MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Spring Creek
Flathead County, Montana

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

Prepared for:

Prepared by:

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #4

YEAR 2016

Spring Creek
Flathead County, Montana

MDT Project Number: NH-MT 5-3(59) 109
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Cover Photo: Relocated segment of Spring Creek, 2016.

1.0 INTRODUCTION

As part of the construction of the Kalispell Bypass U.S. Highway 2 South, the Montana Department of Transportation (MDT) reconstructed a segment of Spring Creek upstream of the Ashley Creek Highway 93 North Bridge crossing. The following report presents results of the fourth year of post stream reconstruction monitoring and compares these results to performance standards outlined in the monitoring plan for the project. The Spring Creek channel relocation project was constructed in 2010; therefore, these results provide documentation of the site's condition six years following the project's completion.

One goal of the Spring Creek stream mitigation project is to provide compensatory mitigation for stream impacts associated with transportation projects in the Missoula District. In order to accomplish this goal, the project’s objective includes constructing 990 feet of new Spring Creek channel with the following design elements:

- Channel banks will generally be constructed with 0.5:1 side slopes
- Pool bottom widths generally 4 feet wide and top widths generally 7.5 feet wide
- Riffle bottom widths generally 5 feet wide and top widths generally 7.5 feet wide
- Floodplain width adjacent to the new stream channel to vary in width from 15.5 feet to 21 feet.
- Upland slopes varying from 2.2:1 to 6.5:1

These design elements were developed to create, enhance, restore, and maintain permanent, naturally self-sustaining, native, or native-like stream and riparian habitats along the newly constructed segment of Spring Creek. If successful, the project will 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 within the USACE permit include monitoring of the on and off-site stream mitigation areas for five years following channel construction to determine whether the site meets, or is trending toward meeting a series of performance standards outlined in the mitigation plan for the site.

<u>Quantitative success criteria for the Spring Creek project include:</u>

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 with 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 an 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 success criteria for the Spring Creek project:

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 monitoring requirements include:

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

Results of the fourth year monitoring of the Spring 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 information on the site's condition are provided as appendices to this report, and include maps indicating the endpoints of riparian belt transects, perpendicular transect surveys and locations of noxious weed infestations, results of transect and profile surveys, photo documentation of the project site, and a planting schematic from the approved design.

2.0 SITE LOCATION

The project reach includes approximately 990 feet of reconstructed channel east of the U.S. Highway 93 ALT corridor. The project site is located in Section 13, Township 7 North, Range 22 West, in Flathead County, Montana (Figure 1).

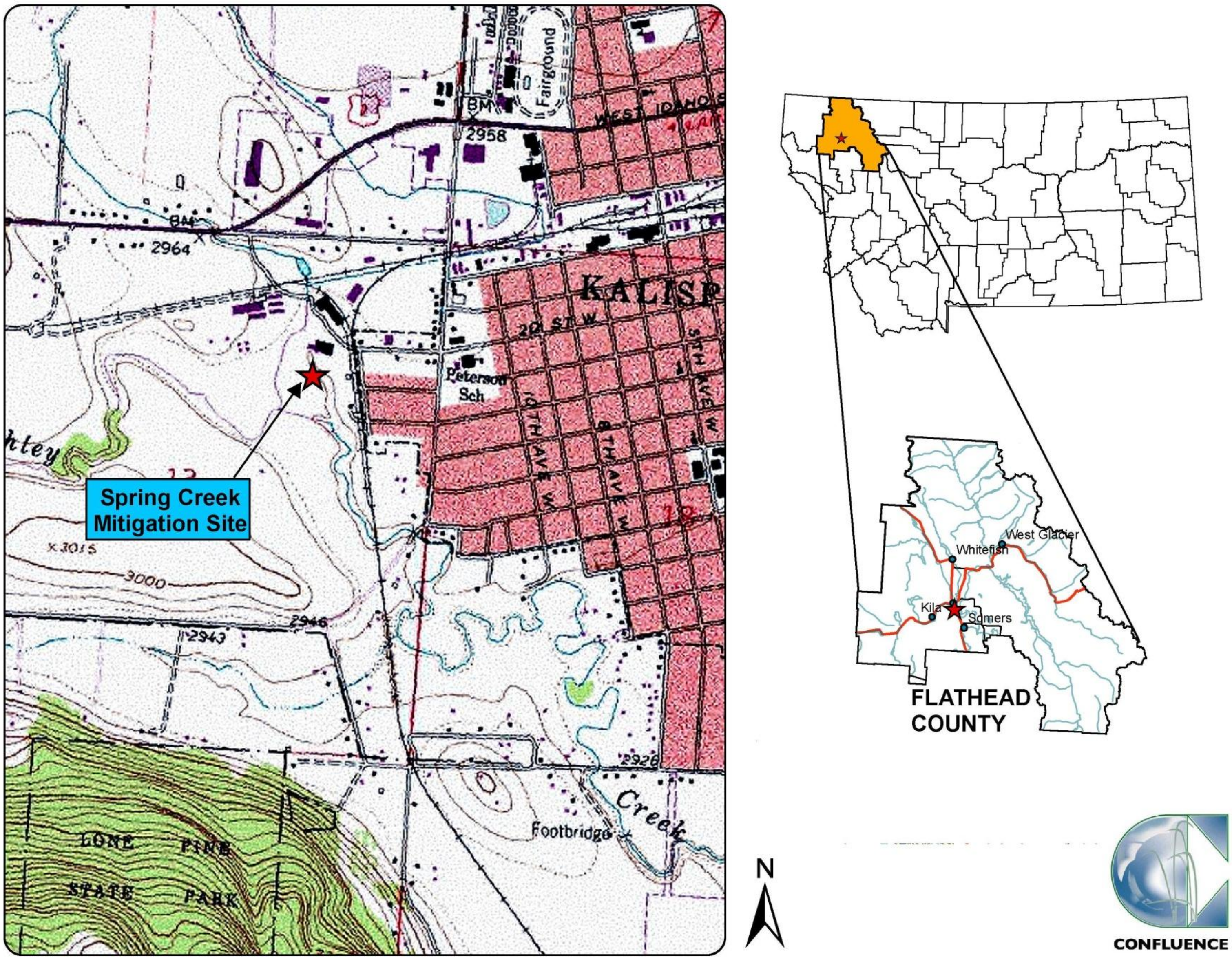

Figure 1. Project location of Spring Creek stream mitigation site.

3.0 MONITORING METHODS

Monitoring field crews visited the Spring Creek project site on August 4, 2016 while survey crews visited the site on August 11, 2016. The following data were collected at the Spring Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

Riparian buffer and vegetation success was monitored by establishing two riparian belt transects during the first monitoring event in 2013 and repeating transect vegetation surveys annually from 2014 – 2016. Data collected along each transect included visual estimates of areal percent cover of total vegetation, woody vegetation and noxious weeds. The riparian transect on the right (west) bank is 25 feet wide and extends 223 feet, while the riparian transect on the left (east) bank is 25 feet wide and extends 296 feet (Figure 3, Appendix A).

The performance target for stream bank vegetation was monitored by conducting a vegetation inventory along both stream banks, which included compiling a list of all plant species and their associated cover classes 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 classification values listed in Table 1.

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

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

Vegetation community boundaries were determined in the field during the active growing season and subsequently delineated on aerial photographs. Community types were designated based on the predominant vegetation species observed within each mapped polygon. Bank stability indices were assigned to the stream bank community types using Winward (2000) stability scores. 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. If a range of stability ratings were provided for the stream bank community, the lowest number in the range of ratings was reported. Also, if the community type was defined by one or more dominant species, the more dominant species stability rating was reported.

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

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.

3.2. Bank Erosion Inventory

The performance target for stream bank stability was monitored by conducting a bank erosion inventory along both stream banks within the project reach. All eroding banks within the project reach were photo-documented annually to document whether erosion conditions deteriorated, remained consistent, or improved. Data collected at each eroding bank included bank length and potential causes of bank erosion.

3.3. Perpendicular Transect and Longitudinal Profile Surveys

Two riffle and two pool transects (cross sections) were surveyed by licensed survey crews. Locations of pool and riffle cross sections were selected based on the Spring Creek planform design sheet, which indicated where riffle and pool habitats were to be constructed. Endpoints of each transect were marked with a pin, flagging, or stake for locating during subsequent monitoring events. A longitudinal profile was surveyed down the thalweg of the channel in 2014, 2015, and 2016 to document aggradation, degradation, and habitat complexity along the project reach. All transects and longitudinal profiles were surveyed using a Trimble R8 GPS with rover and base station units, with survey points taken at inflection points along each transect and profile. Photo-documentation of each transect included photos taken facing upstream, downstream, left, and right from the channel centerline.

3.4. Photo-Documentation

The project site was photographed from several locations to document vegetation establishment and stream bank conditions within the project site. Four permanent photo points were established during the first monitoring event to document changes in the site over time. Additional photos were taken at the endpoints of each perpendicular transect as well as facing upstream, downstream, left and right from the center of the channel. All permanent photo documentation sites were recorded on field maps with compass bearings noted to allow for repetition during subsequent monitoring years.

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 2 summarizes percent cover of total vegetation, woody vegetation, and noxious weeds for each riparian and stream bank transect. Subtotals for the riparian and stream bank inventories are provided, as well as an area-weighted total for both riparian and stream bank zones. In 2016 the total percent riparian cover remained at 100%, with 43% cover by woody species and 6% by noxious weeds. Stream bank transects also displayed 100% cover, with 44% cover by woody species and 5% by noxious weeds. In total, the site exhibited 100% total vegetation cover, with 43% by woody species and 6% by noxious weeds.

No bare ground was observed and both the riparian and stream bank transects exhibited a diversity of herbaceous and woody plant species. Noxious weeds were sporadically found along both banks, riparian areas adjacent to the channel, and along the upland slopes. Additional information regarding noxious weed observations is included in Section 4.3.

Table 2. Percent cover of vegetation transects at Spring Creek from 2013 through 2016.

Belt Transect	Length (ft)	Total % Vegetation Cover				% Woody Cover				% Noxious Weed Cover			
		2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Right (West) Riparian	223	100	100	100	100	35	35	37	38	2	5	9	8
Left (East) Riparian	296	100	100	100	100	57	60	45	46	2	4	6	6
Riparian Subtotal		100	100	100	100	47	49	42	43	2	4	7	6
Right (West) Streambank	995	100	100	100	100	38	60	39	41	6	6	6	5
Left (East) Streambank	995	100	100	100	100	100	100	45	47	4	4	5	5
Streambank Subtotal		100	100	100	100	69	80	42	44	5	5	5	5
Area Weighted Total		100	100	100	100	54	59	42	43	3	5	7	6

Dominant species recorded along the riparian and stream bank transects were combined with visual observations in other areas to develop a vegetation community map (Figure 4, Appendix A). Four vegetation community types were observed in 2016, and are included in Table 3.

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

Community Type	Dominant Species
4	*Prunus* spp./*Cornus alba*
5	*Elymus* spp./*Festuca ovina*
6	*Salix* spp./*Helianthus maximiliani*/*Phalaris arundinacea*
7	*Vicia villosa*/*Bromus inermis*

Vegetation community Type 4 – *Prunus* spp./*Cornus alba* was identified in a small area north of the culvert outlet at the upstream extent of the project reach. Choke cherry (*Prunus virginiana*), bitter cherry (*Prunus emarginata*), and red osier (*Cornus alba*) dominated this community type.

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

Vegetation community Types 2 – *Salix* spp./*Helianthus maximiliani* and 3 – *Salix* spp./*Phalaris arundinacea* were identified in 2013 along the stream bank and riparian zones. These communities were merged in 2016 into community Type 6 – *Salix* spp./*Helianthus maximiliani*/*Phalaris arundinacea*. Drummond's willow (*Salix drummondiana*), Maximilian sunflower (*Helianthus maximiliani*), and reed canary grass (*Phalaris arundinacea*) were observed with nearly equal cover classes, with lesser cover by Gray willow (*Salix bebbiana*), narrow-leaf willow (*Salix exigua*), and Geyer's willow (*Salix geyeriana*).

Vegetation community Type 7 – *Vicia villosa*/*Bromus inermis* was observed in 2016 along the side slopes of the riparian zone between community Types 5 and 6. Winter vetch (*Vicia villosa*) and smooth brome dominated this community type. Winter vetch, an annual, non-native and invasive species was commonly observed across the site growing over and around many of the noxious weed infestations.

Table 4 is a comprehensive list of vegetation species identified within the two belt transects, two stream bank transects, and other incidental plants observed on site. In 2016, 96 plant species were observed on site, an increase by 4 species since 2015, 20 species since 2014, and 42 species since the initial monitoring event in 2013. In 2016, 46% of the species observed on site were considered hydrophytic based on the National Wetland Plant List (Lichvar et al., 2016).

4.2. Stream Bank Vegetation Composition

The stream bank vegetation inventory identified 28 plant species along the banks of Spring Creek (Table 5). Drummond's willow, Maximilian sunflower, and reed canary grass each comprised between 21% and 50% cover along both stream banks in 2016. 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 with root stability indices ≥6. Vegetation community Type 6 – *Salix* spp./*Helianthus maximiliani*/*Phalaris arundinacea* was the dominant vegetation community observed along the stream banks, with an associated stability rating of 7. These native, perennial plant species provide increased soil stability and resistance to erosion along stream banks through their dense rhizomatous and/or fibrous root systems.

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

Scientific Name	Common Name	WMVC Indicator Status*
Agropyron cristatum	Crested Wheatgrass	NL
Agrostis gigantea	Black Bent	FAC
Agrostis stolonifera	Creeping Bent	FAC
Algae, green	Algae, green	NL
Alnus incana	Speckled Alder	FACW
Alopecurus arundinaceus	Creeping Meadow-Foxtail	FAC
Alopecurus pratensis	Field Meadow-Foxtail	FAC
Amelanchier alnifolia	Saskatoon Service-Berry	FACU
Artemisia absinthium	Absinthium	NL
Artemisia biennis	Biennial Wormwood	FACW
Aster sp.	Aster	NL
Beckmannia syzigachne	American Slough Grass	OBL
Betula papyrifera	Paper Birch	FAC
Betula pumila	Bog Birch	OBL
Bromus inermis	Smooth Brome	UPL
Bromus tectorum	Cheatgrass	NL
Carduus nutans	Nodding Plumeless-Thistle	UPL
Carex stipata	Stalk-Grain Sedge	OBL
Centaurea stoebe	Spotted Knapweed	NL
Chenopodium album	Lamb's-Quarters	FACU
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	Bull Thistle	FACU
Clematis ligusticifolia	Deciduous Traveler's-Joy	FAC
Clematis occidentalis	Purple Clematis	NL
Convolvulus arvensis	Field Bindweed	NL
Cornus alba	Red Osier	FACW
Crataegus douglasii	Black Hawthorn	FAC
Cynoglossum officinale	Gypsy-Flower	FACU
Deschampsia cespitosa	Tufted Hairgrass	NL
Descurainia sophia	Herb Sophia	NL
Elymus canadensis	Nodding Wild Rye	FAC
Elymus cinereus	Great Basin Wildrye	NL
Elymus hispidus	Intermediate Wheatgrass	NL
Elymus repens	Creeping Wild Rye	FAC
Epilobium ciliatum	Fringed Willowherb	FACW
Festuca idahoensis	Bluebunch Fescue	FACU
Festuca ovina	**Sheep Fescue**	**UPL**
Galium aparine	**Sticky-Willy**	**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
Impatiens aurella	**Pale-Yellow Touch-Me-Not**	**FACW**
Lactuca serriola	Prickly Lettuce	FACU
Lemna minor	Common Duckweed	OBL
Linaria vulgaris	Butter-and-eggs	NL
Lupinus arbustus	Long-spur Lupine	NL
Lupinus sp.	Lupine	NL
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
Peritoma serrulata	Rocky Mountain Beeplant	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
Plantago major	Great Plantain	FAC
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Populus angustifolia	Narrow-Leaf Cottonwood	FACW
Prunus emarginata	Bitter Cherry	FACU
Prunus virginiana	Choke Cherry	FACU
Pseudotsuga menziesii	Douglas-Fir	FACU
Rosa woodsii	Woods' Rose	FACU
Rumex crispus	Curly Dock	FAC
Salix bebbiana	Gray Willow	FACW
Salix drummondiana	Drummond's Willow	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Salix geyeriana	Geyer's Willow	FACW
Salix lasiandra	Pacific Willow	FACW
Scirpus microcarpus	Red-Tinge Bulrush	OBL
Shepherdia argentea	Silver Buffalo-Berry	FACU
Silene latifolia	Bladder Campion	NL
Silene vulgaris	Maiden's-tears	NL
Sisymbrium altissimum	Tall Hedge-Mustard	FACU
Solanum dulcamara	Climbing Nightshade	FAC
Sonchus arvensis	Field Sow-Thistle	FACU
Stuckenia pectinata	Sage False Pondweed	OBL
Symphoricarpos albus	Common Snowberry	FACU
Symphoricarpos occidentalis	Western Snowberry	FAC
Symphyotrichum ascendens	Western American-Aster	FACU
Tanacetum vulgare	Common Tansy	FACU
Thlaspi arvense	Field Pennycress	UPL
Tragopogon dubius	Meadow Goat's-beard	NL
Trifolium repens	White Clover	FAC
Urtica dioica	Stinging Nettle	FAC
Verbascum thapsus	Great Mullein	FACU
Veronica americana	American Brooklime	OBL
Vicia villosa	Winter Vetch	NL

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

Table 5. Comprehensive list of plant species and their associated cover classes along the stream banks of the Spring Creek mitigation site in 2016.

Streambank Species	Left Bank	Left Bank Cover Class	Right Bank	Right Bank Cover Class	WMVC Indicator Status***
Agrostis stolonifera	X	1			FAC
Alnus incana			X	1	FACW
Beckmannia syzigachne	X	0			OBL
Betula papyrifera			X	0	OBL
Betula pumila	X	0	X	0	OBL
Cirsium arvense	X	1	X	1	FAC
Cirsium vulgare			X	1	FACU
Cornus alba	X	0			FACW
Cynoglossum officinale			X	0	FACU
Epilobium ciliatum	X	2	X	2	FACW
Galium aparine			X	0	FACU
Glyceria grandis	X	0	X	0	OBL
*Helianthus maximiliani**	X	4	X	4	UPL
Melilotus officinalis	X	0			FACU
Mentha arvensis	X	0			FACW
Nasturtium officinale	X	0			OBL
*Phalaris arundinacea**	X	4	X	4	FACW
Poa palustris	X	0			FAC
Rumex crispus	X	1	X	1	FAC
Salix bebbiana	X	1	X	1	FACW
*Salix drummondiana**	X	4	X	4	FACW
Salix exigua	X	1	X	1	FACW
Salix geyeriana	X	1	X	1	FACW
Scirpus microcarpus	X	0			OBL
Symphyotrichum ascendens	X	0			FACU
Tanacetum vulgare	X	0	X	0	FACU
Veronica americana	X	0			OBL
Vicia villosa	X	2	X	2	FAC

*Dominant species along Spring Creek banks
***Based on 2016 NWPL (Lichvar *et al*., 2016)

4.3. Noxious Weed Inventory

Six priority 2B noxious weeds and one state-regulated species were found within the project site in 2016 (Table 6). Locations of noxious weed infestations are shown 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). As noted in Section 4.1, an estimated 6% of the project area has been colonized by noxious weeds, representing a decrease by 1% since 2015, and an increase by 3% since the initial 2013 monitoring event. The decrease in noxious weed infestations observed in 2016 is likely attributed to competition of resources with other plant species, such as winter vetch, a non-noxious species. In 2016, as compared to previous monitoring years, the annual, non-native and invasive winter vetch increased substantially in cover across the site and was the primary species observed growing over and around many of the noxious weed infestations.

Table 6. Montana State listed noxious weed and regulated species observed in 2016 at the Spring Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	*Centaurea stoebe*	Spotted Knapweed
	Cirsium arvense	Canada Thistle
	Convolvulus arvensis	**Field Bindweed**
	Cynoglossum officinale	Houndstongue
	Linaria vulgaris	Yellow Toadflax
	Tanacetum vulgare	Common Tansy
Priority 3 State Regulated	*Bromus tectorum*	Cheatgrass

*Based on the Montana Dept. of Agriculture's Noxious Weed List, 2015
New species identified in 2016 are **bolded.**

4.4. Woody Plant Survival

Pacific willow (*Salix lasiandra*), gray willow, narrow-leaf willow, narrow-leaf cottonwood (*Populus angustifolia*), speckled alder (*Alnus incana*), common snowberry (*Symphoricarpos albus)*, red osier dogwood, silver buffalo-berry (*Shepherdia argentea*), bog birch (*Betula pumila*), and Woods' rose (*Rosa woodsii*) were observed throughout the site. Table 7 indicates the total number of plants inspected and the number of those surviving for each of the past four monitoring years. The majority of the planted woody shrubs remain small and therefore offer a limited amount of cover to the site. In 2016, herbaceous and volunteer woody vegetation establishment along the banks and upland areas of the project site was dense, making it difficult to locate and identify planted woody shrubs. A total of 419 planted trees and shrubs were located in 2016, with 410 of those observed alive. The planting plan called for installation of 668 trees and shrubs. As compared to the planting plan, 61% (410 out of 668) of the trees and shrubs have survived six years following the project's completion.

Although more surviving woody shrubs were observed in 2016, the percent cover provided by woody vegetation along the stream banks decreased in 2015 and 2016 as compared to 2014 (Table 2). The likely cause for this reduction in woody cover is the presence of beavers and their influence on willow establishment along the banks. Two beaver dams were identified in 2015 within the project reach, and a third beaver dam was identified during the 2016 monitoring visit.

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

Year	Total Plants Inspected	Surviving Plants	# of Woody Plantings in Design	Plant Survival Percentage
2013	600	596	668	89%
2014	377	360		54%
2015	440	385		58%
2016	419	410		61%

4.5. Bank Erosion Inventory

In 2015, one 30-foot eroding bank was identified within the project reach (Figure 3, Appendix A). Inspection of this bank in 2016 revealed no additional bank retreat or increase in eroding bank length over the past year (See Additional Photo 2 in Appendix C). Erosion at this location is most likely due to degradation of coir logs used to construct the channel. The bank occurs approximately 30 feet downstream of a beaver dam, which may cause accelerated velocities during storm events just downstream. The adjacent riparian corridor is well vegetated with reed canary grass, Maximilian sunflower, and Canada thistle; however, little floodplain exists along the west side of the channel at this location to disperse energy during high flows. Based on the lack of continued erosion and a densely vegetated riparian zone adjacent to the bank, erosion severity along this bank segment is considered low.

4.6. Channel Form

The formation of pool and riffle habitats within the project reach may be analyzed from the results of perpendicular transect and longitudinal profile surveys of the channel bed (Appendix B). Nine pools were constructed and documented during the 2014 longitudinal profile survey. Slightly shallower pool depths have been documented over the past three years in three of the nine pools; however, pool depths have generally maintained following construction of the project. Two beaver dams were observed in 2015 and a third dam was discovered in 2016, each of which create backwatered pool features. Inspection of the longitudinal profile and surveyed transects does not reveal a noticeable geomorphic response of the channel from these dams such as longer pool lengths or shallower riffle depths. The dams are relatively small thus far and are not causing widespread flooding beyond the channel margins yet; as a result, their influence on channel morphology to date is minimal. With the exception of these beaver dams, the stream bed has generally maintained a similar elevation over the past two years with no signs of vertical instability, head cutting, or significant aggradation. The longitudinal profile surveyed along the project reach verifies the channel displays a variety of riffles and shallow pool habitats throughout its length.

Transect surveys were conducted at four locations including two pool and two riffle features. Maximum depth and bankfull width for each transect are shown in Table 8, while plots of each transect are illustrated in Appendix B. These results indicate pools are approximately 0.5 feet deeper than riffles at the surveyed transects. The relatively low variability in channel depth may be attributed to the planform geometry of the channel, which exhibits low sinuosity and very gently arced meander bends. The high radii of curvature along designated pool sections are unlikely to generate deep pools, although based on the survey results, are creating slightly deeper and slower water habitat than in riffles.

Table 8. Spring Creek maximum depths and bankfull widths from 2013 to 2016.

Transect	Type	Max Depth (ft)				Bankfull Width (ft)			
		2013	2014	2015	2016	2013	2014	2015	2016
1	Pool	3.1	3.2	2.9	2.8	8.9	10.0	8.7	8.8
2	Riffle	2.5	2.2	2.4	2.5	9.3	10.3	9.3	9.6
3	Pool	2.5	2.7	2.5	2.5	8.6	8.6	8.8	8.7
4	Riffle	1.8	2.0	1.9	1.8	5.8	5.6	5.4	5.7
Average Riffles		2.2	2.1	2.2	2.2	7.6	7.9	7.4	7.7
Average Pools		2.8	2.9	2.7	2.7	8.8	9.3	8.8	8.8
Average All		2.5	2.5	2.4	2.4	8.2	8.6	8.1	8.2

The urban runoff hydrology, including influences by retention ponds upstream of the project reach, that characterizes this reach of Spring Creek is also unlikely to generate deep pools over time. The typical hydrology of Spring Creek does not result in flashy or snowmelt driven runoff events. As a result, natural development of deep pool features is unlikely to occur within the reconstructed section of Spring Creek.

Maximum depths of the surveyed riffles and pools has remained shallower than the design depth of 2.7 and 3.7 feet, respectively, although the shallower pool depth measurements are reduced by the location of the transects not occurring at the deepest part of the pool. The bankfull width at riffle transect #2 is wider than the design width of 7.5, while the width at riffle transect #4 is slightly narrower. Pool width are slightly wider than that indicated in the design.

4.7. Wildlife Documentation

Table 9 provides a comprehensive list of wildlife observed at the Spring Creek stream mitigation site during the past four monitoring events. No new wildlife species were observed in 2016. Several beaver trails and three small beaver dams were observed along the channel. The relatively low number of species observed may be attributed to the close proximity of the adjacent highway, human/dog use of the adjacent bike path, and construction traffic from the continued expansion of the Highway 2 Bypass project.

Table 9. Wildlife species observed at the Spring Creek stream mitigation site from 2013 - 2016.

Common Name	Scientific Name
Birds	
American Robin	*Turdus migratorius*
Mallard	*Anas platyrhynchos*
Common Raven	*Corvus corax*
Ring-necked Pheasant	*Phasianus colchicus*
Song Sparrow	*Melospiza melodia*
Sparrow sp.	*Passer* sp.
Warbling vireo	*Vireo gilvus*
Mammals	
Beaver (chew, dam, trail)	*Castor canadensis*
Rodent (burrow)	N/A
White-tailed Deer	*Odocoileus virginianus*

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Spring Creek stream mitigation site is intended to document whether the reconstructed segment of the channel is meeting, or moving toward the performance standards outlined in the monitoring plan. The fourth year of monitoring suggests that all 6 of the quantitative performance standards are being met six years after the project has been constructed (Table 10). Channel form success is considered a qualitative criterion, and is discussed in more detail in the following section. Additional reporting requirements including photo documentation of the project site, channel construction details, and a planting schematic have been included as appendices to this annual monitoring report to provide additional evidence of the site's condition.

5.1. Riparian Buffer Success

Successful establishment by a diversity of woody and herbaceous species has created densely vegetated riparian zones, with a total of 96 species identified in the mitigation area in 2016. Overall, the project area has 94% cover of non-noxious weed species. Approximately 6% of the area has been colonized by a variety of noxious weeds which are identified in Section 4.3. As a result, both of the criteria for riparian buffer success are currently being met. The Spring Creek mitigation site has met both of these success criteria since 2013.

5.2. Vegetation Success

The combined, area-weighted percent cover of the riparian and stream banks within the project area was measured at 100%, as no bare ground was observed. The riparian areas and stream banks exhibited dense vegetation growth with a diversity of woody and herbaceous vegetation, indicating establishment exceeding the 70% coverage criteria.

Woody vegetation plantings indicated a survival rate of 61% six years following construction. Woody plantings remain relatively small but should provide increased percent cover to the site as they mature. Extremely dense and tall vegetation growth within the riparian corridor, particularly by Drummond's willow, Maximilian sunflower, and reed canary grass, made locating woody plantings in 2016 difficult. Survival rates of planted woody species may also have been affected by the presence of beavers in the area. Despite the difficulty of locating woody plantings in 2016, these results indicate the project reach is meeting both of the vegetation success criteria, and has continued to meet these criteria since 2013.

5.3. Vegetation along Stream Banks

Drummond's willow, Maximilian sunflower, and reed canary grass each comprised between 21 and 50% cover along both stream banks in 2016. As a result, vegetation community Type 6 – *Salix* spp./*Helianthus maximiliani*/*Phalaris arundinacea* was the dominant vegetation community observed along the stream banks, with an associated Winward stability rating of 7. Therefore, stream bank vegetation is successfully meeting the associated performance criteria, and has successfully done so for the past four years. Although beavers appear to be using the area as a food source, the abundance of willows growing along the majority of the project reach has maintained excellent bank stability and dense overhanging cover along the reconstructed channel.

5.4. Stream Bank Stability Success

The stream bank inventory identified one 30-foot long eroding bank segment that has retreated approximately 1-2 feet since the project was constructed. Observation of this bank in 2016 noted no additional lateral erosion or lengthening of the erosion. This bank segment represents less than 2% of the overall bank length of 1,990 feet. Erosion at this location appears as a result of decay of the coir logs used to construct the channel, and an undercut forming in its absence. Due to the relatively short eroding bank segment and the establishment of stable vegetation along the bank, corrective actions are not warranted. Performance criteria for the site allow for up to 25% of the stream banks to indicate signs of erosion or instability; as a result, the performance criterion for stream bank stability is currently being met. The Spring Creek mitigation site has continued to meet the bank stability success criteria since the initial monitoring event in 2013.

5.5. Channel Form Success

The reconstructed segment of Spring Creek appears to have stabilized following construction, as evidenced by a dense stand of riparian and stream bank vegetation and minimal bank erosion. No vertical head cuts have been noted to date, and lateral movement has only been observed along a short, 30-foot bank segment.

The Spring Creek channel was designed to convey a capacity equivalent to the estimated 2-year discharge using regional regression equations. The estimated 2 year discharge is 50 cfs (MDT 2010). Discharges above 50 cfs are allowed to escape the main channel and spread across the adjacent floodplain. The Spring Creek floodplain includes a 17.5-foot wide corridor with side slopes of 10% graded toward the channel. No discharge data is available along this channel segment; however, evidence exists that the creek has seen discharges exceeding the channel's capacity. In 2015, flood debris including dead grass and small stems were observed above the top of the bank. Observations of the channel following this event indicate the channel maintained a stable configuration while flows accessed the adjacent, narrow floodplain.

Previous sections of this monitoring report provide data regarding the establishment of dense riparian and wetland vegetation along the stream banks and riparian zones adjacent to the reconstructed segment of Spring Creek. Although percent cover by woody species has declined along the stream banks since 2014, they remain densely vegetated by herbaceous species that show promising results for maintaining stable banks. Beaver activity noted along the channel may be the main cause for the reduction in woody vegetation composition along the banks, and may continue to affect long term establishment of willows along the banks. Undercut banks may also develop as the vegetation continues to mature and the coir logs used to construct the channel eventually decay.

Table 10. Monitoring results as compared to performance criteria for the Spring Creek mitigation site in 2016.

Type	Parameter	Performance Standard	Status	Site Meeting Performance Standard?
Quantitative 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	**94%** of riparian zones have revegetated with non-noxious species	**YES**
		1b. Noxious weeds do not exceed 10% cover within the riparian buffer areas.	**6%** of the project area exhibits noxious weeds	**YES**
	Vegetation Success	2a. Combined aerial cover of riparian and stream bank vegetation communities is at least 70%	Combined riparian and streambank vegetation cover is **100%**	**YES**
		2b. Planted trees and shrubs must exhibit 50% survival after 5 years	Planted shrub surveyes indicate **61%** survival after 6 years	**YES**
	Vegetation along Streambanks	3. Majority of plants on the stream bank must have root stability indexes of at least 6	Dominant stream bank community Type 6 – *Salix* spp./*Helianthus maximiliani* /*Phalaris arundinacea,* with root stability index of 7	**YES**
	Streambank Stability Success	4. Less than 25% of bank length is unstable and classified as eroding bank.	**Less than 2%** of the banks within the project reach exhibit signs of erosion or instability	**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.	See Channel Form Narrative in Section 5.5	**YES**

The longitudinal profile surveyed along the length of the reconstructed channel indicates habitat variability, with a series of shallow pools providing an additional 0.5 to 1.25 feet of depth as compared to riffles. Nine pools were identified on the profile, which corresponds to the number of pools proposed on the design plans. Riffle and pool transect surveys indicate pools are slightly deeper than riffles. The gently meandering planform and spring driven hydrology of this system is unlikely to generate particularly deep pools over time. However, surveys through pool habitats indicate some degree of habitat variability exists within the reconstructed channel segment.

Wildlife habitat variability appears to be improving over time as the stands of willows provide forage for beavers. Three beaver dams were observed in the creek during the 2016 monitoring event, and are generating small backwater pools. These pools may expand depending on continued use of the Spring Creek channel by beavers.

The existence of riffles, shallow pools, and a dense riparian overstory provide relatively good habitat for fish that may migrate from Ashley Creek into Spring Creek. Although Spring Creek does not provide an abundance of slow, deep water habitat, the water depth (>1 foot) and velocities (<3 feet/second) observed during the monitoring visits may be suitable for spawning fish. Substrate composition was not documented as part of the monitoring at this site, but if small gravels are present, this reach of Spring Creek could be utilized for spawning fish. It should be noted the existing channel planform and habitat elements are a vast improvement from the former condition of the channel, which was highly incised and channelized, with banks consisting of discarded wood chips from the adjacent mill operation.

The combined results of channel form indicate the reconstructed segment of Spring Creek is stable and provides floodplain access during flood discharges greater than the estimated 2-year flood event discharge. Evidence of pool and riffle habitats is provided by repeat surveys at pool and riffle transects, as well as the longitudinal profile through the project reach. Channel surveys indicate a constructed channel length of 986 feet. Based on the data presented throughout this section, Spring Creek appears to be meeting the qualitative success criteria for channel form six years following construction.

In summary, all of the success criteria outlined in the Spring Creek monitoring plan have been met six years following construction of the project. In addition to this milestone, the performance criteria for the stream channel and adjacent riparian corridor have been consistently met for the past four years. These monitoring results provide strong evidence the site has successfully achieved its mitigation requirements as outlined in the monitoring plan approved by the U.S. Army Corps. As a result, discontinued monitoring of the Spring Creek may be warranted.

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

The following section offers recommendations that may be considered by MDT for use in designing and implementing future stream and riparian mitigation projects. These recommendations should not be considered required actions to ensure successful mitigation at the Spring Creek project site.

6.1. Riparian and Floodplain Zones

The reconstructed channel segment of Spring Creek is designed with upland side slopes that transition to a narrow, 17.5-foot wide floodplain bench. Perpendicular transect survey results (Appendix B) illustrate floodplain slopes down to the channel which reduces the area available for overbank flooding to a narrow zone adjacent to the channel. This design configuration results in a relatively limited riparian/floodplain zone approximately three times wider than the active channel. 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 floodplain 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.

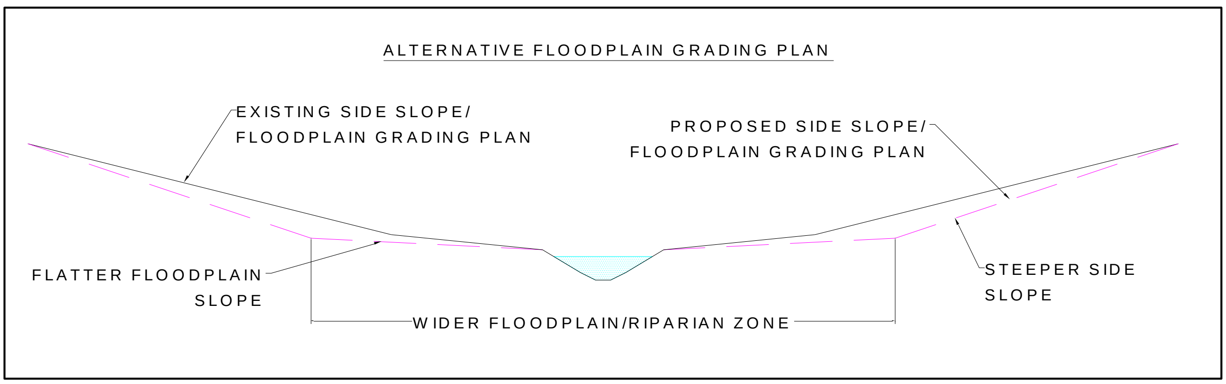

Figure 2. Alternative grading plan to increase floodplain and riparian areas.

6.2. Channel Planform

The Spring Creek channel planform exhibits a very gently meandering pattern within a relatively narrow floodplain corridor. Channel planform design elements often include a comparison of meander radius of curvatures to bankfull width ratios (Rc/W). Gently meandering streams exhibit high Rc/W ratios, while streams with high sinuosity and sharp bends exhibit low Rc/W ratios. Lower Rc/W ratios generally result in pronounced, deeper scour pools on the outside of meander bends, while higher Rc/W ratios typically result in more planar bed profiles with shallow and infrequent pools.

The Spring Creek design plans indicate meander radii ranging between 20 and 30 meters (66-98 feet), and a riffle bankfull top width of 2.0 meters (6.5 feet). These design parameters generate Rc/W ratios ranging from 10.1 to 15.0, which are considered high for meandering streams. Given the meander radii proposed in the channel planform design as compared to the bankfull width, pool features probably will not result following flood events. Additional habitat complexity elements could be generated in future projects by designing for lower Rc/W ratios, increased sinuosity, and wider floodplain corridors. It is acknowledged that each of these habitat improvement elements requires additional excavation (costs) to the overall project; therefore, a cost/benefit analysis is warranted prior to implementing such design considerations. It is also acknowledged that the design channel planform geometry of this segment of Spring Creek is vastly improved from the historic condition of the channel prior to channel reconstruction.

7.0 LITERATURE CITED

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

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

Appendix A

Project Site Maps

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana

CONFLUENCE
consulting incorporated

Legend

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

Spring Creek - 2016 Monitoring Features

Figure 3

Date: 10/13/2016

Spring_features2016.mxd

CONFLUENCE consulting incorporated

Legend

Project Boundary

Vegetation Community Boundary

- Centaurea stoebe
- Cirsium arvense
- Convolvulus arvensis
- Cynoglossum officinale
- Linaria vulgaris
- Tanacetum vulgare

4 Prunus/Cornus Community
5 Elymus/Festuca Community
6 Salix/Helianthus/Phalaris Community
7 Vicia/Bromus Community

Spring Creek - 2016 Noxious Weeds and Vegetation Community

Figure 4

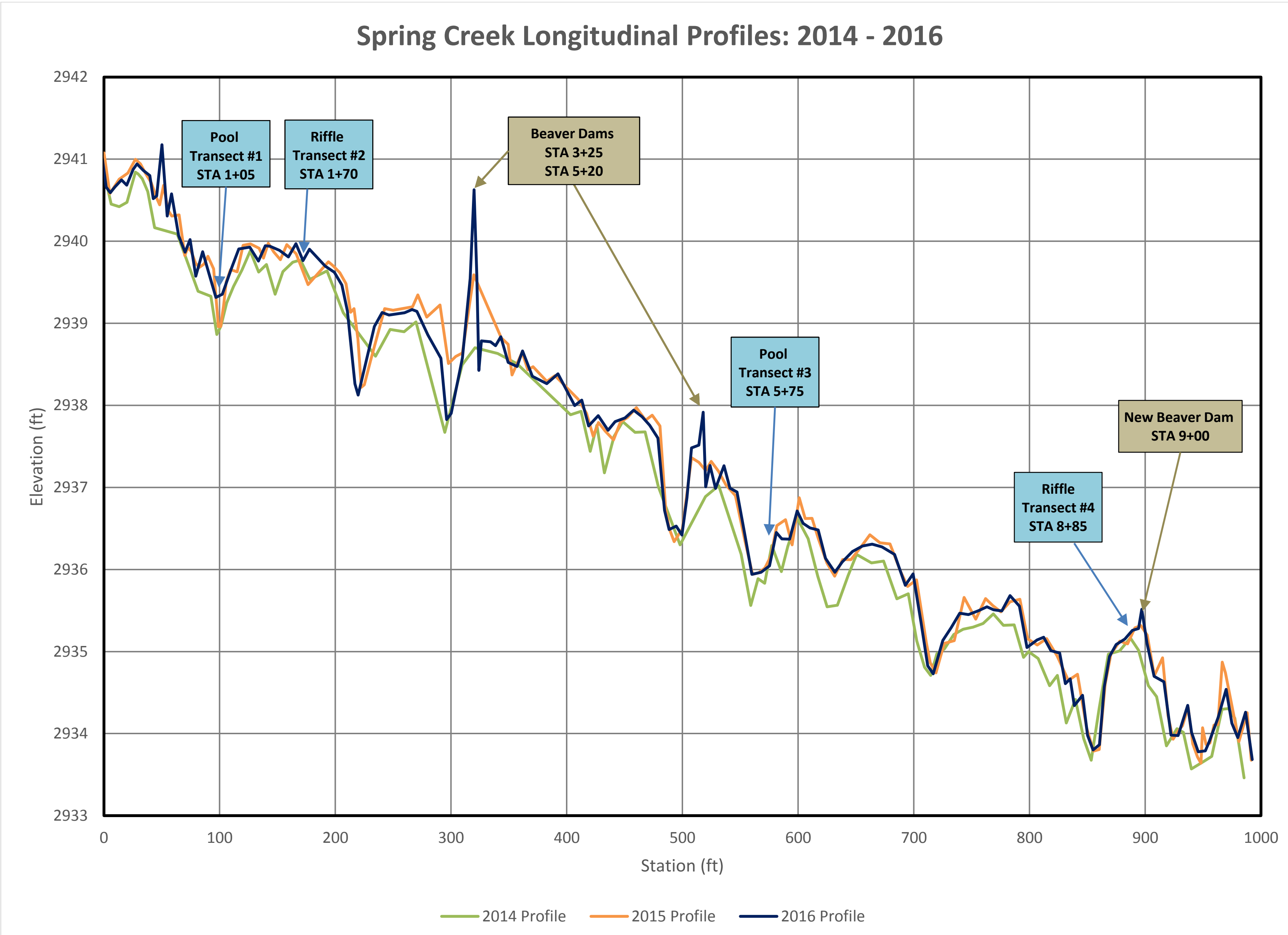
Date: 10/13/2016

Spring_monitor2016.mxd

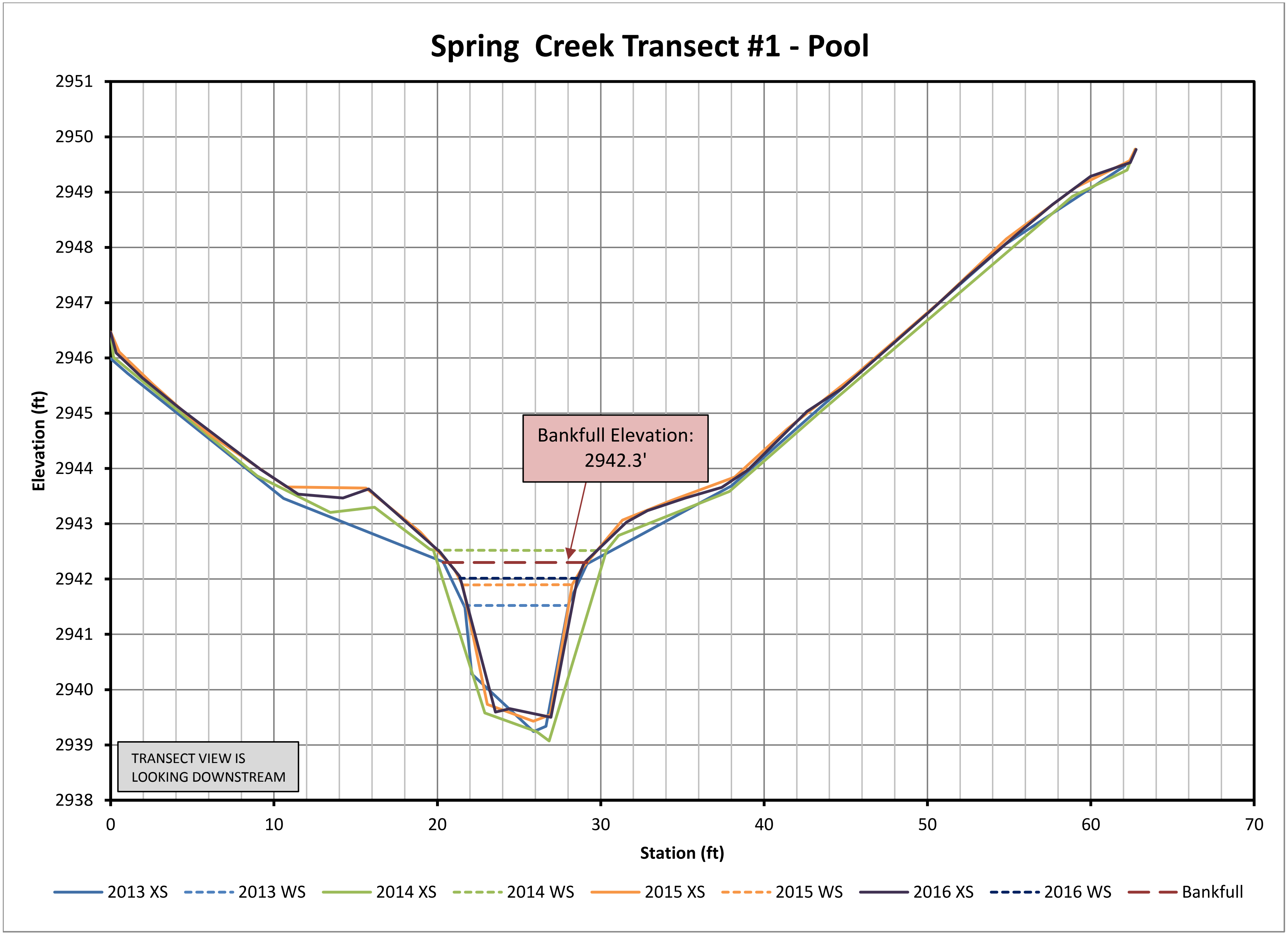
Appendix B

Perpendicular Transect Plots and Longitudinal Profile

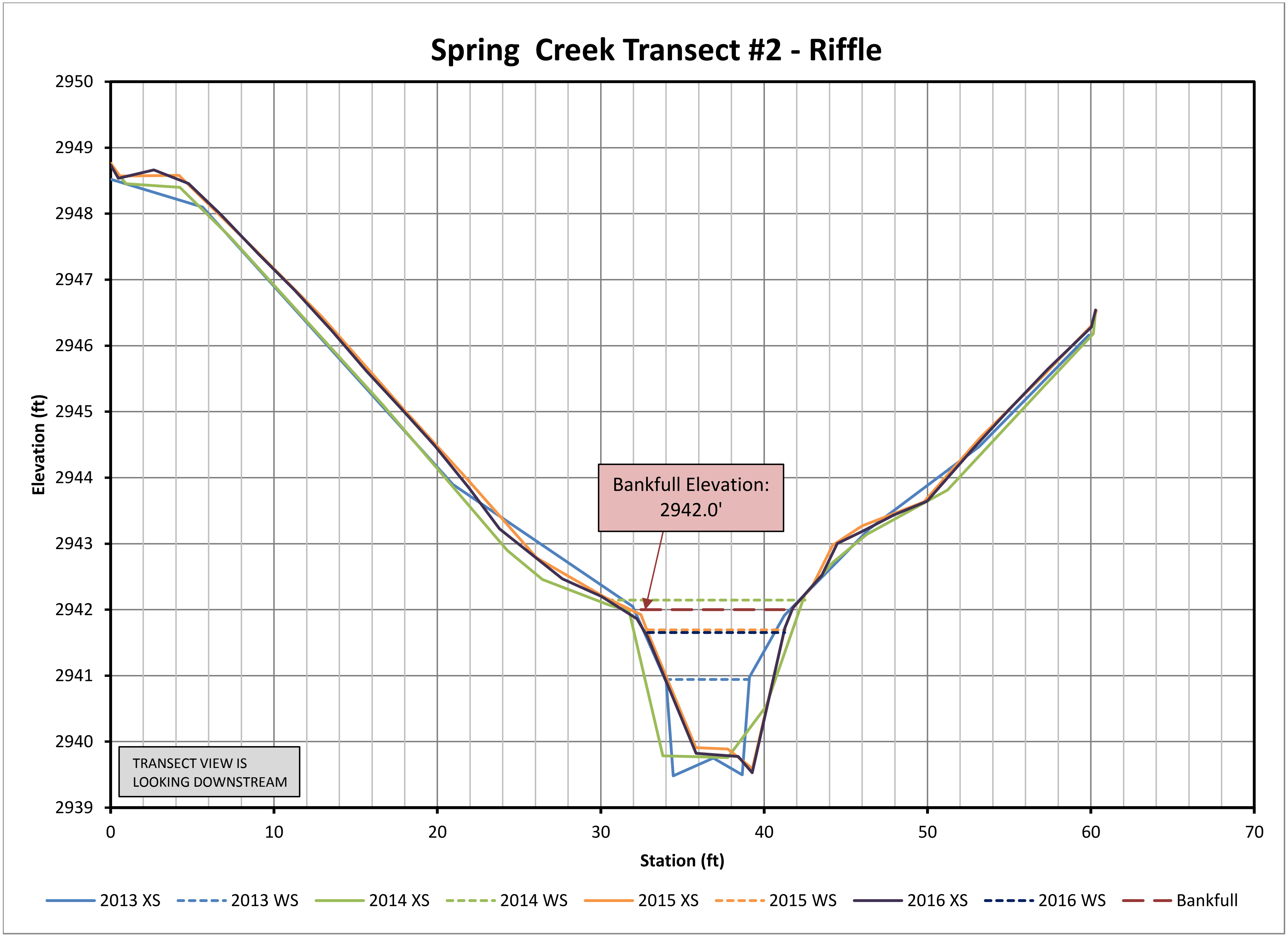
MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana



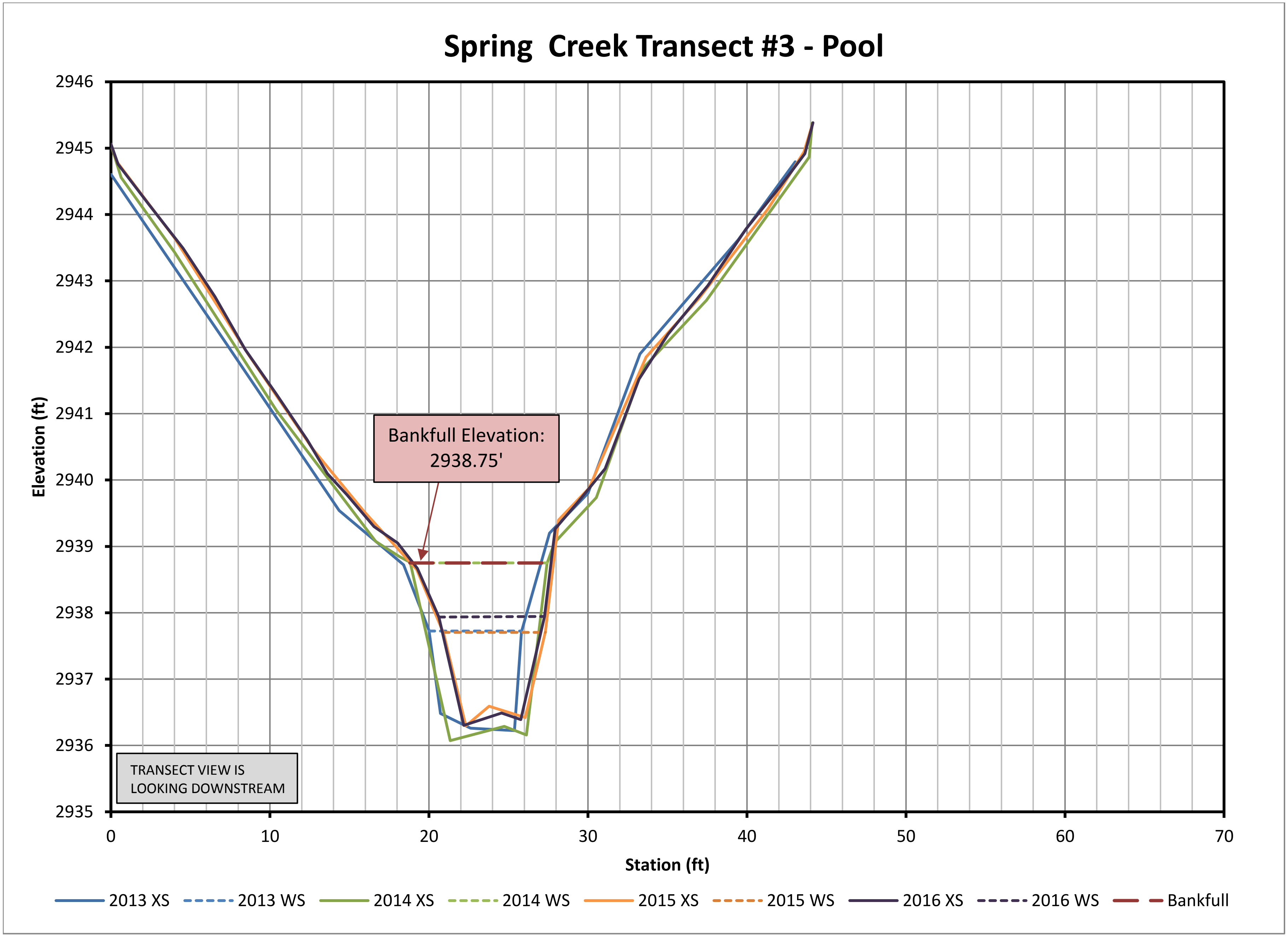
Spring Creek Longitudinal Profiles: 2014 - 2016
Pool Transect #1 STA 1+05
Riffle Transect #2 STA 1+70
Beaver Dams STA 3+25 STA 5+20
Pool Transect #3 STA 5+75
New Beaver Dam STA 9+00
Riffle Transect #4 STA 8+85
Elevation (ft)
2942
2941
2940
2939
2938
2937
2936
2935
2934
2933
Station (ft)
0
100
200
300
400
500
600
700
800
900
1000
2014 Profile
2015 Profile
2016 Profile

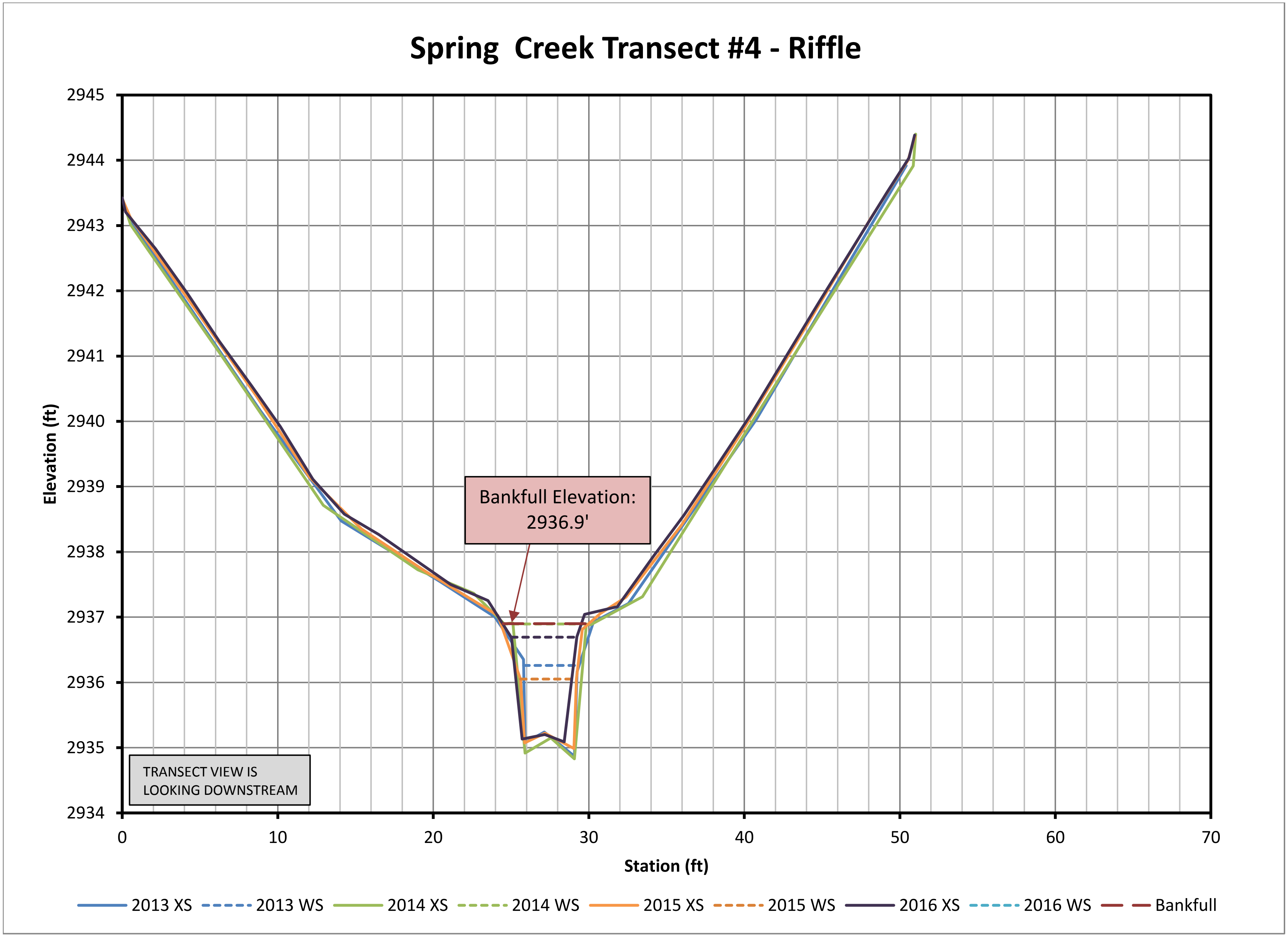


Spring Creek Transect #1 - Pool
Elevation (ft)
2951
2950
2949
2948
2947
2946
2945
2944
2943
2942
2941
2940
2939
2938
Station (ft)
0
10
20
30
40
50
60
70
Bankfull Elevation: 2942.3'
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
Bankfull



Spring Creek Transect #2 - Riffle
Elevation (ft)
Station (ft)
Bankfull Elevation: 2942.0'
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
Bankfull


Spring Creek Transect #3 - Pool
Elevation (ft)
Station (ft)
Bankfull Elevation: 2938.75'
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
Bankfull



Spring Creek Transect #4 - Riffle
Elevation (ft)
2945
2944
2943
2942
2941
2940
2939
2938
2937
2936
2935
2934
Station (ft)
0
10
20
30
40
50
60
70
Bankfull Elevation: 2936.9'
TRANSECT VIEW IS LOOKING DOWNSTREAM
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
Bankfull

Appendix C

Project Site Photos

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

CONFLUENCE

Photo Point 1.1: 2013
Description: View looking north (upstream) at project area. **Compass**: 0 (North)

Photo Point 1.1: 2016
Description: View looking north (upstream) at project area. **Compass**: 0 (North)

Photo Point 1.2: 2013
Description: View looking south (downstream) at project area. **Compass**: 180 (South)

Photo Point 1.2: 2016
Description: View looking south (downstream) at project area. **Compass**: 180 (South)

Photo Point 2: 2013
Description: View looking north of project area from photo point 2. **Compass**: 0 (North)

Photo Point 2: 2016
Description: View looking north of project area from photo point 2. **Compass**: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

CONFLUENCE

Photo Point 3.1: 2013
Description: View looking south from photo point 3
Compass: 180 (South)

Photo Point 3.1: 2016
Description: View looking south from photo point 3
Compass: 180 (South)

Photo Point 3.2: 2013
Description: Looking of upstream end of project area from photo point 3. **Compass**: 90 (East)

Photo Point 3.2: 2016
Description: Looking of upstream end of project area from photo point 3. **Compass**: 90 (East)

Photo Point 4.1: 2013
Description: Northward view of project area from photo point 4. **Compass**: 0 (North)

Photo Point 4.1: 2016
Description: Northward view of project area from photo point 4. **Compass**: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

Photo Point 4.2: 2013
Description: View east across the stream channel.
Compass: 90 (East)

Photo Point 4.2: 2016
Description: View east across the stream channel.
Compass: 90 (East)

Photo Point 4.3: 2013
Description: View looking downstream at project area. **Compass**: 180 (South)

Photo Point 4.3: 2016
Description: View looking downstream at project area. **Compass**: 180 (South)

Additional Photo 1: 2013
Description: Culvert at upstream end of project area.
Compass: 25 (North-Northeast)

Additional Photo 1: 2016
Description: Culvert at upstream end of project area.
Compass: 25 (North-Northeast)

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2016 Monitoring Event

Additional Photo 2: 2016
Description: Eroding stream bank
Compass: 130 (Southeast)

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T1 RIGHT: LOOKING EAST TO T1 LEFT

T1 LEFT: LOOKING WEST TO T1 RIGHT

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T1 RIGHT: LOOKING NORTHEAST UPSTREAM

T1 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T1: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T1: LOOKING SOUTH DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T1 LEFT: LOOKING NORTH UPSTREAM

T1 LEFT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T2 RIGHT: LOOKING EAST TO T2 LEFT

T2 LEFT: LOOKING WEST TO T2 RIGHT

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T2 RIGHT: LOOKING NORTH UPSTREAM

T2 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T2: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T2: LOOKING SOUTH DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T2 LEFT: LOOKING NORTH UPSTREAM

T2 LEFT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T3 RIGHT: LOOKING EAST TO T3 LEFT

T3 LEFT: LOOKING WEST TO T3 RIGHT

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T3 RIGHT: LOOKING NORTH UPSTREAM

T3 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T3: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T3: LOOKING SOUTH DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T3 LEFT: LOOKING NORTH UPSTREAM

T3 LEFT: LOOKING SOUTH DOWNSTREAM

T4 RIGHT: LOOKING EAST TO T4 LEFT

T4 LEFT: LOOKING WEST TO T4 RIGHT

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T4 RIGHT: LOOKING NORTHEAST UPSTREAM

T4 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T4: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T4: LOOKING SOUTH WEST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-11-16

T4 LEFT: LOOKING NORTH UPSTREAM

T4 LEFT: LOOKING SOUTHWEST DOWNSTREAM

Appendix D

Channel Construction Details

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	55

CSF-0.99947 0385

DETAIL

SPRING CREEK CHANNEL CHANGE

LEGEND

STREAM RIFFLE SECTION

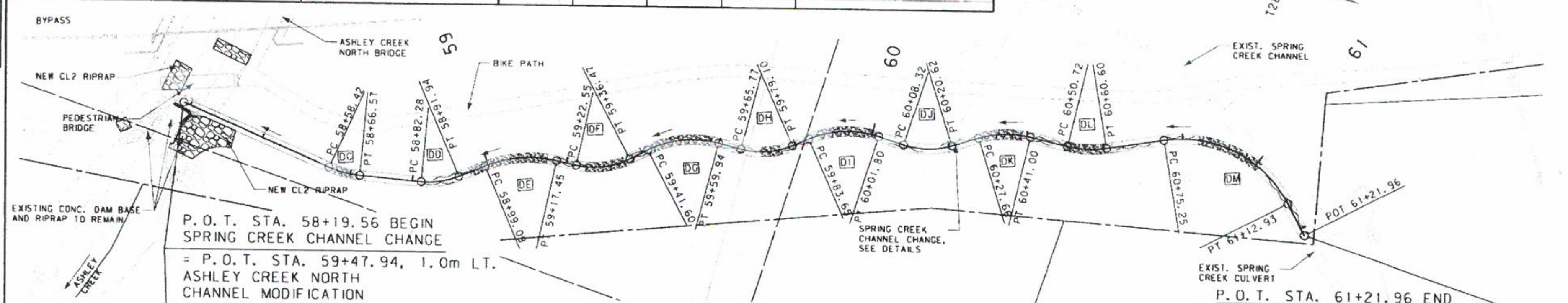
STREAM POOL SECTION

CENTERLINE COORDINATE TABLE NO. 1

STATION	DESCRIPTION	N OR Y COORDINATE	E OR X COORDINATE	REMARKS
58+19.56	POT	449 114.0061	240 825.7126	BEGIN CHANNEL CHANGE
58+58.42	PC	449 152.3917	240 831.7521	
58+62.53	PI	449 156.4550	240 832.3914	
58+66.57	PT	449 160.5089	240 831.6951	
58+82.28	PC	449 175.9866	240 829.0369	
58+87.21	PI	449 180.8454	240 828.2025	
58+91.94	PT	449 184.7597	240 825.2055	
58+99.09	PC	449 190.4408	240 820.8558	
59+08.57	PI	449 197.9650	240 815.0949	
59+17.45	PT	449 207.4331	240 814.7015	
59+22.55	PC	449 212.5234	240 814.4900	
59+29.81	PI	449 219.7736	240 814.1888	
59+36.47	PT	449 225.1439	240 809.3085	
59+41.60	PC	449 228.9423	240 805.8567	
59+51.21	PI	449 236.0516	240 799.3961	
59+59.94	PT	449 245.6579	240 799.3585	
59+65.77	PC	449 251.4802	240 799.3357	
59+72.70	PI	449 258.4061	240 799.3087	

CENTERLINE COORDINATE TABLE NO. 2

STATION	DESCRIPTION	N OR Y COORDINATE	E OR X COORDINATE	REMARKS
59+79.10	PT	449 263.8320	240 795.0042	
59+83.65	PC	449 267.3957	240 792.1771	
59+93.15	PI	449 274.8368	240 786.2739	
60+01.80	PT	449 284.3204	240 786.8010	
60+08.32	PC	449 290.8215	240 787.1622	
60+14.67	PI	449 297.1630	240 787.5147	
60+20.62	PT	449 302.5459	240 784.1438	
60+27.66	PC	449 308.5190	240 780.4035	
60+34.50	PI	449 314.3098	240 776.7773	
60+41.00	PT	449 321.1399	240 776.6003	
60+50.72	PC	449 330.8541	240 776.3487	
60+55.73	PI	449 335.8581	240 776.2190	
60+60.60	PT	449 340.4264	240 774.1728	
60+75.25	PC	449 353.8003	240 768.1822	
60+97.04	PI	449 373.6782	240 759.2783	
61+12.93	PT	449 388.2997	240 775.4221	
61+21.96	POT	449 394.3585	240 782.1117	END CHANNEL CHANGE



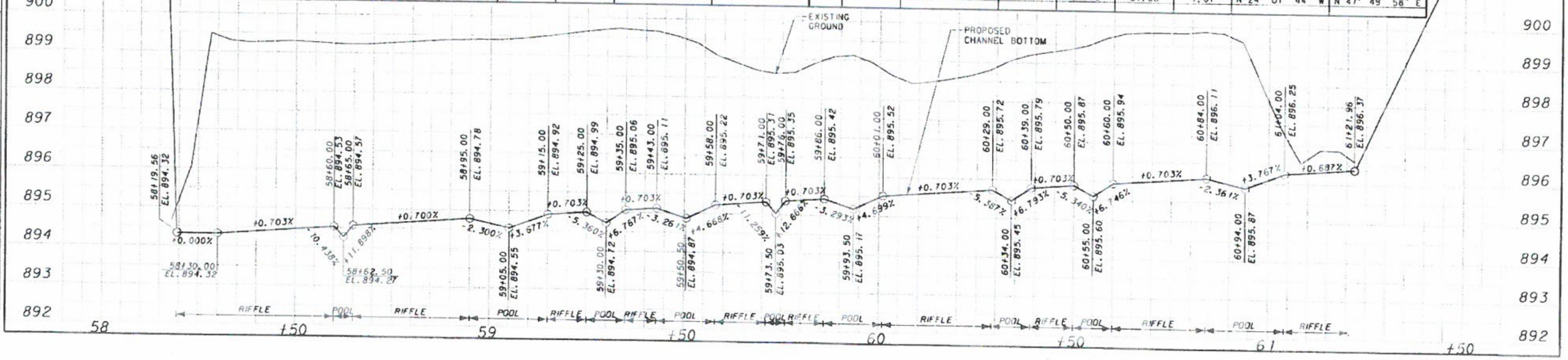
P.O.T. STA. 58+19.56 BEGIN SPRING CREEK CHANNEL CHANGE

= P.O.T. STA. 59+47.94, 1.0m LT. ASHLEY CREEK NORTH CHANNEL MODIFICATION

P.O.T. STA. 61+21.96 END SPRING CREEK CHANNEL CHANGE

SPRING CREEK CHANNEL CHANGE CURVE DATA

CURVE	P.I.	Δ	RADIUS (m)	T	L	E	BACK TANGENT	AHEAD TANGENT
DC	58+62.53	18° 41' 11" LT	25.00	4.11	8.15	0.34	N 8° 56' 29" E	N 9° 44' 43" W
DD	58+87.21	27° 41' 39" LT	20.00	4.93	9.67	0.60	N 9° 44' 43" W	N 37° 26' 22" W
DE	59+08.57	35° 03' 37" RT	30.00	9.48	18.36	1.46	N 37° 26' 22" W	N 2° 22' 45" W
DF	59+29.81	39° 53' 03" LT	20.00	7.26	13.92	1.28	N 2° 22' 45" W	N 42° 15' 47" W
DG	59+51.21	42° 02' 21" RT	25.00	9.61	18.34	1.78	N 42° 15' 47" W	N 0° 13' 27" W
DH	59+72.70	38° 12' 06" LT	20.00	6.93	13.33	1.17	N 0° 13' 27" W	N 38° 25' 32" W
DI	59+93.15	41° 36' 24" RT	25.00	9.50	18.15	1.74	N 38° 25' 32" W	N 3° 10' 51" E
DJ	60+14.67	35° 14' 09" LT	20.00	6.35	12.30	0.98	N 3° 10' 51" E	N 32° 03' 18" W
DK	60+34.50	30° 34' 15" RT	25.00	6.83	13.34	0.92	N 32° 03' 18" W	N 1° 29' 03" W
DL	60+55.73	22° 38' 42" LT	25.00	5.01	9.88	0.50	N 1° 29' 03" W	N 24° 07' 44" W
DM	60+97.04	71° 57' 42" RT	30.00	21.78	37.68	7.07	N 24° 07' 44" W	N 47° 49' 58" E



MONTANA DEPARTMENT OF TRANSPORTATION
MONTANA CADD
SE Stelling Engineers, Inc.

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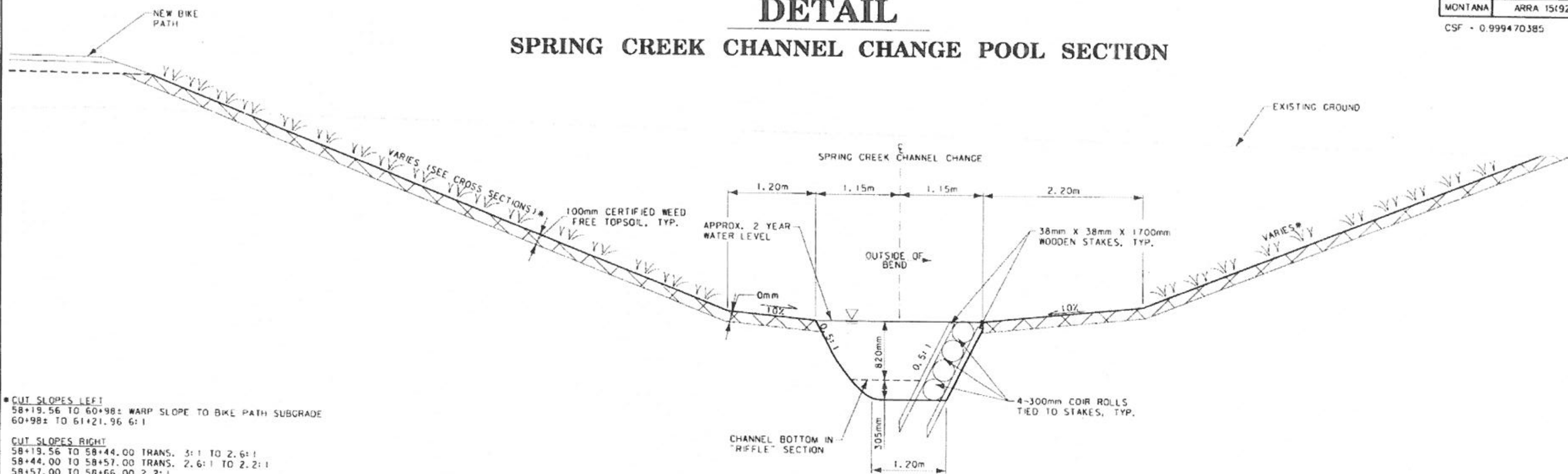
10/6/2009 11:16:35 AM EPS U2160

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	56

CSF = 0.999470385

DETAIL

SPRING CREEK CHANNEL CHANGE POOL SECTION

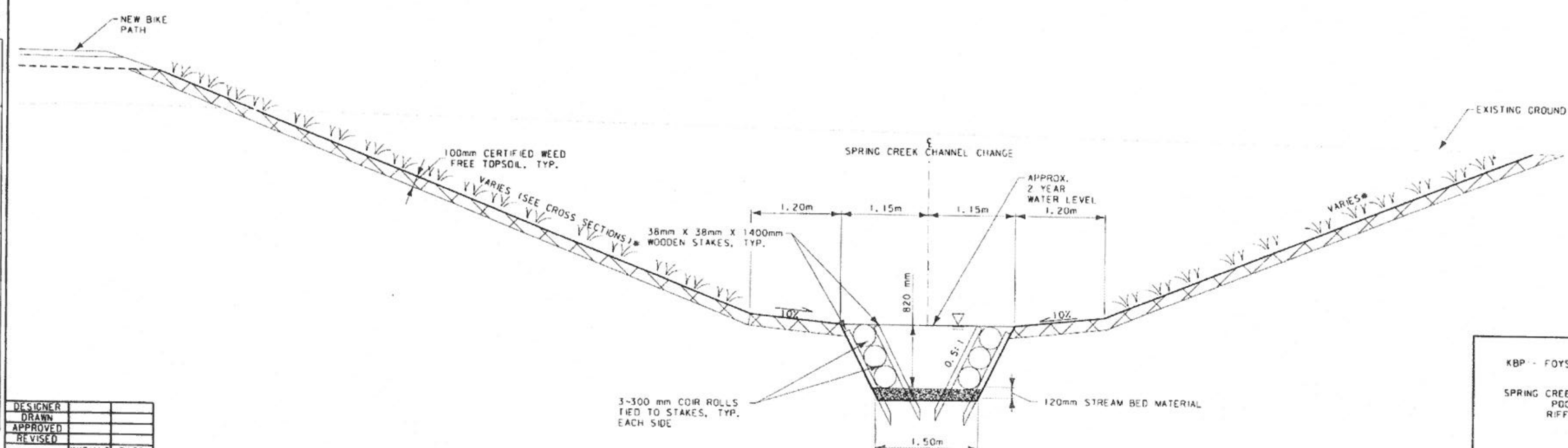


* CUT SLOPES LEFT
58+19.56 TO 60+98± WARP SLOPE TO BIKE PATH SUBGRADE
60+98± TO 61+21.96 6:1

CUT SLOPES RIGHT
58+19.56 TO 58+44.00 TRANS. 3:1 TO 2.6:1
58+44.00 TO 58+57.00 TRANS. 2.6:1 TO 2.2:1
58+57.00 TO 58+66.00 2.2:1
58+66.00 TO 58+87.00 TRANS. 2.2:1 TO 2.8:1
58+87.00 TO 59+08.00 TRANS. 2.8:1 TO 2.6:1
59+08.00 TO 59+30.00 2.6:1
59+30.00 TO 59+51.00 TRANS. 2.6:1 TO 3:1
59+51.00 TO 60+65.00 3:1
60+65.00 TO 61+21.96 TRANS. 3:1 TO 6:1

NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

SPRING CREEK CHANNEL CHANGE RIFFLE SECTION



NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

KBP - FOYS LAKE RD TO US 2

SPRING CREEK CHANNEL CHANGE
POOL SECTION
RIFFLE SECTION

NO SCALE

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MONTANA CADD

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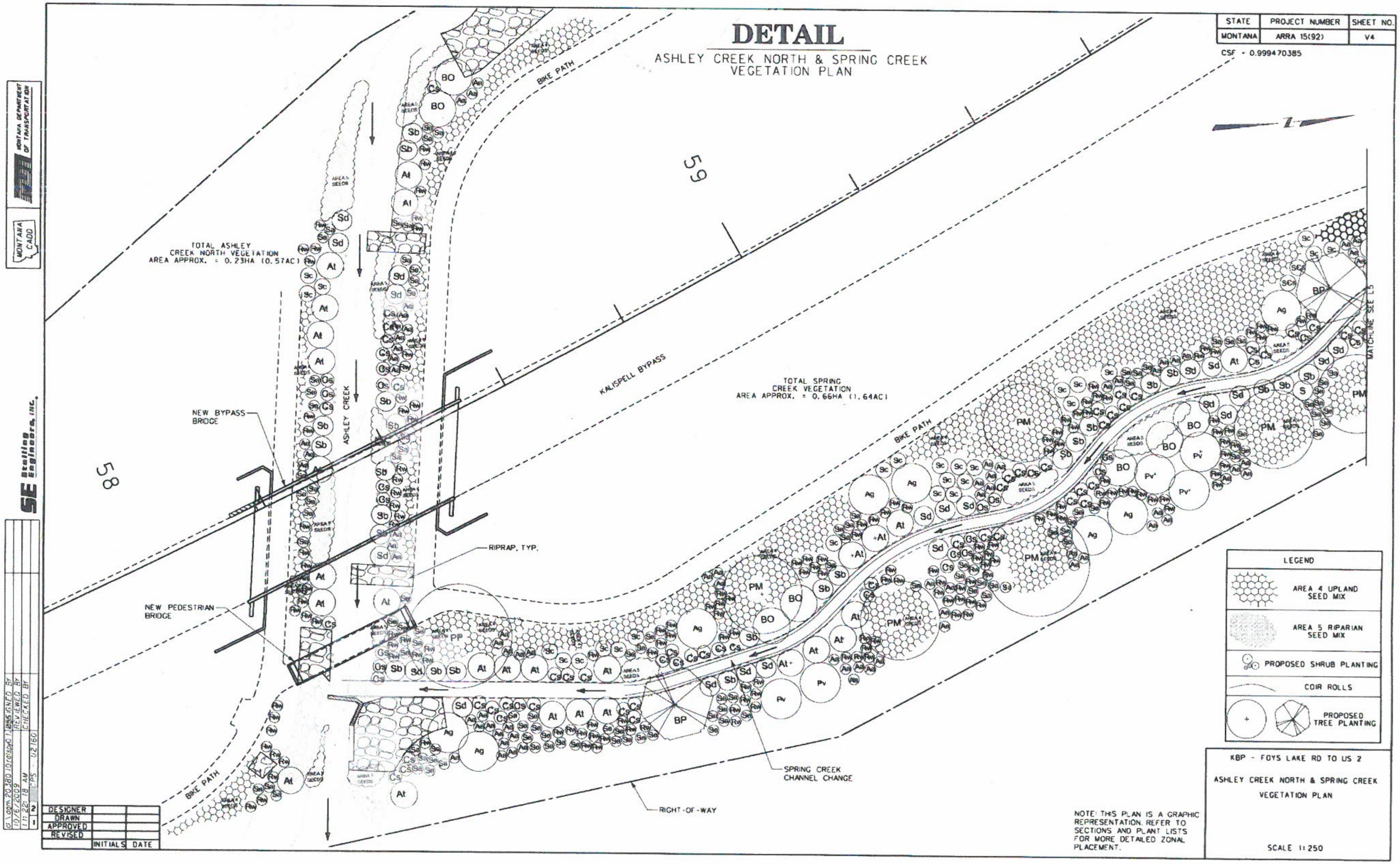
DETAIL
ASHLEY CREEK NORTH & SPRING CREEK
VEGETATION PLAN
STATE
MONTANA
PROJECT NUMBER
ARRA 15(92)
SHEET NO.
V4
CSF = 0.999470385
59
58
KALISPELL BYPASS
BIKE PATH
ASHLEY CREEK
TOTAL ASHLEY
CREEK NORTH VEGETATION
AREA APPROX. = 0.23HA (0.57AC)
TOTAL SPRING
CREEK VEGETATION
AREA APPROX. = 0.66HA (1.64AC)
NEW BYPASS BRIDGE
NEW PEDESTRIAN BRIDGE
RIPRAP, TYP.
SPRING CREEK CHANNEL CHANGE
RIGHT-OF-WAY
MATCHLINE SEE L5
LEGEND
AREA 4 UPLAND SEED MIX
AREA 5 RIPARIAN SEED MIX
PROPOSED SHRUB PLANTING
COIR ROLLS
PROPOSED TREE PLANTING
KBP - FOYS LAKE RD TO US 2
ASHLEY CREEK NORTH & SPRING CREEK
VEGETATION PLAN
SCALE 1:250
NOTE: THIS PLAN IS A GRAPHIC REPRESENTATION. REFER TO SECTIONS AND PLANT LISTS FOR MORE DETAILED ZONAL PLACEMENT.
DESIGNER
DRAWN
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REVISED
INITIALS
DATE
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10/6/2009
11:22:18 AM
MONTANA CADD
MONTANA DEPARTMENT OF TRANSPORTATION
SE Stelling Engineers, Inc.

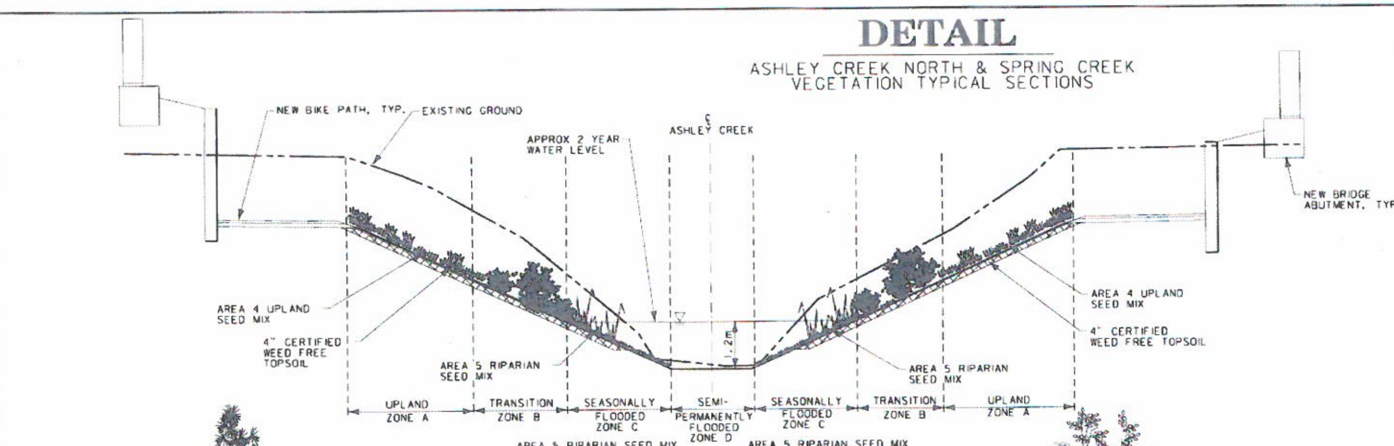
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	V3

CSF = 0.999470385

DETAIL

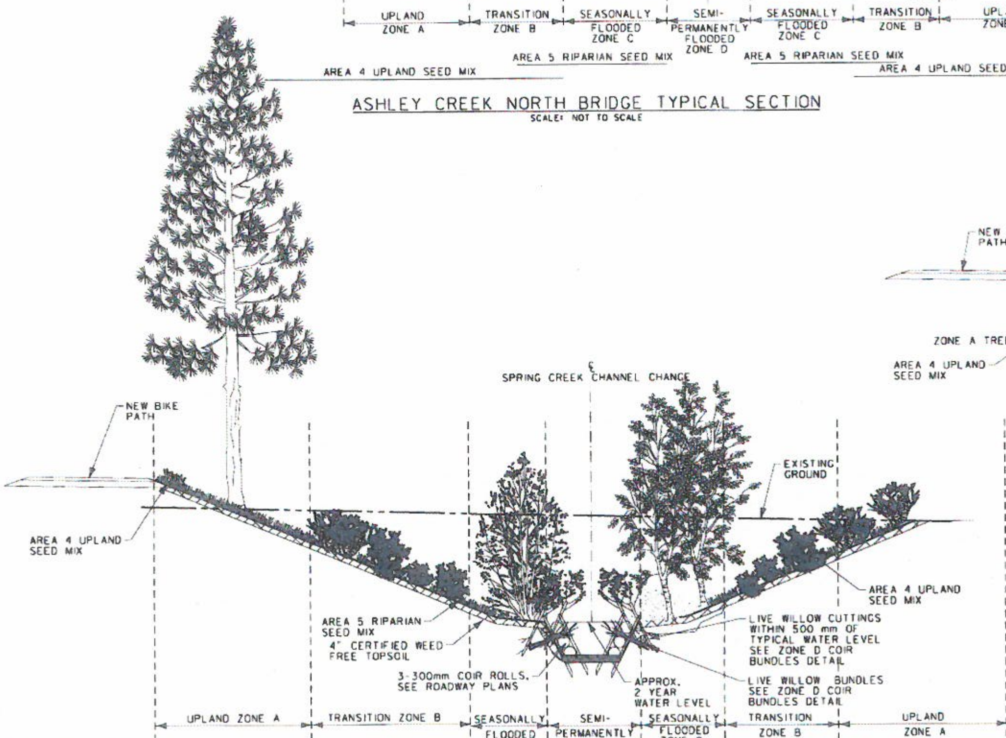
ASHLEY CREEK NORTH & SPRING CREEK VEGETATION TYPICAL SECTIONS

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



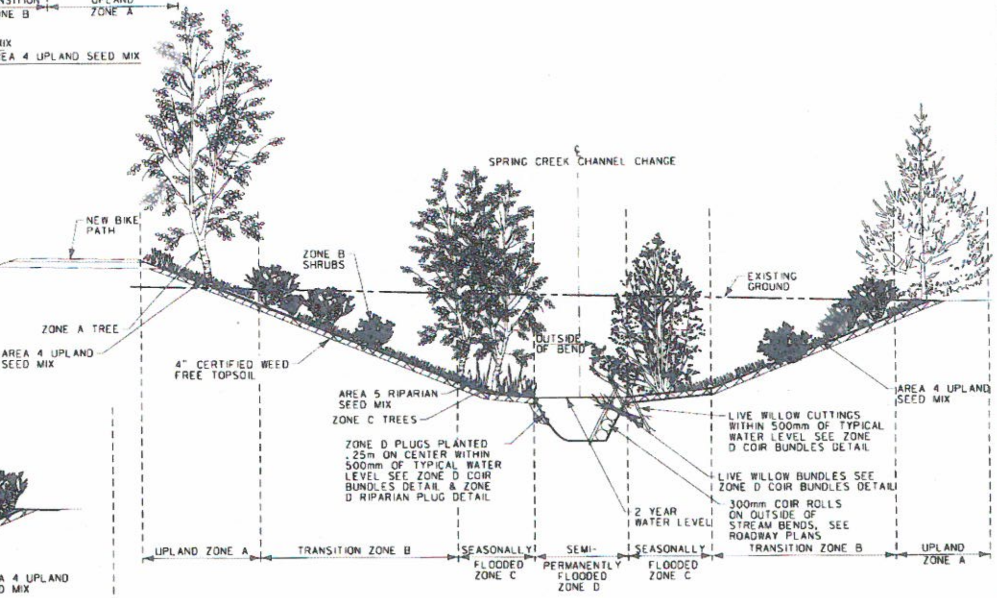
ASHLEY CREEK NORTH BRIDGE TYPICAL SECTION

SCALE: NOT TO SCALE



SPRING CREEK CHANNEL CHANGE RIFFLE TYPICAL SECTION

SCALE: NOT TO SCALE



SPRING CREEK CHANNEL CHANGE POOL TYPICAL SECTION

SCALE: NOT TO SCALE

KBP - FOYS LAKE RD TO US 2

ASHLEY CREEK NORTH & SPRING CREEK VEGETATION TYPICAL SECTIONS

NO SCALE

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STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	V2

CSF - 0.999470385

DETAIL

ASHLEY CREEK NORTH & SPRING CREEK VEGETATION SUMMARY & DETAILS

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 NOVEMBER 15 OR APRIL 30 AND JUNE 1 PROVIDED THE GROUND IS NOT FROZEN.
3. PLANT RIPARIAN PLUGS AS PER PLANTING DETAIL. INSTALL CUTTINGS BETWEEN APRIL 15 AND MAY 1.
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 WEED FREE ORGANIC COMPOST MULCH AS PER SPECIAL PROVISIONS.

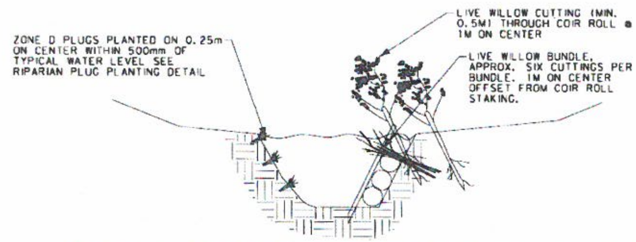
ASHLEY CREEK NORTH & SPRING CREEK CHANNEL CHANGE PLANT LIST *

TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
ZONE A UPLAND				
TREES				
BP	BETULA PAPYRIFERA	PAPER BIRCH	4	10' B&B
PP	PINUS PONDEROSA	PONDEROSA PINE	3	7' B&B
PM	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	8	6' B&B
ZONE B TRANSITIONAL				
SHRUBS				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
Aa	AMELANCHIER ALNIFOLIA	SASKATOON SERVICEBERRY	108	1 GAL.
Pv	PRUNUS VIRGINIANA	COMMON CHOKECHERRY	8	5 GAL.
Rw	ROSA WOODSII	WOODS ROSE	243	1 GAL.
Sc	SHEPHERDIA CANADENSIS	CANADA BUFFALOBERRY	41	1 GAL.
Sa	SYMPHORICARPOS ALBUS	SNOWBERRY	156	1 GAL.
ZONE C SEASONALLY FLOODED				
TREES				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
BO	BETULA OCCIDENTALIS	WATER BIRCH	11	15 GAL.
SHRUBS				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
At	ALNUS INCANA SSP. TENUIFOLIA	THIN-LEAF ALDER	43	5 GAL.
Cs	CORNUS STOLONIFERA/SERICEA	RED-OSIER DOGWOOD	102	1 GAL.
Sb	SALIX BEBBIANA	BEBB WILLOW	38	5 GAL.
Sd	SALIX DRUMMONDIANA	DRUMMOND WILLOW	33	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	500	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	500	CUTTINGS
COIR ROLL LAYERING SPACE 6 CUTTINGS PER BUNDLE @ 1m ON CENTER				
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	1500	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	1500	CUTTINGS
STREAMBANK PLUGS				
	BOTANICAL NAME	COMMON NAME	QNTY	
	CAREX NEBRASCENSIS	NEBRASKA SEDGE	288	PLUGS
	CAREX UTRICULATA	BEAKED SEDGE	403	PLUGS
	CAREX VESICARIA	INFLATED SEDGE	288	PLUGS
	GLYCERIA ELATA (STRIATA)	FOWL MANNAGRASS	173	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		square meters
FROM	TO	
58+19.56	61+31.96	6372
TOTAL		6372

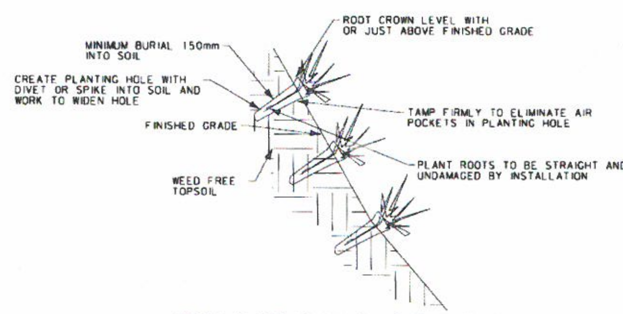
* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".



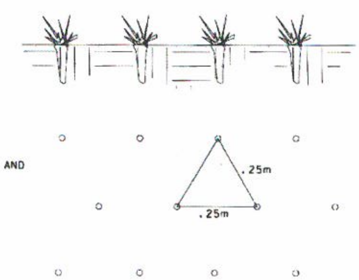
ZONE D COIR BUNDLES WITH WILLOW CUTTINGS AND LAYERING
SCALE: NOT TO SCALE

HARVESTING AND INSTALLATION NOTE:

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



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



SPACING

KBP - FOYS LAKE RD TO US 2

ASHLEY CREEK NORTH & SPRING CREEK VEGETATION SUMMARY & DETAILS

NO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

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