MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Bowser Creek
Flathead County, Montana

Project Completed: 2010
Monitoring Report #3: December, 2015

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #3

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Flathead County, Montana

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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 mitigate the impacts of this project, MDT proposed on-site stream mitigation actions within the widened highway right of way. The following report includes the results of the third 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 five 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 (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 of the goals 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 third 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 18, 2015 while survey crews visited the site on August 26, 2015. The following data were collected at the Bowser Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

Two riparian belt transects established during the first monitoring event in 2013 were monitored to document areal percent cover of total vegetation, woody vegetation, and noxious weeds. 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).

A vegetation inventory was conducted along both stream banks, which included 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 estimated and recorded using the following classification values: 0 (less than 1 percent), 1 (1 to 5 percent), 2 (6 to 10 percent), 3 (11 to 20 percent), 4 (21 to 50 percent), and 5 (greater than 50 percent).

Vegetation community boundaries were determined in the field during the active growing season and subsequently delineated on the 2015 aerial photographs. Community types were named based on the predominant vegetation species that characterized each mapped polygon (Figure 4, Appendix A). 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 (Figure 4, Appendix A). 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.

The project area was visually inspected to document woody vegetation plantings. The total number of live and dead plantings was recorded to calculate woody plant survival.

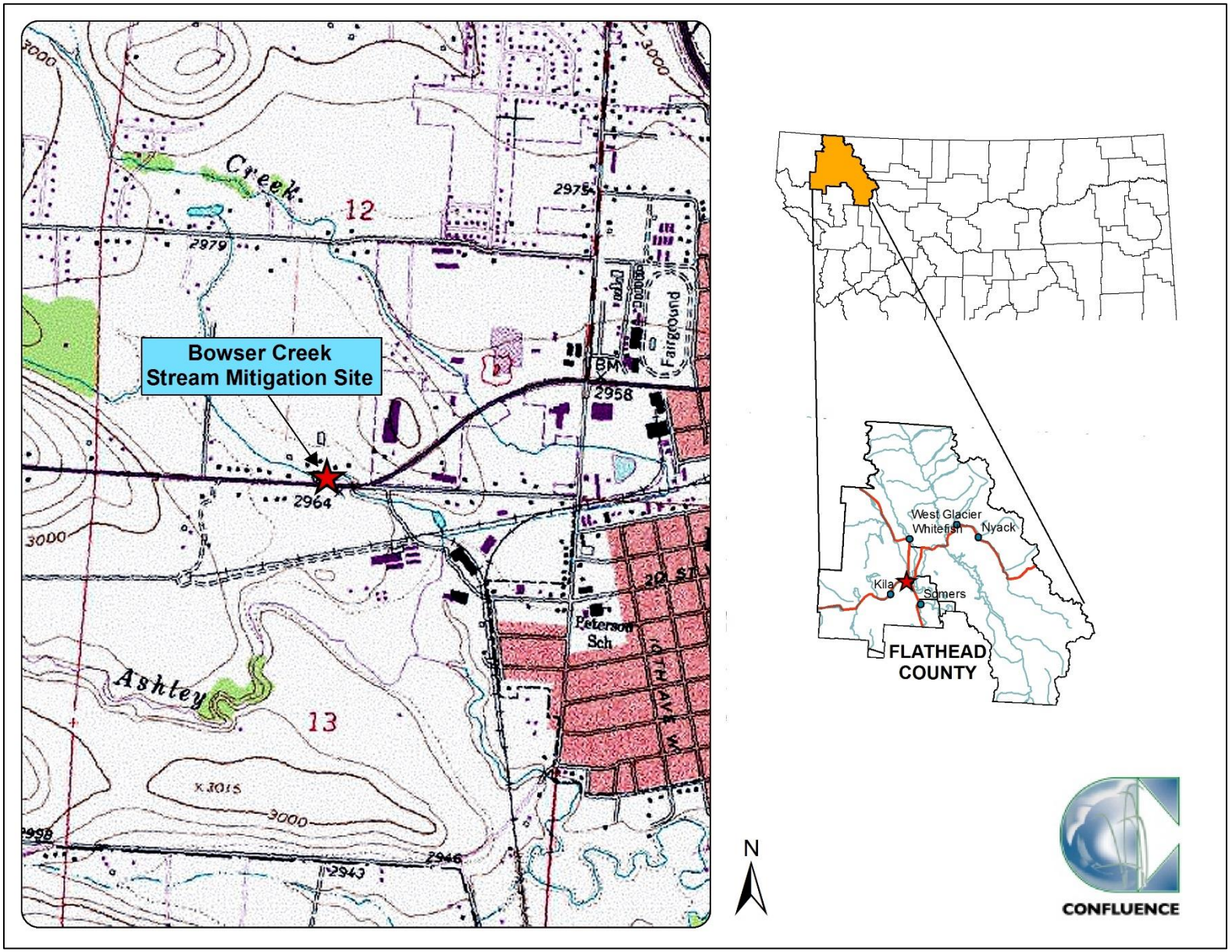


Figure 1. Project location of Bowser Creek stream mitigation site.

3.2. Bank Erosion Inventory

Both stream banks within the project reach were visually inspected to document eroding banks. 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. Channel Surveys

Four perpendicular transects (cross sections) established in 2013 were re-surveyed by licensed survey crews; two at riffles and two at pools. A longitudinal profile of the channel thalweg was surveyed to document bedform complexity and aquatic habitat conditions.

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.

4.0 RESULTS

4.1. Riparian and Stream Bank Vegetation Inventory

Table 1 summarizes the areal percent cover of total vegetation, woody vegetation, and noxious weeds observed along each riparian and stream bank transect. In 2015 the total percent riparian cover remained at 100%, with 12% cover by woody species and 11% by noxious weeds. Stream bank transects also displayed 100% cover, with 13% by woody species and 8% by noxious weeds. In total, the site exhibited 100% total vegetation cover, with 12% by woody species and 10% by noxious weeds.

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). Three vegetation community types were observed in 2015, including community Type 1 – *Elymus* spp., community Type 2 – *Phalaris arundinacea*, and community Type 3 – *Nasturtium officinale*. The upper side slopes of the project were dominated by wild rye (*Elymus* spp.), while the lower slopes and riparian zones adjacent to the channel were dominated by reed canary grass (*Phalaris arundinacea*). A third community type was added in 2015, which included a prolific

stand of watercress (*Nasturtium officinale*) growing in the channel bed. The dense watercress present in the channel is shown in Additional Photo 6 in Appendix C.

Table 1. Percent cover of vegetation transects at Bowser Creek in 2013, 2014, and 2015.

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

Table 2 provides a comprehensive list of plant species observed on site during the 2013, 2014, and 2015 monitoring events. In 2015, 94 plant species were observed, representing an increase of 11 species since 2014 and 39 species since the initial monitoring event in 2013. In 2015, 50% of the species observed were hydrophytic based on the 2014 National Wetland Plant List (NWPL) (Lichvar *et al*., 2014).

4.2. Stream Bank Vegetation Composition

The stream bank vegetation inventory identified 40 plant species along the banks of Bowser Creek (Table 3). Reed canary grass comprised greater than 50% cover along both stream banks in 2015. 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). Success criteria outlined in the monitoring plan state the vegetation along the stream banks will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6. 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 success criteria.

Table 2. Comprehensive vegetation species list for the Bowser Creek stream mitigation site in 2013, 2014, and 2015.

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
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	FAC
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
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

Scientific Name	Common Name	WMVC Indicator Status*
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
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 2014 NWPL (Lichvar *et al*., 2014)
New species identified in 2015 are **bolded**.

Table 3. Plant species and their associated cover classes along the stream banks of the Bowser Creek stream mitigation site in 2015.

Streambank Species	Left bank	Right bank	WMVC Indicator Status*
Agastache urticifolia	X	X	FACU
Agrostis stolonifera	X	X	FAC
Alnus incana		X	FACW
Alopecurus arundinaceus	X	X	FAC
Beckmannia syzigachne	X		OBL
Bromus inermis	X	X	FAC
Carex nebrascensis	X	X	OBL
Carex utriculata	X	X	OBL
Chamerion angustifolium	X		NL
Cirsium arvense	X	X	FAC
Cornus alba	X		FACW
Elymus repens	X	X	FAC
Epilobium ciliatum	X	X	FACW
Equisetum arvense	X	X	FAC
Glyceria grandis		X	OBL
Hordeum jubatum	X		FAC
Lactuca serriola		X	FACU
Lemna minor	X	X	OBL
Medicago lupulina	X		FACU
Melilotus officinalis	X		FACU
Mentha arvensis	X	X	FACW
*Nasturtium officinale***	X	X	OBL
Persicaria amphibia		X	OBL
*Phalaris arundinacea***	X	X	FACW
Phleum pratense	X		FAC
Plantago major	X		FAC
Poa palustris	X	X	FAC
Poa pratensis	X	X	FAC
Rumex crispus	X	X	FAC
Salix bebbiana	X		FACW
Salix sp.	X		NL
Solanum dulcamara	X	X	FAC
Sonchus arvensis	X	X	FACU
Taraxacum officinale	X	X	FACU
Trifolium pratense	X	X	FACU
Trifolium repens	X	X	FAC
Typha latifolia	X	X	OBL
Urtica dioica		X	FAC
Veronica americana	X	X	OBL
Vicia americana	X		FAC

*Based on 2014 NWPL (Lichvar *et al*., 2014)
** *Dominant species observed along Bowser Creek stream banks*
*** *Dominant species observed along Bowser Creek stream bed*

4.3. Noxious Weed Inventory

Twenty-seven infestations of five Montana Listed Priority 2B noxious weeds were mapped within the riparian corridor at the Bowser Creek stream mitigation site and are listed in Table 3. Noxious weed occurrences are displayed 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). In 2014, *Hypericum perforatum* (common St. John's wort) and *Leucanthemum vulgare* (ox-eye daisy) were observed in trace amounts; however, neither of these species were observed in 2015. As a result, they have been removed from the list of noxious weeds present at the Bowser Creek mitigation site. Noxious weeds have continued to increase at the site, with 14 new infestations since 2014. An estimated 10% of the project area has been colonized by noxious weeds, an increase of 3% since 2014 and 7% since the initial 2013 monitoring event. Infestations of *Cirsium arvense*, the most prevalent noxious weed, were located throughout the project area (Figure 4, Appendix A). Butter-and-eggs (*Linaria vulgaris*) was observed for the first time in 2015 just outside of the northern riparian corridor near the center of the site.

Table 4. Montana State-listed noxious weed species observed in 2015 at the Bowser Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	*Centaurea stoebe*	Spotted Knapweed
	Cirsium arvense	Canadian Thistle
	Cynoglossum officinale	Gypsy-Flower
	Linaria vulgaris	**Butter-and-Eggs**
	Tanacetum vulgare	Common Tansy

*Based on the Montana Department of Agriculture's Noxious Weed List, 2015
New species identified in 2015 are **bolded.**

4.4. Woody Plant Survival

Willows, alder, dogwood, snowberry, chokecherry, birch, and Woods' rose were observed as planted woody vegetation species. In 2015, 312 planted trees and shrubs were located, with 279 of those remaining alive (Table 5). 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, 55% (279 of 505) remain alive five years following construction.

Table 5. Woody plant survival at Bowser Creek stream mitigation site in 2013, 2014 and 2015.

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%

4.5. Bank Erosion Inventory

Total eroding stream bank length increased by 60 feet in 2015, and now totals 209 feet, or 24% of the overall project bank length of 878 feet. Photos of each eroding bank are included in Appendix C of this report. Much of the bank erosion is difficult to observe from photographs due to the density of watercress growing up the stream banks. Figure 3 in Appendix A shows the location of each eroding stream bank.

Eroding stream bank EBL1 and EBL2 are located upstream and downstream, respectively, of a culvert entering Bowser Creek from the north. Stone placed underneath the culvert to the toe of the stream bank was installed to prevent localized bank erosion from flows through the culvert; however, this material was not placed far enough up or downstream and erosion is occurring as a result. Fine grained soils are becoming saturated and sloughing during high flow events from the culvert and the stream. No additional erosion was noted during the 2015 monitoring event, and transect surveys at this location do not reveal evidence of additional erosion during the past two years. Erosion severity is considered low at both EBR1 and EBR2.

Erosion along the right (south) bank at EBR1 includes bank sloughing across the channel from the culvert. Bank erosion at this location is likely due to fine grained soils becoming saturated and sloughing when the culvert discharges into Bowser Creek. This bank retreated approximately 3 feet between 2013 and 2014, but no further evidence of erosion was noted during the 2015 monitoring event. Bank erosion severity at EBR1 is considered moderate.

Eroding bank EBR2 is located near the upstream end of the project site where the channel has become wider than the design width. Bank erosion was noted in 2014, and was attributed to fine grained soils and steep stream bank slopes sloughing during high flows. The bank does not appear to have retreated further in 2015. Erosion severity at this bank is considered low.

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. Vegetation along this bank is dominated by *Elymus repens* (creeping wild rye) and *Bromus inermis* (smooth brome). Erosion severity at this location is considered moderate due to the lack of bank stabilizing vegetation and the presence of fine grained soils.

Eroding bank EBL4 was also identified in 2015 as a newly eroding bank segment. Similar to EBL3, erosion along this bank is evident by an overly wide channel as compared to the design width and sloughing, fine grained banks adjacent to *Elymus repens* and *Bromus inermis* vegetation types. Erosion severity at this location is considered moderate due to the vegetation types and fine grained soils present.

Erosion along banks EBL3, EBL4, and EBR2 have resulted in a channel width (~12') that is more than double the design width (~5.5'). This erosion is likely occurring during winter or early spring rain on snow events that create high flows prior to onset of the growing season. Corrective actions are warranted to narrow the channel to a more appropriate width, which may be accomplished at relatively low cost by placing brushy materials along the channel fringe to aid in trapping fine sediments while protecting the stream banks from further erosion.

Erosion occurring along banks EBL1, EBL2, and EBR1 are more likely resulting from high flows discharging from the adjacent retention pond. Stabilization of these banks may require installing protective materials, especially along EBR1, which lies directly across the channel from the retention pond outlet.

4.6. Perpendicular Transect Surveys

Two transects were surveyed at pools and two at riffles, with maximum depth and bankfull width for each indicated in Table 6. These results indicate variability in channel dimensions, with maximum bankfull depths ranging from 1.5 to 3.6 feet and bankfull widths ranging from 5 to 13.6 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 constructed width of 5.5 – 6.5 feet.

Table 6. Pool and riffle widths and depths at Bowser Creek stream mitigation site in 2013, 2014 and 2015.

Transect	Type	Max Depth (ft)			Bankfull Width (ft)		
		2013*	2014*	2015	2013*	2014*	2015
1	Pool	1.9	1.9	1.5	6	6.1	5.0
2	Riffle	2.2	2.2	1.9	12.7	13.5	12.5
3	Pool	3.6	3.9	3.6	14.8	13.8	13.6
4	Riffle	1.9	2	1.7	7.8	8.1	7.6
Average Riffles		2.1	2.1	1.8	10.3	10.8	10.1
Average Pools		2.8	2.9	2.6	10.4	10.0	9.3
Average All		2.4	2.5	2.2	10.3	10.4	9.7

*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 1.5 feet (transect #1) and 3.6 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 1.9 feet (transect #2) and 1.7 feet (transect #4).

Bankfull widths at transects #2 (12.5 feet) and #3 (13.6 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. Willow cuttings installed along the outside bank of each meander 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 do not indicate significant width adjustments over the past three years.

4.7. Longitudinal Profile Survey

Longitudinal profile surveys of the channel thalweg in 2014 and 2015 indicate the presence of three distinct pool features that are 1.0 to 1.5 feet deeper than riffle segments within the project reach. The 2015 profile indicates that in general, the channel bed is approximately 0.2 feet higher than in 2014 along the entire length of the project reach. Average pool and riffle depth at the perpendicular transects were shallower in 2015 than in 2014, and offer additional evidence of sediment deposition throughout the project reach.

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 segments that have become over-wide, and 3) upstream development along Bowser Creek that may be contributing fine sediment. 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.

4.8. Wildlife Documentation

Wildlife observations at the Bowser Creek Stream Mitigation site from 2013 through 2015 have thus far been relatively limited. Signs or presence of two new species were noted in 2015, including raccoon tracks and a passing gull. Limited use of this area by wildlife may be due to the proximity of MT Highway 2, lack of habitat, and the time of day survey crews are present at the site (typically late afternoon).

Table 7. Wildlife observations at Bowser Creek stream mitigation site in 2013, 2014, and 2015.

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

New observations from 2015 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 third year of monitoring suggests that all six quantitative performance standards are being met five years following completion of the project (Table 8). 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 1 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 89% of disturbed areas have successfully revegetated with non-noxious weed species following construction. Desirable vegetative cover was determined by subtracting the percent of noxious weed species cover (11%) from the total vegetative cover along the riparian transects (100%). Performance criteria specify at least 50% of the disturbed areas within the creditable buffer area must be vegetated with non-weedy species; therefore, this criterion is currently being met. Noxious weeds comprise 10% of the vegetative cover site-wide, which is the maximum amount allowed under this performance criterion.

Total combined areal vegetative 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 heavily vegetated 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 vegetative establishment; therefore, this criterion is currently being met.

Woody vegetation plantings indicated a survival rate of 55% five years following construction of the project. The performance criteria states 50% or more of the woody plants installed must survive after five years; therefore, the performance criteria is currently being met five years following construction. Woody plants remain relatively small but should provide increased percent cover of the site as they mature. Dense vegetation growth within the riparian corridor made locating smaller woody plantings difficult during previous monitoring events; however, many additional woody plantings were found in 2015 due to a lesser dense and shorter growth of the understory layer.

5.2. Vegetation Along Stream Banks

Reed canary grass comprised greater than 50% cover along both stream banks in 2015. 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 stream bank inventory identified two new eroding banks in 2015, bringing the total length of erosion to 209 feet, or 24% of the total project bank length of 878 feet. Although a total of six eroding banks have been identified within the project reach, the performance criteria of less than 25% of the project reach exhibiting signs of instability is currently being met at this site. It should be noted that any additional erosion within the project reach will result in failure of this performance criteria. Corrective actions are warranted in channel segments that have become over-wide following construction and along areas near the confluence with the retention pond outlet.

5.4. Channel Form Success

The project reach indicates signs of lateral erosion and channel widening through portions of the newly constructed channel. In areas where the channel is wider than the design width, it does not appear the coir logs stacked along the edge of the channel developed into stable banks and woody cuttings installed to provide additional bank protection have shown poor survival rates.

The longitudinal profile of the channel thalweg shows no signs of vertical instability or channel downcutting; however, the stream bed appeared to rise in elevation by approximately 0.2’ throughout the project reach in 2015 as compared to 2014. This may be due to sediment deposition throughout the length of the channel. It is possible the channel did not experience a flushing flow in the past year and thus has accumulated sediment along the channel bed. The density of watercress throughout the majority of the channel bed may be contributing to a lower sediment transport capacity of the channel during the growing season. Further monitoring efforts will help to indicate whether the channel is capable of flushing sediment and maintaining channel capacity.

Surveyed channel cross sections offer evidence of habitat complexity and variability throughout the project reach. Channel widths and depths vary, indicating a diversity in

habitat features. Although the channel dimensions offer aquatic habitat complexity, the abundance of watercress observed throughout the water column limits the potential use of this habitat by fish and other aquatic life during the growing season.

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 three monitoring events.

Data and photos included in this monitoring report provide evidence of establishment of vegetation along Bowser Creek's banks and riparian corridor. To date, woody shrubs are establishing adjacent to the creek, and as they continue to mature, will provide additional habitat components such as shade, cover, and small woody debris to the channel.

Based on the results of monitoring data collected to date, the modified segment of Bowser Creek is meeting five of the six quantitative performance targets established in the monitoring plan for the site. 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.

The 2015 monitoring of the Bowser Creek mitigation site reveal results for two of the six performance criteria are at or near the threshold of success. Results for percent of eroding/unstable banks (24%) and percent cover of noxious weeds (10%) leave little to no opportunity for additional degradation of these site conditions. Actions to address bank stability and weed infestations within the mitigation site are likely warranted to maintain project success as defined by the performance criteria.

Table 8. 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 **89%** 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 **10%** cover of noxious weeds within riparian zones.	**YES**
	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 **55%.**	**YES**
	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 **24%** 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**

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

6.1. Weed Management

Noxious weeds were observed on approximately 10% of the Bowser Creek project area, with occurrences in riparian and stream bank areas (Figure 4, Appendix A). Recent weed control efforts appear to have been effective at controlled infestations of St. John's wort and Oxeye daisy, as these species were noted during previous monitoring surveys but were not observed in 2015. Although these results are promising, the percent noxious weed cover is currently at the maximum allowable limit to meet the performance standards; therefore continued weed control is recommended to maintain success in this category. 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. Weed control conducted by MDT in the future should concentrate efforts in areas that are most heavily infested by noxious weeds.

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 curvatures. 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 design of the Bowser Creek incorporated discharges observed in Bower Creek and channel dimensions for similarly sized watersheds.

6.3. Floodplain and Riparian Development

Side slope designs 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 also must take into account traffic and safety considerations, and allow for vehicles to exit the roadway safely.

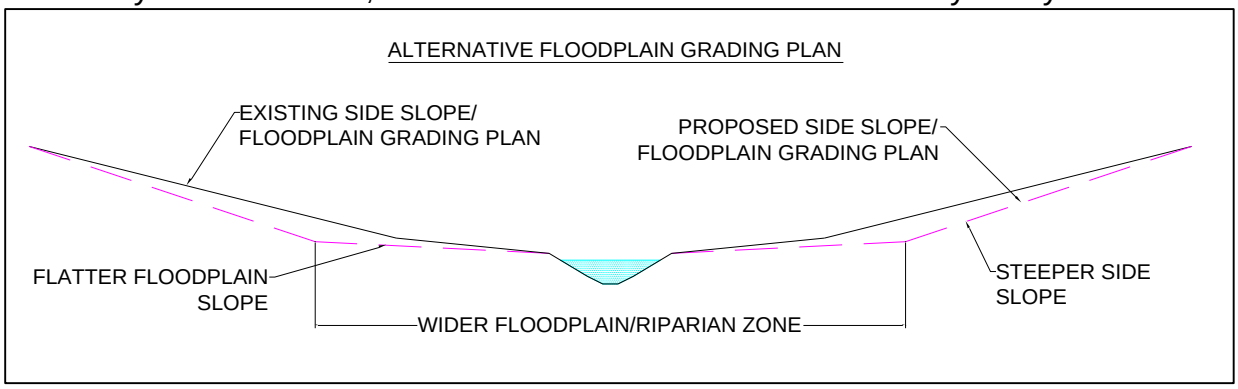


Figure 2. Alternative grading plan to increase floodplain and riparian areas.

6.4. Riparian Vegetation Zone

Design plans indicate riparian planting zones were only prescribed on the south side of Bowser Creek. Increasing the steepness of side slopes as illustrated 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 2015 monitoring event noted only trace amounts of willows growing along the banks, indicating most of the cuttings did not survive. It is unclear why these cuttings did not survive. 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

Natural Resources Conservation Service. 2007. How to Plant Willows and Cottonwoods for Riparian Restoration. Technical Note #23. Boise, Idaho Plant Materials Center, Aberdeen, Idaho.

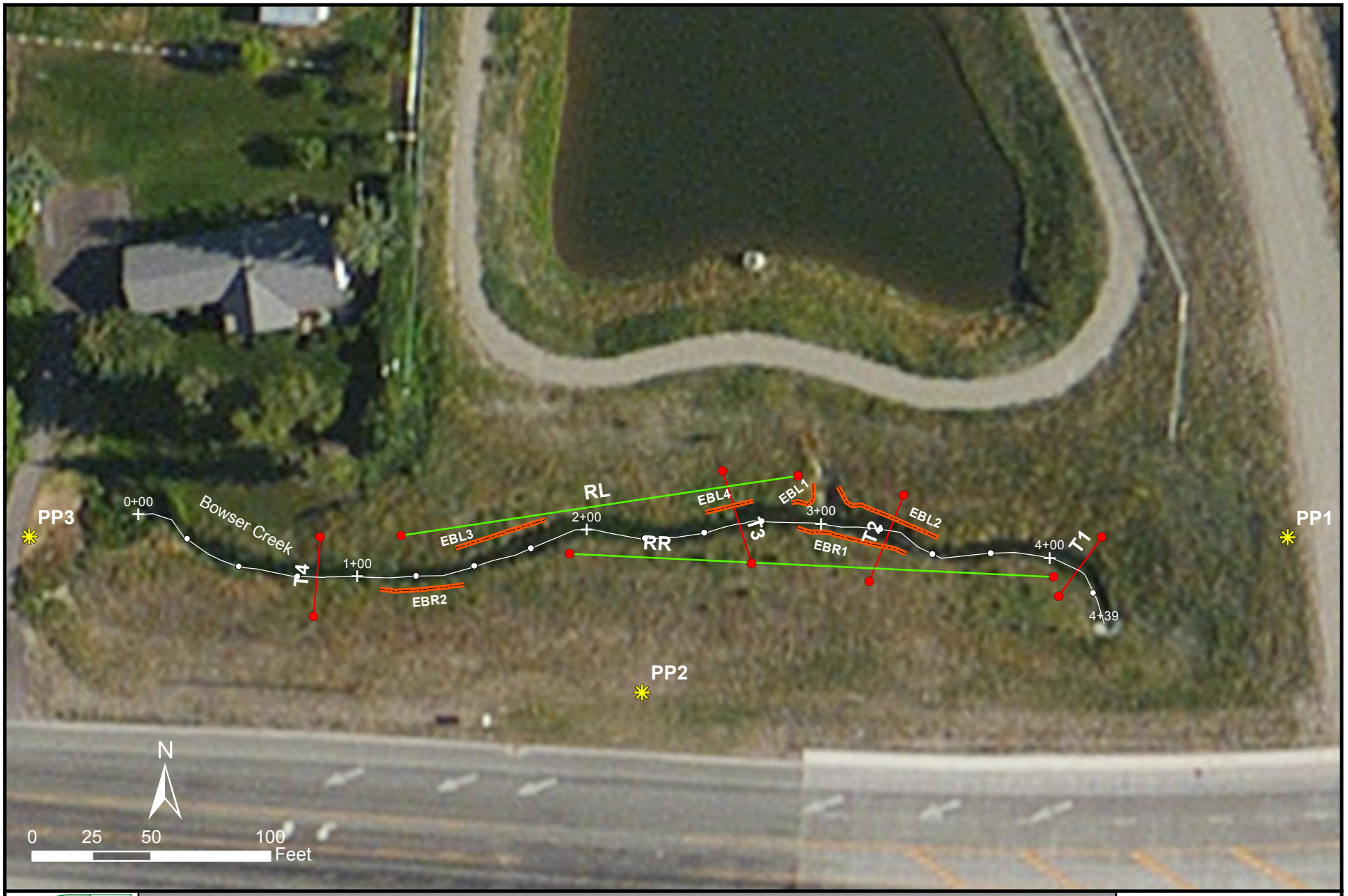
Montana Department of Agriculture. Montana Noxious Weed List. July 2015. Accessed September 2015 at: http://agr.mt.gov/agr/Programs/Weeds/PDF/2015WeedList.pdf.

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

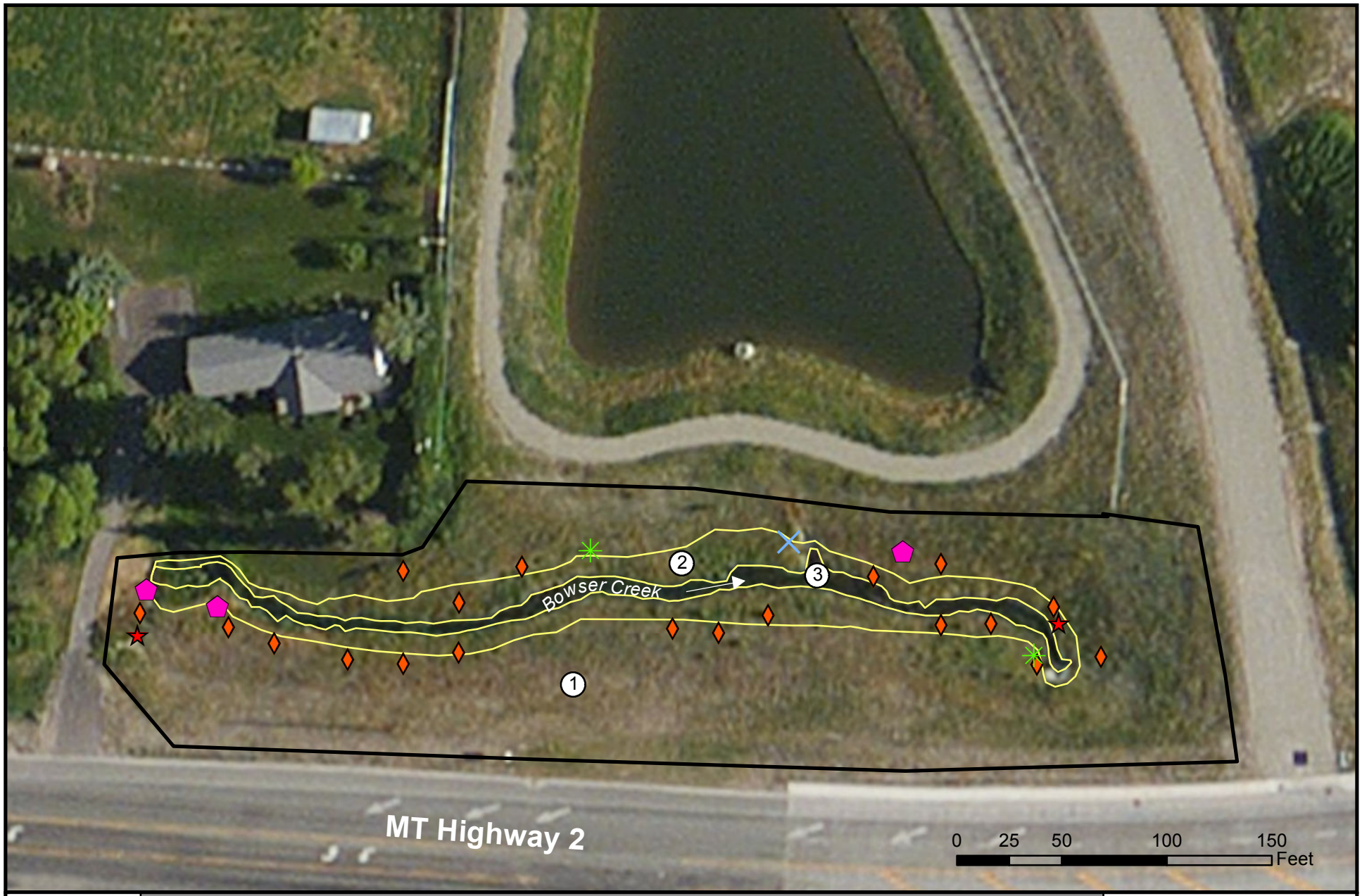
- Photo Points
- Riparian and Perpendicular Transect Endpoints
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Eroding Banks
- Pool and Riffle Transects
- Riparian Transects

Bowser Creek - 2015 Monitoring Features

Figure 3

Date: 10/8/2015

Bowser_features2015.mxd



CONFLUENCE
consulting incorporated

Legend

- Project Boundary
- Vegetation Community Boundary
- Centaurea stoebe
- Cirsium arvense
- Cynoglossum officinale
- Linaria vulgaris
- Tanacetum vulgare
- (1) Elymus spp. Community
- (2) Phalaris arundinacea Community
- (3) Nasturtium officinale Community

N

Bowser Creek - 2015 Noxious Weeds and Vegetation Community

Figure 4

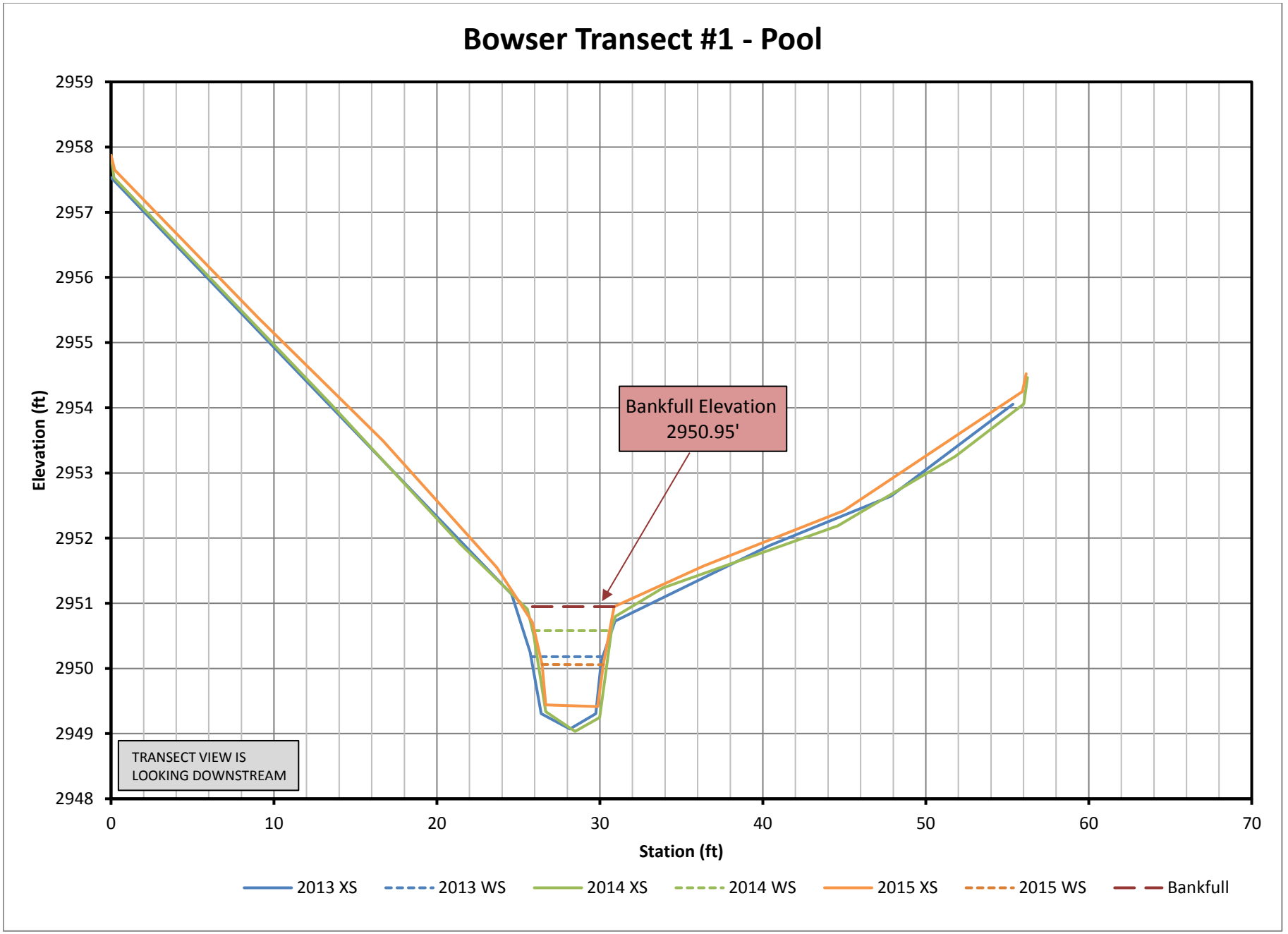
Date: 10/06/2015

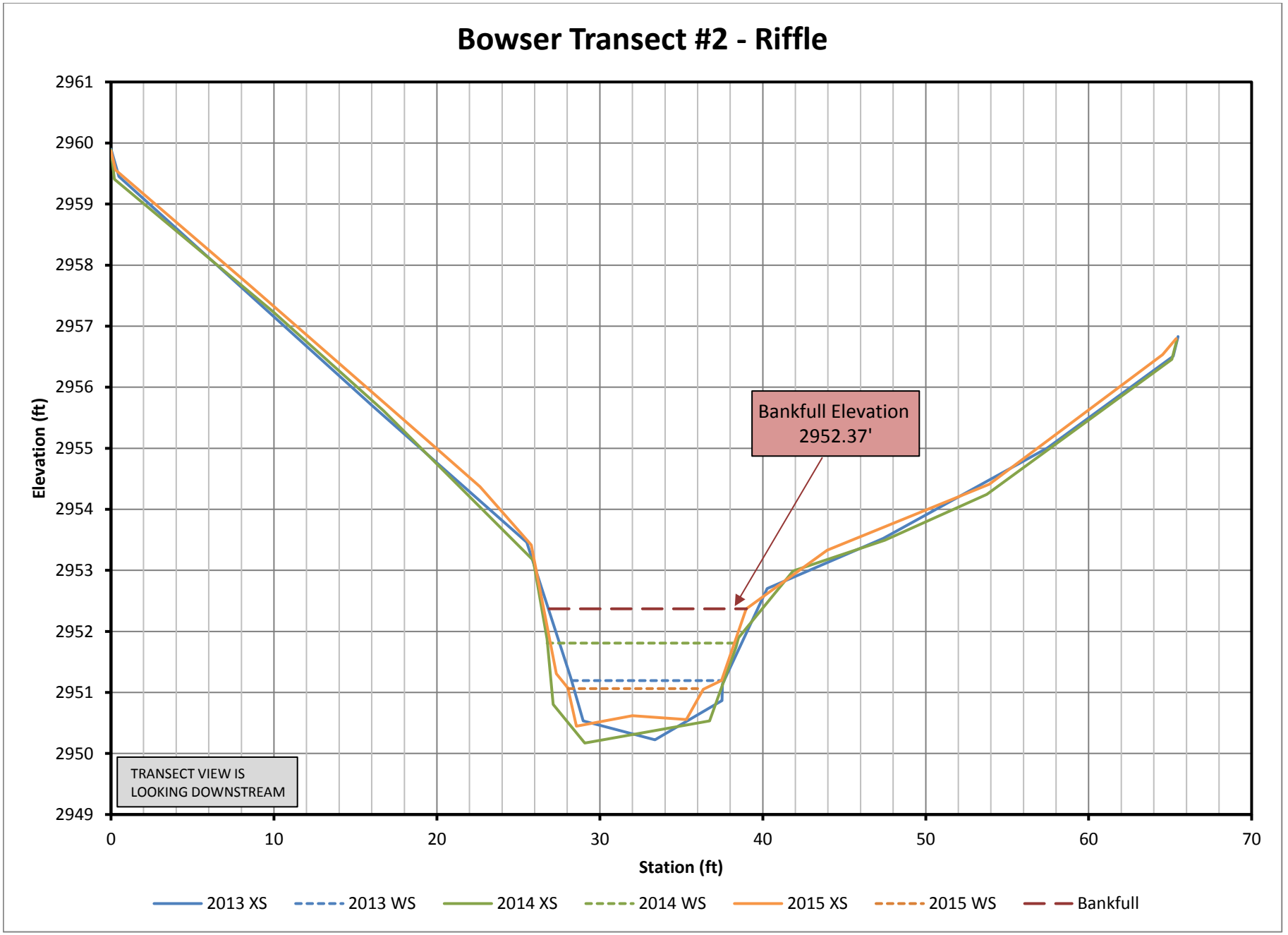
Bowser_monitor2015.mxd

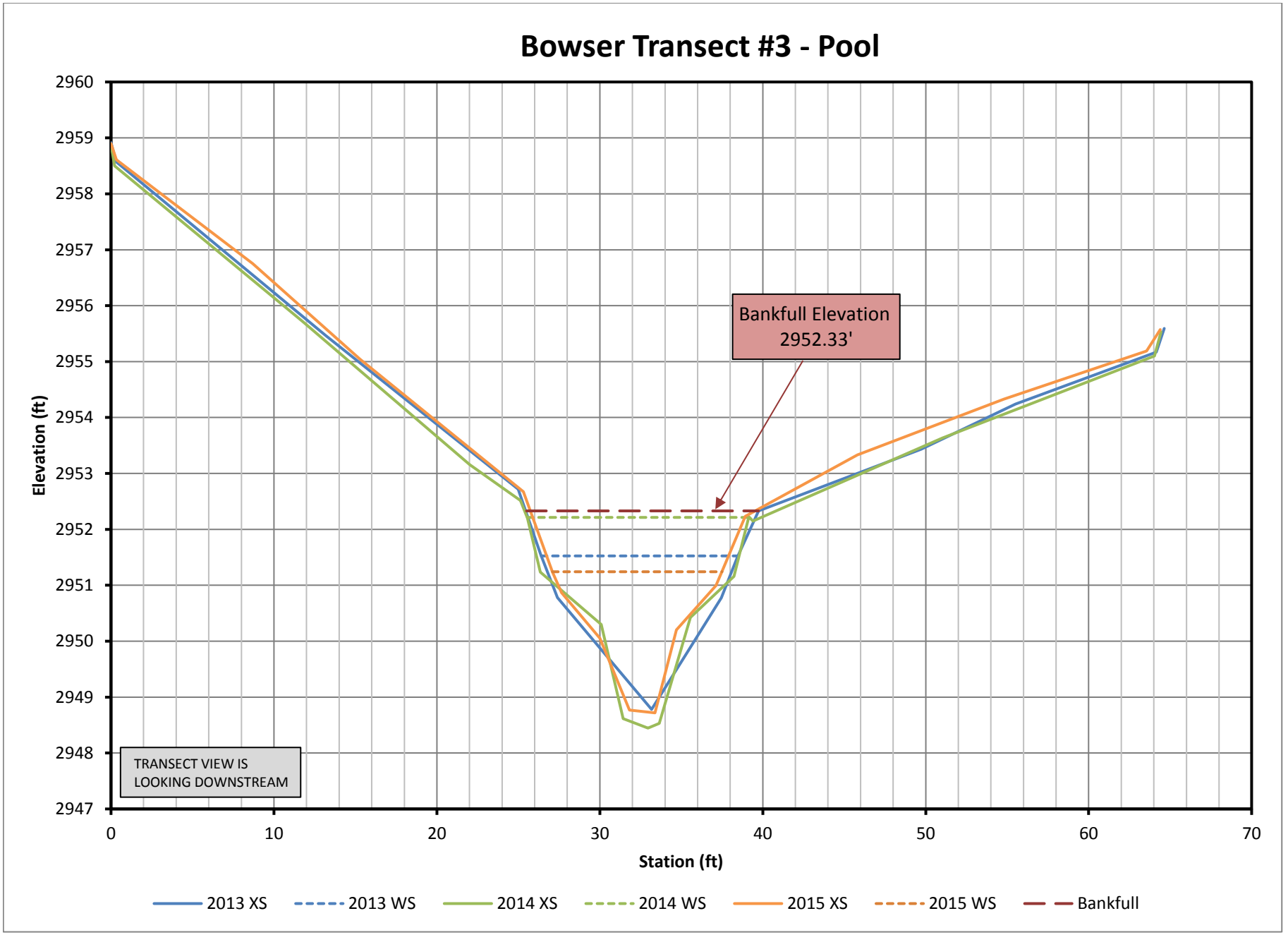
Appendix B

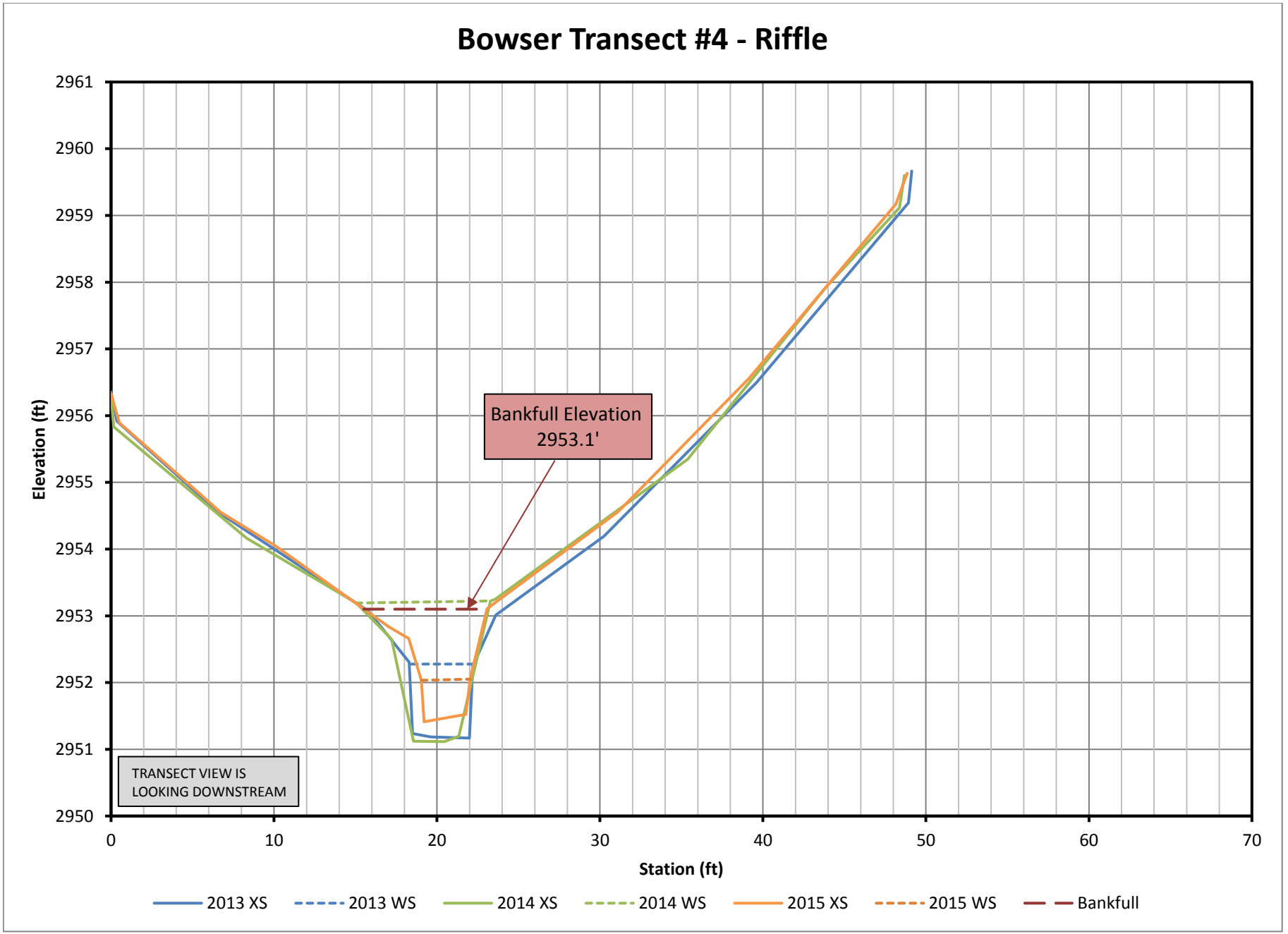
Perpendicular Transect and Longitudinal Profile Plots

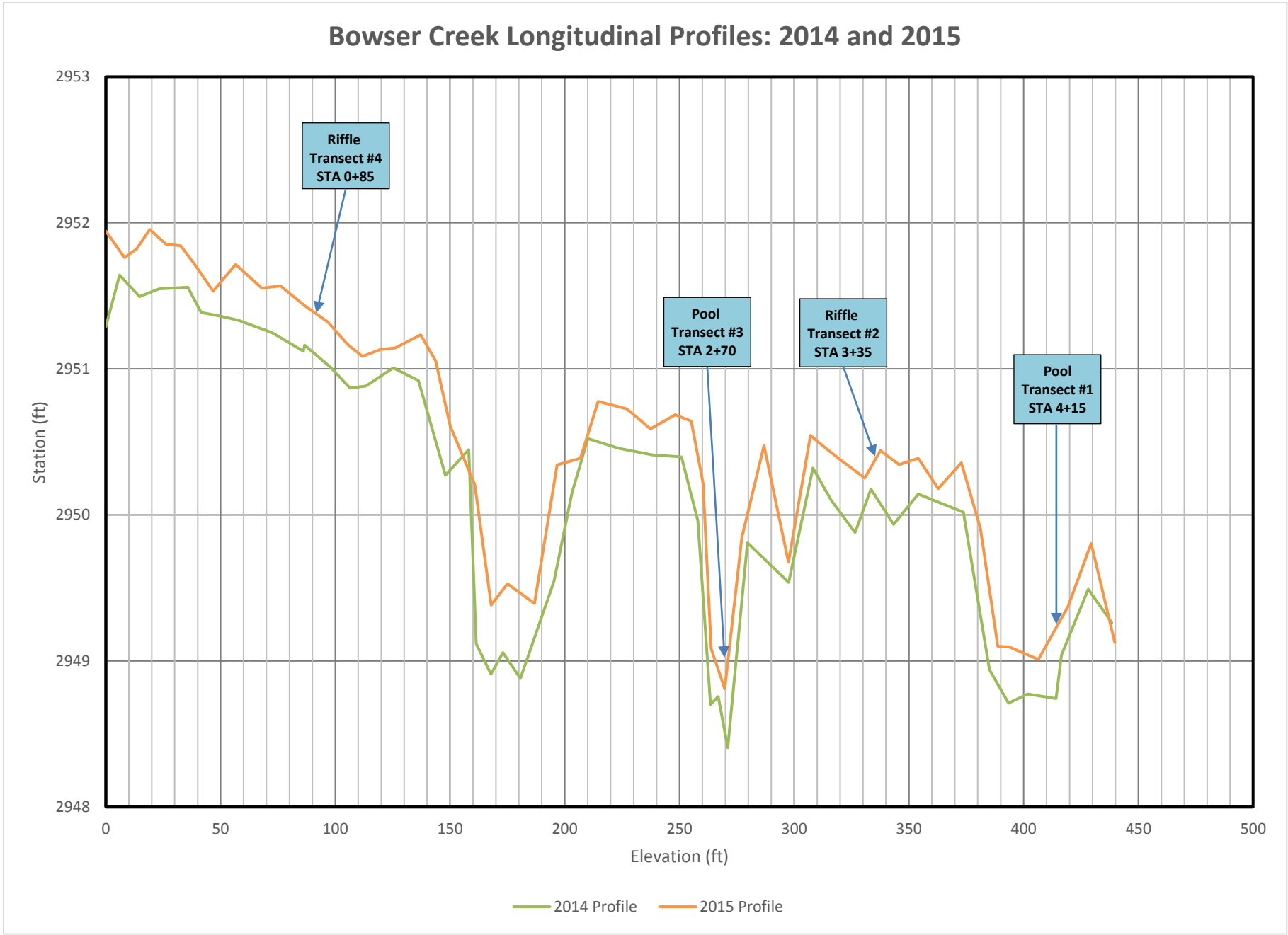
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana


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
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


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
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


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
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


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
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


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

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 2015 Monitoring Events

CONFLUENCE

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

Photo Point 1—2015
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—2015
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—2015
Description: View across Bowser Creek looking north.
Compass: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

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

Photo Point 2.3—2015
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—2015
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—2015
Description: View looking east (downstream) of Bowser Creek from photo point 3. **Compass**: 90 (East)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

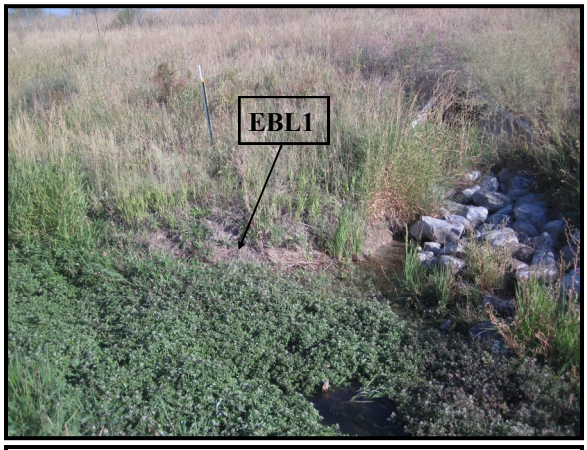
DATE: 2015 Monitoring Event

CONFLUENCE

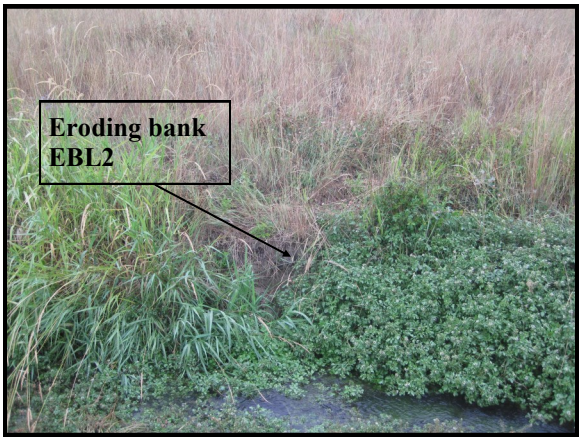
Additional Photo 1—2013
Description: Nasturtium growth in Bowser Creek.
Compass: 90 (East)

Additional Photo 1—2015
Description: Nasturtium growth in Bowser Creek.
Compass: 90 (East)

Additional Photo 2—2013
Description: Eroding Bank L1
Compass: 0 (North)



Additional Photo 2—2015
Description: Eroding Bank L1
Compass: 0 (North)



Additional Photo 3—2013
Description: Eroding bank L2 downstream of culvert. **Compass**: 0 (North)

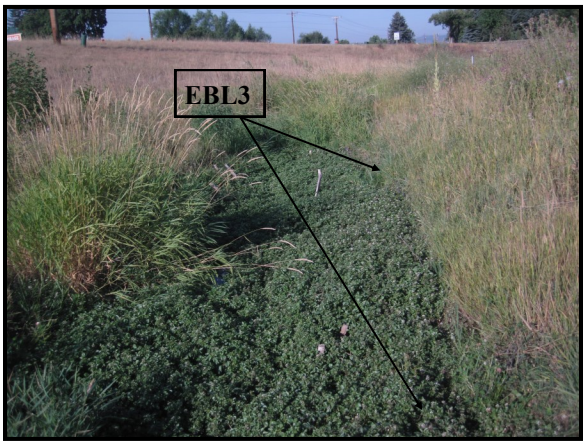
Additional Photo 3—2015
Description: Eroding bank R1 across from culvert.
Compass: 90 (East)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2015 Monitoring Event

CONFLUENCE



Additional Photo 4 - 2015
Description: Eroding Bank EBL3. Note wood stakes previously at edge of bank are now 2-3 feet from bank. Compass 270 (West)

Additional Photo 5 - 2015
Description: Lower end of new eroding bank L4.
Compass 0 (North)

Additional Photo 6 - 2015
Description: Upper end of new eroding bank L4.
Compass: 0 (North)

Additional Photo 7 - 2015
Description: Dense infestation of watercress found throughout Bowser Creek mitigation site. Compass 90 (East)

Additional Photo 8- 2015
Description: Culvert partially blocked by cattail debris at downstream end of project reach.

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T1 LEFT: LOOKING SOUTHWEST TO T1 RIGHT

T1 RIGHT: LOOKING NORTHWEST TO T1 LEFT

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T1 LEFT: LOOKING WEST UPSTREAM

T1 LEFT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T1: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T1: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T1 RIGHT: LOOKING WEST UPSTREAM

T1 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T2 LEFT: LOOKING SOUTH TO T2 RIGHT

T2 RIGHT: LOOKING NORTH TO T2 LEFT

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T2 LEFT: LOOKING WEST UPSTREAM

T2 LEFT: LOOKING SOUTH EAST DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T2: LOOKING WEST UPSTREAM FROM MIDDLE CREEK

T2: LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

T2 RIGHT: LOOKING WEST UPSTREAM

T2 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

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: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T3 RIGHT: LOOKING WEST UPSTREAM

T3 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T4 LEFT: LOOKING SOUTH TO T4 RIGHT

T4 RIGHT: LOOKING NORTH TO T4 LEFT

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

T4 LEFT: LOOKING WEST UPSTREAM

T4 LEFT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 8-26-15

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

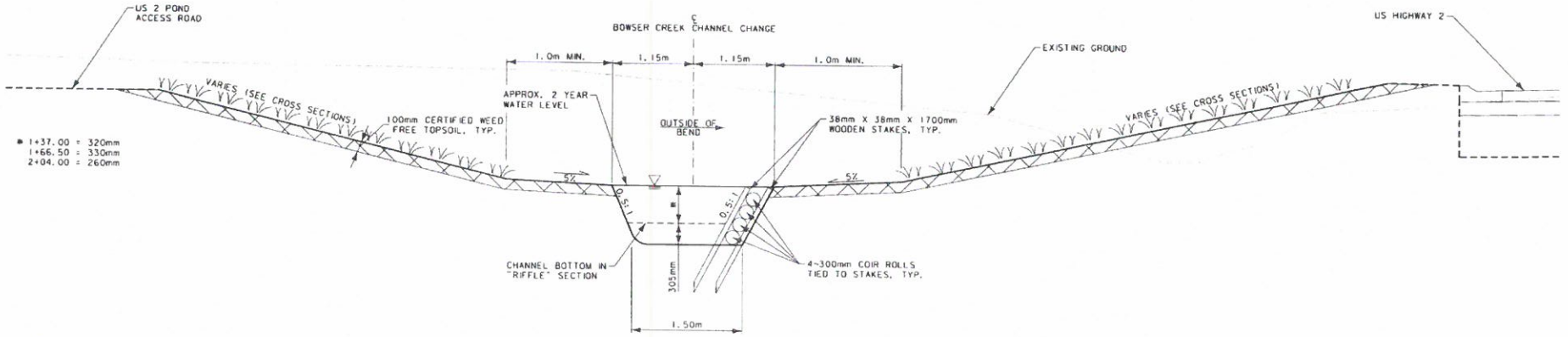
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

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

CSF - 0.999470385

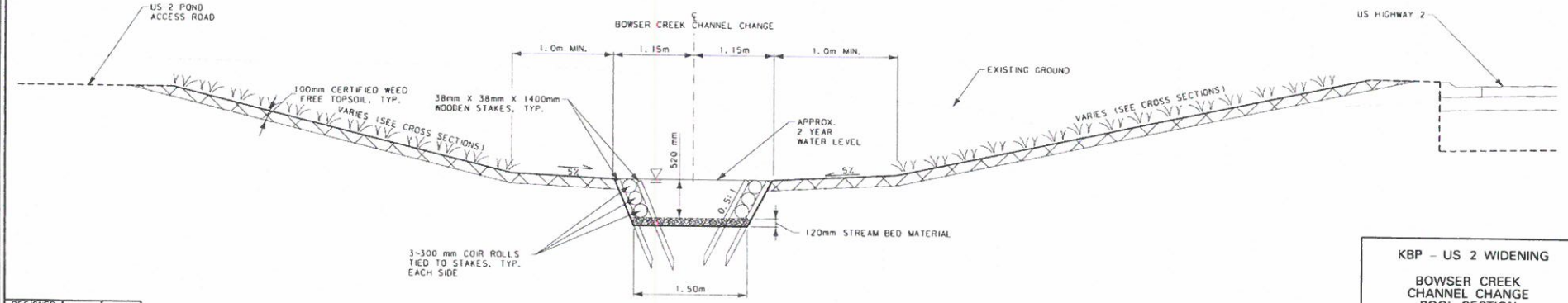
DETAIL

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

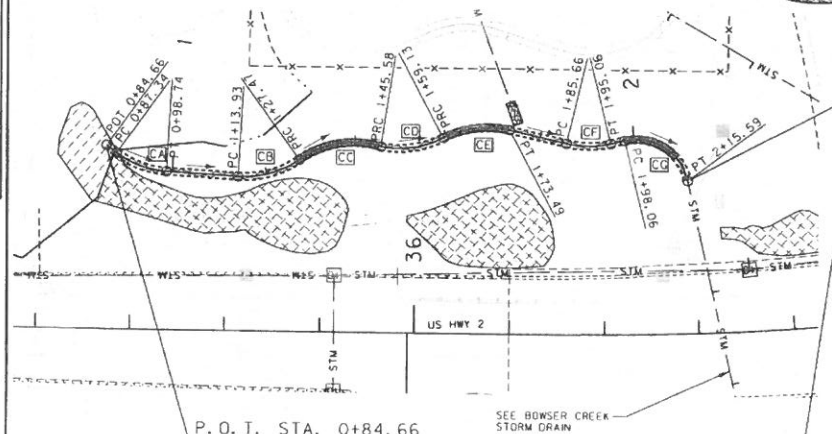
SPRING CREEK CHANNEL CHANGE CURVE DATA

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

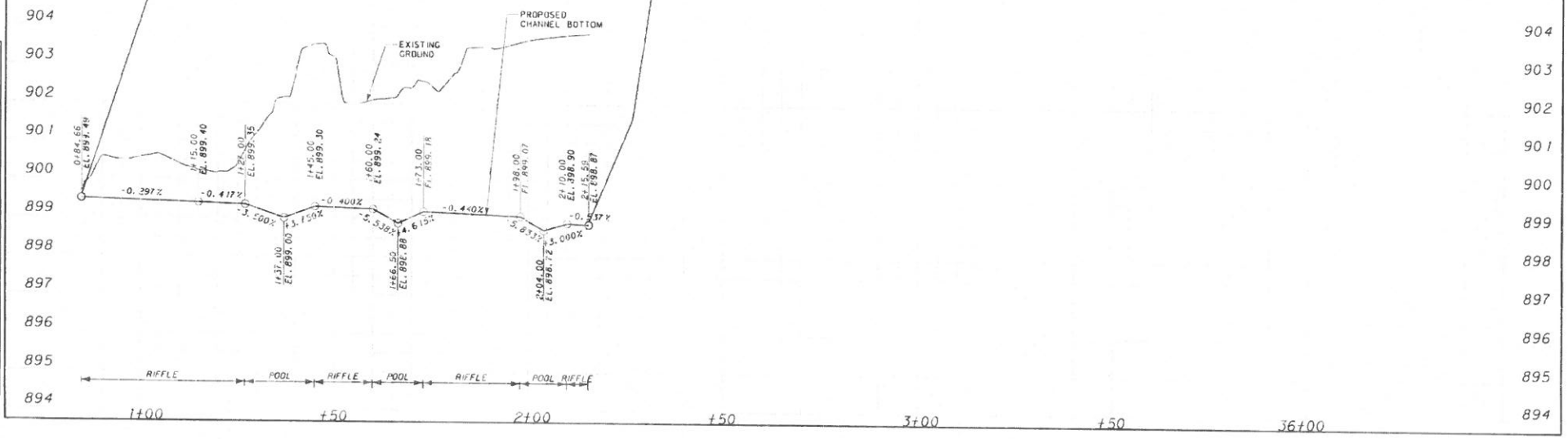


P.O.T. STA. 0+84.66
BEGIN BOWSER CREEK CHANNEL CHANGE =
STA. 35+34.77 US 2

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

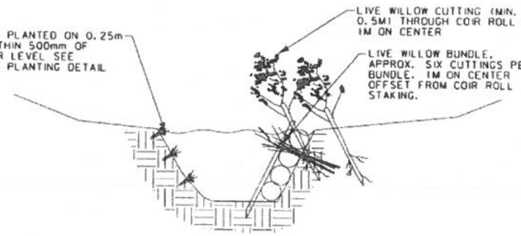
Stelling Engineers, INC.

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 INSTALLATION.
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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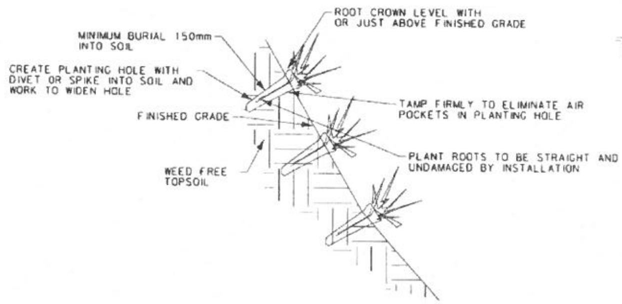
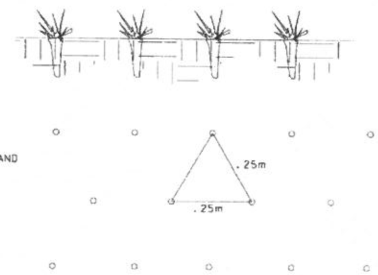
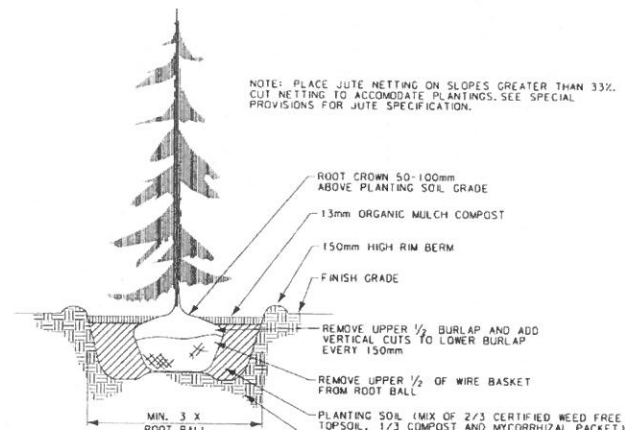
BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY	V2
BOWSER CREEK VEGETATION PLAN	V3
US HWY 2 DETENTION POND VEGETATION PLAN	V4



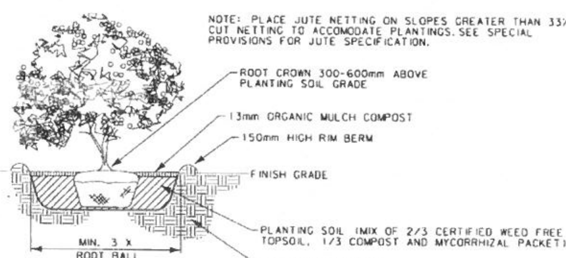
ZONE D RIPARIAN PLUG PLANTING
FOR INSIDE BEND OF SPRING CREEK POOLS
SCALE: NOT TO SCALE



SPACING



TREE PLANTING
SCALE: NOT TO SCALE



SHRUB PLANTING
SCALE: NOT TO SCALE

KBP - US 2 WIDENING

TABLE OF CONTENTS & DETAILS

NO SCALE

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

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

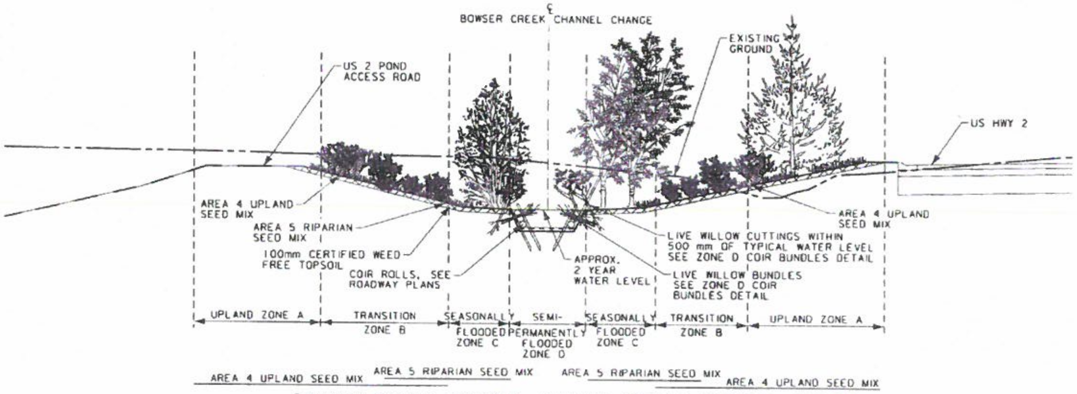
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V2

CSF = 0.999470385

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

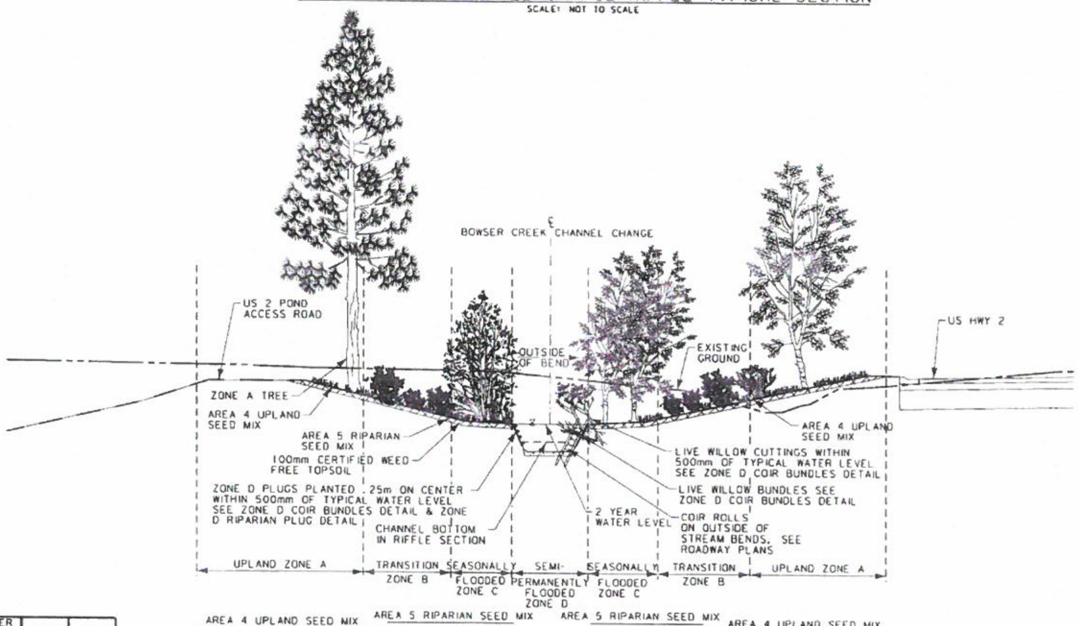
DETAIL

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				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
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				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
BO	BETULA OCCIDENTALIS	WATER BIRCH - MUTLISTEM	5	15 GAL.
SHRUBS				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
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				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	
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				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	666	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	666	CUTTINGS
STREAMBANK PLUGS				
	BOTANICAL NAME	COMMON NAME	QNTY	
	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

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

MONTANA CADD

MDT MONTANA DEPARTMENT OF TRANSPORTATION

SE Stelling Engineers, Inc.

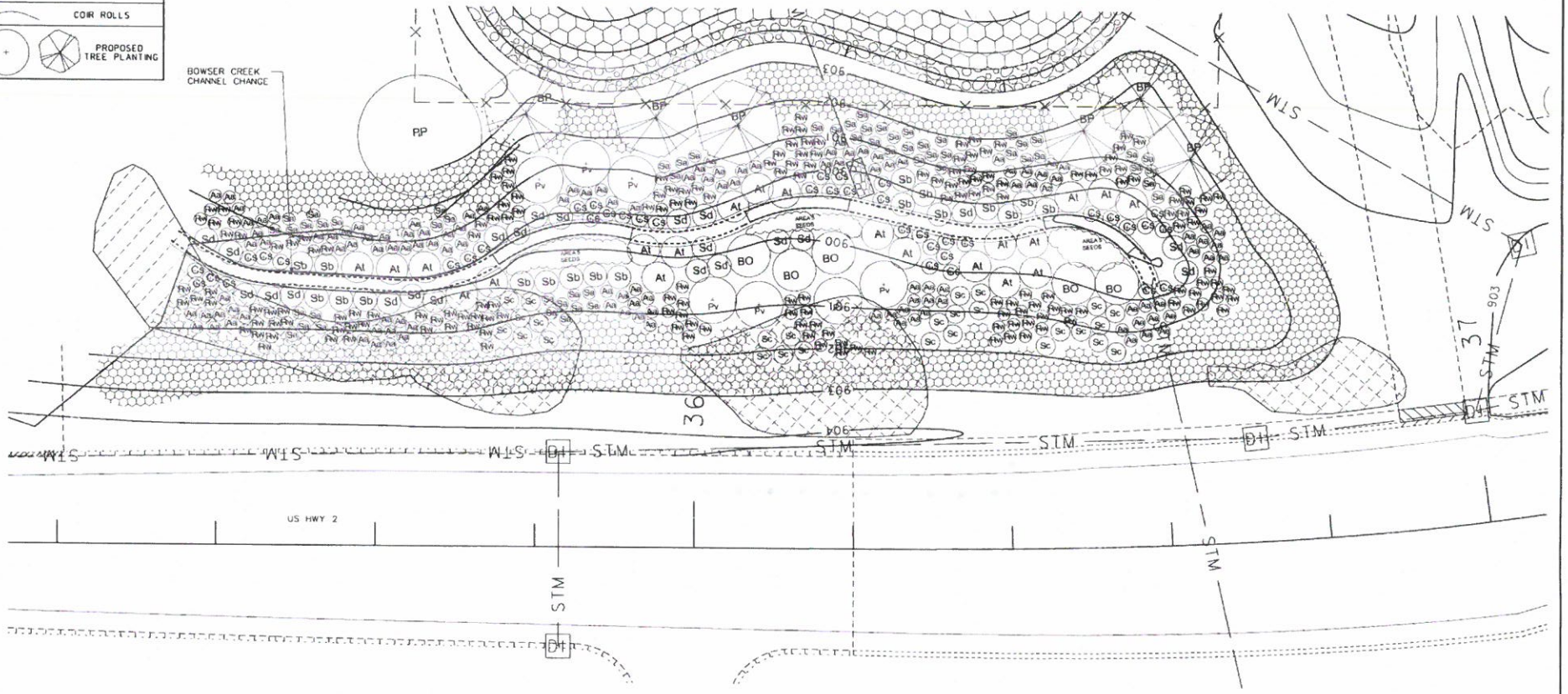
DETAIL

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.