MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Mill Creek
Ravalli County, Montana

Project Constructed: 2011
Monitoring Report #3: December, 2015

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #3

YEAR 2015

Mill Creek
Ravalli County, Montana

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1.0 INTRODUCTION

The following report presents the results of the third year of post stream re-construction monitoring at the U.S. 93 stream crossing at Mill Creek near Hamilton, Montana. This report includes an evaluation of monitoring results in comparison to project performance standards outlined in the approved U.S. Army Corps of Engineers 404 permit for the project. Mitigation is to be monitored for five years to evaluate compliance toward meeting performance standards. The project was constructed in 2011; therefore, these results provide documentation of the site's condition four years following the project's completion.

As part of the construction of the Bear Creek Road-South segment of U.S. Highway 93, the Montana Department of Transportation (MDT) relocated a segment of Mill Creek to align with a new permanent bridge. The realignment of Mill Creek included deactivating and filling approximately 630 feet of the channel and constructing approximately 581 feet of new channel through a relic flood swale. Permanent impacts to Mill Creek were authorized by the U.S. Army Corps of Engineers (USACE), as outlined in Corps permit number NWO-1997-90821-MTH and SPA 124 Authorization number MDT-R2-15-2010.

Special conditions specified in this permit included monitoring of the relocated segment of Mill Creek for five years following channel construction to document streambank stability and the success of riparian vegetation establishment. Performance success criteria outlined in the monitoring plan for the Mill Creek site include:

1. **Riparian vegetation coverage**
   a) Minimum of 80% total vegetative coverage by the end of the third growing season.
   b) Minimum of 50% areal coverage by woody species by the end of the third growing season.

2. **Streambank stability** – any unstable banks within the relocated channel segment will require corrective actions.

Additional reporting requirements outlined in the monitoring plan include:

3. **As-built survey** - as built drawings of the relocated channel at a 1:50 scale or smaller and planting schematic with a planted species list and number of plants planted.

4. **Monitoring stations** - establishment of 4 monitoring stations 75' apart with surveyed cross sections and bank pins installed as permanent reference points.

5. **Photo points** - color photos at each monitoring station showing both banks and upstream and downstream views.

Results of the third year monitoring of the Mill Creek project are summarized 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 reporting requirements including a 2013 topographic survey of the project site, repeated survey results at four perpendicular transects, a typical planting plan from the approved design, photo-documentation of the project site, and a map indicating the endpoints of riparian belt transects and perpendicular transect surveys are included as Appendices to this report.

2.0 SITE LOCATION

The relocated segment of Mill Creek flows beneath a newly constructed bridge on U.S. Highway 93 approximately 7 miles north of Hamilton, Montana (Figure 1). The project reach includes approximately 500 feet of Mill Creek upstream of the Highway 93 Bridge and extends approximately 100 feet downstream of the bridge. The project is located in Section 19, Township 7 North, Range 20 West, in Ravalli County, Montana. Note the topographic map in Figure 1 refers to Mill Creek as Fred Burr Creek below the confluence of these streams. The National Hydrography data set indicates the project area is on Fred Burr Creek, although the major contributing stream and larger watershed upstream of the confluence of these streams is Mill Creek.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on July 21, 2015 while topographic survey crews visited the site on July 27, 2015. The following data were collected at the Mill Creek stream mitigation site:

3.1. Riparian Vegetation Inventory - Belt Transects

Two riparian belt transects established during the first monitoring event in 2013 were re-surveyed to document areal percent cover of total vegetation, woody vegetation, and noxious weeds. The belt transect on the right (south) bank is parallel to the downstream extent of the project reach for 140 feet. The left (north) bank belt transect doglegs to maintain a parallel alignment with the channel for 435 feet. The extent of each riparian transect is shown in Figure 2 of Appendix A.

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, a qualitative severity rating score, and potential causes of bank erosion.

3.3. Perpendicular Transects

Four perpendicular transects (cross sections) established during the first monitoring event were re-surveyed to document vertical and lateral adjustments at two riffles and at two pools.

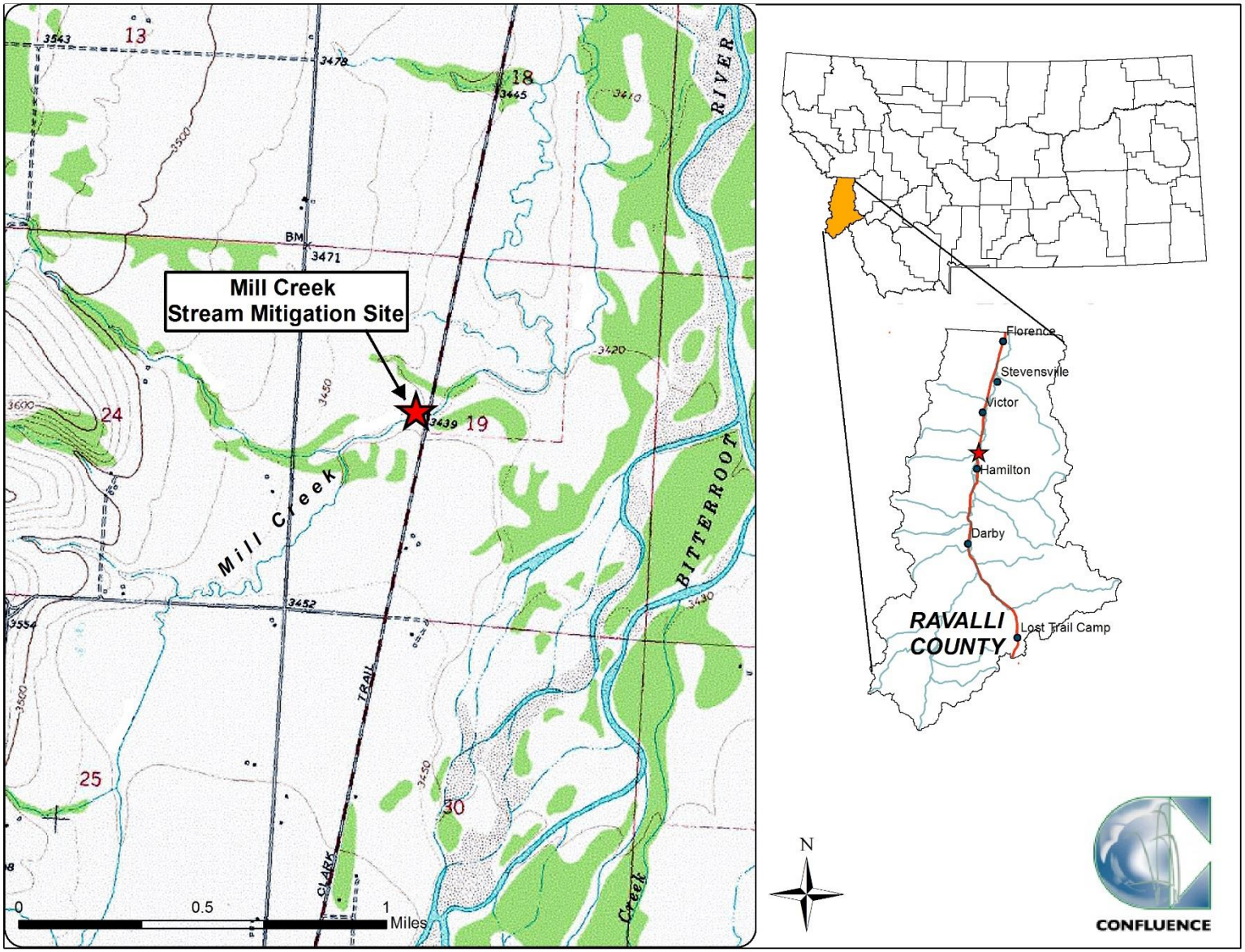


Figure 1. Project location of Mill Creek stream mitigation site.

3.4. Longitudinal Profile

A longitudinal profile of the channel thalweg was surveyed to document bedform complexity and aquatic habitat conditions present within the monitoring reach.

3.5. Photo-Documentation

Photos were taken at all photo points established during the first monitoring event in 2013 to document vegetation establishment and stream bank conditions within the project site. Photos were also taken at each perpendicular cross section in the upstream and downstream direction, as well as toward each stream bank.

4.0 RESULTS

4.1. Riparian Vegetation Inventory-Belt Transects

Table 1 summarizes the vegetative composition of each riparian transect, including an area-weighted areal percent cover of total vegetation, woody vegetation, and noxious weeds. In 2015, the total percent riparian cover was 84%, and included 58% cover by herbaceous species and 26% cover by woody species. Percent cover of noxious weeds continued to increase in 2015 and was estimated at 19%. Noxious weeds were particularly high on the left (north) bank of the project reach (25%) where construction activities occurred.

Table 1. Riparian vegetation composition of Mill Creek in 2013, 2014, and 2015.

Belt Transect	Length (ft)	Total % Riparian Cover			% Woody Cover			% Noxious Weed Cover		
		2013	2014	2015	2013	2014	2015	2013	2014	2015
Right (south bank)	140	100	100	96	60	60	60	1	1	2
Left (north bank)	435	75	80	80	15	15	15	15	20	25
Area weighted Total	575	81	85	84	26	26	26	8	15	19

Table 2 includes a comprehensive list of plant species observed along the new channel alignment and riparian buffer areas in 2013, 2014, and 2015. In 2015, 94 species were observed, representing an increase by 13 species from the previous monitoring event. In 2015, 47 of the species (50%) observed were hydrophytic based on the 2014 National Wetland Plant List (NWPL) (Lichvar et al., 2014).

The vegetation inventory along Mill Creek identified six noxious weeds and one state-regulated species (Table 3). In 2013 and 2014, Field Pepper-Grass (*Lepidium campestre*) was incorrectly identified as Broad-Leaf Pepperwort (*Lepidium latifolium*), which has subsequently been removed from the list of noxious weeds present at this site. Locations of all noxious weeds observed are shown on Figure 3 in Appendix A.

Table 2. Comprehensive list of plant species identified at the Mill Creek stream mitigation site in 2013, 2014, and 2015.

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
Agrostis gigantea	Black Bent	FAC
Agrostis scabra	**Rough Bent**	**FAC**
Algae, brown	**Algae, brown**	**NL**
Algae, green	**Algae, green**	**NL**
Alnus incana	Speckled Alder	FACW
Alopecurus aequalis	Short-Awn Meadow-Foxtail	OBL
Alyssum alyssoides	Pale Alyssum	NL
Antennaria parvifolia	Nuttall's Pussytoes	NL
Artemisia absinthium	**Absinthium**	**NL**
Aster sp.	Aster	NL
Bassia scoparia	Burningbush	FAC
Berteroa incana	**Hoary False-Alyssum**	**NL**
Betula pumila	Bog Birch	OBL
Bromus arvensis	Field Brome	UPL
Bromus inermis	Smooth Brome	FAC
Bromus japonicus	Japanese Brome	NL
Bromus tectorum	Cheatgrass	NL
Calamagrostis canadensis	**Bluejoint**	**FACW**
Calamagrostis stricta	**Slim-Stem Reed Grass**	**FACW**
Carduus nutans	**Nodding Plumeless-Thistle**	**UPL**
Carex aquatilis	Leafy Tussock Sedge	OBL
Carex nebrascensis	Nebraska Sedge	OBL
Carex sp.	Sedge	NL
Carex stipata	Stalk-Grain Sedge	OBL
Carex utriculata	Northwest Territory Sedge	OBL
Centaurea stoebe	Spotted Knapweed	NL
Chamerion angustifolium	Fireweed	NL
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	**Bull Thistle**	**FACU**
Cornus alba	Red Osier	FACW
Crataegus douglasii	Black Hawthorn	FAC
Dactylis glomerata	Orchard Grass	FACU
Dasiphora fruticosa	Golden-Hardhack	FAC
Deschampsia caespitosa	Tufted Hairgrass	FACW
Descurainia sophia	Herb Sophia	NL
Eleocharis palustris	Common Spike-Rush	OBL
Elymus canadensis	**Nodding Wild Rye**	**FAC**
Elymus hispidus	Intermediate Wheatgrass	NL
Elymus repens	Creeping Wild Rye	FAC
Epilobium ciliatum	Fringed Willowherb	FACW
Equisetum arvense	Field Horsetail	FAC
Equisetum hyemale	Tall Scouring-Rush	FACW
Erodium cicutarium	**Stork's Bill**	**NL**
Euphorbia esula	Leafy Spurge	NL
Festuca idahoensis	Bluebunch Fescue	FACU
Fragaria virginiana	Virginia Strawberry	FACU

Scientific Name	Common Name	WMVC Indicator Status*
Geum macrophyllum	Large-Leaf Avens	FAC
Geum sp.	Avens	NL
Juncus balticus	Baltic Rush	FACW
Juncus effusus	Lamp Rush	FACW
Juncus ensifolius	Dagger-Leaf Rush	FACW
Juncus sp.	Rush	NL
Lepidium campestre	**Field Pepper-Grass**	**NL**
Leucanthemum vulgare	Ox-Eye Daisy	FACU
Lolium perenne	Perennial Rye Grass	FAC
Lupinus sericeus	Pursh's Silky Lupine	NL
Medicago lupulina	Black Medick	FACU
Melilotus officinalis	Yellow Sweet-Clover	FACU
Mentha arvensis	American Wild Mint	FACW
Mimulus guttatus	Seep Monkey-Flower	OBL
Myosotis laxa	Bay Forget-Me-Not	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
Pinus ponderosa	Ponderosa Pine	FACU
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Populus angustifolia	Narrow-Leaf Cottonwood	FACW
Populus balsamifera	Balsam Poplar	FAC
***Ranunculus* sp.**	**Buttercup**	**NL**
Ribes lacustre	Bristly Black Gooseberry	FAC
Rosa woodsii	Woods' Rose	FACU
Rumex acetosella	Common Sheep Sorrel	FACU
Rumex crispus	Curly Dock	FAC
Salix bebbiana	Gray Willow	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Scirpus microcarpus	Red-Tinge Bulrush	OBL
Silene vulgaris	Maiden's-tears	NL
Sisymbrium altissimum	Tall Hedge-Mustard	FACU
Solanum dulcamara	Climbing Nightshade	FAC
Solidago canadensis	Canadian Goldenrod	FACU
Sonchus arvensis	Field Sow-Thistle	FACU
Symphoricarpos albus	Common Snowberry	FACU
Tanacetum vulgare	Common Tansy	FACU
Taraxacum officinale	Common Dandelion	FACU
Tragopogon pratensis	Meadow Goat's-beard	NL
Trifolium pratense	Red Clover	FACU
Trifolium repens	White Clover	FAC
Verbascum thapsus	Great Mullein	FACU
Veronica americana	American-Brooklime	OBL

*Based on 2014 NWPL (Lichvar *et al*., 2014)
New species identified in 2015 are **bolded**.
***Lepidium latifolium* was misidentified in 2014 and has been changed to *Lepidium campestre*

Table 3. Montana State listed noxious weed and regulated species observed in 2015 at the Mill Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	***Berteroa incana***	**Hoary False-Alyssum**
	Centaurea stoebe	Spotted Knapweed
	Cirsium arvense	Canadian Thistle
	Euphorbia esula	Leafy Spurge
	Leucanthemum vulgare	Ox-Eye Daisy
	Tanacetum vulgare	Common Tansy
Priority 3 State Regulated	*Bromus tectorum*	Cheatgrass

*Based on the Montana Dept. of Agriculture 2015 Noxious Weed List.
New species identified in 2015 are **bolded**.
***Lepidium latifolium* was misidentified in 2014 and has been changed to *Lepidium campestre.*

4.2. Bank Erosion Inventory

Four eroding banks were observed within the project reach (EBL3, EBL4, EBR1, EBR2). No new bank erosion was noted in 2015. Two eroding banks (EBL1 and EBL2) that were identified in 2013 occur just upstream of the project reach, and combined into one long eroding bank segment in 2014 (herein referred to as EBL1-2). Locations of all eroding banks are illustrated on Figure 2 in Appendix A. A qualitative erosion severity rating was generated by observing substrate composition of the bank, vegetation composition, and whether depositional features such as point bars were developing near the erosional area. Descriptions of erosion at each bank are included in the following section.

Eroding Bank EBL1-2 was documented as two separate eroding banks in 2013 which combined during 2014 to form one continuous 247-foot eroding bank. This bank occurs on private land upstream of the project reach, but has been documented in previous monitoring reports due to the potential of this bank affecting the project reach. This bank has continued to erode northward, the retreat rate estimated at 2-5 feet over the past year (see photo points 4.2, 4.3, and 4.4, Appendix C). Lateral movement of the bank has now cut beneath a large ponderosa pine tree near the downstream end of the eroding segment. This tree is in jeopardy of falling into the channel if erosion continues. If this tree falls across the channel, its size could create a sizable obstruction across the channel width, and may result in localized channel adjustments. It is unclear at this time how any channel adjustments may affect the reconstructed project reach.

Bank erosion at EBL1-2 is due to adjacent point bar formation forcing the channel against a relatively high, herbaceous vegetated stream bank along a relatively sharp meander. Root wads and large rocks placed, but not keyed into the toe of the banks are causing increased scour and block failure. The vegetation community along these banks include speckled alder, Kentucky bluegrass, smooth brome, sedges, common yarrow, western-wheat grass, Canadian goldenrod, and ox-eye daisy. The bank retreated between 3 and 7 feet from 2013 to 2014 and an additional 2-5 feet from 2014

to 2015. Based on the combination of eroding factors, severity of erosion along EBL1-2 is considered high.

Erosion at EBL3 is occurring at the head of the former channel alignment (now backfilled with gravel, cobble, and soil), and extends downstream approximately 90 feet beyond the root ball of a fallen tree. In 2014, erosion was noted along the toe of the bank, causing it to retreat. The vegetation community consists of short-awn meadow foxtail, white and red clover, Kentucky bluegrass, common tansy, and ox-eye daisy. Erosion along this bank did not appear to advance in length or retreat further in 2015. The bank has retreated approximately 1 to 2 feet since 2013. Based on the combination of erosion factors, severity of erosion along EBL3 is considered low.

At eroding bank EBL4, bank sloughing has continued to occur upstream and downstream of several root balls that fell into the channel. The 64-foot long eroding bank has several root balls from cut trees along the toe, which may have been used to construct the log and root wad revetment just downstream. Bank instability at this location was potentially caused by removal of the trees for use in log revetment construction, or from natural channel adjustments following construction. The dominant vegetation along the bank includes reed canary grass and smooth brome. The bank retreated approximately 1 to 2 feet between 2013 and 2014, but does not appear to have retreated further in the past year. Erosion severity along this bank is considered low to moderate.

At eroding bank EBR1, several trees have fallen into the channel due to undercutting directly across the channel from EBL4. Trees have also fallen away from the channel, providing evidence of undercutting and block failure, or blow down. Photo evidence does not indicate further erosion beneath the fallen trees, and it does not appear this bank has laterally migrated in the past year. The vegetation community along this bank consists of cottonwood, speckled alder, smooth brome, and bog birch. Bank erosion severity along this 58-foot segment is considered low.

Erosion at EBR2 was noted along 65 feet of the channel across from the head of the deactivated stream channel. Erosion at this location is due to channel adjustments and scour along the outside of a meander. No additional erosion was noted over the past year at this bank. The vegetation community is dominated by reed canary grass with a speckled alder and bog birch overstory. These factors contribute to an overall low erosion severity rating. Of note, the adjustment in channel alignment due to erosion at EBL1-2 may eventually result in additional erosion at eroding bank EBR2 due to high flows directed toward eroding bank EBR2.

4.3. Perpendicular Transects

Surveyed transects were established in 2013 and have been re-surveyed in 2014 and again in 2015. Plots for each surveyed transect are included in Appendix B. Transects #2 and #3 were surveyed at scour pools formed by woody debris jams, while transects #1 and #4 were surveyed at riffles.

The channel at riffle transect #1 was intended to be positioned at a riffle; however, monitoring indicates this feature is more indicative of a pool. A shallow bar has formed on the left side of the channel and thalweg near the right bank. Minor erosion was noted along the right bank during the 2014 monitoring event, although the re-surveys do not indicate significant lateral migration further southward. Upstream of this transect, the channel has migrated northward (Eroding Bank EBL1-2), and the channel has now established a shallow pool along the right bank through transect #1. Inspection of the longitudinal profile also indicates the bed at this transect occurs at a shallow pool (STA 140+00).

Riffle transect #4 occurs just above the last bend upstream of the U.S. Highway 93 Bridge. The re-survey at this transect in 2015 revealed no change to the bed elevation (outside of measurement error) since the previous monitoring event. This riffle section appears to be stable and efficiently transporting incoming sediment. Inspection of the longitudinal profile indicates the bed at this transect occurs at the downstream extent of a long pool at Station 500+00 and is about 25 feet upstream from the next riffle crest.

Pool transect #2 occurs at a woody debris jam, and has maintained its width and depth over the past two monitoring events. Only slight elevation changes are noted in the repeat surveys. Inspection of the longitudinal profile indicates this transect occurs within a shallow pool at Station 235+00.

The channel at pool transect #3 has maintained its width and depth since the previous monitoring event. A woody debris jam has established here and has formed a sizable scour pool on the left (north) side of the channel and a smaller, shallower pool on the right (south) side. The mid-channel bar appears to have accumulated some gravels, but is similar in elevation to the original survey performed in 2013. Inspection of the longitudinal profile indicates this transect also occurs within one of the shallower pools within the project reach at Station 300+00.

Results of the monitoring transects reveal relatively minor adjustments to the channel bed and banks throughout the project reach. This reach of Mill Creek is highly active with a relatively high supply of bedload transporting from upstream reaches of the creek. Creeks exhibiting high bedload composition tend to migrate as bars develop and bank migration recruits woody debris. The monitoring reach includes several large trees and woody debris, which provide opportunities for bedform complexity and variability in habitat features. As a result of these factors, channel adjustments are likely to continue occurring within the monitoring reach. These adjustments and subsequent erosion/deposition observed do not necessarily equate to channel instability, as these are natural processes that occur within meandering stream channels.

4.4. Longitudinal Profile

A longitudinal profile of the stream bed along the thalweg was surveyed in 2014 and again in 2015 to document bedform complexity and aquatic habitat conditions (Appendix B). The bed profile indicates continued presence of several shallow as well

as two deep pools separated by very short riffles. The channel has maintained a consistent gradient with minor adjustments to elevations at some of the riffle crests. Shorter, shallower pools have been maintained primarily between meander bends where woody debris creates scour against the stream bed. The two deeper pools occur where the channel is scouring against the outside bank of the meander bends. As mentioned in the previous section, the woody debris complexity and relatively high bedload composition evident in this segment of Mill Creek is likely to continue resulting in minor adjustments to the stream bed as the channel transports sediment and water.

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Mill Creek Stream Mitigation site is intended to document whether the reconstructed segment of the channel is meeting performance standards outlined in the approved U.S. Army Corps permit for the project. Table 4 summarizes the status of each performance criteria following the third year of monitoring and four years following completion of the project. Additional reporting requirements, including results of the perpendicular transects, bed profile survey, photo-documentation, and as-built topographic schematics are included as appendices to this report and offer additional documentation of the site's condition.

Table 4. Status of performance standards three years following project completion.

Parameter	Success Criteria	Status	Meeting Performance Criteria?
Riparian Cover	80% total vegetative coverage after 3rd year	Total vegetative cover of the project site is 84**%** following third year of monitoring (96% of south bank and 80% of left bank).	Yes
	50% woody species coverage after 3rd year	Woody cover of the project site is 26**%** following third year of monitoring (60% of south bank and 15% of north bank).	No
Streambank Stability	Unstable banks identified within the project reach will require corrective action	Four eroding bank segments were observed in 2015 and range in severity from minor to moderate.	No

5.1. Riparian Cover

Vegetation along the south bank of Mill Creek was minimally disturbed during construction of the new channel alignment and was limited to a short (approximately 50') reach immediately adjacent to the new highway bridge. This channel segment has been stabilized with rock to protect the bridge infrastructure. As a result, the success of revegetation efforts should focus on the north bank along areas where construction equipment accessed the new channel alignment and filled the former channel configuration.

Total vegetative cover observed along the north bank riparian transect was 80%, which falls right at the success criteria threshold of 80%. Patches of bare ground were observed along the deactivated channel alignment. Bare ground was also observed beneath mature ponderosa pine trees, although the layer of pine needles beneath these

trees is a natural cause for bare ground cover. When factoring in the undisturbed south bank, total vegetative cover across the site was 84%.

Woody vegetation cover along the north bank remained at 15% cover, which falls well below the success criteria threshold of 50%. No woody vegetation was observed along the backfilled channel segment, and few woody shrubs were observed along the north bank of the newly aligned channel. Several mature ponderosa pine trees remain along the north bank and provide the majority of the woody species composition. When factoring in the undisturbed south bank woody species cover, total woody cover for the site remained at 25%. Vegetation cover along the south bank remained consistent with 60% cover provided by woody species. The performance criteria for woody vegetation cover has been met along the south bank; therefore efforts to increase woody vegetation cover within the project should focus on the north bank.

Cover of noxious weeds increased to 25% along the north side of the channel, 2% along the south side of the channel, and 19% of the vegetation within the monitored riparian transects. Six noxious weed species were observed. Based on these results, weed control and the establishment of additional woody vegetation will be necessary along the north bank to meet performance criteria for riparian cover.

5.2. Bank Erosion Inventory

The eroding bank inventory did not document any additional eroding banks beyond those identified during previous monitoring efforts. Four eroding streambanks were observed in the project area, while one additional eroding bank (EBL1-2) occurs immediately upstream of the project reach (Figure 2, Appendix A). The eroding bank upstream of the project area was included in the bank inventory due to its potential to affect the project reach.

The total length of bank erosion observed within the project reach did not change from the 2014 (second) monitoring event. The severity of erosion within the project reach is considered low, and is likely due to the channel naturally adjusting within the new alignment. Bedload deposition and scour created by meander bends and woody debris is likely to continue resulting in minor lateral movement of the stream banks. The erosion occurring within the project reach does not jeopardize infrastructure or threaten to overtake the deactivated channel segment.

The eroding bank immediately upstream of the project area has continued advancing northward, and is now threatening to undercut a large ponderosa pine tree at the upstream end of the project reach. This bank will likely continue to erode until a stable radius of curvature is established, or until this meander bend is cut off. The lateral migration of the bank northward does not currently jeopardize infrastructure, and is not currently threatening the relocated channel segment. If the ponderosa pine tree falls across the channel, it may create a larger debris jam and result in a more significant channel adjustment. As a result of this potential, continued monitoring is recommended during high flows to prevent a larger channel alignment change.

6.0 MANAGEMENT RECOMMENDATIONS

6.1. Woody Vegetation Establishment

Woody vegetation composition is relatively low along the disturbed sections of the north bank, which prevents achievement of the performance criteria for this category. Installation of additional woody vegetation is recommended within 25' of the bank, particularly within backfilled areas of the deactivated channel segment. No woody vegetation was observed within the backfilled channel segment. Installation of willows, alder, chokecherry, or Wood's rose within these areas would improve woody species composition within the riparian zone and assist in meeting this performance target.

6.2. Weed Control

Weed species comprised 25% of the north bank vegetation composition. Weed control efforts are warranted along the north bank to prevent the spread of these species. Weed species necessary to target include hoary false alyssum, spotted knapweed, Canadian thistle, leafy spurge, ox-eye daisy, common tansy.

6.3. Channel Stability

The project reach exhibits a significant amount of recent bedload deposition, gravel point bar formation, and formation of woody debris jams. The result of these processes includes some relatively minor lateral adjustments within the newly activated channel segment. Lateral bank adjustments are typical in streams exhibiting an abundance of bedload material, and should not be mistaken for overall channel instability. The stream banks within the project reach include a gravel/cobble toe overlain by a lens of finer gravel and vegetated topsoil. The banks are relatively steep and susceptible to lateral movements during high flows. Eliminating erosion from occurring within the entire project reach would require armoring each outside meander bend with oversized boulders, or constructing a series of barbs or vanes to deflect energy away from the banks. Neither of these approaches lends to development of a natural channel with supporting habitat components, or would provide appropriate mitigation to offset the project's impacts.

The approved 404 permit for the Mill Creek project states, "If any unstable stream banks are visible within the relocated channel, corrective measures will be required." Four eroding banks occur within the relocated channel segment of the project reach (EBL3, EBL4, EBR1, and EBR2). These banks exhibit bank sloughing, resulting in recruitment of gravel and woody debris to the channel, both of which are beneficial to maintaining trout habitat. In order to maintain a functional, sustainable stream channel, it could be argued these banks should be allowed to naturally adjust until such time as the channel configuration threatens stability of the bridge or highway. However, in order to meet the success criteria outlined in the permit, all of these banks must receive corrective actions. Corrective actions that would prevent erosion from occurring anywhere within the project reach include 1) installing toe armor along all banks susceptible to erosion, or 2) installing flow deflection structures such as a barb or vane to redirect the thalweg away from all banks susceptible to erosion. While implementation of these techniques may prove successful in meeting the success criteria for bank stability within the project

reach, they may result in increased erosion in other reaches of Mill Creek as the energy of the stream is transferred elsewhere. Furthermore, bank armoring or flow deflection techniques may require mitigation depending on their extent, which runs counter to the goal of the Mill Creek project to self-mitigate.

Two eroding banks identified during the 2013 monitoring event have combined into one long, eroding bank immediately upstream of the project reach (EBL1-2). Although these banks lie on private land upstream of the project reach, they have been noted and mapped due to their potential to affect the reconstructed channel segment. This bank lies along a very sharp bend of Mill Creek, where the channel turns approximately 135 degrees over a length of about 200 feet. This sharp turn in the channel will likely continue to result in lateral movement of the channel to the north until a stable meander radius is established. Continued northward movement of the meander may result in flows directed toward the south bank of Mill Creek, where erosion along bank EBR2 has been noted. The landowner has attempted to slow the erosion along EBR1-2 by cabling a tree and placing large boulders along the bank; however, these efforts are unlikely to successfully reduce the rate of lateral bank movement at this location. Erosion along this bank could be reduced with bioengineering techniques including installing a stone toe, resloping the vertical bank, and installing dense woody riparian vegetation.

6.4. Floodplain Fill

A chunk of asphalt was found in the materials used to fill the deactivated channel segment. It is unknown where the material used to fill the old channel originated, or whether that material came from excavating the new channel alignment. It is possible fragments of asphalt may have been mixed with native gravel and cobbles near the highway project where fill material was generated. It is recommended all fill materials used to fill deactivated channel segments be inspected for foreign materials prior to placement.

6.5. Woody Debris

Several woody debris jams have formed in the channel upstream of the bridge. These woody debris jams include trees that have been cut down, as well some that have naturally fallen into the creek. These debris jams are currently providing good aquatic habitat features, but should be monitored to ensure they do not create a large constriction upstream of the highway bridge. The bridge has been designed to convey a large flood event and will likely be successful at passing woody debris as well; however, periodic inspection of this bridge during and immediately following greater than bankfull flood events is recommended.

7.0 LITERATURE CITED

Lichvar, R.W., M. Butterwick, N.C. Melvin, and W.N. Kirchner. 2014. *The National Wetland Plant List. 2014 Update of Wetland Ratings*. Phytoneuron 2014-41:1-42.

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

Appendix A

Project Maps

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli 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

2015 Monitoring Features
Mill Creek

Figure 2

Date: 10/6/2015

MillCreek_features2015

CONFLUENCE
consulting incorporated

Legend

- Berteroa incana
- Centaurea stoebe
- Cirsium arvense
- Euphorbia esula
- Leucanthemum vulgare
- Tanacetum vulgare

N

0 25 50 100 150 200 Feet

2015 Monitoring Noxious Weeds Mill Creek

Figure 3

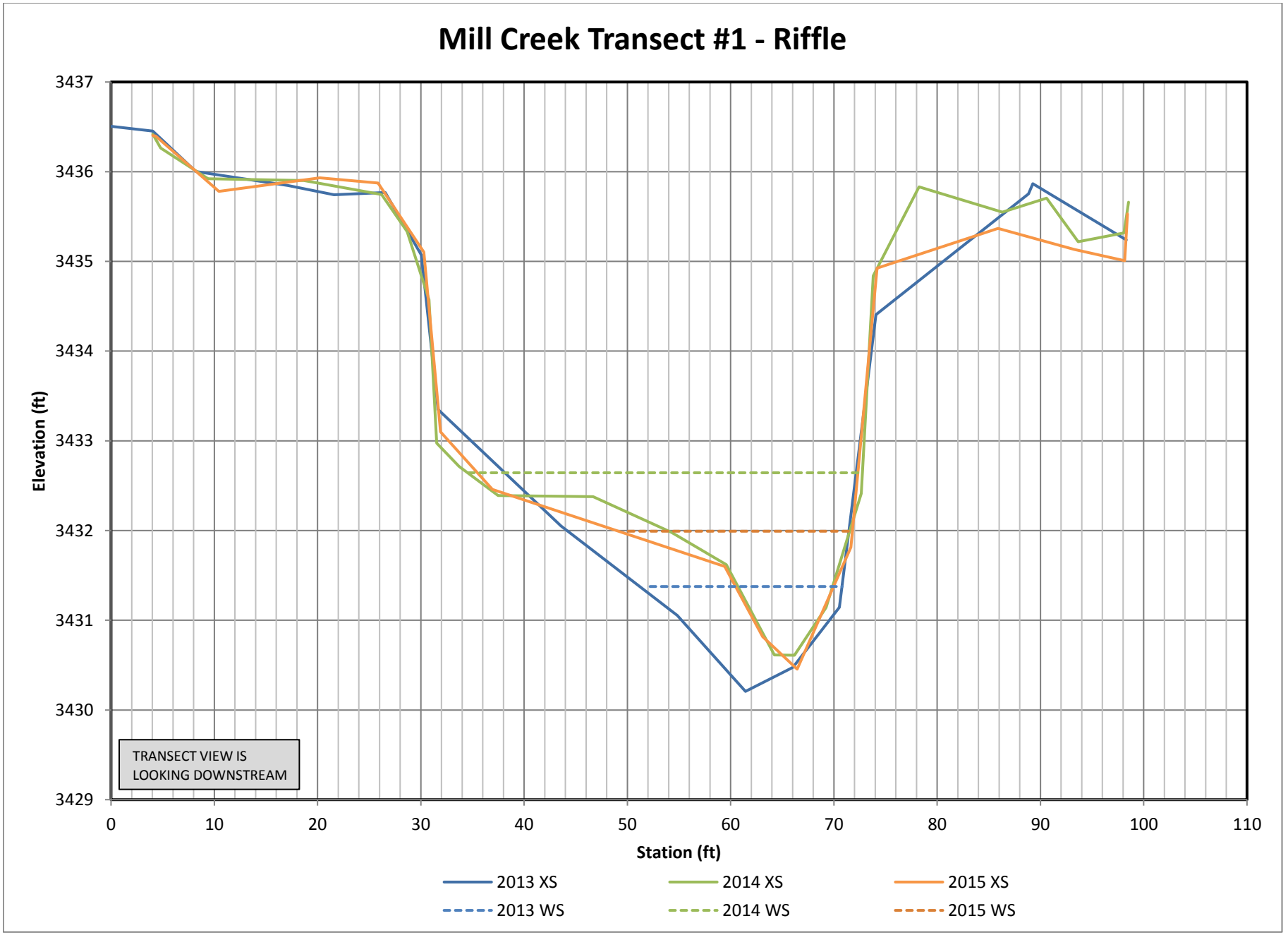
Date: 09/28/2015

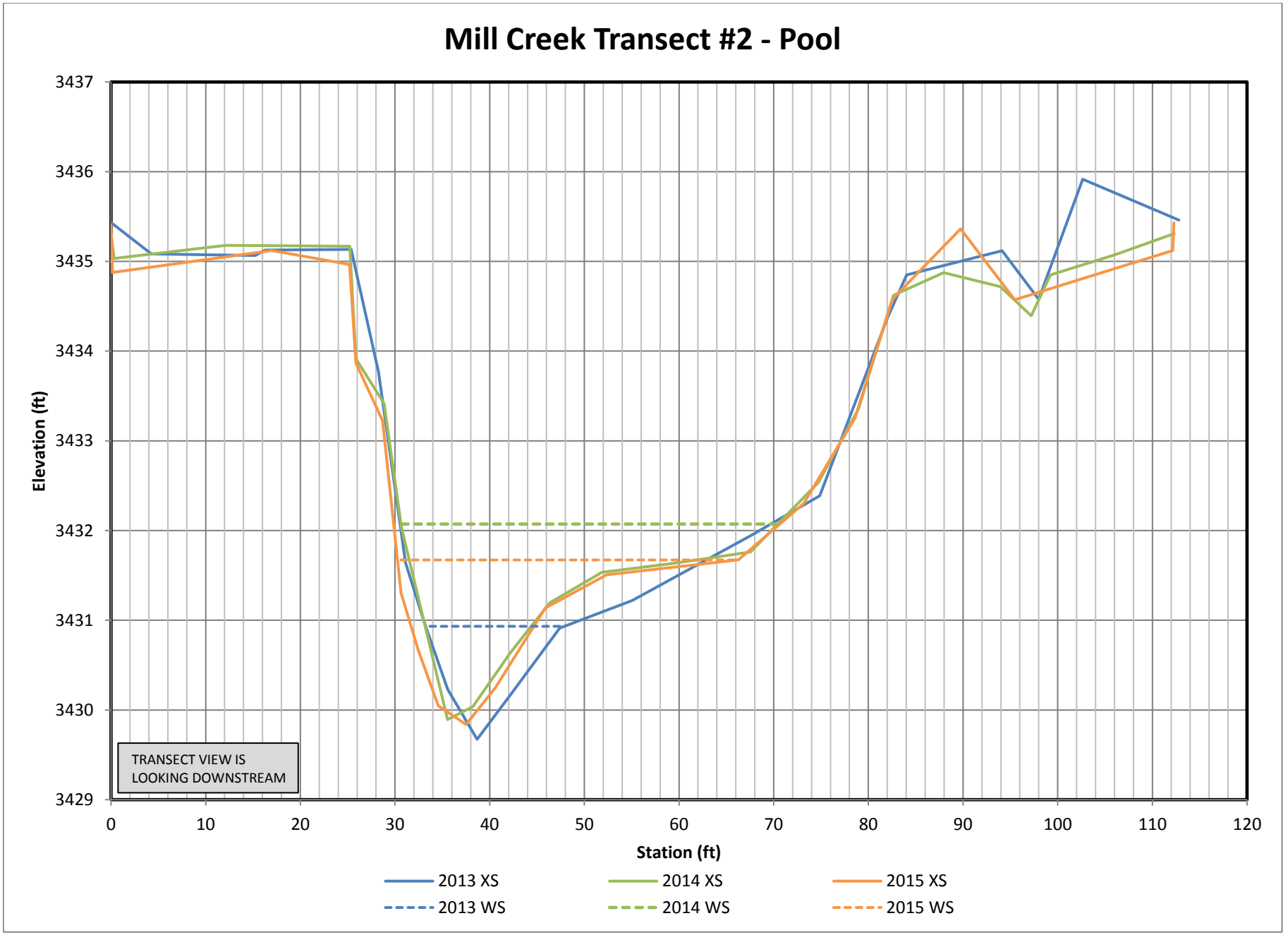
MillCreek_Weeds2015.mxd

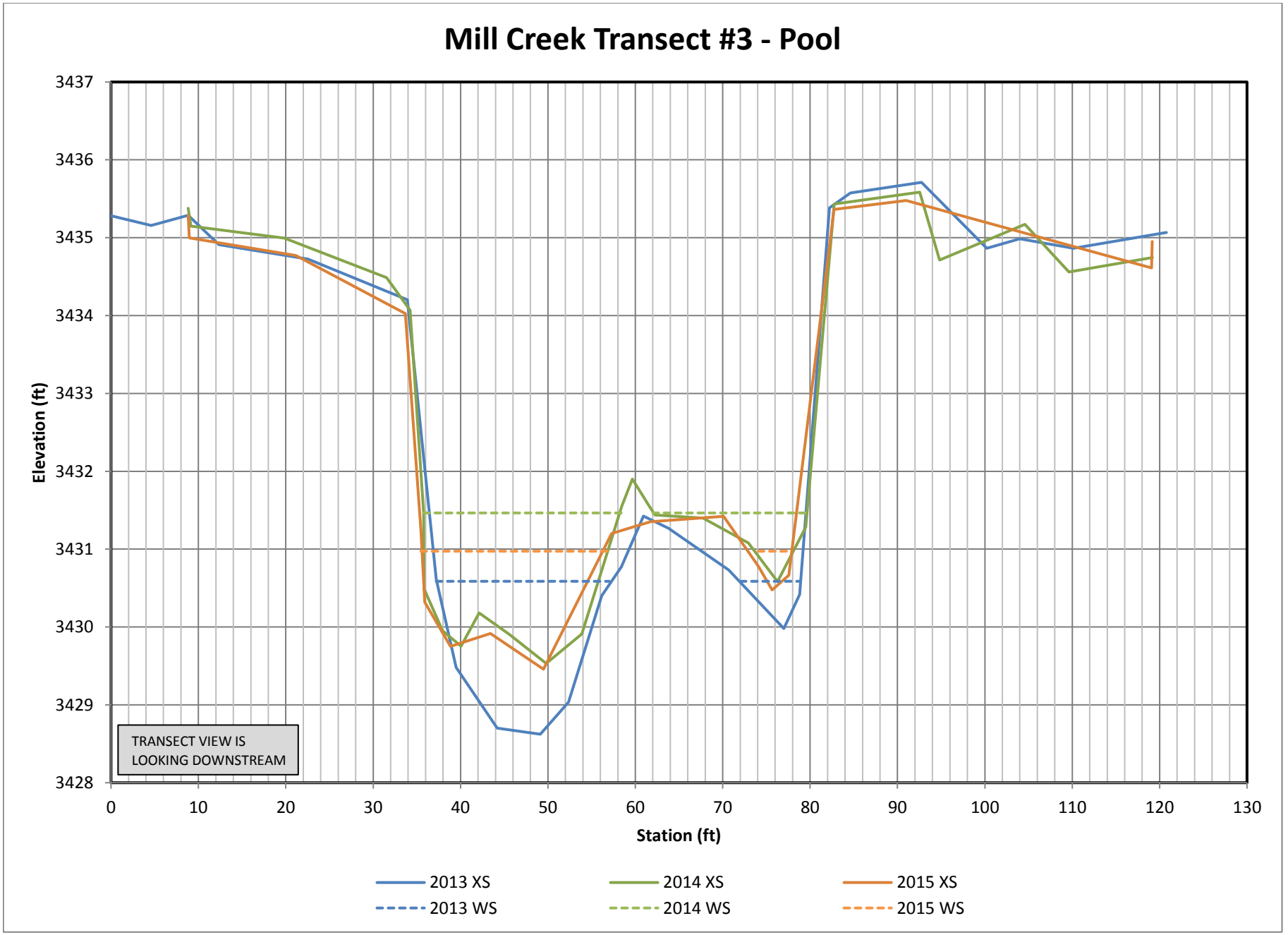
Appendix B

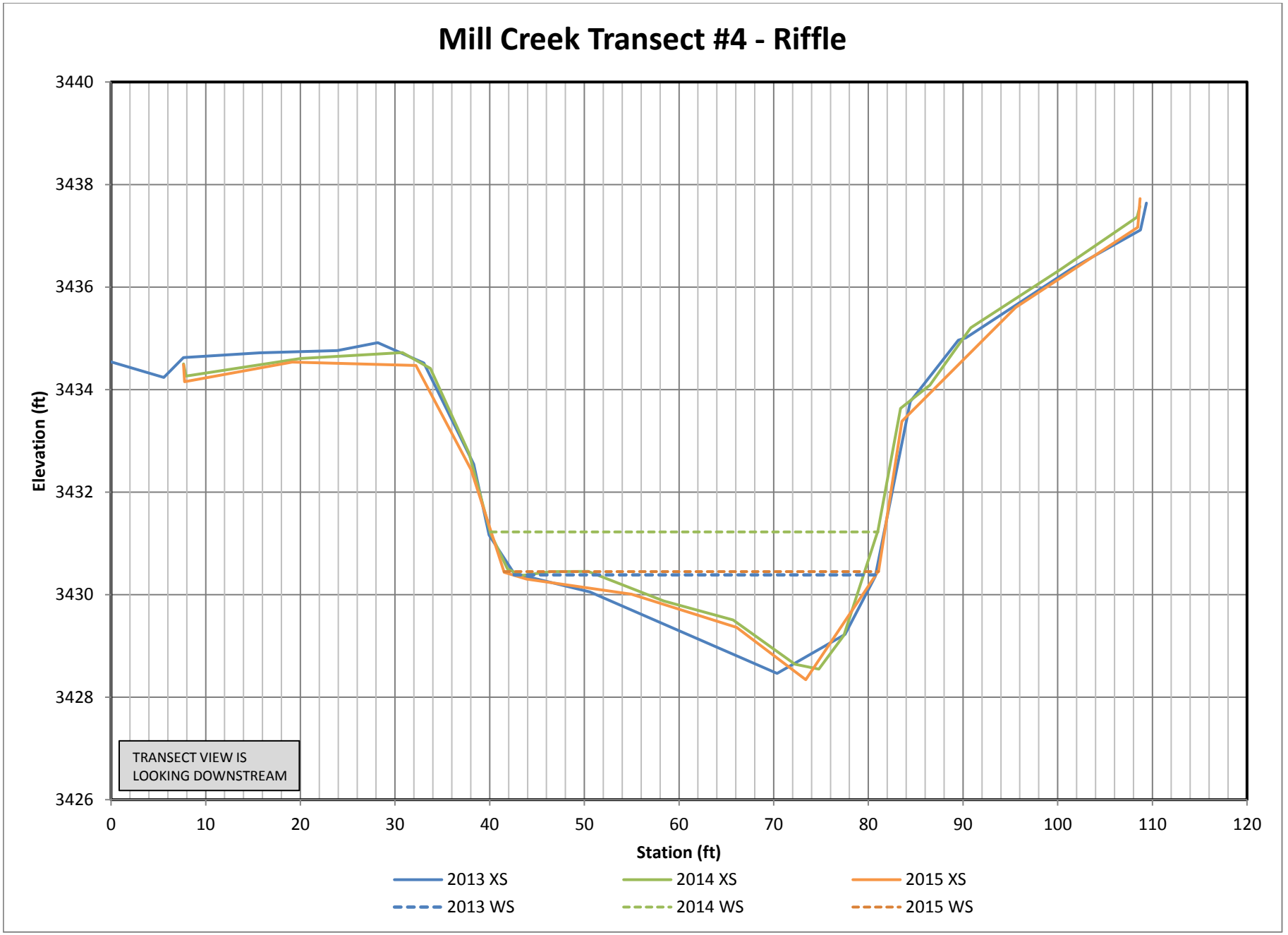
Perpendicular Transect and Longitudinal Profile Plots

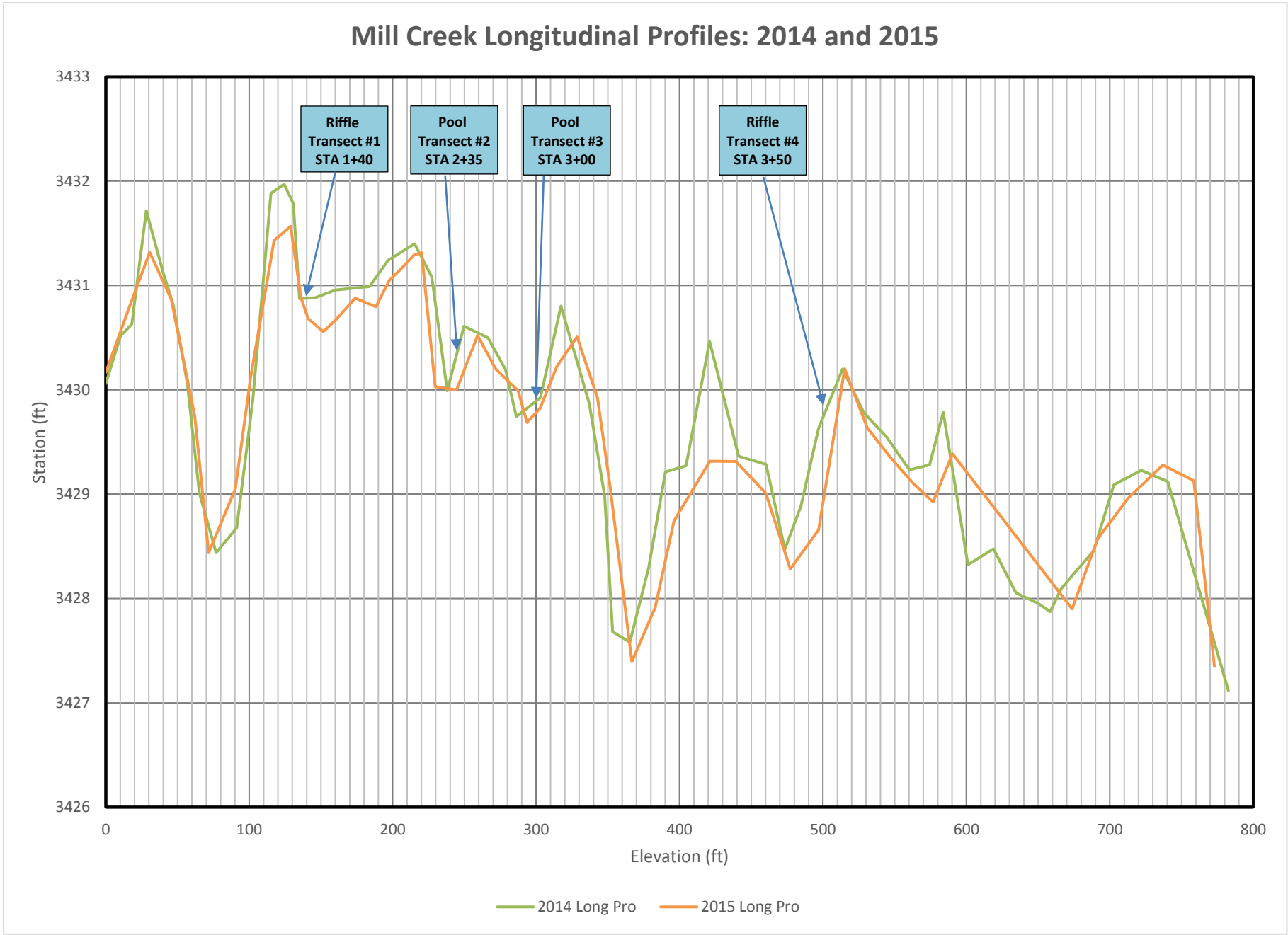
MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana


Mill Creek Transect #1 - Riffle
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
0
10
20
30
40
50
60
70
80
90
100
110
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2013 WS
2014 WS
2015 WS


Mill Creek Transect #2 - Pool
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
0
10
20
30
40
50
60
70
80
90
100
110
120
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2013 WS
2014 WS
2015 WS


Mill Creek Transect #3 - Pool
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
3428
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Station (ft)
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2013 WS
2014 WS
2015 WS


Mill Creek Transect #4 - Riffle
Elevation (ft)
3440
3438
3436
3434
3432
3430
3428
3426
0
10
20
30
40
50
60
70
80
90
100
110
120
Station (ft)
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2014 XS
2015 XS
2013 WS
2014 WS
2015 WS


Mill Creek Longitudinal Profiles: 2014 and 2015
Riffle Transect #1 STA 1+40
Pool Transect #2 STA 2+35
Pool Transect #3 STA 3+00
Riffle Transect #4 STA 3+50
Station (ft)
3433
3432
3431
3430
3429
3428
3427
3426
0
100
200
300
400
500
600
700
800
Elevation (ft)
2014 Long Pro
2015 Long Pro

Appendix C

Project Site Photos

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 1.1—2013
Description: View from south bridge abutment of north bank. **Compass**: 45 (Northeast)

Photo Point 1.1—2015
Description: View from south bridge abutment of north bank. **Compass**: 45 (Northeast)

Photo Point 1.2—2013
Description: View from right bridge abutment down-stream. **Compass**: 45 (Northeast)

Photo Point 1.2—2015
Description: View from right bridge abutment down-stream. **Compass**: 45 (Northeast)

Photo Point 2.1—2013
Description: View of bridge from Photo Point 2
Compass: 113 (East-Southeast)

Photo Point 2.1—2015
Description: View of bridge from Photo Point 2
Compass: 113 (East-Southeast)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 2.2—2013
Description: View from north bank of fence line looking across stream channel. **Compass**: 225 (Southwest)

Photo Point 2.2—2015
Description: View from north bank of fence line looking across stream channel. **Compass**: 225 (Southwest)

Photo Point 2.3—2013
Description: View from Photo Point 2 looking up-stream. **Compass**: 248 (West-Southwest)

Photo Point 2.3—2015
Description: View from Photo Point 2 looking up-stream. **Compass**: 248 (West-Southwest)

Photo Point 2.4—2013
Description: View of deactivated channel alignment
Compass: 270 (West)

Photo Point 2.4—2015
Description: View from Photo Point 2 looking up-stream. **Compass**: 270 (West)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 2.5—2013
Description: View of deactivated channel alignment.
Compass: 248 (West-Southwest)

Photo Point 2.5—2015
Description: View of deactivated channel alignment.
Compass: 248 (West-Southwest)

Photo Point 3.1—2013
Description: View of deactivated channel segment from Photo point 3. **Compass**: 68 (East-Northeast)

Photo Point 3.1—2015
Description: View of deactivated channel segment from Photo point 3. **Compass**: 68 (East-Northeast)

Photo Point 3.2—2013
Description: View of deactivated channel plug
Compass: 45 (East)

Photo Point 3.2—2015
Description: View of deactivated channel plug
Compass: 45 (East)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 3.3—2013
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 0 (North)

Photo Point 3.3—2015
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 0 (North)

Photo Point 3.4—2013
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 315 (Northwest)

Photo Point 3.4—2015
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 315 (Northwest)

Photo Point 3.5—2013
Description: View of upstream extent of deactivated channel segment **Compass**: 270 (West)

Photo Point 3.5—2015
Description: View of upstream extent of deactivated channel segment **Compass**: 270 (West)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 3.6—2013
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 248 (WSW)

Photo Point 3.6—2015
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 248 (WSW)

Photo Point 3.7—2013
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 180 (South)

Photo Point 3.7—2015
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 180 (South)

Photo Point 4.1—2013
Description: View looking across deactivated channel segment. **Compass**: 90 (East)

Photo Point 4.1—2015
Description: View looking across deactivated channel segment. **Compass**: 90 (East)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 4.2—2013
Description: View across stream channel toward south bank. **Compass**: 180 (South)

Photo Point 4.2—2015
Description: View across stream channel toward south bank. **Compass**: 180 (South)

Photo Point 4.3—2013
Description: View of point bar formation from Photo Point 4. **Compass**: 225 (Southwest)

Photo Point 4.3—2015
Description: View of point bar formation from Photo Point 4. **Compass**: 225 (Southwest)

Photo Point 4.4—2013
Description: View of boulders, logs, and root wads placed on bank. **Compass**: 248 (West-Southwest)

Photo Point 4.3—2015
Description: View of boulders, logs, and root wads placed on bank. **Compass**: 248 (West-Southwest)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Photo Point 5.1—2013
Description: View looking upstream of south bank taken from bridge. **Compass**: 248 (West-Southwest)

Photo Point 5.1—2015
Description: View looking upstream of south bank taken from bridge. **Compass**: 248 (West-Southwest)

Photo Point 5.2—2013
Description: View looking upstream from bridge.

Photo Point 5.2—2015
Description: View looking upstream from bridge.

Photo Point 5.3—2013
Description: View looking upstream from bridge.
Compass: 203 (South-Southwest)

Photo Point 5.3—2015
Description: View looking upstream from bridge.
Compass: 203 (South-Southwest)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2015 Monitoring Events

Additional Photo 1
Description: Eroding Bank EBL1 - 2013 (panoramic)

Additional Photo 1
Description: Eroding Bank EBL1 - 2015 (panoramic)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2015 Monitoring Events

CONFLUENCE

Additional Photo 2
Description: Eroding Bank EBL2- 2013 (panoramic)

Additional Photo 2
Description: Eroding Bank EBL2 - 2015 (panoramic)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2014 and 2015 Monitoring Events

CONFLUENCE

Additional Photo 3
Description: Upper section of Eroding Streambank EBL3 in 2014

Additional Photo 3
Description: Upper section of Eroding Streambank EBL3 in 2015

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2014 and 2015 Monitoring Events

Additional Photo 4
Description: Lower section of Eroding Streambank L3 in 2014 (panoramic)

Additional Photo 4
Description: Lower section of Eroding Streambank L3 in 2015 (panoramic)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: 2013 and 2015 Monitoring Events

CONFLUENCE

Additional Photo 5
Description: Eroding streambank EBL4 in 2013.

Additional Photo 5
Description: Eroding streambank EBL4 in 2015.

Additional Photo 6
Description: Eroding streambank EBR1 in 2013.

Additional Photo 6
Description: Eroding streambank EBR1 in 2015.

Additional Photo 7
Description: Eroding streambank EBR2 in 2014.

Additional Photo 7
Description: Eroding streambank EBR2 in 2015.

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T1 LOOKING NORTH UPSTREAM FROM T1 SOUTH

T1 LOOKING SOUTH DOWNSTREAM FROM T1 NORTH

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T1 LOOKING WEST UPSTREAM FROM SOUTH BANK

T1 LOOKING EAST DOWNSTREAM FROM SOUTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T1 LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T1 LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T1 LOOKING WEST UPSTREAM FROM NORTH BANK

T1 LOOKING EAST DOWNSTREAM FROM NORTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T2 LOOKING NORTH UPSTREAM FROM T2 SOUTH

T2 LOOKING SOUTH DOWNSTREAM FROM T2 NORTH

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T2 LOOKING WEST UPSTREAM FROM SOUTH BANK

T2 LOOKING EAST DOWNSTREAM FROM SOUTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T2 LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T2 LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

T2 LOOKING WEST UPSTREAM FROM NORTH BANK

T2 LOOKING EAST DOWNSTREAM FROM NORTH BANK

T3 LOOKING NORTH UPSTREAM FROM T3 SOUTH

T3 LOOKING SOUTH DOWNSTREAM FROM T3 NORTH

T3 LOOKING WEST UPSTREAM FROM SOUTH BANK

T3 LOOKING EAST DOWNSTREAM FROM SOUTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T3 LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T3 LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T3 LOOKING WEST UPSTREAM FROM NORTH BANK

T3 LOOKING EAST DOWNSTREAM FROM NORTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T4 LOOKING NORTH UPSTREAM FROM T4 SOUTH

T4 LOOKING SOUTH DOWNSTREAM FROM T4 NORTH

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T4 LOOKING WEST UPSTREAM FROM SOUTH BANK

T4 LOOKING EAST DOWNSTREAM FROM SOUTH BANK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T4 LOOKING WEST UPSTREAM FROM MIDDLE CREEK

T4 LOOKING EAST DOWNSTREAM FROM MIDDLE CREEK

PROJECT NAME: 2015 MDT STREAM MITIGATION—MILL CREEK

DATE: 7-27-15

T4 LOOKING WEST UPSTREAM FROM NORTH BANK

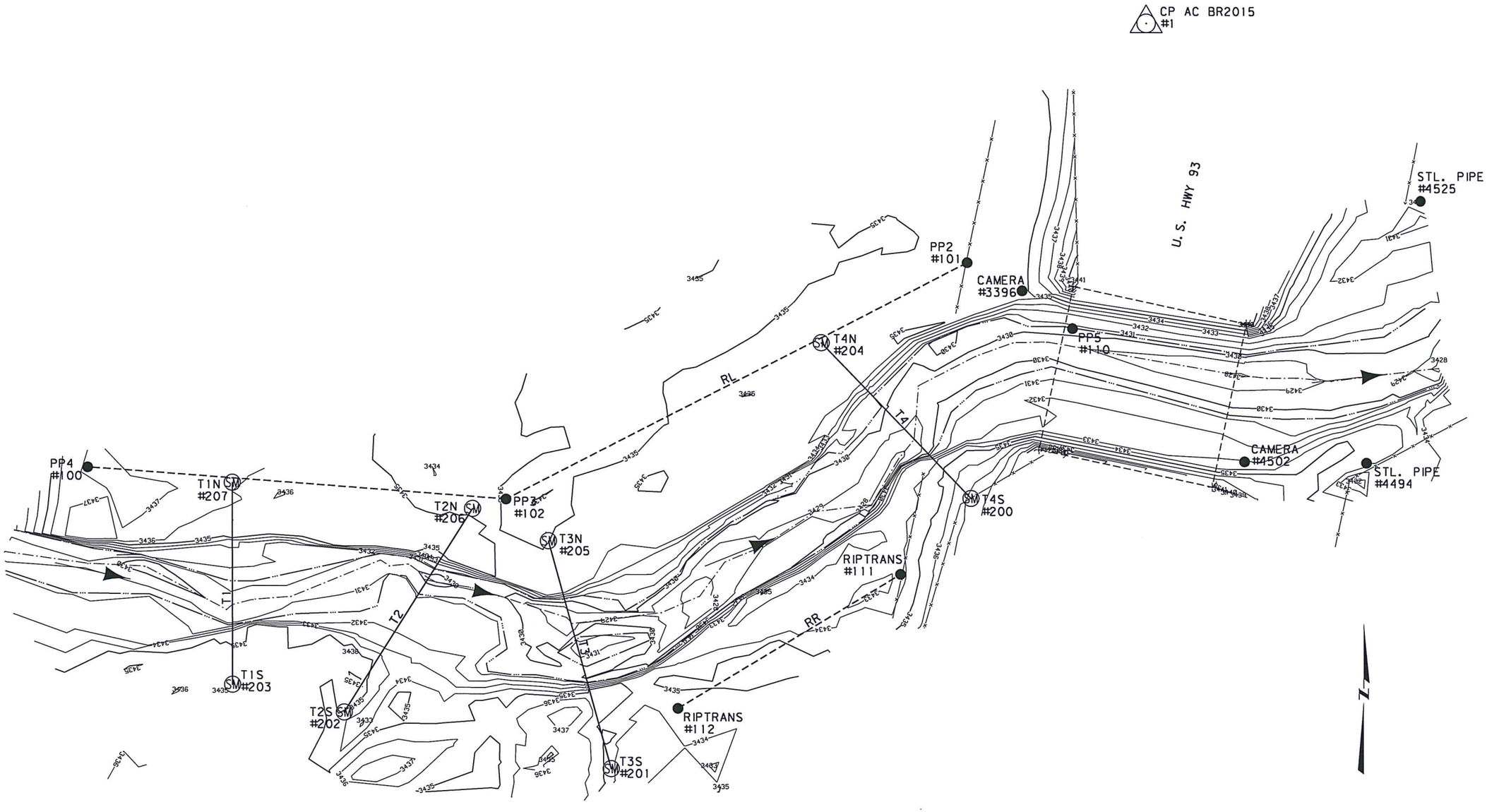
T4 LOOKING EAST DOWNSTREAM FROM NORTH BANK

Appendix D

As-Built Surveys & Planting Schematics

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana

CONTROL TABLE				
PNT#	NORTHING	EASTING	ELEV.	DESCRIPTION
1	800550.322	796062.299	3440.783	CP AC BR2015
2	799324.627	795743.954	3443.762	CP AC BS2015



SURVEYOR NOTES:

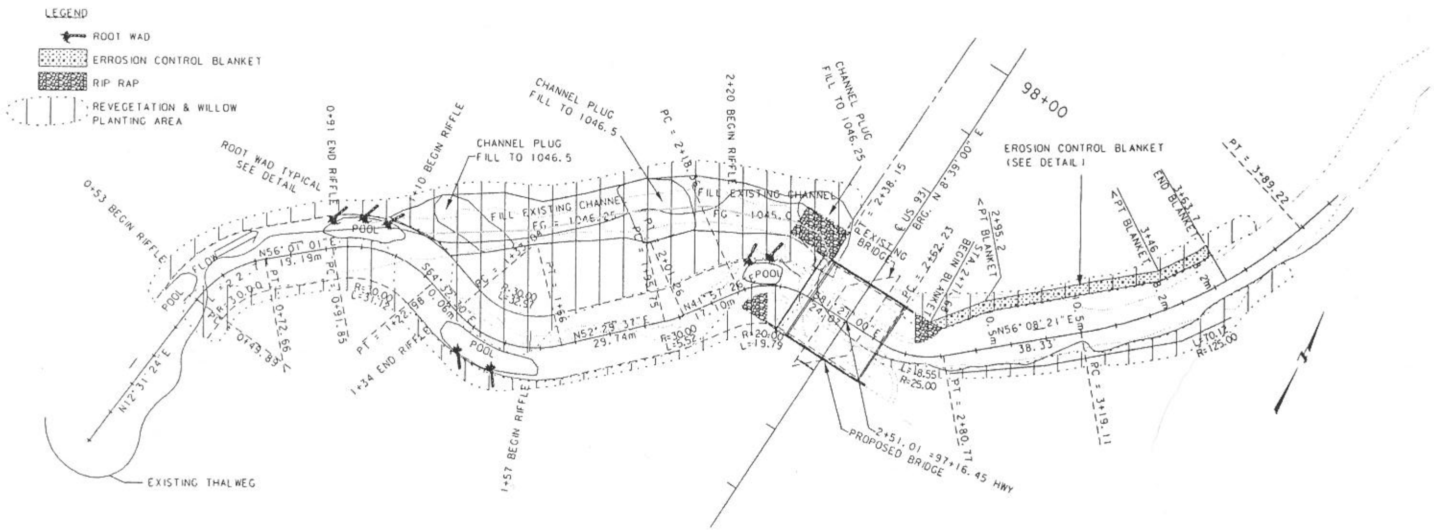
1. THIS SURVEY IS BASED ON FOUND MDT ALUMINUM CAPS STAMPED BR2015 AND BS2015 BUT THEY DO NOT HAVE ESTABLISHED MDT COORDS AND ELEVATIONS. THEREFORE LOCAL CONTROL WAS ESTABLISHED FOR THIS SITE WITH TRIMBLE GPS RTK SURVEY AND THE APPROXIMATE ASSUMED ELEVATION AT MDT ALUM CAP BR2015.
2. THE COORDINATES SHOWN HEREON ARE BASED ON MONTANA STATE PLANE GRID

0 25 50 75 100

3	MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\MILL CREEK\MillcreekPLAN .dgn	DESIGNED BY	ARNE W		MILL CREEK TOPO	MDT STREAM MITIGATION MONITORING SURVEY
2		12/9/2013	REVIEWED BY				
1		11:04:43 AM awiebe	CHECKED BY	LARRY R			

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 7-1(94)54	24

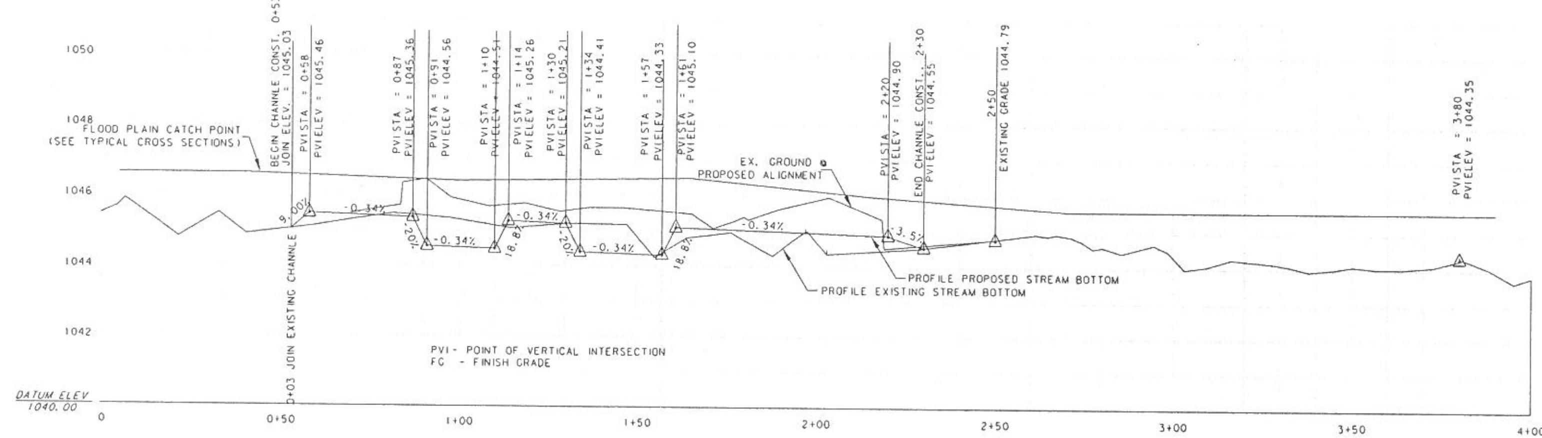
BEAR CREEK ROAD - SOUTH



PLAN

COORDINATE TABLE

STATION		NORTHING	EASTING
0+00.00	POT	30 048.8339	55 813.2378
0+49.89	PC	30 097.5369	55 824.0557
0+61.86	PI	30 109.2191	55 826.6506
0+72.66	PT	30 115.9079	55 836.5735
0+91.85	PC	30 126.6342	55 852.4861
1+08.98	PI	30 136.2068	55 866.6871
1+22.98	PT	30 128.8451	55 882.1502
1+33.04	PC	30 124.5211	55 891.2326
1+51.41	PI	30 116.6240	55 907.8201
1+66.00	PT	30 127.8094	55 922.3938
1+95.75	PC	30 145.9183	55 945.9883
1+98.51	PI	30 147.6025	55 948.1827
2+01.26	PT	30 149.6596	55 950.0321
2+18.36	PC	30 162.3748	55 961.4637
2+29.15	PI	30 170.3985	55 968.6774
2+38.15	PT	30 168.7758	55 979.3445
2+62.23	PC	30 165.1551	56 003.1444
2+71.95	PI	30 163.6925	56 012.7585
2+80.77	PT	30 169.1110	56 020.8338
3+19.11	PC	30 190.4690	56 052.6647
3+55.11	PI	30 210.5314	56 082.5648
3+89.22	PT	30 243.4254	56 097.2103
4+03.47	POT	30 256.4436	56 103.0064



PROFILE

LAND & WATER CONSULTING, INC.

MONTANA CADD

MONTANA DEPARTMENT OF TRANSPORTATION

c:\dgn\a015rodel207.dgn
2/17/2011
12:09:18 PM
EPS - U2160

MILL CREEK CHANNEL RESTORATION DETAIL

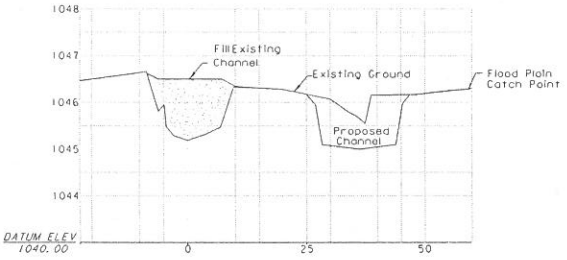
STA. 97+16

SHEET 1 OF 3

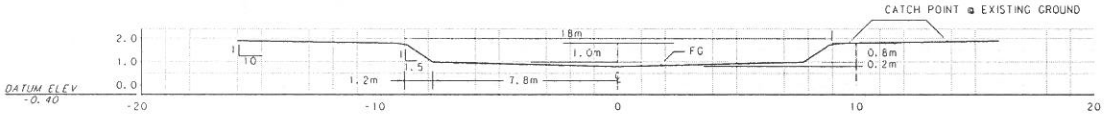
NO SCALE

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 7-1194154	25

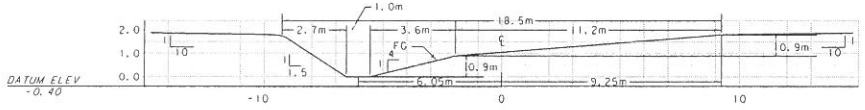
BEAR CREEK ROAD - SOUTH



CROSS SECTIONS 1+97



TYPICAL RIFFLE CROSS SECTION



TYPICAL POOL LEFT CROSS SECTION

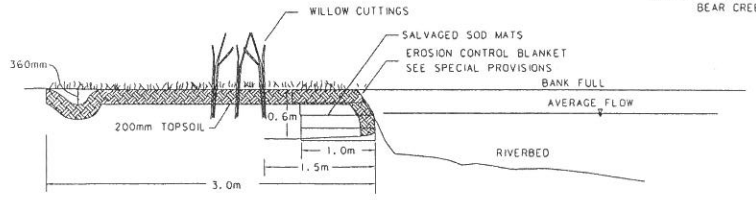
NOTES:

① SEE PLANS FOR POOL LOCATION. POOL LEFT (PL) SHOWN; MIRROR ABOUT CENTERLINE (℄) FOR POOL RIGHT LOOKING DOWNSTREAM.

② TRANSITION 4.0m BETWEEN POOL ↕ RIFFLE.

③ ROUND SLOPES FOR NATURAL APPEARANCE.

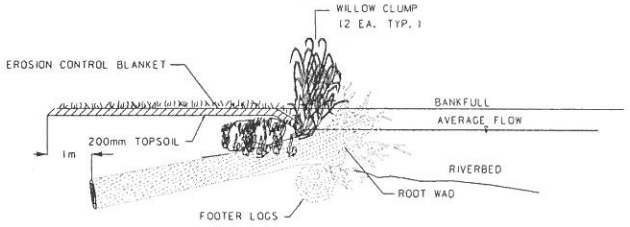
STATION From	STATION To	POOL LEFT	RIFFLE (INCLUDES 4m TRANSITION)	POOL RIGHT
0+00	0+53			
0+53	0+91		X	
0+91	1+10	X		
1+10	1+34		X	
1+34	1+57			X
1+57	2+20		X	
2+20	2+30	X		
2+30	5+00			



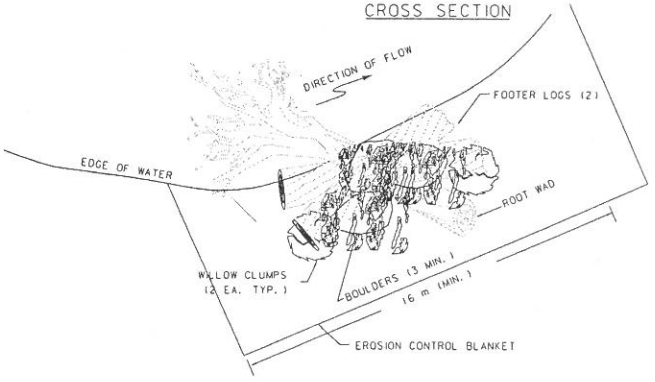
1. SUB EXCAVATE BANKS 0.6 METERS.
2. LAY LOWER BLANKET MINIMUM 1.5 METERS FROM EDGE OF BANK.
3. BACK FILL WITH NATIVE MATERIAL AND 0.2 METERS TOPSOIL.
4. FACE STREAM BANK BACKFILL WITH 1.0 METERS OF SALVAGED SOD MATS.
5. WRAP BLANKET AND EXTEND 3.0 METERS MIN. FROM BANK EDGE.

EROSION CONTROL BLANKET TYPICAL

MILL CREEK



CROSS SECTION



PLAN

ROOT WAD TYPICAL

MILL CREEK

MILL CREEK CHANNEL RESTORATION DETAIL
STA. 97+16
SHEET 2 OF 3
NO SCALE

MONTANA DEPARTMENT OF TRANSPORTATION
MDT
MONTANA CADD
LAND & WATER CONSULTING, INC.

G:\lgm\0715\dwf\07_dwg
2/17/2017
12:09:20 PM
1 = 1 EPS - 10160