West of Missoula - NW

Bridge Type, Size and Location (TSL) Report

Frenchtown Irrigation District (FID) – Main Canal

STPS 263 – 1(28)6

UPN 6141000

MDT
July 10, 2018

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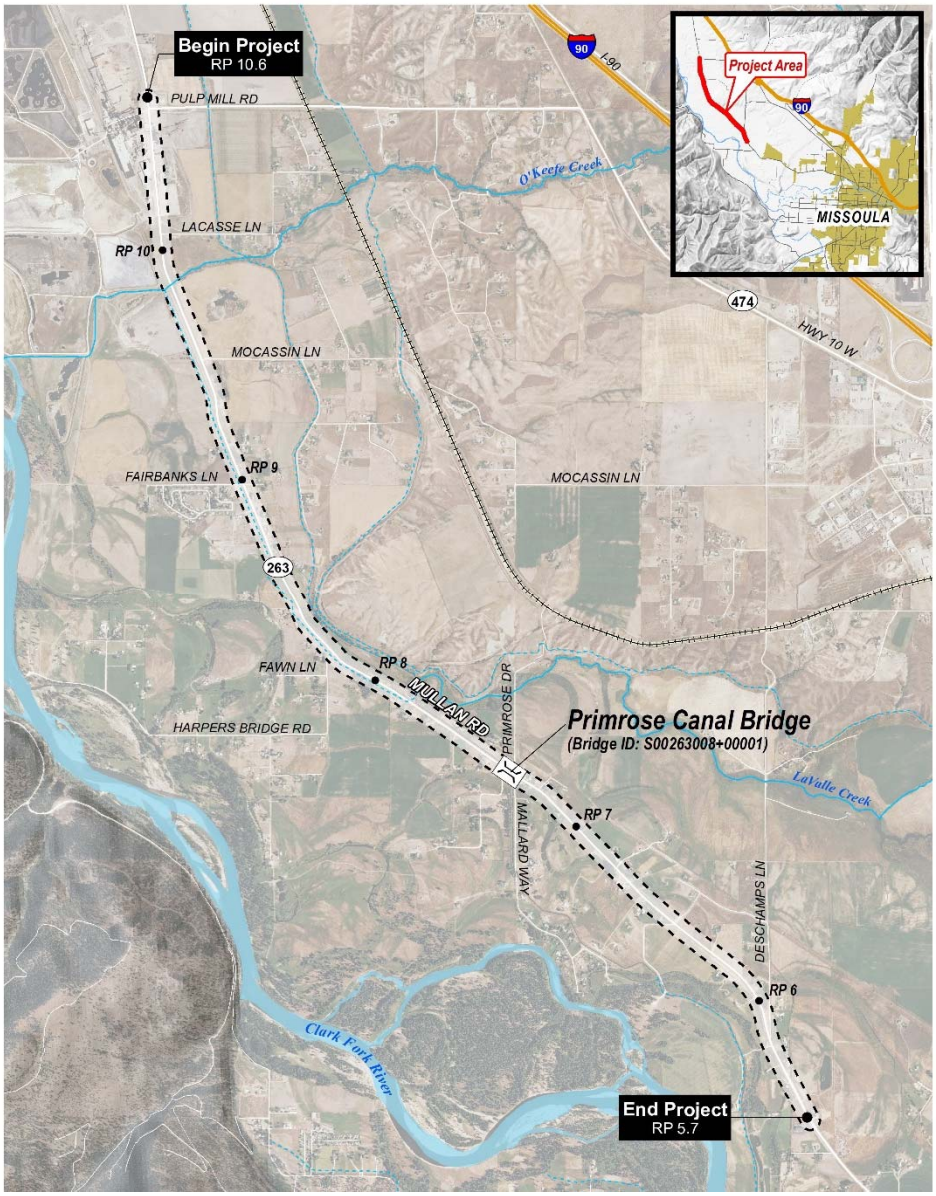
1 Introduction

This project has been nominated to improve the driving surface and safety of the roadway by upgrading the clear zone. Also included in the project will be adding new guardrail, pavement markings, signing, and fencing. These improvements will reduce the crash rate and severity throughout this length of road. Full pavement reconstruction is required the entire length of the project. The relocation and/or removal of irrigation canals and privately owned structures that closely parallel the roadway will be required on this project.

Figure 1. Project Area Map



The purpose of this Bridge Type, Size, and Location (TSL) Report is to document the project design criteria, identify bridge alternatives and construction phasing options, and provide recommendations on the preferred bridge alternate for the Frenchtown Irrigation District (FID) - Main Canal crossing.

2 Site Description

The project is located in Missoula County, beginning on S-263 RP 5.7, just west of the intersection between S-263 (Mullan Road) and Deschamp's Lane. The beginning of the project station is 101+00.00 (STPS 263-1(28)6). The project extends west to RP 10.6, just past the intersection of S-263 (Mullan Road) with S-474 (Pulp Mill Road) to the end of project station 358+30.00 (STPS 263-1(28)6). This segment of road is located in Township 14 N, Range 20 W (Sections 4 and 5), Township 14 N, Range 21 W (Sections 30, 31, and 32), Township 14 N, Range 21 W (Sections 13, 24, and 25).

Secondary 263 is functionally classified as a Rural Collector Road. The geometric design criteria for Rural Collector Roads (Secondary System) will be used.

The proposed project alignment and stationing will begin at 101+00 near RP 10.6 and increase as the project extends east.

Figure 2. Primrose Canal Bridge Site Map

3 Existing Bridge

The existing bridge over the Frenchtown Irrigation District (FID) - Main Canal has a 23 ft. span and 28 ft. deck width. The bridge is square and is comprised of non-composite steel stringers supporting corrugated metal deck pans filled with gravel and topped with

an asphalt overlay. The superstructure was built in 1970 and is supported on a steel pier cap bearing on concrete abutments. According to the Preliminary Field Review Report the concrete abutments were installed prior to the superstructure and are of unknown age. Additional information on the existing bridge is summarized below:

Bridge Inventory No.	S00263008+00001
Route	Off System
Year Built	1970 (Superstructure) Unknown (Substructure)
Length	23’-0”
Deck Roadway Width	26’-0” (Inspection Report)
Out to Out Deck Width	28’-0”
Sufficiency Rating	65.05
Deck Rating	6

Figure 3. Existing Bridge (Looking Southwest)

Bridge replacement is a more practical option compared to rehabilitation for the following reasons:

- The condition and structural details for the abutments is unknown
- Retrofitting and/or widening the existing structure would leave in place superstructure components that are over 45 years old.

Therefore, the existing bridge will be removed and replaced as part of this project.

4 Hydraulics

The existing bridge nearly spans the Frenchtown Irrigation District (FID) Main Canal and therefore has a negligible impact on water surface elevations in the canal. The existing bridge has a clear span of 20.76’ with a low chord elevation of 3075.13. The design flow is 172 cfs, which matches the Main Canal’s original design flow and FID’s water right. The bridge opening perpendicular to the canal flow will be 21.2’ at the top of the water surface and will completely span the canal for the design flow so that the bridge does not impact canal operations. The proposed low-chord elevation of 3075.45 will provide over 2 feet of freeboard for the design flow. The existing canal bottom is composed of cobbles and gravel. Riprap or other scour mitigation measures will not be necessary due to estimated velocities of less than 2.5 feet per second for flows up to 172 cfs. Preliminary hydraulic design information taken at the upstream face cross section is summarized below:

Preliminary Stream Data

Design Flow:	172 cfs
Design Water Surface Elevation	3073.18

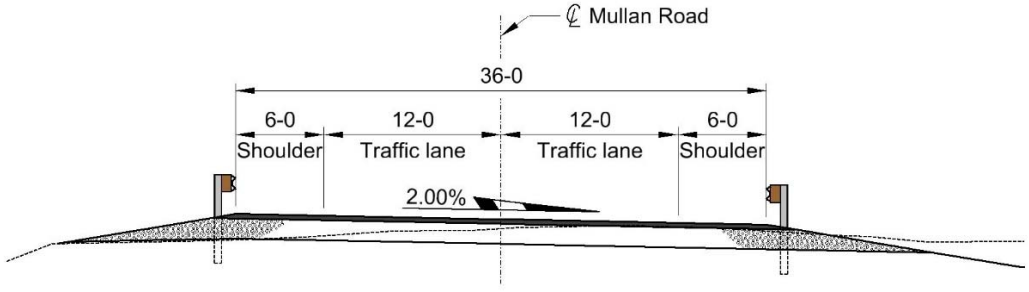
Refer to the *Preliminary Bridge Hydraulics Report (Activity 170)* for additional information.

5 Roadway Design Elements

The proposed roadway horizontal alignment will generally follow the existing alignment while bringing all horizontal curves up to current standards. Refer to the *Preliminary Roadway Design Report (Activity 102)* for additional information.

See the figure below for the roadway typical section at the bridge.

Figure 4. Roadway Typical Section



The roadway will have a constant superelevation of 2.0% across the bridge to allow for storm water and roadway drainage to flow away from the canal.

The design speed is 60 mph. The posted speed limit for the majority of the project is 55 mph. There is one section at the beginning of the project where the speed limit is reduced to 35 mph in the vicinity of the vacant Pulp Mill site. Additional roadway design information is summarized below:

Mullan Road Preliminary Design Data

Present 2017 ADT =	1,670
Letting 2021 ADT =	1,770
Design 2041 ADT =	2,390
DHV =	250
Trucks =	7.7%
V =	60 mph
18 kip ESAL's =	77 Daily
Growth Rate =	1.5% Annually

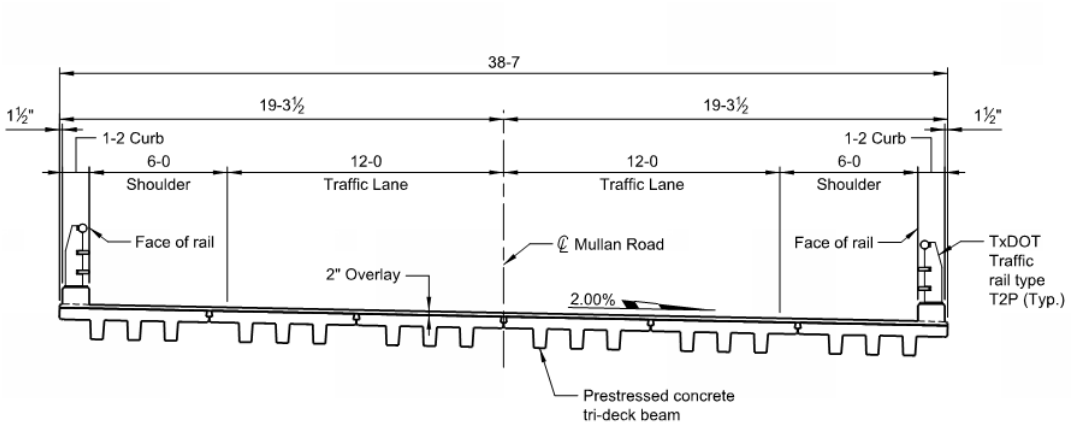
The project will fully reconstruct the road surface due to its deteriorating existing condition. The reconstruction will include safety enhancements such as revised curvature, widened shoulders, improved clear zone, updated signing and striping and additional rumble strips. Temporary construction easements and permits may be required to construct the new bridge.

6 Bridge Typical Section

The Irrigation Main Canal Bridge will be constructed to support 2 - 12' lanes with 6' shoulders with a total roadway width of 36'. This typical section exceeds MDT bridge design standards for a Secondary Roadway with traffic volumes listed in Section 4. The shoulder widths on the bridge will match the approach roadway.

The schematic below represents the proposed typical section at the bridges.

Figure 5. Bridge Typical Section (Looking Ahead on Line)



TYPICAL SECTION
Scale ~ ⅛" = 1'-0"
(Looking Ahead on Line)

7 Bridge Design Criteria

The new bridge will be designed in accordance with the current AASHTO and MDT standards. Specifically, the following standards and specifications apply:

- Montana Structures Manual
- AASHTO LRFD Bridge Design Specifications, 8th Edition
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition
- Montana Standard Specifications for Road and Bridge Construction, 2014

- The following seismic design data, determined in accordance with the *2011 AASHTO Guide Specifications for LRFD Seismic Design*, with 2015 Interims will be used for the final bridge design:
  - Approximate Return Period = 1000 year
  - Peak Ground Acceleration (PGA) = 0.136g
  - Site Class D (assumed and TBD in ACT 130)
  - Effective Peak Ground Acceleration, A_s = 0.208g
  - Design Spectral Acceleration Coefficient (0.2s period), S_{DS} = 0.502
  - Design Spectral Acceleration Coefficient (1.0s period), S_{D1} = 0.244
  - Seismic Zone 2 (SDC = B per Guide Specification)
  - Operational Classification = Other

The following primary criteria will be used to develop bridge options:

Table 1: Bridge Evaluation Criteria

Criteria	Objective
Quick Replacement	Replacement structure needs to be built during the time the canal is dry (Oct – April).
Minimize Structure Depth	Minimize grade raise impacts while providing adequate freeboard over the canal
Minimize Canal Impacts	Selected alternate should have minimal impact on the Irrigation Main Canal and provide an adequate hydraulic opening

Other considerations for the bridge design are summarized below.

Aesthetics

Options for aesthetics are not considered to be required at this site due to the rural location of the bridge and low visibility to the general public.

Bridge Deck Drainage

Storm water drainage from the bridge deck will be captured at the shoulders and conveyed towards the bridge ends. Intermediate deck drains are not anticipated and drainage near the abutments will be directed towards the shoulders for infiltration.

Barrier

MDT has indicated that the project should utilize a MASH approved guardrail. For this study, the proposed bridge rail is the TXDOT T2P which will eventually be adopted as

standard MDT bridge railing. The TXDOT T2P railing is currently proposed on two other projects in the Missoula District. The bridge rail type is subject to change based on future guidance from MDT.

Utilities

There is a 4” conduit attached to the south side of the existing bridge carrying a CenturyLink underground telephone line. This utility will need to be perpetuated across the new structure.

8 Bridge Foundations

Geotechnical borings have not yet been collected for the FID Main Canal Bridge. Borings at the proposed foundation locations along with final geotechnical recommendations are forthcoming upon selection of the preferred bridge alternate.

9 Construction Staging

Traffic will be maintained throughout construction by utilizing a detour around the bridge replacement at the FID Main Canal. A temporary bridge will be required for roadway traffic to crossover the canal, likely placed to the south. The canal is typically dry from October through April. The canal could be temporarily filled in lieu of constructing a temporary detour bridge if the work can be completed during the period when the canal is dry. Additional coordination with the irrigation district is necessary to move forward with this option for detouring traffic.

10 Bridge Alternates

A simple span is the best option for crossing the irrigation canal, this would eliminate any piers or obstructions that would catch debris and would perpetuate the existing condition without causing a rise in the water surface elevation. The new abutments will be skewed at 10-degrees to the roadway alignment to allow the opening to parallel the canal and not require any regrading of the existing channel. Due to the unknown age and type of existing abutments, there is potential for issues to arise during construction due to the new southeast abutment being placed in the same location as the existing abutment. The new abutment location is controlled by maintaining the existing channel alignment and providing adequate room for improved roadside safety between Primrose Drive and the end of the structure. The following bridge alternates were investigated for the crossing at the proposed site:

Alternate A: Precast Concrete Tri-Deck with a 25’-0” span length. A precast tri-deck bridge is an efficient and economical solution for the canal crossing. The precast superstructure would allow for rapid construction, especially if combined with precast abutments. Six (6) 1’-4” deep tri-deck beams, approximately 6’-5” wide would be used to span the canal. A 2” overlay, likely asphalt, cast on top of the beams with a waterproof membrane is recommended to provide a wearing surface and improve rideability. Using

a concrete overlay or a thickened top slab will be investigated during final design. A MASH compliant bridge rail can be attached to the exterior girders. Precast flat slabs were also considered but tri-deck girders were recommended by the fabricator for the specified span length. For preliminary cost estimates, abutments are assumed to be semi-integral and supported on steel piles.

Alternate B: Rolled Steel Girders with a 25'-0" span length and a cast-in-place concrete deck. Six (6) W18x65 steel girders at 7'-1" spacing are proposed with an 8" thick deck. Due to the girder depth plus the 8" concrete deck, the steel girder alternate would require an approximate 6" roadway grade raise. There is additional cost in not only raising the roadway 6" but the FID Main Canal would be impacted from Sta 260+00 to 273+00 and would require relocation since there is not adequate room to catch grade without impacting FID Main Canal geometry. The parcel just north of the bridge (west side of Mullan Rd) contains an existing outbuilding that would need to be relocated or reconstructed along with a private water well at Sta 271+10 RT due to the profile grade raise. The estimate for the grade raise, canal relocation and relocation of outbuilding and well is approximately $100,000. Unpainted AASHTO M270 Grade 50 weathering steel is assumed for the steel type of the girders. For preliminary cost estimates, abutments are assumed to be semi-integral and supported on steel piles.

Alternate C: Aluminum Box Culvert. An aluminum box culvert with a 25'-4" span does not provide adequate hydraulic opening at the design water surface elevation without raising the roadway profile grade 6" to meet minimum cover requirements. This is the maximum span provided by the fabricator. This option will not move forward due to hydraulics issues and roadway impacts including FID Main Canal relocation.

Alternate D: Low-Rise Steel Arch. A low-rise arch was investigated to minimize raising the grade of the roadway. However, a roadway grade raise of 2' is necessary in order to provide adequate fill over the arch and provide the necessary width at the design water surface elevation. This option will not move forward due to hydraulic issues.

Alternate E: Precast Concrete Arch. A 28' span was the minimum span width that was hydraulically adequate. This option requires a roadway grade raise of 4" to provide the minimum required cover. The existing channel is approximately 24' wide. Using this arch structure would require the centerline of the channel to be shifted to the west to accommodate the wider opening. The additional width of the structure could not be divided evenly on each side of the canal centerline due to the close proximity of the approach at Primrose Drive on the east side of the channel. This option will not move forward due to roadway impacts and FID Main Canal relocation.

Alternate F: Double Cell Box. A single cell box culvert is not practical given the required span length. Therefore, a double cell configuration was included in the evaluation. This option was not recommended as part of the project hydraulic evaluation due to concerns with the center wall catching debris. This option will not move forward.

Table 2: Bridge Alternate Matrix

Bridge Alternate	Description	Total Length (ft)	Comments
A	Precast Concrete Tri-Deck	25’-0”	• Lowest cost alternate • Short construction duration • Option for precast abutments
B	Steel Girder	25’-0”	• Requires 6” roadway grade raise • Highest cost alternate • Option for precast abutments • Longer construction duration • Impacts to FID Main Canal and adjacent property
C	Aluminum Box	25’-4”	• Inadequate hydraulic opening at design water surface elevation • Requires 6” roadway grade raise • Impacts to FID Main Canal and adjacent property
D	Low-Rise Arch	32’-7”	• Inadequate hydraulic opening at design water surface elevation • Requires 2’-0” roadway grade raise • Impacts to FID Main Canal and adjacent property
E	Concrete Arch	28’-0”	• Requires 4” roadway grade raise • Requires canal realignment • Impacts to FID Main Canal and adjacent property
F	Double Cell Box	24’-0”	• Inadequate hydraulic opening; potential to catch debris

A cost summary of the two bridge alternates that met both the roadway and hydraulic criteria is included in the table below. The costs were based on average MDT bid tabulations from past projects applied to the estimated quantities for each of the bridge alternates. Where appropriate, the unit prices were adjusted based on supplier information and engineering judgment to reflect the specific characteristics of this project. Cost estimates for each of the bridge alternates is included in Appendix B. Preliminary layouts for each of the alternates considered are included in Appendix A.

Table 3. Estimated Construction Cost Summary

	Bridge Alternate	
	Precast Tri-Deck	**Steel Girder w/ CIP Deck**
Bridge Cost	$175,000	$172,200
Bridge Cost / SF	$180 / SF	$179 / SF
Remove Structure	$25,000	$25,000
Roadway Grade Raise	$0	$100,000
Mobilization (8%)	$16,000	$23,800
Subtotal	**$216,000**	**$321,000**
Contingencies (20%)	$43,200	$64,200
Construction Engineering (10%)	$21,600	$32,100
Total Est. Cost	**$280,800**	**$417,300**
Source: MDT Bid Tabs 2017		

11 Conclusion

Bridge Alternate A was selected for final design. The precast concrete Tri-Deck does not require an additional grade raise from the proposed alignment, can span the existing channel alignment and is the low-cost option of the bridge alternates evaluated.

Appendix A.

Appendix B.

Project:	**West of Missoula - NW**	Computed:	**JDS**	Date:	**6/22/2018**
Subject:	**Primrose - Substructure Cost Estimates**	Checked:	**JCM**	Date:	**7/5/2018**
Task:	**Tri Deck Option**	Page:		of:	
Job #:	**10042464**	No:			

Tri Deck Option

Bridge Span Information

Span (C/C Brg)	25.000	ft	Out-Out Deck Width	38.583	ft
Beam Extension (Beyond CL Brg)	0.500	ft	Number of Beams	6	
Total Beam Length	26.000	ft	Beam Spacing (C/C)	6.000	ft
Tri-Deck 1'-4" Depth	1.333	ft	Overhang	4.292	ft
Assumed Haunch Thickness	0.000	ft	# of Exp. Brg's/Beam	0	
Number of Concrete Bridge Barriers	2		Deck Thickness	0.167	ft
Number of Pedestrian Rails	0		Deck Area	1003.2	ft^2

Quantity Calcultions

Linear Feet of MTS	156.0	ft	*(Total Beam Length x Number of Beams)*
Linear Feet of Bridge Barrier	72.0	ft	*(Total Beam Length x Number of Barriers)*
Linear Feet of Hand Rail	0.0	ft	*(IF Ped. Rail <> 0, then Total Beam Length x Number of Barriers)*
Linear Feet of Pedestrian Rail	0.0	ft	*(Total Beam Length x Number of Pedestrian Rails)*
Number of Elastomeric Exp. Brgs	0	EACH	*(Number of Beams x # of Expansion Bearing's/Beam)*
Volume Haunch	0.0	CF	*(Total Beam Length x Number of Beams x Avg. Haunch x 4')*
Volume Deck	167.2	CF	*(Total Beam Length x Out-Out Deck Width x Deck Thickness)*
Epoxy R/F in Deck	0.0	LB	*(Deck Volume + Haunch Volume)(Deck R/F Ratio [200 LB/CY])*
Epoxy R/F in Barrier	1016.0	LB	*(Length of Barrier - Number Barrier x 5' x 2)(Typ. Barrier R/F Ratio) + (Number Barrier x 5' x 2)(End Barrier R/F Ratio)*

Cost Estimate

- Leave Override blank if you want to use Average Cost Data, otherwise place value to use in Override

Item #	Description	Unit Cost Average	Unit Cost Override	Effective Unit Cost	Quantity		Cost
401 020 048	Plant Mix Surf Gr S-1/2in		$ 30.00	$ 30.00	11.1	TON	$ 333
553 010 480	Tri Deck		$ 300.00	$ 300.00	156.0	LF	$ 46,800
555 010 200	Epoxy R/F	$ 1.50	$ 1.60	$ 1.60	1016.0	LB	$ 1,626
	Bridge Barrier	$ 81.67	$ 90.00	$ 90.00	72.0	LF	$ 6,480
563 000 110	Waterproof Membrane		$ 24.00	$ 24.00	111.5	SY	$ 2,675
565 000 010	Elastomeric Brg	$ 3,959.24	$ 1,500.00	$ 1,500.00	2.0	LS	$ 3,000
					Sub-Total	**$**	**60,914**
					Cost/SF	**$**	**60.72 /SF**

Item Description	Wt (kips)
Deck	25.08
Haunch	0.00
Beams	106.39
Barrier	25.56

Total Superstructure Dead Load **157 kips**

Project:	**West of Missoula - NW**	Computed:	**JDS**	Date:	**6/22/2018**
Subject:	**Alternate B - Primrose - Superstructure Cost**	Checked:	**JCM**	Date:	**7/5/2018**
Task:	**Steel Girder Alternate**	Page:		of:	
Job #:	**10042464**	No:			

Steel Girders - Total Length 25 ft, 6 Girders at 7.083 ft spacing

Bridge Span Information

Total Span Length (C/C Brg)	25.0	ft	Out-Out Deck Width	38.583	ft
Beam Extension (Beyond CL Brg)	0.500	ft	Number of Beams	6	
Total Beam Length	26.000	ft	Beam Spacing (C/C)	7.083	ft
Average Flange Width	0.633	ft	Overhang	1.583	ft
Assumed Haunch Thickness	0.333	ft	# of Brg's/Beam	2	
Number of Concrete Bridge Barriers	2		Deck Thickness	0.667	ft
Number of Pedestrian Rails	0		Deck Area	1003.2	ft^2
Total Steel Weight Type 1	12,000	lb*	DL Bearing Rxn	15.0	kip*
			Abut LL Rxn	64.0	kip*

**From Steel Bridge Runs*

Quantity Calcultions

Linear Feet of Bridge Barrier	72.0	ft	*(Total Beam Length x Number of Barriers)*
Linear Feet of Hand Rail	0.0	ft	*(IF Ped. Rail <> 0, then Total Beam Length x Number of Barriers)*
Linear Feet of Pedestrian Rail	0.0	ft	*(Total Beam Length x Number of Pedestrian Rails)*
Number of Elastomeric Exp. Brgs	12	EACH	*(Number of Beams x # of Expansion Bearing's/Beam)*
Volume Haunch	32.9	CF	*(Total Beam Length x Number of Beams x Avg. Haunch x Flange Width)*
Volume Deck	668.8	CF	*(Total Beam Length x Out-Out Deck Width x Deck Thickness)*
Epoxy R/F in Deck	5197.9	LB	*(Deck Volume + Haunch Volume)(Deck R/F Ratio [200 LB/CY])*
Epoxy R/F in Barrier	1016.0	LB	*(Length of Barrier - Number Barrier x 5' x 2)(Typ. Barrier R/F Ratio) + (Number Barrier x 5' x 2)(End Barrier R/F Ratio)*

Cost Estimate

- Leave Override blank if you want to use Average Cost Data, otherwise place value to use in Override

Item #	Description	Unit Cost Average	Unit Cost Override	Effective Unit Cost	Quantity		Cost
556 010 011	Standard Gir.	$ 1.65		$ 1.65	12000	LB	$ 19,800
551 020 107	Deck Concrete	$ 581.61	$ 650.00	$ 650.00	26.0	CY	$ 16,893
555 010 200	Epoxy R/F	$ 1.50	$ 1.60	$ 1.60	6213.9	LB	$ 9,942
	Bridge Barrier	$ 81.67	$ 90.00	$ 90.00	72.0	LF	$ 6,480
565 000 010	Elastomeric Brg	$ 3,959.24	$ 5,000.00	$ 5,000.00	1.0	LS	$ 5,000
					Sub-Total	**$**	**58,115**
					Cost/SF	**$**	**57.93 /SF**

Dead Load Reaction **90 kips**

Project:	**West of Missoula - NW**	Computed:	**JDS**	Date:	**6/22/2018**
Subject:	**Primrose - Substructure Cost Estimates**	Checked:	**JCM**	Date:	**7/5/2018**
Task:	**Abutment - Steel Piles**	Page:		of:	
Job #:	**10042464**	No:			

Abutment - Steel Piles

Superstructure Information

Deck + Haunch Thickness	1.00	ft	Total Super. Depth	2.63	ft
Girder/Beam Depth	1.50	ft	Out-to-Out Deck	38.58	ft
Bearing Height	0.13	ft	Skew	10.00	Degrees

Substructure Information

Cap Width	4.00	ft	Backwall Thickness	1.67	ft
Cap Height	4.00	ft	Backwall Height	2.63	ft
Cap Length	39.18	ft	Backwall Length	39.18	ft
Wingwall Height at Abut.	6.63	ft	Wingwall Length	5.19	ft
Wingwall Height at End	2.00	ft	Wingwall Thickness	1.67	ft
Length of Piles	30.00	ft			
Number of Piles	5				

Quantity Calcultions

Pile Length Furnished	157.5	LF	*(Number Piles x [Length of Piles + 1.5'])*
Pile Length Driven	150.0	LF	*(Number Piles x Length of Piles)*
Cap Concrete	626.9	CF	*(Cap Height x Cap Width x Cap Length)*
Cap R/F	2902.1	LB	*(Vol. Cap)x(Substructure Reinforcement Ratio [125 LB/CY])*
Backwall Concrete	171.4	CF	*(Backwall Height x BW Width x BW Length)*
Backwall R/F	793.5	LB	*(Vol. Backwall)x(Substructure Reinforcement Ratio [125 LB/CY])*
Wingwall Concrete	74.6	CF	*2x(Wingwall Thick. x Wingwall Length x Average Wingwall Height)*
Wingwall R/F	345.3	LB	*(Vol. Wingwall)x(Substructure Reinforcement Ratio [125 LB/CY])*

Cost Estimate

- Leave Override blank if you want to use Average Cost Data, otherwise place value to use in Override
- Backwall & Cap are Epoxy R/F, Wingwalls are Black Bars, and Drilled shaft are Seismic
- Select Seal Type - Either Strip Seal or Modular Joint.

Item #	Description	Unit Cost Average	Unit Cost Override	Effective Unit Cost	Quantity		Cost
551 020 035	Structure Conc.	$ 519.59	$ 700.00	$ 700.00	38.2	CY	$ 26,713
555 010 100	Reinforcing Steel	$ 1.34	$ 1.60	$ 1.60	345.3	LB	$ 552
555 010 200	Epoxy R/F	$ 1.50	$ 1.60	$ 1.60	3695.7	LB	$ 5,913
559 050 103	Furn. Pipe 16x0.5	$ 66.70	$ 70.00	$ 70.00	157.5	FT	$ 11,025
559 060 103	Drive Pipe 16x0.5	$ 10.56	$ 30.00	$ 30.00	150.0	FT	$ 4,500
559 040 035	Dynamic Load Test	$ 4,797.24	$ 5,000.00	$ 5,000.00	1.0	EA	$ 5,000
559 060 350	'ile Conical Drive Pt	$ 445.82	$ 475.00	$ 475.00	5.0	EA	$ 2,375

Sub-Total $ 56,078

Cost/End Bent $ 57,000