MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Bowser Creek
Flathead County, Montana

Project Completed: 2010
Monitoring Report #4: December, 2016

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE consulting incorporated

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #4

YEAR 2016

Bowser Creek
Flathead County, Montana

MDT Project Number: NH 15(93)
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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 six 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 fourth year monitoring at the Bowser Creek stream mitigation site are presented in Section 4 and compared to performance standards in Section 5. Section 6 provides management recommendations to maximize the potential for meeting all performance standards at this and other similar mitigation sites. 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 4, 2016 while survey crews visited the site on August 11, 2016. The following data were collected at the Bowser Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

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 estimates. 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 4, Appendix A).

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%

Vegetation community boundaries were determined 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.

The project site was visually inspected to document the presence of noxious weeds. All noxious weed infestations were mapped on aerial photographs, with species and extents noted. Observations of isolated noxious weed occurrences were included in the species lists and total areal percent cover estimate of noxious weeds within the project area, but were not mapped.

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.

3.2. Bank Erosion Inventory

Stream bank stability performance was monitored by conducting an erosion inventory along the length of both stream banks within the project reach. Each eroding bank within the project reach was photo-documented. Data collected at each eroding bank included bank length and potential causes of bank erosion.

3.3. Perpendicular Transect and Longitudinal Profile Surveys

Four perpendicular transects (cross sections) were established in 2013 to document vertical and lateral stability within the project reach. Each of the four transects 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 in 2014, 2015, and 2016 to document aggradation, degradation, and habitat complexity along the project reach. All transects 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.

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.

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.

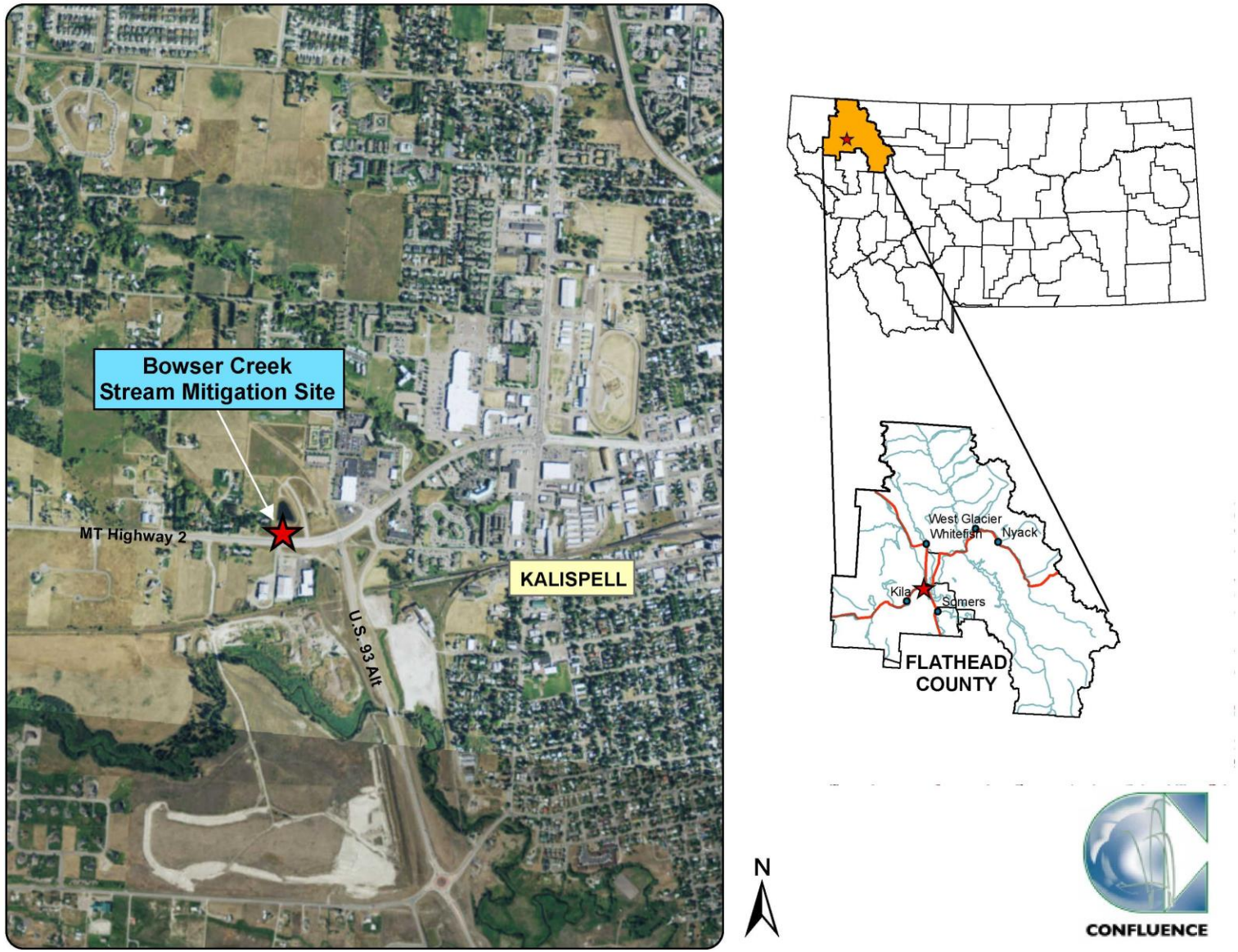

Figure 1. Project location of Bowser Creek stream mitigation site.

4.0 RESULTS

4.1. Riparian and Stream Bank Vegetation Inventory

Table 2 summarizes the areal percent cover of total vegetation, woody vegetation, and noxious weeds observed along each riparian and stream bank transect. In 2016 the total percent riparian cover remained at 100%, with 10% cover by woody species and 14% by noxious weeds. Stream bank transects also 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 100% total vegetation cover, with 9% by woody species and 13% by noxious weeds.

Table 2. Percent cover of vegetation transects at Bowser Creek in 2013 through 2016.

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

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 4, Appendix A). Four vegetation community types were observed in 2016, and are included in Table 3.

Table 3. Vegetation community types observed at Bowser Creek in 2016.

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. Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), and fringed willowherb (*Epilobium ciliatum*) were also commonly observed at 6 to 10 percent cover.

Vegetation community Type 3 – *Nasturtium officinale* was identified within the channel. Watercress (*Nasturtium officinale*) dominated this community type with more than 50% cover growing in the channel bed. This community has been consistently observed in dense stands along the stream bed during the growing season.

Vegetation community Type 4 – *Cirsium* spp./*Bromus inermis* was observed in 2016 in between community Types 2 and 5. Canada thistle, bull thistle, and smooth brome (*Bromus inermis*) dominated this community type.

Vegetation community Type 1 – *Elymus* spp. was identified in 2013 along the upper side slopes of the project area and was changed in 2016 to community Type 5 – *Elymus* spp./*Festuca ovina* to represent the increased cover of sheep fescue (*Festuca ovina*) in addition to nodding wild rye (*Elymus canadensis*) and slender wild rye (*Elymus trachycaulus*).

Table 4 provides a comprehensive list of plant species observed on site during the 2013 through 2016 monitoring events. In 2016, 97 plant species were observed, representing an increase of 3 species since 2015, 14 species since 2014, and 42 species since the initial monitoring event in 2013. One of the three new species observed in 2016 was native and considered beneficial to the restoration efforts within the project area, while the other two species were non-native. In 2016, 48% of the species observed were hydrophytic based on the 2016 National Wetland Plant List (NWPL) (Lichvar *et al*., 2016).

4.1. Stream Bank Vegetation Composition

The stream bank vegetation inventory identified 35 plant species along the banks of Bowser Creek (Table 5). Reed canary grass comprised greater than 50% cover along both stream banks in 2016. 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.

Table 4. Comprehensive vegetation species list for the Bowser Creek stream mitigation site from 2013 through 2016.

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
Chamerion angustifolium	Fireweed	NL
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 cinereus	Great Basin Wildrye	NL
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
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
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
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

*Based on 2016 NWPL (Lichvar *et al*., 2016)
New species identified in 2016 are **bolded**.

Table 5. Plant species and their associated cover classes along the stream banks of the Bowser Creek stream mitigation site in 2016.

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	1	X	0	OBL
Carex utriculata	X	2	X	2	OBL
Cirsium arvense	X	2	X	2	FAC
Cirsium vulgare	X	0			FACU
Cornus alba	X	0			FACW
Elymus repens	X	1	X	1	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	1	X	1	UPL
Lactuca serriola			X	0	FACU
Melilotus officinalis	X	0	X	0	FACU
Mentha arvensis	X	0	X	0	FACW
*Nasturtium officinale***	X	1	X	1	OBL
*Phalaris arundinacea***	X	5	X	5	FACW
Poa palustris	X	0	X	0	FAC
Poa pratensis	X	1	X	1	FAC
Rumex crispus	X	0	X	0	FAC
Salix bebbiana	X	0			FACW
Salix drummondiana			X	0	FACW
Salix exigua			X	0	FACW
Sonchus arvensis	X	0	X	0	FACU
Taraxacum officinale	X	0	X	0	FACU
Trifolium pratense	X	1	X	1	FACU
Trifolium repens	X	1	X	1	FAC
Typha latifolia	X	1	X	1	OBL
Urtica dioica			X	0	FAC
Veronica americana	X	1	X	1	OBL
Vicia americana	X	0			FAC

*Based on 2016 NWPL (Lichvar *et al*., 2016)
*** Dominant species observed along Bowser Creek stream banks*
**** Dominant species observed along Bowser Creek stream bed*

4.2. Noxious Weed Inventory

A total of 27 infestations of six Montana Listed Priority 2B noxious weeds were mapped within the Bowser Creek stream mitigation site and are listed in Table 6. Locations of noxious weed infestations are provided on Figure 4 in Appendix A with the exception of those observed in trace amounts, which were not mapped. Each mapped noxious weed occurrence was identified in areas less than 0.1 acre in size with a low cover

class (1 to 5 percent). Noxious weeds have continued to increase at the site. An estimated 13% of the project area has been colonized by noxious weeds, representing an increase by 3% since 2015, 6% since 2014, and 10% since the initial 2013 monitoring event. Infestations of Canada thistle, the most prevalent noxious weed, were located throughout the project area. In 2016, Canada thistle was so commonly observed that it was identified as a dominant species in community Type 4 (Figure 4, Appendix A).

Table 6. Montana State-listed noxious weed species observed in 2016 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, 2015
New species identified in 2016 are **bolded.**

4.3. 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 2016, 181 planted trees and shrubs were located, with 143 of those observed alive (Table 7). It is unknown how many plants were installed during construction of the project; however, the planting plan called for planting 505 trees and shrubs. As compared to the planting plan, 28% (143 of 505) have survived six years following construction.

Table 7. Woody plant survival at Bowser Creek stream mitigation site from 2013 through 2016.

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%

4.4. Bank Erosion Inventory

Previous monitoring reports provided an account of eroding banks observed during the growing season. Monitoring of the Bowser Creek site in 2013, 2014, and 2015 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 vegetation.

In 2016, the monitoring team also visited the site on April 11 to observe the stream banks prior to the onset of the growing season. Observations of the reconstructed segment of Bowser Creek during this field visit indicated:

- Bank erosion reported in previous monitoring reports along the left (north) side of the channel does not appear caused by scour during high flows.
- 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 (See Additional Photos 4, 5, 6, 7, and 8, Appendix C).
- 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 (EBL2, EBL3, and EBL4 as shown on Figure 3 in Appendix A).

Eroding banks EBR1 and EBR2 are not actively eroding; rather, these banks exhibit fine grained materials that are now exposed following decomposition of the coir rolls used to construct the banks five years ago. As a result of these observations, banks EBR1 and EBR2 are no longer classified as eroding and their bank lengths have been removed from the eroding bank tally (See Additional Photos 2 and 3 in Appendix C).

Eroding stream bank EBL1 is located immediately upstream of a culvert entering Bowser Creek from the north. Erosion at EBL1 was noted during the first monitoring event; however, the bank does not appear to have retreated any further in the past four years (see Additional Photo 7 in Appendix C). Vegetation has established along the length of the bank and bare ground is no longer exposed. Previous monitoring reports assigned a low erosion severity rating along the bank based on the lack of active erosion occurring. As a result of the factors described above, EBL1 has been removed from the list of eroding banks along Bowser Creek and no longer is included on Figure 3 in Appendix A.

Eroding bank EBL2 is located just downstream of the culvert noted above. 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 (see Additional Photo 8 in Appendix C). 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 between the time it was

constructed in 2010 and the first monitoring event in 2013. No further erosion was noted during the 2015 or 2016 monitoring events. As a result of the lack of recent erosion noted, erosion severity is considered low at EBL2.

Eroding bank EBL3 was identified in 2015 as a newly eroding bank segment. Erosion along this bank is evident from the wood stakes that were used to construct the outside edge of the bank, which are now 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 significant seep observed near the downstream end of EBL3 is causing bank calving and sediment inputs to the channel (see Additional Photo 5 in Appendix C). As a result of these factors, bank erosion along EBL3 is considered moderate.

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 has 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*. Erosion severity at this location is considered moderate due to the vegetation community type and fine grained soils present.

4.5. 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 8 (plots for each transect included in Appendix B). These results indicate very little change in channel width and depth over the past year, with maximum bankfull depths ranging from 1.7 to 3.5 feet and bankfull widths ranging from 6 to 13.8 feet. The range of channel widths and depths observed by these transects indicates the establishment of variable habitat elements throughout the reach, but also indicates the channel has become wider in some areas since its assumed constructed width of 5.5 – 6.5 feet.

Table 8. Pool and riffle widths surveyed at Bowser Creek stream mitigation site from 2013 through 2016.

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

*Max depth and bankfull width values from 2013 and 2014 have been adjusted from previous monitoring reports based on refinement of bankfull elevations at each transect

Surveyed pool depths were 1.7 feet (transect #1) and 3.5 feet (transect #3). Pool design depth was 2.7 feet, indicating the pool at transect #1 is relatively shallow, while the pool at transect #3 is relatively deep. Depths at riffles were 2 feet (transect #2) and 1.9 feet (transect #4).

Bankfull widths at transects #2 (11.8 feet) and #3 (13.8 feet) indicate the channel has become wider through some segments than the design width of 5.5-6.5 feet. Evidence of this was also observed where the banks have retreated from the wooden stakes that were used to pin a stack of coir logs along the edge of the channel. These coir logs do not appear to have resulted in a stable bank configuration following their biodegradation. As noted in the bank erosion inventory (EBL2), some segments of the bank along the left (north) side of the channel appear to have slumped due to seepage from the adjacent retention pond. Vegetation establishment along these channel segments has not developed to withstand the slumping banks where the seeps enter Bowser Creek. Willow cuttings installed along the outside bends of the new channel have not successfully established, as their presence was found only in trace amounts along the stream bank vegetation inventory. Assuming the channel was constructed as designed, it appears the channel widened prior to the first monitoring event, as the survey results indicate some channel narrowing over the past two years. This is due to vegetation establishment along the right (south) bank (see additional photo 8 on page C-4 of Appendix C which reveals the vegetation encroachment along the right bank).

4.6. Longitudinal Profile Survey

Longitudinal profile surveys of the channel thalweg in 2014, 2015, and 2016 indicate the presence of three distinct pool features that are 1.0 to 1.75 feet deeper than riffle segments within the project reach (plotted profile included in Appendix B). The 2016 profile indicates the stream bed elevation has remained relatively consistent over the past year, with the exception of a higher riffle crest near station 2+00. The survey profiles indicate two of the three pool features within the project reach have become shorter and slightly shallower over the past three years, which may be due to sediment deposition in these deeper features.

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, residential development and extension of the Highway 93 North bypass project are occurring immediately west and north of the project site. Each of these types of development may be contributing sediment loads to Bowser Creek and may be contributing to the sediment observed in the channel. 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. Continued

monitoring will reveal whether the channel flushes fine sediment deposits during future high flow events, or if continued sedimentation within the channel continues to occur.

4.7. Wildlife Documentation

Wildlife observations at the Bowser Creek Stream Mitigation site from 2013 through 2016 have thus far been relatively limited. In 2016, white-tailed deer and raccoon tracks were the only signs of wildlife observed. Limited use of this area by wildlife may be due to the proximity of MT Highway 2, construction activities associated with the adjacent US 93 overpass, lack of habitat, and the time of day survey crews are present at the site (typically late afternoon).

Table 9. Wildlife observations at Bowser Creek stream mitigation site from 2013 through 2016.

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*
Sparrow sp.	*Passer* sp.

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 fourth year of monitoring suggests four of the six quantitative performance standards are being met five years following completion of the project (Table 10). 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 an aggressive 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.

Table 10. 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 **86%** 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 **14%** 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 **100%**	**YES**
		2b. Planted trees and shrubs must exhibit 50% survival after 5 years	Planted tree and shrub survival documented at **28%.**	**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 **13%** 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**

5.1. Riparian Buffer Success

The results in Table 2 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, the woody plantings remain relatively small and therefore offer a limited percent of the overall cover.

Vegetation monitoring of the riparian buffer indicated 86% 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 (14%) observed in the riparian transects from the total vegetation cover observed in the riparian transects (100%). 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 13% of the vegetation cover site-wide, which is above the maximum allowable limit to meet the performance criterion.

Total combined areal vegetation cover of the riparian zone and both right and left stream banks along Bowser Creek is currently 100%. 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 28% six 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. Woody plants remain relatively small but should provide increased areal percent cover to the site as they mature.

5.2. Vegetation along Stream Banks

Reed canary grass comprised greater than 50% cover along both stream banks in 2016. 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 2015 monitoring report described bank erosion at six locations, totaling 209 feet, or 24% of the total project bank length of 878 feet. The erosion inventory in 2016 was performed during the April monitoring event to enable better observation of actively eroding banks. The results of the 2016 monitoring event resulted in removal of three eroding bank segments previously reported due to vegetation establishment, reduced erosion, and recovery of stability along these three banks. Based on the updated stream bank observations, a total of 110 feet of eroding banks occur within the reconstructed segment of Bowser Creek. This represents 13% of the overall bank length of 878 feet. 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 varies from 1.7 to 3.5 feet. These results provide evidence the channel is providing variable riffle and pool habitat features.

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. While the design of this channel segment suggests floodplain connectivity, no evidence of out-of-bank flows (sediment deposits, debris lines, flow paths) has been noted during the past four monitoring events.

Riparian habitat along stream banks

The banks of Bowser Creek have become well vegetated with a diversity of 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 woody shrubs were observed along the stream banks, their contribution to overall cover 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 provide additional evidence of riparian vegetation composition along Bowser Creek's banks and riparian corridor.

Based on the evidence provided above, the reconstructed segment of Bowser Creek has met the qualitative channel form success criteria as outlined in the monitoring plan.

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

The following are recommendations that may be considered by MDT for use in designing and implementing future stream and riparian mitigation projects. With the exception of noxious weed management, these recommendations should not be considered required actions to ensure successful mitigation at the Bowser Creek project site.

6.1. Weed Management

Noxious weeds were observed on approximately 13% of the Bowser Creek project area, with occurrences in both the riparian and stream bank areas (Figure 4, Appendix A). Weed control efforts do not appear to have effectively reduced infestations of noxious weeds. The percent noxious weed cover is currently above the maximum allowable limit to meet the performance standards, therefore increased weed control is recommended to successfully meet this criterion. The documentation of noxious weed occurrences provided in this monitoring report allow for MDT to develop management plans for controlling noxious weeds along the reconstructed segment of Bowser Creek.

6.2. Use of Reference Data to Document Successful Pool Formation

The reconstructed segment of Bowser Creek has been designed with a low sinuosity and very broadly sweeping meanders. The ability of this channel segment to maintain long term pool habitat may be limited by the relatively straight planform geometry and prescribed radius of curvature. However, assessment of the ability of Bowser Creek to successfully generate pool habitat should take into account the creek's natural ability to do so. In order to determine whether Bowser Creek is successfully providing adequate pool habitats, survey results from the reconstructed pool segments should be compared against appropriate reference reach pool data. If the reference reach data suggests a relatively straight planform alignment is appropriate, development of deep pools will be naturally limited. Collection of reference reach data, whenever available, is suggested for use in developing more specific success criteria pertaining to pool development on future stream mitigation projects.

Reference reach data may not always be available, as was the case for this reconstructed segment of Bowser Creek. Much of the Bowser Creek corridor has been developed and modified by highway and residential development. As a result, the Bowser Creek design incorporates channel dimensions sized to convey the observed discharges in Bower Creek and similarly sized watersheds.

6.3. Floodplain and Riparian Development

Designed side slope dimensions along Bowser Creek provide room for a very narrow, 14-foot wide riparian and floodplain zone. Perpendicular transect survey results (Appendix B) illustrate a narrow bankfull bench adjacent to the creek has been constructed for flood inundation and wetland/riparian vegetation establishment. Integrating a slightly steeper upland side slope design would provide for a wider, more functional floodplain and riparian zone by allowing the stream to access a larger flat zone adjacent to the active channel (Figure 2). Constructing steeper side slopes and a wider floodplain area requires additional excavation; therefore, a cost/benefit analysis of creating additional floodplain and wetland features, and the associated mitigation credits, is potentially worth consideration for future stream and riparian mitigation designs. Design of steeper side slopes along floodplains adjacent to highways must also take into account traffic and safety considerations, and allow for vehicles to exit the roadway safely.

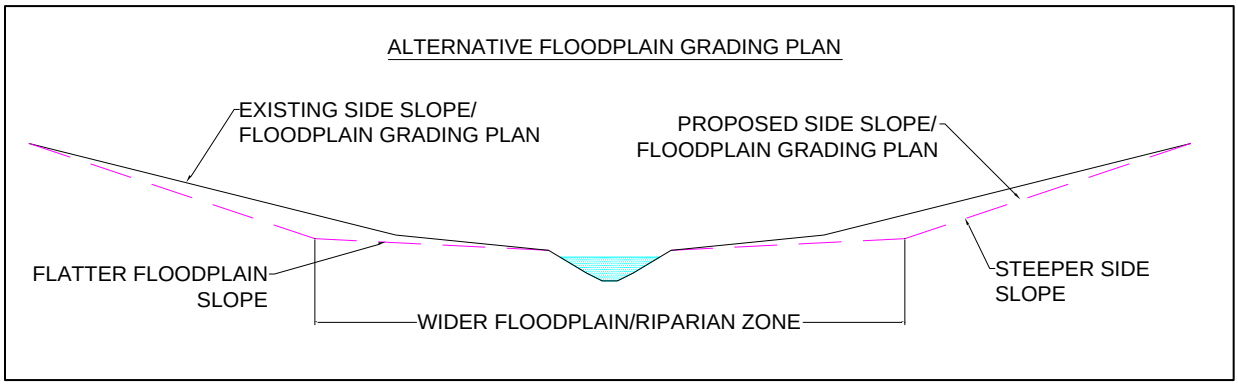

Figure 2. Alternative grading plan to increase floodplain and riparian areas.

6.4. Riparian Vegetation Zone

Design plans indicate riparian planting zones were prescribed only on the south side of Bowser Creek. Increasing the steepness of side slopes, as illustrated in Figure 2, would result in a wider riparian corridor, allowing for increased riparian vegetation establishment and the ecological benefits of such features along both sides of the channel. Consideration of this alternative grading plan is suggested for future stream mitigation projects.

6.5. Vegetation Success

Monitoring of vegetation along the immediate stream banks (within 3 feet of the active channel) indicates very limited survival of woody cuttings installed along the outside of meander bends. According to the design details, cuttings were placed above and below the upper coir log fastened to the bank with wooden stakes. The 2016 monitoring event noted only trace amounts of willows growing along the banks, indicating most of the cuttings did not survive or were washed away where the channel widened. It is unclear whether these willow sprigs were not installed (no dead willow stakes were found) or if they have all perished following installation. Willows that did survive may begin to generate additional coverage as they mature and begin to sucker. The NRCS has prepared several guidance documents outlining specific harvesting, storing, and installation techniques that maximize survival rates of woody cuttings installed along stream banks (NRCS 2007).

7.0 LITERATURE CITED

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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

Legend

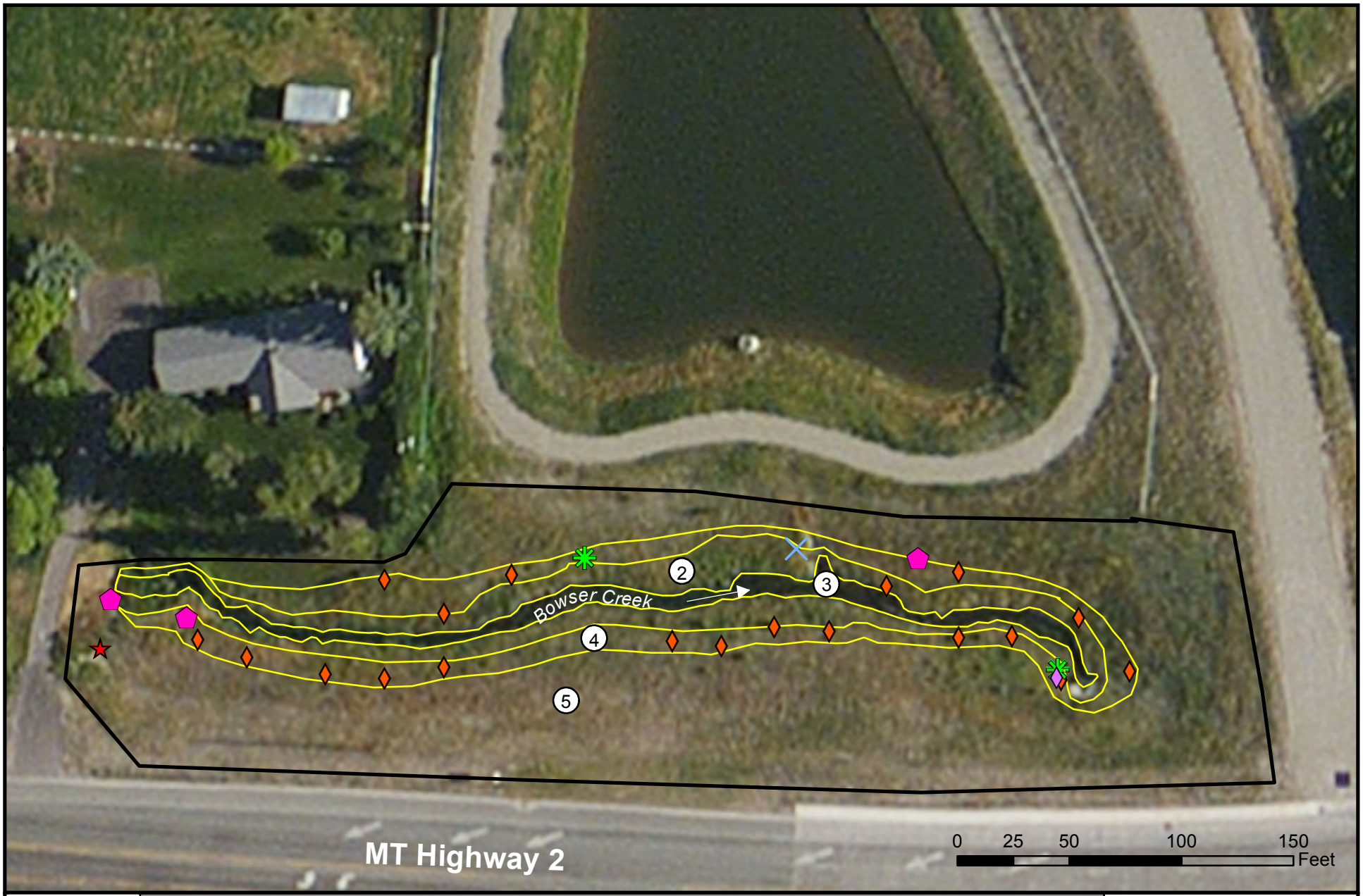
- Photo Points
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Eroding Banks
- Pool and Riffle Transects
- Riparian Transects

Bowser Creek - 2016 Monitoring Features

Figure 3

Date: 10/11/2016

Bowser_features2016.mxd



CONFLUENCE
consulting incorporated

Legend

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

N

Bowser Creek - 2016 Noxious Weeds and Vegetation Community

Figure 4

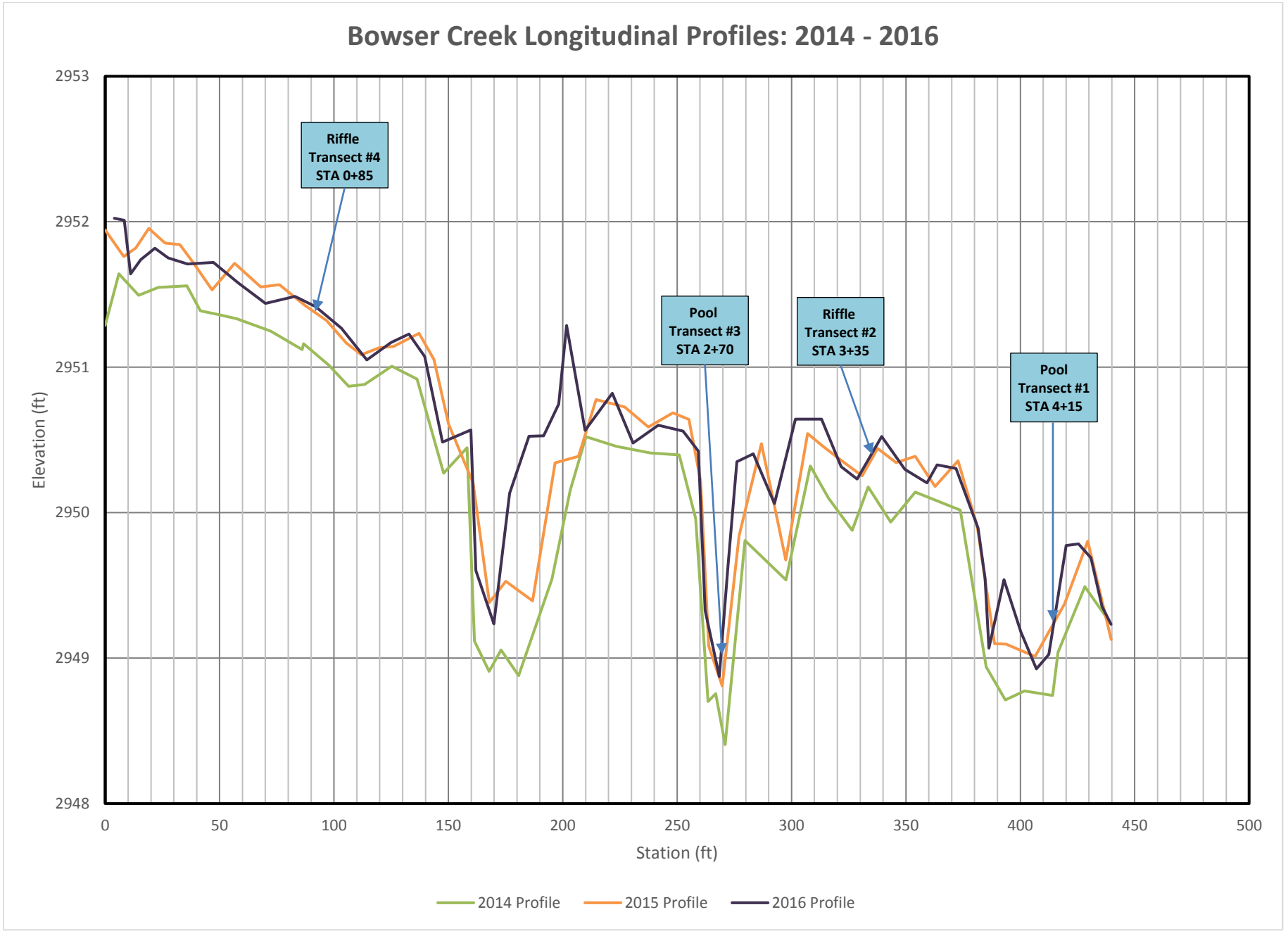
Date: 10/11/2016

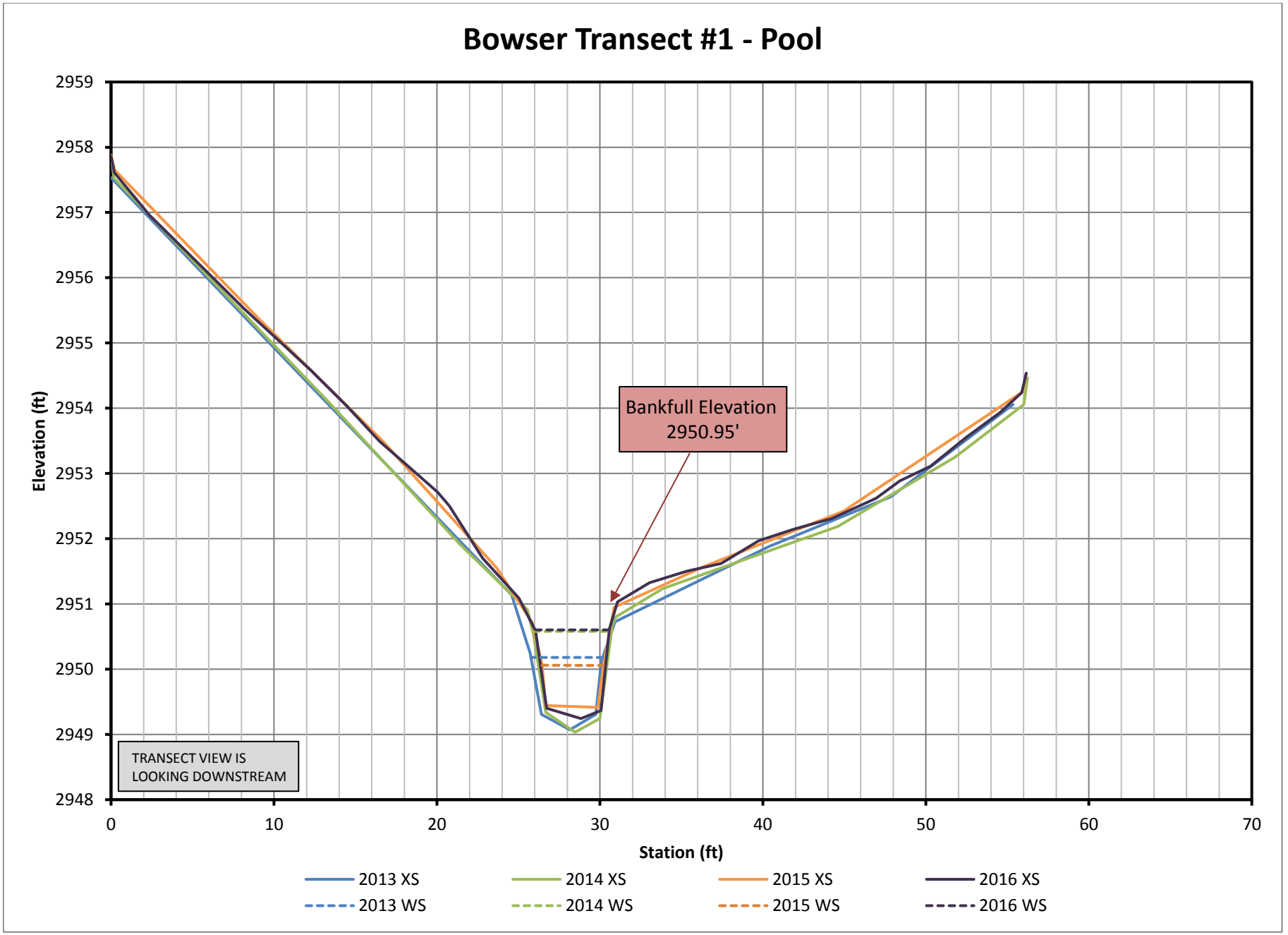
Bowser_monitor2016.mxd

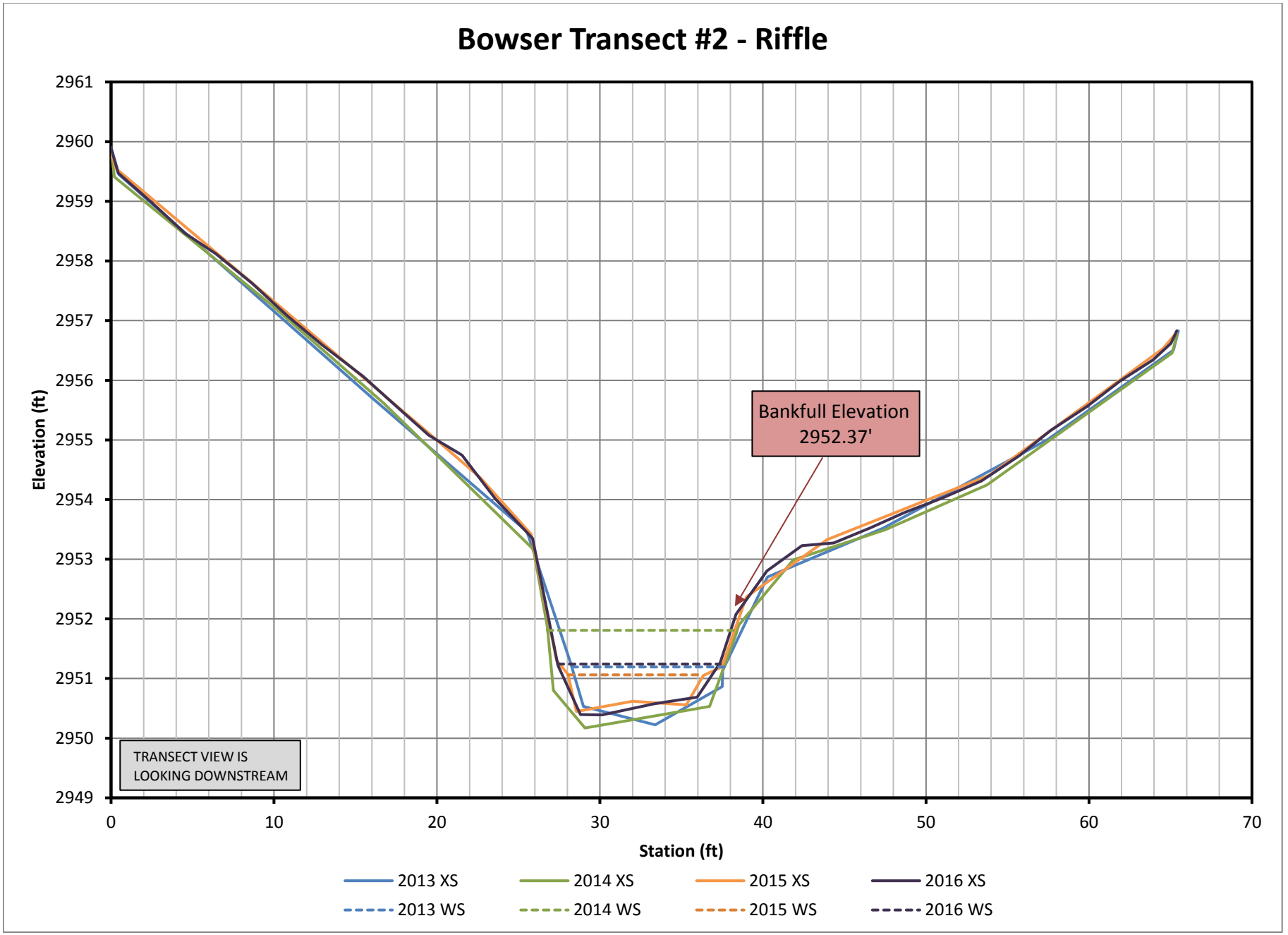
Appendix B

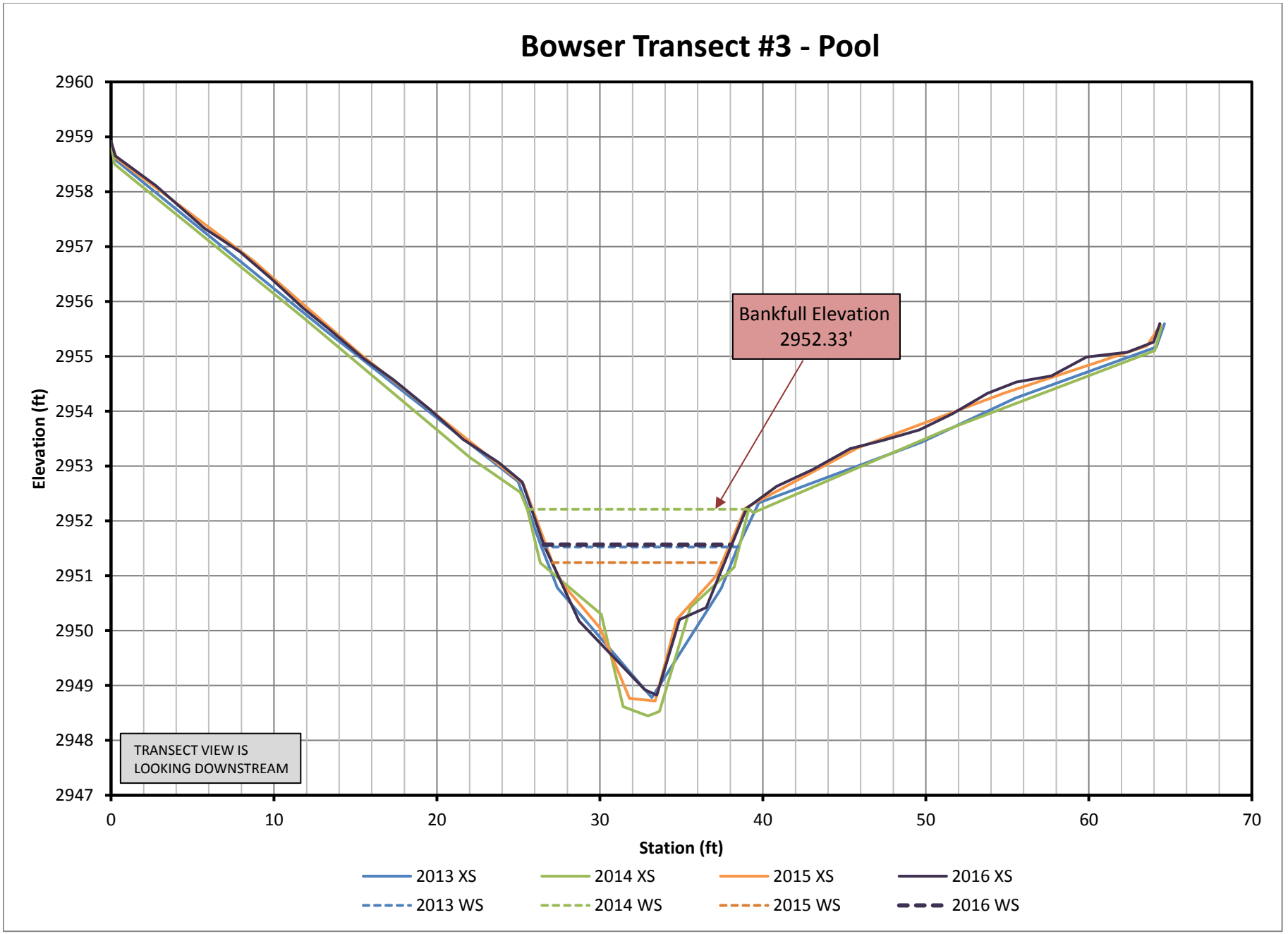
Perpendicular Transect and Longitudinal Profile Plots

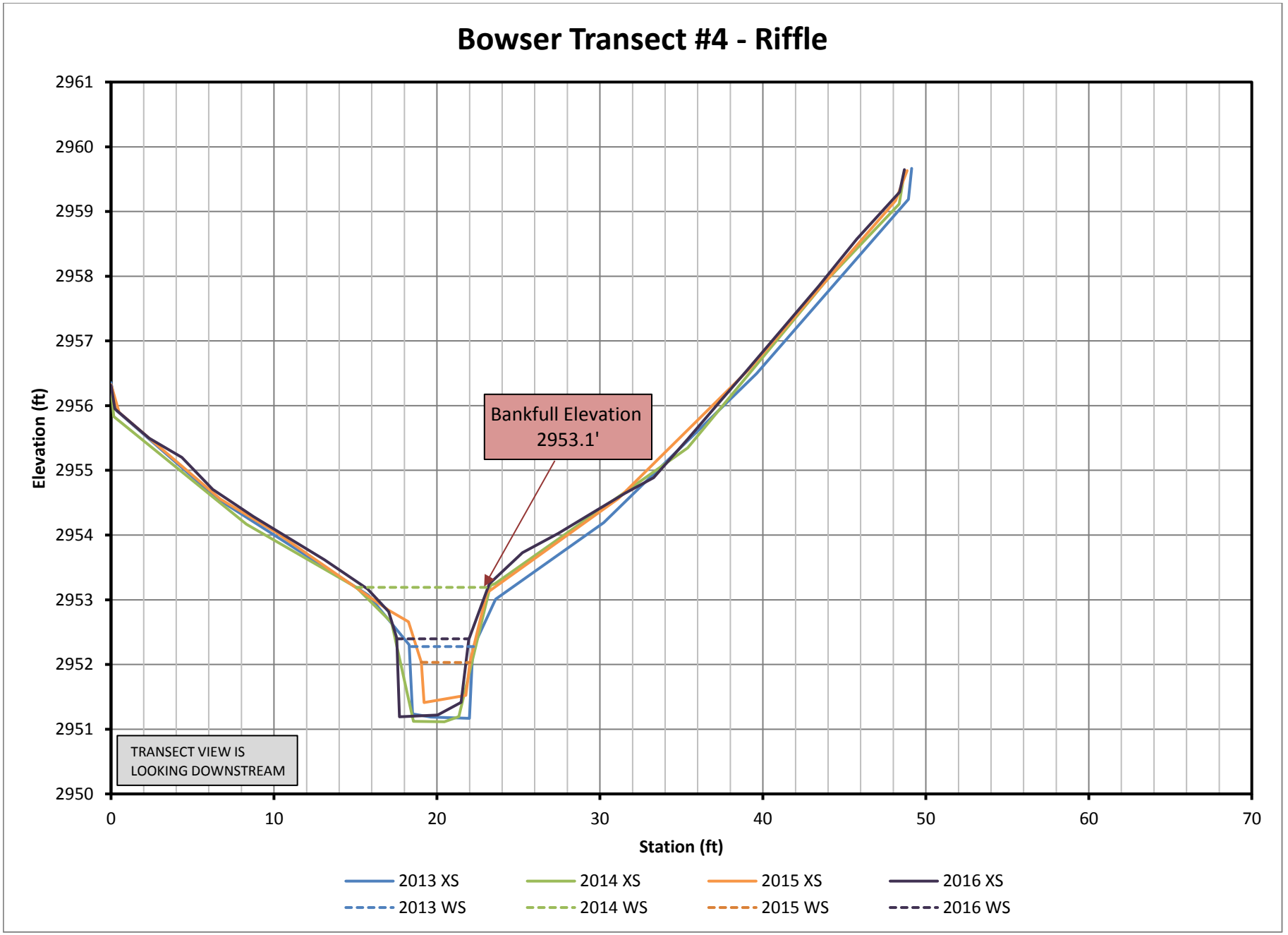
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana


Bowser Creek Longitudinal Profiles: 2014 - 2016
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


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


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
2013 WS
2014 WS
2015 WS
2016 WS


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


Bowser Transect #4 - Riffle
Elevation (ft)
2961
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
0
10
20
30
40
50
60
70
Station (ft)
Bankfull Elevation
2953.1'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2016 XS
2013 WS
2014 WS
2015 WS
2016 WS

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 2016 Monitoring Events

CONFLUENCE

Photo Point 1—2013
Description: View looking west (upstream) of Bowser Creek. **Compass**: 270 (West)

Photo Point 1—2016
Description: View looking west (upstream) of Bowser Creek. **Compass**: 270 (West)

Photo Point 2.1—2013
Description: View looking northwest at Bowser Creek.
Compass: 315 (Northwest)

Photo Point 2.1—2016
Description: View looking northwest at Bowser Creek.
Compass: 315 (Northwest)

Photo Point 2.2—2013
Description: View across Bowser Creek looking north.
Compass: 0 (North)

Photo Point 2.2—2016
Description: View across Bowser Creek looking north.
Compass: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

CONFLUENCE

Photo Point 2.3—2013
Description: View looking northeast across Bowser Creek. **Compass**: 45 (Northeast)

Photo Point 2.3—2016
Description: View looking northeast across Bowser Creek. **Compass**: 45 (Northeast)

Photo Point 2.4—2013
Description: View looking east across Bowser Creek. from photo point 2. **Compass**: 90 (East)

Photo Point 2.4—2016
Description: View looking east across Bowser Creek. from photo point 2. **Compass**: 90 (East)

Photo Point 3.1—2013
Description: View looking east (downstream) of Bowser Creek from photo point 3. **Compass**: 90 (East)

Photo Point 3.1—2016
Description: View looking east (downstream) of Bowser Creek from photo point 3. **Compass**: 90 (East)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

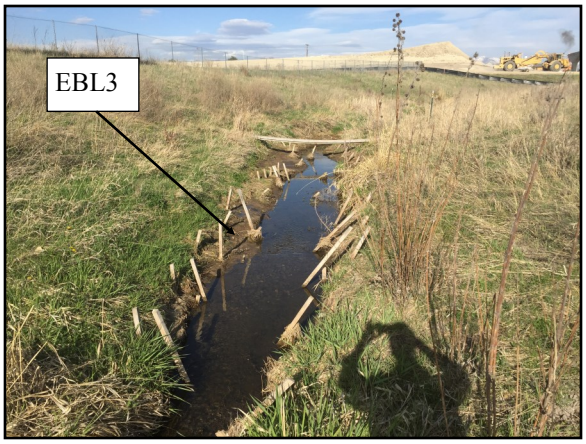
CONFLUENCE

Additional Photo 1: August 2013
Description: Dense Watercress growth in Bowser Creek. **Compass**: 90 (East)

Additional Photo 1: August, 2016
Description: Dense watercress growth in Bowser Creek. **Compass**: 90 (East)

Additional Photo 2: April, 2016
Description: Eroding bank EBR2 (not eroding)
Compass: 90 (East)

Additional Photo 3: April, 2016
Description: Eroding bank EBR1 (not eroding)
Compass: 90 (East)



Additional Photo 4: April 2016
Description: View downstream of eroding bank EBL3. Compass 90

Additional Photo 5: April, 2016
Description: View of seep causing saturation and bank failure at downstream end of EBL3.

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

CONFLUENCE

Additional Photo 6: April 2016
Description: View looking upstream at EBL3
Compass: 270 (West)

Additional Photo 7: April 2016
Description: View looking across channel at EBL1
Compass: 0 (North)

Additional Photo 8: April 2016
Description: View downstream of EBL2.
Compass: 90 (East)

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T1 LEFT: LOOKING SOUTHWEST TO T1 RIGHT

T1 RIGHT: LOOKING NORTHEAST TO T1 LEFT

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T1 LEFT: LOOKING WEST UPSTREAM

T1 LEFT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T1: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T1: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T1 RIGHT: LOOKING WEST UPSTREAM

T1 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T2 LEFT: LOOKING SOUTH TO T2 RIGHT

T2 RIGHT: LOOKING NORTH TO T2 LEFT

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T2 LEFT: LOOKING WEST UPSTREAM

T2 LEFT: LOOKING SOUTH EAST DOWNSTREAM

T2: LOOKING WEST UPSTREAM FROM MIDDLE CREEK

T2: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

T2 RIGHT: LOOKING WEST UPSTREAM

T2 RIGHT: LOOKING EAST DOWNSTREAM

T3 LEFT: LOOKING SOUTH TO T3 RIGHT

T3 RIGHT: LOOKING NORTH TO T3 LEFT

T3 LEFT: LOOKING WEST UPSTREAM

T3 LEFT: LOOKING EAST DOWNSTREAM

T3: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T3: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T3 RIGHT: LOOKING WEST UPSTREAM

T3 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T4 LEFT: LOOKING SOUTH TO T4 RIGHT

T4 RIGHT: LOOKING NORTH TO T4 LEFT

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T4 LEFT: LOOKING WEST UPSTREAM

T4 LEFT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-11-16

T4: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T4: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

T4 RIGHT: LOOKING WEST UPSTREAM

T4 RIGHT: LOOKING EAST DOWNSTREAM

Appendix D

Construction Plan Sheets

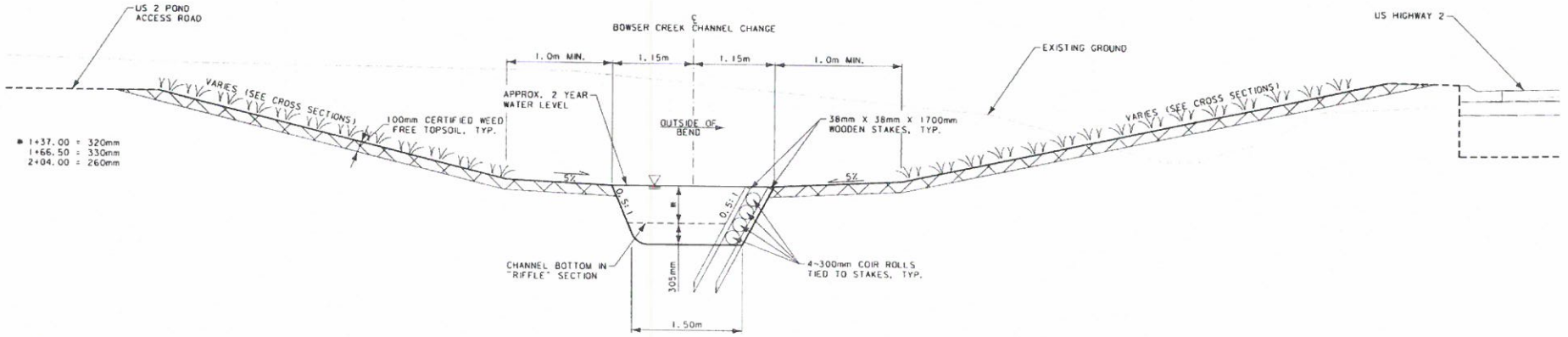
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

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

CSF - 0.999470385

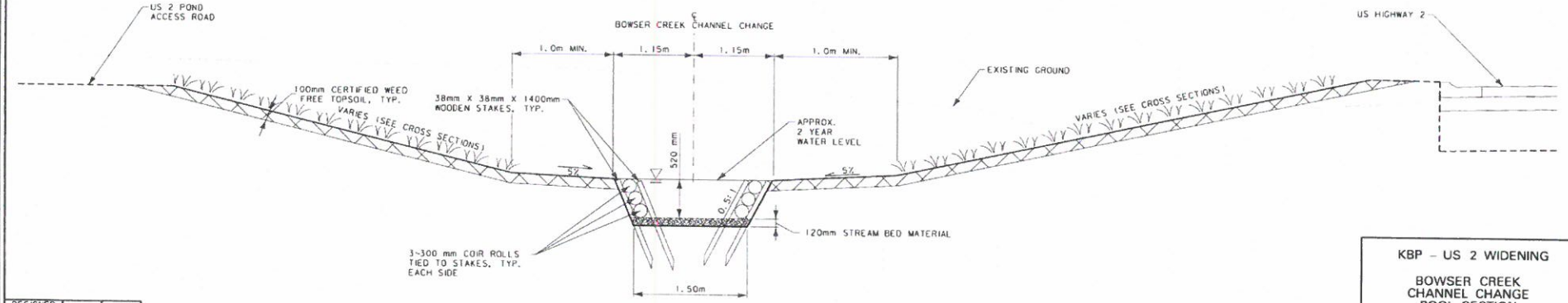
DETAIL

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

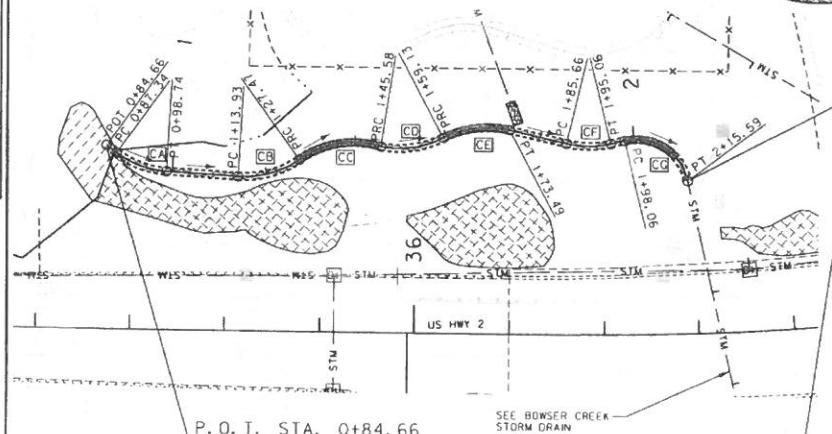
SPRING CREEK CHANNEL CHANGE CURVE DATA

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

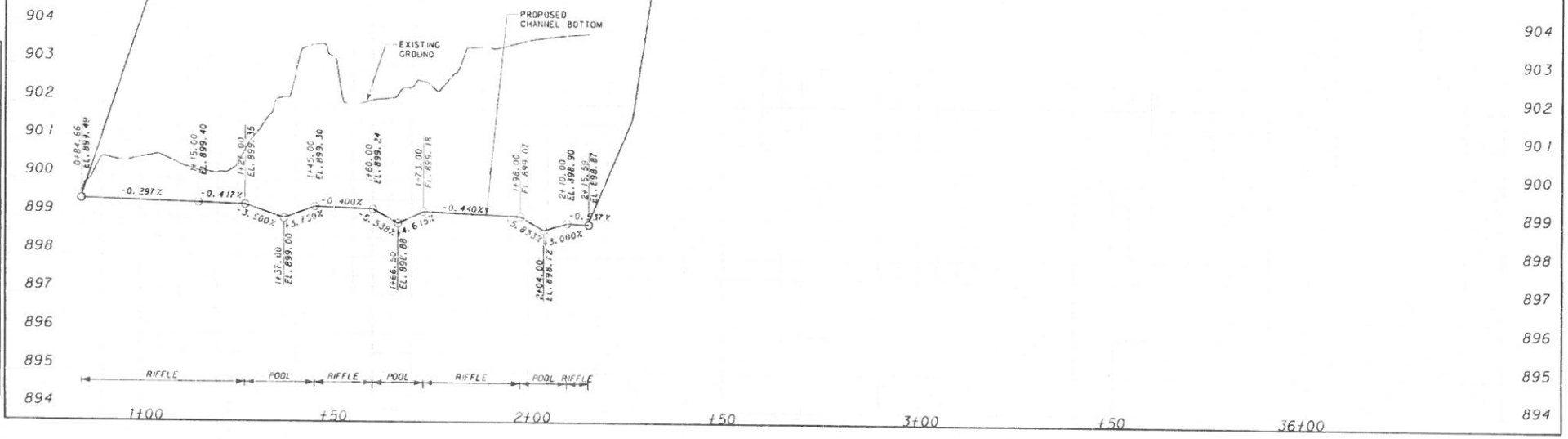


P.O.T. STA. 0+84.66
BEGIN BOWSER CREEK CHANNEL CHANGE =
STA. 35+34.77 US 2

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

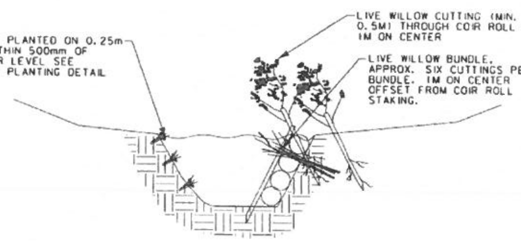
Stelling Engineers, INC.

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

CSF = 0.999470385

DETAIL

TABLE OF CONTENTS & DETAILS



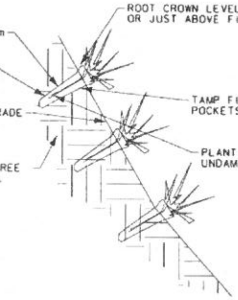
ZONE D COIR BUNDLES WITH WILLOW CUTTINGS AND LAYERING

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.

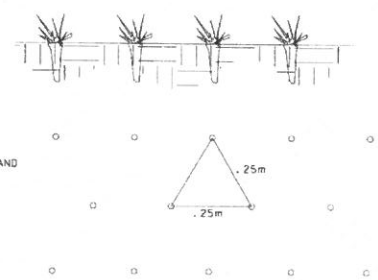
TABLE OF CONTENTS



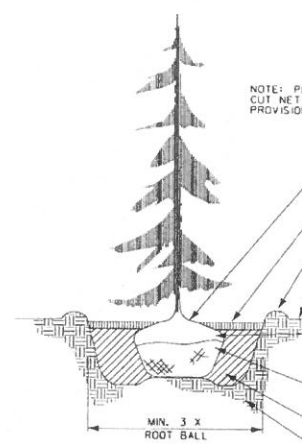
ZONE D RIPARIAN PLUG PLANTING

FOR INSIDE BEND OF SPRING CREEK POOLS

SCALE: NOT TO SCALE



SPACING



NOTE: PLACE JUTE NETTING ON SLOPES GREATER THAN 33%. CUT NETTING TO ACCOMODATE PLANTINGS. SEE SPECIAL PROVISIONS FOR JUTE SPECIFICATION.

TREE PLANTING

SCALE: NOT TO SCALE

NOTE: PLACE JUTE NETTING ON SLOPES GREATER THAN 33%. CUT NETTING TO ACCOMODATE PLANTINGS. SEE SPECIAL PROVISIONS FOR JUTE SPECIFICATION.

SHRUB PLANTING

SCALE: NOT TO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

KBP - US 2 WIDENING

TABLE OF CONTENTS & DETAILS

NO SCALE

MONTANA CADD

MDT MONTANA DEPARTMENT OF TRANSPORTATION

SE Stelling Engineers, INC.

DESIGNED BY
REVIEWED BY
CHECKED BY

3/2/2010

1:49:12 PM

EPS - U9652

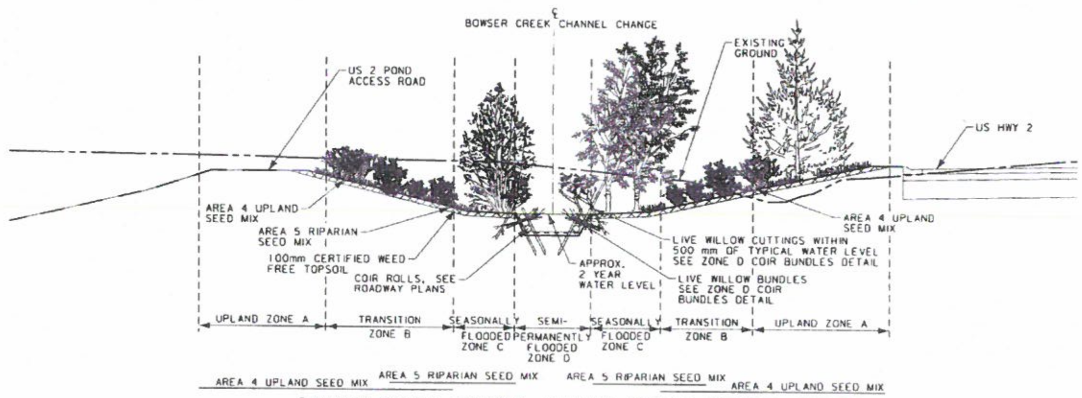
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V2

CSF = 0.999470385

DETAIL

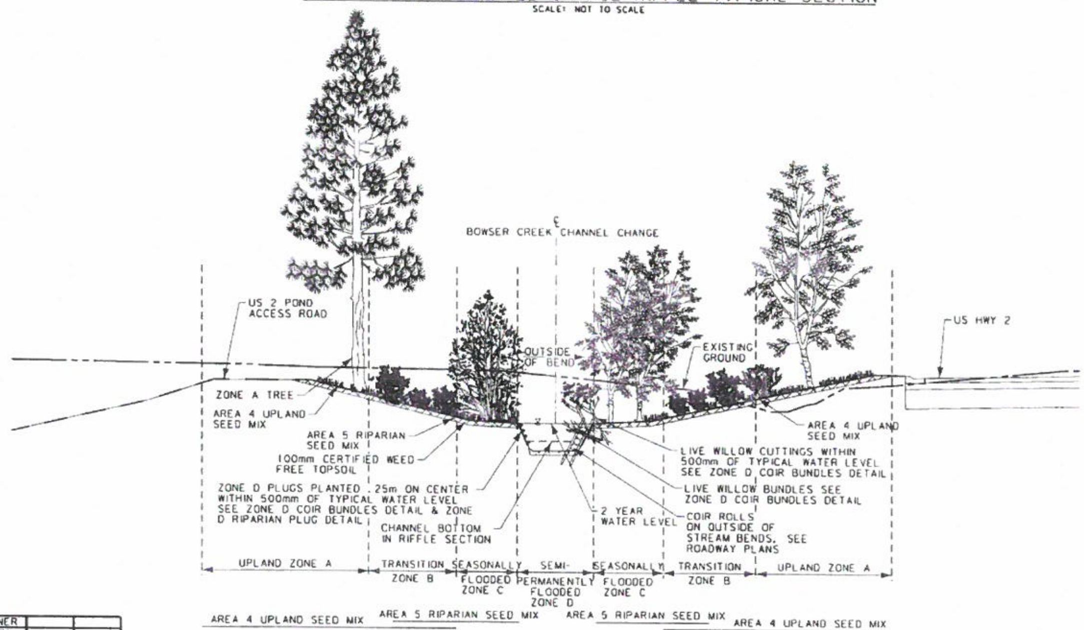
BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY

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



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 - MUTLI STEM	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".

KBP - US 2 WIDENING

BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY

NO SCALE

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MDT MONTANA DEPARTMENT OF TRANSPORTATION — MONTANA CADD

SE Stelling Engineers, Inc.

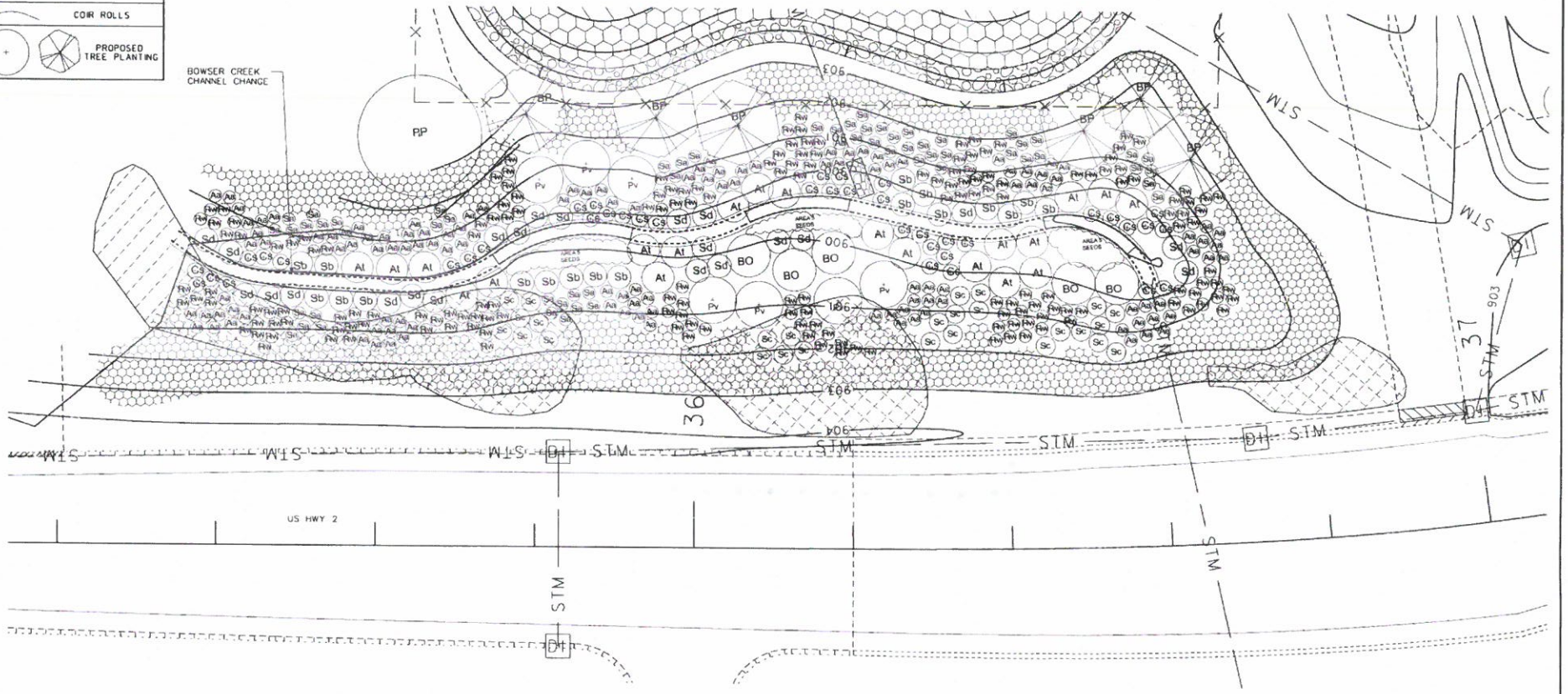
DETAIL

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.