318 AUTHORIZATION REVIEW

I have reviewed the above project on behalf of the Montana Department of Environmental Quality (DEQ) pursuant to the Montana Water Quality Short-term Water Quality Standards for Turbidity 75-5-318 MCA:

☒ This project **will not** increase turbidity if completed according to the conditions listed in the 310 or 124 permit. Therefore, application to DEQ for a 318 authorization **is not** required.

O Impacts to the physical and biological environment from turbidity generated as a result of this project are uncertain. Therefore, the applicant must contact the Montana Department of Environmental Quality, 1520 East Sixth Avenue, Box 200901, Helena, MT 59620-0901, (406 444-3080) to determine project specific narrative conditions required to meet short-term water quality standards and protect aquatic biota.

O Turbidity generated from this project is expected to be short-term and have only temporary and minor impacts on the physical and biological environment. Therefore, compliance with the conditions stated in ***DEQ's Short Term Water Quality Standard for Turbidity Related to Construction Activity***, as well as other conditions listed in the 310 or 124 permit, are appropriate for this project.

DFWP Representative's Signature _____ Date 1·26·23

Revised: 5/12/2021 310 Form 270 and Instructions may be downloaded from: http://dnrc.mt.gov/*licenses-and-permits/stream-permitting*	**CD/AGENCY USE ONLY**	Application #	LC-01-23	Date Received	1/25/23
	Date Accepted	1/25/23	Initials CME	Date FW: to FWP	1/25/23

This space is for all Department of Transportation and SPA 124 permits (government projects).

Project Name Click to enter text.

Control Number Click to enter text. Contract Letting Date Date

MEPA/NEPA Compliance ☐Yes ☐No If yes, #C5 of this application does not apply.

JOINT APPLICATION FOR PROPOSED WORK IN MONTANA'S STREAMS, WETLANDS, FLOODPLAINS & OTHER WATER BODIES

This is a standardized application to apply for one or all local, state, or federal permits listed below.

- Refer to instructions to determine which permits apply and submit a signed application to each applicable agency.
- Incomplete applications will result in the delay of the application process.
- The applicant is responsible for obtaining all necessary permits and landowner permission before beginning work.
- **Other laws may apply.**

	PERMIT	**AGENCY**	**FILL OUT SECTIONS**	**FEE**
x	310 Permit	Local Conservation District	A - E and G	Inquire locally
	SPA 124 Permit	Department of Fish, Wildlife and Parks	A - E and G	No fee
	318 Authorization 401 Certification	Department of Environmental Quality	A - E and G	$250 (318); $400 - $20,000 (401)
	Navigable Rivers Land Use License, Lease, or Easement	Department of Natural Resources and Conservation, Trust Lands Management Division	A - E and G	$50, plus additional fee
	Section 404 Permit, Section 10 Permit	U. S. Army Corps of Engineers (USACE)	A - G F1-8	Varies ($0 - $100)
	Floodplain Permit	Local Floodplain Administrator	A - G	Varies by city/county ($25 - $500+)

A. APPLICANT INFORMATION

APPLICANT NAME (person responsible for project)**:** NorthWestern Energy
Has the landowner consented to this project? ☒ Yes ☐ No
Mailing Address: 11 East Park, Butte, MT 59701
Physical Address: Same
Cellphone:406-565-2461 Home Phone: Click here to enter or N/A. E-Mail:sady.babcock@northwestern.com

LANDOWNER NAME (if different from applicant): NorthWestern Energy Easement
Mailing Address: Click here to enter mailing address or N/A.
Physical Address: Click here to enter physical address or N/A.
Cellphone: Click here to enter or N/A. Home Phone:Click here to enter or N/A. E-Mail:Click here to enter or N/A.

CONTRACTOR/COMPANY NAME (if applicable): TBD
PRIMARY CONTACT NAME: Click here to enter name
Mailing Address: Click here to enter name or N/A.
Physical Address: Click here to enter name or N/A.
Cellphone:Click here to enter or N/A. Home Phone:Click here to enter or N/A. E-Mail:Click here to enter or N/A.

B. PROJECT SITE INFORMATION

1. NAME OF **STREAM** or **WATER BODY** at project location Tributary of Ten Mile Creek
   Project Address/Location: Benton Ave Nearest Town Helena
   County C Geocode: Click here to enter text.
   Choose.1/4 of the Choose. 1/4 of, Section 18 Township, 10N Range 3W & Section 13, T10N, R4W
   Latitude 46.623848°Enter Latitude.Longitude -112.042092° Refer to section B1 in the instructions.

2. Is the proposed activity within **SAGE GROUSE** areas designated as general, connected, or core habitat?
   Yes ☐ No ☒ Attach consultation letter if required. Refer to section B2 in the instructions.

3. Is this a **STATE NAVIGABLE WATERWAY**? The state owns beds of certain navigable waterways**.**
   Yes ☐ No☒ If yes, send a copy of this application to the appropriate DNRC land office. Refer to section B3 in the instructions.

4. **WHAT IS THE CURRENT CONDITION** of the proposed project site? Describe the existing bank condition, bank slope, height, nearby structures, and wetlands. What vegetation is present? Refer to section B4 in the instructions.

The existing banks are relatively flat approximately 1.5' in height and heavily vegetated with introduced grass species and cattails.

C. PROPOSED PROJECT OR ACTIVITY INFORMATION

1. **TYPE OF PROJECT** (check all that apply) Refer to section C1 in the instructions.

☐ **Agricultural and Irrigation Projects:** Diversions, Headgates, Flumes, Riparian fencing, Ditches, etc.

☐ **Buildings/Structures:** Accessory Structures, Manufactured Homes, Residential or Commercial Buildings, etc.

☐ **Channel/Bank Projects:** Stabilization, Restoration, Alteration, Dredging, Fish Habitat, Vegetation or Tree Removal, or any other work that modifies existing channels or banks.

☐ **Crossings/Roads:** Bridge, Culvert, Fords, Road Work, Temporary Access, or any project that crosses over or under a stream or channel.

☐ **Mining Projects:** All mining related activity, including; Placer Mining, Aggregate Mining, etc.

☐ **Recreation related Projects:** Boat Ramps, Docks, Marinas, etc.

☒ **Other Projects:** Cistern, Debris Removal, Excavation/Pit/Pond, Placement of Fill, drilling or directional boring, Utilities, Wetland Alteration. Other project type not listed here _____

_____

2. IS THIS APPLICATION FOR an annual maintenance permit? ☐ Yes ☒ No
(If yes attach annual plan of operation to this application) – Refer to section C2 in the instructions.

3. WHY IS THIS PROJECT NECESSARY? STATE THE PURPOSE OR GOAL of the proposed project. Refer to section C3 in the instructions.

NorthWestern Energy (NWE) is rerouting approximately 3,800' of natural gas pipeline. The purpose of the reroute is to move the pipeline away from a high consequence area.

4. PROVIDE A BRIEF DESCRIPTION of the proposed project plan and how it will be accomplished. Refer to section C4 in the instructions.

NWE proposes to bore approximately 675 feet of 12" steel natural gas pipeline under a tributary of Ten Mile Creek and Benton Avenue as part of the reroute project. The bore will go under the tributary at a depth of 11 feet. The bore entry excavation is approximately 100 feet from the edge of the bank on the west side and the exit location is 450 feet from the east edge of the creek. See attached bore profile.

5. **WHAT OTHER ALTERNATIVES were considered to accomplish the stated purpose of the project?** Why was the proposed alternative selected? Refer to section C5 in the instructions.

Open Trench – This alternative was dismissed due to environmental impacts.
Bore – This alternative was chosen due to the reduced impacts and the ability to get under Benton Ave and the tributary of Ten Mile Creek in one bore.

6. **NATURAL RESOURCE BENEFITS OR POTENTIAL IMPACTS. Please complete the information below to the best of your ability**.

* Explain any temporary or permanent changes in erosion, sedimentation, turbidity, or increases of potential contaminants. What will be done to minimize those impacts?
The project should have no temporary or permanent changes in erosion, sedimentation or turbidity due to the disturbance associated with the entry and exit locations being away from the edge to the water and a vegetated buffer protecting the creek from any potential erosion associated with the bore hole excavations.

- Will the project cause temporary or permanent impacts to fish and/or aquatic habitat? What will be done to protect the fisheries?

There will be no impacts to fish and/aquatic habitat.

- What will be done to minimize temporary or permanent impacts to the floodplain, wetlands, or riparian habitat?

There will be no temporary or permanent impacts to the floodplain, wetlands, or riparian habitat as they will not be disturbed during the bore.

- What efforts will be made to decrease flooding potential upstream and downstream of project?

The project will have no impacts to flooding.

- Explain potential temporary or permanent changes to the water flow or to the bed and banks of the waterbody. What will be done to minimize those changes?

The project will have no temporary or permanent changes to the water flow.

- How will existing vegetation be protected and its removal minimized? Explain how the site will be revegetated. Include weed control plans.

The entry and exit locations will be returned to original grade following tie in's. The area will be reclaimed and seeded upon reroute completion.

D. CONSTRUCTION DETAILS

1. PROPOSED CONSTRUCTION DATES. Include a project timeline. Start date 4/1/2023
Finish date 6/30/2023 How long will it take to complete the project? 2-3 months Is any portion of the work already completed? ☐ Yes ☒ No (If yes, describe previously completed work.)
Refer to section D1 in the instructions.
Click here to enter text.

2. PROJECT DIMENSIONS. Describe length and width of the project. Refer to section D2 in the instructions.
The bore is approximately 675'. The entry and exit holes will be approximately 10' x 10'.Click here to enter text.

3. EQUIPMENT. List all equipment that will be used for this project. How will the equipment be used on the bank and/or in the water? Note: All equipment used in the water must be clean, drained and dry. Refer to section D3 in the instructions.

A horizontal directional drilling rig will be used to complete the bore. Support equipment will include a backhoe, service trucks, welding trucks and miscellaneous trailers.

Will equipment from out of state be used? YES ☐ NO ☒ UNKNOWN ☐
Will the equipment cross west over the continental divide to the project site? YES ☐ NO ☐ UNKNOWN ☐
Will equipment enter the Flathead Basin? YES ☐ NO ☒ UNKNOWN ☐

4. MATERIALS. Provide the total quantity and source of materials proposed to be used or removed. Note: This may be modified during the permitting process therefore it is **recommended you do not purchase materials until all permits are issued.** List soil/fill type, cubic yards and source, culvert size, rip-rap size, any other materials to be used or removed on the project. Refer to section D4 in the instructions.

Cubic yards/Linear feet	Size and Type	Source
675 LF	12" steel pipe	

E. REQUIRED ATTACHMENTS

1. **PLANS AND/OR DRAWINGS** of the proposed project. **Include**:
   - Plan/Aerial view
   - an elevation or cross section view
   - dimensions of the project (height, width, depth in feet)
   - location of storage or stockpile materials dimensions and location of fill or excavation sites
   - drainage facilities
   - location of existing/proposed structures, such as buildings, utilities, roads, or bridges
   - an arrow indicating north
   - Site photos

2. **ATTACH A VICINITY MAP OR A SKETCH** which includes: The water body where the project is located, roads, tributaries, other landmarks. Place an "X" on the project location. Provide written directions to the site. This is a plan view (looking at the project from above).

3. **ATTACH ANNUAL PLAN OF OPERATION if requesting a Maintenance 310 Permit.**

4. **ATTACH AQUATIC RESOURCE MAP.** Document the location and boundary of all waters of the U.S. in the project vicinity, including wetlands and other special aquatic sites. Show the location of the ordinary high-water mark of streams or waterbodies. **if requesting a Section 404 or Section 10 Permit.** Ordinary high-water mark delineation included on plan or drawings and/or a separate wetland delineation.

F. ADDITIONAL INFORMATION FOR U.S. ARMY CORPS OF ENGINEERS (USACE) SECTION 404, SECTION 10 AND FLOODPLAIN PERMITS.

Section F should only be filled out by those needing Section 404, Section 10, and/or Floodplain permits. Applicants applying for Section 404 and/or Section 10 permits complete F 1- 8. Applicants applying for Floodplain permits, complete all of Section F. Refer to section F in the instructions.

FOR QUESTIONS RELATING TO SECTION F, QUESTIONS 1-8 PLEASE CONTACT THE USACE BY TELEPHONE AT 406-441-1375 OR BY E-MAIL MONTANA.REG@USACE.ARMY.MIL.

1. Identify the specific **Nationwide Permit(s)** that you want to use to authorize the proposed activity. Refer to section F1 in the instructions.

N/A – Not waters of the United States, including wetlands, will be impacted due to the project.

2. Provide the **quantity of materials** proposed to be used in waters of the United States. What is the length and width (or square footage or acreage) of impacts that N occurring within waters of the United States? How many cubic yards of fill material will be placed below the ordinary high-water mark, in a wetland, stream, or other waters of the United States? Note: Delineations are required of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Refer to section F2 in the instructions.

Click here to enter text.

3. How will the proposed project avoid or minimize **impacts to waters of the United States?** Attach additional sheets if necessary. Refer to section F3 in the instructions.

Click here to enter text.

4. Will the project impact greater than 0.10-acre of wetland and/or more than 300 linear feet of stream or other waters? If yes, describe how the applicant is going to **compensate (mitigation bank, in-lieu fee program, or permittee responsible)** for these unavoidable impacts to waters of the United States. Refer to section F4 in the instructions.

Click here to enter text.

5. Is the activity proposed within any component of the **National Wild and Scenic River System**, or a river that has been officially designated by Congress as a **"study river"**? Refer to section F5 in the instructions.

☐ Yes ☐ No

6. Does this activity require permission from the USACE because it will alter or temporarily or permanently occupy or use a **USACE authorized civil works project? (Examples include USACE owned levees, Fort Peck Dam, and others)**? Refer to section F6 in the instructions.

☐ Yes ☐ No

7. List the **ENDANGERED AND THREATENED SPECIES** and **CRITICAL HABITAT(s)** that might be present in the project location. Refer to section F7 in the instructions.

Click here to enter text.

8. List any **HISTORIC PROPERTY(S)** that are listed, determined to be eligible or are potentially eligible (over 50 years old) for listing on the National Register of Historic Places." Refer to section F8 in the instructions.

Click here to enter text.

9. List **all applicable local, state, and federal** permits and indicate whether they were issued, waived, denied, or pending. Note: All required local, state, and federal permits, or proof of waiver must be issued prior to the issuance of a floodplain permit. Refer to section F9 in the instructions.

Click here to enter text.

10. List the **NAMES AND ADDRESSES OF LANDOWNERS** adjacent to the project site. This includes properties adjacent to and across from the project site. (Some floodplain communities require certified adjoining landowner lists).
    NAME OF **Adjacent Landowner**: Click here to enter name Click here to enter Address
    NAME OF **Adjacent Landowner**: Click here to enter name Click here to enter Address
    NAME OF **Adjacent Landowner**: Click here to enter name Click here to enter Address
    NAME OF **Adjacent Landowner**: Click here to enter name Click here to enter Address

11. **Floodplain Map Number** N/A Refer to section F11 in the instructions.

12. Does this project comply with **local planning or zoning regulations**? Refer to section F12 in the instructions.
    ☐ Yes ☐ No

G. SIGNATURES/AUTHORIZATIONS

Some agencies require original signatures. **After completing the form**, make the required number of copies and **then sign each copy.** Send the copies with original signatures and additional information required directly to each applicable agency.

The statements contained in this application are true and correct. The applicant possess' the authority to undertake the work described herein or is acting as the duly authorized agent of the landowner. The applicant understands that the granting of a permit does not include landowner permission to access land or construct a project. Inspections of the project site after notice by inspection authorities are hereby authorized. Refer to section G in the instructions.

APPLICANT: NorthWestern Energy:
Print Name: Sarah "Sady" Babcock

Sarah "Sady" Babcock 01/25/2023
Signature of Applicant Date

LANDOWNER:
Print Name: Not required for Utilities per Instructions

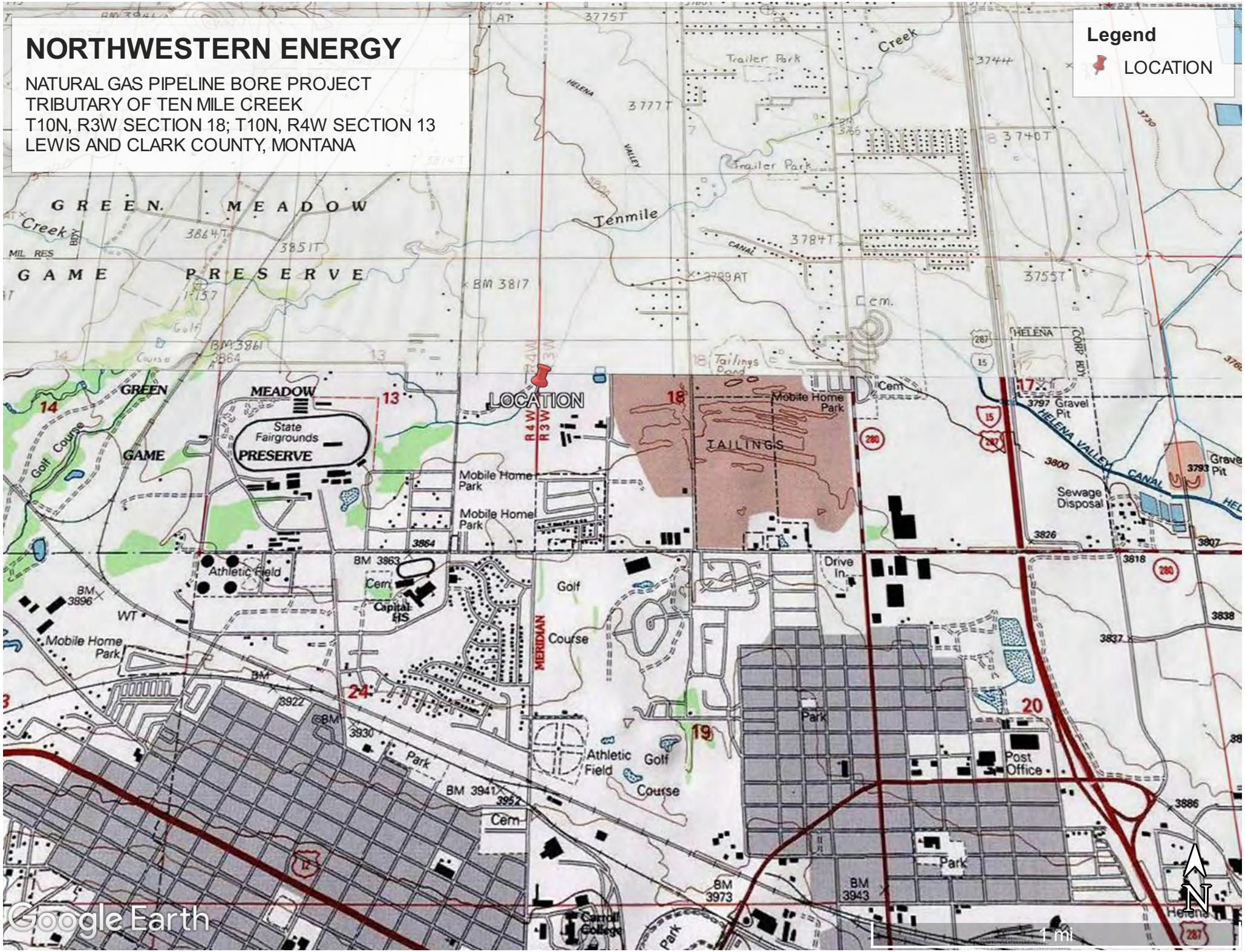
_____
Signature of Landowner Date

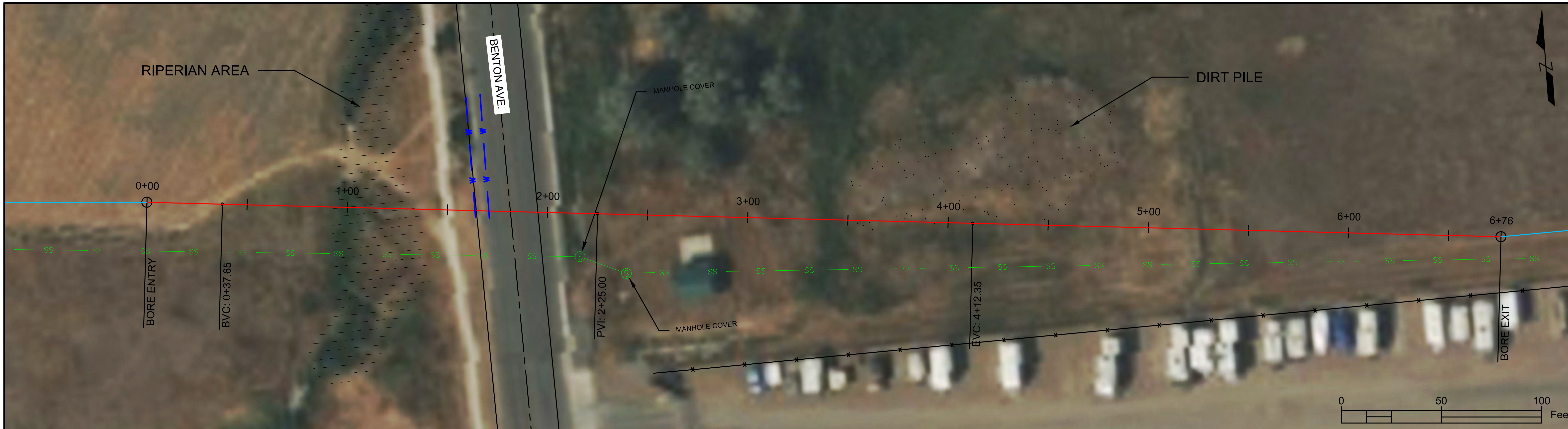
*CONTRACTOR'S PRIMARY CONTACT (if applicable):
Print Name: Click here to enter name.

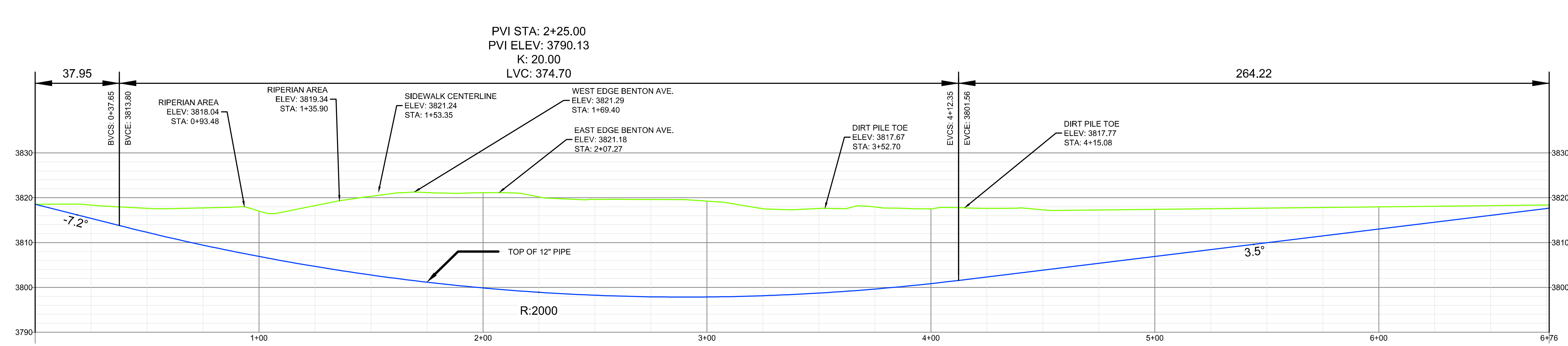
_____
Signature of Contractor/Agent Date
*Contact agency to determine if contractor signature is required.

NORTHWESTERN ENERGY

NATURAL GAS PIPELINE BORE PROJECT
TRIBUTARY OF TEN MILE CREEK
T10N, R3W SECTION 18; T10N, R4W SECTION 13
LEWIS AND CLARK COUNTY, MONTANA







EG ELEV.	PIPE ELEV.
3818.3	3815.4
3817.6	3812.3
3817.7	3809.4
3817.0	3806.9
3818.2	3804.7
3820.3	3802.8
3821.2	3801.2
3821.1	3799.9
3820.2	3798.9
3819.6	3798.2
3819.6	3797.9
3819.2	3797.9
3817.5	3798.1
3817.6	3798.7
3817.9	3799.6
3817.5	3800.8
3817.6	3802.3
3817.3	3803.9
3817.3	3805.4
3817.4	3806.9
3817.5	3808.4
3817.7	3810.0
3817.8	3811.5
3817.9	3813.0
3818.1	3814.5
3818.2	3816.1
3818.4	3817.6

PIPE DEPTH (ft)
1.27
2.54
3.39
4.40
5.37
6.47
7.71
8.91
10.09
10.14
10.78
12.66
14.48
16.14
17.55
18.90
19.82
20.20
20.64
21.25
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11.60
11.05
10.49
9.94
9.38
8.83
8.27
7.72
7.16
6.61
6.05
5.50
4.94
4.39
3.83
3.28
2.72
2.17
1.61
1.06
0.72

NO	REVISION	DATE	BY	CK	ENG	PE	APP	REFERENCE DRAWING	DWG. NO.

NorthWestern Energy

DRAWN	Z.CRAMER	DATE	12/9/2022
CHECKED	S.GLEASON	SCALE	1"=50'
ENGINEERED	M.MULLOWNEY	APPROVED	NWE

HELENA HCA REROUTE
12" SPLIT HDD
BENTON AVE. CROSSING

DRAWING NUMBER A-22053-2 SHEET 2 OF 2

Form 272 (Rev. 06/01/06) (filename 27206)

STATE OF MONTANA
NATURAL STREAMBED AND LAND PRESERVATION ACT (310 LAW)

Application No. _____
Date Submitted to District_____

TEAM MEMBER REPORT

1. Applicant Mark Pieloch
   Name of perennial stream Stickney Creek County Lewis & Clark
   Location of proposed activity ☐☐☐☐, Section _____ Township _____ Range _____

2. Onsite inspection at Stickney Creek @ sterling bridge (location) on 2/16/23 (date) at 130 (time)

3. **Review considerations:**

	Insignificant	Moderate	Significant	N/A
(a) effects of soil erosion and sedimentation:	☐	☒	☐	
(b) risk of flooding or erosion problems upstream or down:	☒ - based no rge modeling			
(c) effects of stream channel alterations:	☒	☐	☐	
(d) effects on streamflow, turbidity, or water quality caused by materials used or by removal of ground cover:		☒		
(e) effects on fish and aquatic habitat:		☒		
(f) are there reasonable alternatives to reduce disturbance to stream or better accomplish the purpose of the project?	☐ **yes** (see below)		☒ no	

4. **Recommendation:**

☐ Approval as proposed ☒ Approval with modifications ☐ Denial ☐ Request for time extension

5. **Modifications/Comments**:
   ☐ See attached (if more room is necessary)

- Revegetate any disturbed areas with native vegetation
- Use BMP's (straw waddles or silt fence) to minimize downstream sediment mobilization
- Ensure rip rap is placed as designed
- Complete after July 1.
- Provide follow up photos after completion

6. **Signature of Team Member(s)**

J. Mueller – FWP Date 2/16/23
Name/Representing ☐ Waive 15-day waiting period after board's decision

Matt Pierce – SEA Date 2/16/23
Name/Representing ☐ Waive 15-day waiting period after board's decision

John Baum LAC CA Date 2-16-23
Name/Representing ☐ Waive 15-day waiting period after board's decision

318 AUTHORIZATION REVIEW

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DFWP Representative's Signature _____ Date 2/16/23

CONSTRUCTION DRAWINGS

DEVILS KITCHEN RANCH

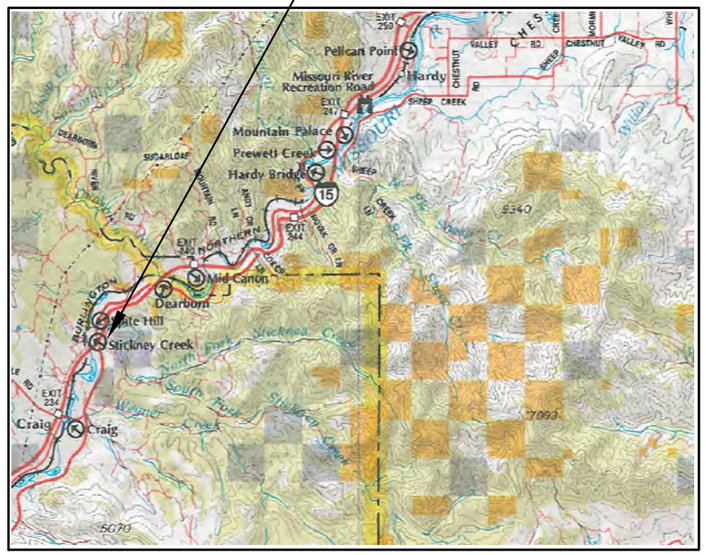
STICKNEY CREEK BRIDGE REPLACEMENT

LEWIS AND CLARK COUNTY, MONTANA

SHEET INDEX

PROJECT VICINITY

PROJECT LOCATION



FOR PREFABRICATED STEEL BRIDGE SUPPLIER:
PLANS SHOW REQUIRED ELEMENTS OF THE STEEL BRIDGE. SUPPLIER TO FURNISH ALL ELEMENTS IDENTIFIED IN THE SPECIAL PROVISION, MEETING THE SPECIFICATIONS DEFINED.

FOR BRIDGE CONTRACTOR:
PLANS SHOW ALL ELEMENTS RELATED TO THE CONSTRUCTION CONTRACT. PREFABRICATED STEEL BRIDGE TO BE PURCHASED SEPARATELY BY OWNER. CONTRACTOR TO SUPPLY STEEL ANCHOR BOLTS.

SUMMARY OF ESTIMATED ROAD PLAN QUANTITIES

LOCATION	¾" MINUS TOP COURSE (CU. YD.)	SEEDING & FERTILIZING (ACRES)
TOTAL	32	0.25

SUMMARY OF ESTIMATED BRIDGE PLAN QUANTITIES

LOCATION	LENGTH BRG TO BRG (LIN. FT.)	HP XXxXX STEEL PILES (LIN. FT)		PILE DRIVING POINTS (EACH)	STRUCTURE EXCAVATION TYPE II (CU. YD.)	UNCLASSIFIED EXCAVATION (CU. YD.)	STRUCTURE CONCRETE (CU. YD.)	HAUL & PLACE RIPRAP CLASS II (CU. YD.)	BRIDGE END BACKFILL (CU. YD.)	1" MINUS GRAVEL DECK SURFACING (CU. YD.)
		FURNISH	DRIVE							
BENT NO. 1		XXX	XXX	4	23	199	8	75	78	
BENT NO. 2		XXX	XXX	4	23	220	8	75	78	
SUPERSTRUCTURE	56									27
TOTAL	56	XXX	XXX	8	46	419	16	150	156	27

ENGINEER OF RECORD: Nate Peressini, PE

QUALITY CONTROL REVIEWER: Kathy Thompson, PE

STAHLY ENGINEERING & ASSOCIATES
PROFESSIONAL ENGINEERS & SURVEYORS
www.seaeng.com

2223 MONTANA AVE.
STE. 201
BILLINGS, MT 59101
Phone: (406)601-4055
Fax: (406)601-4062

3530 CENTENNIAL DR.
HELENA, MT 59601
Phone: (406)442-8594
Fax: (406)442-8557

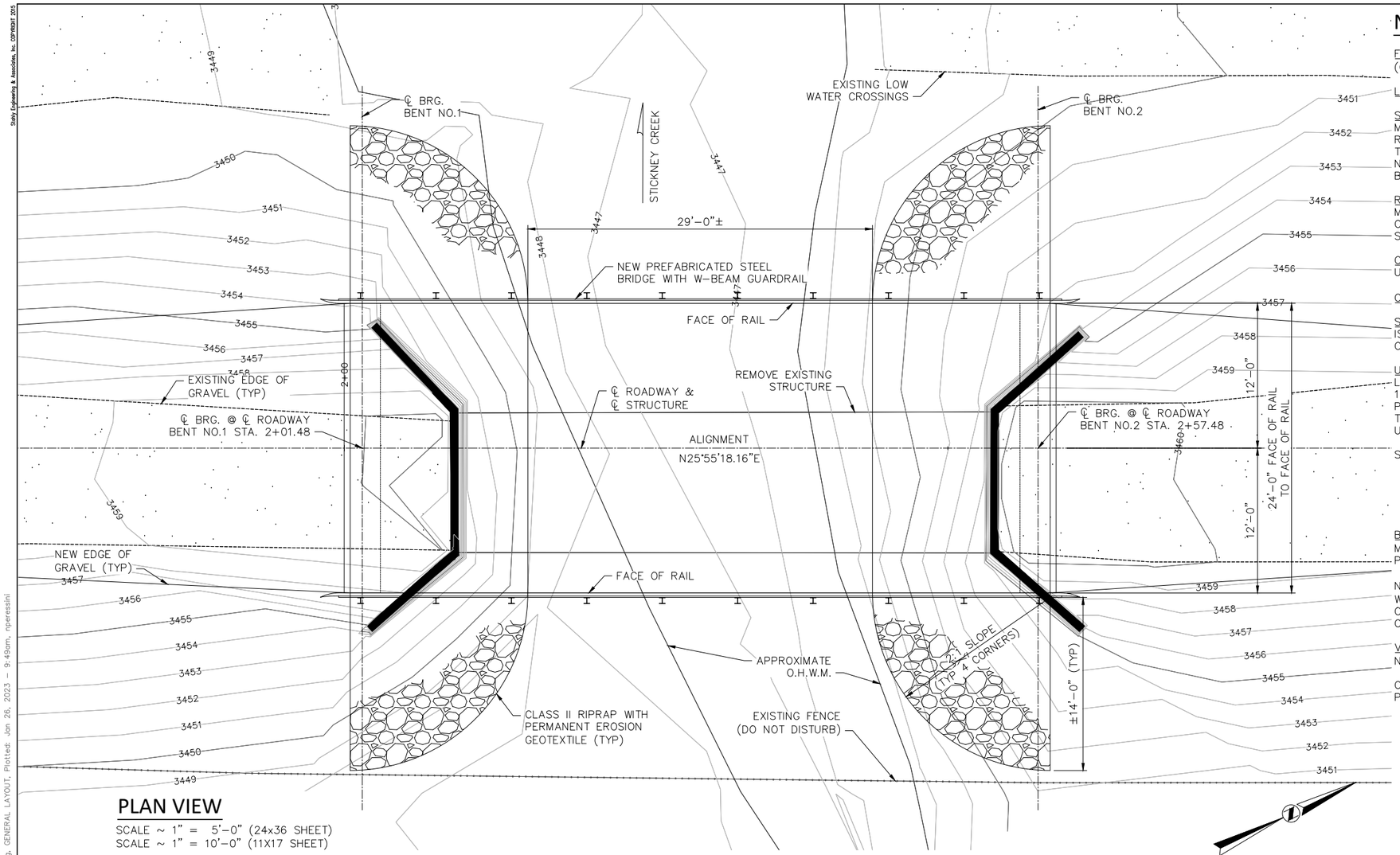
851 BRIDGER DR. STE. 1
BOZEMAN, MT 59715
Phone: (406)522-8594
Fax: (406)522-9528

ISSUE/REVISION				
No.	DATE	DESCRIPTION	EOR	QCR
1	11/29/2022	90% SET	NTP	KLT
2	1/26/2023	PERMITTING SET	NTP	KLT

DEVILS KITCHEN RANCH
STICKNEY CREEK BRIDGE
REPLACEMENT
LEWIS AND CLARK
COUNTY, MONTANA

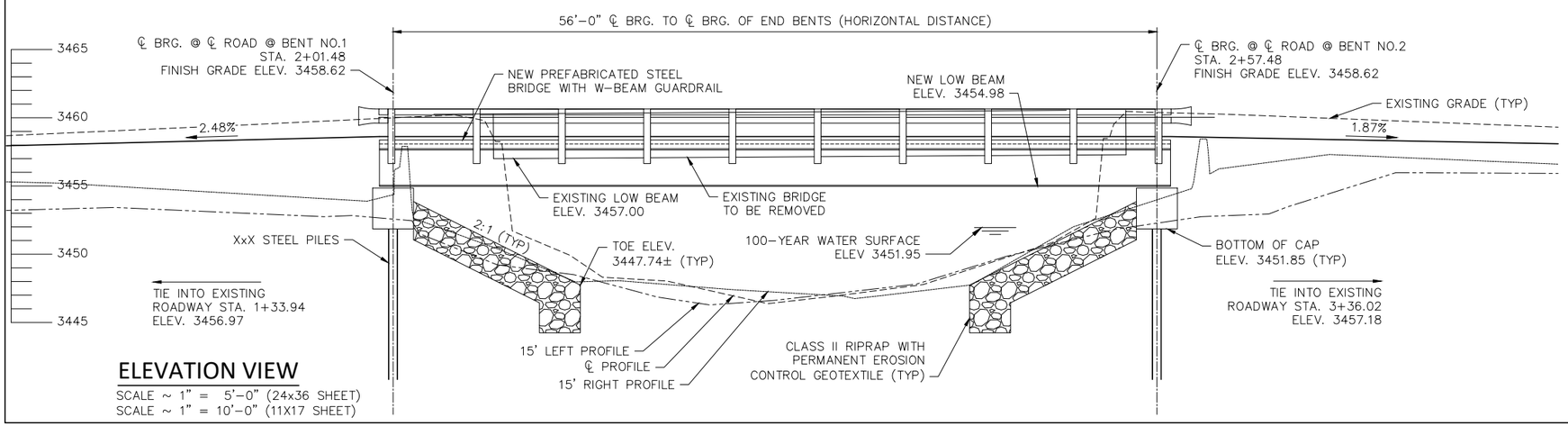
TITLE SHEET

SHEET
T1



PLAN VIEW

SCALE ~ 1" = 5'-0" (24x36 SHEET)
SCALE ~ 1" = 10'-0" (11X17 SHEET)



ELEVATION VIEW

SCALE ~ 1" = 5'-0" (24x36 SHEET)
SCALE ~ 1" = 10'-0" (11X17 SHEET)

NOTES

FINISHED GRADE: FINISHED GRADE OF BRIDGE IS BASED ON NAD83 (GEOID12A)

LIVE LOAD: STANDARD HL-93 LOADING.

SPECIFICATIONS: MONTANA DEPARTMENT OF TRANSPORTATION AND THE MONTANA TRANSPORTATION COMMISSION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 2020 EDITION, AND ANY AMENDMENTS THERETO, AND THE SPECIAL PROVISIONS GOVERN UNLESS OTHERWISE NOTED. THE DESIGN WAS PREPARED IN ACCORDANCE WITH AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, NINTH EDITION – 2020.

REINFORCING STEEL: USE NEW DEFORMED TYPE REINFORCING STEEL MEETING THE REQUIREMENTS OF AASHTO M31 GRADE 60. INCLUDE ALL COSTS ASSOCIATED WITH FURNISHING AND PLACING NEW REINFORCING STEEL IN THE UNIT PRICE BID FOR STRUCTURE CONCRETE.

CAST IN PLACE CONCRETE: UNLESS OTHERWISE APPROVED OR SPECIFIED USE STRUCTURE CONCRETE FOR ALL SUBSTRUCTURE CONCRETE.

CONCRETE STRENGTH: USE f'c = 4000 P.S.I. FOR STRUCTURE CONCRETE.

STRUCTURE EXCAVATION: STRUCTURE EXCAVATION FOR THE ABUTMENTS IS CALCULATED FROM THE NATURAL GROUND LINE AS IT EXISTS BEFORE CONSTRUCTION BEGINS.

UTILITIES: UTILITIES SHOWN ON THIS GENERAL LAYOUT ARE FROM UTILITY LOCATES. ALL EXISTING UTILITIES MAY NOT BE SHOWN. CALL 1-800-424-5555 FOR UTILITY LOCATES AT LEAST TWO WORKING DAYS PRIOR TO STARTING ANY CONSTRUCTION ACTIVITY THAT COULD DISTURB THE UTILITY. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO UTILITIES WITHIN THE CONSTRUCTION LIMITS.

SEE SHEET B2 FOR SECTION A-A.

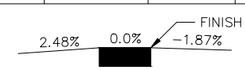
BASIS OF BEARING:
MONTANA STATE PLANE, 2500, NAD83(2011) INTERNATIONAL FEET PROJECTED TO GROUND UNITS AT:

NORTH LATITUDE-	47°06'37.13796"
WEST LONGITUDE-	111°56'39.55445"
ORTHOMETRIC HEIGHT-	3410.154 IFT
CONVERGENCE ANGLE-	-1.78803056°

VERTICAL DATUM:
NAVD88(GEOID18)

CONTROLLING PROJECT COORDINATES ARE LISTED IN THE SURVEY CONTROL POINT TABLE.

CONTROL POINT TABLE				
POINT#	NORTHING	EASTING	ELEVATION	DESCRIPITION
1	1052253.378'	1360302.636'	3454.07'	½" RB STAHLY CP
2	1051460.126'	1360067.482'	3454.11'	STAHLY RPC
3	1052208.654'	1360665.585'	3460.89'	STAHLY RPC
4	1051894.741'	1360156.328'	3452.28'	STAHLY RPC



PROFILE GRADE

NO SCALE

HYDRAULIC DATA

DRIFT:	MODERATE
SCOUR:	MODERATE
ICE:	MODERATE
DRAINAGE AREA:	41.5 SQ.MI.
2-YEAR STAGE:	3448.51
DESIGN FLOOD FLOW (Q100 YR.):	1380 CFS
DESIGN FLOOD STAGE:	3451.95
DESIGN FLOOD VELOCITY:	13.14 FT/S
BASE FLOOD STAGE (Q100 YR.):	3451.95
LOW BEAM ELEVATION:	3454.98

DESIGN AND BASE FLOOD STAGE ELEVATIONS INCLUDE BACKWATER.

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ISSUE/REVISION

No.	DATE	DESCRIPTION	EOR	QCR
1	11/29/2022	90% SET	NTP	KLT
2	1/26/2023	PERMITTING SET	NTP	KLT

DEVILS KITCHEN RANCH
STICKNEY CREEK BRIDGE
REPLACEMENT
LEWIS AND CLARK
COUNTY, MONTANA

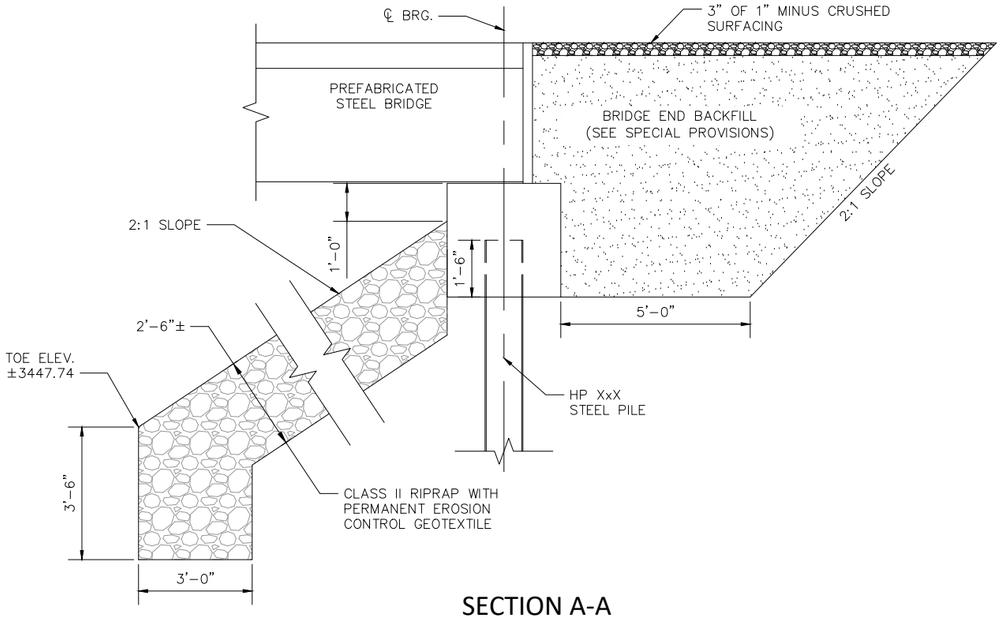
GENERAL LAYOUT

SHEET
B1

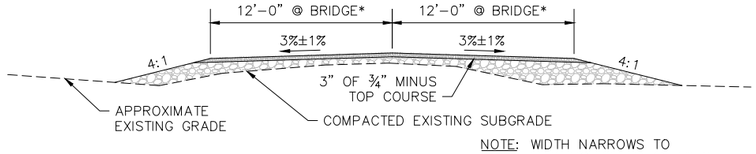
PILE INFORMATION				
	BOTTOM OF CAP ELEVATION	DESIGN PILE TIP ELEVATION	RECOMMENDED FURNISH LENGTH	ULT. PILE CAPACITY
BENT 1	3451.85	XXXX.XX	XX FT	XXX KIPS
BENT 2	3451.85	XXXX.XX	XX FT	XXX KIPS

NOTES

1. SOILS AND FOUNDATION MATERIALS: THE GENERAL LAYOUT (B1) PLAN SHOWS POINTS WHERE SK GEOTECHNICAL DRILLED BOREHOLES. SEE THE GEOTECHNICAL REPORT, SHEETS GE1–GEX, FOR ORIGINAL BORING LOGS AND ADDITIONAL SUBSURFACE INFORMATION.
2. CONTACT THE ENGINEER IF PILE TIP ELEVATIONS DEVIATE MORE THAN 1.0 FOOT FROM THE ELEVATION INDICATED.
3. SEE STANDARD DETAIL SHEET PSD FOR STANDARD PILE SPLICE DETAILS AND PILE TIPS.



SECTION A-A
NO SCALE



NOTE: WIDTH NARROWS TO EXISTING, SEE PLAN VIEW SHEET B1

TYPICAL SECTION
SCALE ~ 1" = 5'–0" (24x36 SHEET)
SCALE ~ 1" = 10'–0" (11X17 SHEET)

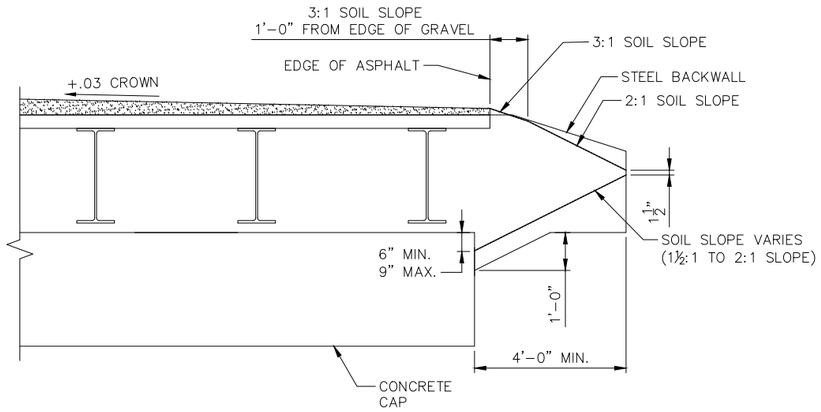
NOTE

ALL BRIDGE APPROACH WORK SHALL BE DONE IN ACCORDANCE WITH MONTANA PUBLIC WORKS STANDARD SPECIFICATIONS (MPWSS) 7TH EDITION.

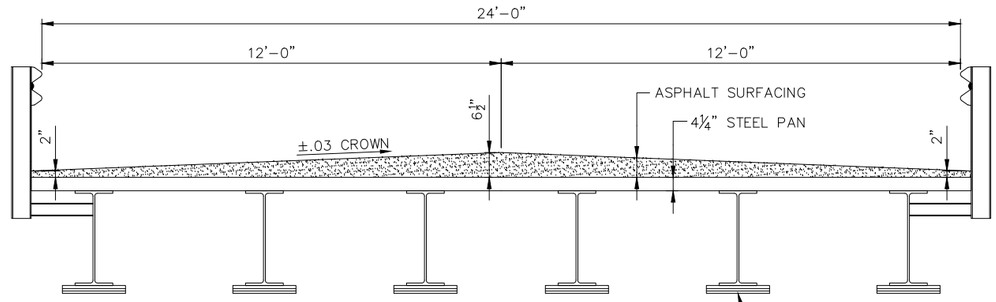
SOME ITEMS OF MPWSS ARE HIGHLIGHTED FOR IMPORTANCE BELOW. TECHNICAL SPECIFICATIONS ARE AMENDED TO INCLUDE THE NOTES BELOW:

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

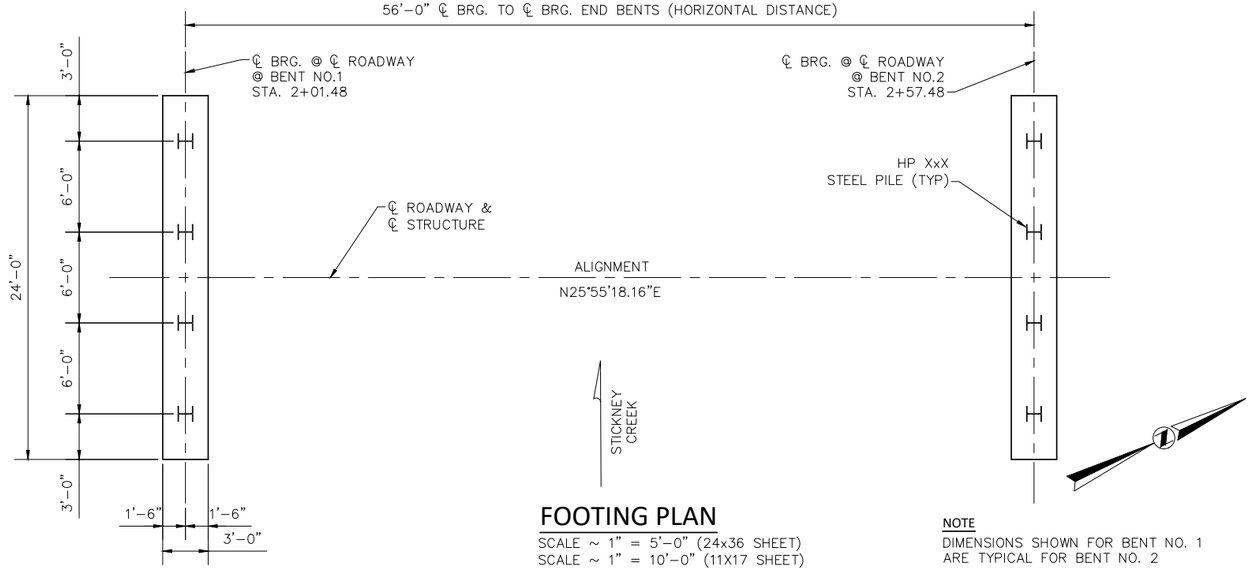
SECTION 02235 CRUSHED BASE COURSE
1. CRUSHED BASE COURSE SHALL BE ¾" MINUS



WINGWALL FILL DETAIL
NO SCALE



TYPICAL DECK SECTION
NO SCALE



FOOTING PLAN
SCALE ~ 1" = 5'–0" (24x36 SHEET)
SCALE ~ 1" = 10'–0" (11X17 SHEET)

NOTE

DIMENSIONS SHOWN FOR BENT NO. 1 ARE TYPICAL FOR BENT NO. 2

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No.	DATE	DESCRIPTION	EOR	QCR
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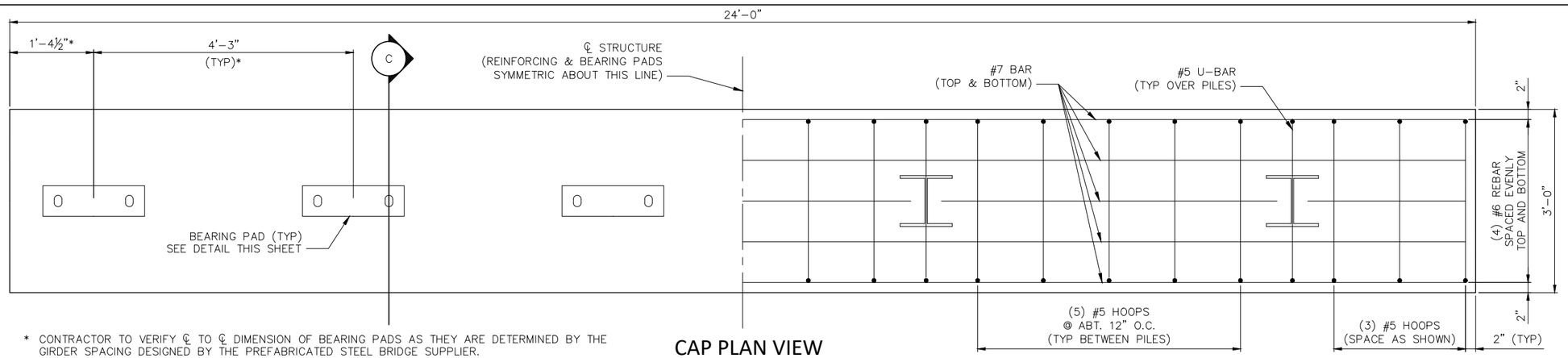
DEVILS KITCHEN RANCH
STICKNEY CREEK BRIDGE
REPLACEMENT
LEWIS AND CLARK
COUNTY, MONTANA

FOOTING PLAN
&
MISC. DETAILS

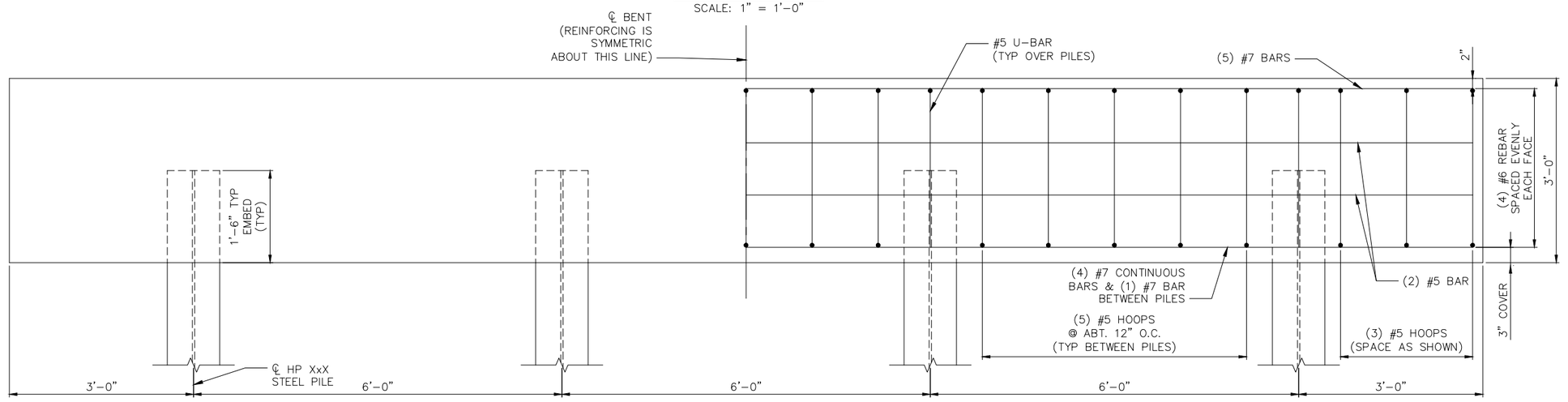
SHEET
B2



* CONTRACTOR TO VERIFY ℄ TO ℄ DIMENSION OF BEARING PADS AS THEY ARE DETERMINED BY THE GIRDER SPACING DESIGNED BY THE PREFABRICATED STEEL BRIDGE SUPPLIER.

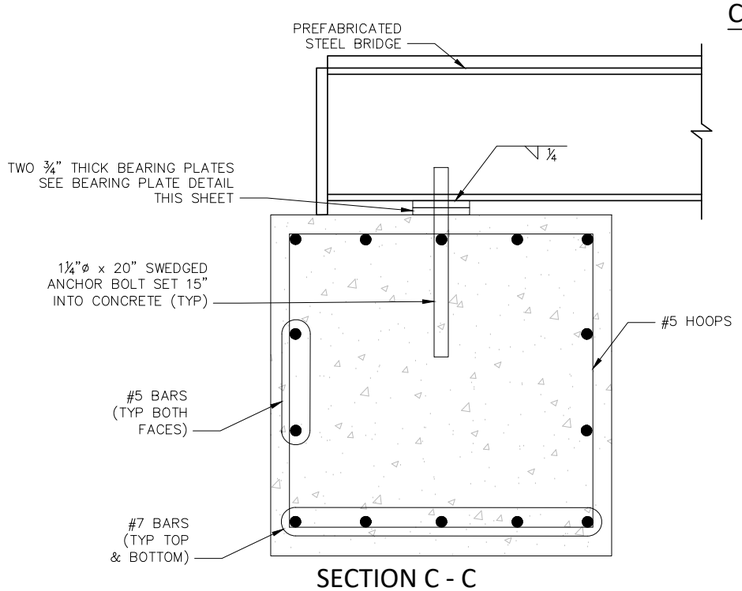
CAP PLAN VIEW

SCALE: 1" = 1'-0"



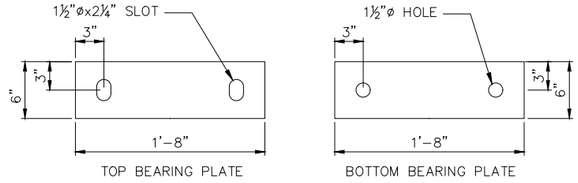
CAP ELEVATION VIEW

SCALE: 1" = 1'-0"



SECTION C - C

SCALE: 1½" = 1'-0"



BEARING PLATE DETAIL

SCALE: 1½" = 1'-0"

NOTES

1. ALTERNATIVE BEARING ASSEMBLIES MAY BE SUBMITTED AS AN EQUAL WITH PREFABRICATED BRIDGE SHOP DRAWINGS.
2. USE TWO HEX NUTS TO SECURE BEARING PAD.

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DEVILS KITCHEN RANCH
STICKNEY CREEK BRIDGE
REPALCEMENT
LEWIS AND CLARK
COUNTY, MONTANA

FOOTING DETAILS

SHEET
B3

Notes:

General:

1. Information included on this sheet is taken from the Manual on Uniform Traffic Control Devices 2003 Edition.

Support:

2. Signs and object markers are shown for one direction of travel only.

Standard:

3. Devices similar to those depicted shall be placed for the opposite direction of travel.

4. Pavement markings no longer applicable shall be removed or obliterated as soon as practicable.

5. Temporary barriers and end treatments shall be crashworthy.

Guidance:

6. If the tangent distance along the temporary diversion is more than 180 m (600 ft), a Reverse Curve sign, left first, should be used instead of the Double Reverse Curve sign, and a second Reverse Curve sign, right first, should be placed in advance of the second reverse curve back to the original alignment.

7. When the tangent section of the diversion is more than 180 m (600 ft), and the diversion has sharp curves with recommended speeds of 50 km/h (30 mph) or less, Reverse Turn signs should be used.

8. Where the temporary pavement and old pavement are different colors, the temporary pavement should start on the tangent of the existing pavement and end on the tangent of the existing pavement.

Option:

9. Flashing warning lights and/or flags may be used to call attention to the warning signs.

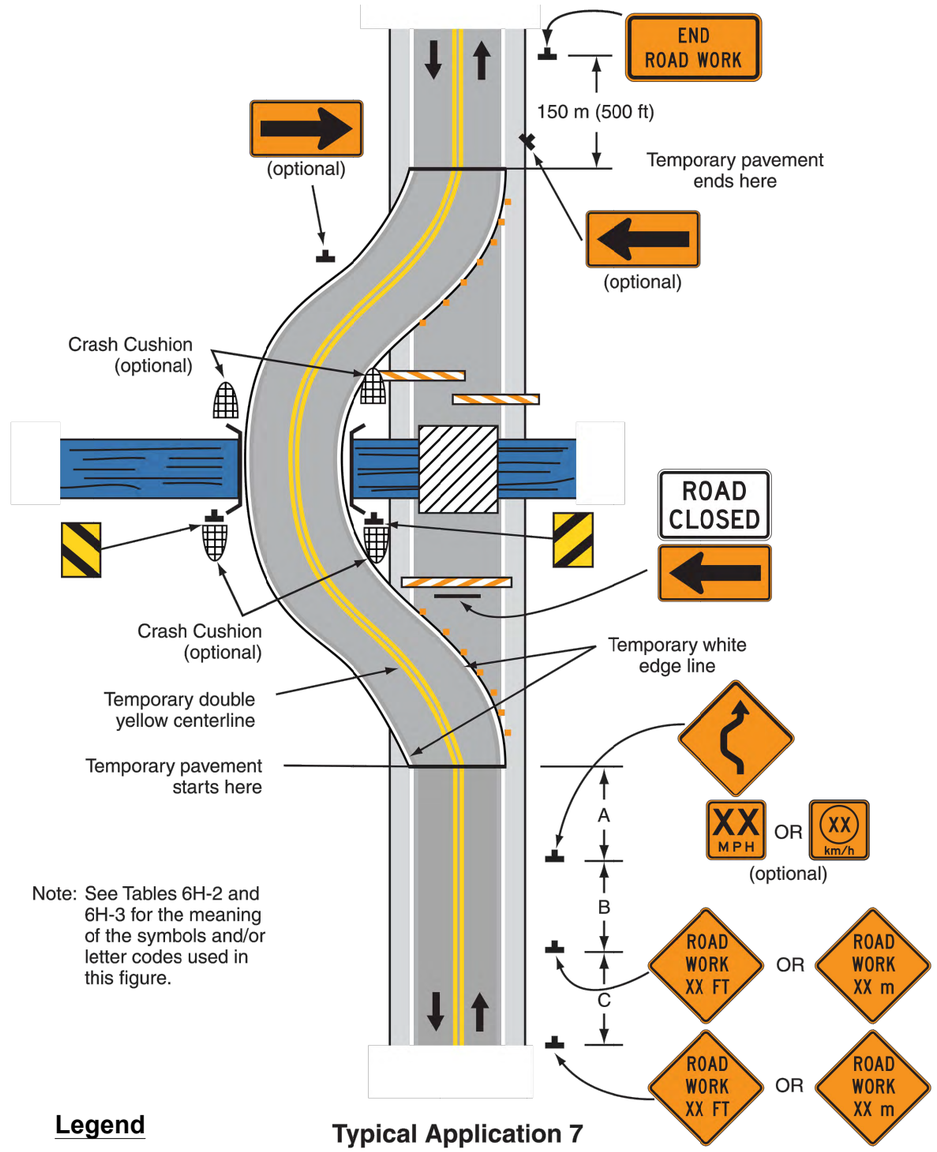
10. On sharp curves, large arrow signs may be used in addition to other advance warning signs.

11. Delineators or channelizing devices may be used along the diversion.

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	30 (100)	30 (100)	30 (100)
Urban (high speed)*	100 (350)	100 (350)	100 (350)
Rural	150 (500)	150 (500)	150 (500)
Expressway / Freeway	300 (1,000)	450 (1,500)	800 (2,640)

* Speed category to be determined by highway agency

** Distances are shown in meters (feet). The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The third sign is the first one in a three-sign series encountered by a driver approaching a TTC zone.)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 7

Legend

- Channelizing device
- Crash Cushion
- Direction of traffic
- Sign (shown facing left)
- Type III Barricade
- Work space

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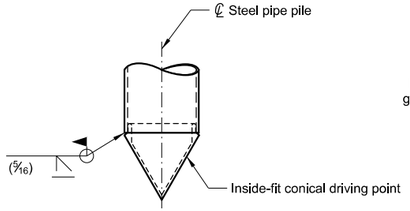
ISSUE/REVISION

DEVILS KITCHEN RANCH
STICKNEY CREEK BRIDGE
REPLACEMENT

LEWIS AND CLARK
COUNTY, MONTANA

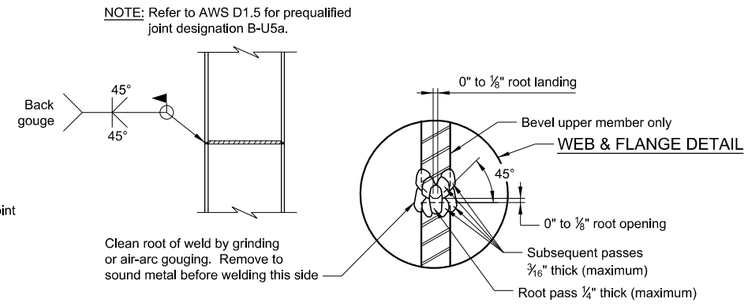
TRAFFIC CONTROL PLAN

SHEET
TC1



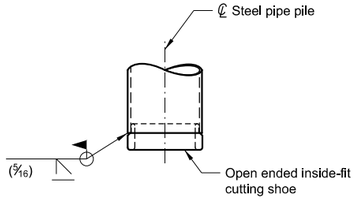
CONICAL DRIVING POINT WELD DETAIL

Slip driving point inside pipe.



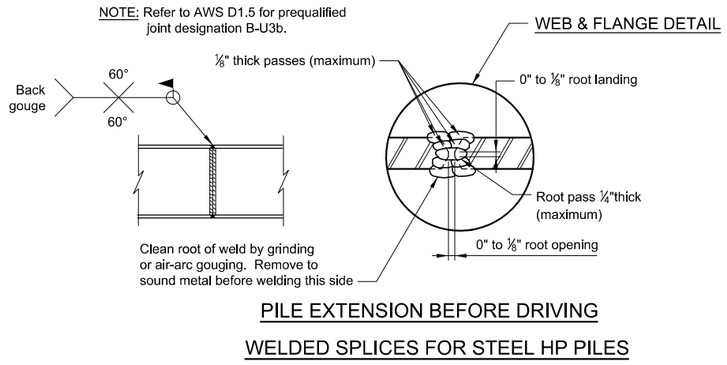
PILE EXTENSION AFTER DRIVING

(Pile Vertical)



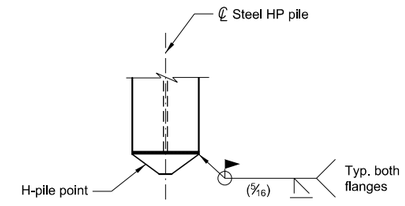
CUTTING SHOE WELD DETAIL

Slip shoe inside pipe.



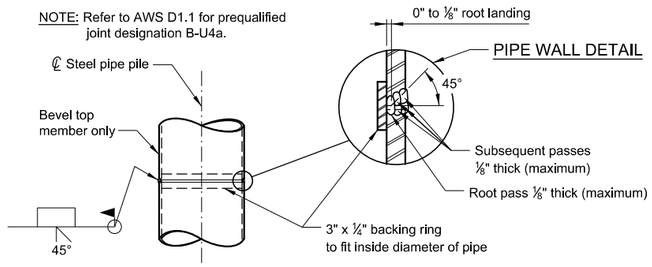
PILE EXTENSION BEFORE DRIVING

WELDED SPLICES FOR STEEL HP PILES



H-PILE POINT WELD DETAIL

Do not weld web or inside of flanges.



PILE EXTENSION AFTER DRIVING

(Pile Vertical)

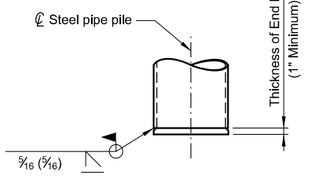
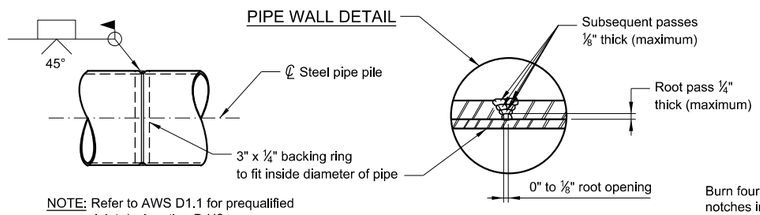


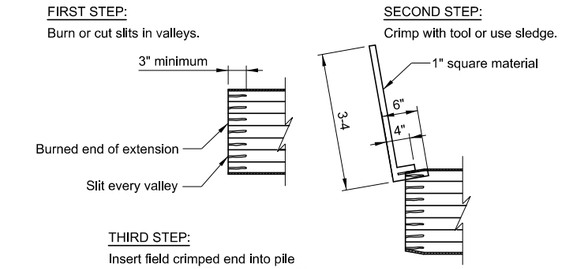
PLATE END WELD DETAIL

Align plate with outside of pipe.



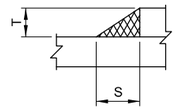
PILE EXTENSION BEFORE DRIVING

WELDED SPLICES FOR STEEL PIPE PILES

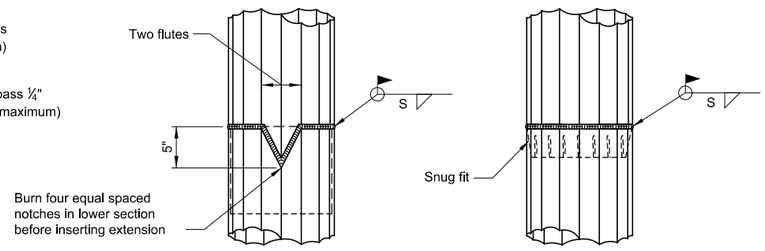


FIELD CRIMPING DETAIL FOR CUT-OFF EXTENSIONS

Gage of Pile T	Weld Size S
9 gage (0.1495")	1/4"
7 gage (0.1793")	5/16"
5 gage (0.2092")	5/16"
3 gage (0.2391")	3/8"



NOTE: Refer to AWS D1.1 for weld requirements.



FACTORY CRIMPED EXTENSION

FIELD CRIMPED EXTENSION

WELDED SPLICES FOR STEEL FLUTED PILES

NOTES

PILE SPLICES: Use only E7018 series electrodes. Prepare the weld surfaces to a smooth, uniform finish. Remove all fins, tears, loose scale, slag, rust, grease, moisture and other material that would prevent proper welding.

PILE TIPS: Use only E7018 series electrodes to attach pile tips.

PILE TYPE: See Footing Plan sheets for correct pile type, pile tip and pile tip elevations.

STANDARD PILE SPLICE DETAILS AND PILE TIPS

No Scale

MDT MONTANA DEPARTMENT OF TRANSPORTATION

BRIDGE BUREAU

DATES								$FILEABBREVS
REVISED								
REVISED								
REVISED								
REVISED								
APPROVED	1-30-15	D.F.J.	$TIME$
CHECKED	1-30-15	D.F.J.	
DRAWN	1-23-15	T.J.B.	

DRAWING NO.
PSD

Engineers and Land Surveyors
851 Bridger Drive, Suite 1, Bozeman, MT 59715 | phone: 406-522-8594
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Hydrology and Hydraulics Report
Stickney Creek Bridge Replacement

Introduction

This report covers the proposed replacement of a vehicular bridge on Rocky Road over Stickney Creek about 3 miles northeast of Craig, Montana (Section 26, T16N, R03W). The existing steel railroad car bridge founded on vertical concrete abutments will be completely removed and replaced with a proposed 56-foot single span bridge utilizing a prefabricated steel bridge founded on steel driven piles and concrete caps. The new abutments will be set back from the existing channel and armored in riprap at a slope of 2:1. The crossing is located at 47°6'35" Latitude and -111°56'39" Longitude.

Hydrology

The contributing drainage basin is just about 12 miles long from east to west and averages 4 miles in width, encompassing 41.5 square miles. The drainage area originates at an elevation of over 7,000 feet, then drops over 3,500 feet to the bridge crossing. The drainage basin, located in the Southwest Region, was delineated and flows were calculated using the USGS StreamStats Application. This

application utilizes Montana Regression Equations to calculate peak runoff. A copy of these results is included with this report.

Design Flood	Peak Discharge (cfs)
Q_2	98
Q_5	256
Q_{10}	424
Q_{25}	726
Q_{50}	1,020
Q_{100}	1,380
Q_{200}	1,810
Q_{500}	2,520

Hydraulics

The US Army Corps of Engineers Hydrologic Engineering Center – River Analysis Program (HEC-RAS) version 5.0.7 was utilized to analyze the existing conditions, which includes the previously mentioned steel railroad car superstructure founded on vertical concrete abutments. Three additional bridges exist less than 200-feet downstream of this crossing: two bridges on Interstate 15 and one on the Craig Frontage Road. Low beam elevations of these structures were collected, and the model was created containing ineffective flow areas throughout the downstream cross sections to conservatively model the influence of these structures in both the existing and proposed models.

The purpose of this study is to show that the proposed replacement bridge crossing will cause no adverse impacts upstream or downstream. This will be done by determining a Base Flood Elevation (BFE) of the existing bridge structure and comparing it to the proposed bridge structure. This crossing is located outside of any floodplain boundaries; therefore, no floodplain regulations exist for this crossing. Due to the close vicinity to downstream bridges, it was determined that the proposed design will be held to no-rise in the BFE with the replacement of the existing structure.

Stahly Engineering personnel competed a site visit and performed a topographic and hydraulic survey. The hydraulic survey included a total of seven cross sections, located at the existing bridge as well as 400-feet upstream and downstream of the crossing. Additionally, a cross section of the existing roadway and structure was collected and used in the model as the existing roadway centerline. An exhibit identifying the cross-section locations is included with this report.

Information gathered from the previously mentioned site visit, site photos, and aerial imagery were used to determine roughness coefficients (Manning's n-values). Outside of the channel the floodplain varies from grassy fields to large trees and willows. For this reason, the over bank areas vary from a 0.030 to a 0.080. To be conservative, the model was created with all over bank areas with a 0.080 n-value. The channel is estimated to have a 0.035 n-value as it is clean and straight but with stones and weeds.

The hydraulic design components of HEC-RAS were used to determine scour depths for both contraction and abutment scour. Laursen's clear-water or live bed contraction scour equations (Laursen 1960 & 1963) are used to compute the contraction scour depth. The determining factor for

which equations are used is based on the critical velocity in which the median diameter bed material (D50) will be set into motion. The D50 was determined using engineering judgement during the site visit at a value of 150 mm, which was used in the analysis. HIRE equations (Richard, 1990) and the Froehlich equation (Froehlich, 1989) are used by HEC-RAS to calculate the scour depth around abutments. The correct equation is selected by computing a ratio of the embankment length to the approach depth.

Bridge Structure

As previously mentioned, the new bridge structure consists of a 24-foot wide by 56-foot single span prefabricated steel superstructure founded on a driven steel pile foundation and concrete caps. The new bridge structure has a low beam elevation of 3454.98 feet, which is 2-feet lower than the existing structure at an elevation of 3457.00 feet. This change is due to a deeper beam section required for the proposed span, as well as flattening the existing steep road approaches for the current bridge. At a slope of 2:1, Class II riprap, 2.5-feet thick, will extend from the concrete cap to outside the banks of the stream. The riprap slopes will be anchored with a 3.5-feet deep and 3-feet thick key.

Results

The following table summarizes the results for the 100-year base flood, BFE. The proposed structure has freeboard of 3.03 feet during the 100-year event.

X-Section	Reach Length (ft)	100-year Water Surface Elev. (ft)			Channel Velocity (ft/sec)		
		Existing	Proposed	Difference	Existing	Proposed	Difference
400	209	3454.62	3454.36	-0.26	7.83	8.84	+1.01
200	113	3454.67	3454.30	-0.37	4.28	4.90	+0.62
100	92	3454.63	3454.26	-0.37	3.02	3.22	+0.20
15	31	3454.07	3453.80	-0.	7.20	6.66	-0.54
Bridge	-	3452.00	3451.95	-0.05	8.17	7.59	-0.58
-15	128	3451.57	3451.56	-0.01	7.18	6.59	-0.59
-100	286	3451.07	3451.07	0	8.23	8.23	0
-400	0	3449.80	3449.80	0	10.24	10.24	0

As expected, the 100-year water surface elevations drop with the replacement of the existing bridge. Velocities upstream of the structure slightly increase, as velocities immediately downstream decrease as a result of the increased conveyance and sloped, riprapped abutments on the proposed structure. Furthermore, the vertical abutments of the existing structure were constructed directly on the edge of the active channel, causing increased velocities during high flow events. Overall, the proposed bridge at this location should have no adverse impacts upstream or downstream. The results from the HEC-RAS model are included.

Lastly, the calculated contraction and abutment scour depths for 100-year event are summarized in the table below. Laursen's clear-water equations were used by the hydraulic component within HEC-RAS to calculate the contraction scour and HIRE and Froehlich equations were used on the south and north abutments respectively to calculate abutment scour.

Design Flood	X-Section	Channel Contraction Scour (ft)	Left Abutment Scour (ft)	Right Abutment Scour (ft)
100-year	0	0.33	14.18	9.92

To mitigate the scour around the new bridge abutments the previously mentioned riprap slopes will be utilized. This riprap was appropriately sized per Federal Highway Administration Publication Hydraulic Engineering Circular No. 23 "Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition Volume 1." Bridge riprap sizing calculations use the average velocity in the constricted channel section under the bridge, the specific gravity of rock riprap, the depth of flow through the bridge constriction, along with the abutment type to determine a D50 material size for the riprap. This calculation is included with this report and determined a D50 value of 1.200 feet or Class II riprap.

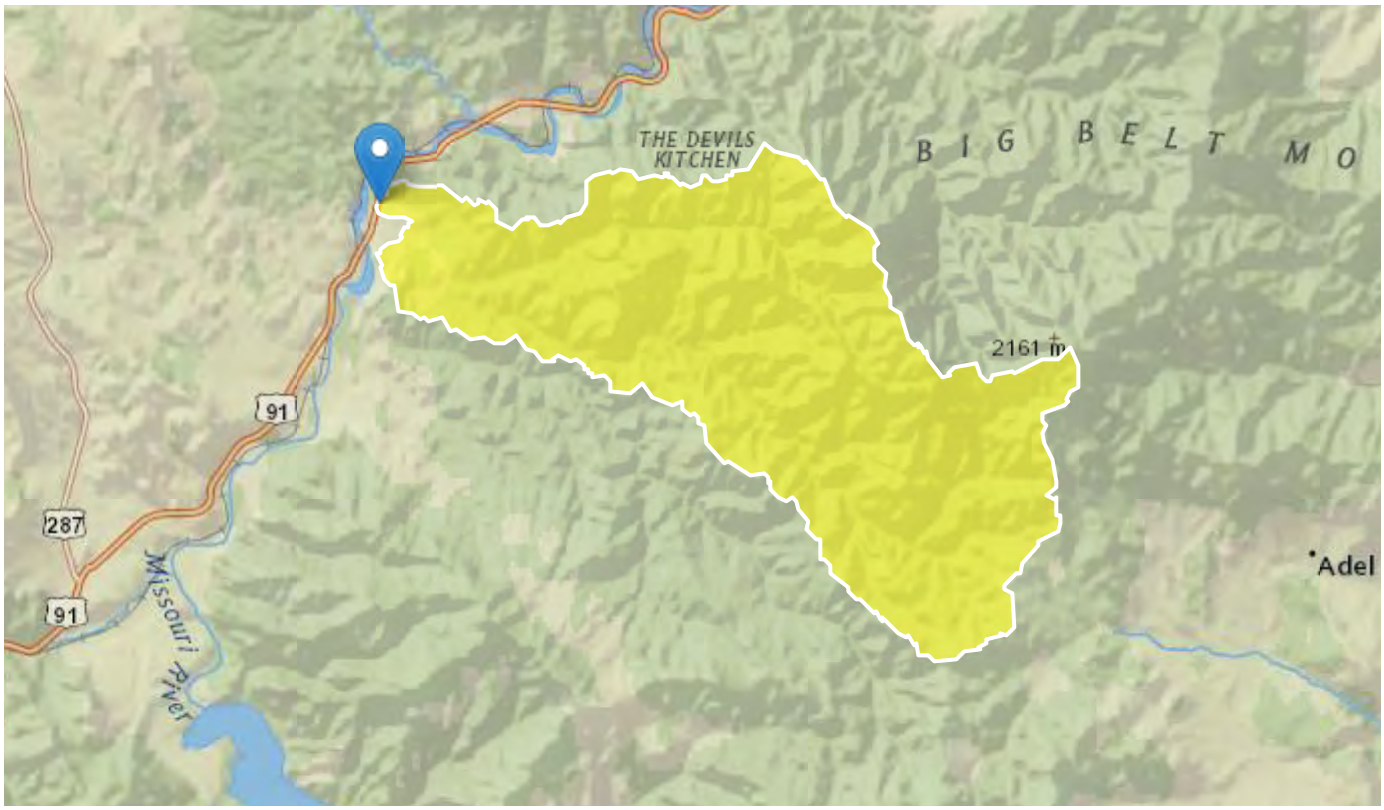
Stahly Engineering & Associates, Inc.

Nate T Peressini, P.E.
Project Engineer

Enclosures: StreamStats Stickney Creek Bridge (8 Pages)
Cross Section Location (1 Page)
HEC-RAS Results (10 Pages)
Scour Report & Riprap Sizing (2 Pages)

StreamStats Report - Stickney Creek Bridge

Region ID: MT
Workspace ID: MT20221111201542136000
Clicked Point (Latitude, Longitude): 47.10929, -111.94463
Time: 2022-11-11 13:16:10 -0700



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CHANWD_RS	Channel width determined from remotely sensed data sources, including aerial imagery	22	feet
CONTDA	Area that contributes flow to a point on a stream	41.5	square miles
EL6000	Percent of area above 6000 ft	7.5	percent
WACTCH	Width of active channel	16	feet
WBANKFULL	Width of channel at bankfull	22	feet

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics

Peak-Flow Statistics Parameters [100.0 Percent (41.5 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	41.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	7.5	percent	0	100

Peak-Flow Statistics Parameters [100.0 Percent (41.5 square miles) SW Region Active Channel SIR 2020 5142]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
WACTCH	Width Of Active Channel	16	feet	1.8	223

Peak-Flow Statistics Parameters [100.0 Percent (41.5 square miles) SW Region Bankfull SIR 2020 5142]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
WBANKFULL	Width Of Bankfull Channel	22	feet	3.5	260

Peak-Flow Statistics Parameters [100.0 Percent (41.5 square miles) SW Region Aerial Photo SIR 2020 5142]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CHANWD_RS	Channel_Width_remotely_sensed	22	feet	2.6	219.2

Peak-Flow Statistics Flow Report [100.0 Percent (41.5 square miles) SW Region BasinC 2015 5019F]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	ASEp
66.7-percent AEP flood	58.8	ft^3/s	12.4	279	118
50-percent AEP flood	97.6	ft^3/s	25.4	374	96
42.9-percent AEP flood	120	ft^3/s	33.2	434	90.1
20-percent AEP flood	256	ft^3/s	82.4	796	76.9
10-percent AEP flood	424	ft^3/s	144	1250	72.1
4-percent AEP flood	726	ft^3/s	248	2120	71.3
2-percent AEP flood	1020	ft^3/s	347	3000	72
1-percent AEP flood	1380	ft^3/s	457	4160	73.8
0.5-percent AEP flood	1810	ft^3/s	581	5640	76.5
0.2-percent AEP flood	2520	ft^3/s	772	8230	80.3

Peak-Flow Statistics Disclaimers [100.0 Percent (41.5 square miles) SW Region Active Channel SIR 2020 5142]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [100.0 Percent (41.5 square miles) SW Region Active Channel SIR 2020 5142]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	ASEp
Active chan width 66.7 percent AEP flood	70.7	ft^3/s	26.4	190	81.5
Active Channel Width 50-percent AEP flood	105	ft^3/s	47.2	233	65.9
Active chan width 42.9 percent AEP flood	122	ft^3/s	57.1	261	62.4
Active Channel Width 20-percent AEP flood	205	ft^3/s	97.7	430	58.6
Active Channel Width 10-percent AEP flood	297	ft^3/s	129	682	62.5
Active Channel Width 4-percent AEP flood	435	ft^3/s	164	1160	71.1
Active Channel Width 2-percent AEP flood	554	ft^3/s	187	1640	79
Active Channel Width 1-percent AEP flood	686	ft^3/s	208	2260	87
Active Channel Width 0.5-percent AEP flood	837	ft^3/s	228	3070	96.2

Statistic	Value	Unit	PIl	Plu	ASEp
Active Channel Width 0.2-percent AEP flood	1050	ft^3/s	253	4370	108

Peak-Flow Statistics Disclaimers [100.0 Percent (41.5 square miles) SW Region Bankfull SIR 2020 5142]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [100.0 Percent (41.5 square miles) SW Region Bankfull SIR 2020 5142]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	ASEp
Bankfull width 66.7 percent AEP flood	71.8	ft^3/s	25.6	202	93.6
Bankfull Width 50-percent AEP flood	103	ft^3/s	44.6	238	76.9
Bankfull width 42.9 percent AEP flood	122	ft^3/s	55.4	269	72.1
Bankfull Width 20-percent AEP flood	212	ft^3/s	100	449	65.7
Bankfull Width 10-percent AEP flood	300	ft^3/s	131	688	67.8
Bankfull Width 4-percent AEP flood	441	ft^3/s	167	1160	74.7
Bankfull Width 2-percent AEP flood	559	ft^3/s	191	1640	81.6
Bankfull Width 1-percent AEP flood	688	ft^3/s	213	2220	88.8
Bankfull Width 0.5-percent AEP flood	827	ft^3/s	231	2960	97.2
Bankfull Width 0.2-percent AEP flood	1040	ft^3/s	254	4250	109

Peak-Flow Statistics Disclaimers [100.0 Percent (41.5 square miles) SW Region Aerial Photo SIR 2020 5142]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [100.0 Percent (41.5 square miles) SW Region Aerial Photo SIR 2020 5142]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	ASEp

Statistic	Value	Unit	PIl	PIu	ASEp
Rem sens chan width 66.7 percent AEP fld	112	ft^3/s	17	739	190
Rem_sens_chan_width_50_percent_AEP_flood	155	ft^3/s	29.1	824	157
Rem sens chan width 42.9 percent AEP fld	175	ft^3/s	35.1	872	147
Rem_sens_chan_width_20_percent_AEP_flood	287	ft^3/s	66.1	1250	123
Rem_sens_chan_width_10_percent_AEP_flood	395	ft^3/s	94.3	1650	114
Rem_sens_chan_width_4_percent_AEP_flood	573	ft^3/s	136	2420	112
Rem_sens_chan_width_2_percent_AEP_flood	711	ft^3/s	163	3100	114
Rem_sens_chan_width_1_percent_AEP_flood	865	ft^3/s	191	3910	118
Rem_sens_chan_width_0_5_pct_AEP_flood	1040	ft^3/s	218	4950	123
Rem_sens_chan_width_0_2_pct_AEP_flood	1280	ft^3/s	250	6560	131

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
66.7-percent AEP flood	58.8	ft^3/s	12.4	279	118
50-percent AEP flood	97.6	ft^3/s	25.4	374	96
42.9-percent AEP flood	120	ft^3/s	33.2	434	90.1
20-percent AEP flood	256	ft^3/s	82.4	796	76.9
10-percent AEP flood	424	ft^3/s	144	1250	72.1
4-percent AEP flood	726	ft^3/s	248	2120	71.3
2-percent AEP flood	1020	ft^3/s	347	3000	72
1-percent AEP flood	1380	ft^3/s	457	4160	73.8
0.5-percent AEP flood	1810	ft^3/s	581	5640	76.5
0.2-percent AEP flood	2520	ft^3/s	772	8230	80.3
Active chan width 66.7 percent AEP flood	70.7	ft^3/s	26.4	190	81.5
Active Channel Width 50-percent AEP flood	105	ft^3/s	47.2	233	65.9
Active chan width 42.9 percent AEP flood	122	ft^3/s	57.1	261	62.4
Active Channel Width 20-percent AEP flood	205	ft^3/s	97.7	430	58.6
Active Channel Width 10-percent AEP flood	297	ft^3/s	129	682	62.5
Active Channel Width 4-percent AEP flood	435	ft^3/s	164	1160	71.1

Statistic	Value	Unit	PII	PIu	ASEp
Active Channel Width 2-percent AEP flood	554	ft^3/s	187	1640	79
Active Channel Width 1-percent AEP flood	686	ft^3/s	208	2260	87
Active Channel Width 0.5-percent AEP flood	837	ft^3/s	228	3070	96.2
Active Channel Width 0.2-percent AEP flood	1050	ft^3/s	253	4370	108
Bankfull width 66.7 percent AEP flood	71.8	ft^3/s	25.6	202	93.6
Bankfull Width 50-percent AEP flood	103	ft^3/s	44.6	238	76.9
Bankfull width 42.9 percent AEP flood	122	ft^3/s	55.4	269	72.1
Bankfull Width 20-percent AEP flood	212	ft^3/s	100	449	65.7
Bankfull Width 10-percent AEP flood	300	ft^3/s	131	688	67.8
Bankfull Width 4-percent AEP flood	441	ft^3/s	167	1160	74.7
Bankfull Width 2-percent AEP flood	559	ft^3/s	191	1640	81.6
Bankfull Width 1-percent AEP flood	688	ft^3/s	213	2220	88.8
Bankfull Width 0.5-percent AEP flood	827	ft^3/s	231	2960	97.2
Bankfull Width 0.2-percent AEP flood	1040	ft^3/s	254	4250	109
Rem sens chan width 66.7 percent AEP fld	112	ft^3/s	17	739	190
Rem_sens_chan_width_50_percent_AEP_flood	155	ft^3/s	29.1	824	157
Rem sens chan width 42.9 percent AEP fld	175	ft^3/s	35.1	872	147
Rem_sens_chan_width_20_percent_AEP_flood	287	ft^3/s	66.1	1250	123
Rem_sens_chan_width_10_percent_AEP_flood	395	ft^3/s	94.3	1650	114
Rem_sens_chan_width_4_percent_AEP_flood	573	ft^3/s	136	2420	112
Rem_sens_chan_width_2_percent_AEP_flood	711	ft^3/s	163	3100	114
Rem_sens_chan_width_1_percent_AEP_flood	865	ft^3/s	191	3910	118
Rem_sens_chan_width_0_5_pct_AEP_flood	1040	ft^3/s	218	4950	123
Rem_sens_chan_width_0_2_pct_AEP_flood	1280	ft^3/s	250	6560	131

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (https://doi.org/10.3133/sir20155019)

Chase, K.J., Sando, R., Armstrong, D.W., and McCarthy, P., 2021, Regional regression equations based on channel-width characteristics to estimate peak-flow frequencies

at ungaged sites in Montana using peak-flow frequency data through water year 2011 (ver. 1.1, September 2021): U.S. Geological Survey Scientific Investigations Report 2020–5142, 49 p. (https://doi.org/10.3133/sir20205142)

Channel-width Methods Weighting

Only 3 estimation methods can be weighted; the 3 estimation methods with lowest SEP values were weighted

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction

SW_Region

Statistic	Value	Unit	PIl	PIu	SEP
PK0_2AEP	1960	ft^3/s	645	5940	0.294
PK0_5AEP	1350	ft^3/s	480	3780	0.273
PK10AEP	334	ft^3/s	163	684	0.19
PK1AEP	1020	ft^3/s	387	2680	0.257
PK20AEP	217	ft^3/s	114	415	0.172
PK2AEP	753	ft^3/s	306	1850	0.238
PK42_9AEP	122	ft^3/s	62.1	238	0.178
PK4AEP	540	ft^3/s	236	1240	0.219
PK50AEP	104	ft^3/s	50.8	211	0.189
PK66_7AEP	67.3	ft^3/s	27.5	164	0.236

Channel-width Methods Weighting Citations

Chase, K.J., Sando, R., Armstrong, D.W., and McCarthy, P., 2021, Regional regression equations based on channel-width characteristics to estimate peak-flow frequencies at ungaged sites in Montana using peak-flow frequency data through water year 2011 (ver. 1.1, September 2021): U.S. Geological Survey Scientific Investigations Report 2020-5142, 49 p. (https://pubs.er.usgs.gov/publication/sir20205142)

Application Version: 4.11.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

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STICKNEY CREEK BRIDGE
CROSS SECTION LOCATION

LEWIS & CLARK
COUNTY, MONTANA

DESIGNED: NTP
DRAWN: NTP
CHECKED: KLT
DATE: 11-23-2022

SHEET
1

HEC-RAS River: STICKNEY CREEK Reach: Reach 1 Profile: Q100

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	400	Q100	Existing	1380.00	3448.56	3454.62	3454.36	3455.21	0.003698	7.83	472.67	309.34	0.60
Reach 1	400	Q100	Proposed	1380.00	3448.56	3454.36	3454.36	3455.17	0.005030	8.84	398.39	281.47	0.69
Reach 1	200	Q100	Existing	1380.00	3447.87	3454.67		3454.77	0.000833	4.28	972.59	302.42	0.29
Reach 1	200	Q100	Proposed	1380.00	3447.87	3454.30	3452.86	3454.43	0.001179	4.90	860.50	298.13	0.35
Reach 1	100	Q100	Existing	1380.00	3447.99	3454.63		3454.69	0.000428	3.02	1237.10	383.00	0.21
Reach 1	100	Q100	Proposed	1380.00	3447.99	3454.26		3454.32	0.000527	3.22	1108.28	317.25	0.23
Reach 1	15	Q100	Existing	1380.00	3446.90	3454.07	3451.65	3454.55	0.002261	7.20	342.34	687.53	0.49
Reach 1	15	Q100	Proposed	1380.00	3446.90	3453.80	3451.24	3454.18	0.002046	6.66	385.43	620.79	0.46
Reach 1	0			Bridge									
Reach 1	-15	Q100	Existing	1380.00	3446.89	3451.57	3450.48	3452.30	0.004030	7.18	230.02	237.21	0.61
Reach 1	-15	Q100	Proposed	1380.00	3446.89	3451.66	3450.39	3452.25	0.003315	6.59	267.81	248.69	0.55
Reach 1	-18.269*	Q100	Existing	1380.00	3446.79	3451.57	3450.44	3452.27	0.003844	7.08	236.71	226.86	0.59
Reach 1	-18.269*	Q100	Proposed	1380.00	3446.79	3451.62	3450.42	3452.23	0.003377	6.69	267.37	234.17	0.56
Reach 1	-21.538*	Q100	Existing	1380.00	3446.68	3451.55	3450.40	3452.25	0.003774	7.08	241.29	201.20	0.59
Reach 1	-21.538*	Q100	Proposed	1380.00	3446.68	3451.58	3450.44	3452.21	0.003438	6.79	266.83	202.15	0.56
Reach 1	-24.807*	Q100	Existing	1380.00	3446.58	3451.53	3450.43	3452.23	0.003754	7.12	244.14	199.57	0.59
Reach 1	-24.807*	Q100	Proposed	1380.00	3446.58	3451.55	3450.43	3452.19	0.003477	6.87	266.94	200.21	0.57
Reach 1	-28.076*	Q100	Existing	1380.00	3446.47	3451.49	3450.34	3452.21	0.003799	7.21	244.91	197.35	0.59
Reach 1	-28.076*	Q100	Proposed	1380.00	3446.47	3451.51	3450.34	3452.17	0.003519	6.96	266.97	198.11	0.57
Reach 1	-31.346*	Q100	Existing	1380.00	3446.37	3451.45	3450.35	3452.19	0.003860	7.30	245.37	194.91	0.60
Reach 1	-31.346*	Q100	Proposed	1380.00	3446.37	3451.47	3450.36	3452.15	0.003574	7.05	266.75	195.81	0.58
Reach 1	-34.615*	Q100	Existing	1380.00	3446.26	3451.42	3450.32	3452.17	0.003881	7.37	246.60	192.28	0.60
Reach 1	-34.615*	Q100	Proposed	1380.00	3446.26	3451.44	3450.32	3452.13	0.003593	7.12	267.41	193.32	0.58
Reach 1	-37.884*	Q100	Existing	1380.00	3446.16	3451.39	3450.26	3452.15	0.003872	7.42	248.62	189.55	0.60
Reach 1	-37.884*	Q100	Proposed	1380.00	3446.16	3451.42	3450.25	3452.11	0.003582	7.16	269.03	190.80	0.58
Reach 1	-41.153*	Q100	Existing	1380.00	3446.06	3451.37	3450.28	3452.13	0.003860	7.46	250.81	186.59	0.60
Reach 1	-41.153*	Q100	Proposed	1380.00	3446.06	3451.40	3450.26	3452.09	0.003562	7.20	271.12	188.14	0.58
Reach 1	-44.423*	Q100	Existing	1380.00	3445.95	3451.35	3450.26	3452.11	0.003810	7.47	254.08	179.85	0.60
Reach 1	-44.423*	Q100	Proposed	1380.00	3445.95	3451.39	3450.24	3452.07	0.003521	7.22	274.00	185.03	0.58
Reach 1	-47.692*	Q100	Existing	1380.00	3445.85	3451.35	3450.24	3452.08	0.003703	7.44	259.13	156.96	0.59
Reach 1	-47.692*	Q100	Proposed	1380.00	3445.85	3451.38	3450.22	3452.05	0.003429	7.19	278.33	161.27	0.57
Reach 1	-50.961*	Q100	Existing	1380.00	3445.74	3451.34	3450.22	3452.06	0.003584	7.39	265.82	141.49	0.58
Reach 1	-50.961*	Q100	Proposed	1380.00	3445.74	3451.37	3450.21	3452.03	0.003334	7.16	284.07	146.34	0.56
Reach 1	-54.230*	Q100	Existing	1380.00	3445.64	3451.34	3450.20	3452.03	0.003476	7.35	273.53	130.32	0.58
Reach 1	-54.230*	Q100	Proposed	1380.00	3445.64	3451.37	3450.17	3452.01	0.003249	7.13	290.58	131.16	0.56
Reach 1	-57.500*	Q100	Existing	1380.00	3445.53	3451.33	3450.17	3452.01	0.003380	7.31	281.46	127.62	0.57
Reach 1	-57.500*	Q100	Proposed	1380.00	3445.53	3451.36	3450.17	3451.99	0.003178	7.11	297.23	128.48	0.55
Reach 1	-60.769*	Q100	Existing	1380.00	3445.43	3451.33	3450.17	3451.99	0.003299	7.29	289.35	124.67	0.56
Reach 1	-60.769*	Q100	Proposed	1380.00	3445.43	3451.35	3450.13	3451.97	0.003122	7.11	303.73	125.53	0.55
Reach 1	-64.038*	Q100	Existing	1380.00	3445.33	3451.32	3450.15	3451.97	0.003228	7.27	297.05	121.29	0.56
Reach 1	-64.038*	Q100	Proposed	1380.00	3445.33	3451.34	3450.14	3451.95	0.003069	7.11	310.22	122.26	0.54
Reach 1	-67.307*	Q100	Existing	1380.00	3445.22	3451.31	3450.14	3451.95	0.003165	7.26	304.53	117.29	0.55
Reach 1	-67.307*	Q100	Proposed	1380.00	3445.22	3451.34	3450.14	3451.94	0.003024	7.12	316.35	118.39	0.54
Reach 1	-70.576*	Q100	Existing	1380.00	3445.12	3451.30	3450.10	3451.93	0.003121	7.27	311.46	113.08	0.55
Reach 1	-70.576*	Q100	Proposed	1380.00	3445.12	3451.33	3450.12	3451.92	0.002999	7.14	321.91	113.59	0.54
Reach 1	-73.846*	Q100	Existing	1380.00	3445.01	3451.30	3450.14	3451.91	0.003090	7.29	317.90	111.55	0.55
Reach 1	-73.846*	Q100	Proposed	1380.00	3445.01	3451.32	3450.15	3451.91	0.002983	7.18	327.15	111.68	0.54
Reach 1	-77.115*	Q100	Existing	1380.00	3444.91	3451.29	3450.11	3451.90	0.003059	7.31	324.47	110.05	0.55
Reach 1	-77.115*	Q100	Proposed	1380.00	3444.91	3451.31	3450.13	3451.90	0.002958	7.20	333.04	110.18	0.54
Reach 1	-80.384*	Q100	Existing	1380.00	3444.81	3451.28	3450.14	3451.88	0.003032	7.33	331.16	108.61	0.55
Reach 1	-80.384*	Q100	Proposed	1380.00	3444.81	3451.30	3450.15	3451.88	0.002937	7.23	339.00	108.72	0.54
Reach 1	-83.653*	Q100	Existing	1380.00	3444.70	3451.28	3450.15	3451.87	0.003006	7.35	338.06	107.20	0.54
Reach 1	-83.653*	Q100	Proposed	1380.00	3444.70	3451.30	3450.15	3451.87	0.002917	7.26	345.13	107.31	0.54
Reach 1	-86.923*	Q100	Existing	1380.00	3444.60	3451.27	3450.13	3451.86	0.002977	7.37	345.46	105.83	0.54

HEC-RAS River: STICKNEY CREEK Reach: Reach 1 Profile: Q100 (Continued)

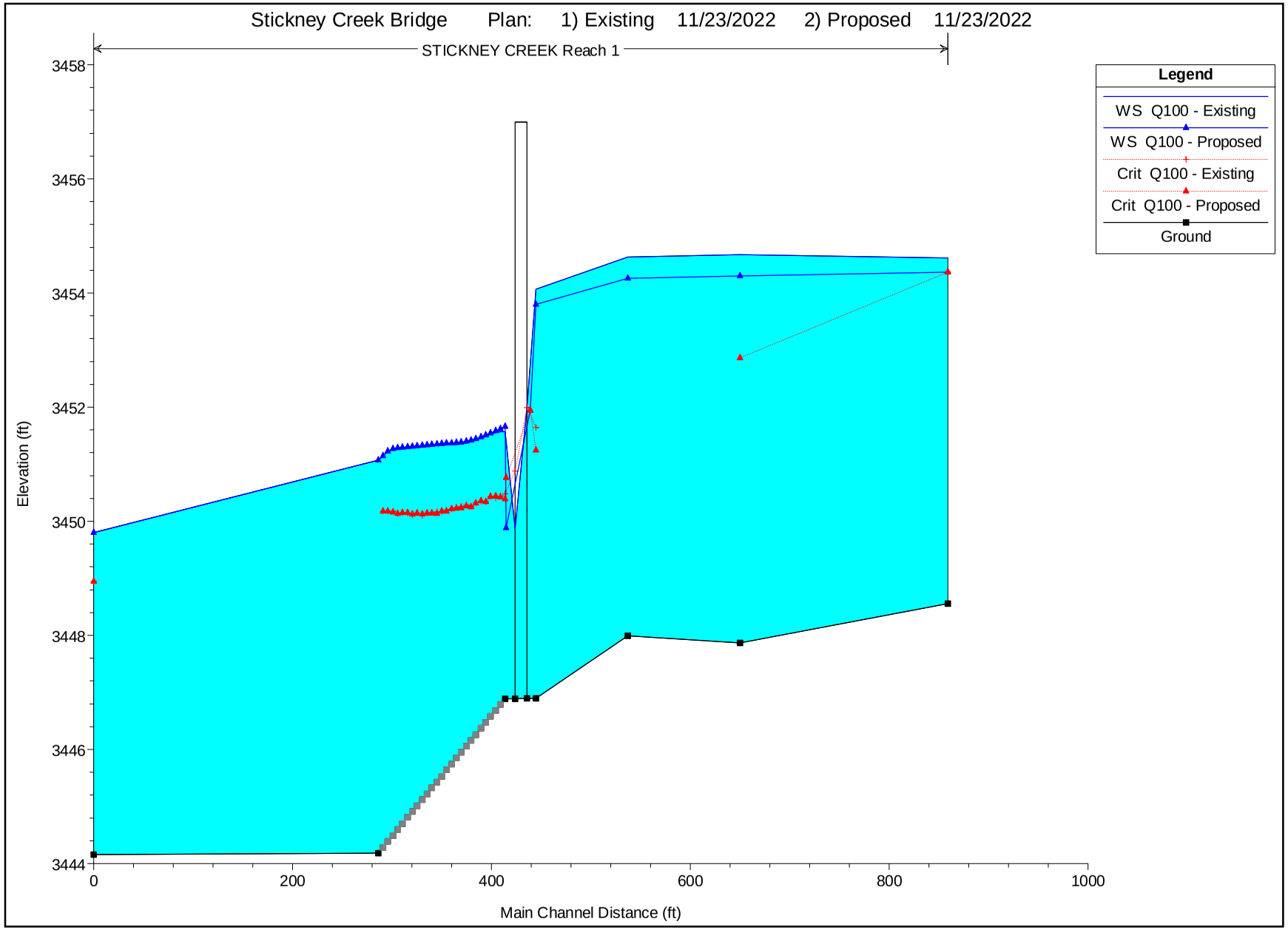
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	-86.923*	Q100	Proposed	1380.00	3444.60	3451.29	3450.14	3451.86	0.002912	7.30	350.83	105.92	0.54
Reach 1	-90.192*	Q100	Existing	1380.00	3444.49	3451.26	3450.17	3451.84	0.002989	7.43	350.91	104.46	0.54
Reach 1	-90.192*	Q100	Proposed	1380.00	3444.49	3451.27	3450.16	3451.85	0.002965	7.40	353.55	104.49	0.54
Reach 1	-93.461*	Q100	Existing	1380.00	3444.39	3451.23	3450.18	3451.83	0.003094	7.59	351.68	103.02	0.55
Reach 1	-93.461*	Q100	Proposed	1380.00	3444.39	3451.23	3450.18	3451.83	0.003102	7.59	352.20	103.01	0.55
Reach 1	-96.730*	Q100	Existing	1380.00	3444.28	3451.14	3450.18	3451.80	0.003404	7.93	343.65	101.34	0.58
Reach 1	-96.730*	Q100	Proposed	1380.00	3444.28	3451.14	3450.18	3451.80	0.003410	7.94	343.50	101.34	0.58
Reach 1	-100	Q100	Existing	1380.00	3444.18	3451.07		3451.77	0.003681	8.23	334.82	99.77	0.60
Reach 1	-100	Q100	Proposed	1380.00	3444.18	3451.07		3451.77	0.003681	8.23	334.82	99.77	0.60
Reach 1	-400	Q100	Existing	1380.00	3444.16	3449.80	3448.95	3450.52	0.006003	10.24	374.94	421.73	0.77
Reach 1	-400	Q100	Proposed	1380.00	3444.16	3449.80	3448.95	3450.52	0.006003	10.24	374.94	421.73	0.77

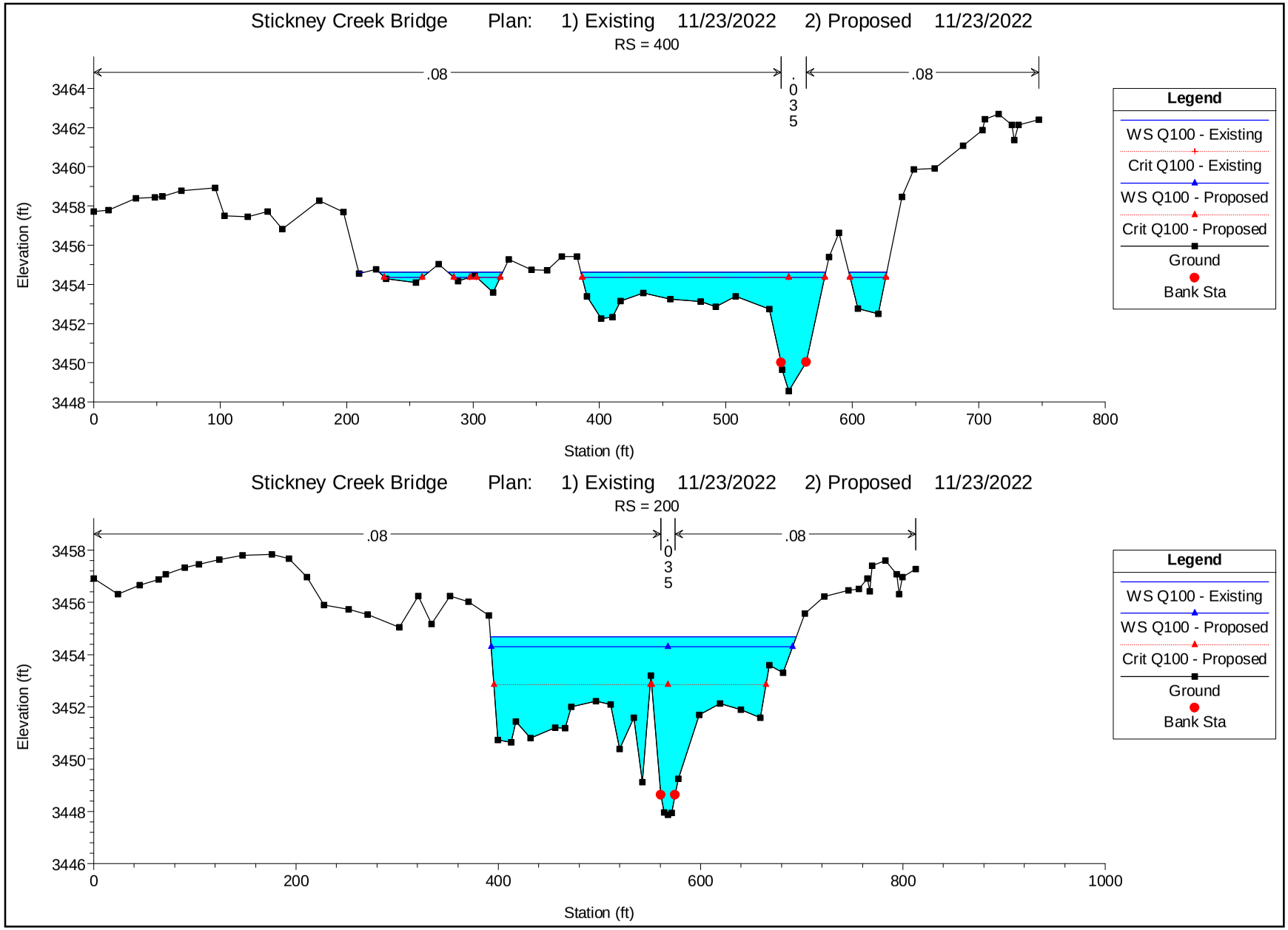
Plan: Existing STICKNEY CREEK Reach 1 RS: 0 Profile: Q100

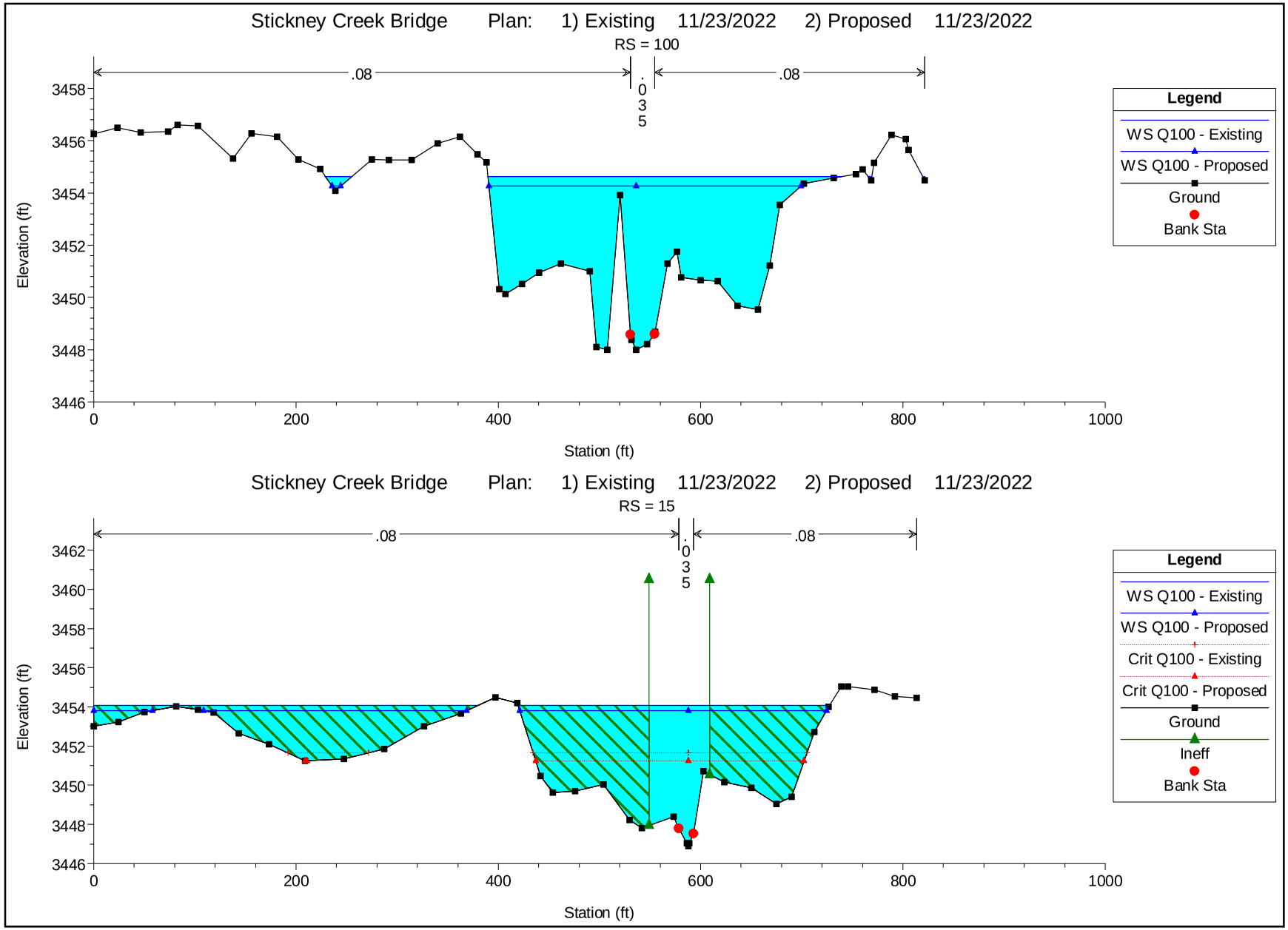
E.G. US. (ft)	3454.55	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	3454.07	E.G. Elev (ft)	3454.04	3453.36
Q Total (cfs)	1380.00	W.S. Elev (ft)	3452.00	3449.87
Q Bridge (cfs)	1380.00	Crit W.S. (ft)	3452.00	3450.88
Q Weir (cfs)		Max Chl Dpth (ft)	5.10	2.98
Weir Sta Lft (ft)		Vel Total (ft/s)	8.17	13.57
Weir Sta Rgt (ft)		Flow Area (sq ft)	169.00	101.72
Weir Submerg		Froude # Chl	0.90	1.53
Weir Max Depth (ft)		Specif Force (cu ft)	804.67	770.16
Min El Weir Flow (ft)	3460.11	Hydr Depth (ft)	4.02	2.42
Min El Prs (ft)	3457.00	W.P. Total (ft)	48.53	45.64
Delta EG (ft)	2.24	Conv. Total (cfs)	12083.9	7021.5
Delta WS (ft)	2.50	Top Width (ft)	42.00	42.00
BR Open Area (sq ft)	379.21	Frctn Loss (ft)	0.13	
BR Open Vel (ft/s)	13.57	C & E Loss (ft)	0.32	
BR Sluice Coef		Shear Total (lb/sq ft)	2.84	5.37
BR Sel Method	Energy only	Power Total (lb/ft s)	23.15	72.92

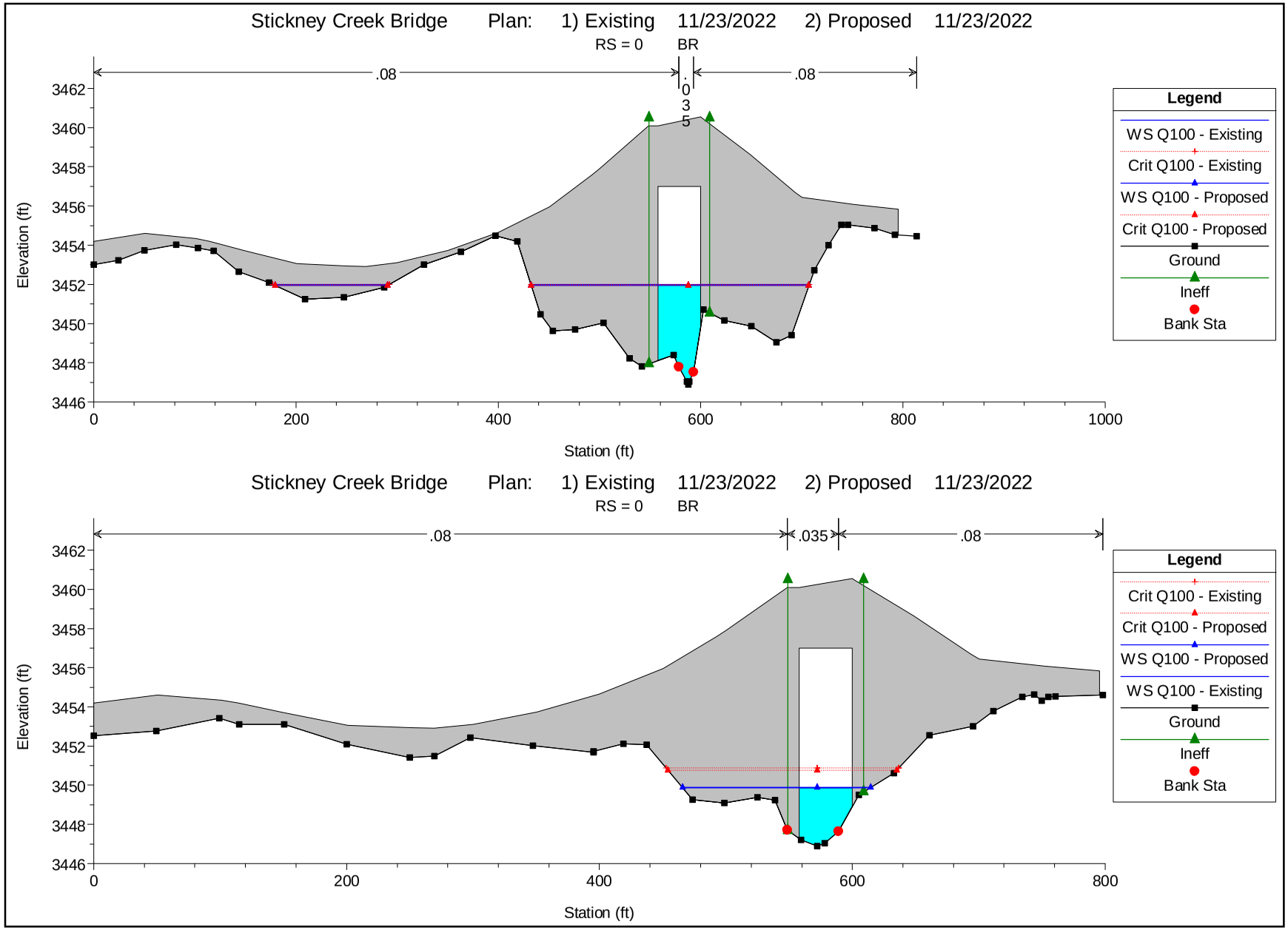
Plan: Proposed STICKNEY CREEK Reach 1 RS: 0 Profile: Q100

E.G. US. (ft)	3454.18	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	3453.80	E.G. Elev (ft)	3453.73	3452.90
Q Total (cfs)	1380.00	W.S. Elev (ft)	3451.95	3449.88
Q Bridge (cfs)	1380.00	Crit W.S. (ft)	3451.95	3450.76
Q Weir (cfs)		Max Chl Dpth (ft)	5.05	2.99
Weir Sta Lft (ft)		Vel Total (ft/s)	7.59	13.14
Weir Sta Rgt (ft)		Flow Area (sq ft)	181.80	105.03
Weir Submerg		Froude # Chl	1.07	1.57
Weir Max Depth (ft)		Specif Force (cu ft)	777.93	713.72
Min El Weir Flow (ft)	3458.51	Hydr Depth (ft)	3.46	2.37
Min El Prs (ft)	3454.98	W.P. Total (ft)	54.91	45.78
Delta EG (ft)	1.93	Conv. Total (cfs)	12210.1	7584.1
Delta WS (ft)	2.14	Top Width (ft)	52.52	44.41
BR Open Area (sq ft)	356.73	Frctn Loss (ft)	0.22	
BR Open Vel (ft/s)	13.14	C & E Loss (ft)	0.35	
BR Sluice Coef		Shear Total (lb/sq ft)	2.64	4.74
BR Sel Method	Energy only	Power Total (lb/ft s)	20.04	62.30


Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
STICKNEY CREEK Reach 1
Legend
WS Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Existing
Crit Q100 - Proposed
Ground
Elevation (ft)
3458
3456
3454
3452
3450
3448
3446
3444
0
200
400
600
800
1000
Main Channel Distance (ft)


Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = 400
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
WS Q100 - Existing
Crit Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Proposed
Ground
Bank Sta
Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = 200
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
WS Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Proposed
Ground
Bank Sta


Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = 100
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
WS Q100 - Existing
WS Q100 - Proposed
Ground
Bank Sta
Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = 15
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
WS Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Existing
Crit Q100 - Proposed
Ground
Ineff
Bank Sta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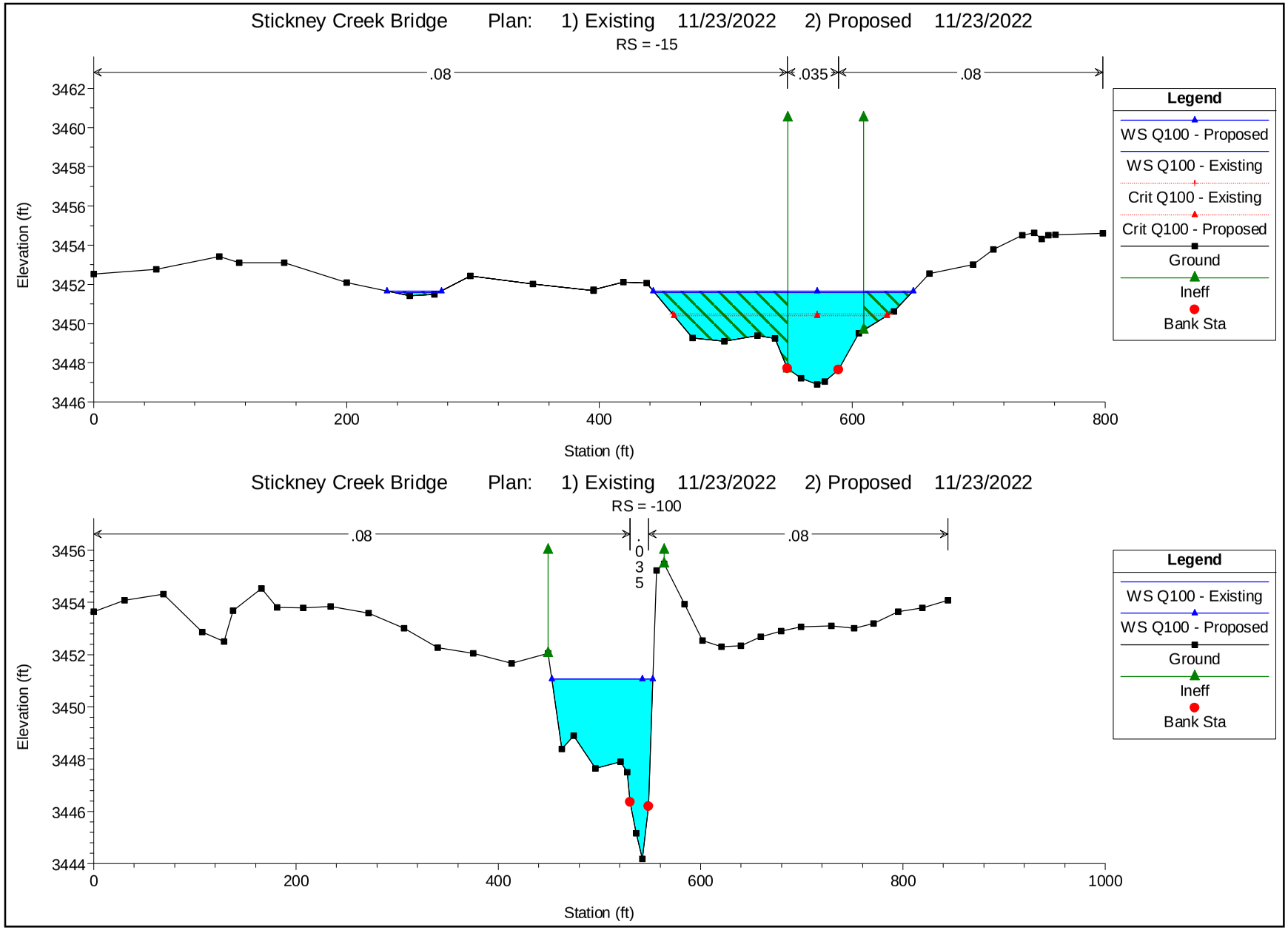
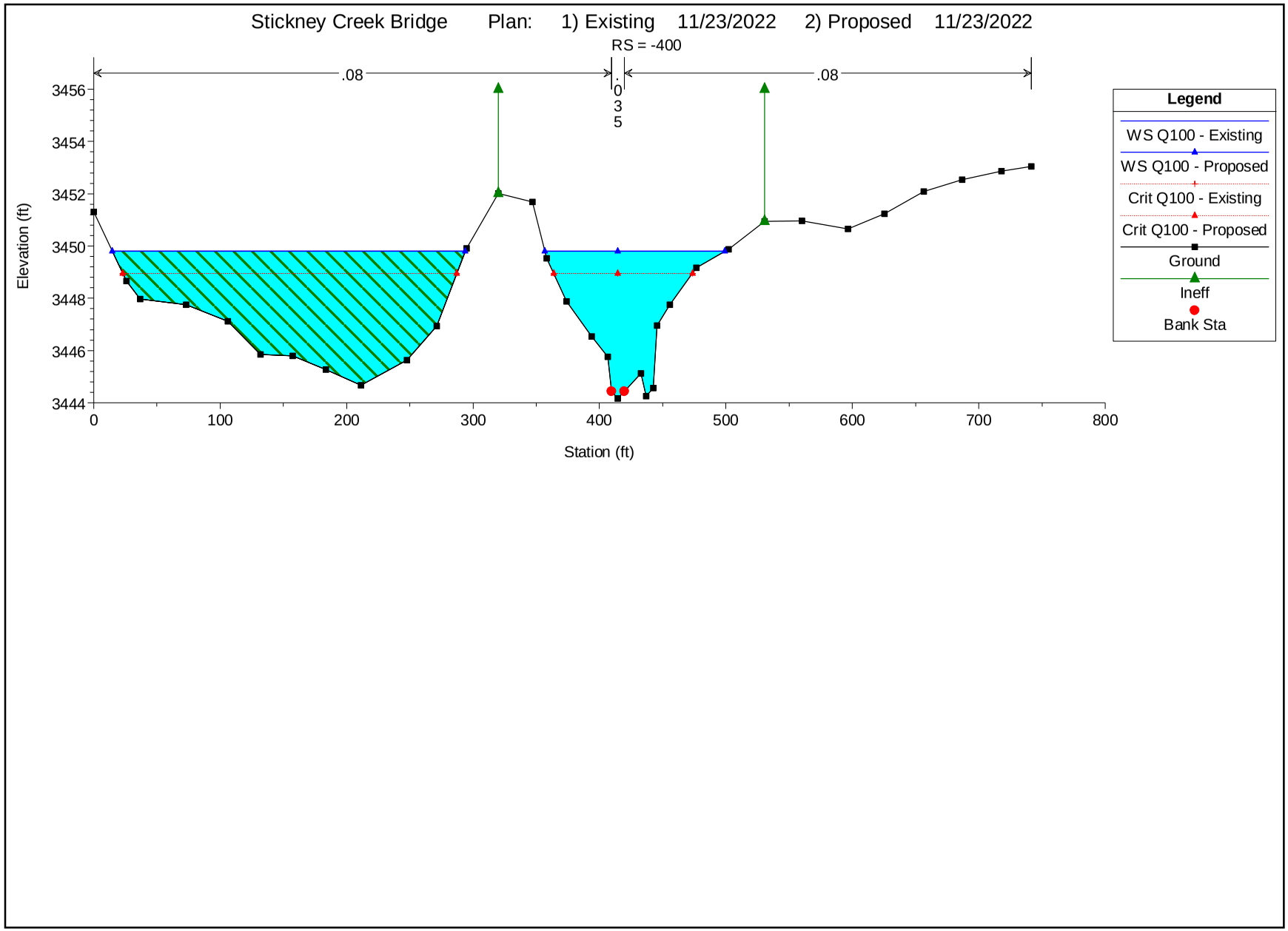
RS = 0 BR
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
WS Q100 - Existing
Crit Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Proposed
Ground
Ineff
Bank Sta
Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = 0 BR
.08
.035
.08
Elevation (ft)
Station (ft)
Legend
Crit Q100 - Existing
Crit Q100 - Proposed
WS Q100 - Proposed
WS Q100 - Existing
Ground
Ineff
Bank Sta


Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = -15
.08
.035
.08
Elevation (ft)
3462
3460
3458
3456
3454
3452
3450
3448
3446
0
200
400
600
800
Station (ft)
Legend
WS Q100 - Proposed
WS Q100 - Existing
Crit Q100 - Existing
Crit Q100 - Proposed
Ground
Ineff
Bank Sta
Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = -100
.08
.035
.08
Elevation (ft)
3456
3454
3452
3450
3448
3446
3444
0
200
400
600
800
1000
Station (ft)
Legend
WS Q100 - Existing
WS Q100 - Proposed
Ground
Ineff
Bank Sta


Stickney Creek Bridge Plan: 1) Existing 11/23/2022 2) Proposed 11/23/2022
RS = -400
.08
.035
.08
Elevation (ft)
3456
3454
3452
3450
3448
3446
3444
0
100
200
300
400
500
600
700
800
Station (ft)
Legend
WS Q100 - Existing
WS Q100 - Proposed
Crit Q100 - Existing
Crit Q100 - Proposed
Ground
Ineff
Bank Sta

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	3.31	6.40	2.77
	Approach Velocity (ft/s):	0.92	3.02	0.77
	Br Average Depth (ft):	3.78	4.69	3.32
	BR Opening Flow (cfs):	349.19	942.69	88.12
	BR Top WD (ft):	20.23	14.84	6.93
	Grain Size D50 (mm):	150.00	150.00	150.00
	Approach Flow (cfs):	511.10	460.63	408.28
	Approach Top WD (ft):	167.69	23.79	191.52
	K1 Coefficient:	0.590	0.590	0.590
Results				
	Scour Depth Ys (ft):	0.00	0.33	0.00
	Critical Velocity (ft/s):	10.77	12.03	10.46
	Equation:	Clear	Clear	Clear

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	558.00	600.00
	Toe Sta at appr (ft):	510.43	561.38
	Abutment Length (ft):	167.69	191.52
	Depth at Toe (ft):	5.95	4.24
	K1 Shape Coef:	0.55 - Spill-through abutment	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	167.69	191.52
	Avg Depth Obstructed Ya (ft):	3.31	2.77
	Flow Obstructed Qe (cfs):	511.10	408.28
	Area Obstructed Ae (sq ft):	554.72	530.07
Results			
	Scour Depth Ys (ft):	14.18	9.92
	Froude #:	0.21	0.20
	Equation:	HIRE	HIRE

Combined Scour Depths

Left abutment scour + contraction scour (ft):	14.18
Right abutment scour + contraction scour (ft):	9.92

Bridge Riprap Sizing per Hydraulic Engineering Circular No. 23
Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance - Third Edition
September 2009
Publication No. FHWA-NHI-09-112

Inputs

13.14	= V, characteristic average velocity in the contracted section, ft/s
2.65	= Ss, specific gravity of rock riprap (typically use 2.65)
32.2	= g, gravitational acceleration, 32.2 ft/s2
2.99	= y, depth of flow in the contracted bridge opening, ft
spill-through	= Abutment type: spill-through vertical wall

Calculations

1.339	= Froude Number for wide opening (V/(gy)^1/2)
1.650	= (Ss - 1)
1.793	= V^2/gy

For Froude Numbers <= 0.80 (Equation 14.1)

0.89	= K
0.539	= K/(Ss - 1)
2.892	= D50 (ft)

For Froude Numbers > 0.80 (Equation 14.2)

0.61	= K
0.370	= K/(Ss - 1)
1.200	= D50 (ft)

Summary

1.200 = D50, caluculated median stone diameter, ft

Note: Class I D50 = 0.66 ft
Class II D50 = 1.32 ft
Class III D50 = 2.00 ft

Class II = Class of Riprap selected