Missoula County Bridge Rehabilitations Preliminary Engineering Report

- ***Schwartz Creek Road Clark Fork River Bridge***

Prepared For: Missoula County Public Works

Prepared by: Christopher Agro, PE
Luke Carlson, PE, CFM

Reviewed by: Charlie Brisko, PE
Date: 03/19/2025

Morrison-Maierle
1055 Mount Avenue
Missoula, MT 59801

Morrison Maierle
engineers • surveyors • planners • scientists

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Missoula County has a need to rehabilitate the Schwartz Creek Road Bridge which crosses the Clark Fork River. The structure has its own unique needs that include, bearing seat spalling, pier scour, concrete cracking, and abutment erosion. The structure has been reviewed by Morrison Maierle using available as-built plans, documented bridge inspection reports, and a field visit to the site. Potential rehabilitation efforts have been analyzed for effectiveness, constructability, service life, public need, and cost. Preferred rehabilitation efforts are suggested.

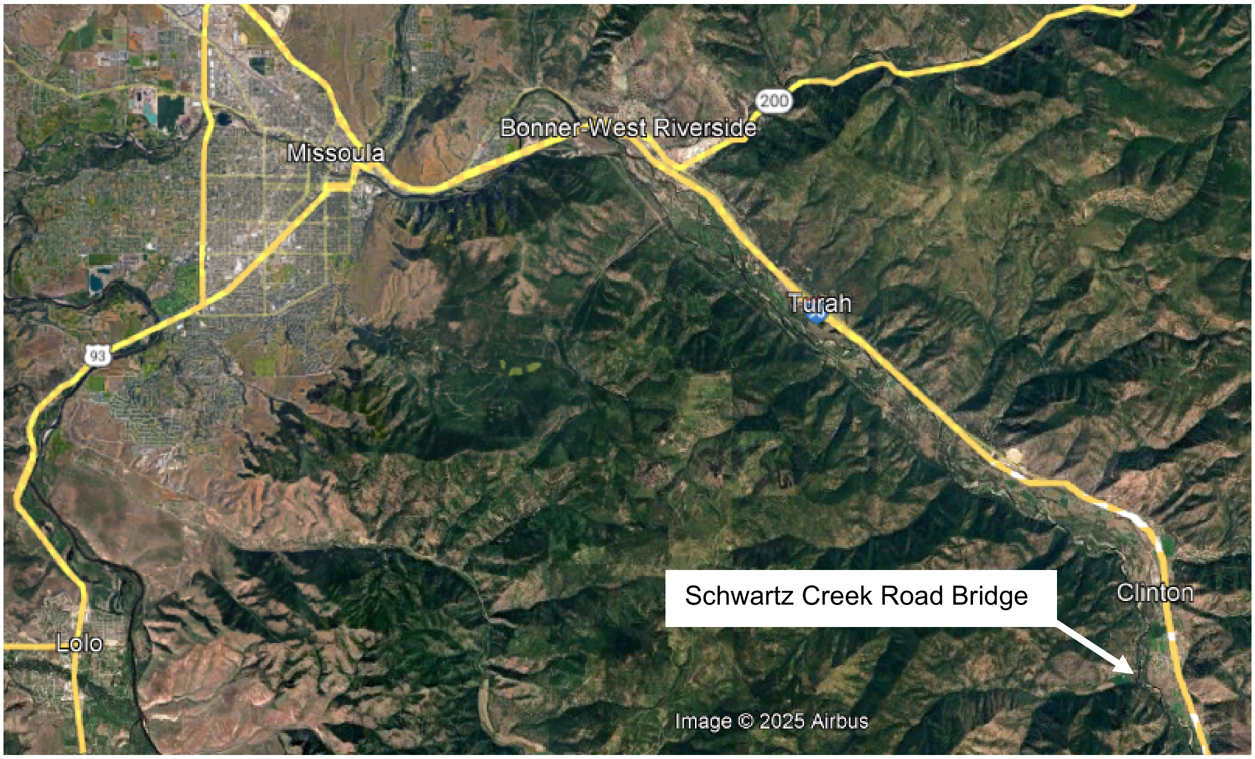

FIGURE 1: LOCATION MAP

Bridge rehabilitation is a common and successful way to extend the service life of a structure while limiting costs. Often certain aspects of the bridge can be in deteriorated condition and threaten the safety of the bridge while most others are in satisfactory condition. In these cases, it is much more cost effective to rehabilitate the aspect in deteriorated condition rather than replace the entire structure.

2. BRIDGE OVERVIEW

The Schwartz Creek Road structure at milepost 31.9 was originally constructed in 1956. The four-span bridge is 219.9-feet in length and 16.0-feet wide. The structure is a simple span steel two girder system with wide flange floor beams and a timber deck. The structure currently has a scour critical status, with foundation elements which are scour critical for both the typical scour design and the scour check flood events. The stability of Pier 3, located near the center of the river channel is the primary concern and portions of the pier footing are currently exposed. This pier footing is supported by untreated timber piles of unknown length. The structure also has multiple areas of spalled concrete with the primary concern areas being at bearing pedestals.

FIGURE 2: SCHWARTZ CREEK ROAD BRIDGE

2.1 BRIDGE LAYOUT

The as-built drawings of the bridge label the Bents from east to west, Bent No. 1 being at the east end and Bent No. 5 being at the west end. The underwater bridge inspection matches this geometry; however, the routine bridge inspection labels the Bents in the opposite direction. For consistency, the Bents in this report are labeled from east to west as detailed in the as-built drawings. See the image below for clarification.

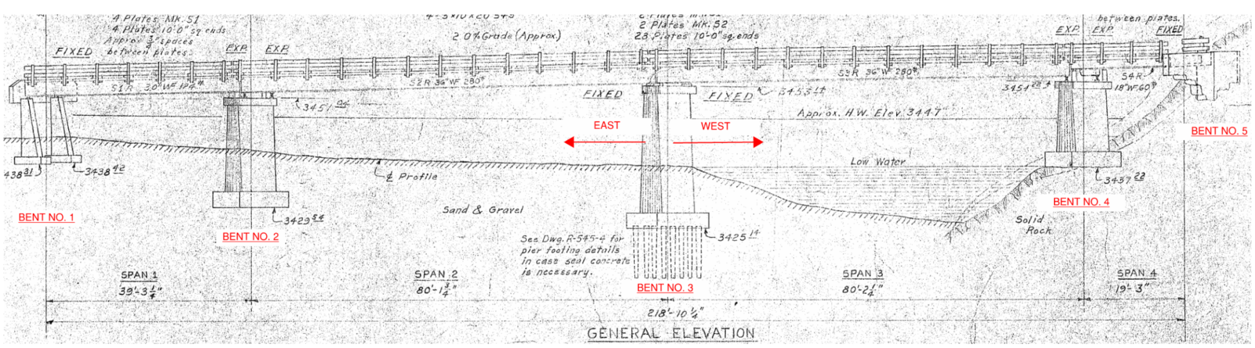

FIGURE 3: SCHWARTZ CREEK ROAD BRIDGE GEOMETRY

3. HYDRAULICS

3.1 HYDRAULIC DATA

An existing HEC-RAS model version 5.0.7 was utilized to obtain the hydraulic data necessary to complete scour calculations. The purpose of the model, prepared by Allied Engineering, was a new floodplain study. The model release date was 2/8/2022. Allied Engineering also prepared a 2D model to inform development of the 1D floodplain model. The 2D model was reviewed to assist in estimating the pier scour angle of attack.

3.2 SCOUR

A scour analysis was completed for the existing 4-span bridge for the scour design flood (Q_{100}) and the scour check flood (Q_{500}). The scour calculations were completed using photo gradation analysis. Four photographs were taken along the banks of Schwartz Creek and FHWA's Hydraulic Toolbox version 5.4.1.0 was utilized to complete photo gradation. Key material sizes for scour evaluation are listed in the table below.

TABLE 1: SCHARTZ CREEK CHANNEL BED MATERIALS (PHOTO GRADATION)

% Passing	Particle Size (mm)	Particle Size (ft)
D_{50}	82.9	0.272
D_{84}	141	0.463
D_{95}	159	0.522

Pier scour calculations were completed for Pier 2 (eastern) and Pier 3 (center). Pier 4 (western) lies outside of the channel edge and appears to be founded on competent bedrock. Angle of attack for the scour design and check flood ranges from 30° to 25° for Pier 2, respectively. The angle of attack for pier scour was set to 10° to account for uncertainty in the potential angle of attack during high flows for Pier 3. Contraction scour computations were completed using FHWA Hydraulic Toolbox. The D_{50} and D_{95} at this site are considered coarse bed materials. Pier scour computations were completed using several methods documented in HEC-18. Pier scour methods included, the standard HEC-18 approach which does not consider channel bed materials, coarse-bed pier scour, Complex Piers Case 1, and Complex Piers Case 1 with the 4th edition K_4 factor for coarse bed materials.

Estimated scour depth values without considering the coarse-bed channel materials yielded scour depths ranging from 13 feet to 21 feet for the existing bridge piers. These methods are recommended for design of new bridges. Because this is an existing bridge for which scour monitoring and scour mitigation is being considered, we recommend considering scour risk using coarse-bed methods. Estimated scour depth values using coarse-bed pier scour for Pier 2, and complex piers scour case 2 with HEC-18 4th Ed. K_4 for Pier 3 at the existing bridge for the 100-year and 500-year events are summarized in Table 2. Long-term channel profile data does not exist and history of channel degradation or aggredation was not identified in the maintenance and inspection records. Therefore, long-term aggradation or degradation are not believed to be a concern at this site. The low scour elevation depth is summarized in Table 3.

TABLE 2: SCOUR DEPTH SUMMARY

Discharge (cfs)	Contraction Scour Depth (ft)	Pier 2 (eastern) Scour Depth	Pier 3 (center) Scour Depth (ft)
Q_{100}=20,300	0.0	8.0	6.2
Q_{500}=26,900	0.0	8.5	6.3

TABLE 3: LOW SCOUR ELEVATION

Pier	Channel Bottom Elevation (ft) (1)	minus	Contraction Scour (ft)	minus	Pier 2 Scour (ft)	equals	Low Scour Elevation (ft)	Bottom of Footing Elevation (ft) (2)
Pier 2	3,459.0	-	0.0	-	8.5	=	3,450.5	3,459.2
Pier 3	3,459.0	-	0.0		6.3	=	3,452.7	3,454.8

(1) From HEC-RAS model. Recommend survey confirmation.
(2) Estimated from 8/30/2021 underwater inspection report and the spring 2020 site survey for the floodplain study using common top of deck elevations.

Based on the scour analysis, there is more risk of bridge failure due to scour at the existing pier 2, especially if the main river channel shifts eastward at the existing low channel elevation, than failure due to scour at pier 3. The local channel bed at pier 2 is about 4.3 feet higher than the low channel bed elevation (thalweg) reported in Table 3. If pier 2 scours without the low channel migrating to the pier, the predicted scour depth is right at the bottom of the footing. Therefore, we recommend that Plan of Action updates for the Schwartz Creek Bridge, even after scour mitigation is constructed, include monitoring and potential closure of the bridge during large flow events to minimize risk to the traveling public.

3.3 SCOUR COUNTERMEASURE ALTERNATIVES

Scour countermeasure is recommended for Pier 2 and Pier 3. The following countermeasures were evaluated following guidance in HEC-23:

- Rock riprap, (HEC-23 DG 11), and
- Grout-filled bags (HEC-23 DG 13)
- Monitoring Instrumentation

Rock Riprap

Rock Riprap countermeasure includes placing riprap, with an underlying filter material, on the surface of the channel bed. The riprap and filter material surround the pier at pier 3. For pier 2, the riprap and filter material is only recommended around the upstream nose. Preliminary calculations suggest Class II Riprap over Class I Riprap as a filter material. Preliminary quantities and cost estimates are shown in Table 3. Quantities assume placement would occur under water and costs are for material only. Following installation of this countermeasure, regular monitoring and inspection is required to ensure countermeasure is stable.

Grout Filled Bags

Grout Filled Bags countermeasure includes a single layer of 1’ deep grout filled bags. The bags will surround the pedestal at pier 3. For pier 2, the bags are only recommended at the upstream nose. Preliminary quantities and cost estimates are shown in Table 4. Following installation of this countermeasure, regular monitoring and inspection is required to ensure countermeasure is stable.

TABLE 4: HYDRAULICS QUANTITIES SUMMARY AND COST ESTIMATE

Countermeasure	Material	Quantity	Material Cost
Rock Riprap P2	Class I Riprap	10 yd^3	$500
	Class II Riprap	20 yd^3	$1,300
		SUBTOTAL	**$1,800**
Rock Riprap P3	Class I Riprap	50 yd^3	$2,500
	Class II Riprap	85 yd^3	$5,525
		SUBTOTAL	**$8,025**
		TOTAL P2+P3	**$9,825**
Grout Filled Bags P2	Grout Filled Bags	10 yd^3	$6,500
Grout Filled Bags P3	Grout Filled Bags	40 yd^3	$26,000
		TOTAL P2+P3	**$32,500**
Scour Monitoring Instrumentation P2	Fixed/Float-out Sensor	1 each	$37,500
Scour Monitoring Instrumentation P3	Fixed/Float-out Sensor	1 each	$37,500
		TOTAL P2+P3	**$75,000**

Note: Costs are for features only and do not include design engineering, mobilization, construction engineering, or contingencies. See Table 5 for complete project cost.

In addition to the recommended physical pier scour mitigation features summarized above, Missoula County may want to consider installing fixed/float-out instrumentation scour monitoring equipment at both pier 2 and pier 3. This monitoring instrumentation countermeasure would allow Missoula County staff to evaluate scour progression during large flow events and hopefully make timely decisions for bridge closure prior to an unacceptable risk of failure occurs. Whether or not scour monitoring instrumentation is implemented, we recommend annual observation/inspection of the bridge piers and channel bed elevation and location after spring runoff high flows and after any other high flow events.

3.4 ENVIRONMENTAL CONSIDERATIONS AND EXPECTED PERMITTING

The project is within a Zone AE designated floodplain and a floodplain permit will be required. Additionally, a Section 404 permit, SPA 124 permit, and a 318 authorization will be required.

The Grout Filled Bag countermeasure involves the least volume of fill into the active channel and likely the least amount of channel disturbance. However, the Grout Filled Bag countermeasure does cover a larger surface area than the other alternative.

The Rock Riprap countermeasure requires the most volume of fill into the active channel.

Scour monitoring instrumentation is the least environmentally impactful alternative.

3.5 CONCLUSIONS AND RECOMMENDATIONS

Morrison Maierle recommends installation of scour countermeasure at Pier 2 and Pier 3. As noted above, annual monitoring and inspection is recommended along with consideration of fixed/float-out monitoring instrumentation.

4. STRUCTURE

4.1 REHABILITATIONS

Evaluation of the most recent MDT structure inspection report revealed the following structural concerns:

- Cracked and spalled concrete bearing pedestals at Bent Number 3.
- Spalls in concrete pier caps at Bent Number 2 and Number 4.
- Crack/delamination/spall at Abutment Number 1.
- Undermining of earthwork at Abutment Number 1.
- Cracks in tack welds at two intermediate diaphragms in spans 2 and 3.
- Bent anchor rod at Bent 2.

A field visit conducted by Morrison Maierle confirmed these deficiencies and Morrison Maierle recommends repairing most of these known defects as described below.

FIGURE 4: BENT NUMBER 3 PEDESTAL

FIGURE 5: BENT NUMBER 4 CAP

FIGURE 6: ABUTMENT NUMBER 1

Further review of the pedestal spalls revealed that there is an existing steel block within the concrete pedestal that supports the steel girder bearings. Therefore, the repair would not require any jacking of the superstructure. The suggested repair is to remove any loose concrete within the pedestal, preferably all pedestal concrete, and replace with a high strength grout pedestal of the same size. The grout would have much higher compressive strength than the existing concrete and would also have much better bond capabilities to the existing steel and concrete. Additionally, reinforcing steel dowels could be installed vertically into the bent cap to allow for additional rebar placement.

The recommended repair of spalled concrete at Bent Number 2 and Number 4 is to remove any loose or deteriorated concrete and replace with a structural concrete mix such as MDT's Concrete Class Structure. Removal lines should be set with a clean saw cut and removal should not damage any existing reinforcing steel. Any reinforcing steel damaged, cut, or corroded to where it has lost 50 percent of its effective cross section should be replaced in kind. New concrete should be bonded to existing with an epoxy resin bonding agent. Areas where a significant amount of concrete has spalled would require new rebar to be added by anchoring into existing concrete. However, none of the spalled areas on this structure are expected to be that significant.

The crack at abutment 1 may have been caused by the undermining of the earthwork under the bent or by settlement of the abutment segments. Since the crack may have a structural cause, it should be monitored for any further separation. The recommended repair at the existing crack at abutment 1 is to remove any delaminated concrete, clean cracks, fill with low viscosity injection epoxy, and repair area as described above for spalled concrete. Removal of delaminated concrete may not be necessary as a structural crack would not have much delamination. Consequently, care should be taken when removing loose concrete. Additionally, earthwork and riprap should be added at abutment 1 underneath and in front of the backwall.

There are several options for construction access methods to complete these repairs. The repairs at abutment 1 can be done out of the water during low water season and will not affect the roadway above. All repairs at intermediate piers can be done using either of the following access methods:

- Platforms built on the piers using access from the top of bridge deck. This approach will require intermittent road closures. Emergency access could be provided but otherwise road would be closed for multiple hours at a time.
- Work from a small barge tied to piers with small boats to access barge.
- Manlift/forklift from the shoreline and from within the river. Forklift would need to enter the river to access pier 3.

Costs do not vary significantly between the different access options; however, equipment entrance into the river will be most cost effective. Construction method will most likely be determined by road closure availability, permit agency allowance to enter the river with equipment, and contractors' preference.

There are four expansion bearings on the structure, two at Bent Number 2 and two at Bent Number 4. The existing expansion bearings are a steel rocker and pin assembly that was a common detail when the bridge was initially built. These details are known to wear and freeze and eventually restrict movement of the beams above and they are often replaced with elastomeric bearing devises during rehabilitation projects. Additionally, the bearings have consistently been at or near maximum expansion and one bearing has a bent anchor rod. This indicates that the bearings may either be frozen, or the substructure may have settled slightly. These bearings however do not appear to be causing any structural damage to the bridge.

Replacing existing expansion bearings would require jacking the superstructure, removing the existing bearings, and placing new elastomeric bearings. New bearings can potentially reuse the existing anchor bolts. New bearings will most likely require a spacer assembly to make up any height difference between the old bearings and new bearings since rocker bearings are generally taller than elastomeric bearings.

Bearing replacement will require a bridge closure to jack the superstructure. Retrofits to the existing end diaphragm and connections will be required to jack the structure since there is not enough space to jack under the existing beams and the existing diaphragms do not have the required capacity. Jacking could potentially be done under live load; however, this would require significant more cost to install larger jacking members and work platforms. Since bearing replacement would be costly, include complicated construction and design, and since the existing bearings do not appear to be causing additional damage, replacement is not required at this time. A cost estimate is provided for consideration which assumes a full bridge closure.

The cracked welds at the intermediate diaphragms do not appear to have extended into the structure steel members. The welds are not structural as the diaphragms are connected by rivets to the steel beam web. No repair is recommended at this time; however, the cracks should be monitored for any protrusion into the structural members.

A full bridge replacement was also considered for cost comparison purposes. Cost estimate was prepared by using average cost per square foot for recent bridges of similar size.

4.2 CONCLUSIONS AND RECOMMENDATIONS

TABLE 5: SCHWARTZ CREEK COST ESTIMATE

Rehabilitation	Location	Quantity	Cost
All Recommended Work			$279,825
Mobilization, Engineering, & Contingencies			$246,694
		TOTAL*	**$526,519**
Optional Additives			
Replace Bearings	Bent No. 2	2	$12,000
Replace Bearings	Bent No. 4	2	$12,000
Traffic Control			$10,000
Mobilization, Engineering, & Contingencies			$76,000
		TOTAL	**$110,000**
Replace Bridge		6,640 ft^2	**$6,000,000**

*Note: See detailed cost estimate in Appendix A.

Morrison Maierle recommends completing the bridge rehab work as described above. Repairs to bearing pedestals, concrete spalls, concrete cracks, and earthwork will each extend the service life of the structure. Further erosion of the bearing pedestal concrete could weaken the lateral resistance of the anchor rods and allow for the steel blocks to shift which could cause the beams to drop to the pier cap. The other concrete repairs will prevent further damage as well as protect the existing reinforcing steel from corrosion. Lastly, bearing replacement, while not an immediate need, would ensure proper movement of the existing girders and prevent potential damage to the girders due to frozen or stiff expansion bearings. The following items should continue to be monitored through bridge inspections.

- Repaired crack at abutment 1
- Expansion bearings (if not replaced)
- Cracks in tack welds at intermediate diaphragms

Generally, if the rehabilitation cost estimate approaches about 70% of the cost to fully replace the structure, then replacement becomes the more cost-effective choice in terms of life-cycle costs. As shown in the table above, rehab costs are estimated at less than 1% of the cost to replace the structure. This structure does not carry abundant traffic and much of the structure is in good condition. Therefore, full replacement is not recommended.

5. APPENDIX A – COST ESTIMATES

COST ESTIMATE

Prepared By: Morrison Maierle

<u>Missoula County Bridge Rehabilitations</u>
<u>Preliminary Engineering Report</u>

Schwartz Creek Road Clark Fork River Bridge - Rehabilitation

Job No.	674015		
Computed	CCA	Date	1/15/2025
Checked	CEB	Date	3/19/2025
Sheet No.	1	Of	1

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
REPAIR PEDESTAL	LS	1	$25,000	$25,000
REPAIR SPALLS AT BENT NO. 2 CAP	LS	1	$15,000	$15,000
REPAIR SPALLS AT BENT NO. 4 CAP	LS	1	$10,000	$10,000
REPAIR CRACK AT ABUTMENT NO. 1	LS	1	$10,000	$10,000
EARTHWORK	LS	1	$8,000	$8,000
**ROCK RIPRAP - CLASS 1*	CY	60	$65	$3,900
**ROCK RIPRAP - CLASS 2*	CY	105	$85	$8,925
**EQUIPMENT RENTED BY COUNTY*	LS	1	$50,000	$50,000
TRAFFICE CONTROL	LS	1	$74,000	$74,000
DESIGN ENGINEERING, BID DOCS, AND PUBLIC INTEREST	LS	1	$75,000	$75,000

*Cost estimate based on the County performing the work.

BASE CONSTRUCTION SUBTOTAL	**$279,825**
MOBILIZATION (20%)	$55,965
SUBTOTAL	**$335,790**
CONTINGENCIES (40%)	$134,316
CONSTRUCTION ENGINEERING (12%)	$56,413
TOTAL ESTIMATED COST	**$526,519**