MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Bowser Creek
Flathead County, Montana

Project Completed: 2010
Monitoring Report #5: December, 2017

Prepared for:

VISION ZERO
zero deaths · zero serious injuries
MONTANA DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE
consulting incorporated

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #5

YEAR 2017

Bowser Creek
Flathead County, Montana

MDT Project Number: NH 15(93)
Control Number: 2038-011

USACE Number: NWO-2009-01808-MTM

Prepared for:

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Cover: Looking west across the Bowser Creek Stream Mitigation Site in 2017.

1.0 INTRODUCTION

As part of construction of the Kalispell Bypass U.S. Highway 2 South, the Montana Department of Transportation (MDT) modified a segment of Bowser Creek to allow for highway widening and improved traffic. In order to offset the impacts of this project, MDT proposed on-site stream mitigation actions within the widened highway right of way. The following report includes results from the fourth year of post-project monitoring of the on-site mitigation actions along the modified segment of Bowser Creek. This monitoring report includes an evaluation of monitoring results in comparison to project performance standards outlined in the post-construction monitoring plan for the site. The project was constructed in 2010; therefore, these results provide documentation of the site's condition seven years following the project's completion.

Over several decades, the alignment of Bowser Creek was modified to fit between the original Highway 2 alignment and residential development. An expanded MDT right-of-way was acquired to provide additional space to relocate the stream away from the widened road footprint. The relocation of Bowser Creek was permitted in a modification to U.S. Army Corps of Engineers (USACE) permit NWO-2009-018098-MTM. The project proposed placement of 0.267 acres of wetland fill in the original Bowser Creek channel and 709 feet of stream impacts resulting from relocating 429 feet of the channel and placing a 218-foot segment of the creek into a culvert beneath MT Highway 2.

One goal of the project is to provide compensatory mitigation for stream impacts resulting from widening of U.S. Highway 2 at its intersection with the Alternate U.S. 93 Kalispell Bypass. MDT has selected on-site stream mitigation to meet this goal. Specific objectives intended to achieve this goal include:

- Constructing 430 linear feet of new Bowser Creek channel slightly north of the existing channel
- Laying back floodplain slopes adjacent to the channel from 1.5:1 to a 4:1 slope or flatter
- Implementing an aggressive revegetation plan to re-establish native riparian and upland vegetation.

If successful, the project will create, enhance, restore, and maintain permanent, naturally self-sustaining, native or native-like stream and riparian habitat. The project is designed to protect the functional values of riparian lands, floodplains, wetlands, and uplands for the benefit of fish and wildlife habitat, water quality, floodwater retention, groundwater recharge, open space, aesthetic values, and environmental education.

Provisions outlined in the USACE permit include monitoring the mitigation areas for five years following construction to determine whether the site is meeting, or moving toward meeting the performance criteria outlined in the monitoring plan. Specific success criteria for the Bowser Creek stream mitigation site include:

Quantitative success criteria:

1. **Riparian Buffer Success** will be achieved when
    a. Woody and riparian vegetation becomes established, and noxious weeds do not exceed 10% cover within the riparian buffer areas.
    b. Any area within the creditable buffer area disturbed by the project construction must have at least 50% areal cover of non-noxious weed species by the end of the monitoring period.
2. **Vegetation Success** will be achieved when
    a. Combined areal cover of riparian and stream bank vegetation communities is ≥70%
    b. Planted trees and shrubs will be considered successful where they exhibit 50% survival after 5 years.
3. **Vegetation along Stream Banks** will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6 (subject to 1.a and 1.b above).
4. **Stream Bank Stability Success** will be achieved where; following restoration, less than 25% of bank length is unstable and classified as eroding bank. For this purpose "eroding bank" will be defined as any bank greater than two feet in length that is more than 50% bare mineral soil and has no roots, surface vegetation, or other stabilizing structure (e.g. rock, woody debris) to inhibit erosion.

Qualitative performance criteria:

5. **Channel Form Success** will be achieved when the stream stabilizes, includes pools and riffles, allows for flood events to occupy the floodplain, and the habitat features such as riparian plant communities have successfully established along stream banks.

Additional reporting requirements:

6. **Photo Documenting** success of restored stream channel and stream bank vegetation community development showing distinct positive changes from pre-construction to final monitoring year in comparison with the establishment reference reach.

Results of the fifth year monitoring at the Bowser Creek stream mitigation site are presented in Section 4 and compared to performance standards in Section 5. Additional information to aid in documenting the site's condition are provided as appendices to this report, and include maps showing locations of riparian vegetation transects, perpendicular transects, and locations of noxious weeds; transect and longitudinal profile survey plots; photo documentation of the project site; and a planting schematic from the approved design.

2.0 SITE LOCATION

The modified segment of Bowser Creek flows east within a newly constructed channel immediately north of U.S. Hwy 2 near the intersection of U.S. Highway 2 and Alternate U.S. 93 Kalispell Bypass (Figure 1). This monitoring site is located in Section 12, Township 28 North, Range 22 West, in Flathead County, Montana.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on August 3, 2017 while survey crews visited the site on August 8, 2017. The following data were collected at the Bowser Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

Two types of transect-based vegetationsurveys were conducted on the Bowser Creek site, one of streambank vegetation that exists within three feet of the channel edge, and one of riparian vegetation with a belt transect twenty-five feet further upland.

Stream bank vegetation performance was monitored by establishing transects along both stream banks, and compiling a list of all plant species and their associated cover classes identified within three feet of the active channel. Percent cover of all species observed along the entire length of each bank was visually estimated and recorded using the classification values listed in Table 1.

Table 1. Classification values and associated percent cover classes used for vegetation inventories.

Classification Value	% Cover
0	<1%
1	1-5%
2	6-10%
3	11-20%
4	21-50%
5	>50%

Performance of riparian buffer and vegetation success was monitored by establishing two riparian belt transects. Monitoring data collected along each transect included areal percent cover of total vegetation, woody vegetation, and noxious weeds. Visual estimates of all vegetation species, woody species, and noxious weeds were performed within the riparian buffer areas extending 25 feet on either side of the active stream channel. Areal percent cover was recorded for each vegetation category based on ocular estimate methodologies outlined in Elzinga et al. (1998). The riparian belt transect on the right (south) stream bank runs parallel to the channel for 204 feet, while the left (north) bank extends 167 feet (Figure 2, Appendix A).

In addition to the two types of vegetation belt transects, vegetation community boundaries were mapped in the field during the active growing season and subsequently delineated on aerial photographs. Community types were designated

based on the predominant vegetation species within each mapped polygon. Bank stability indices were assigned to the stream bank community types using Winward (2000) stability scores.

Noxious weed infestations, with cover classes ranging from low to high, were identified and mapped on aerial photographs, with species noted. Observations of isolated noxious weed occurrences and those with a trace cover class were included in the species lists and total areal percent cover estimate of noxious weeds within the project area, but were not mapped. Percent cover of noxious weed species observed along the riparian belt transects were visually estimated and recorded using the classification values listed in Table 2. Woody planting survival was monitored by visually inspecting vegetation plantings. The total number of live and dead plantings was recorded to calculate woody plant survival.

Table 2. Classification values and associated percent cover classes used for noxious weed inventory.

Classification Value	% Cover
Trace (T)	<1%
Low (L)	1-5%
Moderate (M)	6-25%
High (H)	25-100%

3.2. Bank Erosion Inventory

Streambank stability performance was monitored by conducting a visual erosion inventory within the project reach. Each eroding bank within the project reach was photo-documented with eroding bank length and potential causes of bank erosion noted. A qualitative erosion severity rating was generated by observing substrate composition of the bank, vegetation composition, and whether depositional features such as point bars were developing near the erosional area.

3.3. Perpendicular Transect and Longitudinal Profile Surveys

Four perpendicular cross sections were established in 2013 to document vertical and lateral stability within the project reach. Each of the four cross sections was re-surveyed annually to document vertical and lateral adjustments at two riffles and at two pools. A longitudinal profile was surveyed down the thalweg of the channel from 2014 through 2017 to document aggradation, degradation, and habitat complexity along the project reach. All cross sections and longitudinal profiles were surveyed using a Trimble R8 GPS with rover and base station units, with survey points taken at inflection points along each transect and profile. Locations of monitoring cross sections and longitudinal profile stationing are illustrated on Figure 2 in Appendix A.

3.4. Photo Documentation

Photo documentation of the site was repeated at several locations to document vegetation establishment and stream bank conditions. Three photo documentation

points were established during the 2013 monitoring event to document changes in the site over time. Additional photos were taken facing upstream, downstream, left and right from the center of the channel, and at the endpoints of each perpendicular transect.

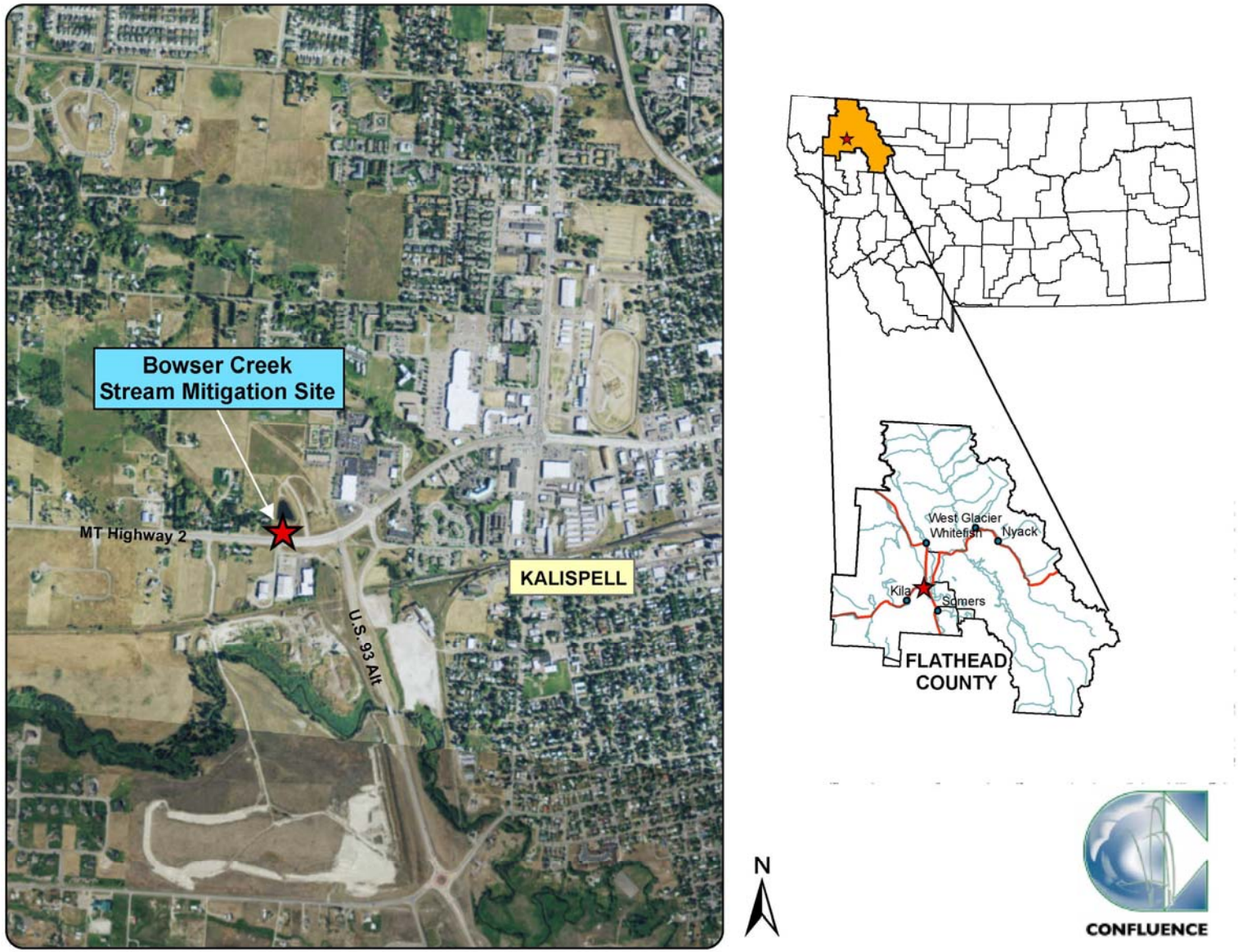


Figure 1. Project location of Bowser Creek stream mitigation site.

3.5. Wildlife Documentation

Wildlife use of the project reach was documented by creating a list of all bird, mammal, and herpetile species observed during the site visit. Wildlife species were identified through visual observation, scat, tracks, and observation of nests, burrows, dens, feathers, etc.

4.0 RESULTS

4.1. Riparian and Stream Bank Vegetation Inventory

Error! Reference source not found. summarizes the areal percent cover of total vegetation, woody vegetation, and noxious weeds observed along each three foot wide streambank transect adjacent to the stream, and each 25 foot wide riparian belt transect further upland, during the 2014 through 2017 monitoring events. In addition to presenting results for the transects individually, **Error! Reference source not found.** includes area-weighted, site-wide totals for each of these vegetation cover categories. In 2017 the total percent riparian cover decreased to 95%, with 10% cover by woody species and 16% by noxious weeds. Stream bank transects displayed 100% cover, with 6% by woody species and 10% by noxious weeds. In total, using a length-based weighted average of vegetation cover for riparian and stream bank transects, the site exhibited 96% total vegetation cover, with 9% by woody species and 15% by noxious weeds.

Table 3. Percent cover of vegetation transects at Bowser Creek in 2013 through 2017.

Belt Transect	Length (ft)	Total % Vegetation Cover					% Woody Cover					% Noxious Weed Cover				
		2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Right (South) Riparian	204	100	100	100	100	95	2	5	7	5	5	2	5	10	13	15
Left (North) Riparian	167	100	100	100	100	95	14	15	17	15	15	5	10	12	15	17
Riparian Subtotal		100	100	100	100	95	8	10	12	10	10	4	7	11	14	16
Right (South) Stream Bank	465	100	100	100	100	100	17	20	15	7	7	4	5	6	10	10
Left (North) Stream Bank	465	100	100	100	100	100	12	10	10	5	5	4	10	10	10	10
Stream Bank Subtotal		100	100	100	100	100	15	15	13	6	6	4	8	8	10	10
Area Weighted Total		**100**	**100**	**100**	**100**	**96**	**9**	**11**	**12**	**9**	**9**	**3**	**7**	**10**	**13**	**15**

Dominant species recorded along the riparian and stream bank transects were combined with visual observations in other areas to develop a vegetation community map (Figure 3, Appendix A). Four vegetation community types were observed in 2017, and are included in Table 4.

Table 4. Vegetation community types observed at Bowser Creek in 2017.

Community Type	Dominant Species
2	*Phalaris arundinacea*
3	*Nasturtium officinale*
4	*Cirsium* spp./*Bromus inermis*
5	*Elymus* spp./ *Festuca ovina*

Vegetation community Type 2 – *Phalaris arundinacea* was identified along both stream banks and riparian zones adjacent to the channel. Reed canary grass (*Phalaris arundinacea)* dominated this community type, with lesser cover provided by Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), Nebraska sedge (*Carex nebrascensis*), watercress (*Nasturtium officinale*) along both stream banks, fringed willowherb (*Epilobium ciliatum*), and others.
Vegetation community Type 3 – *Nasturtium officinale* was identified within the channel. Watercress dominated this community type with more than 50% cover growing in the channel bed and 6 to 10% cover along both stream banks. This community has been consistently observed in dense stands along the stream bed during the growing season, and had expanded to both stream banks during the 2017 monitoring event.

Vegetation community Type 4 – *Cirsium* spp./*Bromus inermis* was observed in between community Types 2 and 5. Canada thistle, bull thistle, and smooth brome (*Bromus inermis*) dominated this community type.

Vegetation community Type 5 – *Elymus* spp./*Festuca ovina* was identified along the upper side slopes of the project area. Sheep fescue (*Festuca ovina*), nodding wild rye (*Elymus canadensis*), slender wild rye (*Elymus trachycaulus*), and western-wheat grass (*Pascopyrum smithii*) were the most commonly observed species within this vegetation community.

Table 5 provides a comprehensive list of plant species observed on site during the 2013 through 2017 monitoring events. Since 2013, 99 plant species have been identified within the project area, including two new species observed in 2017. Of the two newly observed species, red-tinge bulrush (*Scirpus microcarpus*) is native and considered beneficial for the increase of native species diversity within the project area, while true forget-me-not (*Myosotis scorpioides*), is non-native and competes with native species for limited resources. In 2017, 51% of the species observed were hydrophytic based on the 2016 National Wetland Plant List (NWPL) (Lichvar *et al*. 2016).

4.2. Stream Bank Vegetation Composition

The stream bank vegetation inventory identified 40 plant species along the banks of Bowser Creek (Table 6). Reed canary grass comprised 21-50% cover along both stream banks in 2017 (see additional photo #5 in Appendix C). The Winward stability ratings are based on vegetation communities rather than individual species; therefore, a vegetation community was assigned to each stream bank based on one or more dominant species (Winward 2000). Vegetation community Type 2 – *Phalaris arundinacea* was the dominant vegetation community observed along the stream banks, with an associated Winward stability rating of 9.

4.3. Noxious Weed Inventory

A total of 26 infestations of six Montana Listed Priority 2B noxious weeds were mapped within the Bowser Creek stream mitigation site and are listed in Table 7. Locations of noxious weed infestations are provided on Figure 3 in Appendix A with the exception of those observed as isolated occurrences and those in trace amounts. A low cover class (1 to 5 percent) was identified for all mapped weed occurrences within the project area.

Noxious weeds have continued to increase at the site over the past five monitoring events. In 2017, a visual estimate of 15% of the project area was colonized by noxious weeds, representing an increase by 2% since the 2016 monitoring event. Infestations of Canada thistle, the most prevalent noxious weed, were located throughout the project area. In both 2016 and 2017, Canada thistle was so commonly observed that it was identified as a dominant species in community Type 4 (Figure 3, Appendix A).

Table 5. Comprehensive vegetation species list for the Bowser Creek stream mitigation site from 2013 through 2017.

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
Acer negundo	Ash-Leaf Maple	FAC
Agastache urticifolia	Nettle-Leaf Giant-Hyssop	FACU
Agropyron cristatum	Crested Wheatgrass	NL
Agrostis gigantea	Black Bent	FAC
Agrostis stolonifera	Spreading Bent	FAC
Alnus incana	Speckled Alder	FACW
Alopecurus arundinaceus	Creeping Meadow-Foxtail	FAC
Amelanchier alnifolia	Saskatoon Service-Berry	FACU
Artemisia absinthium	Absinthium	NL
Artemisia biennis	Biennial Wormwood	FACW
Beckmannia syzigachne	American Slough Grass	OBL
Betula pumila	Bog Birch	OBL
Bromus inermis	Smooth Brome	UPL
Carduus nutans	Nodding Plumeless-Thistle	UPL
Carex nebrascensis	Nebraska Sedge	OBL
Carex sp.	Sedge	NL
Carex stipata	Stalk-Grain Sedge	OBL
Carex utriculata	Northwest Territory Sedge	OBL
Centaurea cyanus	Garden Cornflower	FACU
Centaurea stoebe	Spotted Knapweed	NL
Chamaenerion angustifolium	Narrow-Leaf Fireweed	FACU
Chenopodium album	Lamb's-Quarters	FACU
Chorispora tenella	Common Blue-Mustard	NL
Cicuta douglasii	Western Water-Hemlock	OBL
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	Bull Thistle	FACU
Cornus alba	Red Osier	FACW
Cynoglossum officinale	Gypsy-Flower	FACU
Descurainia sophia	Herb Sophia	NL
Elymus canadensis	Nodding Wild Rye	FAC
Elymus repens	Creeping Wild Rye	FAC
Elymus trachycaulus	Slender Wild Rye	FAC
Epilobium ciliatum	Fringed Willowherb	FACW
Equisetum arvense	Field Horsetail	FAC
Festuca ovina	Sheep Fescue	UPL
Geum macrophyllum	Large-Leaf Avens	FAC
Geum sp.	Avens	NL
Geum triflorum	Old-Man's-Whiskers	FACU
Glyceria grandis	American Manna Grass	OBL
Glyceria striata	Fowl Manna Grass	OBL
Helianthus maximiliani	Maximilian Sunflower	UPL
Helianthus nuttallii	Nuttall's Sunflower	FACW
Hordeum jubatum	Fox-Tail Barley	FAC
Hypericum perforatum	Common St. John's-Wort	FACU
Juncus balticus	Baltic Rush	FACW
Juncus sp.	Rush	NL
Lactuca serriola	Prickly Lettuce	FACU
Lemna minor	Common Duckweed	OBL
Leucanthemum vulgare	Ox-Eye Daisy	FACU
Leymus cinereus	Great Basin Lyme Grass	FAC
Linaria vulgaris	Butter-and-Eggs	NL
Lysichiton americanus	Yellow-Skunk-Cabbage	OBL
Medicago lupulina	Black Medick	FACU
Medicago sativa	Alfalfa	UPL
Melilotus albus	White Sweetclover	NL
Melilotus officinalis	Yellow Sweet-Clover	FACU
Mentha arvensis	American Wild Mint	FACW
Myosotis scorpioides	**True Forget-Me-Not**	**FACW**
Nasturtium officinale	Watercress	OBL
Onopordum acanthium	Scotch Thistle	NL
Pascopyrum smithii	Western-Wheat Grass	FACU
Persicaria amphibia	Water Smartweed	OBL
Persicaria sp.	Smartweed	NL
Phalaris arundinacea	Reed Canary Grass	FACW
Phleum pratense	Common Timothy	FAC
Plantago lanceolata	English Plantain	FACU
Plantago major	Great Plantain	FAC
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Prunus virginiana	Choke Cherry	FACU
Ranunculus sp.	Buttercup	NL
Rosa woodsii	Woods' Rose	FACU
Rudbeckia hirta	Black-Eyed-Susan	FACU
Rumex crispus	Curly Dock	FAC
Salix bebbiana	Gray Willow	FACW
Salix drummondiana	Drummond's Willow	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Salix sp.	Willow	NL
Scirpus microcarpus	**Red-Tinge Bulrush**	**OBL**
Silene vulgaris	Maiden's-tears	NL
Solanum dulcamara	Climbing Nightshade	FAC
Solidago canadensis	Canadian Goldenrod	FACU
Sonchus arvensis	Field Sow-Thistle	FACU
Stachys byzantina	Woolly Hedgenettle	NL
Stuckenia pectinata	Sago False Pondweed	OBL
Symphoricarpos albus	Common Snowberry	FACU
Tanacetum vulgare	Common Tansy	FACU
Taraxacum officinale	Common Dandelion	FACU
Thlaspi arvense	Field Pennycress	UPL
Tragopogon dubius	Meadow Goat's-beard	NL
Trifolium pratense	Red Clover	FACU
Trifolium repens	White Clover	FAC
Triglochin maritima	Seaside Arrow-Grass	OBL
Typha latifolia	Broad-Leaf Cat-Tail	OBL
Urtica dioica	Stinging Nettle	FAC
Verbascum thapsus	Great Mullein	FACU
Veronica americana	American Brooklime	OBL
Vicia americana	American Purple Vetch	FAC

*2016 National Wetland Plant List; *Western Mountains, Valleys, and Coasts* (WMVC) (Lichvar *et al.* 2016)
New species identified in 2017 are **bolded**.

Table 6. Plant species and their associated cover classes along the stream banks of the Bowser Creek stream mitigation site in 2017.

Streambank Species	Left bank	Left Bank Cover Class	Right bank	Right Bank Cover Class	WMVC Indicator Status*
Agrostis stolonifera	X	0	X	0	FAC
Alnus incana			X	0	FACW
Alopecurus arundinaceus	X	1	X	1	FAC
Artemisia absinthium			X	0	NL
Bromus inermis	X	1	X	1	UPL
Carex nebrascensis	X	3	X	1	OBL
Carex utriculata	X	2	X	2	OBL
Cirsium arvense	X	2	X	2	FAC
Cirsium vulgare	X	0	X	1	FACU
Cornus alba	X	0			FACW
Cynoglossum officinale			X	0	FACU
Elymus repens	X	0	X	0	FAC
Epilobium ciliatum	X	2	X	2	FACW
Equisetum arvense	X	1	X	1	FAC
Geum macrophyllum			X	0	FAC
Glyceria striata	X	0	X	0	OBL
Helianthus maximiliani	X	0	X	0	UPL
Juncus balticus	X	1			FACW
Lactuca serriola			X	0	FACU
Leucanthemum vulgare			X	0	FACU
Melilotus officinalis	X	0	X	0	FACU
Mentha arvensis	X	0	X	1	FACW
Myosotis scorpioides			X	0	FACW
*Nasturtium officinale****	X	2	X	2	OBL
*Phalaris arundinacea***	X	4	X	4	FACW
Poa palustris	X	1	X	1	FAC
Poa pratensis	X	1	X	1	FAC
Rumex crispus	X	0	X	0	FAC
Salix bebbiana	X	0			FACW
Salix drummondiana	X	0	X	0	FACW
Salix exigua			X	0	FACW
Scirpus microcarpus	X	0	X	0	OBL
Sonchus arvensis	X	0	X	0	FACU
Taraxacum officinale	X	0	X	0	FACU
Trifolium pratense	X	0	X	0	FACU
Trifolium repens	X	0	X	0	FAC
Typha latifolia	X	1	X	1	OBL
Urtica dioica			X	0	FAC
Veronica americana	X	1	X	1	OBL
Vicia americana	X	0	X	0	FAC

*2016 National Wetland Plant List; *Western Mountains, Valleys, and Coasts* (WMVC) (Lichvar *et al.* 2016)
** *Dominant species observed along Bowser Creek stream banks*
*** *Dominant species observed along Bowser Creek stream bed*
See Table 1 for classification values and associated percent cover classes used for stream bank vegetation inventory.

Table 7. Montana State-listed noxious weed species observed in 2017 at the Bowser Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	*Centaurea stoebe*	Spotted Knapweed
	Cirsium arvense	Canada Thistle
	Cynoglossum officinale	Houndstongue
	Leucanthemum vulgare	Oxeye Daisy
	Linaria vulgaris	Yellow Toadflax
	Tanacetum vulgare	Common Tansy

*Based on the Montana Department of Agriculture's Noxious Weed List, February 2017

4.4. Woody Plant Survival

Willows (*Salix* spp.), speckled alder (*Alnus incana*), red osier dogwood (*Cornus alba*), common snowberry (*Symphoricarpos albus*), chokecherry (*Prunus virginiana*), bog birch (*Betula pumila*), and Woods' rose (*Rosa woodsii*) were observed as planted woody vegetation species. In 2017, 188 planted trees and shrubs were located, with 147 of those observed alive (Table 8). It is unknown how many plants were installed during construction of the project; however, the revegetation plan called for planting 505 trees and shrubs. As compared to the revegetation plan, 29% (147 of 505) have survived seven years following construction. While a few of the surviving shrubs have grown to between 4 and 5 feet tall, the majority of these shrubs remain small and don't substantially contribute to the percent cover of the site by woody species. Overall, the project site includes less than 10% cover by woody species.

Table 8. Woody plant survival at Bowser Creek stream mitigation site from 2013 through 2017.

Year	Total Plants Inspected	Surviving Plants	# of Woody Plantings in Design	Woody plant survival based on planting plan
2013	127	122	505	24%
2014	127	119		24%
2015	312	279		55%
2016	181	143		28%
2017	188	147		29%

4.5. Bank Erosion Inventory

Previous monitoring reports provided an account of eroding banks observed during the growing season. Monitoring of the Bowser Creek site from 2013-2015 and again in 2017 was performed in August when the banks were well vegetated and the stream bed was densely covered with watercress. The timing of these monitoring events proved challenging to accurately determine the extent and cause of erosion, as well as photo-documenting erosion along banks that were covered with dense vegetation. Locations

of eroding banks are provided on Figure 2 in Appendix A, while photos of each eroding bank can be found in Appendix C.

In 2016, the monitoring team also visited the site in April to observe the stream banks prior to the onset of the growing season. Observations of the reconstructed segment of Bowser Creek during that field visit indicated:

- Bank erosion along the left (north) side of the channel does not appear caused by scour during high flows as is typical of snowmelt driven streams.
- A retention pond has been constructed approximately 100 feet north of Bowser Creek. It appears the pond is elevated as compared to Bowser Creek, causing water to seep from the pond into Bowser Creek.
- The seepage of water from the retention pond toward Bowser Creek is causing bank saturation and instability where the seeps daylight along the north side of the stream channel.
- Saturated, fine grained materials along the north bank of Bowser Creek are transported downstream during high water events, resulting in bank retreat in locations where seeps enter Bowser Creek (including EBL2, EBL3, and EBL4 as shown on Figure 3 in Appendix A).

Eroding bank EBL2 is located just downstream of an overflow culvert connecting the retention pond with Bowser Creek. Inspection of the creek during the April, 2016 site visit revealed the channel has widened from its assumed constructed width of 5.5 feet to over 13 feet. Survey transect #2 runs through this eroding bank, and repeated surveys through this transect indicate the left bank initially retreated approximately 1.5 feet from 2013 to 2014 and has since remained relatively stable. Based on these survey results, this segment of reconstructed channel likely widened by six feet between the time it was constructed in 2010 and the first monitoring event in 2013. No further erosion has been noted since 2015, and as a result of the lack of recent erosion noted, it is considered stable.

Eroding bank EBL3 was identified in 2015 as a newly eroding bank segment. Erosion along this bank was evident from the wood stakes that were used to construct the outside edge of the bank, which were 2 to 3 feet away from the edge of the bank. The channel is approximately 12 feet wide at this location, which is 6.5 feet wider than the design width of 5.5 feet. As noted above, erosion along EBL3 is associated with bank saturation and seeps entering Bowser Creek caused by the adjacent retention pond. Vegetation along this bank is dominated by Canada thistle, bull thistle, and smooth brome. The majority of the bank does not appear to be actively eroding; however, a seep observed near the downstream end of EBL3 is continuing to cause some bank calving. As a result of these factors, bank erosion along EBL3 is considered low.

Eroding bank EBL4 was also identified in 2015 as a newly eroding bank segment, and has been attributed to seeps entering the channel from the north. Similar to EBL3, erosion along this bank resulted in a wider channel as compared to the design width

and sloughing, fine grained banks adjacent to community Type 4 – *Cirsium* spp./*Bromus inermis*. Monitoring in 2017 did not reveal additional bank loss since 2016; therefore it is considered stable.

Although previous bank erosion inventories identified slumping and washing of materials along the three eroding banks mentioned above, no new erosion was noted during the 2017 monitoring event. Based on these observations, the majority of bank length previously identified as eroding has stabilized. Calving of the lower 15 feet of eroding bank EBL3 is due to a seep entering the channel at this location, and remains the only actively eroding bank section. This bank length represents less than 2% of the overall reconstructed bank length of 880 feet.

4.6. Perpendicular Transect Surveys

Two perpendicular cross section transects were surveyed at pools and two at riffles, with maximum depth and bankfull width for each indicated in Table 9 (plots for each transect included in Appendix B). In 2017, maximum bankfull depths ranged from 1.7 to 3.0 feet and bankfull widths ranged from 6.3 to 13.5 feet. Over the past five years, the channel indicates segments that are wider than the design width of 5.5 to 6.5 feet, which can be attributed to the decay of coir logs placed along both banks. The loss of bank structure following the natural biodegradation of the logs has resulted in portions of the channel as wide as 13.5 feet. Bank structure has been compromised by seepage from the adjacent retention pond, and is causing segments of the north bank to slump. These channel segments are unlikely to recover back to the design dimension due to the unnatural hydrology and continuous saturation caused by seepage from the retention pond; however they provide a diversity in channel form and are not continuing to degrade or erode. Based on the vast majority of the reconstructed channel performing as intended, attempts to narrow the channel through these relatively short, over-wide segments is unwarranted.

Table 9. Pool and riffle widths surveyed at Bowser Creek stream mitigation site from 2013 through 2017.

Transect	Type	Max Depth (ft)					Bankfull Width (ft)				
		2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
1	Pool	1.9	1.9	1.5	1.7	1.7	6.0	6.1	5.0	6.0	6.3
2	Riffle	2.2	2.2	1.9	2	1.9	12.7	13.5	12.5	11.8	12.8
3	Pool	3.6	3.9	3.6	3.5	3.0	14.8	13.8	13.6	13.8	13.5
4	Riffle	1.9	2	1.7	1.9	1.9	7.8	8.1	7.6	7.5	7.5
Average Riffles		2.1	2.1	1.8	2.0	1.9	10.3	10.8	10.1	9.7	10.2
Average Pools		2.8	2.9	2.6	2.6	2.4	10.4	10.0	9.3	9.9	9.9
Average All		2.4	2.5	2.2	2.3	2.1	10.3	10.4	9.7	9.8	10.0

4.7. Longitudinal Profile Survey

Repeated longitudinal profile surveys of the channel thalweg indicate the presence of at least three distinct pool features that are between 1.0 and 1.75 feet deeper than riffle segments within the project reach (plotted profile included in Appendix B). The 2017 profile reveals the development of a compound pool between STA 1+60 and 2+10 where previous profiles only indicated one long pool. This compound pool development

may be the result of the channel adjusting to gently arced meander bends, which are often unable to maintain long pool features due to limited scouring in the absence of woody debris. With the exception of this pool feature, the bed elevation of the channel has remained relatively consistent over the past year. The survey profiles indicate two of the three pool features within the project reach have become shorter and slightly shallower over the past four years, which may be due to sediment depositing in the constructed pools.

Fine sediments accumulating in the channel may be due to a combination of factors, including 1) increased roughness of the channel bed and water column caused by proliferation of watercress during the growing season, 2) the reduced ability of the channel to transport fine sediments through the short reaches that have widened, 3) upstream development along Bowser Creek that may be contributing fine sediment, and 4) the inability of the channel to scour pool features due to the relatively straight channel alignment. While upstream sediment sourcing was not a component of the monitoring plan, nearby construction, including residential development and completion of the Highway 93 North bypass project may have, contributed to fine sediment loads observed in Bowser Creek. The dense watercress observed in the channel will trap some of the sediment moving downstream during the growing season, and may help to narrow some of the over-wide areas along the channel if the depositional areas are able to vegetate with annual or perennial species.

4.8. Wildlife Documentation

Wildlife observations at the Bowser Creek Stream Mitigation site from 2013 through 2017 have thus far been relatively limited. In 2017, a red-tailed hawk was observed, as well as a white-tailed deer bedding area. Limited use of this area by wildlife may be due to the proximity of recently completed MT Highway 2, construction activities associated with the adjacent US 93 overpass, lack of habitat, and the time of day monitoring field crews are present at the site (typically late afternoon).

Table 10. Wildlife observations at Bowser Creek stream mitigation site from 2013 through 2017.

Common Name	Scientific Name
Mammals	
Raccoon (scat, tracks)	*Procyon lotor*
White-tailed Deer	*Odocoileus virginianus*
Birds	
Gull sp.	*Larus* sp.
American Robin	*Turdus migratorius*
Mallard	*Anas platyrhynchos*
Red-tailed Hawk	***Buteo jamaicensis***
Sparrow sp.	*Passer* sp.

New species identified in 2017 are **bolded**.

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Bowser Creek stream mitigation site is intended to document whether the reconstructed segment of the channel is meeting, or moving toward meeting the performance standards outlined in the monitoring plan. Results from the fifth year of

monitoring suggests four of the six quantitative performance standards are being met seven years following completion of the project (Table 11). Thus far, the project has met the physical objectives of a) constructing 430 linear feet of new channel; b) laying back floodplain slopes adjacent to the channel from 1.5:1 to 4:1 slope or flatter; and c) implementing a revegetation plan to re-establish native riparian and upland vegetation. Channel form success is considered a qualitative criterion, and is discussed in more detail in Section 5.4.

5.1. Riparian Buffer Success

The results in Table 3 indicate the reconstructed segment of Bowser Creek has developed a densely vegetated understory, which primarily consists of herbaceous vegetation along the riparian and stream bank zones. Woody riparian vegetation is also establishing; however, while the woody planting survival rate remained nearly consistent in 2017, the plantings are relatively small in size, and therefore offer a limited percent of the overall cover.

Vegetation monitoring of the riparian buffer indicated 79% of disturbed areas have successfully revegetated with non-noxious weed species following construction. Non-noxious vegetation cover was determined by subtracting the percent noxious weed cover (16%) observed in the riparian transects from the total vegetation cover observed in the riparian transects (95%). Performance criteria specify at least 50% of the disturbed areas within the creditable buffer area must be vegetated with non-noxious weed species; therefore, this criterion is currently being met. Noxious weeds comprise 15% of the vegetation cover site-wide, which is above the maximum allowable limit to meet the performance criterion. The percent cover estimates recorded for all vegetation categories, including noxious weeds, may have been influenced by a combination of factors, including, but not limited to, adjacent land management, previous herbicide applications, differences in annual precipitation and temperature, calibration training completed by field staff, and other unknown factors that make it difficult to determine the exact cause(s) for increases or decreases in coverage.

Total combined areal vegetation cover of the riparian zone and both right and left stream banks along Bowser Creek decreased in 2017 to 96%. Both riparian and stream bank zones are primarily vegetated with herbaceous species, while woody species are establishing along the sloped areas adjacent to the channel. The performance criterion for this category specifies ≥70% of the combined riparian and stream bank vegetation communities must have vegetation establishment; therefore, this criterion is currently being met.

Woody vegetation plantings indicated a survival rate of 29% seven years following the project's completion. The performance criteria states 50% or more of the woody plants installed must survive after five years; therefore, this criterion is not currently being met. If the remaining woody plantings survive, their continued growth and maturation will provide increased areal percent cover to the site.

Table 11. Performance standards for the Bowser Creek Stream Mitigation Site.

Type	Parameter	Performance Standard	Status	Site Meeting Performance Criteria?
Performance Criteria	Riparian Buffer Success	1a. Areas within creditable riparian buffer disturbed during construction must have 50% or greater aerial cover of non-noxious weed species by the end of the monitoring period	Vegetation transects indicate **79%** cover of the riparian zones with non-noxious weed species	**YES**
		1b. Noxious weeds do not exceed 10% cover within the riparian buffer areas.	Vegetation transects indicate **16%** cover of noxious weeds within riparian zones.	**NO**
	Vegetation Success	2a. Combined aerial cover of riparian and stream bank vegetation communities is at least 70%	Combined aerial cover of riparian and stream bank vegetation is **96%**	**YES**
		2b. Planted trees and shrubs must exhibit 50% survival after 5 years	Planted tree and shrub survival documented at **29%.**	**NO**
	Vegetation along Streambanks	3. Majority of plants on the stream bank must have root stability indices of at least 6	Dominant streambank community along both stream banks is community Type 2- *Phalaris arundinacea* , with a root stability index of 9**.**	**YES**
	Streambank Stability Success	4. Less than 25% of bank length is unstable and classified as eroding bank.	Observations noted **less than 2%** of the stream banks are eroding or unstable.	**YES**
Qualitative Criteria	Channel Form	5. Will be achieved when the stream stabilizes, includes pools and riffles, allows for flood events to occupy the floodplain, and the habitat features such as riparian plant communities have successfully established along streambanks.	Evidence of channel form success provided in Section 5.4	**YES**

5.2. Vegetation along Stream Banks

Reed canary grass comprised between 21-50% cover (closer to 50%) along both stream banks in 2017. As a result, vegetation community Type 2 – *Phalaris arundinacea* was the dominant vegetation community observed along the stream banks, with an associated Winward stability rating of 9. Therefore, stream bank vegetation is successfully meeting the associated performance criteria.

5.3. Stream Bank Stability

The erosion inventory in 2016 was performed during the April monitoring event to enable better observation of actively eroding banks. Although the same segments of the north bank remain affected by seepage from the adjacent retention pond, no new erosion was noted in 2017, and several previously eroding bank segments have stabilized over the past two years. Active erosion remains along only 15 feet of the stream bank where a seep enters the channel from the north, which represents less than 2% of the overall bank length within the project reach. The performance criteria for eroding banks states less than 25% of the stream banks within the project may be classified as eroding; therefore, the project site is meeting the success criteria for this category.

5.4. Channel Form Success

The channel form success criteria states, “will be achieved when the stream stabilizes, includes pools and riffles, allows for flood events to occupy the floodplain, and the habitat features such as riparian plant communities have successfully established along streambanks”. The following section addresses each of these channel form components as observed along Bowser Creek.

Channel stability

Measures to document stability of the project reach include 1) surveying a longitudinal profile along the channel thalweg, 2) surveying channel cross sections, and 3) conducting an erosion inventory along both banks. The longitudinal profile of the stream bed indicates no evidence of vertical instability such as head cutting degradation of the stream bed. Cross section surveys reveal portions of the channel have become wider since the project was constructed; however, the channel does not appear to be actively widening. Rather, it appears channel width increased along portions of the channel within the first two years following construction and prior to the first monitoring event in 2013. The most recent bank erosion inventory indicated most of the erosion noted along the channel is due to saturated banks resulting from drainage of the adjacent retention pond. While some banks are sloughing into the channel as a result of these seeps, overall bank stability is relatively good throughout the project.

Pool and riffle features

The proliferation of watercress along the channel makes visual observations of pool and riffle habitats in Bowser Creek difficult during the growing season. The best method of deciphering pool and riffle habitats is to inspect the longitudinal profile of the channel thalweg, which indicates adjustments to the channel bed throughout the project reach.

The profile suggests three distinct pools and three riffles occur within the reconstructed channel segment, while cross sections indicate depth has varied over the past five years from 1.7 to 3.0 feet. These results indicate the channel provides variable habitat features in support of aquatic life.

Floodplain connectivity

The reconstructed segment of Bowser Creek was designed to convey an estimated 2 year return interval discharge within the low flow channel. Discharges greater than the 2 year flow are able to access a floodplain approximately 14 feet wide with a design grade of 5% slope toward the channel. Beyond this floodplain, the floodway has been designed to convey up to a 100 year discharge without over-topping Highway 2.

Riparian habitat along stream banks

The vegetation along the banks of Bowser Creek is composed of 50% native and 50% non-native herbaceous and woody species (see Section 4.2). The dominant vegetation observed along the banks is reed canary grass, which provides excellent resistance to bank erosion. Although five species of planted and/or volunteer woody shrubs were observed along the stream banks, their contribution to cover along the banks is limited to less than 1%. It appears the unrooted willow stems installed along the outside meander bends either did not successfully establish or were washed out where the channel widened. As a result, woody species composition along the banks is lacking. Photo documentation of the stream channel is provided in Appendix C and offers additional evidence of riparian vegetation composition along Bowser Creek's banks and riparian corridor.

6.0 LITERATURE CITED

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. *Measuring and monitoring plant populations*. Bureau of Land Management (BLM) Technical Reference 1730-1. Washington, DC: U.S. Department of the Interior.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. *The National Wetland Plant List*: *2016 Update of Wetland Ratings.* Phytoneuron 2016-30: 1-17. Published 28 April 2016. ISSN 2153 733X

Montana Department of Agriculture. *Montana Noxious Weed List*. February 2017. Accessed September 2017 at: http://agr.mt.gov/Portals/168/Documents/Weeds/2017%20Noxious%20Weed%20List.pdf.

Winward, 2000. Monitoring the Vegetation Resources in Riparian Areas. Gen. Tech. Report RMRS-GTR.47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Appendix A

Project Site Maps

MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

CONFLUENCE
consulting incorporated

Legend

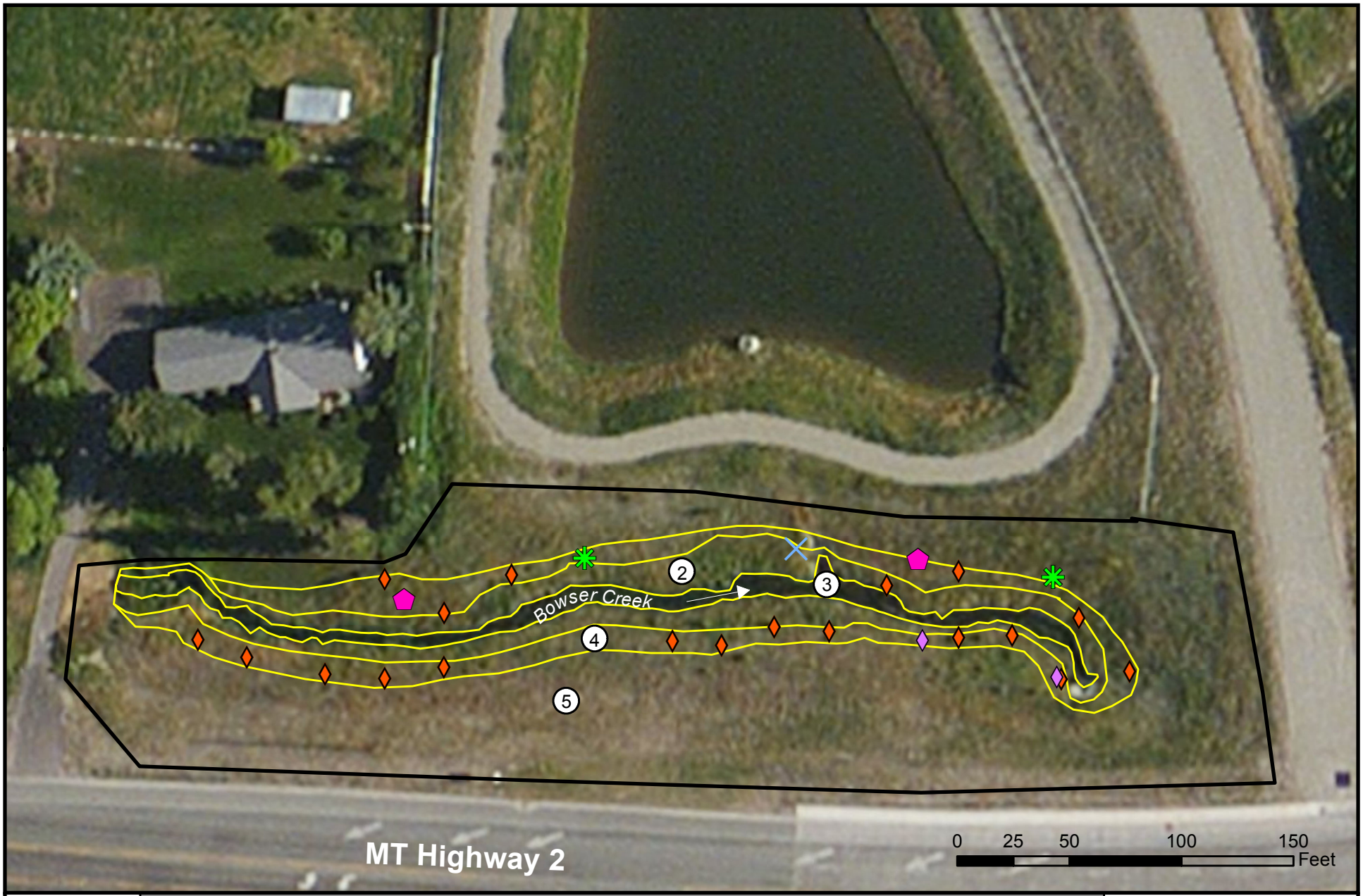
- Photo Points
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Eroding Banks
- Pool and Riffle Transects
- Riparian Transects

Bowser Creek - 2017 Monitoring Features

Figure 2

Date: 11/5/2017

Bowser_features2017.mxd



CONFLUENCE
consulting incorporated

Legend

- Project Boundary
- Vegetation Community Boundary
- Centaurea stoebe
- Cirsium arvense
- Cynoglossum officinale
- Leucanthemum vulgare
- Linaria vulgaris
- (2) Phalaris arundinacea Community
- (3) Nasturtium officinale Community
- (4) Cirsium spp./Bromus inermis Community
- (5) Elymus spp./Festuca ovina Community

N

Bowser Creek - 2017 Noxious Weeds and Vegetation Community

Figure 3

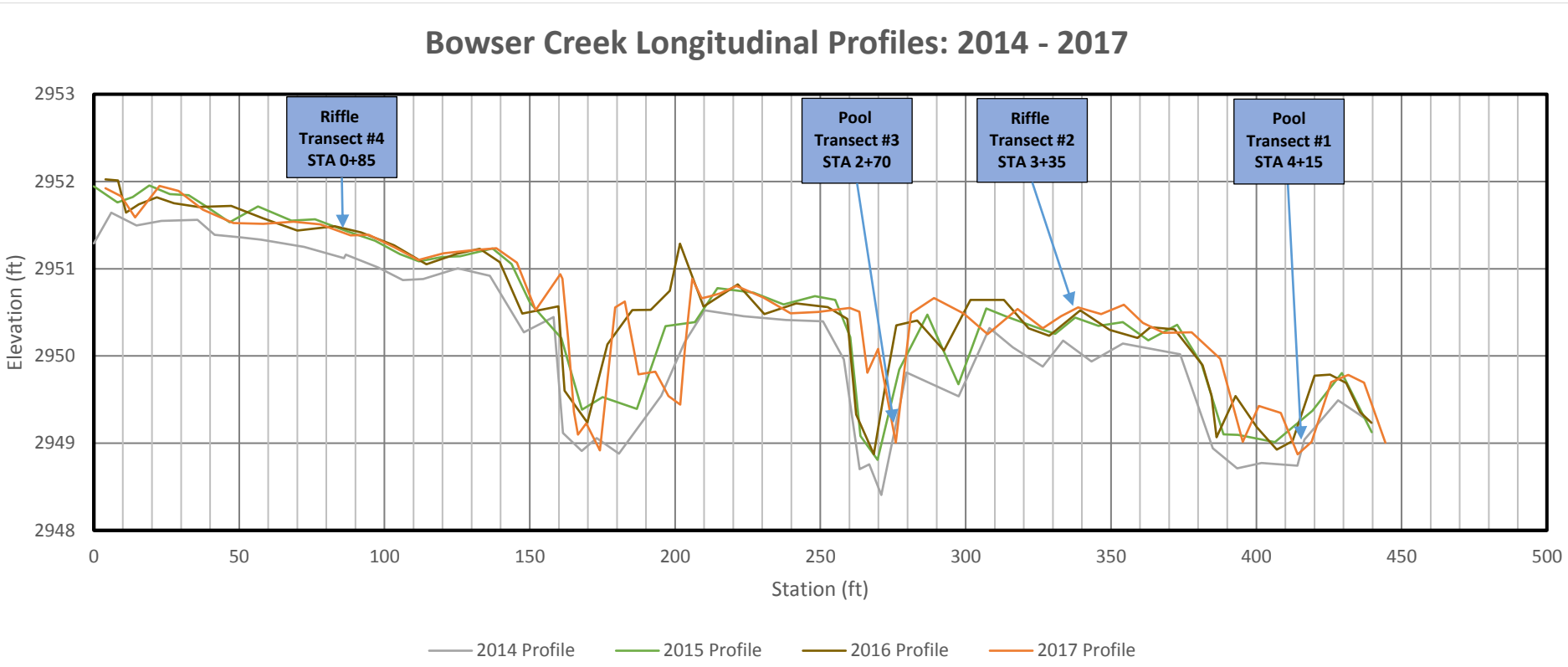
Date: 9/25/2017

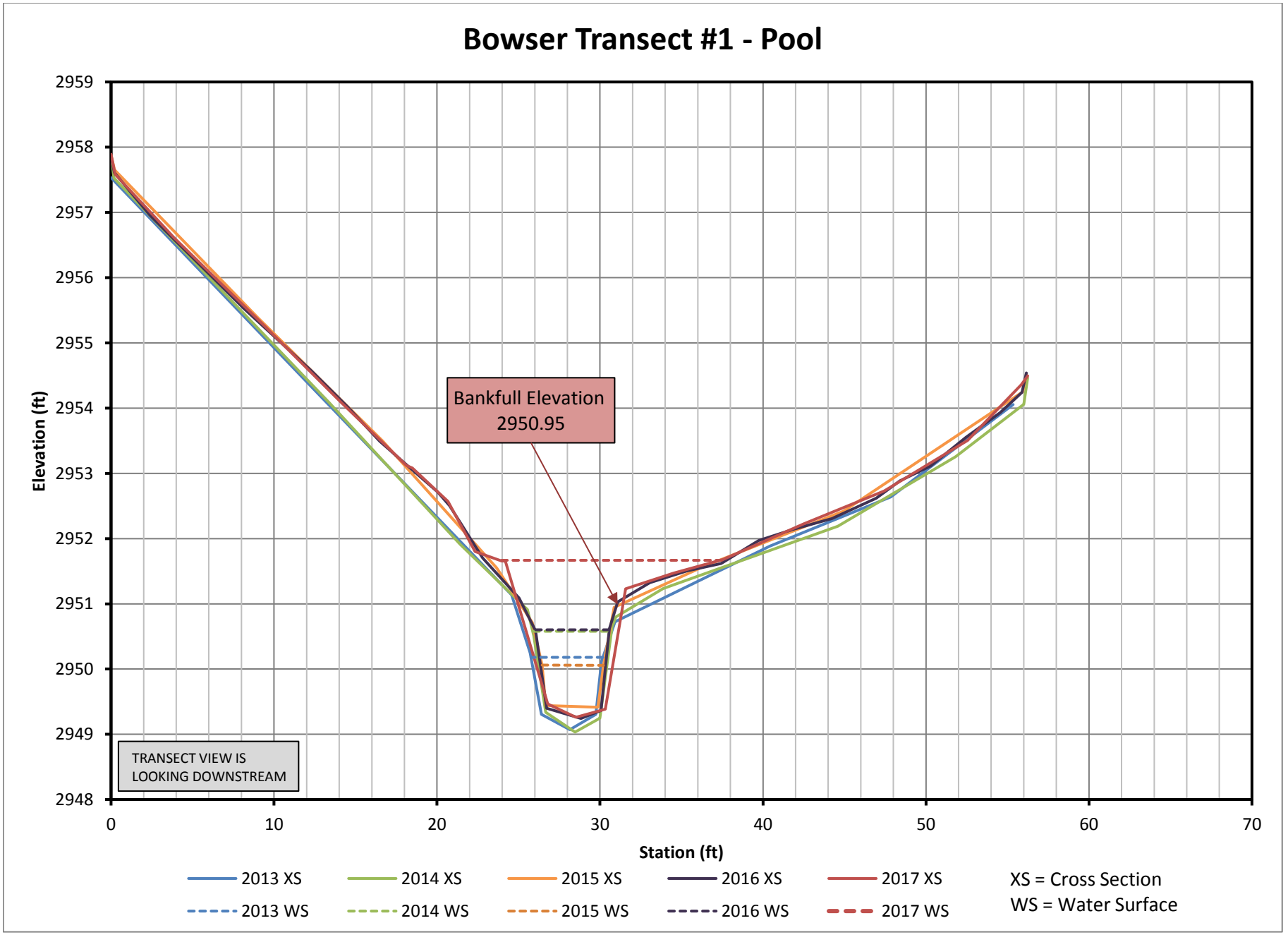
Bowser_monitor2017.mxd

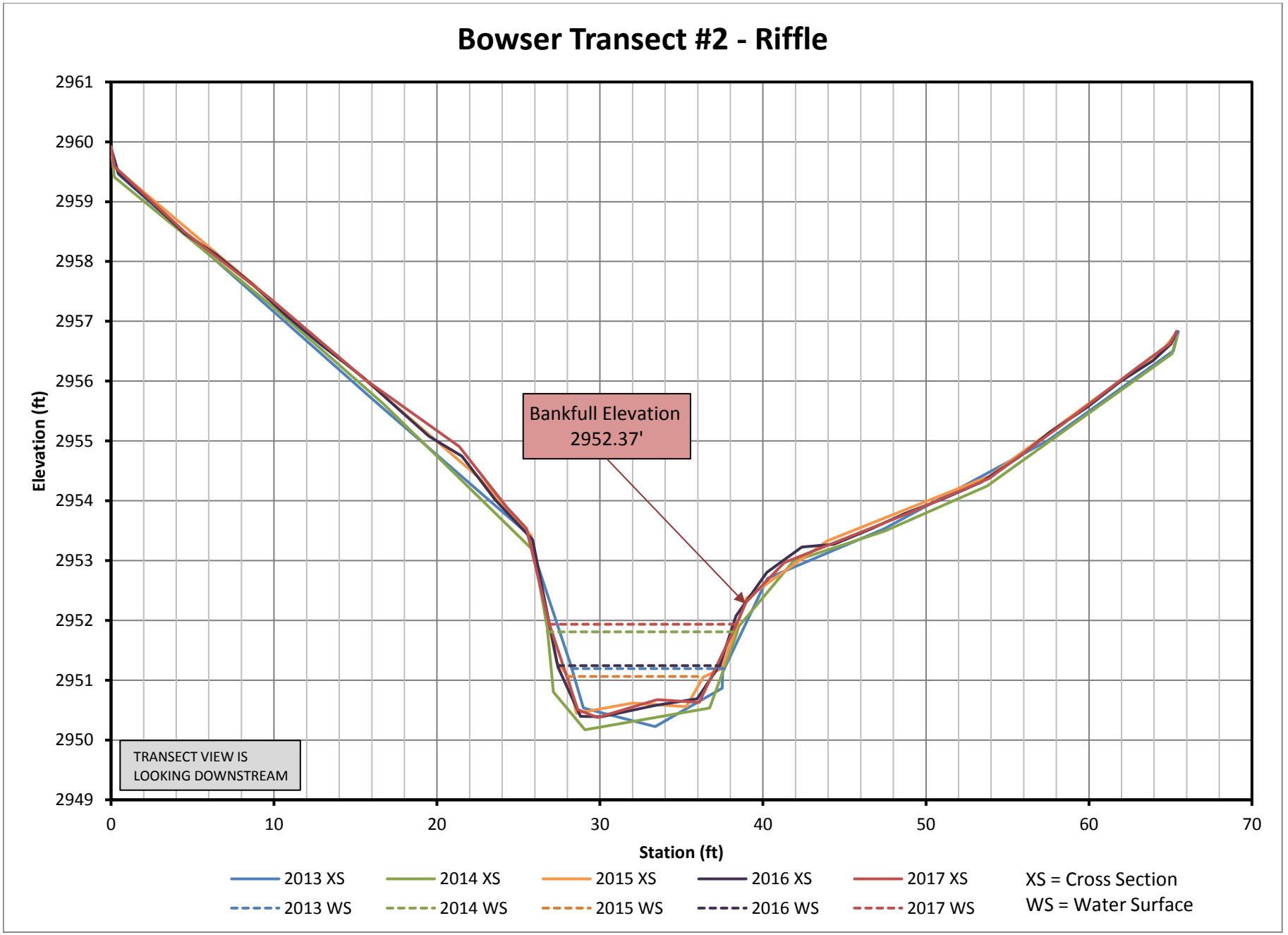
Appendix B

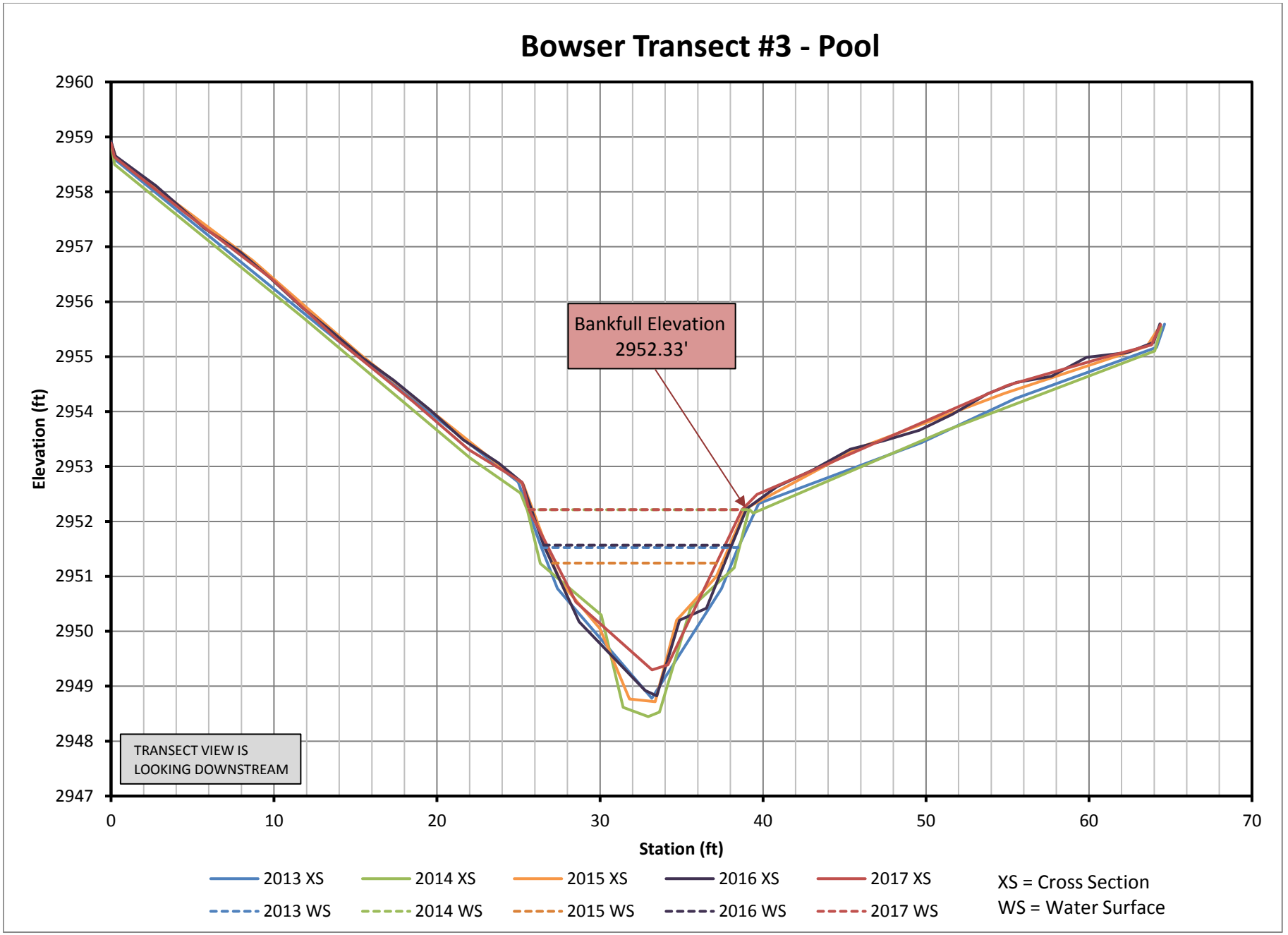
Perpendicular Transect and Longitudinal Profile Plots

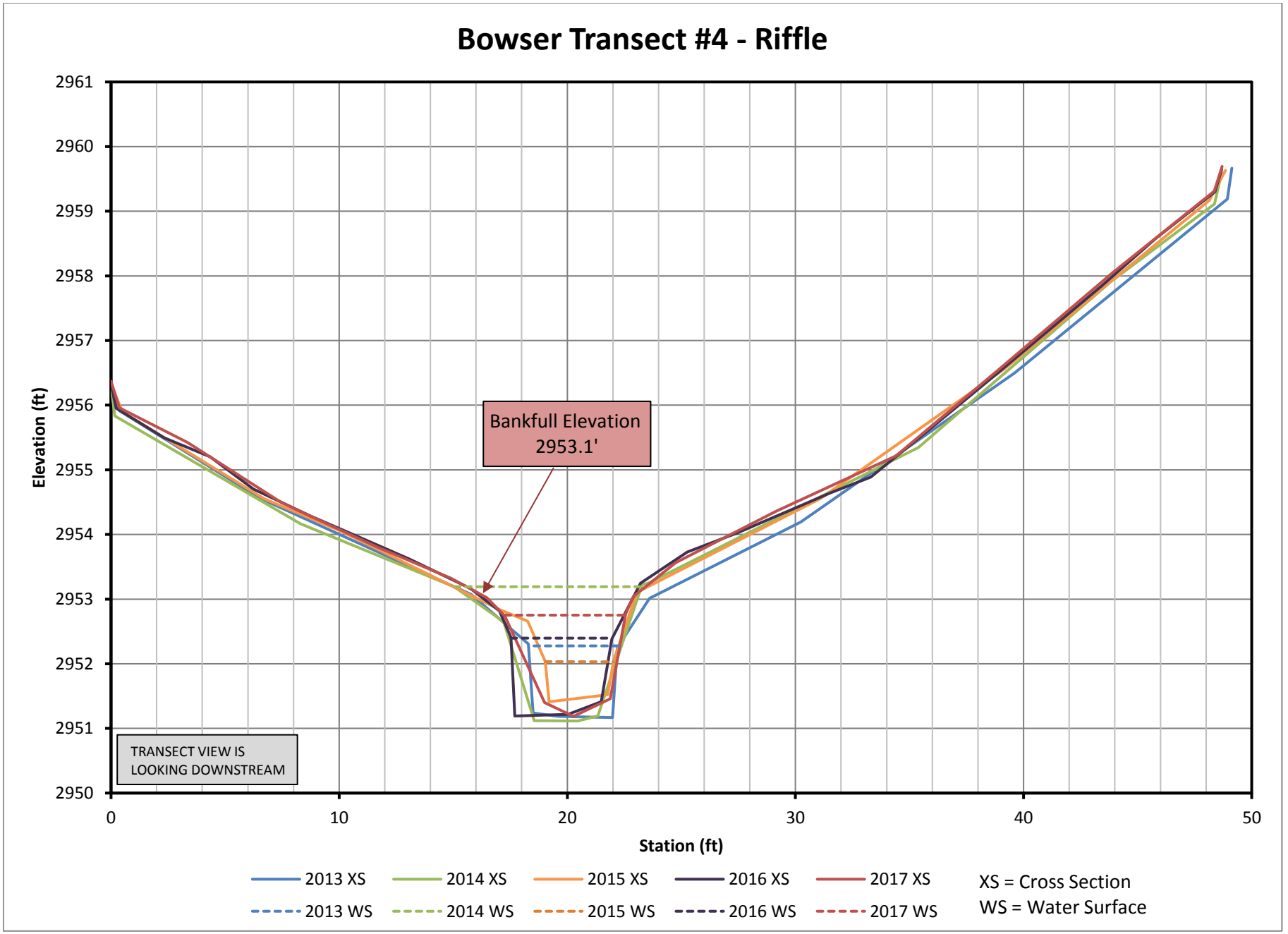
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana


Bowser Creek Longitudinal Profiles: 2014 - 2017
Riffle Transect #4 STA 0+85
Pool Transect #3 STA 2+70
Riffle Transect #2 STA 3+35
Pool Transect #1 STA 4+15
Elevation (ft)
2953
2952
2951
2950
2949
2948
0
50
100
150
200
250
300
350
400
450
500
Station (ft)
2014 Profile
2015 Profile
2016 Profile
2017 Profile


Bowser Transect #1 - Pool
Elevation (ft)
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
2948
Bankfull Elevation
2950.95
TRANSECT VIEW IS
LOOKING DOWNSTREAM
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2014 XS
2015 XS
2016 XS
2017 XS
2013 WS
2014 WS
2015 WS
2016 WS
2017 WS
XS = Cross Section
WS = Water Surface


Bowser Transect #2 - Riffle
Elevation (ft)
2961
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
0
10
20
30
40
50
60
70
Station (ft)
Bankfull Elevation
2952.37'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2016 XS
2017 XS
2013 WS
2014 WS
2015 WS
2016 WS
2017 WS
XS = Cross Section
WS = Water Surface


Bowser Transect #3 - Pool
Elevation (ft)
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
2948
2947
Bankfull Elevation
2952.33'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2014 XS
2015 XS
2016 XS
2017 XS
2013 WS
2014 WS
2015 WS
2016 WS
2017 WS
XS = Cross Section
WS = Water Surface


Bowser Transect #4 - Riffle
Elevation (ft)
2961
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
0
10
20
30
40
50
Station (ft)
Bankfull Elevation
2953.1'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2016 XS
2017 XS
2013 WS
2014 WS
2015 WS
2016 WS
2017 WS
XS = Cross Section
WS = Water Surface

Appendix C

Project Area Photos

MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2017 Monitoring Events

CONFLUENCE

2013 **2017**

Photo 1: View looking west (upstream) of Bowser Creek.

2013 **2017**

Photo 2.1: View looking northwest at Bowser Creek.

2013 **2017**

Photo 2.2: View across Bowser Creek looking north.

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2017 Monitoring Events

CONFLUENCE

2013 **2017**

Photo 2.3: View looking east (downstream) of Bowser Creek from photo point 3.

2013 **2017**

Photo 2.4: View looking east across Bowser Creek. from photo point 2.

2013 **2017**

Photo 3.1: View looking east (downstream) of Bowser Creek from photo point 3.

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2017 Monitoring Events

CONFLUENCE

2013 **2017**

Additional Photo 1: Prolific watercress growth shown in 2013 was less prevalent in 2017.

2013 **2017**

Additional Photo 2: Eroding bank EBL3.

2013 **2017**

Additional Photo 3: Eroding bank EBL4.

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2017 Monitoring Events

CONFLUENCE

2013

2017

Additional Photo 4: Widened channel segment.

2017

Additional Photo 5: Dense reed canarygrass along upper segment of Bowser Creek

Appendix D

Construction Plan Sheets

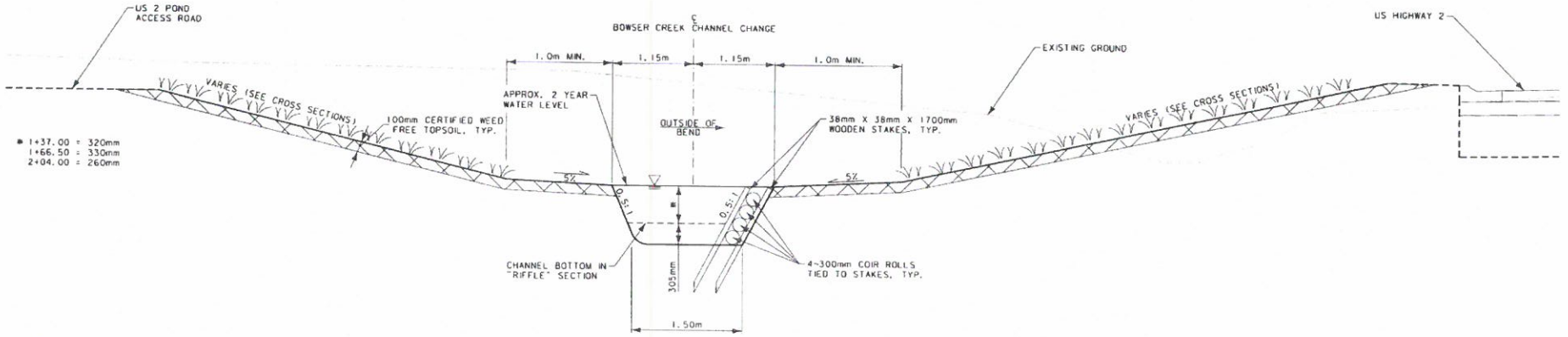
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	39

CSF - 0.999470385

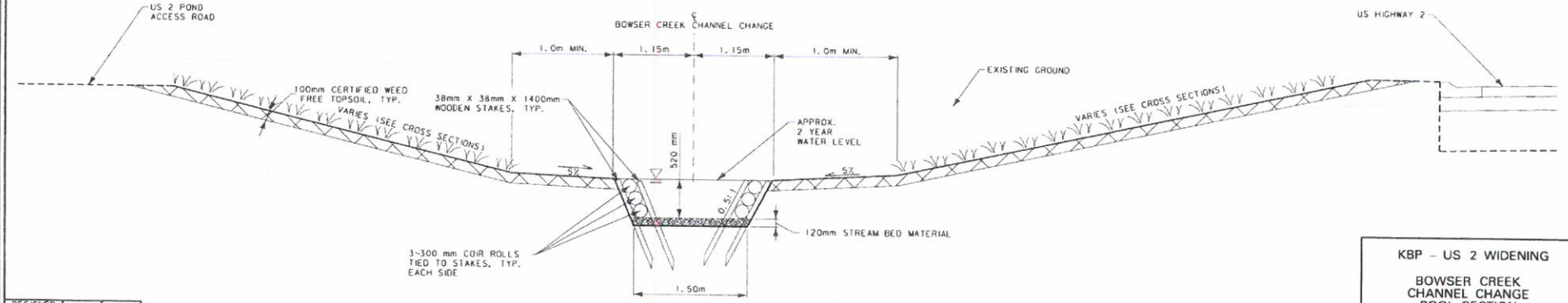
DETAIL

BOWSER CREEK CHANNEL CHANGE POOL SECTION



NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

BOWSER CREEK CHANNEL CHANGE RIFFLE SECTION



NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

KBP - US 2 WIDENING

BOWSER CREEK CHANNEL CHANGE POOL SECTION RIFFLE SECTION

NO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stelling Engineers, INC.

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	40

CSF- 0.999470385

DETAIL

BOWSER CREEK CHANNEL CHANGE

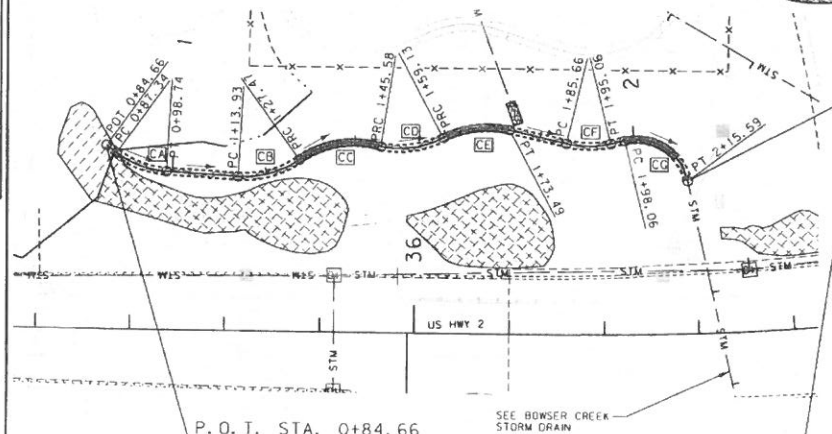
SPRING CREEK CHANNEL CHANGE CURVE DATA

CURVE	P.I.	Δ	RADIUS (m)	T	L	E	BACK TANGENT	AHEAD TANGENT
CA	0+93.20	32° 39' 20" LT	20.00	5.86	11.40	0.84	S 50° 45' 07" E	S 83° 24' 28" E
CB	1+20.97	38° 48' 07" LT	20.00	7.04	13.54	1.20	S 83° 24' 28" E	N 57° 47' 25" E
CC	1+37.20	51° 53' 00" RT	20.00	9.73	18.11	2.24	N 57° 47' 25" E	S 70° 19' 35" E
CD	1+52.63	38° 48' 35" LT	20.00	7.04	13.55	1.20	S 75° 55' 20" E	N 65° 16' 06" E
CE	1+66.63	41° 08' 10" RT	20.00	7.50	14.36	1.36	N 65° 16' 06" E	S 73° 35' 44" E
CF	1+90.45	26° 56' 29" LT	20.00	4.79	9.40	0.57	S 73° 35' 44" E	N 79° 27' 47" E
CG	2+09.31	91° 18' 24" RT	11.00	11.25	17.53	4.74	N 79° 27' 47" E	S 9° 13' 48" E

LEGEND

STREAM RIFFLE SECTION

STREAM POOL SECTION

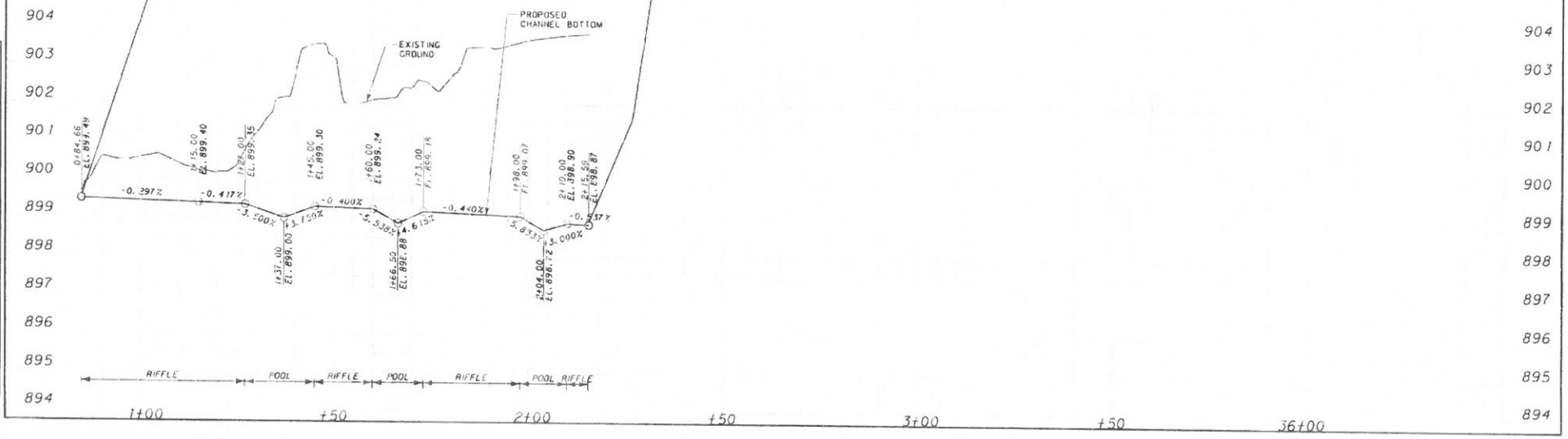


P.O.T. STA. 0+84.66
BEGIN BOWSER CREEK CHANNEL CHANGE =
STA. 35+34.77 US 2

P.O.T. STA. 2+15.59
END BOWSER CREEK CHANNEL CHANGE=
STA. 36+56.67 US 2

CENTERLINE COORDINATE TABLE

STATION	DESCRIPTION	N OR Y COORDINATE	E OR X COORDINATE	REMARKS
0+84.66	POT	449 740.9132	240 357.7066	BEGIN CHANNEL CHANGE
0+87.34	PC	449 739.2154	240 359.7848	
0+93.20	PI	449 735.5085	240 364.3220	
0+98.74	PT	449 734.8359	240 370.1422	
1+13.93	PC	449 733.0927	240 385.2258	
1+20.97	PI	449 732.2841	240 392.2228	
1+27.47	PRC	449 736.0384	240 398.1823	
1+37.20	PI	449 741.2244	240 406.4145	
1+45.58	PRC	449 737.9489	240 415.5760	
1+52.63	PI	449 736.2352	240 422.4094	
1+59.13	PRC	449 739.1827	240 428.8082	
1+66.63	PI	449 742.3225	240 435.6246	
1+73.49	PT	449 740.2030	240 442.8239	
1+85.66	PC	449 736.7665	240 454.4968	
1+90.45	PI	449 735.4135	240 459.0926	
1+95.06	PT	449 736.2896	240 463.8025	
1+98.06	PC	449 736.8382	240 466.7522	
2+09.31	PI	449 738.8962	240 477.8162	
2+15.59	PT	449 727.7881	240 479.6213	END CHANNEL CHANGE



MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

Stelling Engineers, INC.

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V1

CSF = 0.999470385

DETAIL

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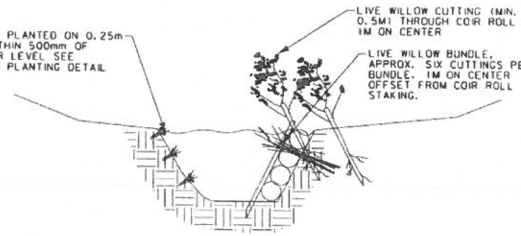

ZONE D COIR BUNDLES WITH WILLOW CUTTINGS AND LAYERING
SCALE: NOT TO SCALE

HARVESTING AND INSTALLATION NOTE:

1. HARVEST AND PLANT CUTTINGS DURING DORMANT SEASON.
2. USE HEALTHY STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE CUTTINGS OR SPLIT ENDS DURING INSTALLATTION.
4. BRIEFLY SOAK CUTTINGS IN WATER AND ROOTING HORMONE PRIOR TO INSTALLATION.
5. FOR LAYERING, BUNDLE 6 CUTTINGS TOGETHER AND BIND WITH BIODEGRADABLE JUTE STRING.
6. INSTALL WILLOW CUTTING AND WILLOW BUNDLE LAYERING DURING BANK GRADING AND COIR PLACEMENT.
7. WILLOW CUTTING AND WILLOW BUNDLES SHALL EXTEND INTO EXPECTED MOISTURE SOIL ZONES.
8. IF NECESSARY, CUT SMALL HOLES IN COIR ROLLS AND INSERT LIVE WILLOW CUTTING.
9. INSERT BUNDLES INTO SOIL BETWEEN COIR ROLLS.

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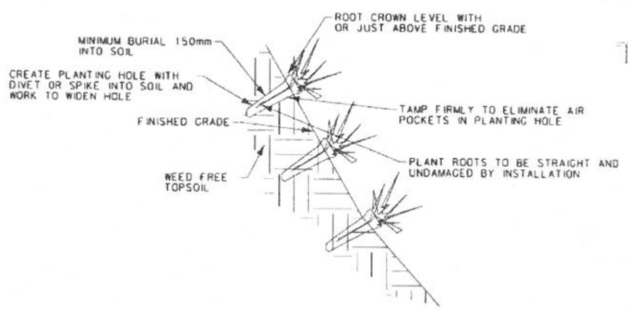
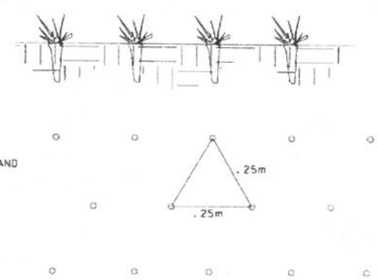
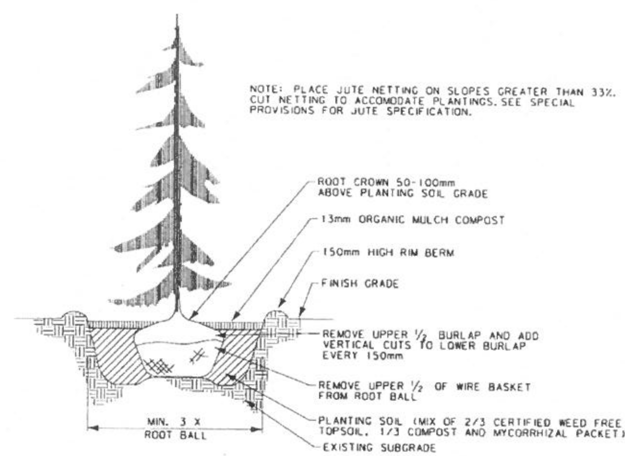


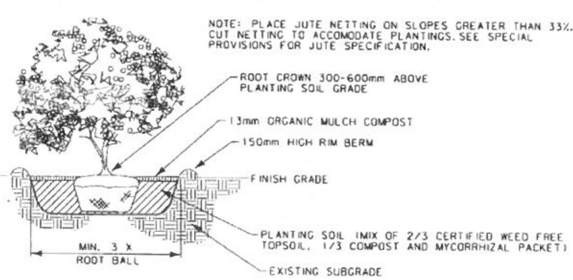
ZONE D RIPARIAN PLUG PLANTING
FOR INSIDE BEND OF SPRING CREEK POOLS
SCALE: NOT TO SCALE



SPACING



TREE PLANTING
SCALE: NOT TO SCALE



SHRUB PLANTING
SCALE: NOT TO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

KBP - US 2 WIDENING

TABLE OF CONTENTS & DETAILS

NO SCALE

MDT MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stelling Engineers, INC.

DESIGNED BY
REVIEWED BY
CHECKED BY

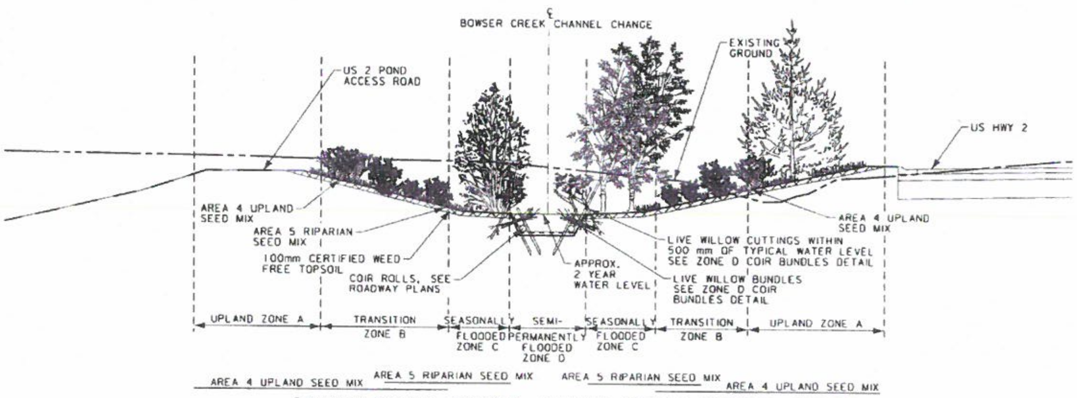
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V2

CSF = 0.999470385

NOTES: 1. SEE ROADWAY PLANS FOR CHANNEL CONSTRUCTION DETAILS.
2. TYPICAL SECTIONS ARE GENERAL CONCEPTUAL DESIGN. FOR INFORMATION ONLY

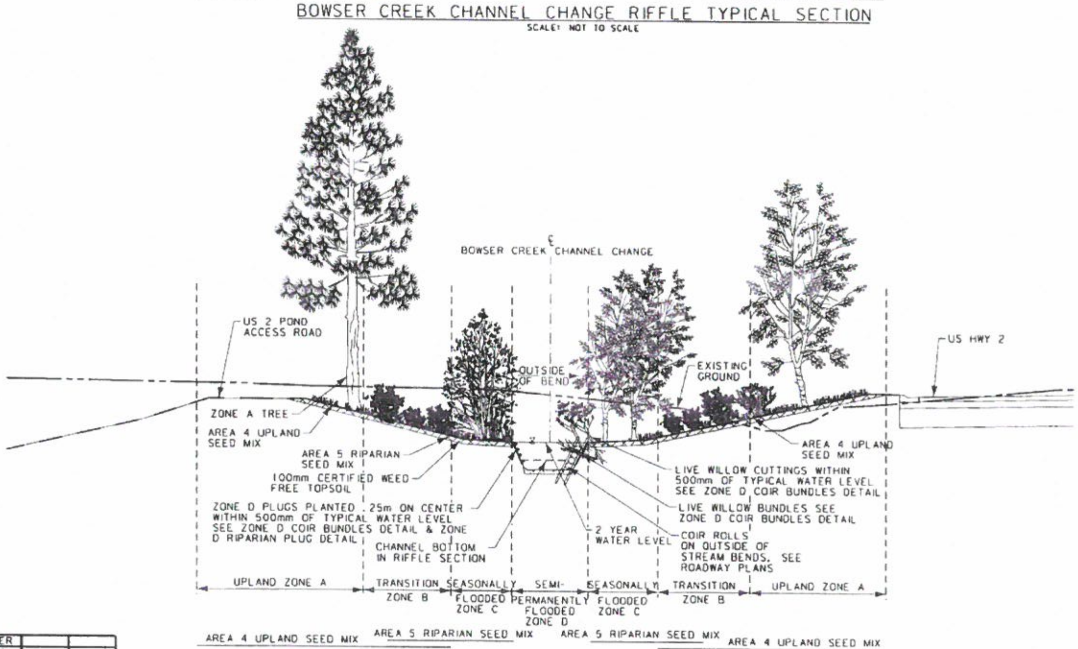
DETAIL

BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY



BOWSER CREEK CHANNEL CHANGE RIFFLE TYPICAL SECTION

SCALE: NOT TO SCALE



BOWSER CREEK CHANNEL CHANGE POOL TYPICAL SECTION

SCALE: NOT TO SCALE

CHANNEL PLANTING SEQUENCE

1. PLACE COIR ROLL AS PER COIR ROLLS DETAIL IN ROADWAY PLANS AND SPECIAL PROVISIONS.
2. INSTALL PLANTS BETWEEN THE DATES OF OCTOBER 1 AND MAY 15 PROVIDED THE GROUND IS NOT FROZEN.
3. PLANT RIPARIAN PLUGS AS PER PLANTING DETAIL.
4. PLANT WILLOW CUTTINGS AND BUNDLES AS PER PLANTING DETAIL.
5. INSTALL JUTE NETTING ON SLOPES GREATER THAN 3:1 AS PER SPECIAL PROVISIONS.
6. SEED UPLAND AREA 4 AND RIPARIAN AREA 5 AS PER SEEDING SPECIAL PROVISIONS.
7. PLANT TREES AND SHRUBS AS PER PLANTING DETAILS.
8. APPLY MYCORRHIZAL FUNGI AS PER SPECIAL PROVISIONS.
9. APPLY WEED FREE ORGANIC COMPOST MULCH AS PER SPECIAL PROVISIONS.

BOWSER CREEK CHANNEL CHANGE PLANT LIST *

TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
ZONE A UPLAND — TREES				
BP	BETULA PAPYRIFERA	PAPER BIRCH	6	10' B&B
PP	PINUS PONDEROSA	PONDEROSA PINE	1	7' B&B
ZONE B TRANSITIONAL — SHRUBS				
Aa	AMELANCHIER ALNIFOLIA	SASKATOON SERVICEBERRY	124	1 GAL.
Pv	PRUNUS VIRGINIANA	COMMON CHOKECHERRY	7	5 GAL.
Rw	ROSA WOODSII	WOODS ROSE	177	1 GAL.
Sc	SHEPHERDIA CANADENSIS	CANADA BUFFALOBERRY	27	1 GAL.
Sa	SYMPHORICARPOS ALBUS	SNOWBERRY	57	1 GAL.
ZONE C SEASONALLY FLOODED — TREES				
BO	BETULA OCCIDENTALIS	WATER BIRCH - MUTLISTEM	5	15 GAL.
SHRUBS				
At	ALNUS INCANA SSP. TENUIFOLIA	THIN-LEAF ALDER	21	5 GAL.
Cs	CORNUS STOLONIFERA/SERICEA	RED-OSIER DOGWOOD	40	1 GAL.
Sb	SALIX BEBBIANA	BEBB WILLOW	18	5 GAL.
Sd	SALIX DRUMMONDIANA	DRUMMOND WILLOW	22	5 GAL.
ZONE D SEMI-PERMANENTLY FLOODED — COIR ROLL STAKING (SPACE @ 1m ON CENTER)				
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	222	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	222	CUTTINGS
COIR ROLL LAYERING (SPACE 6 CUTTINGS PER BUNDLE @ 1m ON CENTER)				
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	666	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	666	CUTTINGS
STREAMBANK PLUGS				
	CAREX NEBRASCENSIS	NEBRASKA SEDGE	120	PLUGS
	CAREX UTRICULATA	BEAKED SEDGE	167	PLUGS
	CAREX VESICARIA	INFLATED SEDGE	120	PLUGS
	GLYCERIA ELATA (STRIATA)	FOWL MANNAGRASS	73	PLUGS

* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".

JUTE NETTING *

STATION FROM	STATION TO	square meters
35+34.77	36+58.67	200
TOTAL		200

* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".

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BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY

NO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

MONTANA CADD

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SE Stelling Engineers, Inc.

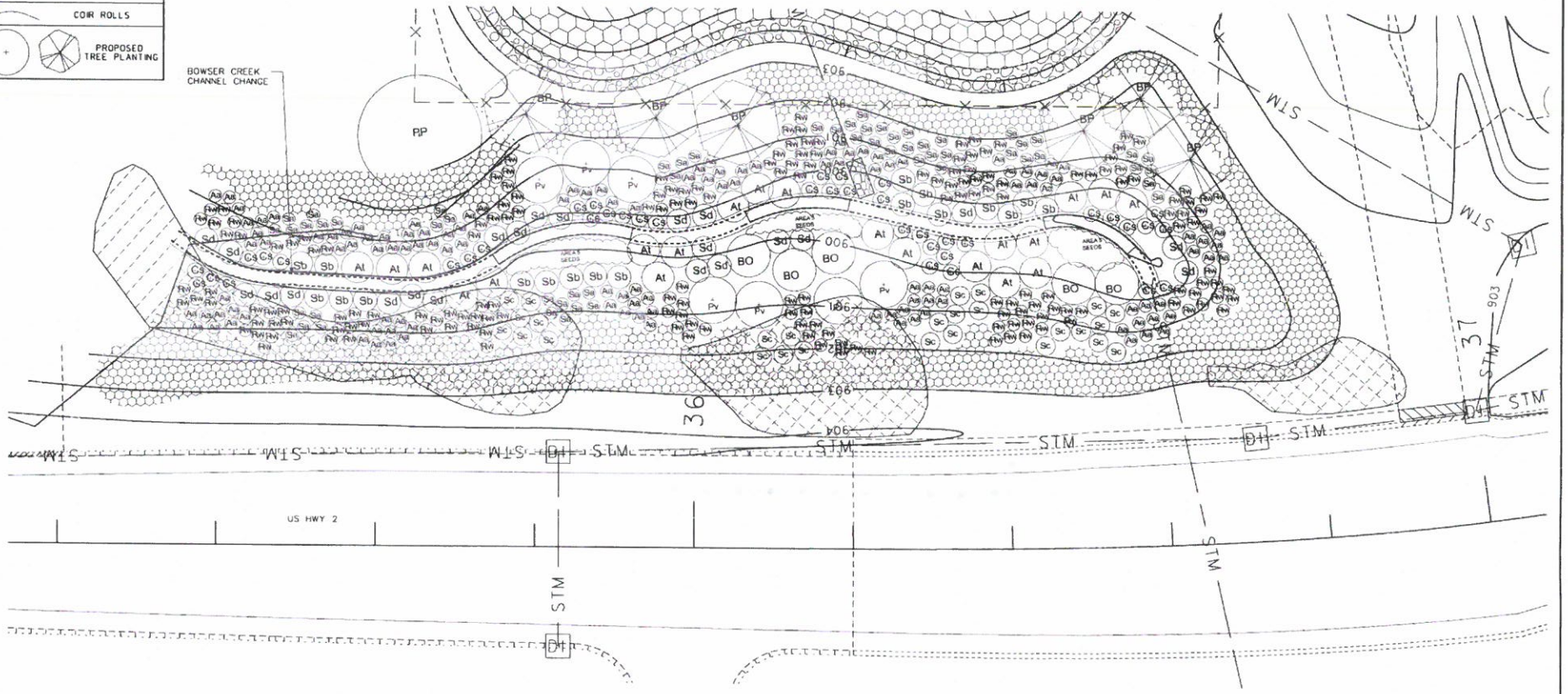
DETAIL

BOWSER CREEK
VEGETATION PLAN

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V3

CSF = 0.999470385

LEGEND
AREA 4 UPLAND SEED MIX
AREA 5 RIPARIAN SEED MIX
PROPOSED SHRUB PLANTING
COIR ROLLS
PROPOSED TREE PLANTING



NOTE: THIS PLAN IS A GRAPHIC REPRESENTATION. REFER TO SECTIONS AND PLANT LISTS FOR MORE DETAILED ZONAL PLACEMENT.

KBP – US 2 WIDENING

BOWSER CREEK
VEGETATION PLAN

SCALE = 1:250

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MONTANA DEPARTMENT OF TRANSPORTATION
MDT
MONTANA CADD
SE Stelling Engineers, INC.