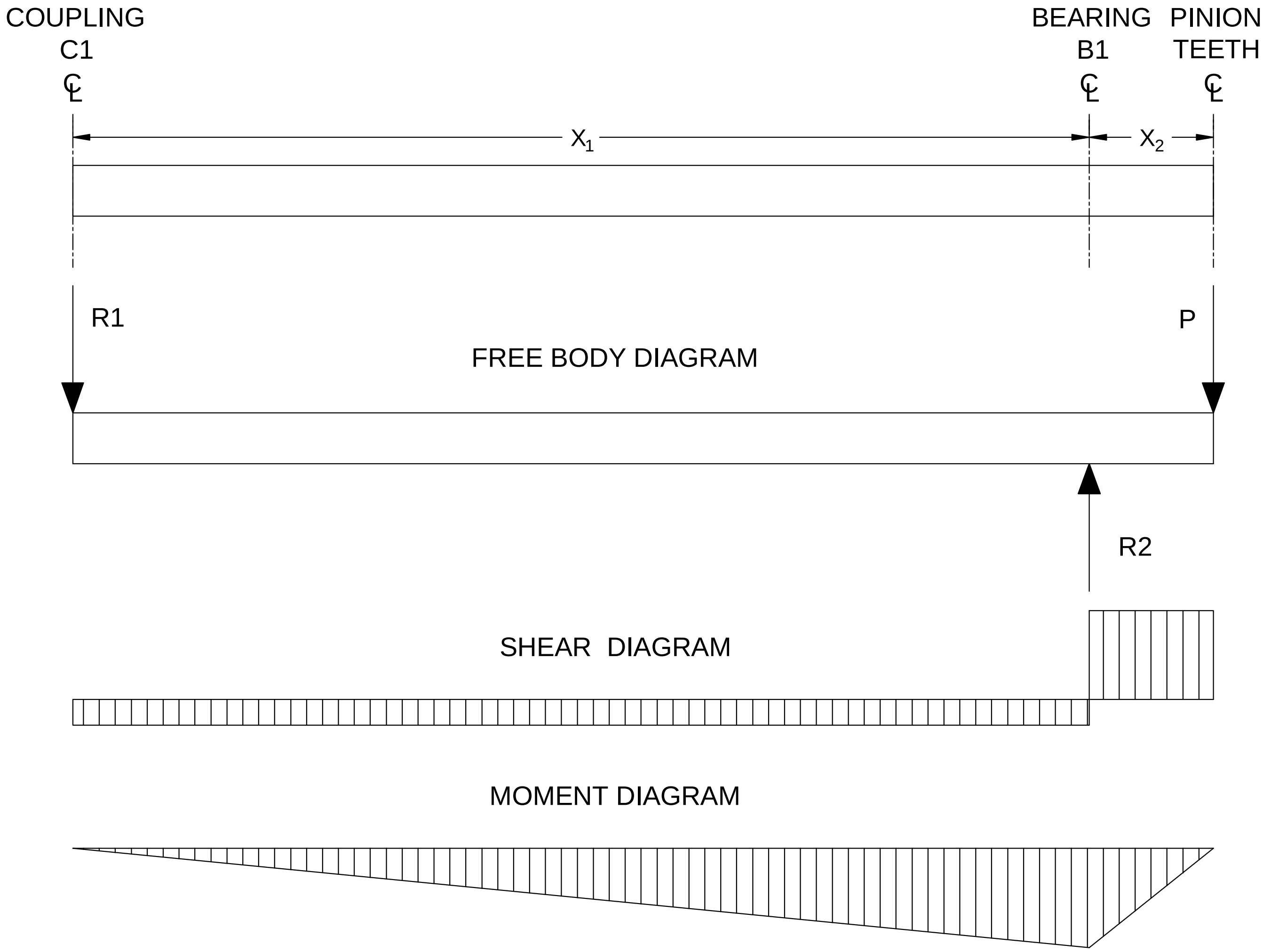


Figure 1: Free Body Diagram of Rack Pinion Shaft

Determine Stresses at the Rack Pinion Shafts (S1) at 150% FLT:

Assumptions:

1. Neglect weight of the pinion and shaft.
2. Combined stress due to bending moment and torsional shear.
3. Treat shaft as a simply supported beam in bending treating the resultant tooth load and reactions as point loads acting at the centerlines of the pinion teeth and shaft bearing and C1 coupling centerlines.

Calculate the reactions and maximum internal moments. Refer to Figure 1 for identification of the following variables.

$P := F_{Resultant}$ $\qquad$ $P = 29089.6 \cdot lbf$

$x_1 := (85.25 + 1.5 + .5 \cdot 5.5)in - 9.75in$ $\qquad$ $x_1 = 79.7 \cdot in$

$x_2 := 9.75in$ $\qquad$ $x_2 = 9.8 \cdot in$

$R_2 := P \cdot (x_1 + x_2) \div x_1$ $\qquad$ $R_2 = 32646.1 \cdot lbf$

$R_1 := P \cdot x_2 \div x_1$ $\qquad$ $R_1 = 3556.4 \cdot lbf$

Check the S1 shaft per AASHTO requirements

1. Check the S1 shaft at bearing B1 where the maximum moment occurs. Neglect other locations since there are no changes to shaft geometery.

Inputs

$M_{S1} := R_1 \cdot x_1 = 283624 \cdot lbf \cdot in$ — Find max moment at this location

$n_{S2} := speed_{Motor\_Condition\_2} \div Ratio = 2.06 \cdot rpm$ — Speed of shaft (condition 2)

$Ø_{S1} := 4in$

Outputs

Condition 2:

$$K_{S1\_Cond\_2} := 1 + 0.03 \cdot \sqrt{\frac{n_{S2}}{rpm}} = 1.04$$

K factor for condition 2

$$\sigma_{S1} := \frac{16 \cdot K_{S1\_Cond\_2}}{\pi \cdot Ø_{S1}^{3}} \cdot \left(M_{S1} + \sqrt{M_{S1}^{2} + T_{Rack\_Pinion\_Shaft}^{2}}\right) = 49675 \cdot psi$$

Normal stress due to combined moment and torsion

$$\tau_{S1} := \frac{16 \cdot K_{S1\_Cond\_2}}{\pi \cdot Ø_{S1}^{3}} \cdot \left(\sqrt{M_{S1}^{2} + T_{Rack\_Pinion\_Shaft}^{2}}\right) = 26133 \cdot psi$$

Shear stress due to combined moment and torsion

Determine Bearing Stresses at B1 Bearings at 150% FLT of the Motor:

Note that material information is not available. Assume a maximum allowable pressure of 1,000 psi per Table 6.7.7.1.2-1 in 2008 AASHTO LRFD.

$A_{Bearing} := (10.5in \cdot 4in) \cdot .9$ (subtract 10% for grease grooves) — $A_{Bearing} = 37.8 \cdot in^{2}$

$P_{Bearing} := R_2$ — $P_{Bearing} = 32646.1 \cdot lbf$

$\sigma_{Bearing} := P_{Bearing} \div A_{Bearing}$ — $\sigma_{Bearing} = 863.7 \cdot psi$

Bridge: Hood River Lift Bridge

Job No.: SB796

Revision Notes

PURPOSE:

Determine the sheave trunnion bearing stresses.
Assume reactions at the bearings are due to operating conditions used in the trunnion fatigue analysis. Refer to "SB796.Trunnion Fatigue.R4.RGG.RTK"

Inputs:

$R_{1\_Trunnion\_Bearing} := 114354lbf$ — Refer to SBE Trunnion Fatigue analysis

$R_{2\_Trunnion\_Bearing} := 166993lbf$ — Refer to SBE Trunnion Fatigue analysis

$L_{Trunnion\_Bearing} := 10in$ — Ref. Page 43 of the design drawings

$W_{Trunnion\_Bearing} := 7.5in$ — Ref. Page 43 of the design drawings

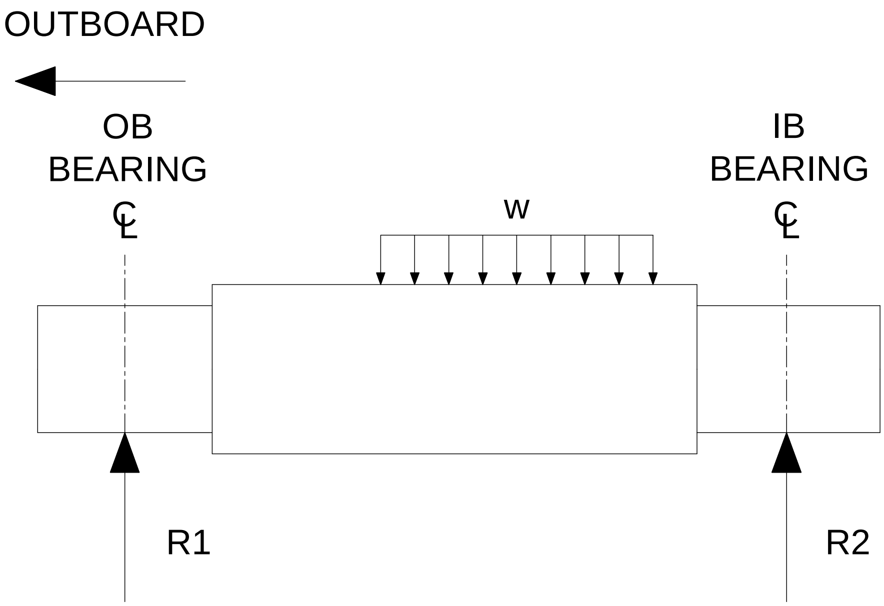


Figure 1: Free body diagram of trunnion bearing shaft

Calculate trunnion bearing stresses.

$A_{Trunnion\_Bearing} := L_{Trunnion\_Bearing} \cdot W_{Trunnion\_Bearing} \cdot .9$ (subtract 10% for grease grooves)

$A_{Trunnion\_Bearing} = 67.5 \cdot in^2$

$\sigma_{Trunnion\_Bearing\_1} := R_{1\_Trunnion\_Bearing} \div A_{Trunnion\_Bearing}$

$\sigma_{Trunnion\_Bearing\_1} = 1694.1 \cdot psi$

$\sigma_{Trunnion\_Bearing\_2} := R_{2\_Trunnion\_Bearing} \div A_{Trunnion\_Bearing}$

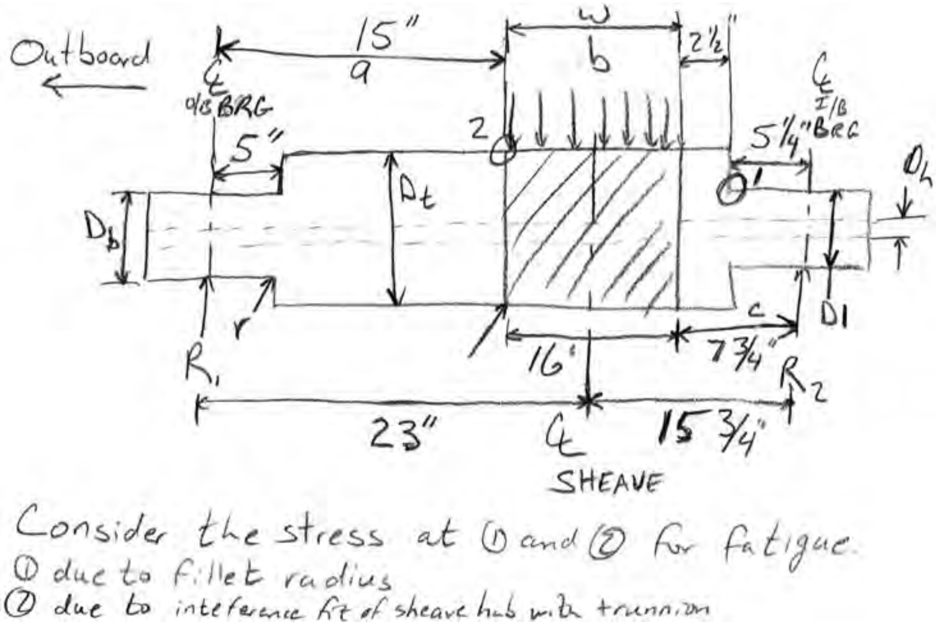
$\sigma_{Trunnion\_Bearing\_2} = 2474 \cdot psi$

Bridge: Hood River **Job No.:** SB796

▶ Template Revision History

▶ File Revision History

PURPOSE: Counterweight Sheave Trunnion Fatigue Analysis



Inputs

Trunnion Shaft Properties:

$D_t := 10 \cdot in$ Diameter of trunnion at the sheave hub

$D_b := 7.5 \cdot in$ Diameter of trunnion on the bearing journal portion of the trunnion

$d1 := 7.5in$ The smallest diameter at the fillet.

$r := 0.25in$ Fillet radius

$D_h := 1.5 \cdot in$ Diameter of hole through the center of the trunnion

Shaft Support:

$x_1 := 5.25 \cdot in$ Distance from R2 to location 1

$x_2 := 15 \cdot in$ Distance from R1 to location 2

$a := 15 \cdot in$ Distance of R1 to the outboard end of the sheave hub.

$b := 16 \cdot in$ Length of trunnion portion where load is applied (sheave hub width).

$c := 7.75in$ Distance of R2 to the inboard end of the sheave hub.

Trunnion Material

$S_{UT} := 105$ (ksi) - Based on a average measured Brinell hardness of 215.

$\sigma_{ut} := S_{UT}$ (AASHTO Notation)

$\sigma_{yt} := 80000psi$ Approximate based on forgings with simliar ultimate strength

$E := 29 \cdot 10^6 \cdot psi$ Modulus of Elasticity

$R_a \leq 125$ Assumed surface roughness at fillet (µin).

Misc.:

$f := .2$ Trunnion Bearing Coefficient of Friction.

$D_{steel} := 490 \frac{lbf}{ft^3}$

Load:

Calculate the loads on the trunnion:

$R := 13 \div 16in$ Sheave rope groove radius

$D := 2 \cdot R = 1.625 \cdot in$ Rope diameter

1 5/8" Fiber Core 6x37 Improved Plow Steel per 1979 plans (as stated in HDR 3/22/16 inspection report)

$S := 107(2000lbf) = 214000 \cdot lbf$ Breaking Strength Source: Wire Rope User's Manual

$S_{factor} := 8$ AASHTO Safety Factor for design for direct rope load

$S_{design} := S \div S_{factor} = 26750 \cdot lbf$ Approximate expected load if designed per AASHTO

$Qty := 4$ Total quantity of counterweight ropes per sheave

$F_{ropesth} := S_{design} \cdot Qty = 107000 \cdot lbf$ Theoretical total load on counterweight ropes

$F_{ropes} := 128300lbf = 128300 \cdot lbf$ Max measured corner load on counterweight ropes per vibration method (SE rope group)

$OP_{load} := 3978 \cdot 4lbf$ 100% FLT full load torque of the current installed motor as an equivalent force at the ropes.

Calculate the weight of the trunnion:

$r_1 := \frac{7.5}{2} in$

$r_2 := \frac{10}{2} in$

$L_1 := 10.25in + 10.75in = 21.00 \cdot in$

$L_2 := 10in + 8in + 8in + 2.5in = 28.50 \cdot in$

$W_1 := L_1 \cdot \left(\pi \cdot r_1^{\,2}\right) \cdot D_{steel} = 263.08 \cdot lbf$

$W_2 := L_2 \cdot \left(\pi \cdot r_2^{\,2}\right) \cdot D_{steel} = 634.73 \cdot lbf$

$W_{trunnion} := W_1 + W_2 = 898 \cdot lbf$

Calculate the weight of the sheave (see next page for sheave sections):

$R_{1i} := 10in \div 2 \quad R_{1o} := 19in \div 2 \quad D_1 := 16in$

$W_1 := D_1 \cdot \left[\pi\left(R_{1o}^{\,2} - R_{1i}^{\,2}\right)\right] \cdot D_{steel} = 930.04 \cdot lbf$

$R_{2i} := 20in \div 2 \quad R_{2o} := 30in \div 2 \quad D_2 := 3in$

$W_2 := D_2 \cdot \left[\pi\left(R_{2o}^{\,2} - R_{2i}^{\,2}\right)\right] \cdot D_{steel} = 334.07 \cdot lbf$

$R_{3i} := 74in \div 2 \quad R_{3o} := 90in \div 2 \quad D_3 := 2in$

$W_3 := D_3 \cdot \left[\pi\left(R_{3o}^{\,2} - R_{3i}^{\,2}\right)\right] \cdot D_{steel} = 1168.79 \cdot lbf$

$R_{4i} := 90in \div 2 \quad R_{4o} := 96in \div 2 \quad D_4 := 10in$

$W_4 := D_4 \cdot \left[\pi\left(R_{4o}^{\,2} - R_{4i}^{\,2}\right)\right] \cdot D_{steel} = 2485.46 \cdot lbf$

$R_{5i} := 30in \div 2 \quad R_{5o} := 74in \div 2 \quad D_5 := 2.5in$

$A_{cutout} := 282.0210in^2 \cdot 8$

$W_5 := D_5 \cdot \left[\pi\left(R_{5o}^{\,2} - R_{5i}^{\,2}\right) - A_{cutout}\right] \cdot D_{steel} = 948.39 \cdot lbf$

$A_{stiffener} := 175in^2 + 91.7977in^2 \quad D_{stiffener} := 1.5in$

$W_{stiffener} := D_{stiffener} \cdot A_{stiffener} \cdot D_{steel} \cdot 8 = 907.85 \cdot lbf$

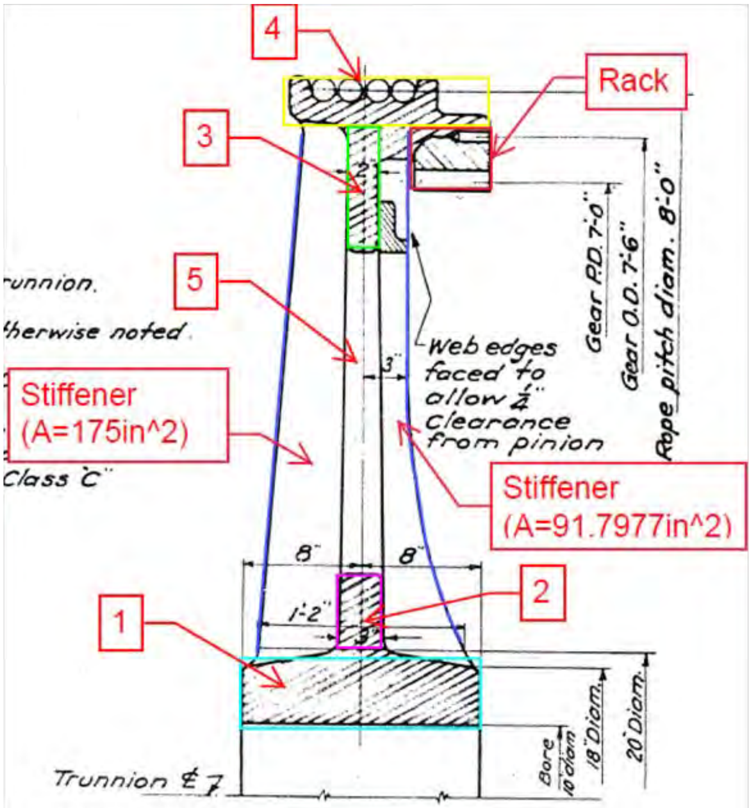
$R_{racki} := 84in \div 2 \quad R_{racko} := 90in \div 2 \quad D_{rack} := 5in$

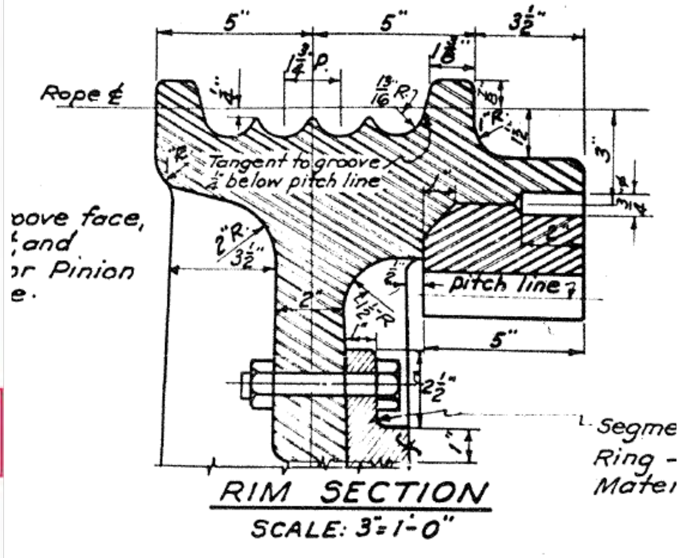
$W_{rack} := D_{rack} \cdot \left[\pi\left(R_{racko}^{\,2} - R_{racki}^{\,2}\right)\right] \cdot D_{steel} = 1162.55 \cdot lbf$

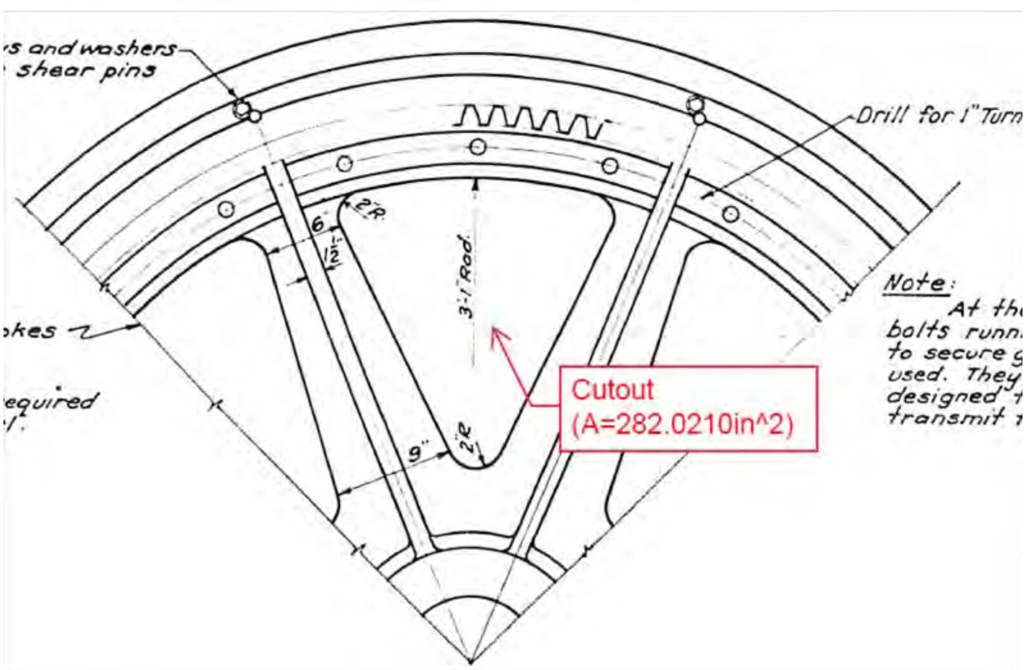
$W_{sheave} := W_1 + W_2 + W_3 + W_4 + W_5 + W_{stiffener} + W_{rack} = 7937 \cdot lbf$

Stafford Bandlow Engineering
Calculation Sheet

Made By: RGG 11/4
Checked By: RTK 12/8







$wb := F_{ropes} \cdot 2 + W_{trunnion} + W_{sheave} + OP_{load} = 281347 \cdot lbf$ Total load on one trunnion including rope tension, sheave weight, trunnion weight and operating loads.

Calculate the reactions at bearing supports R1 and R2:

$L := a + b + c$ Total trunnion length between reactions R1 and R2

$R_1 := \frac{wb}{2 \cdot L} \cdot (2 \cdot c + b)$ Blodgett 7.1-6 Design of Weldments $R_1 = 114354 \cdot lbf$

$R_2 := wb - R_1$ $R_2 = 166993 \cdot lbf$

Calculate the shear stress at the bearing fillet:

$A_b := \frac{\pi}{4} \cdot \left(d1^2 - D_h^2\right)$ Cross sectional area at fillet $A_b = 42.41 \cdot in^2$

$\tau_b := \frac{R_2}{A_b}$ Shear stress calculation at bearing fillet $\tau_b = 3937 \cdot \frac{lbf}{in^2}$

Bending stress at the trunnion fillet (Location 1):

$I_b := \frac{\pi}{64} \cdot \left(d1^4 - D_h^4\right)$ $I_b = 155.07 \cdot in^4$ Moment of inertia for bearing journal part of trunnion

$M_{f1} := R_2 \cdot \left(x_1\right)$ $M_{f1} = 876713 \cdot lbf \cdot in$ Calculate the moment at the fillet.

$c_b := \frac{d1}{2} = 3.75 \cdot in$ Farthest point from center

$\sigma_{f1} := \frac{M_{f1} \cdot c_b}{I_b}$ Calculate the bending stress

$\sigma_{f1} = 21202 \cdot psi$ Bending stress at location 1 for fatigue consideration

Bending stress at the outboard end of the sheave hub (Location 2):

$I_b := \frac{\pi}{64} \cdot \left(D_t^4 - D_h^4\right)$ $I_b = 490.63 \cdot in^4$ Moment of inertia for bearing journal part of trunnion

$M_{f2} := R_1 \cdot x_2$ $M_{f2} = 1715309 \cdot lbf \cdot in$ Calculate the moment at the fillet.

$c_b := \frac{D_t}{2} = 5.00 \cdot in$ Farthest point from center

$\sigma_{f2} := \frac{M_{f2} \cdot c_b}{I_b}$ Calculate the bending stress

$\sigma_{f2} = 17481 \cdot psi$ Bending stress at location 2 for fatigue consideration

Stress Concentration Factor at the Fillet (Ref. Chart 3.10 Peterson's Stress Concentration Factors, 2nd Ed., 1997.)

$r = 0.25 \cdot in$ Fillet radius $D := D_t$ $d := d1$

$$t := \frac{D - d}{2}$$

Calculate K_t (Refer to Peterson's Chart 3.10 Pp 164)

$\frac{t}{r} = 5.00$ **Note: this calculation is only valid for** $2.0 \le \frac{t}{r} \le 20.0$

$$C_1 := 1.232 + .832 \cdot \sqrt{\frac{t}{r}} - \frac{.008 \cdot t}{r}$$

$$C_2 := -3.813 + .968 \cdot \sqrt{\frac{t}{r}} - \frac{0.260 \cdot t}{r}$$

$$C_3 := 7.423 - 4.868 \cdot \sqrt{\frac{t}{r}} + \frac{0.869 \cdot t}{r}$$

$$C_4 := -3.839 + 3.070 \cdot \sqrt{\frac{t}{r}} - \frac{0.600 \cdot t}{r}$$

$$K_t := C_1 + C_2 \cdot \left(\frac{2 \cdot t}{D}\right) + C_3 \cdot \left(\frac{2 \cdot t}{D}\right)^2 + C_4 \cdot \left(\frac{2 \cdot t}{D}\right)^3$$

$K_t = 2.37$ Stress concentration factor for bending (compare calculated value to Figure A6.2-4)

Calculate K_{ts} (Refer to AASHTO Figure A6.2-5)

$K_{ts} := 1.86$ $K_{ts} = 1.86$ Stress concentration factor for torsion (from Figure A6.2-5)

Adjusted stress at the fillet (Location 1):

$$\sigma_{fmax} := \sigma_{f1} \cdot K_t$$

$$\sigma_{fmax} = 50266 \cdot \frac{lbf}{in^2}$$

Compared the adjusted stress at the fillet to the stress at Area 2:

$$\frac{\sigma_{fmax}}{(\sigma_{f2})} = 2.88$$

The stress concentration factor at the outboard sheave hub interference (shrink) fit with the trunnion needs to be greater than or equal 2.88 to govern the fatigue life of the sheave trunnion. Published ltierature regarding stress concentration due to shrink varies widely and is not clear at location 2. Therefore consider location 1 only when evaluating the fatigue life of the trunnion.

Endurance Limit (Equations from Shigley and Mischke, p. 278-288)

$S_{UT} = 105.00$ Ultimate strength of the steel (in ksi, but leave unitless here)

$S_{eprime} := 0.504 \cdot S_{UT} \cdot 1000 \cdot \frac{lbf}{in^2}$ $S_{eprime} = 52920 \cdot \frac{lbf}{in^2}$

$K_a := 2.7 \cdot \left[\left(S_{UT} \right)^{-.265} \right]$ Factors a (2.7) and b (-.265) are acceptable for all machined trunnions under Ra = 125μin based on SBE review of available literature.

$K_a = 0.79$

$K_b := 0.6$ Size factor (ranges from 0.6 to 0.75 for this diameter- set at 0.6 for worst case)

$K_c := 1$ Load factor, this should be set equal to 1 for bending calcs

$K_d := 1$ Temp factor, set equal to 1 for temps less than 160°F

$K_e := 1$ Miscellaneous effects factor - includes stress concentration, not used here since we've already accounted for stress concentration.

$S_e := K_a \cdot K_b \cdot K_c \cdot K_d \cdot K_e \cdot S_{eprime}$

$S_e = 24976 \cdot \frac{lbf}{in^2}$ Endurance limit

Compare this value to the adjusted stress at the fillet. If Se is lower than the following stress, the life will be finite.

Adjusted stress at fillet

$\sigma_{fmax} = 50266 \cdot \frac{lbf}{in^2}$

Note := | "Adjusted Stress is ABOVE Endurance Limit, "so Fatigue IS a concern. " if $\sigma_{fmax} > S_e$
"Adjusted Stress is BELOW Endurance Limit, "so Fatigue IS NOT a concern. " otherwise

Note = "Adjusted Stress is ABOVE Endurance Limit, "so Fatigue IS a concern. "

Fatigue Strength
Cycles to Failure

(Equations from Shigley and Mischke, p. 278-280, eqn. 7-5, 7-6, 7-7)

$$factor_a := \frac{\left(0.9 \cdot S_{UT} \cdot 1000 \cdot \frac{lbf}{in^2}\right)^2}{S_e} \qquad factor_a = 357555.89 \cdot \frac{lbf}{in^2}$$

$$factor_b := \frac{-1}{3} \cdot \log\left(0.9 \cdot \frac{S_{UT} \cdot 1000 \cdot \frac{lbf}{in^2}}{S_e}\right) \qquad factor_b = -0.19$$

$\sigma_a := \sigma_{fmax}$ This is the completely reversed stress - assume to be stress at fillet

$$N := \begin{cases} \left(\frac{\sigma_a}{factor_a}\right)^{\frac{1}{factor_b}} & \text{if } \sigma_{fmax} > S_e \\ \text{"Infinite Life "} & \text{otherwise} \end{cases}$$

$N = 26495$ Total # cycles for failure

Determine the average number of full lift height operations per for the service of the bridge:

Number of Cycles per operation :

$$Cycl := \frac{81}{8 \cdot \pi} \cdot 2 = 6.4$$

Caluclate the number of full lift height operations required to reach the fatigue strength:

$$N_{lifts} := \frac{N}{Cycl} = 4110$$ Total # of full lifts for failure

Consider the average number of full lifts over the service life (1938 to 2016) the lift span would have to operate to reach the endurance limit:

$$AVG := \frac{N}{78 \cdot Cycl} = 53$$ Average number of full lift operations per year

Article 6.7.4.1 Fatigue.

Check fatigue at fillet per AASHTO LRFD equation 6.7.4.1-1:

Convert the theoretical stress concentration factors K_t and K_{ts} to fatigue stress concentration factors, K_F and K_{FS} using equations provided in AASHTO 6.7.3.2

$a_{sqrt} := \left(.2204 \cdot e^{-.0124 \cdot \sigma_{ut}}\right) \cdot in^{.5}$ Neuber Constant based on trendline equation from plotted data in AASHTO table 6.7.3.2-1

$q := \left(1 + a_{sqrt} \div \sqrt{r}\right)^{-1}$

$a_{sqrt} = 0.0599 \cdot in^{.5}$

$K_F := 1 + q \cdot (K_t - 1)$ $K_F = 2.22$

$K_{FS} := 1 + q \cdot (K_{ts} - 1)$ $K_{FS} = 1.77$

$M_a := M_{f1}$

$T_m := f \cdot (R_1 + R_2) \cdot \frac{D_b}{2} = 17584 \cdot lbf \cdot ft$

$\sigma_{ut} = 105$ Minimum specified ultimate strength of the material. Units are ksi but calculation requires variable to be unitless.

$\sigma_{yt} = 80000 \cdot psi$ Minimum specified yield strength of the material.

$$\frac{32}{\pi \cdot d1^3}\left(\left|\frac{K_F \cdot M_a}{S_e}\right| + \left|\frac{\sqrt{3} \cdot K_{FS} \cdot T_m}{2 \cdot \sigma_{yt}}\right|\right) = 1.98$$

Equation C6.7.4.1-1 (result must be ≤ 0.8 to be ok according to AASHTO)

Note for trunnion bascule trunnions which experience a single one-way bending cycle for each complete bridge opening use ≤ 1

APPENDIX E

WJE NDT REPORT

PORT OF HOOD RIVER
HOOD RIVER BRIDGE
Sheave Trunnion Examinations

Hood River, Oregon / White Salmon, Washington

Final Report
January 5, 2017
WJE No. 2016.6472

Prepared for:
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PORT OF HOOD RIVER
HOOD RIVER BRIDGE
Sheave Trunnion Examinations

Hood River, Oregon / White Salmon, Washington

____
Robert Gessel, CWI, CRI, ASNT Level III
Project Manager

Final Report
January 5, 2017
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PORT OF HOOD RIVER
HOOD RIVER BRIDGE
Nondestructive Examination of Sheave Trunnions

Hood River, Oregon / White Salmon, Washington

INTRODUCTION

As requested by Stafford Bandlow Engineering, Inc. (SBE), sheave trunnions in the Hood River Bridge were examined by Wiss, Janney, Elstner Associates, Inc. (WJE) during a site visit of October 27-29, 2016. Nondestructive examinations were used in evaluations of the trunnions. An investigative study of the bridge by SBE prompted the examinations in consideration of high relative stress levels in the trunnions, the service life of the bridge, and as a component of investigation in evaluating operational problems with the bridge machinery. The Port of Hood River provided access to the bridge, and support in examination of the trunnions.

BACKGROUND

The Hood River Bridge, shown in Figure 1, also known as the White Salmon Bridge, crosses the Columbia River between Hood River, Oregon and White Salmon, Washington. The bridge was originally a deck truss structure built in 1924. Alterations to the bridge, including the addition of a through truss lift-span to facilitate navigation of the river, were completed in 1938 to accommodate rising water due to construction of the nearby Bonneville Dam. The bridge has been owned, operated, and maintained by the Port of Hood River since 1950.

VERTICAL LIFT SPAN

Machinery for operation of the span is supported in north and south counterweight towers of the bridge, as shown in Figure 2. The approximate 81-ft. lift of the 262-ft 6-in. length, tower-driven span is facilitated by four sheave trunnions, as shown in Figure 3, for transport of the wire rope. Each sheave is in assembly with a trunnion, supported at each end in plain bronze-lined bearings, as seen in Figure 4 with the cap removed for examination of the journal.

Trunnion Design

The four trunnions in the Hood River Bridge are specified as S.A.E.3145 H.T. steel forgings, and share the design configuration illustrated in Figure 5. The trunnion geometry is relatively simple, with a 10 inch diameter mid-section to support the sheave, and journal ends reduced to a 7 1/2 inch diameter that matches the bronze bearings. A 1/4 inch radius fillet at each end transitions the journals to the mid-section sheave seat. A 1 1/2 inch diameter center-bored cooling hole extends the length of the trunnion. The configuration of the trunnion, however, is neither symmetrical end to end, nor in assembly with the sheave. The inboard journal is 1/2 inch greater in length than the outboard journal, and the sheave is seated with an offset towards the inboard end of the trunnion mid-section, as seen in Figure 6.

TRUNNION EXAMINATIONS

Initial observations of the trunnion journals revealed various condition states. Some journals, as shown in Figure 7, were in good condition. Moderate bronze embedment, as seen in Figure 8 was evident in one journal, suggesting a period of insufficient lubrication. Minor to moderate scoring was also observed in some trunnion journals, as shown in Figures 9 and 10. Lubricants appeared to be contaminated and in need of replacement. Therefore, SBE used diesel fuel to flush and clean the trunnion bearings prior to applications of new lubrication. Corrosion pitting of the journal surface, as shown in Figure 11, observed mainly at inboard journals of the northwest, southwest and southeast trunnions, is probably the result of contaminated lubricants. An example shown in Figure 12 is a closer view of the typically shallow pitting.

Minor damage observed high in the transitional fillet of the outboard journal in the SW trunnion, as shown in Figure 13, appears to be the result of impact from an unknown source. No distress, or interference to operation of the lift span originating from these surface blemishes was evident at the time of examination.

Procedures for nondestructive examination of the subject sheave trunnions were developed for evaluation of the entire trunnion, but with emphasis on areas with greatest susceptibility to crack initiation. The transitional regions between the journals and the sheave seat were identified as regions of highest stress concentration, and were the primary focus of examinations. These regions, located at the interior end of each journal, could be accessed for direct examination upon removal of the bearing caps. The sheave wheel/trunnion interface at the outboard side of the sheave was identified by SBE as third area of examination emphasis, but access to this area was not satisfactory for direct visual or nondestructive examination.

Examinations of the trunnions included nondestructive ultrasonic and magnetic particle methods. Both methods have limitations, but the magnetic particle method is primarily an enhanced surface examination application, while ultrasonic methods are volumetric, with the capability of long distance component penetration. The primary equipment used in nondestructive examination of the Hood River Bridge trunnions is presented in Table 1.

Magnetic Particle Examination

A wet fluorescent magnetic particle examination technique was implemented for examination of the 1/4 inch radius journal transitional regions of the Hood River Bridge trunnions, as shown in Figure 14. The area was cleaned locally with a grease removing solvent prior to examination. With the area darkened, this examination technique was used to define the location of linear discontinuities by fluorescence of the examination medium when illuminated under an ultraviolet light. The magnetic particles were carried in a petroleum based suspension for optimal mobility and attraction to potential leakage in magnetic fields induced locally using the magnetic yoke. The high contrast produced by the fluorescence of the particles is particularly advantageous in detection of discontinuities on highly machined surfaces, such as the journal transitional regions. The procedures and technique for magnetic particle examinations were in compliance with the provisions of ASTM E-709, "Standard Guide for Magnetic Particle Testing".

Magnetic particle examinations of the journal transitional regions required direct access, therefore, testing of each journal was necessary in three increments. Beginning with the lift span in the seated position, the exposed surface of the transitional region was magnetized as far as practical during application of the inspection medium. The movable span was raised to reposition the trunnions at approximate third points to allow examinations of the full circumference. A heavy weight canvas tarp was used to cover the journals, equipment, and test personnel during examinations, providing the required darkened environment for viewing of the fluoresced particles. No significant indications were detected in magnetic particle examination of the transitional fillet regions of the trunnion journals.

Ultrasonic Examination

Ultrasonic waves are uniquely suited for detection of cracks or other discontinuities with orientation transverse to the direction of propagation. The procedures for ultrasonic examinations were developed for basic evaluation of trunnion areas most susceptible to initiation of cracking due to fatigue. These include the transitional fillet regions that were also subjected to magnetic particle examination, and the location of contact between the outboard side of the sheaves and the trunnion mid-section. Prior to examination, paint was removed from the end surface of the trunnions to permit satisfactory scanning and transmission of the ultrasonic wave.

Axial oriented ultrasonic waves introduced from the end surfaces were used for measurement of primary geometric features, as well as evaluation within the specific regions suspected of greatest potential crack initiation. Initial scans with a straight beam (0° longitudinal-wave transducer) penetrated the full length of the trunnions, and defined the distance to the transition at the end opposite the scanning surface. A second ultrasonic scan was implemented with a similar longitudinal wave transducer, but with a 14° angle that was directed toward the journal surface, providing enhanced sensitivity within the specific region of examination. The 14° transducer provided primary evaluation of the transitional region, as well as scans of the sheave/trunnion interface. Figure 15 illustrates a graphic representation of ultrasonic scans used in examination of the trunnions.

Limited scans were implemented using a 45° (nominal) radial oriented transducer from the trunnion bore-hole for evaluation of the outboard side sheave/trunnion interface region. An initial 0° straight beam radial oriented scan from the bore-hole, verifying the soundness of the local material and transmission of the ultrasonic wave, preceded the shear-wave scan. Prior to scanning, the bore was prepared with a rotary flap-wheel sander and cleaned to enhance transducer contact and sound transmission.

The transducers for scans from the bore-hole were mounted, as shown in Figures 16 and 17, on “shoes” attached to a handle, and contoured to match the radius of the trunnion bore-hole. The shoes used to carry the transducers and couple them to the bore-hole surface were manipulated manually, and did not include spring loaded positioner equipment to maintain firm contact with the bore-hole surface. However, the equipment performed as intended and allowed for a thorough volumetric examination of the subject trunnion areas.

The ultrasonic test instrument and transducers were calibrated for distance linearity and detection sensitivity using the WJE long distance standard, shown in Figure 18. The configuration of the standard does not match the configuration of the actual trunnion, but includes geometric features to establish appropriate equipment settings, and a defined notch for comparative evaluation. A separate standard was used for calibrations of the bore-hole transducers, and for the low angle longitudinal transducer.

Evaluation Based on Nondestructive Examinations

The data produced from ultrasonic scans and magnetic particle examination of the trunnions form the basis of evaluations. The two methods, although different, corroborate to establish an assessment of the transitional region where both methods were applied. No significant indications were detected in the transitional region by either method in any of the eight journals. The third area of emphasis for the examinations (at the outboard edge of the sheave wheel) was accessed only in ultrasonic scans. Several low level signals were produced in scans of this area, but the axial locations were not consistent. An examination of the trunnion surface in some of these locations revealed blemishes and shallow pitting in the trunnion surface adjacent to the outboard side of the sheave wheel. The indications were minor in signal magnitude, mainly a single point reflection (little or no radial length) and were not indicative of cracks. The condition of each trunnion is summarized in Table 2.

DISCUSSION

The methods and procedures for evaluation of the sheave trunnions offer a high probability for detection of potential distress in the trunnions. No discontinuities of significance were identified in the examinations. The extent of corrosion and scoring that was observed in trunnion journals is not considered severe, as the surface area is substantially intact. The operational life of the trunnion journals might benefit from removal of the higher ridges of the most prominent scoring. In addition, the small gouges observed in the outboard southwest trunnion journal, as should any transitional area blemish, be blended with the surrounding area to mitigate potential stress concentrations. Areas of pitting at the general surface should be cleaned to remove contamination that might promote further corrosion. The Machine surface, however, should be left intact with no attempts to blend into the surrounding surface. Most importantly, perhaps, the lubricants in the journals require monitoring and maintenance to reduce wear and prevent further advance of corrosion to the journal surface.

The transitional fillet region between the journal and the trunnion shoulder is shown on the drawings with a relatively small 1/4 inch radius. The fillet area was not measured at the time of our field investigation, but a review of the photos suggest that the diameter may be larger. A larger radius would be expected to reduce the calculated ratio of concentrated stress in this critical region.

The longitudinal 14° scan with axial orientation from end surfaces was directed toward the transitional regions of the trunnions. The characteristic enhanced sensitivity of low angled transducers, in comparison with the straight beam scan, produced more definitive trace deflections for evaluation of this region. In many trunnions the distance to the transitional region from the end surface entry point of the low angled transducer is of prohibitive length for definitive scan evaluation. While the scan with a 45° bore-hole transducer offers enhanced evaluation in the critical region, the combination of magnetic particle evaluation and the low angled ultrasonic scan provides a conclusive evaluation. The detection of cracks in this region would prompt recommendation of additional scans of this area using a bore-hole probe with additional scanning angles.

The low-angled axial oriented scans of the outboard side sheave region are much further from the end surface, therefore, scanning from the bore-hole is more definitive. The 45° (nominal) transducer that was used for this scan improves sensitivity and offers an alternate approach to the area of examination, but required manipulation of the handle for positioning and contact. Scans with this device improve evaluation of the region, but a device with suspended transducers would be preferred for future scans and would produce more consistent scanning, especially if indications produced in other scans require further evaluation.

SUMMARY AND RECOMMENDATIONS

Data produced in nondestructive examinations by WJE formed the basis of evaluations for the four sheave trunnions that facilitate operation of the vertical lift span for the Hood River Bridge. Based on our assessments, the trunnions do not include volumetric or surface-breaking defects in the areas of interest that would limit continued service. The trunnion examinations included visual, magnetic particle, and multiple ultrasonic scans. Minor ultrasonic indications occasionally detected in scans of the trunnion mid-section sheave interface area were not characteristic of developing cracks.

We recommend measures to mitigate the effects of surface blemishes, including high point removal of surface scoring, or blending of impact damage to the transitional region. Also, lubrication of the trunnion journals should be maintained with an appropriate grease to avoid further damage from corrosion or bronze embedment. We recommend periodic nondestructive examinations based on similar procedures at intervals that do not exceed 5 years. In future examinations, it is our opinion that the ultrasonic bore-hole scans would benefit from development and fabrication of a bore-specific transducer positioning apparatus as well as a test standard that closely resembles the configuration of the critical regions subject to examination.

Please contact us if you require further information regarding the content of this report, or if we may be of further assistance.

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TABLES

Table 1. Primary Nondestructive Equipment for Hood River Bridge Trunnions

Equipment	General Description	Primary Application
Test Instrument	Krautkramer USN 36 Digital Ultrasonic Flaw Detector	Production and detection of ultrasonic pulse
Transducer 1	Axial scan - straight beam, longitudinal 1.0 inch diameter - 2.25 MHz	Axial dimension and general examination
Transducer 2	Axial scan - angle beam, longitudinal 1.0 inch diameter - 2.25 MHz with shoe producing 14º longitudinal wave	Axial oriented longitudinal scan Primary scan of inboard and outboard end transition regions
Transducer 3	Bore hole scan - straight beam, longitudinal-wave radial orientation 0.5 inch diameter - 2.25 MHz with contoured shoe fitted to bore hole	Scans of trunnion for continuity and verification of wave transmission
Transducer 4	Bore hole scan - angle beam, shear-wave with radial orientation 0.5 inch diameter - 2.25 MHz with contoured shoe fitted to bore hole, producing 43.5º shear wave	Scans of sheave trunnion interface region at outboard side of sheave
Linear & Sensitivity Calibration Standard	WJE distance and linearity standard (5 & 9 inch Shear - 9 & 18 inch Longitudinal)	Longitudinal and shear wave horizontal linearity Longitudinal sensitivity for axial transducers Radial 0^{0} linearity
Low Angle Standard	4 inch - Low Angle Standard	Calibration of low angle transducers
1 1/2 dia. Bore-hole standards	1 1/2 inch bore - 3 inch shear wave distance & companion sensitivity standard	Calibration of 1 1/2 bore transducers
Ultrasonic Couplant	30 weight motor oil	Ultrasound coupling
Magnetic Yoke	Parker Research Model B-310 Miniature Magnetic Particle Yoke	Induction of magnetic fields for examinations
Ultraviolet Light	Spectroline Model 818-150P	Illumination of examination area for fluorescing of the inspection medium
Inspection Medium	Magna Glow M-14 By Magna-Flux	Inspection Medium for detection of cracks
Cleaning Solvent	Generic - Brake parts cleaner	Surface cleaning prior to examinations

Table 2. Summary of Examination and Condition - Hood River Bridge Trunnions

Trunnion Exam	Nondestructive Examinations		Noted Journal Condition	Comment
	MPE	UE		
Northwest Inboard Journal	No significant indications	*No significant indications	Minor bronze embedment Moderate corrosion pitting Light wear - one score line	-
Northwest Outboard Journal	No significant indications	*No significant indications	Light wear	-
Northwest at outboard sheave-face	NA	** No significant indications	NA	-
Northeast Inboard Journal	No significant indications	*No significant indications	Light wear	-
Northeast Outboard Journal	No significant indications	*No significant indications	Light scoring and light wear	-
Northeast - at outboard sheave-face	NA	** No significant indications	NA	-
Southwest Inboard Journal	No significant indications	*No significant indications	Moderate scoring Moderate corrosion	-
Southwest Outboard Journal	No significant indications	*No significant indications	Minor bronze embedment Small gouges high in fillet Minor corrosion pitting	Blend gouges
Southwest at outboard sheave-face	NA	** No significant indications	NA	Local pitting or surface blemish
Southeast Inboard Journal	No significant indications	*No significant indications	Minor scoring Moderate corrosion pitting Bronze embedment	-
Southeast Outboard Journal	No significant indications	*No significant indications	Light wear Minor corrosion	-
Southeast at outboard sheave-face	NA	** No significant indications	NA	-
Key: MPE - Magnetic Particle Examination UE - Ultrasonic Examination NA - Not Applicable				

* Axial oriented scans only

** Through bore-hole scan and axial scan

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FIGURES

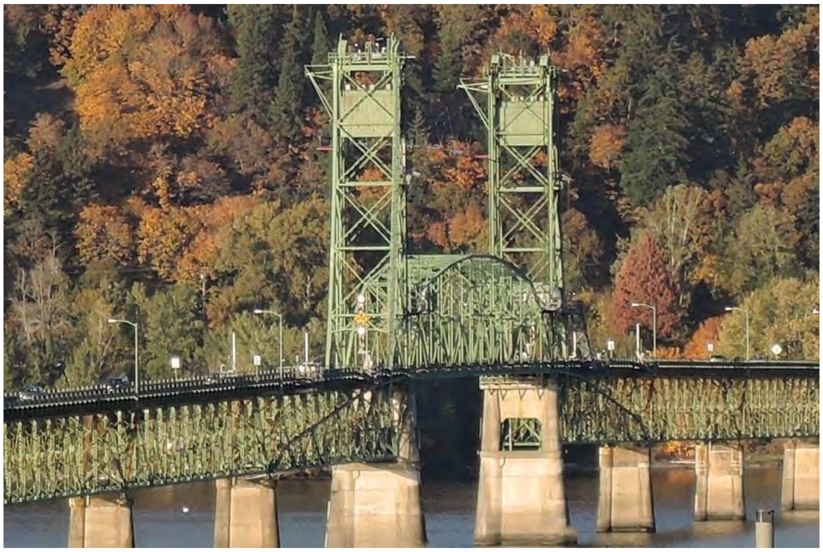

Figure 1. The Hood River Bridge is shown as viewed from the Oregon side of the river, looking North.

Figure 2. The south counterweight tower is shown with sheave trunnions and associated machinery.

Figure 3. A sheave trunnion assembly in the north tower is shown beneath a partially open enclosure.

Figure 4. Following removal of the bearing cap, the lower section of a bearing is shown with the northeast trunnion journal seated within.

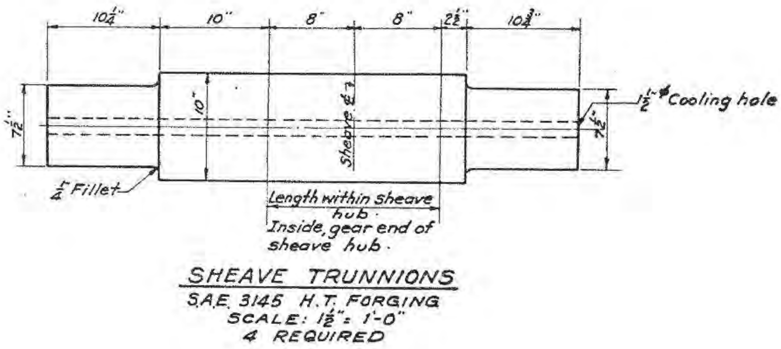

Figure 5. The trunnion configuration is near symmetrical in appearance, but dimensions vary slightly end to end, and the sheave seats off-center toward the interior of the bridge.

Figure 6. About 1/3 of each trunnion mid-section is exposed at the outboard end due to the offset mounting position of the sheave.

Figure 7. The northeast inboard trunnion journal exhibited nearly negligible wear of the journal surface.

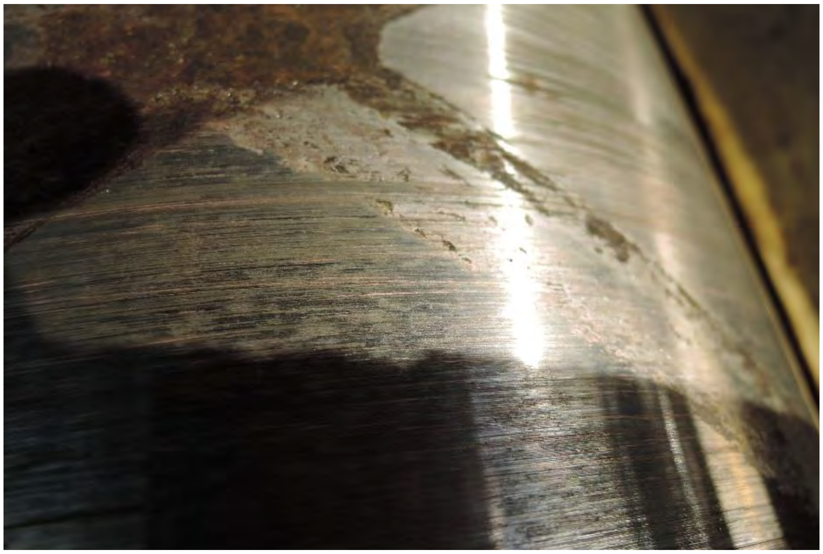

Figure 8. Bronze embedment as shown at the inboard journal surface of the southeast trunnion is indicative of insufficient lubrication.

Figure 9. Minor scoring was observed near the middle of the northwest trunnion journal.

Figure 10. Moderate scoring was evident in the inboard journal of the southwest trunnion.

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Figure 11. Corrosion pitting of the inboard journal of the southwest trunnion was indicative of contaminants within the bearing lubrication.

Figure 12. Pitting of journal surfaces is mostly local and shallow as shown in the inboard journal of the southwest trunnion.

Figure 13. A series of small gouges was observed through much of the circumference within the mid to high portion of the fillet region at the outboard journal of the southwest trunnion.

Figure 14. Magnetic particle examination was applied at the transitional region of the trunnions.

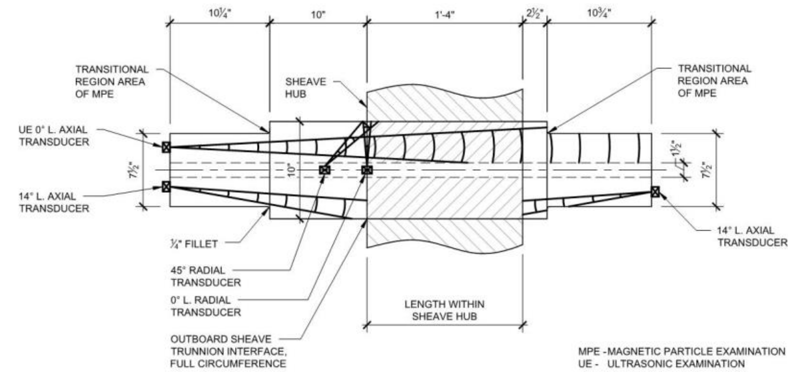


Figure 15. Multiple ultrasonic scans of the Hood River Bridge trunnions were introduced from end and bore-hole surfaces.

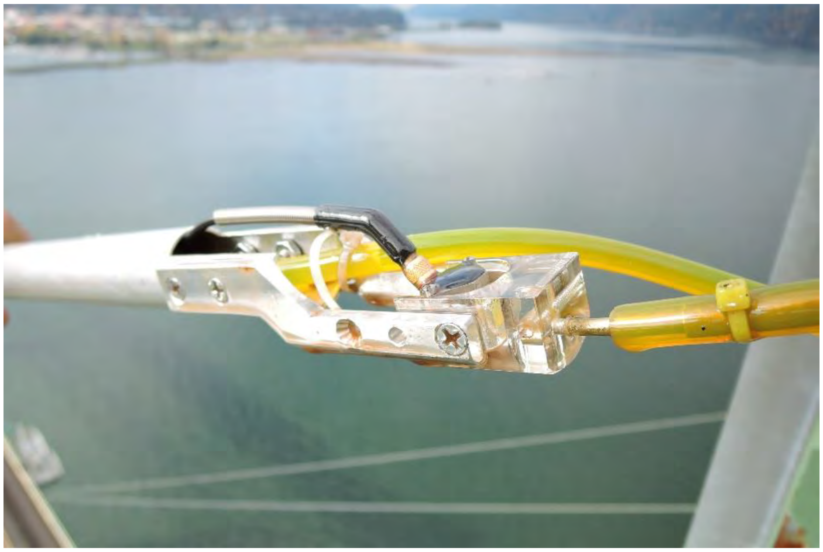


Figure 16. Shear wave scans were preceded by a straight beam scan with radial orientation for soundness and dimensional verification.

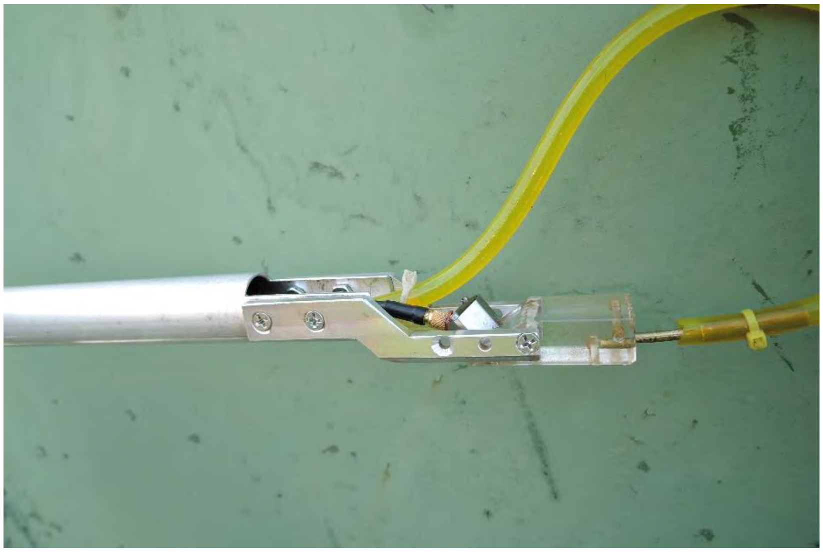


Figure 17. The transducer used in shear-wave scans from the bore-hole allowed an extended reach, but did not include a suspension to assist in maintaining contact with the bore surface.

Figure 18. The ultrasonic test standard shown above was used in calibrations of the ultrasonic test apparatus.

STAFFORD BANDLOW ENGINEERING, INC.

Port of Hood River

Hood River Bridge to Return to Operational Condition

Stafford Bandlow Engineering

Bridge Control System Modifications and Commissioning

Overview

The Hood River Bridge was out of service from November of 2015 to August 2016 due to bridge control system issues and damage to the bridge caused by a failure which occurred during operation. Upon investigation, SBE concluded that the failure revolved around the inability of the existing bridge control system to recognize, take action or correct a bridge skew condition.

Stafford Bandlow Engineering, Inc. (SBE) was retained by the Port of Hood River to verify the mechanical integrity of the bridge for operation and electrically modify the bridge control system to enable the bridge to be operated safely and reliably.

SBE developed a modified design for the bridge control system, specified and procured equipment to accurately monitor span skew and ultimate skew and provided installation details for the system modifications.

Implementation of Control System Additions and Modification

The procured equipment and modifications to the bridge control system were installed by the Port of Hood River Contractor with SBE oversight and SBE programming. This work took place during the last week of July 2016 and the second week of August 2016.

Following a cursory mechanical inspection and bridge control system modifications, the bridge was successfully tested August 10th and 11th, 2016.

Although the testing was successful, a number of the proposed additional bridge protective devices were not completely installed or commissioned at that time and the bridge was not considered ready to be placed back into service.

The installation, commissioning and placing the bridge into service took place on September 6th thru September 8th, 2016. Additionally, at this same time, baseline mechanical and electrical testing was performed to verify that the bridge is operating within its rating and a determination made of its balance condition.

As part of the September 2016 field work, SBE also performed a limited mechanical inspection of the bridge and then performed a trunnion fatigue analysis to assess the long-term integrity of the mechanical operating system which are addressed in a separate report.

Following the successful installation of the electrical modifications and their testing, the bridge was returned to service on September 8, 2016. Following a period of successful in-service operation, a failure occurred on November 22, 2016 that was caused by instrumentation falsely indicating a bridge skew condition. This failure condition was addressed by SBE on November 29th and 30th, 2016 and the bridge returned to service. No further operational issues have been reported.

Bridge Control System Additions and Modifications

The following bridge control system additions and modifications were made to the bridge to protect the bridge against over-skew and ultimate skew conditions. These modifications trip the system and enable skew correction to be made without the need for the operator to perform multiple steps or for him to make a decision as to direction of operation of the bridge to correct skew. See Appendix I for the revised drawings that fully describe the modifications and additions that have been made to the bridge control system.

The present skew monitoring system is non-operational, has been disconnected and based on the setup of its intelligent display meter has never functioned correctly.

As part of the modification work, this monitoring device and its associated logic was disconnected and removed from the bridge operating system. This failed device was replaced with an inclinometer to monitor over-skew and a tilt switch to monitor ultimate skew.

1. Over-Skew Monitoring
   The over-skew transducer and associated intelligent meter has been arranged to monitor the moving span for skew and has been set to trip the tower drive motors at an angle of skew of 0.2 degrees in either direction (North or south). The bridge control logic has been modified such that it recognizes the direction of skew and configures the logic to enable automatic correction of skew commanded by the bridge operator.

2. Ultimate Skew Monitoring
   This condition can only occur if the over-skew has failed or a catastrophic failure has occurred to the bridge mechanical system. The ultimate skew consists of a tilt switch that has been set to trip the tower drive motors at an angle of 0.4 degrees in either direction. The bridge control logic has been modified such that it prevents the operator from operating the bridge under an ultimate skew condition and disables the normal bridge drive control functions. In the event of an ultimate skew condition occurring the operator must inform the designated qualified bridge maintenance person. The designated qualified bridge maintenance person shall switch the bridge control system to maintenance mode using his key to manually operate the bridge to correct the ultimate skew condition and return the bridge to service.

The existing tower drive motor control and their integration into the overall bridge control system is problematic with respect to the ability of the bridge to attempt to operate when one tower drive motor is switched off or has failed. When this failure condition occurs, there was nothing at present to prevent an attempted operation of the bridge and a catastrophic skew condition occurring.

The motor starter control circuits for the tower drive motors has been revised as part of the control system modification work to install motor current monitoring relays. The relay outputs have been configured to block operation of the bridge unless both tower drive motors are energized.

Additionally, to aid with the elimination of any skew condition occurring the control system associated with the tower drive motors was modified to eliminate high speed operation of the bridge. This change now limits the speed of the tower drive motors to 600 rpm from the existing 1,800 rpm synchronous speed.

The above work was performed by Port of Hood River contract electrician with SBE Engineer providing oversight.

System Calibration and Testing

1. Skew Monitoring Control System Modification Testing

   The control system modified wiring was point to point checked for continuity against the bridge control system modified drawings prior to energizing the bridge control system. This was completed satisfactorily and all wiring discrepancies re-wired.

   The over-skew inclinometer with its intelligent meter and the ultimate skew tilt switch, both were calibrated and accurately set by programming in accordance with the manufacturers guidelines.

   The control system was energized and the status of all control system devices checked against the modified drawings for accuracy. The bridge was next raised to a height of approximately 5' followed by returning the moving bridge to its seated position. The functioning of the control system and skew devices were monitored for correct operation. It should be noted that no skew was observed and the over-skew meter skew indication remained unchanged.

2. Skew Device Testing

   Following the successful conclusion of the first partial raising of the bridge to a height of approximately 5', skew device testing was performed. This consisted of forcing the bridge into a skew condition and determining the accuracy of the skew monitoring devices and their metering outputs. Note that the forcing of the bridge into a skew condition was carried out in both directions of skew and was achieved in bridge maintenance mode by only operating a single motor to create skew. The trip points were accurately set and tested for consistency. Both the over-skew and the ultimate skew produced excellent repeatability to within 0.01 of a degree. The accuracy of the skew devices was checked by physically measuring the actual skew and comparing it with the output from the over-skew monitor.

   Following the first successful operation of the bridge to a height of 5' this was repeated to a height of approximately 30' in increments of 5' to determine if skew was an issue in bridge operation and to determine if there were any physical issues associated with operating the bridge.

   The bridge operated smoothly for the most part, however there were periods during travel where the span seemed to stutter. This condition persisted during all test openings of the bridge but did not appear to be caused by the electric drive system for the bridge.

3. Under Current Relay Testing

   The under current relays and their logic were tested to ensure that the bridge could not be operated unless both tower drive motors were energized. All possible reasons for motor failure were tested:

   1. Open motor starter disconnect switch.
   2. Remove starter control fuse.
   3. Trip starter overload.
   4. Disconnect on of the motor leads.

   The relays operated correctly and the bridge could not be operated if any one of the above conditions was applied.

4. Calibrating Existing Height Metering

   The existing panel mounted bridge height indicator meters were found to not reflect the true height of the bridge and appeared to be indicating almost two times the actual raised height of the bridge.

SBE re-calibrated the height indicators for both towers and confirmed during bridge operation that both indicators were accurately reflecting the actual height of the operating bridge.

5. Test Openings

   Test openings of the bridge were conducted following the commissioning of the revised skew monitoring system and the above described adjustments.

   The bridge was successfully raised to a height of 66’ with no electrical control problems and no indication of a skew condition. There did appear to be the previously reported stuttering of the movable span for a portion of the raising cycle of the bridge and this is addressed in full in the mechanical bridge operating report.

Bridge In-Service Failure

Following the successful installation of the electrical modifications and their testing, the bridge was returned to service on September 8, 2016. Following a period of successful in-service operation, a failure occurred on November 22, 2016 that was caused by instrumentation falsely indicating a bridge skew condition. SBE staff immediately responded to the failure and made appropriate corrections and modifications to ensure that in the event of a false indication of skew, the faulty device could be taken out of service to allow continued bridge operation using back up protective devices. No further operational issues have been reported since this incident.

Conclusions

Based on the operating results of the modified bridge control system, the introduction of movable bridge mounted inclinometer and tilt switch, it is concluded that;

1. The bridge is now protected against being inadvertently operated with only one tower drive operational.
2. In the event of an over-skew condition the bridge control system will trip the bridge and enable the operator to automatically correct for skew without decisions having to be made regarding direction of skew correction.
3. In the event of an ultimate-skew failure, a catastrophic bridge control system failure will be avoided by automatically tripping the bridge and locking it out. Under this scenario only a qualified bridge maintenance person will be authorized to correct skew.
4. As part of the modifications to the bridge control system the speed of operation of the bridge has been reduced, this operating speed reduction assists in reducing the possibility of bridge skewing during operation.
5. The changes that have been made to the electrical control system will assure that the bridge should operate reliably with respect to a skew condition failure damaging the bridge or without an unprotected skew condition occurring. The changes do not provide a system to automatically control skew. The control of skew will require extensive changes to the bridge drive motor control system and were beyond the scope of the present work.

Recommendations

Although the above modifications and additions enable the bridge to be operated reliably and without the fear of a catastrophic skew condition occurring, these changes do not address the more major issue of the bridge not being provided with controllable drives or an automatic means of correcting for skew. It is strongly recommended that the existing two speed tower drive motors and their starters be replaced with new motors and variable frequency drives or, if possible, implement additional motor controls to the existing system with the following features;

i. Enable the speed and torque output of the drives to be controlled.

ii. Provide control for electro-mechanical brakes such that the brakes are only released when the tower drive motors are providing the bridge holding function.

iii. Use the drives to provide dynamic braking thereby controlling overhauling loads and providing braking torque for the driven system.

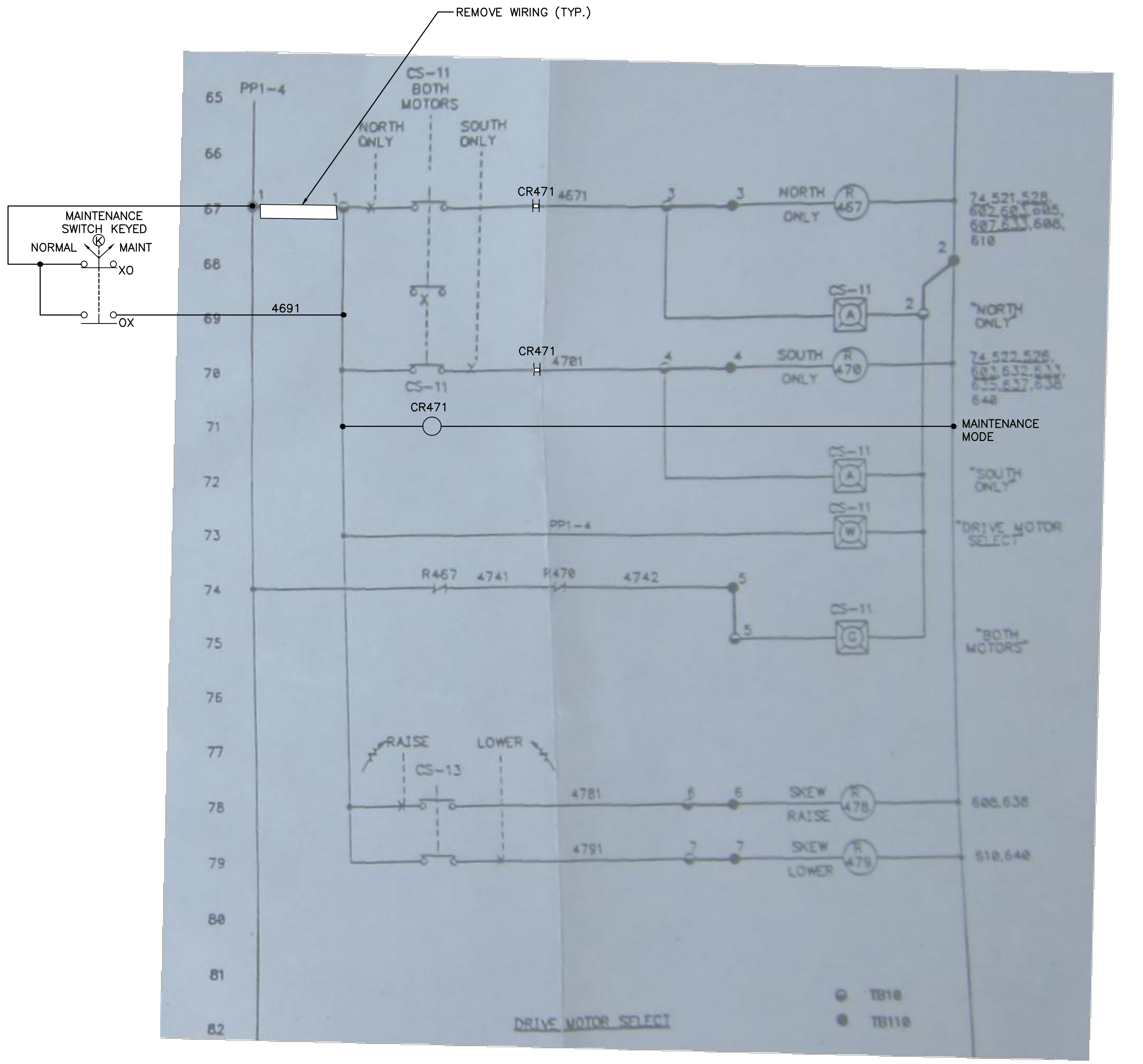
The above skew and drive control recommended modifications, can either be incorporated into the existing bridge control system or be part of a more extensive bridge electrical system rehabilitation that would include replacement of the bridge control console, motor control center, and electro-mechanical brakes, vehicular traffic control system, bridge navigation lighting as well as the bridge drive motors and controllers and bridge cable and conduit installation.

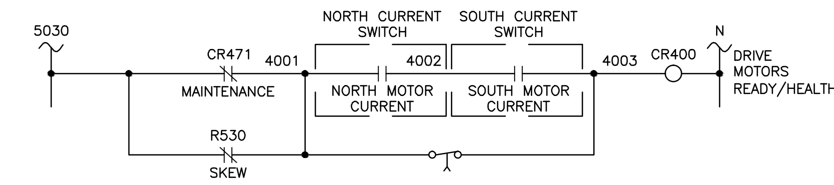
The cost of the recommended skew and drive control changes with new motors, drives and skew control is approximately $240,000 in 2017 Dollars. The cost of the defined extensive bridge electrical rehabilitation is approximately $750,000.

As can be seen, the costs of these two approaches vary significantly and the choice of which approach is the most appropriate is based on the life expectancy and condition of the existing system and the frequency of operation of the bridge.

Based on the status of the existing bridge control system and the limited frequency of operation of the Hood River Bridge, it is recommended that the changes be limited to implementing the skew and drive control recommendations and not the extensive bridge electrical rehabilitation. It is recommended that this work be implemented within the next year to upgrade the bridge control system in accordance with AASHTO.

APPENDIX I
ELECTRICAL CONTROL MODIFICATIONS
AS-BUILT DRAWINGS





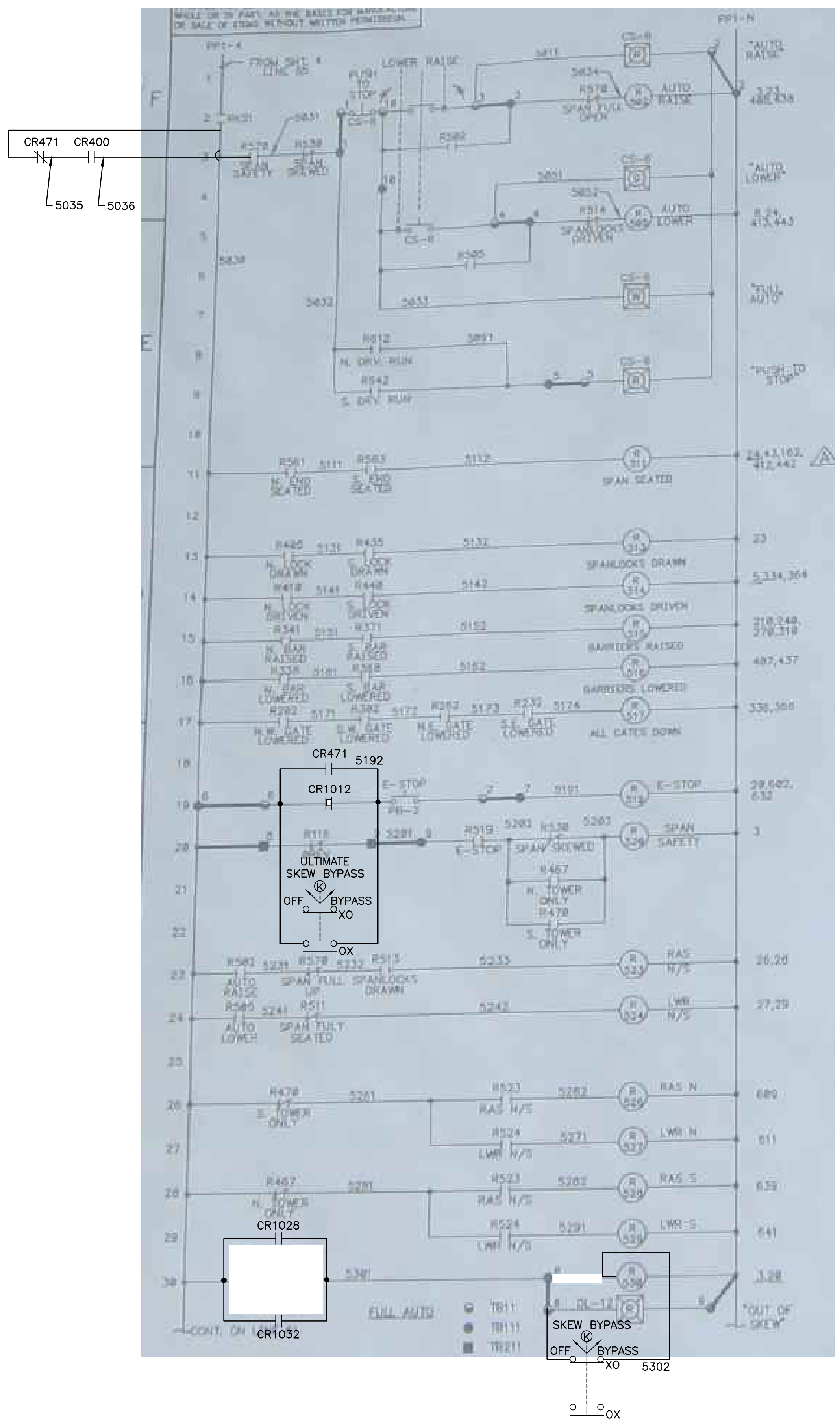
MAINTENANCE SELECTOR SWITCH CIRCUIT MODIFICATION

NOTES:

1. ADDED A KEY OPERATED MAINTENANCE SWITCH
   a. NORMAL POSITION WILL ONLY ALLOW BOTH MOTORS TO BE SELECTED FOR OPERATION.
   b. IN MAINTENANCE MODE, THE QUALIFIED MAINTAINER CAN SELECT TO OPERATE NORTH, SOUTH OR BOTH DRIVE MOTORS USED FOR TROUBLESHOOTING, TESTING OR ULTIMATE SKEW ELIMINATION.
2. ADDED COMPONENTS:
   a. KEY OPERATED TWO-POSITION TWO POLE SWITCH
   b. AB RELAY (700-P400A1)

1 / –	E1/E5	HOOK RIVER BRIDGE	ELECTRICAL CONTROL SCHEMATIC MODIFICATION 1 OF 4	DESIGNED LQX/GTR CHECKED GTR	DRAWN LQX REVISED ----	REVIEWED GTR DATE 12-01-16 STRUCTURE FILE NUMBER ----

DESIGN AGENCY



SKEW TRIP MODIFICATION

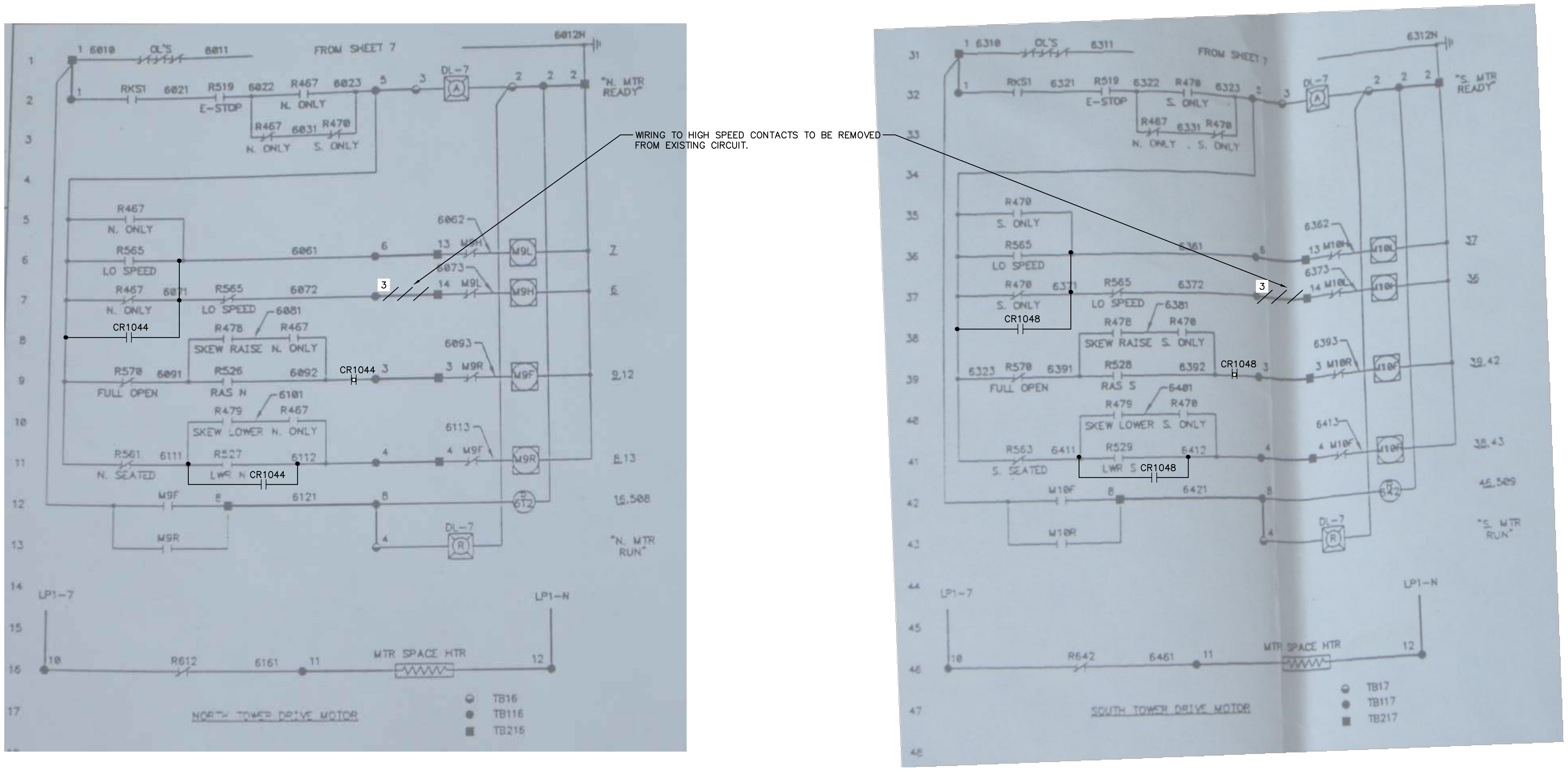
NOTES:

1. THE ADDITION OF THE PARALLEL CR471 AND CR1012 TO THE E–STOP CIRCUIT WILL TRIP THE E–STOP RELAY DUE TO ULTIMATE SKEW. BRIDGE WILL BECOME INOPERABLE UNDER THE NORMAL OPERATION UNTIL THE MAINTENANCE PERSONNEL HAS ELIMINATED THE ULTIMATE SKEW. THE ULTIMATE SKEW CORRECTION CAN BE PERFORMED WITH KEY OPERATED MAINTENANCE SWITCH ON "MAINTENANCE" MODE.

2. NEW INCLINOMETER OUT OF SKEW TRIP FUNCTION – IF SPAN IS IN SKEW, THE RELAY R530 WILL BE ENERGIZED. IT WILL ILLUMINATE OUT OF SKEW LIGHT ON CONTROL CONSOLE, DE–ENERGIZE SPAN SAFETY RELAY R520 AND CONSEQUENTLY DISABLE THE AUTO RAISE AND LOWER CIRCUIT UNTIL THE SKEW CONDITION HAS BEEN ELIMINATED.

2 / –	E2/E5	HOOK RIVER BRIDGE	ELECTRICAL CONTROL SCHEMATIC MODIFICATION 2 OF 4	DESIGNED LQX/GTR CHECKED GTR	DRAWN LQX REVISED ———	REVIEWED GTR DATE 12–01–16 STRUCTURE FILE NUMBER ––––

DESIGN AGENCY



NORTH AND SOUTH DRIVE MOTOR CONTROL MODIFICATION LOW SPEED ONLY

NOTES:

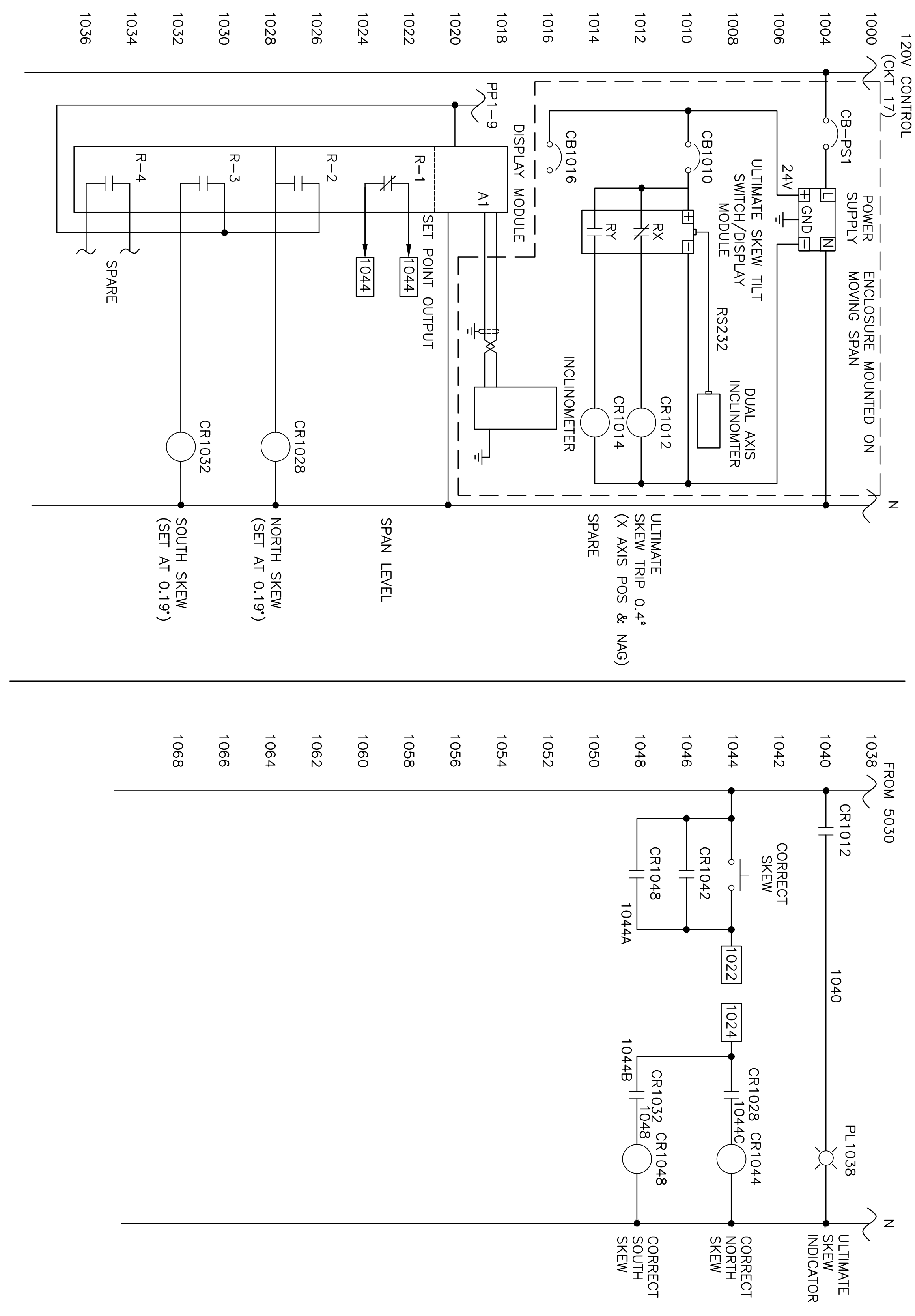
1. DISCONNECTED DRIVE MOTOR HIGH SPEED CONTACTOR M9H AND M10-H. THIS ENSURES THAT BRIDGE CANNOT OPERATE AT HIGH SPEED.
2. ADDED CORRECT NORTH SKEW CONTACT TO LOW SPEED CONTACTOR CIRCUIT (CR1044).
3. ADDED CORRECT SOUTH SKEW CONTACT TO LOW SPEED CONTACTOR CIRCUIT (CR1048).
4. ADDED CORRECT NORTH SKEW CONTACT TO MOTOR REVERSE CONTACTOR (M9R) CIRCUIT (CR1044).
5. ADDED CORRECT SOUTH SKEW CONTACT TO MOTOR REVERSE CONTACTOR (M10R) CIRCUIT (CR1048).

HOOK RIVER BRIDGE	ELECTRICAL CONTROL SCHEMATIC MODIFICATION 3 OF 4	DESIGNED LQX/GTR; CHECKED GTR; DRAWN LQX; REVISED ——; REVIEWED GTR; DATE 12-01-16; STRUCTURE FILE NUMBER ----	DESIGN AGENCY S&B ENGINEERING

E3/E5

3 / –

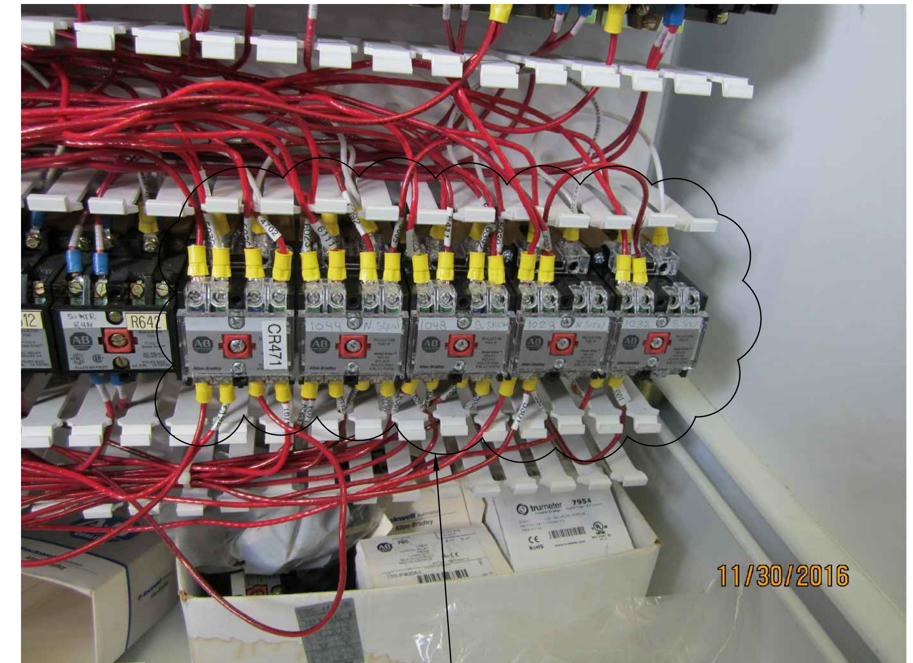
ADDITIONAL CONTROL CIRCUITS



4 / 1	E4 / E5	HOOK RIVER BRIDGE	ELECTRICAL CONTROL SCHEMATIC MODIFICATION 4 OF 4	DESIGNED LQX/GTR; CHECKED GTR	DRAWN LQX; REVISED ———	REVIEWED GTR DATE 12-01-16; STRUCTURE FILE NUMBER ----

DESIGN AGENCY S&B ENGINEERING

CONTROL CONSOLE



RELAY CABINET

CONTROL CONSOLE (SIDE PANEL)

DEVICE LOCATIONS

5 / –	E5 / E5	HOOK RIVER BRIDGE	CONTROL DEVICE LOCATIONS	DESIGNED LQX/GTR; CHECKED GTR	DRAWN LQX; REVISED ——	REVIEWED GTR; DATE 12-01-16; STRUCTURE FILE NUMBER ----

DESIGN AGENCY

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Commission Memo

Prepared by: Michael McElwee
Date: February 7, 2017
Re: Bridge Seismic Evaluation

HDR Engineers has prepared the attached Draft 'Seismic Vulnerability Assessment' for the Bridge. This effort was anticipated in the Port's FY17 Budget and the current Two-Year Bridge Work Plan. The objectives of the assessment were to better characterize the seismic vulnerabilities of the Bridge, understand seismic retrofit options and identify corresponding order-of-magnitude cost implications.

David McCurry will attend the meeting to provide an overview of the draft report's findings.

RECOMMENDATION: Informational.

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Hood River-White Salmon Interstate Bridge

Seismic Vulnerability Assessment

Final Report

Port of Hood River, Oregon

January 17, 2017

Contents

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Abbreviations

ADT	average daily traffic
ARS	acceleration response spectrum
Bridge	Hood River-White Salmon Interstate Bridge
CSZ	Cascadia Subduction Zone
DSL	Department of State Lands
ERS	Earthquake Resisting System
FHWA	Federal Highway Administration
LL	lower level ground motion
ODOT	Oregon Department of Transportation
PL	Performance Level
POHR	Port of Hood River
UL	upper level ground motion
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1 Purpose and Need

The Hood River-White Salmon Interstate Bridge (Bridge) is a vital infrastructure link for the economic viability of the region's industries, community livability, and access for public health and safety. To protect and maintain the Bridge, the Port of Hood River (POHR) seeks to understand the existing structure vulnerabilities, including seismic vulnerability, in order to make an informed decision for seismic retrofit. One of the key vulnerabilities of the Bridge is damage and loss of function in the event of an earthquake. The overarching goal is to improve community resiliency.

A 2012 study of Pacific Northwest earthquake hazards published by the USGS determined that the odds are greater than one in three for a magnitude 8 CSZ earthquake event occurring within the next 50 years, and greater than one in ten for a magnitude 9 CSZ earthquake event within the next 50 years. In addition, according to a 2015 statewide natural hazard risk assessment study, nearby local seismic faults along the Hood River present a closer potential source of earthquakes. Distance tends to dissipate the intensity and duration of ground shaking, and Hood River is not in the area of highest anticipated ground shaking. However, the soil properties surrounding the Bridge and the age of the structure itself make it highly susceptible to ground shaking.

Since the Bridge was constructed before the regions seismic activity history was known and before seismic resiliency was considered in bridge design considerations, it has a number of seismic deficiencies. The POHR conducted this study because the Hood River-White Salmon Interstate Bridge is not only an important local connection, but is also a vital regional and bi-state connection for post-earthquake recovery.

1.1 Port Goals

This report was authorized by the POHR to better understand:

- The seismic hazard at the site and the related consequences to this bridge depending on the type of earthquake;
- How to mitigate the potential seismic vulnerabilities of the Bridge;
- The steps and possible sequencing of seismic retrofit work that would improve the Bridge's performance in an earthquake and improve community resiliency; and
- The related costs, timeline, impacts, and processes for implementing seismic retrofit strategies for use in short- and long-term planning.

1.2 Project Objectives and Scope

Project specific objectives to meet the stated goals above are to:

- Provide meaningful but summarized information to the Port to understand and weigh the benefits of making a seismic retrofit investment for the aging bridge structure;
- Formulate concept seismic retrofits consistent with federal and state guidelines that are reasonable, achievable, and fundable; and

- Estimate the project cost, next steps for engineering analysis and project development, and an understanding of key impacts;

The following project scope that achieves the above goals and objectives includes:

- A general survey of the structure and supporting elements to identify deficiencies that would prevent bridge use after a seismic event;
- A high level summary of local seismicity, seismic design criteria, vulnerability, analysis methodology, and seismic retrofit alternatives which are often referred to as Earthquake Resisting Systems (ERSs); and
- Technical guidance, planning level recommendations, and estimates for bridge seismic retrofit including sequencing of work.

1.3 Importance of the Bridge

The Bridge connects the City of Hood River in Oregon to State Route 14 on the Washington side. This bridge is a connection that is important both locally and regionally. Residents cross the Bridge frequently for work, commerce, education, healthcare, and pleasure. Local emergency services rely on the Bridge as the only cross-river connection within many miles in each direction, with the Bridge of the Gods 32 miles to the West, and The Dalles Bridge 22 miles to the East.

Figure 1-1. View of the Hood River-White Salmon Interstate Bridge

Source/Note: https://upload.wikimedia.org/wikipedia/commons/d/d1/Hood_River_Bridge.jpg. Washington on the left and Hood River, Oregon, on the right.

The Bridge is an essential emergency detour route for highway and interstate traffic. This fact was exemplified when an oil train derailment and subsequent oil car fire in Mosier, Oregon in June 2016, required I-84 closures and traffic detours to Washington SR14 and onto the Bridge. This recent event highlighted the vital importance of the Bridge as a critical link for the broader region and local area; the Bridge effectively became part of the interstate system as an emergency detour route. Maintaining the Bridge's viability for vehicular and truck traffic is essential for the safety, vitality, and resiliency both locally and regionally.

The Oregon Resilience Plan specifically addresses the need to prepare for a Cascadia Subduction Zone event and has designated U.S. 97 combined with a loop created by I-

84, I-5, and OR 58 near Eugene-Springfield as post-earthquake transportation backbone lifeline routes. As emergency supplies move east-west along I-84 and north-south along U.S. 97, the Hood River-White Salmon Bridge could also provide important access between states for freight mobility, emergency supplies delivery, and reconstruction assistance.

The Columbia River itself must also remain navigable after an earthquake to deliver goods and services on the river system; the Bridge must not block navigation. The regions ports and river traffic will play an important role in recovery after an earthquake as points of goods exchange, storage, equipment delivery and transfer, and response operations.

2 Seismic Hazard

Until the 1980s, the Pacific Northwest was generally believed to be seismically inactive despite its place along the Ring of Fire, the perimeter of the Pacific Ocean marked by historic and current volcanic activity. Relatively small local faults along the Hood River were believed to pose the greatest risk with potential to cause ground shaking up to magnitude 6 in the Hood River area. Recent historic and physical evidence compiled in the last 30 years led to greater awareness of different and possibly more catastrophic seismic events. An earthquake event is scientifically predicted to occur along the Cascadia Subduction Zone (CSZ), where the Juan de Fuca tectonic plate off the west coast is slowly pushing beneath the continental North American tectonic plate.

Seismic hazard is generally greater in areas to the west of the Cascade Mountain Range. Hood River is on the edge of the Cascades, but statewide emergency management coordination efforts have grouped Hood River County and its associated cities into a general region with other eastern Oregon counties that have relatively less seismic hazard. However, according to the Oregon Natural Hazards Mitigation Plan, Hood River and the Bridge have the soft soils and historical earthquakes that lead to greater damaging impacts compared to the rest of the region (State).

2.1 Seismic Scale

Earthquakes are measured on two scales: magnitude and intensity.

- Magnitude: The *Richter scale* was devised as a simple way to compare medium-sized earthquakes in Southern California in the 1930s. Over the years, other approaches were created to increase accuracy and account for very large, distant earthquakes. The current 1 to 10 scale used in the United States is the *Moment Magnitude scale* which compares the relative energy released by an earthquake. When earthquake numbers are reported today, it is typically the Moment Magnitude scale value although rarely identified as such.
- Intensity: The Modified Mercalli scale accounts for local effects, potential damage, and impact to humans, animals, structures, and natural objects. This scale uses Roman numerals I to XII.

Table 2-1. Modified Mercalli Scale Intensity

Level	Intensity
I	Not felt except by very few under especially favorable conditions
II	Felt only a few persons at rest, especially on upper floors of buildings
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings; many people do not recognize it as an earthquake; standing motor cars may rock slightly; vibrations similar to the passing of a truck; duration estimated
IV	Felt indoors by many, outdoors by few during the day; at night, some awakened; dishes, windows, doors disturbed; walls make cracking sound; sensation like heavy truck striking building; standing motor cars rocked noticeably
V	Felt by nearly everyone; many awakened; some dishes, windows broken; unstable objects overturned; pendulum clocks may stop
VI	Felt by all, many frightened; some heavy furniture moved; a few instances of fallen plaster; damage slight
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken
VIII	**Damage slight is specially designed structures; considerable damage in ordinary substantial buildings with partial collapse; damage great in poorly built structures; fall of chimneys, factory stacks, columns, monuments, walls; heavy furniture overturned**
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; damage great in substantial buildings with partial collapse; buildings shifted off foundations
X	Some well well-built wooden structures destroyed; most masonry and wood structures destroyed with foundations; rails bent
XI	Few, if any (masonry) structures standing; bridges destroyed; rails bent greatly
XII	Damage total; lines of sight and level are distorted; objects thrown into air

Source: Oregon Natural Hazards Mitigation Plan, Table 2-13. An earthquake will be quantified with a magnitude value, but its surrounding impacts are gauged by a range of intensity values. For example, the CSZ event in Oregon is expected to be a magnitude value between 8 or 9, but its intensity will range from VI to X across the state.

In the area of the Bridge, the Oregon Natural Hazards Mitigation Plan shows a Mercalli intensity value of Level VIII (State, Fig. 2-173). This relates to an approximate Richter Scale of 6 to 7, as shown in Table 2-2. In terms of expected damage and loss, the area is classified as a High Hazard location (State, Fig. 2-175).

Table 2-2. Earthquake Scale Comparison

Intensity (Mercalli)	Observations (Mercalli)	Richter Scale Magnitude (approx. comparison)
I	No effect	1 to 2
II	Noticed only by sensitive people	2 to 3
III	Resembles vibrations caused by heavy traffic	3 to 4
IV	Felt by people walking; rocking of free standing objects	4
V	Sleepers awakened; bells ring	4 to 5
VI	Trees sway, some damage from falling objects	5 to 6
VII	General alarm, cracking of walls	6
VIII	**Chimneys fall and some damage to building**	**6 to 7**
IX	Ground crack, houses begin to collapse, pipes break	7
X	Ground badly cracked, many buildings destroyed, some landslides	7 to 8
XI	Few buildings remain standing, bridges destroyed	8
XII	Total destruction, objects thrown in air, shaking and distortion of ground	8 or greater

Source: http://www.diffen.com/difference/Mercalli_Scale_vs_Richter_Scale

2.2 Sources of Seismic Hazard

The site that the Bridge is situated on has two main sources of seismic hazard which could produce two different types of earthquakes:

- Local Faults: The Hood River fault zone, located along the Hood River about 1 mile southeast of the Bridge and extending south. These are intra-crustal, near-surface faults having a localized impact. Ground shaking is likely to be of relative short duration, possibly high intensity, but will dissipate quickly away from the source.
- Large Plate Faults: The CSZ event, caused by movement along tectonic plates. Ground shaking is likely to be of extended duration with significant aftershocks. When these plates slip, the released energy will have an impact hundreds of miles inland.

A 2012 study of Pacific Northwest earthquake hazards published by the USGS determined that the odds are greater than one in three for a magnitude 8 CSZ earthquake event occurring within the next 50 years, and greater than one in ten for a magnitude 9 CSZ earthquake event within the next 50 years. Depending on the local soil and distance from the earthquake, the equivalent magnitude of a CSZ earthquake at the Bridge could be a magnitude 6 or more.

In addition to the direct ground shaking, the Bridge may experience direct damage associated with ground movement and soil failures. As described in the Oregon Natural Hazards Mitigation Plan, the area around the Bridge has the following vulnerabilities:

- **Ground amplification hazard is very high** (State, Fig. 2-169). Seismic shaking effects dissipate with distance from the location of the event. However, soft soils, like those found around the Port, can magnify ground motions and create greater hazard.
- **Susceptibility to liquefaction hazard is very high** (State, Fig. 2-170). Loose and saturated sandy soils can essentially become liquefied during an earthquake, losing the ability to support its own weight and loads from a bridge.
- **Susceptibility to landslide hazard induced by earthquakes is moderate** (State, Fig. 2-171). Strong ground shaking can cause new landslides or reactivate dormant ones. The Bridge is located on and surrounded by historically large landslides on both sides of the Columbia River. These large landslides pose a sizeable hazard for the Bridge.

3 Bridge Configuration

The Bridge today consists of several segments of different structures types, characterized mostly by the deck truss spans, but also the iconic through-truss lift span and towers, reinforced concrete spans, and steel girder spans. Each of the structure types will respond differently to an earthquake. Segments of the Bridge are grouped together for this vulnerability study, as follows and shown in the aerial view in:

- <u>Approach Spans</u>: There are two unique approach structure types on the two ends of the bridge which connect the Bridge to Oregon and Washington. Top down, the Oregon Approach spans are concrete deck supported on two continuous steel girders, which are supported on reinforced concrete piles substructure spliced to steel pile foundations. The Washington Approach spans are longer than the Oregon Approach and consist of concrete deck supported by eight reinforced concrete deck girder spans, which are supported on two-column bents substructure founded on spread footings. The Oregon and Washington Approach spans are relatively short and will have a minor response overall when characterizing the bridge response to earthquakes.
- <u>Steel Truss Spans</u>: The majority of the Bridge consists of an open grid steel decking on steel beams, which are supported by a steel truss that spans between concrete pier substructures, which then have variable foundation types below the water across the length of the bridge. Starting at the Oregon Approach spans, there are two pony trusses, eight deck trusses, and eight more deck trusses on the Washington side of the lift span. The steel through-truss on the lift span is included in the lift span discussion below. Given this type of structure is the longest, it most significantly characterizes the bridge response to earthquakes.
- <u>Lift Span</u>: The vertical lift span over the navigation channel includes a deck truss span, steel towers on each side with large concrete counterweights, and auxiliary trusses mounted to outboard of the adjacent Steel Truss Spans on either side of the lift span. This span includes electrical and mechanical movable bridge systems that

require specific discussion later in the report. The massive counterweights suspended high in the air will have a profound effect on the structure response to an earthquake.

Figure 3-1. Bridge Segments for Discussion of Seismic Vulnerability

4 Site Conditions

For this seismic vulnerability study, a desk top study of foundation soil conditions was conducted based on information currently available. All information shown for the site soils and geology was obtained from previously written documents. If the POHR advances the seismic retrofit design, then additional site soils investigation, geotechnical engineering, and site-specific geologic hazard characterizations are necessary. The depth of investigation will depend on the selected level of retrofit effort. The characteristics of foundation soils and slopes will have a marked impact on the structure response during an earthquake. *Soft soils can often amplify ground shaking; loose sandy soils are known to liquefy during an earthquake and can settle downward, lose capacity to support bridge foundations, and often result in slope instability causing landslides*.

The 1924 plans for the original bridge show approximately 40 feet of sandy alluvial deposits that make up the river bed of the Columbia River at the Bridge. Below these loose sandy soils is bedrock at about 40-foot below the mud line. Starting at the existing bridge foundation just north of the navigation channel and moving north towards the Washington shore, this bedrock rises quickly and is exposed in one nearby location. From the same lift span, approaching the Oregon mainland toward the south, the bedrock below the sand does not rise as quickly.

In 2011, a geotechnical data report was produced for the SR35 Columbia River Crossing Project (which looks at bridge replacement alternatives) in which three borings were taken west/downstream of the existing bridge and generally confirmed the bedrock depth shown on the 1924 plans.

Using the current bent numbering scheme from Oregon toward Washington, Piers 1 and 13-16, 18-20, and 21-28 are founded on spread footings. Abutment E, Bent D, and Bents 2-11 and 17 are founded on piles. Bent 12 is unique in that it was originally founded on a spread footing, but when the bridge was raised to accommodate the higher water elevation when the Bonneville Dam was installed, the Bent 12 footing was enlarged and deep foundation piles were added.

In 2009, a foundation report for the I-84 Exit 64 (Button Bridge Road) Bridge was also produced through a geotechnical investigation for the bridge replacement. The exit 64 Bridge is located just south of the Hood River-White Salmon Bridge, but the foundation report suggests the south bridge abutment area consists of alluvial river deposits underlain by deep basalt (bed rock). Basically, the south abutment area is loose sandy fill that may liquefy in an earthquake, resulting in loss of foundation strength.

5 Structural Seismic Vulnerabilities

A preliminary review of the bridge identified several potential seismic vulnerabilities. Identification is based on a study of the bridge configuration and site conditions, combined with experience on detailed analysis and design of similar structure types and bridge retrofits in the Pacific Northwest.. A specific analysis of the bridge for seismic loading was not completed at this early phase. Additional analysis is needed to better define the deficiencies and costs for retrofit. A drawing of the Bridge elevation found in Appendix B shows the locations of the seismic vulnerabilities described in the following sections. As described above, the various structure types that define the Bridge configuration have unique vulnerabilities and are separated for clarity.

5.1 Oregon Approach Spans

The two steel girder spans on the Oregon Approach have potential seismic vulnerabilities shown in Table 5.1 and further described in Appendix B.

Table 5-1. Oregon Approach Span Structure Seismic Vulnerabilities

Bridge Feature	Seismic Vulnerabilities & Anticipated Consequences	Location Details
Seat Width / Transverse Restraints	• Insufficient beam seat length and inadequate transverse restraints for lateral loading. • *Consequence: spans may fall off of the supports. Extended closure is anticipated.*	Abutment E, Bent D, and Bent 1
Pile Bents	• Concrete column and pile internal steel reinforcing is inadequate to confine the concrete core and will not be reliably ductile when subjected to cyclic loading. • Concrete piles to steel piles splices are poorly confined and prone to brittle shear failure. • *Consequence: piers may fail and collapse. Extended closure is anticipated.*	Bent D
Knee Wall and Connection to Substructure	• The knee wall and its connection to the pier cap may lack sufficient strength to resist design seismic forces. • *Consequence: structure damage that may result in loss of strength and repair is anticipated.*	Bent 1
Pile Caps	• Pile cap foundations may lack adequate size and strength to resist seismic demands from pier walls • *Consequence: structure damage that may result in loss of strength and repair is anticipated.*	Bent E

5.2 Washington Approach Spans

The eight reinforced concrete deck girder spans on the Washington Approach have potential seismic vulnerabilities shown in Table 5.2 and further described in Appendix B.

Table 5-2. Washington Approach Span Structure Seismic Vulnerabilities

Bridge Feature	Seismic Vulnerabilities & Anticipated Consequences	Location Details
Seat Width / Transverse Restraints	• Insufficient beam seat length and inadequate transverse restraint against lateral seismic forces. • *Consequence: spans may fall off of the supports. Extended closure is anticipated.*	Bent 20, Bents 21 through 28
Connection of Superstructure to Substructure	• At the fixed end of each girder, the existing girder to crossbeam dowel connection lacks sufficient strength to resist lateral seismic forces. • *Consequence: spans may fall off of the supports. Severe damage is anticipated.*	Bents 20 through 28
End Diaphragms	• End diaphragms may lack adequate strength to resist column demand loads • *Consequence: structure damage that may result in loss of strength and repair is anticipated.*	Bent 20 and Bent 28
Crossbeams	• Existing crossbeams may lack adequate strength to resist the forces transferred from columns during seismic events. • *Consequence: structure damage that may result in loss of strength and repair or replacement is anticipated.*	Bents 21 through 27
Column Extensions and Connections	• Column extensions at Bent 20 to support the reinforced concrete deck girder span (Span 20) are inadequately confined for reliable ductility when the bridge is subjected to cyclic loading and are more prone to brittle shear failure. • The dowel connection at the base of the column extension to the top of Bent 20 may lack sufficient strength to resist design seismic forces. • *Consequence: structure damage that may result in loss of strength and repair or replacement is anticipated.*	Bent 20
Spread Footings	• Existing spread footing foundations are too small and may lack adequate size and strength to resist seismic demand loads. • *Consequence: piers may fail and collapse. Extended closure is anticipated.*	Bents 20-28
Columns	• Existing columns internal steel reinforcing is inadequate to confine the concrete core and will not be reliably ductile when the bridge is subjected to cyclic loading. • *Consequence: columns may fail causing collapse of spans. Extended closure is anticipated.*	Bents 21-27

5.3 Steel Truss Spans Seismic Vulnerabilities

The many Steel Truss spans on the bridge have potential seismic vulnerabilities shown in Table 5.3 and further described in the Appendix B figures.

Table 5-3. Steel Truss Spans Structure Seismic Vulnerabilities

Bridge Feature	Seismic Vulnerabilities & Anticipated Consequences	Location Details
Seat Width / Transverse Restraints	• Insufficient beam seat length and inadequate transverse restraint against lateral seismic forces. • *Consequence: spans may fall off of the supports. Extended closure expected.*	Bent 1-20
Truss Members and Connections	• Existing steel gusset plates and truss members may lack sufficient strength to resist design seismic forces. • *Consequence: structure damage may result in closure of spans to repair steel. Extended closure expected.*	Spans 1-10, 12-19
Pile Caps	• Pile caps may lack adequate size and strength to resist seismic demand loads. • *Consequence: structure damage that may result in loss of strength. Repair is anticipated.*	Bents 2-11, 17
Pier Walls	• Existing pier walls may lack sufficient flexural and shear strength to resist design seismic forces. • *Consequence: structure damage that may result in loss of strength. Repair or replacement is anticipated.*	Bents 1-20
Bearings	• Steel rocker bearings are unstable during a seismic event and may tip over. Fixed steel bearings may be unable to transfer seismic forces to the substructure. • *Consequence: Trusses may fall off the piers. Extended closure expected.*	Bents 1-20
Spread Footings	• Existing spread footing foundations are too small and may lack adequate size and strength to resist seismic demand loads. • *Consequence: piers may fail and collapse. Extended closure expected.*	Bents 1, 12-16, 18-20

5.4 Lift Span Seismic Vulnerabilities

The Lift Span has a number of unique potential seismic vulnerabilities shown in Table 5.4 and further described in the Appendix B figures. This discussion excludes the deficiencies already noted in Section 5.3 regarding the concrete piers and steel truss spans, but these deficiencies are present in Span 11 and the flanking Spans 10 and 12.

Table 5-4. Lift Span Seismic Vulnerabilities

Bridge Feature	Seismic Vulnerabilities & Anticipated Consequences	Location Details
Concrete Counterweights	• Massive counterweights suspended near the tops of towers are expected to sway and impact the towers, causing damage. In addition, the massive swaying weight can imbalance the tower and overstress the structure. • *Consequence: full collapse of the towers and flanking spans is possible. Major damage and extended closure expected.*	Lift Span Towers
Gusset plates and Connections	• Existing steel gusset plates and truss members may lack sufficient strength to resist design seismic forces which are amplified due to the counterweight. • *Consequence: structure damage may result in closure of spans to repair steel. Extended closure expected.*	Span 11, Towers, Auxiliary Trusses
Steel truss members	• Existing steel truss members may lack sufficient strength to resist design seismic forces. • *Consequence: structure damage may result in closure of spans to repair steel. Extended closure expected.*	Span 11, Towers, Auxiliary Trusses
Mechanical & Electrical Equipment	• Various pieces may not be sufficiently secured to the bridge. • *Consequence: structure damage that may result in loss of strength. Repair or replacement is anticipated.*	Top of towers & operator's house
Bearings	• Steel rocker bearings are unstable during a seismic event and may tip over. Fixed steel bearings may be unable to transfer seismic forces to the substructure. • *Consequence: Trusses may fall off the piers. Extended closure expected.*	Piers 11 & 12
Foundations	• Existing foundations are too small and very likely lack adequate size and strength to resist seismic demand loads which are significantly amplified by the tall towers and counterweights. • *Consequence: piers may fail and collapse. Extended closure expected.*	Piers 11 & 12

6 Seismic Retrofit Approach

Using current high-level approaches to preliminary seismic risk assessment, the Bridge's potential areas of vulnerability were identified. Appropriate preliminary retrofit alternatives are outlined with associated concept level estimated costs. A full implementation of these retrofits can be made, or the retrofits can be implemented using a step-wise approach.

6.1 Full Retrofit Approach

There are three general approaches to mitigate the seismic vulnerabilities of the Bridge: Do Nothing, Phase 1, and Phase 2. These are described further as:

1. **Do Nothing** – This alternative involves the Bridge remaining as it is, along with continued routine inspections and monitoring. In the event of an earthquake, the structure will likely experience significant damage to the lift span and truss spans, and be inaccessible for at least months, if not years. If a large CSZ earthquake occurs, many regional resources will be strained further increasing the time required to restore the bridge. The Bridge is expected to need extensive repairs, including full span and pier replacements to restore the connection across the river. The lift span is particularly vulnerable and the U.S. Coast Guard is unlikely to allow limited vertical clearance after an earthquake, as large barges and vessels will be needed for regional recovery.
2. **Phase 1 Seismic Retrofit:** – This approach to seismic retrofit meets the "life safety" design criteria used by Oregon Department of Transportation (ODOT) and the Federal Highway Administration (FHWA). It is associated with less frequent, stronger ground shaking forces and focuses on preventing loss of life. After an earthquake, the structure may not be useable but will be stable enough to allow people to evacuate the bridge to safety. The Bridge may then need extensive repairs or may need to be mostly replaced. A Phase 1 Seismic Retrofit secures the span trusses and beams to their supporting foundations to prevent them from falling off during an earthquake. Damage will occur and need to be repaired.
3. **Phase 2 Seismic Retrofit** – This approach to seismic retrofit typically includes all retrofit measures needed to meet the Phase 1 seismic retrofit, as well as a higher level of resiliency as it seeks to meet the post-earthquake "serviceability" design criteria used typically by ODOT and FHWA. Designing for this alternative is associated with more frequent, lower magnitude ground shaking forces and requires the structure to remain useable post-earthquake, possibly with minor repair. In addition to the Phase 1 work, it increases the strength or ductility of the substructure and foundations (piers, footings, and piles) to resist or accommodate anticipated seismic loads. This can involve enlargement of the substructure and foundations by adding concrete and steel, seismic isolation bearings, and possibly soil improvements to combat potential soil liquefaction (loss of supporting strength during an earthquake). Phase 2 Seismic Retrofit is expected to cost more than Phase 1, but result in a much more resilient infrastructure and much shorter time the Bridge will be out of service.

The cost of full implementation of the retrofits is presented below.

Table 6-1. Overview of Bridge Seismic Retrofit Alternatives & Concept Costs

Approach	Time to Complete Retrofit	Cost to Construct Retrofit
Do Nothing	0 mos.	$ 0 M
Phase 1 Seismic Retrofit	24 mos.	$16 M
Phase 2 Seismic Retrofit	48 mos.	$124 M

After an earthquake, the Bridge is expected to require a varying amount of repair and will have associated closures to repair and replace damaged components before being reopened. The table below provides concept-level estimates of the anticipated impacts.

Table 6-2. Overview of Bridge Post-Earthquake Impacts

Approach	Shortest Post-EQ Closure	Anticipated Post-EQ Closure	Order of Magnitude Cost to Remedy Damage
Do Nothing	12 mos.	48 mos.	$180 M
Phase 1 Seismic Retrofit	3 mos.	6 mos.	$30 M
Phase 2 Seismic Retrofit	< 1 wk.	< 1 mo.	$3 M

6.2 Step-Wise Seismic Retrofit Approach

If funds are not available to fully implement a Phase 1 or Phase 2 seismic retrofit, it is feasible to implement seismic retrofit in a step-wise approach or a program of retrofits. There are several ways to implement a step-wise retrofit program. There is a relatively high likelihood of an earthquake that will cause damage on the Bridge. A possible approach to implementing retrofits is to focus on each segment of the Bridge.

The approach presented below assumes that the elements of the bridge which are most costly to repair are retrofit first. The step-wise approach also assumes a Phase 1 approach, prior to Phase 2. Conducting a Phase 1 type retrofit has the potential for a greater resiliency against smaller level earthquakes when compared to the existing condition, but also requires a much smaller initial expenditure to complete. The Port must decide the most reasonable approach given. The table below provides an overview of the costs of a step-wise implementation of retrofit. Additional details are provided in Appendix B.

Table 6-3. Step-Wise Approach to Improving Seismic Resiliency

Phase	Step	Cost		Benefit Gained
		Each Step	Cumulative	
1	1	$1,752,000	$1,752,000	Reduce probability of Lift Span collapse
	2	$11,431,000	$13,183,000	Reduce probability of Steel Truss Spans collapse
	3	$2,030,000	$15,213,000	Reduce probability of WA Approach Spans collapse
	4	$990,000	$16,203,000	Reduce probability of OR Approach Spans collapse
2	1	$7,285,000	$7,285,000	Greatly increased resiliency of Lift Span
	2	$107,086,000	$114,371,000	Greatly increased resiliency of Steel Truss Spans
	3	$8,344,000	$122,715,000	Greatly increased resiliency of WA Approach Spans
	4	$925,000	$123,640,000	Greatly increased resiliency of OR Approach Spans

7 Concept Cost Estimates

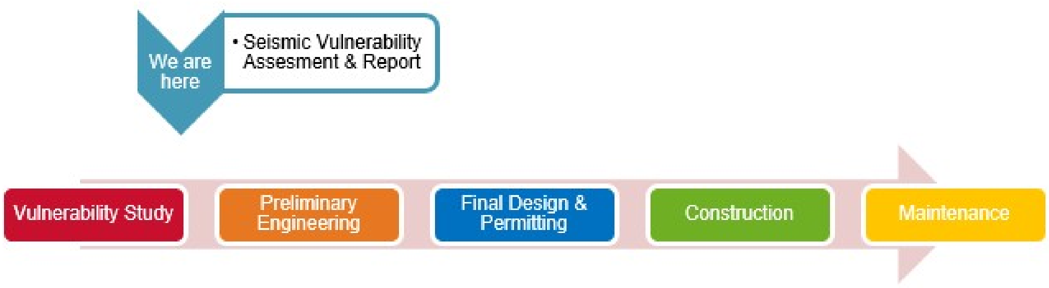
Construction cost estimates were prepared for each alternative based on estimated quantities and unit pricing for the proposed retrofit measures. Non-bridge-related costs were estimated based on anticipated access, traffic control, and roadway impacts. A 10 percent mobilization factor, 35 percent contingency factor, 15 percent preliminary engineering factor, and 15 percent construction engineering and inspection factor were applied to the construction subtotal. The detailed cost estimate summary is provided in Appendix A.

8 Seismic Resiliency Process

The process toward improving the Bridge's seismic resiliency involves a series of intentional steps of engineering analysis, design, permitting, external coordination, and construction to advance toward implementation of a solution that would meet the goals and objectives of the Port.

1. **Seismic Vulnerability Assessment**: The concept study and report (which is covered by this report) is the first step in the process toward improving the Bridge's seismic resiliency by the constructing physical retrofit. This study provides high-level information to make risk-based and informed decisions and utilizes existing drawings and applying engineering experience and judgment to identify potential vulnerabilities and resolution. Detailed seismic analysis of the existing bridge is not conducted at this time. This step solely provides decision-making information.

Figure 8-1. Process Toward Improved Bridge Seismic Resiliency



2. **Preliminary Engineering:** The next step is to finalize the design criteria and conduct analytical calculation of the bridge in order to pin down the specific locations and magnitude of vulnerabilities and identify actual retrofit design solutions to mitigate the seismic vulnerabilities. In the Preliminary Engineering phase, a structural analysis of the Bridge is conducted to characterize and quantify the response to an earthquake using specialized software programs. The results of this analysis provide the data needed to develop cost estimates and schedule implications if taken through construction. At the beginning of this phase, the Port can select a preferred alternative and level of retrofit or choose to advance multiple alternatives to have better data to support decision-making. Depending on the selected alternative for seismic retrofit, which the Port may want to better understand or advance in this step,

a more detailed analysis may be required in this phase. For example, a simple Phase 1 Seismic Retrofit Alternative will require less data collection and engineering analysis. A Phase 2 Seismic Retrofit Alternative, in contrast, will require a more detailed analysis, and supporting data such as subsurface soil borings in the river. The Port should finalize the selection of the preferred alternative by the end of the Preliminary Engineering phase. The Port should select a level of seismic retrofit that best resolves the goals and objectives of the Port within the available means.

3. **Final Design & Permitting:** In this step of the seismic retrofit process, the preferred alternative is advanced through a series of analysis and design task to culminate in construction bid plans, specification, and detailed construction cost estimates. This step requires external stakeholder engagement and partnering with regulatory and impacted agencies, such as the U.S. Coast Guard, cities, counties, and state governments on both sides of the river. Environmental and public impacts may need to be identified, quantified, and mitigated in order to avoid extensive impacts. Depending on the selected level of seismic resiliency and level of impacts that could result from construction (e.g., noise, traffic) the design may be more or less complicated.
4. **Construction:** Once the design is complete and final plans and specs are ready for bid, a contractor can be selected and full construction implemented. This is typically the most costly steps as it involves mobilizing the contractor and associated risks.
5. **Maintenance:** After construction is completed and documented, it is important to continue to monitor, maintain, operate, and repair the Bridge to ensure the designs installed for retrofit are in good working order. For example, bearings and seismic restrainers, if used, will need on-going inspection and maintenance. The lift span of the Bridge will require on-going maintenance to ensure proper performance.

9 Key Issues for Seismic Retrofit

The Bridge and site include the following features relevant to eventual seismic retrofit:

- **Traffic**: The estimated average daily traffic (ADT) at this Bridge in year 2014 was 13,300 vehicles per day, with approximately 29 percent being commercial trucks. The detour route via the Bridge of the Gods in Cascade Locks, Oregon is approximately 40 miles, though there is seasonal flux due to the harvest season. Construction closures will negatively impact traffic flow and should consider seasonal peak volumes.
- **Utilities**: The Bridge carries gas and communications lines. If retrofit design cannot accommodate the existing conduits, relocation coordination will be required.
- **Geometrics**: The existing roadway width is 19'-6" and on a straight alignment, with a horizontal curve at the Washington shore. Vertical grade on the Oregon Approach is +3.0 percent, transitioning to +1.0 percent to the lift span. On the north side of the lift span, the -1.0 percent grade transitions to a level grade and then to a series of short vertical curves on the Washington Approach. Overhead vertical clearance is 15'-9" at the lift span truss. Retrofit design will not change existing grades or reduce clearances.

- **Safety:** The Bridge inspection reports, anecdotal reports, and field observations indicate the bridge rail is substandard. There are numerous dings and scrapes on the bridge rail and lift span truss elements due to the substandard roadway width and travel speeds exceeding posted limits. Construction traffic control will need to account for these hazards.
- **Environmental:** Various species of concern, including salmon, inhabit the Columbia River. Forested wetlands may be present on the Washington shore. Migratory Bird Treaty Act compliance provisions must be met, and construction work below the ordinary high water may require permitting with the U.S. Army Corps of Engineers (USACE) and the Department of State Lands (DSL). To meet construction schedules, design should account for the various species and necessary permitting lead times.
- **Right-of-Way/Access:** There is no existing access road to the Columbia River, however, there are boat launches on both shores downstream of the bridge. There is a pedestrian path under Span 2 on the Oregon shore; a single railroad track passes under Span 26 on the Washington shore. Heavy vegetation and trees are under the Washington Approach. Construction access may require vegetation grubbing, railroad coordination, barge docking, and equipment delivery routes.

10 References

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Appendix A. Cost Estimate Summary

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

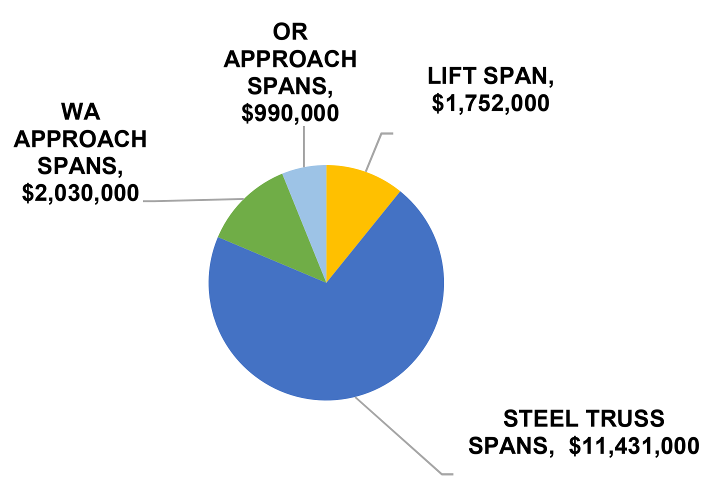
Concept Cost Estimates for Seismic Retrofits

All Phases | All Steps

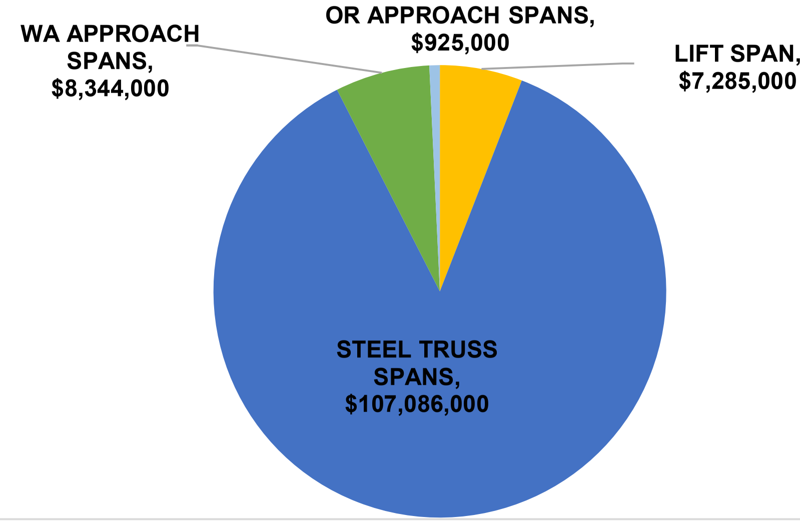
1/17/2017

PHASE	STEP	RETROFIT AREA - LOCATION	STEP TOTAL	CUMM. TOT.
1	1	LIFT SPAN	$ 1,752,000	$ 1,752,000
	2	STEEL TRUSS SPANS	$ 11,431,000	$ 13,183,000
	3	WA APPROACH SPANS	$ 2,030,000	$ 15,213,000
	4	OR APPROACH SPANS	$ 990,000	$ 16,203,000
2	1	LIFT SPAN	$ 7,285,000	$ 7,285,000
	2	STEEL TRUSS SPANS	$ 107,086,000	$ 114,371,000
	3	WA APPROACH SPANS	$ 8,344,000	$ 122,715,000
	4	OR APPROACH SPANS	$ 925,000	$ 123,640,000

PHASE 1 SEISMIC RETROFITS



PHASE 2 SEISMIC RETROFITS



PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 1

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
LIFT SPAN	Span 11, Bents 11-12	LS	1	$ 745,000	$ 745,000
	7 Strengthen truss members & connections	LS	1	$ 480,000	$ 480,000
	Structural steel	LB	24000	$ 20	$ 480,000
	8 Strengthen truss members & connections	LS	1	$ 240,000	$ 240,000
	Structural steel	LB	12000	$ 20	$ 240,000
	9 Secure mechanical equipment	LS	1	$ 25,000	$ 25,000
		LS	1	$ 25,000	$ 25,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 745,000**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	0.5%	$ 3,700
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 44,700
Contractor Mobilization	8.0%	12.0%	10.0%	$ 74,500
Erosion Control	0.5%	2.0%	0.5%	$ 3,700
Construction Contingency	5.0%	45.0%	40.0%	$ 298,000
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 149,200
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 573,800***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 1,319,000***

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$5,000	$ 5,000
Owner Administrative Costs	5.0%	15.0%	8.0%	$ 105,500
Design Consulting Engineering	8.0%	15.0%	12.0%	$ 158,300
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 158,300
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 433,000***
TOTAL PROJECT COST ESTIMATE				***$ 1,752,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 2

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
STEEL TRUSS SPANS	Bents 1-11 and 12-20	LS	1	$ 2,160,000	$ 2,160,000
	1 Enlarge seat/shear lugs	LS	1	$ 1,320,000	$ 1,320,000
	Concrete	CUYD	560	$ 1,500	$ 840,000
	Reinforcement	LB	150000	$ 1	$ 150,000
	Dowels	EACH	5000	$ 30	$ 150,000
	P/T	LB	18000	$ 10	$ 180,000
	6 Replace steel bearings	LS	1	$ 840,000	$ 840,000
	Bearings	EACH	84	$ 10,000	$ 840,000
	Spans 1-10 and 12-19	LS	1	$ 2,880,000	$ 2,880,000
	7 Strengthen truss members & connections	LS	1	$ 2,880,000	$ 2,880,000
	Structural steel	LB	144000	$ 20	$ 2,880,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 5,040,000**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	0.5%	$ 25,200
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 302,400
Contractor Mobilization	8.0%	12.0%	10.0%	$ 504,000
Erosion Control	0.5%	2.0%	0.5%	$ 25,200
Construction Contingency	5.0%	45.0%	40.0%	$ 2,016,000
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 1,008,900
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 3,881,700***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 8,922,000***

(121)

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 2

1/17/2017

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$5,000	$ 5,000
Owner Administrative Costs	5.0%	15.0%	6.0%	$ 535,300
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 892,200
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 1,070,600
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 2,509,000***
TOTAL PROJECT COST ESTIMATE				***$ 11,431,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 3

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
WASHINGTON APPROACH SPANS	Bents 20 and 28	LS	1	$ 185,200	$ 185,200
	1 Enlarge seat/shear lugs	LS	1	$ 132,000	$ 132,000
	Concrete	CUYD	56	$ 1,500	$ 84,000
	Reinforcement	LB	15000	$ 1	$ 15,000
	Dowels	EACH	500	$ 30	$ 15,000
	P/T	LB	1800	$ 10	$ 18,000
	3 Allow dowel fuse	EACH	2	$ -	$ -
	4 Strengthen end diaphragm	LS	1	$ 53,200	$ 53,200
	Concrete	CUYD	26	$ 1,500	$ 39,000
	Reinforcement	LB	7000	$ 1	$ 7,000
	Dowels	EACH	240	$ 30	$ 7,200
	Bents 21-27	LS	1	$ 711,200	$ 711,200
	1 Enlarge seat/shear lugs	LS	1	$ 462,000	$ 462,000
	Concrete	CUYD	196	$ 1,500	$ 294,000
	Reinforcement	LB	52500	$ 1	$ 52,500
	Dowels	EACH	1750	$ 30	$ 52,500
	P/T	LB	6300	$ 10	$ 63,000
	3 Allow dowel fuse	LS	9	$ -	$ -
	5 Strengthen crossbeams	LS	1	$ 249,200	$ 249,200
	Concrete	CUYD	91	$ 1,500	$ 136,500
	Reinforcement	LB	24500	$ 1	$ 24,500
	Dowels	EACH	840	$ 30	$ 25,200
	P/T	LB	6300	$ 10	$ 63,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 896,400**

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 3

1/17/2017

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	1.0%	$ 9,000
Temp. Protection & Direction of Traffic	3.0%	8.0%	3.0%	$ 26,900
Contractor Mobilization	8.0%	12.0%	10.0%	$ 89,600
Erosion Control	0.5%	2.0%	0.5%	$ 4,500
Construction Contingency	5.0%	45.0%	40.0%	$ 358,600
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 176,600
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 665,200***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 1,562,000***

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$100,000	$ 25,000
Owner Administrative Costs	5.0%	15.0%	6.0%	$ 93,700
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 156,200
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 187,400
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 468,000***
TOTAL PROJECT COST ESTIMATE				***$ 2,030,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Phase 1 | Step 4

Concept Cost Estimates for Seismic Retrofits

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
OREGON APPROACH SPANS	Bent E	LS	1	$ 66,000	$ 66,000
	1 Enlarge seat/shear lugs	LS	1	$ 66,000	$ 66,000
	Concrete	CUYD	28	$ 1,500	$ 42,000
	Reinforcement	LB	7500	$ 1	$ 7,500
	Dowels	EACH	250	$ 30	$ 7,500
	P/T	LB	900	$ 10	$ 9,000
	Spans SE and SD	LS	1	$ 300,000	$ 300,000
	2 Replace with one span	LS	1	$ 300,000	$ 300,000
	Deck area estimate	SF	2000	$ 150	$ 300,000
	Bent 1	LS	1	$ 66,000	$ 66,000
	1 Enlarge seat/shear lugs	LS	1	$ 66,000	$ 66,000
	Concrete	CUYD	28	$ 1,500	$ 42,000
	Reinforcement	LB	7500	$ 1	$ 7,500
	Dowels	EACH	250	$ 30	$ 7,500
	P/T	LB	900	$ 10	$ 9,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 432,000**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	0.5%	$ 2,200
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 25,900
Contractor Mobilization	8.0%	12.0%	10.0%	$ 43,200
Erosion Control	0.5%	2.0%	0.5%	$ 2,200
Construction Contingency	5.0%	45.0%	40.0%	$ 172,800
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 86,500
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 332,800***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 765,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 1 | Step 4

1/17/2017

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$5,000	$ 5,000
Owner Administrative Costs	5.0%	15.0%	6.0%	$ 45,900
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 76,500
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 91,800
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 225,000***
TOTAL PROJECT COST ESTIMATE				***$ 990,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | Step 1

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
LIFT SPAN	Bents 11-12	LS	1	$ 3,200,000	$ 3,200,000
	17 Isolation bearings & seismic restrainers	EA	16	$ 200,000	$ 3,200,000
					$ -
					$ -
					$ -
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 3,200,000**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	1.0%	$ 32,000
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 192,000
Contractor Mobilization	8.0%	12.0%	10.0%	$ 320,000
Erosion Control	0.5%	2.0%	0.5%	$ 16,000
Construction Contingency	5.0%	45.0%	40.0%	$ 1,280,000
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 642,600
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 2,482,600***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 5,682,600***

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$5,000	$ 5,000
Owner Administrative Costs	5.0%	15.0%	6.0%	$ 341,000
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 568,300
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 681,900
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 1,602,000***
TOTAL PROJECT COST ESTIMATE				***$ 7,285,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | Step 2

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
STEEL TRUSS SPANS	Bents 1, 12-16, 18-20	LS	1	$ 4,323,400	$ 4,323,400
	13 Strengthen spread footings	LS	1	$ 4,323,400	$ 4,323,400
	Concrete	CUYD	2140	$ 1,500	$ 3,210,000
	Reinforcement	LB	535000	$ 1	$ 535,000
	Dowels	EACH	15000	$ 30	$ 450,000
	Excavation	CUYD	4280	$ 30	$ 128,400
	Bents 1-20	LS	1	$ 9,696,000	$ 9,696,000
	16 Strengthen pier walls	LS	1	$ 9,696,000	$ 9,696,000
	Concrete	CUYD	4800	$ 1,500	$ 7,200,000
	Reinforcement	LB	1200000	$ 1	$ 1,200,000
	Dowels	EACH	43200	$ 30	$ 1,296,000
	Bent 20	LS	1	$ 50,000	$ 50,000
	12 Strengthen column extension & connection	LS	1	$ 50,000	$ 50,000
		LS	1	$ 50,000	$ 50,000
	Bents 2-11,17	LS	1	$ 37,386,950	$ 37,386,950
	15 Strength pile caps	LS	1	$ 37,386,950	$ 37,386,950
	Concrete	CUYD	11690	$ 1,500	$ 17,535,000
	Reinforcement	LB	2922000	$ 1	$ 2,922,000
	Dowels	EACH	17315	$ 30	$ 519,450
	Excavation	CUYD	17530	$ 30	$ 525,900
	Drilled shaft concrete	CUYD	8200	$ 400	$ 3,280,000
	Drilled shaft reinf	LB	983000	$ 1	$ 983,000
	CSL tubes	LF	35200	$ 8	$ 281,600
	CSL tests	EACH	880	$ 1,000	$ 880,000
	Drilled shaft excavation	CUYD	8200	$ 900	$ 7,380,000
	Permanent casing	LF	4400	$ 700	$ 3,080,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 51,456,350**

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | **Step 2**

1/17/2017

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	1.0%	$ 514,600
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 3,087,400
Contractor Mobilization	8.0%	12.0%	10.0%	$ 5,145,600
Erosion Control	0.5%	2.0%	0.5%	$ 257,300
Construction Contingency	5.0%	45.0%	35.0%	$ 18,009,700
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 10,004,800
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 37,019,400***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 88,475,750***

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$10,000	$ 10,000
Owner Administrative Costs	5.0%	15.0%	5.0%	$ 4,423,800
Design Consulting Engineering	8.0%	15.0%	8.0%	$ 7,078,100
Construction Admin, Engineering, & Inspection	8.0%	15.0%	8.0%	$ 7,078,100
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$20,000	$ 20,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 18,610,000***
TOTAL PROJECT COST ESTIMATE				***$ 107,086,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | Step 3

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
WASHINGTON APPROACH SPANS	Bent 28	LS	1	$ 250,000	$ 250,000
	10 Leave end bents, improve approach soil	LS	1	$ 250,000	$ 250,000
		LS	1	$ 250,000	$ 250,000
	Bents 21-28	LS	1	$ 3,502,450	$ 3,502,450
	13 Strengthen spread footings	LS	1	$ 759,850	$ 759,850
	Concrete	CUYD	400	$ 1,500	$ 600,000
	Reinforcement	LB	98000	$ 1	$ 98,000
	Dowels	EACH	1800	$ 30	$ 54,000
	Excavation	CUYD	785	$ 10	$ 7,850
	14 Strengthen columns	LS	1	$ 2,742,600	$ 2,742,600
	Concrete	CUYD	1470	$ 1,500	$ 2,205,000
	Reinforcement	LB	367500	$ 1	$ 367,500
	Dowels	EACH	5670	$ 30	$ 170,100
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 3,752,450**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	0.5%	$ 18,800
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 225,100
Contractor Mobilization	8.0%	12.0%	10.0%	$ 375,200
Erosion Control	0.5%	2.0%	0.5%	$ 18,800
Construction Contingency	5.0%	45.0%	40.0%	$ 1,501,000
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 751,200
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 2,890,100***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 6,642,550***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | Step 3

1/17/2017

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$20,000	$ 20,000
Owner Administrative Costs	5.0%	15.0%	5.0%	$ 332,100
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 664,300
Construction Admin, Engineering, & Inspection	8.0%	15.0%	10.0%	$ 664,300
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 20,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 1,701,000***
TOTAL PROJECT COST ESTIMATE				***$ 8,344,000***

PORT OF HOOD RIVER BRIDGE - SEISMIC VULNERABILITY STUDY

Concept Cost Estimates for Seismic Retrofits

Phase 2 | Step 4

1/17/2017

RETROFIT TYPE & LOCATION		UNIT	QTY.	UNIT COST	SUBTOTAL
OREGON APPROACH SPANS	Bent E	LS	1	$ 250,000	$ 250,000
	10 Leave end bents, improve approach soil	LS	1	$ 250,000	$ 250,000
		LS	1	$ 250,000	$ 250,000
	Bent 1	LS	1	$ 50,000	$ 50,000
	11 Strengthen knee wall & connection	LS	1	$ 50,000	$ 50,000
		LS	1	$ 50,000	$ 50,000
SUBTOTAL (RAW CONSTRUCTION COSTS)					**$ 300,000**

ADDITIONAL CONSTRUCTION ITEMS	LOW	HIGH	ESTIMATE	SUBTOTAL
Construction Surveying	0.5%	5.0%	50.0%	$ 150,000
Temp. Protection & Direction of Traffic	3.0%	8.0%	6.0%	$ 18,000
Contractor Mobilization	8.0%	12.0%	10.0%	$ 30,000
Erosion Control	0.5%	2.0%	0.5%	$ 1,500
Construction Contingency	5.0%	45.0%	40.0%	$ 120,000
Construction Cost Escalation (%/year)	0.5%	3.5%	3.0%	-
Year of Cost & Total Escalation	2018	2022	2020	$ 79,000
SUBTOTAL (ADDITIONAL CONSTRUCTION ITEMS)				***$ 398,500***
TOTAL ESTIMATED CONSTRUCTION COST				***$ 698,500***

ADDITIONAL PROJECT COSTS	LOW	HIGH	ESTIMATE	SUBTOTAL
Right-of-Way & Easements	$ 5,000	$ 200,000	$5,000	$ 25,000
Owner Administrative Costs	5.0%	15.0%	6.0%	$ 41,900
Design Consulting Engineering	8.0%	15.0%	10.0%	$ 69,900
Construction Admin, Engineering, & Inspection	8.0%	15.0%	12.0%	$ 83,800
Reimburseable Utility Relocations	$ 5,000	$ 50,000	$5,000	$ 5,000
SUBTOTAL (ADDITIONAL PROJECT ITEMS)				***$ 226,000***
TOTAL PROJECT COST ESTIMATE				***$ 925,000***

Appendix B. Preliminary Vulnerabilities & Retrofit Concepts

Xrefs: POHR_TO2_Bridge_Border.dwg X_POHR_Bridge.dwg
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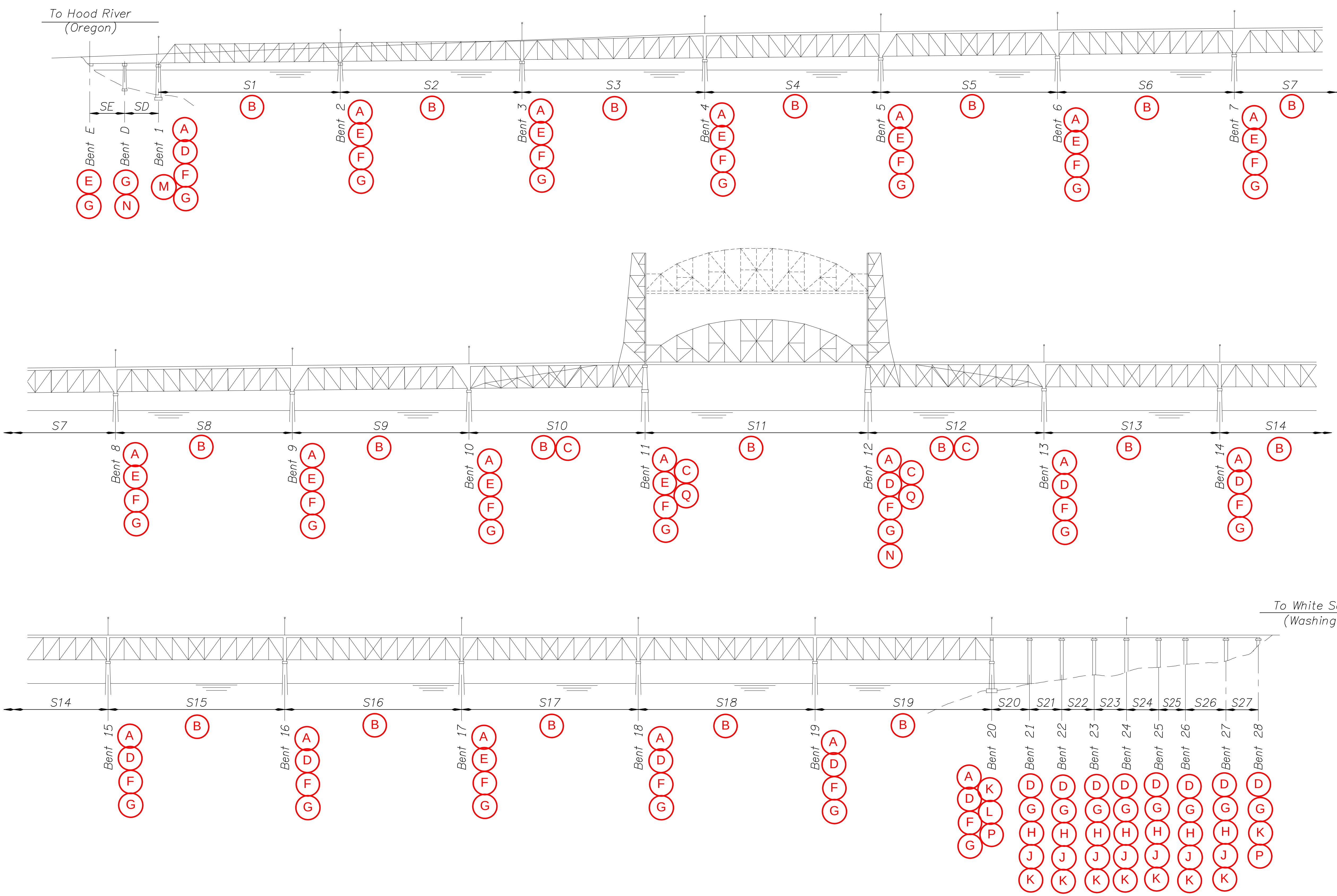

Potential Vulnerabilities Legend

- (A) Unstable bearings
- (B) Weak truss members & connections
- (C) Weak tower members & connections
- (D) Weak spread footings
- (E) Weak pile caps
- (F) Stiff or weak pier walls
- (G) Insufficient seat width/transverse restraint
- (H) Weak crossbeams
- (J) Unconfined columns
- (K) Weak dowel super-/substructure connection
- (L) Unconfined column extension & connection
- (M) Weak knee wall & connection
- (N) Weak pile bent
- (P) Weak end diaphragm
- (Q) Unsecured mechanical equipment

(134)

△	DATE	REVISION	BY

ACCOMPANIED BY DWGS.

DRAFTER:
DESIGNER:
CHECKER:
REVIEWER:

EXPIRES:
EXPIRES:

STRUCTURE NO. 00645
DATE July 2016
CALC. BOOK

HOOD RIVER INTERSTATE BRIDGE

HOOD RIVER - WHITE SALMON HIGHWAY
HOOD RIVER, OR & KLICKITAT, WA COUNTIES

POHR TO2
POTENTIAL VULNERABILITIES

SHEET
OF
DRAWING NO.
--

REPORTS

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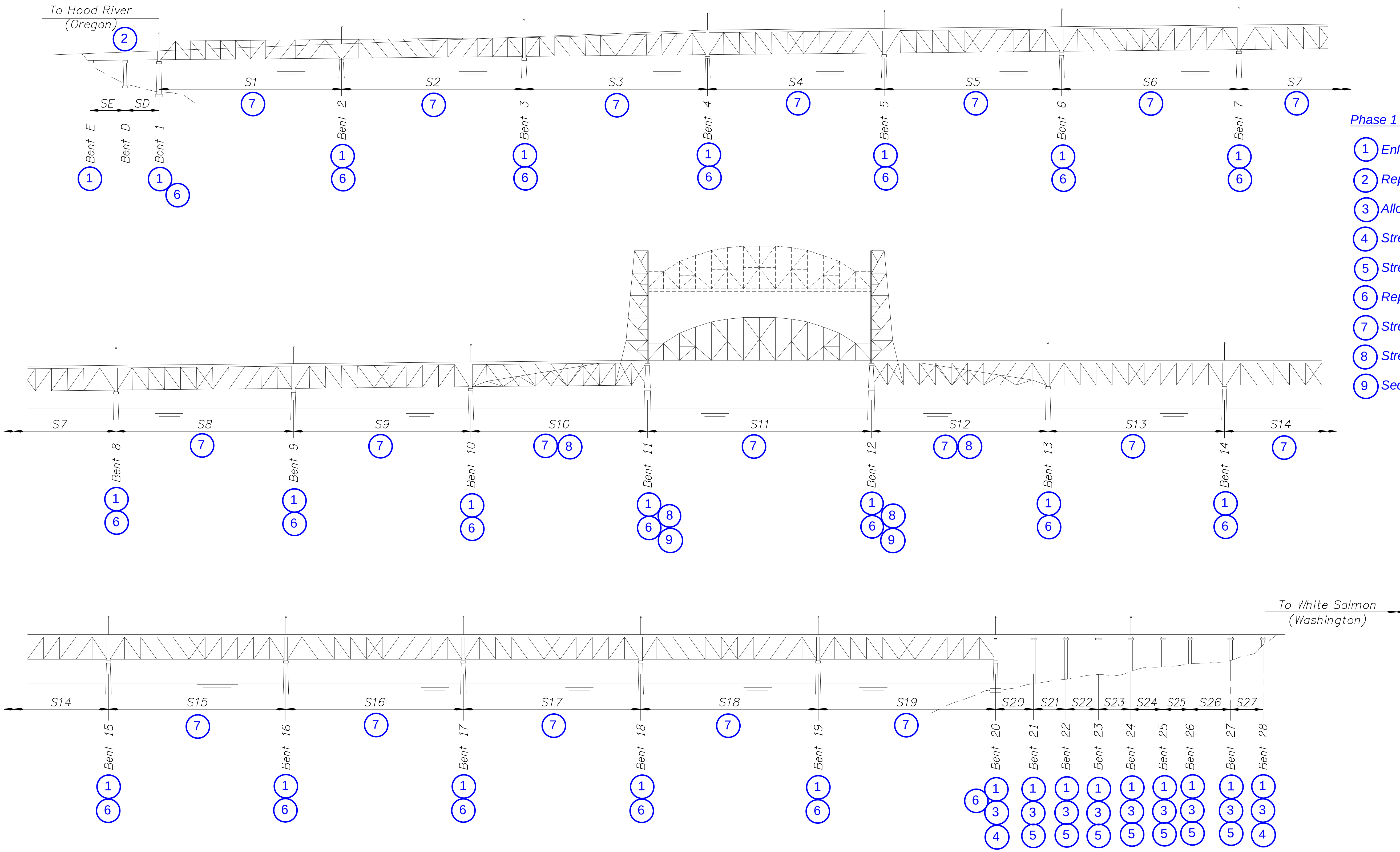


Phase 1 Seismic Retrofit Legend

1. Enlarge seat/add shear lugs
2. Replace with one span
3. Allow dowel fuse
4. Strengthen end diaphragm
5. Strengthen crossbeams
6. Replace steel bearings
7. Strengthen truss members & connections
8. Strength tower members & connections
9. Secure mechanical equipment

DATE	REVISION	BY

ACCOMPANIED BY DWGS.

DRAFTER:
DESIGNER:
CHECKER:
REVIEWER:

EXPIRES:
EXPIRES:

PORT OF HOOD RIVER COMMISSION

HDR

STRUCTURE NO. 00645

DATE July 2016

CALC. BOOK

HOOD RIVER INTERSTATE BRIDGE

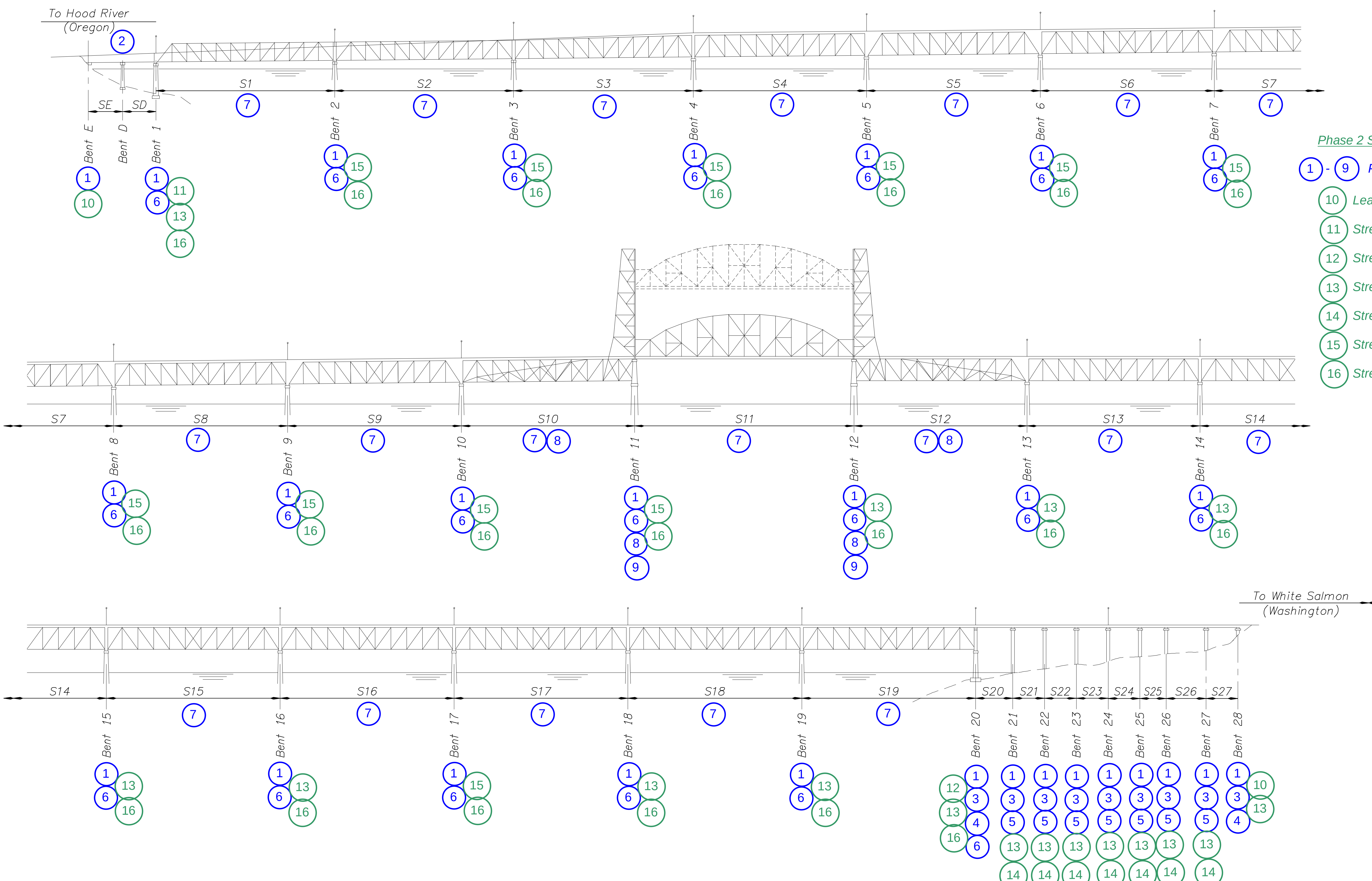
HOOD RIVER - WHITE SALMON HIGHWAY
HOOD RIVER, OR & KLICKITAT, WA COUNTIES

POHR TO2
PHASE 1 SEISMIC RETROFIT

SHEET
OF

DRAWING NO.
--

Xrefs: POHR_TO2_Bridge_Border.dwg X_POHR_Bridge.dwg



Phase 2 Seismic Retrofit Legend

1 - 9 Phase 1 Seismic Retrofit elements

10 Leave end bents, improve approach soil

11 Strengthen knee wall & connection

12 Strengthen column extension & connection

13 Strengthen spread footings

14 Strengthen columns

15 Strengthen pile caps

16 Strengthen pier walls

DATE	REVISION	BY

ACCOMPANIED BY DWGS.

DRAFTER:
DESIGNER:
CHECKER:
REVIEWER:
EXPIRES:
EXPIRES:

STRUCTURE NO. 00645

DATE July 2016

CALC. BOOK

HOOD RIVER INTERSTATE BRIDGE

HOOD RIVER - WHITE SALMON HIGHWAY
HOOD RIVER, OR & KLICKITAT, WA COUNTIES

POHR TO2
PHASE 2 SEISMIC RETROFIT

SHEET
OF

DRAWING NO. --

Commission Memo

Prepared by: Laurie Borton
Date: February 7, 2017
Re: South Basin Dock Management Report

The Commission approved a lease with the Hood River Yacht Club ("Club") for a portion of the South Basin Dock at the May 10, 2016 meeting. The lease continues through April 30, 2017. Upon mutual agreement, and receipt of written notice from the Club by February 15, this lease may be renewed. Club members Lars Bergstrom and Lance Staughton will be in attendance at the February 7 meeting to provide a report and answer questions.

RECOMMENDATION: For discussion.

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Executive Director's Report
February 7, 2017

Staff & Administrative

- Marina Manager Laurie Borton has submitted her notice of retirement effective March 1, 2017. Laurie has been an integral part of Port staff since 2000 and a very effective and capable administrator and Marina Manager. She will be greatly missed. All staff extends heartfelt wishes for a wonderful retirement. Although, she may be busier than here at the Port!

- The tentative budget preparation schedule has been set. The Spring Planning Meeting is expected to occur March 21 and the Budget Committee meeting on April 18. We have scheduled the Budget Hearing on May 16.

- A reminder about the upcoming SDAO annual meeting March 10-13 in Portland. Any Commissioner interested in attending should let Laurie know. Also, consider attending the OneGorge-sponsored capitol receptions that highlight and raise the profile of Gorge priorities and issues. The Olympia event will be February 15 and Salem on March 9.

- I gave the “State of the Port” presentation at the Hood River Rotary Club on February 2. Genevieve did most of the work putting the “Prezi” slide show together and it appeared to be appreciated by the membership.

- Stu Watson started work on January 30, 2017 as the Interim Waterfront Coordinator. The position is expected to have 3-5 month duration.

Recreation/Marina

- Due to the temporary by-pass of the GFCI breaker on C Dock North, no power breaks have occurred in the last month. We will resume efforts to resolve the trip problem when more normal weather conditions return.

- At the next Marina Committee meeting scheduled for February 16, we expect to have Mr. Peter Olmstead, regional permit coordinator with the USACOE attend. This meeting is at the suggestion of some committee members who are seeking a better understanding of the permit process and whether a long-term master plan and list of projects can be approved.

- Liz Whitmore prepared the attached financial summary of Concession/Event activities before she left the Port in January. This assignment was intended to isolate the revenues and expenses directly associated with these aspects of the waterfront recreation operations. Although there are many underlying assumptions, the conclusion is that these activities result in net positive income for the Port.

Development/Property

- The Parking Committee established by City Council has not met since January 17. Future meetings are expected but none have been scheduled as of yet. It is less likely now that the Port would be able to initiate a paid parking plan on its own due to the challenges of enforcement; however I am looking into alternatives. One alternative assumes a part-time city employee and the other would utilize a private contractor.
- Anne prepared three applications for water service at the Lower Mill site and attended a board meeting of the Crystal Springs Water District. Apparently, the District now needs to provide a 90-day public notice prior to approving an increase in the SDC fees so a final decision is not expected before May.

Airport

- I presented the North Ramp project to the County Commission on January 23. We requested that the Windmaster Urban Renewal Board consider a Plan amendment that would provide up to $200,000 to help meet the local match for the Connect VI grant. The County authorized staff to pursue negotiations with the Port.

Bridge/Transportation

- We experienced an unusual occurrence on Monday, January 30 when a vehicle broke down and another ran out of gas simultaneously on the Bridge. The events resulted in about 30 minutes of one-lane closures with response by both City police and Port staff.
- SBE will present their lift span mechanical and electrical findings via conference call at the meeting on February 7.
- The two draft legislative bills related to bridge replacement that have been discussed previously by the Commisison were issued in Salem on February 2 and are attached. Representative Johnson and Senator Thomsen are the primary sponsors of these bills. With the help of Thorn Run, I will be meeting with various legislators in Salem on February 15 to seek support. We will know soon what committees will hold initial hearings on these bills and, eventually, when hearings will be scheduled.
- Steve Siegel, Dan Bates and I met with ODOT Region 1 officials on February 2 in Portland to further describe our bridge replacement efforts. It was a positive meeting and it appeared our efforts would be reasonably considered.

2016 Concession and Events Revenue & Expenses

	Revenue PERMIT FEE	*Expenses* WATER	ELECTRIC	FACILITIES	WF COORD	CAPITAL
				90 hours	*72 hours*	
Event Site						
Big Winds	$ 3,200.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Brian's	$ 3,200.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Cascade Kiteboarding	$ 3,200.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Gorge Kiteboard	$ 3,200.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Kite the Gorge	$ 2,400.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
New Wind	$ 3,200.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Stawicki Photography	$ 1,400.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Sandbar Café	$ 1,050.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
The Local Grind	$ 840.00	$ 160.00	$ 175.00	$ 289.00	$ 165.00	$ 145.00
Hook/Marina						
WhatSUP Kayaking	$ 2,400.00	$ -	$ -	$ 289.00	$ 165.00	$ 145.00
Big Winds	$ 1,600.00	$ -	$ -	$ 289.00	$ 165.00	$ 145.00
Brian's	$ 1,600.00	$ -	$ -	$ 289.00	$ 165.00	$ 145.00
Nichols Basin						
Col Gorge Kayak School	$ 2,400.00	$ 160.00	$ 275.00	$ 289.00	$ 165.00	$ 145.00
Dhaba Dhaba	$ 800.00	$ 160.00	$ 275.00	$ 289.00	$ 165.00	$ 145.00
Total Revenue:	$ 30,490.00	$ 1,760.00	$ 2,125.00	$ 4,046.00	$ 2,310.00	$ 2,030.00
Total Expenses:	$ 12,271.00					
Total Income:	**$ 18,219.00**					

	PERMIT FEE			FACILITIES	WF COORD	MARINA MGR
				34 hrs Events/35 hrs Cruise Ships	*40 hours*	*10 hours*
Events	$ 17,625.00	$ -	$ -	$ 1,530.00	$ 1,280.00	
(35) Cruise Ship Stops	$ 4,850.00	$ -	$ -	$ 1,575.00		$ 460.00
Total Revenue:	$ 22,475.00					
Total Expenses:	$ 4,845.00					
Total Income:	**$ 17,630.00**					

#	LOCATION/EVENT	FEE	WAIVED
	Event Site		
1	CGWA Gorge Cup	$800	
2	Loco Wednesdays		$300
3	CGWA Beach Bash	$1,950	
4	Kiteboarding 4 Cancer	$1,900	
5	Harvest Festival	$4,350	
6	Columbia Gorge Marathon	$1,000	
7	Outrigger Canoe Club Storage	$125	
	Lot #1		
8	Meadows Employee Bus Parking	$600	
9	Lila May Memorial Tutu Trot		$175
10	Union Pacific Parking	$500	
	Jensen Parking Lot		
11	CGWA Swap Meets	$150	
	Nichols Beach		
12	Big Winds SUP Demo	$100	
13	Kayak Shed Demo	$150	
14	Global Sessions	$150	
15	Global Sessions	$150	
	The Spit		
16	4th of July Fireworks		$1,100
	Marina Park/Picnic Shelters		
17	(25) Picnic Shelter Reservations	$850	
18	Oregon Beach Wrestling Chanpionships		$150
19	Windsurfing Camp - ABK Boardsports	$400	
20	Gorge Downwind Paddle Festival	$700	
	Marina Green		
21	Hood 2 River Relay	$1,000	
22	Relay for Life	$900	
23	Real Promotions Concert	$1,000	
	Marina Basin		
24	Oregon Model Yacht Club/Radio Regatta	$300	
25	GORGE Junior Sailing	$300	$2,000
26	HRVHS Sailing Program		$2,000
27	Cross Channel Swim	$250	
	Hook		
28	King of the Hook		$125
	Cruise Ships		
29	(35) Cruise Ship Stops	$4,850	
	2016 Total Revenue from Events	**$22,475**	
	2016 Total Waived Revenue from Events		**$5,850**

79th OREGON LEGISLATIVE ASSEMBLY--2017 Regular Session

House Bill 2750

Sponsored by Representative JOHNSON, Senator THOMSEN

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure **as introduced.**

Modifies laws related to interstate bridges operated by local governments.

Permits Port of Hood River to establish toll on bridges that Port of Hood River has authority to operate and maintain.

A BILL FOR AN ACT

Relating to bridges; creating new provisions; and amending ORS 381.205, 381.265, 381.824, 383.003, 383.004 and 383.035.

Be It Enacted by the People of the State of Oregon:

SECTION 1. ORS 381.205 is amended to read:

381.205. Each county, city, town or port of this state adjoining or bordering on any interstate river or stream of water may construct, reconstruct, purchase, rent, lease or otherwise acquire, **sell or otherwise transfer ownership of, design,** improve, operate and maintain bridges over any interstate river or stream of water to any adjoining state.

SECTION 2. ORS 383.004 is amended to read:

383.004. (1) Except as provided in subsection (2) of this section, a toll may not be established unless the Oregon Transportation Commission has reviewed and approved the toll. The commission shall adopt rules specifying the process under which proposals to establish tolls will be reviewed. When reviewing a proposal to establish tolls, the commission shall take into consideration:

(a) The amount and classification of the traffic using, or anticipated to use, the tollway;

(b) The amount of the toll proposed to be established for each class or category of tollway user and, if applicable, the different amounts of the toll depending on time and day of use;

(c) The extent of the tollway, including improvements necessary for tollway operation and improvements necessary to support the flow of traffic onto or off of the tollway;

(d) The location of toll plazas or toll collection devices to collect the toll for the tollway;

(e) The cost of constructing, reconstructing, improving, installing, maintaining, repairing and operating the tollway;

(f) The amount of indebtedness incurred for the construction of the tollway and debt service requirements, if any;

(g) The value of assets, equipment and services required for the operation of the tollway;

(h) The period of time during which the toll will be in effect;

(i) The process for altering the amount of the toll during the period of operation of the tollway;

(j) The method of collecting the toll; and

(k) The rate of return that would be fair and reasonable for a private equity holder, if any, in the tollway.

(2)(a) Nothing in ORS 383.003 to 383.075 prohibits a city or county from establishing a toll on

NOTE: Matter in **boldfaced** type in an amended section is new; matter [*italic and bracketed*] is existing law to be omitted. New sections are in **boldfaced** type.

LC 2276

any highway, as defined in ORS 801.305, that the city or county has jurisdiction over as a road authority pursuant to ORS 810.010.

(b) Nothing in ORS 383.003 to 383.075 prohibits Multnomah County from establishing a toll on the bridges across the Willamette River that are within the boundaries of the City of Portland and that are operated and maintained by Multnomah County as required under ORS 382.305 and 382.310.

(c) Nothing in ORS 383.003 to 383.075 prohibits the Port of Hood River from establishing a toll or imposing administrative fees for the use of the bridges across the Columbia River that are operated and maintained by the port as authorized under ORS 381.205 to 381.305. Any private entity or unit of government that owns or operates a tollway pursuant to an agreement with the port may impose and collect tolls and administrative fees on the tollway project.

SECTION 3. ORS 381.824 is amended to read:

381.824. Every bridge that passes over a river or body of water forming a boundary between this state and another state, and that has been constructed or acquired and is being operated by the other state or by any county, city**, port** or other municipality of the other state, shall, together with its approaches, be exempt from all property and other taxes in this state, if the other state exempts from all taxation every such interstate bridge, together with its approaches, constructed or acquired and operated by this state or by any county, city**, port** or other municipality of this state.

SECTION 4. ORS 381.265 is amended to read:

381.265. (1) Preparation of the specifications and designs of any bridge constructed under ORS 381.205 to 381.305 may give consideration to and include provisions for facilities and accommodations for traffic by rail as well as for traffic by motor vehicle, team, **bicycle,** pedestrian or other regular highway traffic.

(2) If provision is made for rail traffic, then the agencies under whose jurisdiction and control the bridge has been constructed may contract with any railroad companies for the use of the part of the bridge constructed to accommodate traffic by rail. The contract may be upon such terms and conditions as the interested parties may agree.

SECTION 5. Section 6 of this 2017 Act is added to and made a part of ORS 381.205 to 381.305.

SECTION 6. Notwithstanding ORS 381.260, 381.265, 381.270, 381.275 and 381.280, a tollway project, as defined in ORS 383.003, undertaken by the Port of Hood River under ORS 381.205, is subject to the public contracting requirements described in section 8 of this 2017 Act.

SECTION 7. Section 8 of this 2017 Act is added to and made a part of ORS 383.003 to 383.075.

SECTION 8. (1) The Port of Hood River may award any contract, franchise, license or agreement related to a tollway project, located fully or partially within its district, under a competitive process or by private negotiation with one or more entities, or by any combination of competition and negotiation without regard to any other laws concerning the procurement of goods or services for projects of the port.

(2) When using a competitive process for the award of a tollway project contract, the port shall consider the following factors in addition to the proposer's estimate of cost:

(a) The quality of the design, if applicable, submitted by a proposer. In considering the quality of the design of a tollway project, the port shall take into consideration:

(A) The structural integrity of the design, including the probable effect of the design on the future costs of maintenance of the tollway;

(B) The aesthetic qualities of the design, including such factors as the width of lane separators, landscaping and sound walls;

(C) The traffic capacity of the design;

(D) The aspects of the design that affect safety, such as the lane width, the quality of lane markers and separators, the shape and positioning of ramps and curves and the changes in elevation; and

(E) The ease with which traffic will be able to pass through the toll collection facilities.

(b) The extent to which small businesses will be involved in the tollway project. The port shall encourage participation by small businesses to the maximum extent the port determines is practicable. As used in this paragraph, "small business" means an independent business with fewer than 20 employees and with average annual gross receipts over the last three years not exceeding $1 million for construction firms and $300,000 for nonconstruction firms. "Small business" does not include a subsidiary or parent company belonging to a group of firms that are owned and controlled by the same individuals and that have average aggregate annual gross receipts in excess of $1 million for construction firms or $300,000 for nonconstruction firms over the last three years.

(c) The financial stability of the proposer and the ability of the proposer to provide funding for the tollway project and surety for its performance and financial obligations with respect to the tollway project.

(d) The experience of the proposer and its subcontractors in building and operating projects such as the tollway project.

(e) The terms of the financial arrangement proposed or accepted by the proposer with respect to franchise fees, license fees, lease payments or operating expenses and the proposer's required rate of return from its operation or maintenance of the tollway.

(3) Notwithstanding any other provision of this section, the port may use any method for the award of any contract, franchise, license or agreement that is necessary to comply with the requirements of any grant or other funding source.

(4) If public funds are involved in the project, construction of a tollway project shall be subject to the prevailing wage requirements of ORS 279C.800 to 279C.870.

(5) For purposes of complying with applicable state and local land use laws, including statewide planning goals, comprehensive plans, land use regulations, ORS chapters 195, 196, 197, 198, 199, 215, 221, 222 and 227, and any requirement imposed by the Land Conservation and Development Commission, a tollway project shall be treated as a project of the port and not as a project of any other person or entity.

(6) Tollways, and any related facilities that would normally be purchased, constructed or installed by the port if the tollway were a conventional highway that was constructed and operated by the port, shall be exempt from ad valorem property taxation.

(7) Tollways are considered state highways for purposes of law enforcement and application of the Oregon Vehicle Code.

(8) The provisions of ORS 279.835 to 279.855 and ORS chapters 279A, 279B and 279C do not apply to tollway projects undertaken pursuant to this section, or to agreements entered into under this section, except that if public moneys are used to pay any costs of construction of public works that is part of a project, the provisions of ORS 279C.800 to 279C.870 apply to the public works. In addition, if public moneys are used to pay any costs of construction of public works that is part of a project, the construction contract for the public works must

contain provisions that require the payment of workers under the contract in accordance with ORS 279C.540 and 279C.800 to 279C.870.

(9) Sensitive business, commercial or financial information presented to the Port of Hood River by a private entity for the purpose of determining the feasibility of the entity's participation in a tollway project is exempt from disclosure under ORS 192.410 to 192.505.

(10) The provisions of ORS 383.004 (1), 383.005, 383.013, 383.015, 383.017 and 383.055 do not apply to a tollway project undertaken by the Port of Hood River.

SECTION 9. ORS 383.003 is amended to read:

383.003. As used in ORS 383.003 to 383.075:

(1) "Department" means the Department of Transportation.

(2) "Electronic toll collection system" means a system that records use of a tollway by electronic transmissions to or from the vehicle using the tollway and that collects tolls, or that is capable of charging an account established by a person for use of the tollway.

(3) "Photo enforcement system" means a system of sensors installed to work in conjunction with an electronic toll collection system and other traffic control devices and that automatically produces videotape or one or more photographs, microphotographs or other recorded images of a vehicle in connection with the collection or enforcement of tolls.

(4) "Private entity" means any nongovernmental entity, including a corporation, partnership, company or other legal entity, or any natural person.

(5) "Related facility" means any real or personal property that:

(a) Will be used to operate, maintain, renovate or facilitate the use of the tollway;

(b) Will provide goods or services to the users of the tollway; or

(c) Can be developed efficiently when tollways are developed and will generate revenue that may be used to reduce tolls or will be deposited in the State Tollway Account **or another account established by a unit of government**.

(6) "Toll" means any fee or charge for the use of a tollway.

(7) "Toll booth collections" means the manual or mechanical collection of cash or charging of an account at a toll plaza, toll booth or similar fixed toll collection facility.

(8) "Tollway" means any roadway, path, highway, bridge, tunnel, railroad track, bicycle path or other paved surface or structure specifically designed as a land vehicle transportation route, the construction, operation or maintenance of which is wholly or partially funded with toll revenues resulting from an agreement under ORS 383.005 **or section 8 of this 2017 Act**.

(9) "Tollway operator" means the unit of government or the private entity that is responsible for the construction, reconstruction, installation, improvement, financing, maintenance, repair and operation of a tollway or a related facility.

(10) "Tollway project" means any capital project involving the acquisition of land for, or the construction, reconstruction, improvement, installation, development or equipping of, a tollway, related facilities or any portion thereof.

(11) "Unit of government" means any department or agency of the federal government, any state, any department or agency of a state, any bistate entity created by agreement under ORS 190.420 or other law for the purposes of the Interstate 5 bridge replacement project, and any city, county, district, port or other public corporation organized and existing under statutory law or under a voter-approved charter.

SECTION 10. ORS 383.035 is amended to read:

383.035. (1) A person who fails to pay a toll, established pursuant to ORS 383.004, shall pay to the Department of Transportation the amount of the toll, a civil penalty of not more than $25 and an administrative fee established by the tollway operator not to exceed the actual cost of collecting the unpaid toll.

(2) In addition to any other penalty, **upon written request of a tollway operator other than the department or if the tollway operator is the department,** the department shall refuse to renew the motor vehicle registration of the motor vehicle owned by a person who has not paid the toll, the civil penalty and any administrative fee charged under this section. **The department shall adopt rules establishing a process by which a tollway operator may request the department take action under this subsection.**

(3) This section does not apply to:

(a) A person operating a vehicle owned by a unit of government or the tollway operator;

(b) A person who is a member of a category of persons exempted by the Oregon Transportation Commission from paying a toll; or

(c) A person who is a member of a category of persons made eligible by the commission for paying a reduced toll, to the extent of the reduction.

(4) Subsection (1) of this section does not apply to a person who fails to pay a toll established under section 8, chapter 4, Oregon Laws 2013.

(5)(a) Upon receiving a request from the State of Washington, or from the State of Washington's designee that has contracted with the State of Washington to collect tolls, the department shall provide information to identify registered owners of vehicles who fail to pay a toll established under section 8, chapter 4, Oregon Laws 2013.

(b) If the State of Washington, or the State of Washington's designee that has contracted with the State of Washington to collect tolls, gives notice to the department that a person has not paid a toll established under section 8, chapter 4, Oregon Laws 2013, or a civil penalty or administrative fee imposed by reason of failure to pay the toll, the department shall refuse to renew the Oregon motor vehicle registration of the motor vehicle operated by the person at the time of the violation.

(c) The department may renew an Oregon motor vehicle registration of a person described in paragraph (b) of this subsection upon receipt of a notice from the State of Washington, or from the State of Washington's designee, indicating that all tolls, civil penalties and other administrative fees owed by the person have been paid.

SECTION 11. Notwithstanding ORS 315.037, section 8 of this 2017 Act and the amendments to ORS 381.824 by section 3 of this 2017 Act apply to tax years beginning on or after January 1, 2018.

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79th OREGON LEGISLATIVE ASSEMBLY--2017 Regular Session

House Bill 2749

Sponsored by Representative JOHNSON, Senator THOMSEN

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure **as introduced.**

Directs Port of Hood River, in collaboration with Department of Transportation, to study feasibility of replacing Hood River-White Salmon Interstate Bridge. Directs department to enter into grant agreement with port to reimburse port for expenses of study.

Authorizes issuance of $5 million in lottery bonds to finance study.

Establishes Hood River Bridge Study Fund. Continuously appropriates moneys in fund to Department of Transportation for specified purposes.

Declares emergency, effective on passage.

A BILL FOR AN ACT

Relating to the Hood River-White Salmon Interstate Bridge; and declaring an emergency.

Be It Enacted by the People of the State of Oregon:

__SECTION 1.__ **(1) The Port of Hood River shall, in collaboration with the Department of Transportation, conduct a study of the feasibility of replacing the Hood River-White Salmon Interstate Bridge. The study must evaluate:**

(a) Environmental impacts;

(b) Engineering requirements and design and construction options;

(c) Costs and financing options; and

(d) Project delivery methods and schedules.

(2) The port, in collaboration with the department, shall report the findings of the study to the interim committees of the Legislative Assembly related to transportation no later than December 31, 2018. The report must include recommendations for the next steps to be taken toward funding and constructing a replacement bridge.

__SECTION 2.__ **The Port of Hood River and the Department of Transportation shall, as soon as practicable but no later than December 31, 2017, enter into a grant agreement that:**

(1) Outlines methods by which the port and the department will collaborate to conduct the study described in section 1 of this 2017 Act;

(2) Outlines the project development work necessary for the study;

(3) Provides that the department will issue grants to the port to reimburse the port for expenses incurred in conducting the study, including expenses incurred before the proceeds of the lottery bonds authorized in section 3 of this 2017 Act are disbursed, contingent on satisfactory progress and documentation by the port and subject to applicable law and any pertinent bond requirements; and

(4) Establishes a schedule for grant payments that begins payments as soon as practicable after the grant agreement is executed or after lottery bonds authorized under section 3 of this 2017 Act are issued, whichever is later.

__SECTION 3.__ **(1) For the biennium beginning July 1, 2017, at the request of the Depart-**

NOTE: Matter in **boldfaced** type in an amended section is new; matter [*italic and bracketed*] is existing law to be omitted. New sections are in **boldfaced** type.

ment of Transportation, the State Treasurer is authorized to issue lottery bonds pursuant to ORS 286A.560 to 286A.585 in an amount that produces $5 million in net proceeds and interest earnings for the purposes described in subsection (2) of this section, plus an additional amount estimated by the State Treasurer to be necessary to pay bond-related costs.

(2) Net proceeds of lottery bonds issued under this section in an amount sufficient to provide $5 million in net proceeds and interest earnings must be transferred to the Department of Transportation for deposit in the Hood River Bridge Study Fund, established in section 4 of this 2017 Act, to be used for the purposes described in section 4 of this 2017 Act.

(3) Lottery bonds authorized under this section must be issued no later than June 30, 2018.

(4) The Legislative Assembly finds that the Hood River-White Salmon Interstate Bridge is a vital component in the economy of the Hood River region due to its essential role in the movement of consumers and freight, and that replacement of the bridge will lead to increased business in the Hood River region and improved freight mobility. The Legislative Assembly thereby finds that the use of lottery bonds will create jobs and facilitate and encourage economic development.

SECTION 4. (1) The Hood River Bridge Study Fund is established in the State Treasury, separate and distinct from the General Fund. Interest earned by the Hood River Bridge Study Fund shall be credited to the fund. The fund consists of moneys deposited into the fund under section 3 of this 2017 Act and may include moneys appropriated, allocated, deposited or transferred to the fund by the Legislative Assembly or otherwise and interest earned on moneys in the fund.

(2) Moneys in the fund are continuously appropriated to the Department of Transportation to be used:

(a) To issue grants to the Port of Hood River under the grant agreement described in section 2 of this 2017 Act; and

(b) To pay for expenses incurred by the department in complying with sections 1 and 2 of this 2017 Act.

SECTION 5. This 2017 Act being necessary for the immediate preservation of the public peace, health and safety, an emergency is declared to exist, and this 2017 Act takes effect on its passage.

Commission Memo

Prepared by: Anne Medenbach
Date: February 7, 2017
Re: Lower Mill Wetland Permitting - Schott & Associates

Martin Schott with Schott & Associates is proposing to lead the wetland permitting process for the Lower Mill. This work consists of three tasks:

1. Delineating the wetland on the adjacent property and submitting that report to Department of State Lands (DSL).
2. Preparing and submitting the wetland fill and mitigation permit to DSL and Army Corps (Corps).
3. Responding to questions and comments from and coordinating with DSL, the Corps, and project engineer regarding both the delineation and the permit application.

Surveying is not included in this proposal. The survey will be performed by Terra Surveying and is estimated at $500.

RECOMMENDATION: Approve contract with Schott & Associates for ecology services at the Lower Mill in an amount not to exceed $11,100.

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SCHOTT & ASSOCIATES
Ecologists & Wetland Specialists
11977 S. Toliver Rd. · Molalla, OR 97038 · (503) 829-6318 · FAX (503) 829-3874

October 10, 2016

Anne MedenbACH
Port of Hood River
1000 E. Port Marina Drive
Hood River, OR 97031

Re: Scope-of-Work/Cost Estimate – Lower Mill

Anne:

Sorry about the delay in getting this to you. I know there is a current wetland delineation on the portion of the Lower Mill property. However, a delineation may be required for the mitigation area. Based on our conversations you are looking at the potential to mitigate on the neighbor's property, which probably does not have a current delineation. Another potential mitigation area is the business park you showed us when we toured the various Port projects with you. A wetland delineation on either site would cost $3,400 if you have someone survey the wetlands and prepare a based map. If we GPS the wetland boundary and prepare the map it would cost $4,000. If we have to respond to DSL's review of the delineation we would do the work on a time and materials not to exceed $1,200 basis. DSL can ask for almost anything, but most of the time we can answer within a few hours of work. DSL may request a site visit. We suggest that we be present for any and all agency site visits. Again, we would do the site visit on a Time and materials not to exceed $1,000 basis.

It is my understanding that you would like to fill the wetland at the Lower Mill property. This will require submitting a wetland fill permit application. It cost $5,000 to prepare a wetland fill permit application. DSL has been rejection about 98% of permit application for being incomplete. Responding to DSL review of the application would be on a time and materials basis. We have no idea what they may request, and can't put a cap on how much work it may require to respond. Most of the time, the issues are minor, and only require a few hours of our time to respond. Occasionally, the response requires significantly more effort.

Team meetings would cost $500/meeting if they don't occur when we are in Hood River for another reason.

Sincerely,

Martin R. Schott, Ph.D.

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Commission Memo

Prepared by: Anne Medenbach
Date: February 7, 2017
Re: Lower Mill Wetland/Soil Engineering – Vista GeoEnvironmental

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There are two remaining projects to complete on Lot 902 at the Lower Mill. This lot borders Hwy. 35 and was expanded in 2016 with acquisition of the adjacent 2.53 acres.

Project 1: The lot features a delineated wetland that is 0.86 acres in size. This wetland needs to be filled and then mitigated (replaced) off site.

Project 2: 20,000CY of soil and wood waste was removed from Lots 1011 and 1015. That material was stockpiled on Lot 902 for disposal at a later date.

Vista is proposing to complete the engineering, bid specifications, permit processes and pre-bid project management for both projects simultaneously. On-site project management will be included with a future proposal once construction contracts are in place. Surveys are not included in this proposal. Surveys will be performed by Terra Surveying with a cost estimate of $2,500.

Project 1 Timeline: Once Vista has been engaged, their first task will be to coordinate with Schott & Associates on both preliminary 1200-C and wetland fill and mitigation permits. Once the initial plan is approved by Department of State Lands (DSL), Vista will prepare the engineering, bid docs and specs for the fill, mitigation, and grading work for the final permit application and bidding. Estimated date for permit application is May 2017 with permit approval in early 2018. Bidding for construction will occur in spring of 2018.

Project 2 Timeline: Bid documents and specs will be prepared with the grading plan in early 2017, with bidding for construction immediately to follow. The soil will be moved to the Airport and placed in no-development zones which have been identified as appropriate fill locations. A 1200-C permit may or may not be required, depending on the final locations. This project will take 2-3 months due to the amount of material and the schedule restrictions at the Airport resulting from weather and air traffic. The goal is to contract the work to be done in April/May and complete in Oct/Nov of 2017. Coordination will be done by Vista and Port staff to ensure communication is clear regarding timing of access.

RECOMMENDATION: Approve contract with Vista GeoEnvironmental Services for civil engineering services in an amount not to exceed $36,900.

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489 N. 8TH STREET, SUITE 201
HOOD RIVER, OREGON 97031
541.386.6480

VISTA GEOENVIRONMENTAL SERVICES

January 31, 2017

Ms. Anne Medenbach
Development/Property Manager
Port of Hood River
1000 E Marina Drive
Hood River, Oregon 97031

Subject: Proposal for Civil Engineering Services
Lower Hanel Mill Site & Ken Jernstedt Airfield
Hood River, Oregon

Dear Ms. Medenbach:

Vista GeoEnvironmental Services, LLC (VISTA) is pleased to submit this proposal for civil engineering services to prepare a Grading Plan for a Wetland Mitigation at the Lower Hanel Mill site in Odell, Oregon, and a Grading Plan for approximate 20,000 CY of Soil Placement at the Ken Jernstedt Airfield in Hood River, Oregon.

PROJECT BACKGROUND

The Port of Hood River is planning to relocate an existing wetland located at the Lower Mill site in Odell, Oregon. Wetland mitigation will be required; Vista will prepare a grading plan following directions from Martin Schott and Associates (wetland specialists) to design the new wetland area. Vista understands that the new location of the wetland is on an existing pond adjacent to the Cascade Pet Camp property. The grading plan will also provide access to the pond for the Cascade Pet Camp.

The Port of Hood River is also planning to relocate a stockpile of approximately 20,000 CY of soil and wood debris. The stockpile is located on the Lower Hanel Mill site in Odell, and it will be moved to the Ken Jernstedt Airfield, located in Hood River, Oregon. Vista will prepare a Grading Plan to place the soil such that the material will not restrict airport activities.

PROPOSED SCOPE OF SERVICES

Our proposed scope of services is based on several meetings between Port personnel, Martin Schott and Associates, Vista engineers, and field visits made during December

2016. Vista proposes the following tasks to develop a set of general civil construction drawings and specifications for both projects:

Lower Hanel Mill Site / Wetland Mitigation

Task 1: 1200 C Permit

Deliverables:

- Application Report in PDF format;
- Erosion and Sedimentation Control Cover Sheet;
- Existing Conditions; Erosion and Sedimentation Control Plan;
- Proposed Grading; Erosion and Sedimentation Control Plan; and
- Erosion and Sedimentation Standard Details in CAD and PDF Format.

Task 2: Stormwater Management Plan

Vista will prepare a Stormwater Management Plan Report in conformance with the requirements of Hood River County. This report will contain historic and proposed drainage patterns, the design of storm drainage infrastructure required to convey developed flows along with calculations, drawings and charts as required to support the proposed design.

This report will be part of the wetland mitigation study that will be performed by Schott and Associates, and it will be submitted to the Oregon Department of Environmental Quality (ODEQ) and Hood River County Public Work Engineering Department (HRCPW) for their review and approval.

Deliverables:

- Stormwater Report in PDF format

Task 3: Grading Plan

Vista will design a grading plan for a wetland mitigation that is proposed next to the Cascade Pet Camp property; this grading plan will provide access to the pond from the Pet Camp property. In addition, Vista will prepare a grading plan for the area where the existing wetland to be mitigated is located. This grading plan will be designed to match existing conditions of areas surrounding the site.

Deliverables:

- Cover Sheet;
- General Notes;
- Erosion and Sediment Control;
- Grading Plan; and
- Drainage and Storm Sewer; and
- Standard Details in CAD and PDF format.

Task 4: Specification Bid, Contract Documents, and Project Management

Vista will prepare specifications and contract documents for this project. We have allocated 80 hours that will cover this task and include the time for project management activities.

- Technical Specifications, Contract Documents and Bidding form in Microsoft Word and PDF format.

Ken Jernstedt Airfield / Soil Placement

Task 5: 1200 C Permit

Vista will prepare a 1200 C Permit application and will produce a set of drawings for the Ken Jernstedt Airfield - Soil Placement project. Application and drawings will be submitted to ODEQ, HRCPW and Oregon Department of State Lands (DSL).

Deliverables:

- Application Report in PDF format;
- Erosion and Sedimentation Cover Sheet;
- Existing Conditions; Erosion and Sedimentation Control Plan;
- Proposed Grading, Erosion and Sedimentation Control Plan; and
- Erosion and Sedimentation Standard Details in CAD and PDF format.

Task 6: Grading Plan

Vista will design a grading plan to place approximately 20,000 CY of soil and wood debris in different areas at the Ken Jernstedt Airfield. This design will be performed with the input of the airfield personnel to ensure that the placement of this material does not restrict airport activities.

Deliverables:

- Cover Sheet;
- General Notes;
- Erosion and Sediment Control;
- Grading Plan;
- Drainage and Storm Sewer; and
- Standard Details in CAD and PDF Format.

Task 7: Specification Bid, Contract Documents, and Project Management

Vista will prepare specifications and contract documents for this project. We have allocated 40 hours that will cover this task and include the time for project management activities.

- Technical Specifications, Contract Documents and Bidding form in Microsoft Word and PDF format

PROPOSED BUDGET AND AUTHORIZATION

The proposed budget for the proposed scope of services is $39,150.00 as shown in the attached table. The scope of services will be performed in accordance with the attached General Terms and Conditions, which is hereby made part of this proposal. VISTA will bill for its services on a time and materials basis consistent with the proposed billing assumptions provided on the attached table and will begin work on receiving authorization from you to proceed. In the event conditions change, unforeseen circumstances are encountered, or work efforts are redirected, we will seek your authorization to modify the scope of work and cost estimate.

We appreciate the opportunity to submit this proposal, and we look forward to working with you on this project. If you have any questions or require any additional information, please do not hesitate to contact us.

Sincerely,
Vista GeoEnvironmental Services, LLC

Carlos Garrido, CE-EIT
Asociate

James Jones. P.E.
Senior Engineer

Attachment: Proposed Budget
General Terms and Conditions

Clien Port of Hood
Site Hanel Mill - Hood Riv
Project Hanel Mill Wetland Mitigation Grading Plan
Hood River Airport Grading Plan for Soil Placement
Vista Proposal No. P17-122

				Lower Hanel Mill Site / Wetla								Ken Jernstedt Airfield /							
LABOR				1200 C Permit		Stormwater Management Plan		Grading Plan		Project Management		1200 C Permit		Grading Plan		Project Management		TOTALS	
LABOR CATEGORY	Personnel	Unit	Rate	Hrs	$	Hrs	$	Hrs	$	Hrs	$	Hrs	$	Hrs	$	Hrs	$	Hrs	$
Principal	North, R	HR	$ 155.00		$ -	2.00	$ 310.00	-	$ -	12.00	$ 1,860.00	-	$ -	-	$ -	12.00	$ 1,860.00	26.00	$ 4,030.00
Snr Proj Prof	Jones, J	HR	$ 125.00	-	$ -	12.00	$ 1,500.00	8.00	$ 1,000.00	-	$ -	-	$ -	6.00	$ 750.00	-	$ -	26.00	$ 3,250.00
Project Manager	Garrido, C	HR	$ 115.00	4.00	$ 460.00	4.00	$ 460.00	-	$ -	40.00	$ 4,600.00	4.00	$ 460.00	4.00	$ 460.00	24.00	$ 2,760.00	80.00	$ 9,200.00
Snr Proj Prof	Garrido, C	HR	$ 115.00	16.00	$ 1,840.00	8.00	$ 920.00	32.00	$ 3,680.00	-	$ -	16.00	$ 1,840.00	32.00	$ 3,680.00	-	$ -	104.00	$11,960.00
Project Prof	Eddy, M	HR	$ 95.00	8.00	$ 760.00	4.00	$ 380.00	24.00	$ 2,280.00	-	$ -	8.00	$ 760.00	8.00	$ 760.00	-	$ -	52.00	$ 4,940.00
CADD Drafter	Rice, J	HR	$ 65.00	8.00	$ 520.00	4.00	$ 260.00	12.00	$ 780.00		$ -	8.00	$ 520.00	8.00	$ 520.00	-	$ -	40.00	$ 2,600.00
Office Support	Kimura, J	HR	$ 65.00	2.00	$ 130.00	2.00	$ 130.00	2.00	$ 130.00	4.00	$ 260.00	2.00	$ 130.00	2.00	$ 130.00	4.00	$ 260.00	18.00	$ 1,170.00
		Subtotal Labor		38.00	$ 3,710.00	36.00	$ 3,960.00	78.00	$ 7,870.00	56.00	$ 6,720.00	38.00	$ 3,710.00	60.00	$ 6,300.00	40.00	$ 4,880.00	346.00	$37,150.00

EXPENSES		Unit	Rate	QTY	$	QTY	$	QTY	$	QTY	$	QTY	$	QTY	$	QTY	$	QTY	$
Communication		% DL			$ -		$ -		$ -		$ -		$ -		$ -		$ -	-	$ -
Mileage		Each	$ 25.00	4.00	$ 100.00	8.00	$ 200.00	4.00	$ 100.00	10.00	$ 250.00	4.00	$ 100.00	4.00	$ 100.00	6.00	$ 150.00	40.00	$ 1,000.00
General Expenses		Each	$ 50.00	2.00	$ 100.00	2.00	$ 100.00	2.00	$ 100.00	6.00	$ 300.00	2.00	$ 100.00	2.00	$ 100.00	4.00	$ 200.00	20.00	$ 1,000.00
Adjustment		LS	$ 1.00		$ -		$ -		$ -		$ -		$ -		$ -		$ -	-	$ -
		Subtotal Expenses			$ 200.00		$ 300.00		$ 200.00		$ 550.00		$ 200.00		$ 200.00		$ 350.00		$ 2,000.00
LABOR & EXPENSES SUBTOTAL					$ 3,910.00		$ 4,260.00		$ 8,070.00		$ 7,270.00		$ 3,910.00		$ 6,500.00		$ 5,230.00		$39,150.00
TASK AND PROJECT TOTALS					$ 3,910.00		$ 4,260.00		$ 8,070.00		$ 7,270.00		$ 3,910.00		$ 6,500.00		$ 5,230.00		$39,150.00

Commission Memo

Prepared by: Anne Medenbach
Date: February 7, 2017
Re: Jensen Building Roof Replacement Architecture - Kevin Cooley

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The Jensen Building roof is 36 years old and is starting to fail in several places. The roof is large, about 60,000 sf. This project will consist of reroofing, removing and disposing of any abandoned roof top equipment, and replacing the skylights. The rooftop equipment will need to be removed with a lift and disposed. The skylights leak and will be replaced with similar skylights or with solar tubes depending on cost.

Kevin Cooley has done work for the Port in the past. He specializes in industrial TI's as well as some new construction. He will be putting together plans and specs for the re-roof as well as a cost estimate. Options such as skylight replacement vs solar tubes will be considered during the process.

Staff will also be looking at whether work could be done during this re-roof to prepare for a future solar array. That project would be a much smaller contract and staff is currently working on this with Energy Trust.

RECOMMENDATION: Approve contract with Kevin Cooley for architectural and specification services for the Jensen Building Re-Roof Project in an amount not to exceed $10,900.

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January 25, 2017

Anne Medenbach
Port of Hood River
1000 E. Port Marina Drive
Hood River, OR 97031

SUBJECT: Jensen Building Reroof
Proposal for Architectural Services - **REVISED**

Dear Anne:

Thank you very much for this opportunity to submit a proposal to you for architectural services for this reroof of the Jensen Building. The project consists of the design of a reroof of the main building. It does not include the small out-building to the south. The new roof will be a single-ply TPO with a 20-year manufacturer's warranty. The existing roofing will be removed. You would like the bidding documents to be ready for bidding before the end of February 2017.

The building was built approximately 36 years ago and has about 60,000 square feet of roof area. It is a wood framed roof supported by steel columns and tilt-up concrete walls. The roof is insulated with R-11 fiberglass batt insulation installed tight to the underside of the roof sheathing. There is existing functional and non-functional roof mounted equipment. There is no permanently installed roof access ladder or roof hatch.

This proposal includes the following scope of work:

1) I will visit the site to verify some dimensions and take photos.
2) Work with the Port staff to identify non-functional roof mounted equipment to be removed.
3) Discuss the project with the Hood River Building Official.
4) Select the appropriate roofing weight and acceptable manufacturers with consultation of the Port staff.
5) Draw plans and details to describe the scope of work
6) Write specification and assemble bidding documents.
7) Assist the construction cost estimator.
8) Answer bidders' questions during the bid phase.
9) Construction observation: I will make one or two visits to the construction site to verify that the work is being done according to the design and answer any questions that may come up during construction.
10) Certificate of Substantial Completion for roofing warranty.

I have made these assumptions about the project:

1) The weight of the new roof assembly will not weigh more than the existing roof that will be removed and therefore, will not require a structural engineer to certify that the existing roof structure is capable of supporting the load.
2) The existing acrylic domed skylights will be replaced with new skylights that will fit on the existing curbs. Should the Port choose to replace the skylights with a different size or type of skylight, engineering services would be added to the project as a contract amendment. Likewise, should the Port choose to remove and infill the skylights, any design of interior lighting would be added to the project as a contract amendment.
3) The existing functional roof mounted equipment will remain. Should the Port choose to replace any of this equipment, engineering services would be added to the project as a contract amendment.
4) Should the Port choose to add photovoltaic equipment, engineering services required by this would be added to the project as a contract amendment.
5) The existing roof mounted refrigeration equipment will need to be removed and reinstalled in order to install the new roofing. Any engineering services for piping modifications would be added to the project as a contract amendment.

This proposal excludes the following:

1) Any hazardous material survey and/or removal.
2) Any plans examination fees, permit fees and systems development charges.

My fee for this scope of work including the construction cost estimate will be $10,900. I bill for my services hourly at a rate of $100/hour, I only bill for hours worked. I send out an invoice during the first week of each month for hours spent the previous month. I will use an AIA Document as the agreement form that I will prepare upon acceptance of this proposal.

My reimbursable expenses will be billed at my cost and include printing, plotting, postage and mileage.

I hope this proposal looks agreeable to you. If you have any questions, please call.

Very truly yours,

Kevin Cooley