

MEMORANDUM

TO: Honorable Mayor and City Council of Zumbrota
Neil Jensen, City Administrator

FROM: Bill Angerman, P.E.
Justin Zimmerman, P.E.

DATE: September 16, 2019

RE: Shared Use Path Trestle Bridge Crossing the
Zumbro River – Repair or Replacement Options
Zumbrota, Minnesota

EXECUTIVE SUMMARY

The existing bridge superstructure and railing is reaching the end of its service life. The City will need to make decisions about whether to repair or replace the bridge in the near future. The bridge was inspected, and recommendations made regarding what repairs are required to rehabilitate the bridge. While in good condition for its age, a significant amount of repair would need to be done to rehabilitate the bridge sufficiently for a large service life extension. In addition, the complete extent of required repairs is difficult to know precisely until rehabilitation work has begun. Four options were developed, and costs prepared. Of the four options, rehabilitating the existing structure is the lowest cost option. However, since the original bridge is over 100 years old, this option would likely have a shorter service life than the other two options.

WHKS's recommendation is that if funding could be obtained, the partial bridge replacement option in which the existing limestone pier 7 and the south abutment are reused, and the existing superstructure is replaced with two new prefabricated trusses is likely the best option (option 4). If securing sufficient funding for this option is not possible, rehabilitating the existing bridge would still result in a high-quality structure with a lower up-front cost. A summary of estimated costs, and an estimate of service life before significant repairs are likely to be required, is summarized below.

<u>Option</u>	<u>Description</u>	<u>Cost</u>	<u>Estimated Service Life (years)</u>
1	Bridge Rehabilitation with All Timber Deck	\$540,000	20~40
2	Bridge Rehabilitation with Timber Deck on Timber Beam Spans, Concrete Deck on Steel Beam Spans	\$620,000	20~50
3	Complete Bridge Replacement with New Truss	\$980,000	50~75
4	Reuse Limestone Abutment and One Pier, Replace Superstructure with New Truss	\$780,000	50~75

PROJECT SCOPE

This project investigated options and developed preliminary cost estimates for the rehabilitation or replacement of an existing shared use trail bridge in Zumbrota MN. The bridge crosses the Zumbro River and is located on a trail section that connects a trail running along Jefferson Drive to the southern portion of the Goodhue-Pioneer State Trail. The existing structure is a railroad bridge that was retrofit for trail usage. It is composed of two 50' steel plate girder spans, and seven 13'-6" timber beam spans for an approximate bridge length of 200'. The two steel plate girder spans are supported on limestone abutments and piers. The timber beam spans are supported on timber pile bent piers and a timber pile bent abutment. The existing timber deck is comprised of 8x8 timber ties running across the beams, 2x6 sleepers running longitudinally, 2x6 decking, and 8x8 curbs. An older timber handrail, and a newer chain link rail are present as well. At the SE bridge corner, a steel plaque affixed to the plate girder indicates the steel portions were fabricated by the American Bridge Co. of New York in 1903.



Existing Steel Plate Girder Spans (Looking NW)



Existing Timber Beam Spans (Looking NW)



Existing Timber Deck (looking South)

SITE VISIT AND BRIDGE INSPECTION

A site visit and inspection were performed on August 12th, 2019 to evaluate the existing structure. The primary purpose of this visit was to assess the condition of the bridge's various elements and identify repair needs. The inspection was primarily visual, along with hammer sounding of some accessible timber portions. Some parts of the bridge, including the steel beam span over the river and the top flanges of the steel beams, were not accessible for inspection.

TIMBER DECK AND HANDRAIL

A substantial number of timber 8x8 ties have been replaced recently, along with some deteriorated deck boards. Some original ties that were not replaced are deteriorated/rotten in places. The wooden hand rail had many missing boards. A chain link fence was installed inside of it. The deck and handrail are reaching the end of their service life with many elements in poor condition, and it was assumed that both would be replaced as part of a bridge improvement project.

STEEL PLATE GIRDERS

The steel plate girders are in overall fair condition for their age. The original paint coating of the structure is mostly gone, but the bulk of the rust on the girders appeared to be only surface rust. The steel cross frames and bracing are in poor condition in places with significant section loss and will need repairs as part of a rehabilitation project. The top flange plates of the girders had some section loss in several places as well.

TIMBER BEAMS

The timber beams were visually inspected and sounded in several places with a hammer. Overall they appeared sound and in good condition. One soft/rotten area was noted on an east beam at pier 7 (pier 1 was assumed to be the north most pier).

SOUTH ABUTMENT AND PIERS 7 & 8

The limestone piers and abutments are generally in fair condition. In places, the mortar had deteriorated/eroded away to a maximum depth of around 8"~12". The south abutment in particular had large sections of mortar missing, and a couple small segments of stone that were undermined. In several places a few stones were cracked. None showed signs of having moved or settled. Some grouted rip-rap scour protection is present at the south abutment and appeared to be functioning. Given the very large width of the stones, the present level of mortar deterioration is not a significant structural problem at this time but should be repaired before it worsens.

NORTH ABUTMENT AND PIERS 1 THROUGH 6

All piles on the north abutment were sounded with a hammer to gain an overall sense of their condition. The north abutment is in very poor condition with several piles having extensive rot and section loss. The timber seat and backwall were in fair condition.

Piers 1 through 6 are in fair to good condition for their age with many piles appearing to be sound. A few piles are deteriorated enough that they would need to be repaired as part of a rehabilitation project. The cap beams appeared to be in fair condition. Pier 4 has a diagonal brace that is split and badly damaged, likely from floating debris during recent flooding. Several very large cottonwood logs (approximately 3' diameter) were washed up against pier 4 and could cause problems. Lateral forces on the pier may be greatly increased by the accumulated debris pushing against the pier during a high-water event.

BRIDGE REHABILITATION OPTIONS

EXISTING BRIDGE ELEMENTS THAT NEED REPAIR

As mentioned previously, for the rehabilitation concept it was assumed that the deck and railing would be completely removed and replaced. One item worth noting is that prior to developing bridge rehabilitation plans, a more in-depth inspection of bridge elements is recommended. For the timber components, this is best done by using a wood testing drill capable of measuring timber section loss. The wood testing drill bores a small diameter hole through the member and records the resistance to the drill bit as it progresses. This allows internal voids/rotten areas to be detected, that a visual or acoustic (sounding) inspection may not detect. A summary of the main items that would need to be addressed to rehabilitate the bridge are:

- **Steel Plate Girders:** Overall the steel girders are in good enough condition that they could be reused. The lateral bracing angles and gusset plates in several places were corroded to the point that repairs are required. The top flange plates appeared to have section loss from corrosion as well due to the timbers trapping moisture. However, despite the corrosion, the capacity of the girders is likely sufficient for the loading required for a shared use path. The shared use path loads are only a small fraction of the original loads from rail traffic that the bridge was intended to carry.
- **Timber beams:** The beams appeared to be sound and could be reused. Similar to the plate girders the timber beams are substantially oversized for the required loads from a shared use trail, thus a limited amount of deterioration would not pose a problem. It was assumed in the cost estimates that the beams would be removed and reset. This may be required to repair the timber piers, adjust the timber beam heights to accommodate trail elevations, or possibly replace some beams if the deterioration warrants it.
- **Limestone Piers and Abutment:** Stone masonry is a very long-lasting construction material, and the stone piers and abutments could be reused. Repairing the regions where the grout has eroded would be required, along with filling in the small undermined wing areas with concrete at the south abutment, and possibly adding some additional rip-rap scour protection to the south abutment wings.
- **Timber Piers:** A majority of the timber in the piers appeared to be in good enough condition to not require repair. At several piers however, piles have deteriorated sections that may need replacement. Bad sections can be cut out and replaced with new sound pile sections, and new and old sections spliced together by bolting with steel channels or pipes. For the cost estimates it was conservatively assumed that two piles per pier would be repaired.
- **Timber Abutment:** The north timber pile bent abutment is in very poor condition. It was assumed that full replacement is required.
- **Presence of Lead Paint:** It is not known if the paint coating on the bridge contains lead. Historically, lead paint was used in this time frame and its presence is likely. The presence of lead could increase the cost of repairing the steel plate girders. A small amount of paint removal using power tools equipped with vacuums likely would suffice for the required repairs to the steel cross bracing, and to remove pack rust or more significant corrosion from the top girder flanges. Abrasive blasting to completely clean the plate girders to prepare them for painting would

be cost-prohibitive if lead is present. Given the current lack of corrosion present on the plate girders, combined with the bridge not being exposed to de-icing salts, simply addressing the isolated areas with more advanced corrosion and leaving the bridge steel uncoated would likely be feasible.

DETAILS OF NEW DECK AND RAILING

- **Proposed Trail Width:** For the replacement deck, a clear trail width of 10' was assumed. Bridge widths of new structures can vary from 6' to 14' depending on the usage, location, and cost considerations. A 10' clear width is a reasonable compromise between cost and trail user considerations. The existing deck clear width is 7'-10".
- **Timber Beam Spans:** It was assumed that on the timber beam spans, the new deck would be solid timber planks 5 ½" deep nailed together. This deck type is common on rail to trail facilities in the region. Other timber configurations are possible, but approximate cost range would be comparable. Timber railings were assumed. See appendix A figures 1 and 2 for an example of a bridge with a solid timber deck and timber rails.
- **Steel Plate Girder Spans:** For the steel plate girder spans, either a concrete or timber deck could be used. A concrete deck with steel railing would be low maintenance, long lasting, and would provide better protection from moisture and future corrosion for the plate girders. A timber deck and railing would be a lower cost option. A cost estimate for both deck types was developed for comparison. The estimated cost of rehabilitating the bridge with all of the new deck being timber, option 1, was approximately \$540,000. For option 2, timber deck on the timber beam spans, and a concrete deck on the steel plate girder spans, the estimated cost is \$620,000. See appendix A figures 3 through 5 for typical sections showing the different deck and railing types.

See appendix B for a complete cost breakdown for rehabilitating the existing structure (cost estimates 1 and 2).

COMPLETE BRIDGE REPLACEMENT, OPTION 3

This option assumes that the entire existing structure would be replaced with two new prefabricated steel trusses with 10' clear trail widths. The south abutment is tall (approximately 15'-2" from trail elevation to the top of the grouted rip rap at the abutment base). New abutments of this height that retain substantial amounts of backfill are expensive. Modern prefabricated truss bridges are capable of large spans at relatively reasonable costs. Thus, it was assumed that the bridge length would be increased to allow for a 2:1 or greater slope from the river bank southward, in combination with a smaller abutment more typically used with a trail truss bridge. A total bridge length of 240' was used in the cost estimate. The cost of completely replacing the bridge was estimated at \$980,000. See appendix B cost estimate 3 for a complete cost breakdown for this option.

PARTIAL BRIDGE REPLACEMENT, OPTION 4

This option assumes that the south abutment, and pier 7 would be repaired and reused. A new north abutment would be constructed, and the entire steel and timber superstructure would be replaced with two prefabricated trusses with 10' clear trail widths. This option has several advantages over the other two options.

- It avoids the uncertainty and complexity of repairing the existing plate girders, timber beams, and pile bent piers.
- By reusing the south abutment, this option avoids having to lengthen the bridge as described in the Bridge Rehabilitation Options section of this memo.
- Only one new substructure unit would need to be built which would help lower project costs.
- The stone piers are unique and have historical significance. Incorporating them into the bridge replacement would add a unique feature to the new bridge.

The estimated cost of this option is \$780,000. See appendix B cost estimate 4 for a complete cost breakdown for this option.

WHKS & CO.

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

William Angerman
License No. 26436



FIGURE 1- EXAMPLE OF SOLID TIMBER DECKING AND TIMBER RAIL (FOR OPTIONS 1 & 2)



FIGURE 2- EXAMPLE OF SOLID TIMBER DECKING AND TIMBER RAIL (FOR OPTIONS 1 & 2)

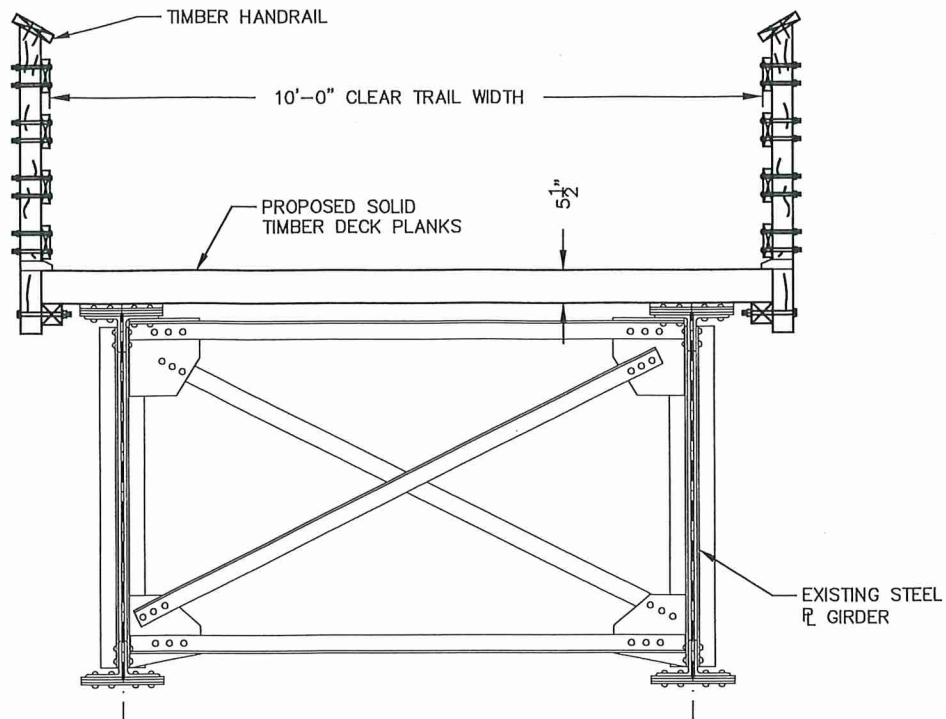


FIGURE 3 - TIMBER DECK FOR STEEL SPANS (OPTION 1)

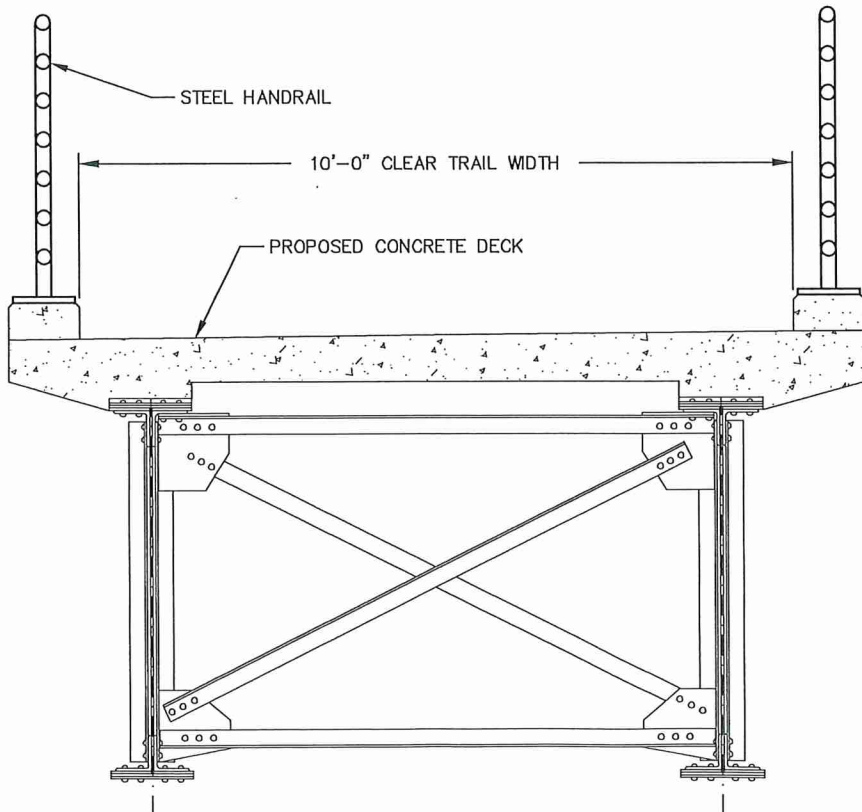


FIGURE 4 - CONCRETE DECK FOR STEEL SPANS (OPTION 2)

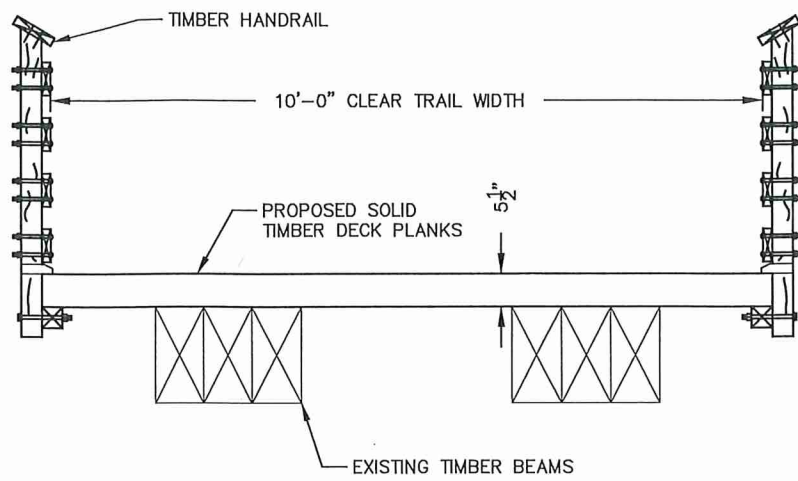


FIGURE 5 - TIMBER DECK ON TIMBER BEAM SPANS (OPTIONS 1 & 2)

Appendix B - Cost Estimate 1
Existing Bridge Rehabilitation, All Timber Deck and Railing
Trestle Bridge Crossing the Zumbro River
Zumbrota, MN
9/13/2019

<u>No.</u>	<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Total</u>
1	MOBILIZATION	1 LS	\$ 40,000	\$ 40,000
2	REMOVALS	1 LS	\$ 40,000	\$ 40,000
3	STEEL CROSS BRACING & CORROSION REPAIRS	1 LS	\$ 40,000	\$ 40,000
4	REMOVE AND REINSTALL TIMBER STRINGERS	1 LS	\$ 10,000	\$ 10,000
5	REPAIRS TO TIMBER STRINGERS	1 LS	\$ 5,000	\$ 5,000
6	STONE PIER/ABUTMENT REPAIRS	3 EACH	\$ 20,000	\$ 60,000
7	TIMBER PILE REPAIR	12 EACH	\$ 3,000	\$ 36,000
8	NEW NORTH ABUTMENT	1 LS	\$ 40,000	\$ 40,000
9	HARDWARE FOR WOOD RAILING AND DECK	1 LS	\$ 24,000	\$ 24,000
10	RANDOM RIPRAP CLASS III	30 CY	\$ 75	\$ 2,250
11	TREATED TIMBER FOR RAILING	3000 BF	\$ 12	\$ 36,000
12	TREATED TIMBER DECKING	6058 BF	\$ 7	\$ 42,406
13	TURF ESTABLISHMENT	1 LS	\$ 5,000	\$ 5,000
14	MISC TRAIL WORK AT APPROACHES	1 LS	\$ 20000	\$ 20,000
			Construction Cost	\$ 400,700
			Contingencies (20%)	\$ 80,000
			Engineering (12%)	\$ 60,000
			Estimated Total Cost	\$ 541,000

Appendix B - Cost Estimate 2
Existing Bridge Rehabilitation, Timber and Concrete Deck
Trestle Bridge Crossing the Zumbro River
Zumbrota, MN
9/13/2019

<u>No.</u>	<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Total</u>
1	MOBILIZATION	1 LS	\$ 40,000	\$ 40,000
2	REMOVALS	1 LS	\$ 40,000	\$ 40,000
3	STEEL CROSS BRACING & CORROSION REPAIRS	1 LS	\$ 40,000	\$ 40,000
4	BRIDGE SLAB CONCRETE (3Y42)	1200 SF	\$ 40	\$ 48,000
5	REINFORCEMENT BARS (EPOXY COATED)	6200 LB	\$ 2	\$ 9,300
6	REMOVE AND REINSTALL TIMBER STRINGERS	1 LS	\$ 10,000	\$ 10,000
7	REPAIRS TO TIMBER STRINGERS	1 LS	\$ 5,000	\$ 5,000
8	STONE PIER/ABUTMENT REPAIRS	3 EACH	\$ 20,000	\$ 60,000
9	TIMBER PILE REPAIR	12 EACH	\$ 3,000	\$ 36,000
10	NEW NORTH ABUTMENT	1 LS	\$ 40,000	\$ 40,000
11	DECORATIVE HAND RAIL	200 LF	\$ 150	\$ 30,000
12	HARDWARE FOR WOOD RAILING AND DECK	1 LS	\$ 12,000	\$ 12,000
13	RANDOM RIPRAP CLASS III	30 CY	\$ 75	\$ 2,250
14	TREATED TIMBER FOR RAILING	1510 BF	12	18,120
15	TREATED TIMBER DECKING	6058 BF	7	42,406
16	TURF ESTABLISHMENT	1 LS	5,000	5,000
17	MISC TRAIL WORK AT APPROACHES	1 LS	\$ 20000	\$ 20,000
Construction Cost				\$ 458,100
Contingencies (20%)				\$ 92,000
Engineering (12%)				\$ 70,000
Estimated Total Cost				\$ 620,000

Appendix B - Cost Estimate 3
Complete Bridge and Substructure Replacement
Trestle Bridge Crossing the Zumbro River
Zumbrota, MN
9/13/2019

<u>No.</u>	<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Total</u>
1	MOBILIZATION	1 LS	\$ 70,000	\$ 70,000
2	REMOVAL OF EXISTING BRIDGE	1 LS	\$ 100,000	\$ 100,000
3	TRUSSES (ASSUME TWO 120' SPANS)	240 LF	\$ 1,900	\$ 456,000
4	ABUTMENTS	2 EACH	\$ 40,000	\$ 80,000
5	CENTER SUPPORT PIER	1 EACH	\$ 50,000	\$ 50,000
6	MISC TRAIL WORK AT APPROACHES	1 LS	\$ 25,000	\$ 25,000
			Construction Cost	\$ 781,000
			Contingencies (15%)	\$ 117,000
			Engineering (9%)	\$ 80,000
			Estimated Total Cost	\$ 978,000

Appendix B - Cost Estimate 4
New Prefabricated Trusses and Reincorporating the Stone Piers
Trestle Bridge Crossing the Zumbro River
Zumbrota, MN
9/13/2019

<u>No.</u>	<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Total</u>
1	MOBILIZATION	1 LS	\$ 60,000	\$ 60,000
2	REMOVALS	1 LS	\$ 60,000	\$ 60,000
3	TRUSSES (ASSUME TWO 100' SPANS)	200 LF	\$ 1,900	\$ 380,000
4	STONE PIER/ABUTMENT REPAIRS	2 EACH	\$ 20,000	\$ 40,000
5	STONE PIER/ABUT MODIFICATIONS	2 EACH	\$ 10,000	\$ 20,000
6	NEW NORTH ABUTMENT	1 LS	\$ 40,000	\$ 40,000
7	RANDOM RIPRAP CLASS III	30 CY	\$ 75	\$ 2,250
8	MISC TRAIL WORK AT APPROACHES	1 LS	\$ 25,000	\$ 25,000
			Construction Cost	\$ 627,300
			Contingencies (15%)	\$ 94,000
			Engineering (9%)	\$ 60,000
			Estimated Total Cost	\$ 781,000