MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Spring Creek
Flathead County, Montana

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

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #3

YEAR 2015

Spring Creek
Flathead County, Montana

MDT Project Number: NH-MT 5-3(59) 109
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Prepared for:

MONTANA DEPARTMENT OF TRANSPORTATION
2701 Prospect Ave
Helena, MT 59620-1001

Prepared by:

Confluence Consulting, Inc.
P.O. Box 1133
Bozeman, MT 59771

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Cover Photo: Relocated segment of Spring Creek, 2014.

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 third 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 five 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 having root stability indexes ≥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 third 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 Spring Creek 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).

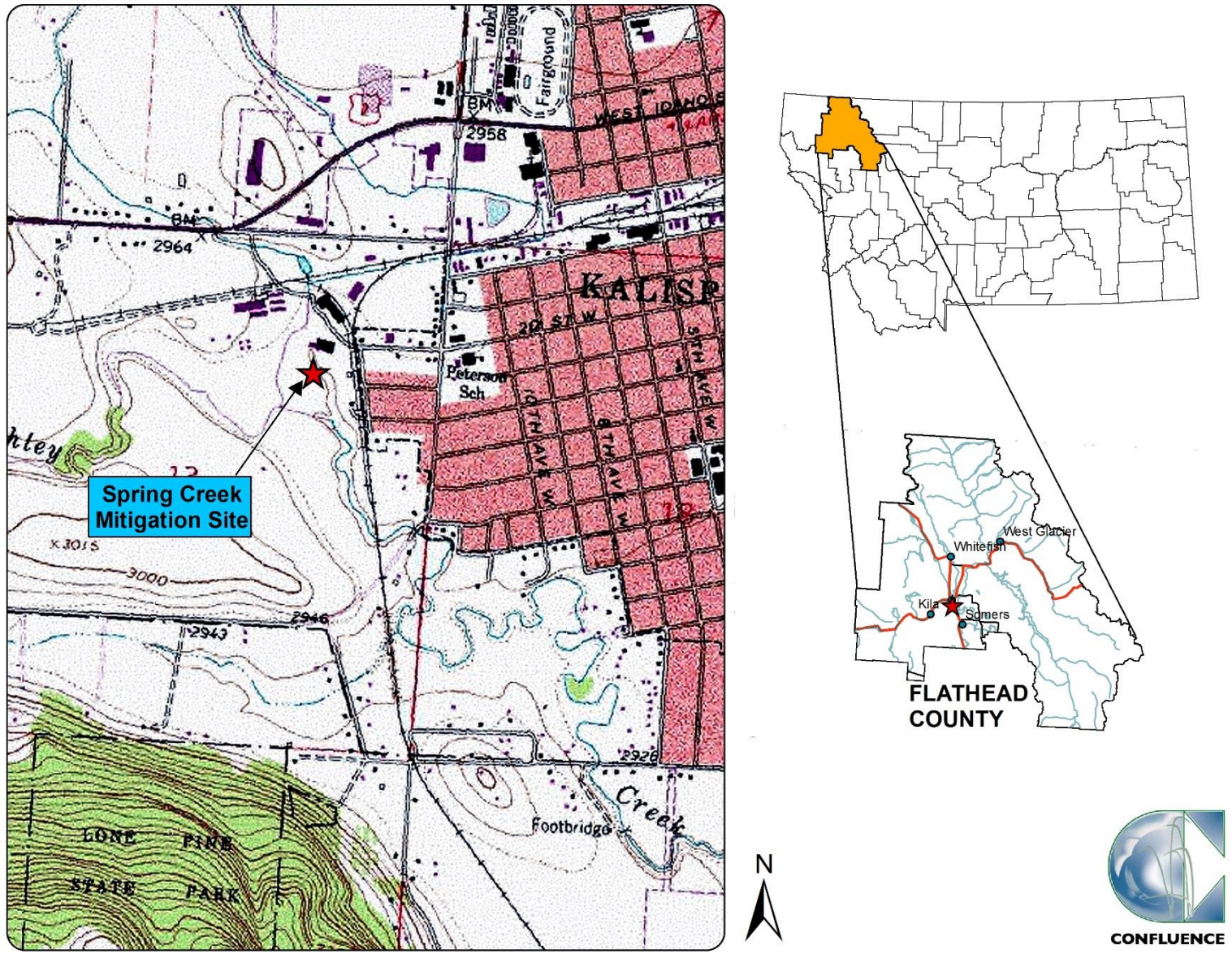


Figure 1. Project location of Spring Creek stream mitigation site.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on August 19, 2015 while survey crews visited the site on August 26, 2015. The following data were collected at the Spring Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

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 riparian transect on the right (west) bank was 25 feet wide and extended 223 feet, while the riparian transect on the left (east) bank was 25 feet wide and extended 296 feet (Figure 3, Appendix A).

A vegetation inventory was conducted along both stream banks, which included compiling a list of all plant species and their associated cover classes identified within three feet of the active channel. Percent cover of all species observed along the entire length of each bank was estimated and recorded using the following classification values: 0 (less than 1 percent), 1 (1 to 5 percent), 2 (6 to 10 percent), 3 (11 to 20 percent), 4 (21 to 50 percent), and 5 (greater than 50 percent).

Vegetation community boundaries were determined in the field during the active growing season and subsequently delineated on the 2015 aerial photographs. Community types were named based on the predominant vegetation species that characterized each mapped polygon (Figure 4, Appendix A). Bank stability indices were assigned to the stream bank community types using Winward (2000) stability scores.

The project site was visually inspected to document the presence of noxious weeds. All noxious weed infestations were mapped on aerial photographs, with species and extents noted (Figure 4, Appendix A). Observations of isolated noxious weed occurrences were included in the species lists and total areal percent cover estimate of noxious weeds within the project area, but were not mapped.

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

3.2. Bank Erosion Inventory

Both stream banks within the project reach were visually inspected to document eroding banks. Each eroding bank within the project reach was photo-documented. Data collected at each eroding bank included bank length and potential causes of bank erosion.

3.3. Channel Surveys

Four perpendicular transects (cross sections) were surveyed by licensed survey crews; two at riffles and two at pools. 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. Photo-documentation of each transect included photos taken facing upstream, downstream, left, and right from the channel centerline. In addition to the perpendicular transects, a longitudinal profile of the channel thalweg was surveyed to document bedform complexity and aquatic habitat conditions.

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 locations for establishing permanent photo points were selected to document changes in the site over time. In addition, photos were taken at the endpoints and facing upstream, downstream, left and right from the center of the channel at each perpendicular transect. 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 1 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 2015 the total percent riparian cover remained at 100%, with 42% cover by woody species and 7% by noxious weeds. Stream bank transects also displayed 100% cover, with 42% by woody species and 6% by noxious weeds. In total, the site exhibited 100% total vegetation cover, with 42% by woody species and 7% by noxious weeds.

No bare ground was observed within the entire project reach, 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 1. Percent cover of vegetation transects at Spring Creek in 2013, 2014 and 2015.

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

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 2015, including community Type 1 – *Elymus* spp./*Bromus inermis*., community Type 2 – *Salix* spp./*Helianthus maximiliani*, community Type 3 – *Salix* spp./*Phalaris arundinacea*, and community Type 4 – *Prunus* spp./*Cornus alba.* The upper side slopes of the project area were dominated by wild rye (*Elymus* spp.) and smooth brome (*Bromus inermis*), while the lower slopes and riparian zones were dominated by willows (*Salix* spp.), reed canary grass (*Phalaris arundinacea*), and Maximilian sunflower (*Helianthus maximiliani*). A small patch of choke cherry (*Prunus virginiana*), bitter cherry (*Prunus emarginata*), and red osier (*Cornus alba*) was observed north of the culvert outlet at the upstream extent of the project reach.

Table 2 is a comprehensive list of vegetative species identified within the two belt transects, two stream bank transects, and other incidental plants observed on site. In 2015, 92 plant species were observed on site, an increase by 16 species since the second monitoring event in 2014 and 38 species since the initial monitoring event in 2013. In 2015, 48% of the species observed on site were considered hydrophytic based on the National Wetland Plant List (NWPL) (Lichvar et al., 2014).

4.2. Stream Bank Vegetation Composition

The stream bank vegetation inventory identified 29 plant species along the banks of Spring Creek (Table 3). Reed canary grass comprised greater than 50% cover along both stream banks in 2015. The Winward stability ratings are based on vegetation communities rather than individual species; therefore, a vegetation community was assigned to each stream bank based on one or more dominant species (Winward, 2000). 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. Success criteria outlined in the monitoring plan state the vegetation along the stream banks will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6. Vegetation community Types 2 – *Salix* spp./*Helianthus maximiliani* and 3 – *Salix* spp./*Phalaris arundinacea* were the dominant vegetation communities observed along the stream banks, with associated stability ratings of 6 and 9, respectively.

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

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	FAC
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
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
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
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	**Wester Snowberry**	**FAC**
Symphyotrichum ascendens	**Wester 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 americana	American Purple Vetch	FAC

*Based on 2014 NWPL (Lichvar *et al*., 2014)
New species identified in 2015 are **bolded**.

Table 3. Comprehensive list of plant species and their associated cover classes along the stream banks of the Spring Creek mitigation site in 2015.

Streambank Species	Left Bank	Right Bank	WMVC Indicator Status***
Agrostis stolonifera	X		FAC
Alnus incana		X	FACW
Beckmannia syzigachne	X		OBL
Betula papyrifera		X	OBL
Betula pumila		X	OBL
Cirsium arvense	X	X	FAC
Cirsium vulgare		X	FACU
Cornus alba	X		FACW
Cynoglossum officinale		X	FACU
Epilobium ciliatum	X	X	FACW
Glyceria grandis	X		OBL
*Helianthus maximiliani***	X	X	UPL
Mentha arvensis	X		FACW
Nasturtium officinale	X		OBL
*Phalaris arundinacea**	X	X	FACW
Poa palustris	X		FAC
Rumex crispus	X	X	FAC
Salix bebbiana	X	X	FACW
*Salix drummondiana***	X	X	FACW
Salix exigua	X	X	FACW
Salix geyeriana	X	X	FACW
Salix sp.	X	X	NL
Scirpus microcarpus	X		OBL
Sisymbrium altissimum		X	FACU
Symphyotrichum ascendens	X		FACU
Tanacetum vulgare		X	FACU
Thlaspi arvense	X	X	UPL
Veronica americana	X		OBL
Vicia americana	X	X	FAC

*Dominant species along Spring Creek banks
**Co-dominant species along Spring Creek banks
***Based on 2014 NWPL (Lichvar *et al*., 2014)

4.3. Noxious Weed Inventory

The Spring Creek field assessment identified five Montana Listed Priority 2B noxious weeds and one state-regulated species (Table 4). Noxious weed occurrences are displayed on Figure 4 in Appendix A with the exception of those observed in trace

amounts, which were not mapped. Each mapped noxious weed occurrence was identified in areas less than 0.1 acre in size with a low cover class (1 to 5 percent). *Convolvulus arvensis* (field bindweed), a noxious weed identified in trace amounts in 2014, was not observed in 2015 and has been removed from the list of noxious weeds present at the Spring Creek mitigation site. As noted in Section 4.1, an estimated 7% of the project area has been colonized by noxious weeds, an increase of 2% since 2014 and 4% since the initial 2013 monitoring event.

Table 4. Montana State listed noxious weed and regulated species observed in 2015 at the Spring Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	*Centaurea stoebe*	Spotted Knapweed
	Cirsium arvense	Canadian Thistle
	Cynoglossum officinale	Gypsy-Flower
	Linaria vulgaris	Butter-and-eggs
	Tanacetum vulgare	Common Tansy
Priority 3 State Regulated	*Bromus tectorum*	Cheatgrass

*Based on the Montana Dept. of Agriculture's Noxious Weed List, 2015

4.4. Woody Plant Survival

Pacific willow, gray willow, coyote willow, black cottonwood, alder, snowberry, red osier dogwood, buffalo-berry, water birch, and Woods' rose were observed throughout the site as planted woody vegetation species. Table 5 indicates the total number of plants inspected and the number of those surviving for each of the past three monitoring years. The majority of the planted woody shrubs remain small and therefore offer a limited amount of cover to the site. Herbaceous vegetation establishing along the banks and upland areas of the project site has become less dense, allowing for easier location and identification of planted woody shrubs. As a result, in 2015 a much higher number of planted shrubs were observed. A total of 440 planted trees and shrubs were located in 2015, with 385 of those remaining alive. The planting plan called for installation of 668 trees and shrubs. As compared to the planting plan, 58% (385 out of 668) of the trees and shrubs have survived five years following the project's completion.

Although many more woody shrubs were observed in 2015, the percent cover provided by woody vegetation along the stream banks decreased in 2015 as compared to 2014 (Table 1). 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 within the project reach, which had not been observed during previous monitoring visits.

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

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%

4.5. Bank Erosion Inventory

Bank erosion was observed along one 30-foot long segment of the constructed channel (Figure 3, Appendix A). The bank has retreated approximately 1-2 feet since it was constructed. Wooden stakes used to pin coir logs remain in the channel, indicating the original extent of the bank at this location. The channel along this bank segment remains relatively densely vegetated with reed canary grass (*Phalaris arundinacea*), with lesser cover provided by Maximilian sunflower (*Helianthus maximiliani*) and Canadian thistle (*Cirsium arvense*). No floodplain exists to the west of the channel, and the adjacent area is a sloped embankment that extends upward to the bike path to the west of the creek. The erosion occurred approximately 30 feet downstream from one of the two beaver dams; however, the dam did not appear to be the primary cause of erosion. The bio-degradation of coir logs installed along the banks appears to have left a void in the bank at this location.

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). The nine pools in the design profile and documented during the 2014 longitudinal profile survey have maintained. Two beaver dams have also formed over the past year, creating backwatered pool features. With the exception of these two beaver dams, the stream bed has generally maintained a similar elevation over the past year 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 habitats as designated on the design plans. Maximum depth and bankfull widths for each transect are shown in Table 6, while plots of each transect are illustrated in Appendix B. These results indicate the average pool depths are slightly deeper than the average riffle depth 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 radius of curvatures along designated pool sections likely will not generate deep pools, although based on the survey results, are creating slightly deeper and slower water habitat than in riffles.

Table 6. Spring Creek maximum depths and bankfull widths in 2013, 2014, and 2015.

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

*Values have been modified from those reported in 2013 and 2014 based on a refinement of bankfull elevation

The spring creek and urban runoff hydrology of this channel are also unlikely to generate deep pools over time. The typical hydrology of Spring Creek generally 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 depth surveyed at both riffles and pools in 2014 and 2015 fell below the design depth of 2.7 and 3.7 feet, respectively, although the shallower pool depths have been affected by the location of the transects not occurring at the deepest part of the pool. The bankfull widths at riffle #1 appears to be wider than the design width of 7.5, while the width at riffle #2 appears to be narrower. Pool widths appear to be slightly wider than the design width. Evidence of channel widening was noted at two locations where wooden stakes used to pin coir logs in place are isolated out in the channel. This evidence of channel widening was observed at the eroding bank segment described in Section 4.5, and along the right (west) bank between Stations 0+75 and 1+00. The stream bank at the latter location does not appear to be actively eroding, and was therefore not included in the bank erosion inventory (see Additional Photo 3, Appendix C). Channel widening at these locations is likely due to bio-degradation of the coir logs used to construct the banks. Due to the relatively short segments of channel widening and the establishment of vegetation along the banks in their absence, no stabilization or corrective actions are warranted at this time.

4.7. Wildlife Documentation

Table 7 provides a comprehensive list of wildlife observed at the Spring Creek stream mitigation site during the past three monitoring events. Species observed on site in 2015 included a warbling vireo, and evidence of beavers and other rodents. Two small beaver dams constructed of willow stems were observed along the channel. The relatively low number of species observed may be attributed to the relatively close proximity to the adjacent highway, human/dog use of the adjacent bike path, and lack of mature tree and shrub cover habitat.

Table 7. Wildlife species observed at the Spring Creek stream mitigation site in 2013, 2014, and 2015.

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 and dam)	***Castor canadensis***
Rodent (burrow)	**N/A**
White-tailed Deer	*Odocoileus virginianus*

New species observed in 2015 are **bolded.**

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 third year of monitoring suggests that all six of the quantitative performance standards are being met five years after the project has been constructed (Table 8). 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 94 species identified in the mitigation area in 2015. The densely vegetated riparian zones have been established by a diversity of woody and herbaceous species, with a total of 94 species identified within the mitigation area in 2015. Overall, the project area has 93% cover by desirable, non-noxious weed species. Approximately 7% 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 being met five years following construction of the project.

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 vegetative growth with a variety of woody and herbaceous vegetation, indicating establishment exceeding the 70% coverage criteria.

Woody vegetation plantings indicated a survival rate of 58% five years following construction. Woody plants remain relatively small but should provide increased

percent cover of the site as they mature. Extremely dense and tall vegetative growth within the riparian corridor, particularly by sunflowers, made locating woody plantings in 2013 and 2014 very difficult; however a reduction in cover by sunflowers along the project reach allowed locating planted shrubs much easier in 2015. These results indicate the project reach is meeting both of the vegetation success criteria five years following construction.

5.3. Vegetation along Stream Banks

Reed canary grass comprised greater than 50% cover along both stream banks in 2015. Secondary dominant stream bank species included Drummond's willow (*Salix drummondiana*) and Maximilian sunflower (*Helianthus maximiliani*). As a result, vegetation community Types 2 – *Salix* spp./*Helianthus maximiliani* and 3 – *Salix* spp./*Phalaris arundinacea* were the dominant vegetation communities observed along the stream banks, with associated Winward stability ratings of 6 and 9, respectively. Therefore, stream bank vegetation is successfully meeting the associated performance criteria.

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. 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 the lack of a stable bank 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.

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 amount of lateral bank erosion. No vertical head cuts have been noted to date, and lateral movement along the short eroding bank segment has been relatively minimal.

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 that exceed that of 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, 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.

The longitudinal profile surveyed along the length of the reconstructed channel indicates some degree of 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 can be identified on the profile, which corresponds to the number of pools proposed on the design plans. Riffle and pool transect re-surveys indicate pools are slightly deeper than riffles. The gently meandering planform and spring driven hydrology of this system likely will not generate particularly deep pools over time. However, surveys through pool habitats indicate some degree of habitat variability exists within the reconstructed channel segment.

Habitat variability appears to be improving over time as the stands of willows provide habitat for beavers. Two small beaver dams were observed in the creek during the 2015 monitoring event, which 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 five years following construction.

Table 8. Monitoring results as compared to performance criteria for the Spring Creek mitigation site in 2015.

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	**93%** of riparian zones have revegetated with non-noxious species	**YES**
		1b. Noxious weeds do not exceed 10% cover within the riparian buffer areas.	**7%** 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 **58%** survival as compared to planting plan	**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 Types 2 – *Salix* spp./*Helianthus maximiliani* and 3 – *Salix* spp./*Phalaris arundinacea,* with root stability indices of 6 and 9, respectively**.**	**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**

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

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.

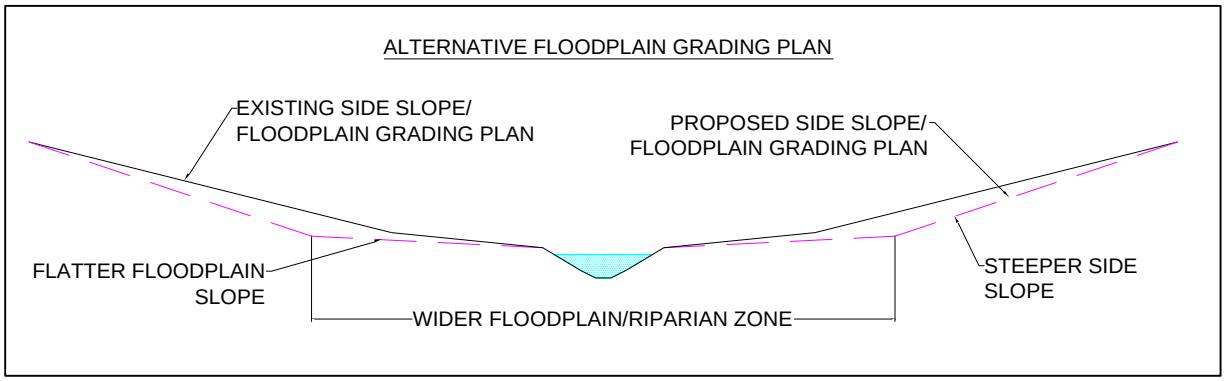


Figure 2. Alternative grading plan to increase floodplain and riparian areas.

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

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

Montana Department of Transportation, 2010. Kalispell Bypass MDT Project #NH-MT 5-3(59)109 FST, CN 2038 On-Site Stream Mitigation Plan, Flathead County, Montana.

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

Spring Creek - 2015 Monitoring Features

Figure 3

Date: 10/12/2015

Spring_features2015.mxd

CONFLUENCE
consulting incorporated

Legend

- Project Boundary
- Vegetation Community Boundary
- Cirsium arvense
- Cynoglossum officinale
- Linaria vulgaris
- Tanacetum vulgare
- Centaurea stoebe
- 1 Elymus/Bromus Community
- 2 Salix/Helianthus Community
- 3 Salix/Phalaris Community
- 4 Prunus/Cornus Community

Spring Creek - 2015 Noxious Weeds and Vegetation Community

Figure 4

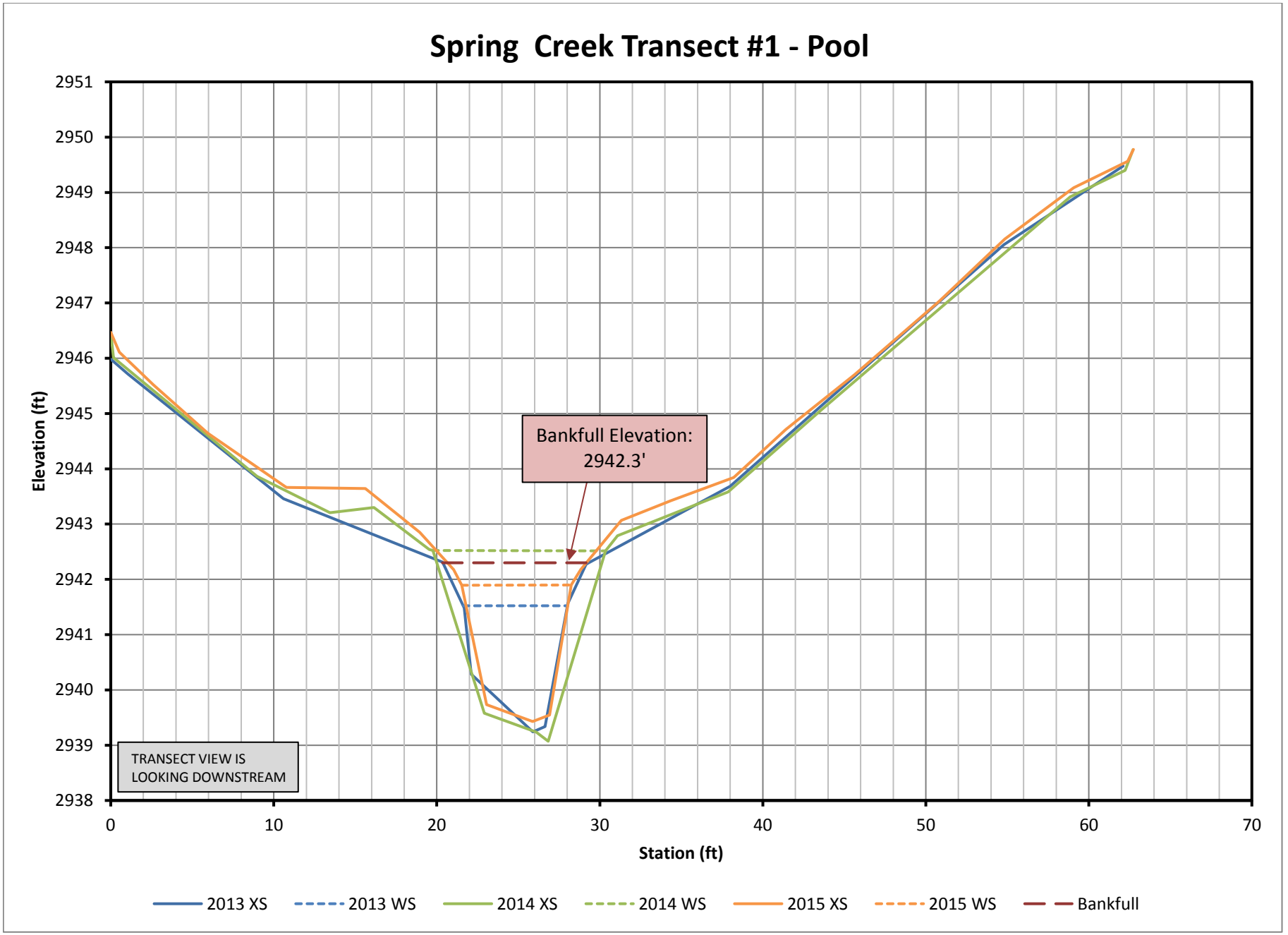
Date: 10/13/2015

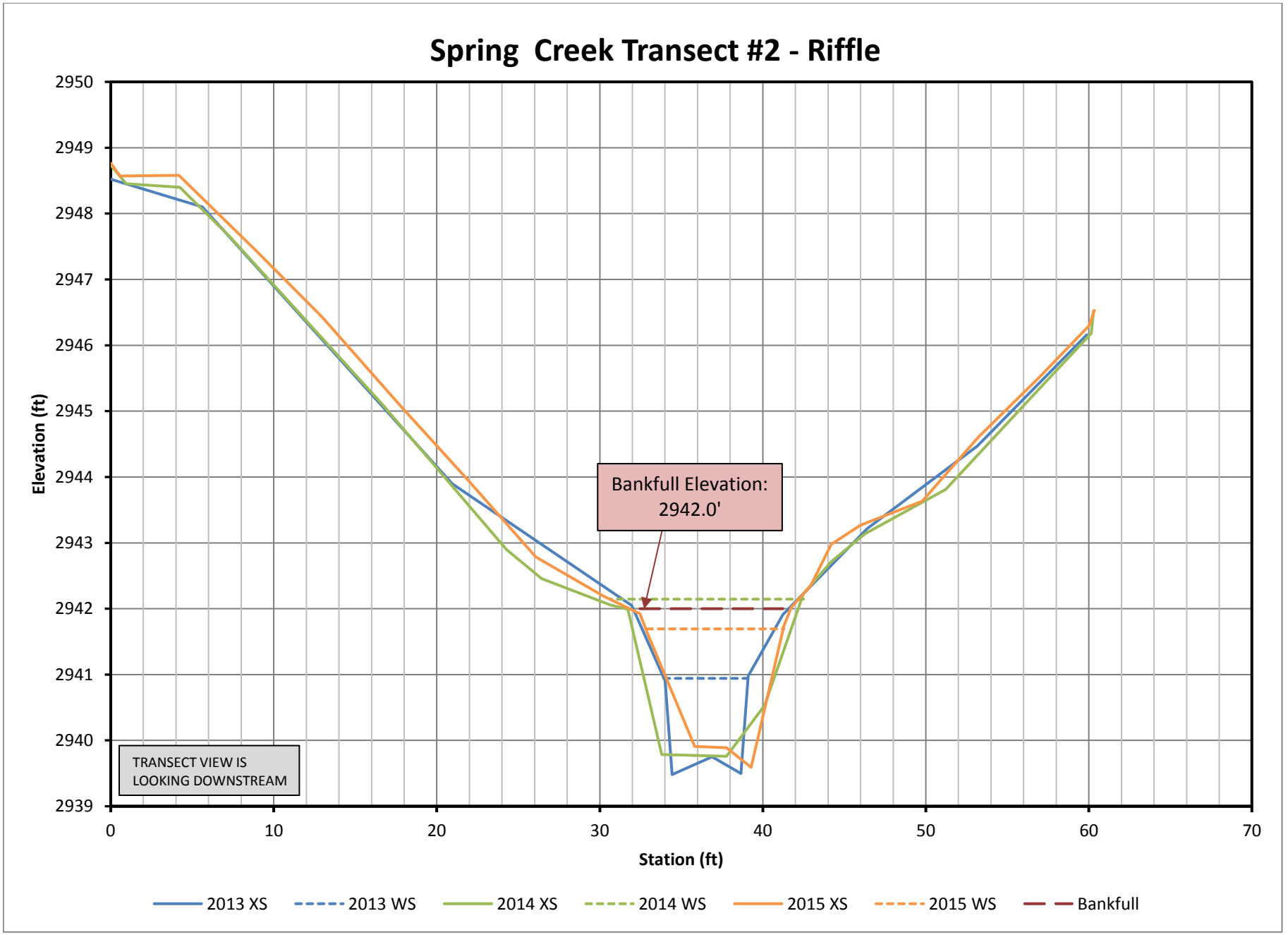
Spring_monitor2015.mxd

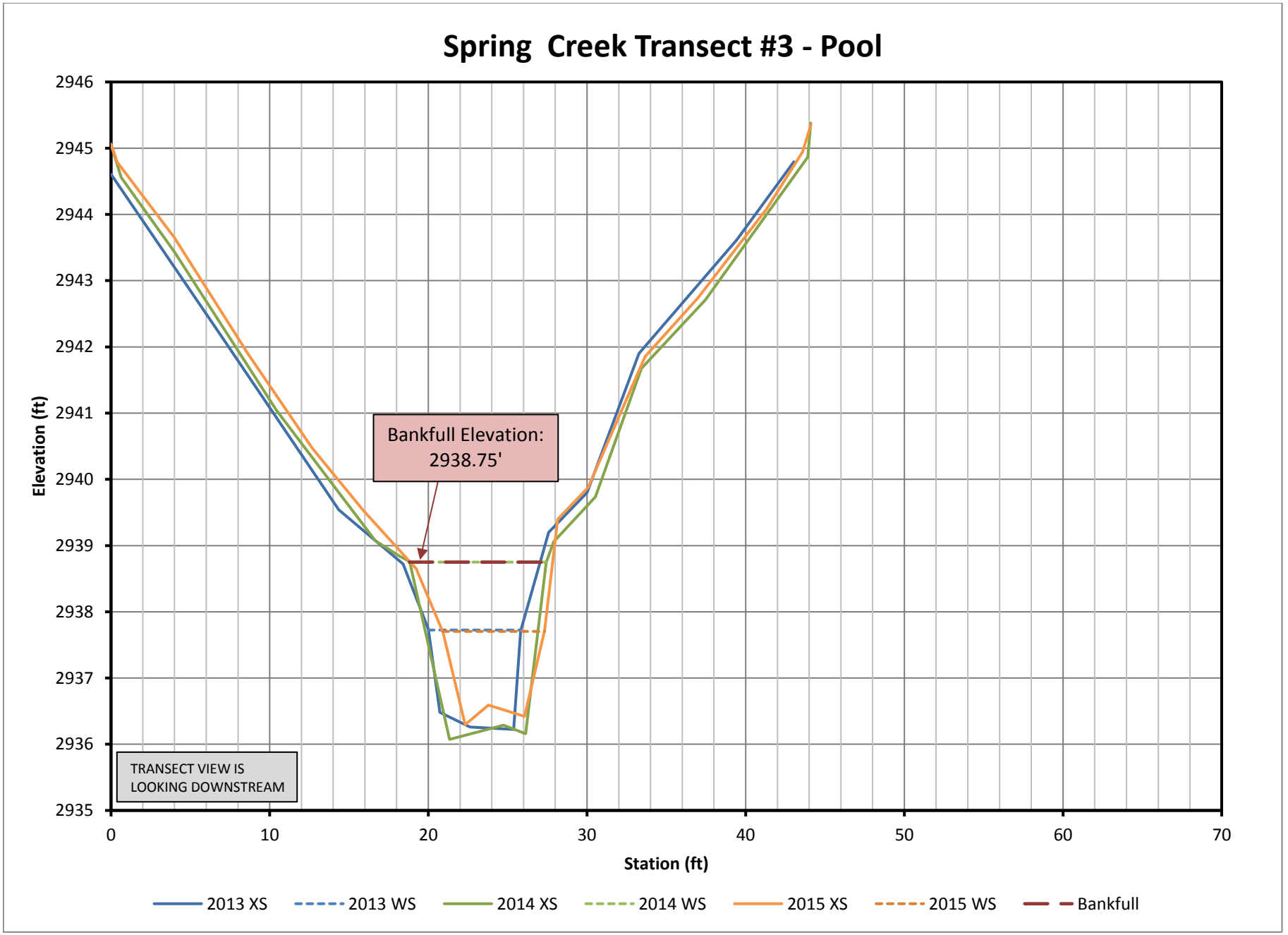
Appendix B

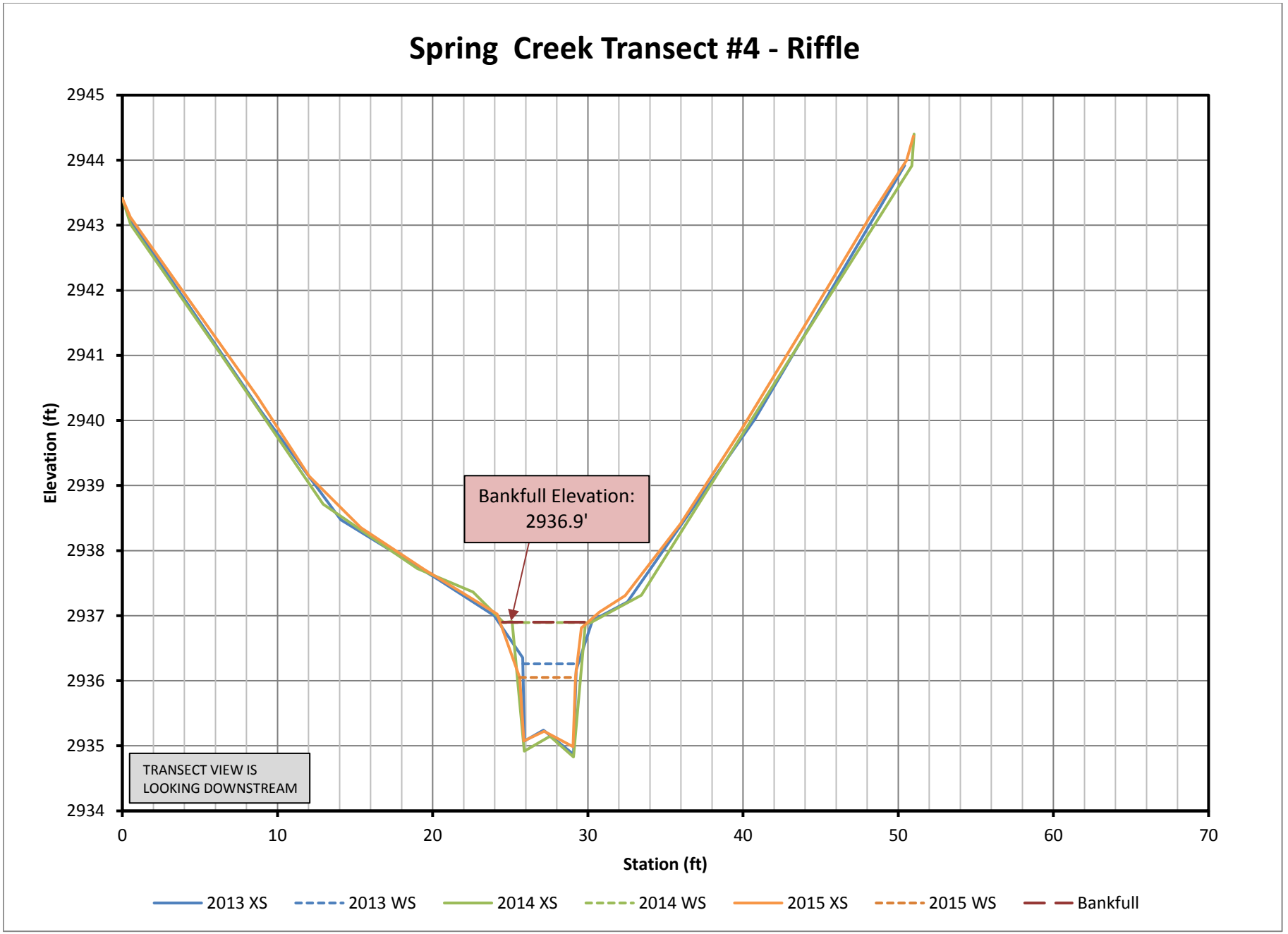
Perpendicular Transect Plots and Longitudinal Profile

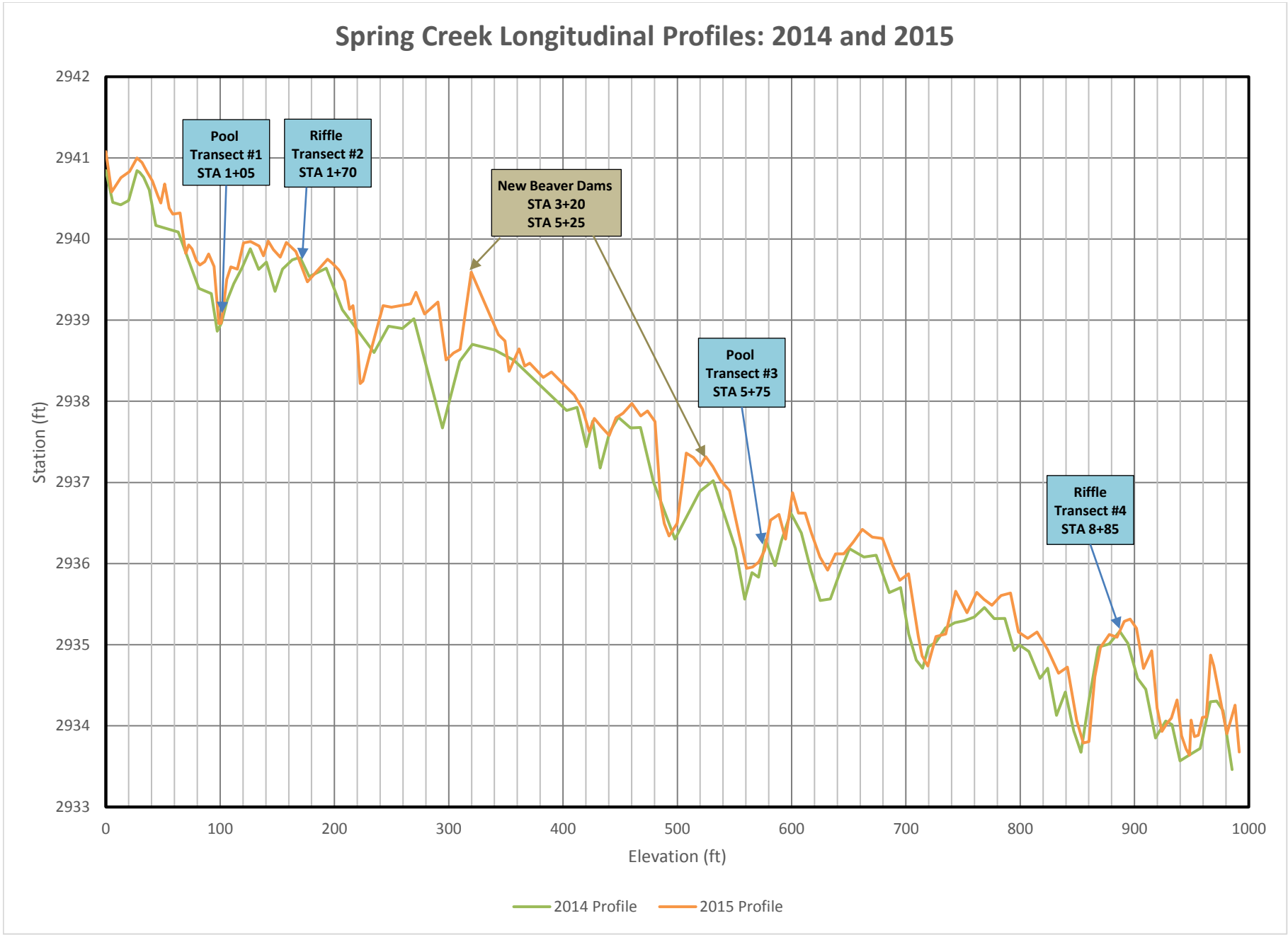
MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana


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


Spring Creek Transect #2 - Riffle
Elevation (ft)
2950
2949
2948
2947
2946
2945
2944
2943
2942
2941
2940
2939
0
10
20
30
40
50
60
70
Station (ft)
Bankfull Elevation:
2942.0'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


Spring Creek Transect #3 - Pool
Elevation (ft)
2946
2945
2944
2943
2942
2941
2940
2939
2938
2937
2936
2935
Bankfull Elevation:
2938.75'
TRANSECT VIEW IS
LOOKING DOWNSTREAM
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS
2014 XS
2014 WS
2015 XS
2015 WS
Bankfull


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


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

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 2015 Monitoring Events

CONFLUENCE

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

Photo Point 1.1—2015
Description: View looking north (upstream) at project area. **Compass**: 0 (North)

Photo Point 1.2 - 2013
Description: View looking north (upstream) at project area. **Compass**: 0 (North)

Photo Point 1.2—2015
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—2015
Description: View looking north of project area from photo point 2. **Compass**: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2013-2014-2015 Monitoring Events

CONFLUENCE

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

Photo Point 3.1—2015
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—2015
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—2015
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 2015 Monitoring Events

CONFLUENCE

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

Photo Point 4.2—2015
Description: View east across the stream channel.
Compass: 90 (East)

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

Photo Point 4.3—2015
Description: View looking south 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—2015
Description: Culvert at upstream end of project area.
Compass: 25 (North-Northeast)

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: 2015 Monitoring Events

CONFLUENCE

Additional Photo 2 - 2015
Description: Eroding Bank EBR1
Compass: 180 (South)

Additional Photo 3 - 2015
Description: Evidence of bank retreat
Compass: 225 (Southwest)

Additional Photo 4 - 2015
Description: Small beaver dam observed in Spring Creek

Additional Photo 5 - 2015
Description: Evidence of high flows - flood debris above banks

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T1 RIGHT: LOOKING EAST TO T1 LEFT

T1 LEFT: LOOKING WEST TO T1 RIGHT

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T1 RIGHT: LOOKING NORTHEAST UPSTREAM

T1 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T1: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T1: LOOKING SOUTH DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T1 LEFT: LOOKING NORTH UPSTREAM

T1 LEFT: LOOKING SOUTH DOWNSTREAM

T2 RIGHT: LOOKING EAST TO T2 LEFT

T2 LEFT: LOOKING WEST TO T2 RIGHT

T2 RIGHT: LOOKING NORTH UPSTREAM

T2 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T2: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T2: LOOKING SOUTH DOWNSTREAM FROM MIDDLE OF CREEK

T2 LEFT: LOOKING NORTH UPSTREAM

T2 LEFT: LOOKING SOUTH DOWNSTREAM

T3 RIGHT: LOOKING EAST TO T3 LEFT

T3 LEFT: LOOKING WEST TO T3 RIGHT

T3 RIGHT: LOOKING NORTH UPSTREAM

T3 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T3: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T3: Looking South downstream from middle of creek

T3 LEFT: LOOKING NORTH UPSTREAM

T3 LEFT: LOOKING SOUTH DOWNSTREAM

T4 RIGHT: LOOKING EAST TO T4 LEFT

T4 LEFT: LOOKING WEST TO T4 RIGHT

T4 RIGHT: LOOKING NORTHEAST UPSTREAM

T4 RIGHT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2015 MDT STREAM MITIGATION—SPRING CREEK

DATE: 8-26-15

T4: LOOKING NORTH UPSTREAM FROM MIDDLE OF CREEK

T4: LOOKING SOUTH WEST DOWNSTREAM FROM MIDDLE OF CREEK

T1 LEFT: LOOKING NORTH UPSTREAM

T1 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=0.99947O385

DETAIL

SPRING CREEK CHANNEL CHANGE

LEGEND

STREAM RIFFLE SECTION

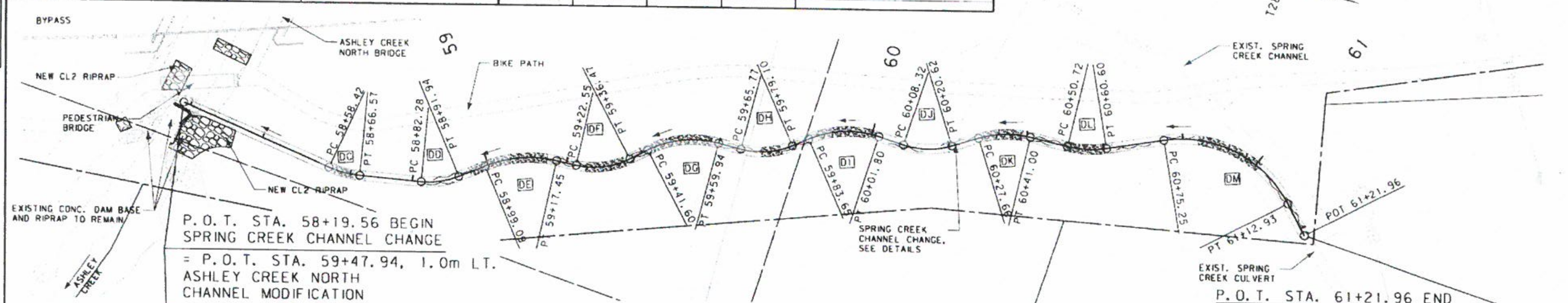
STREAM POOL SECTION

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



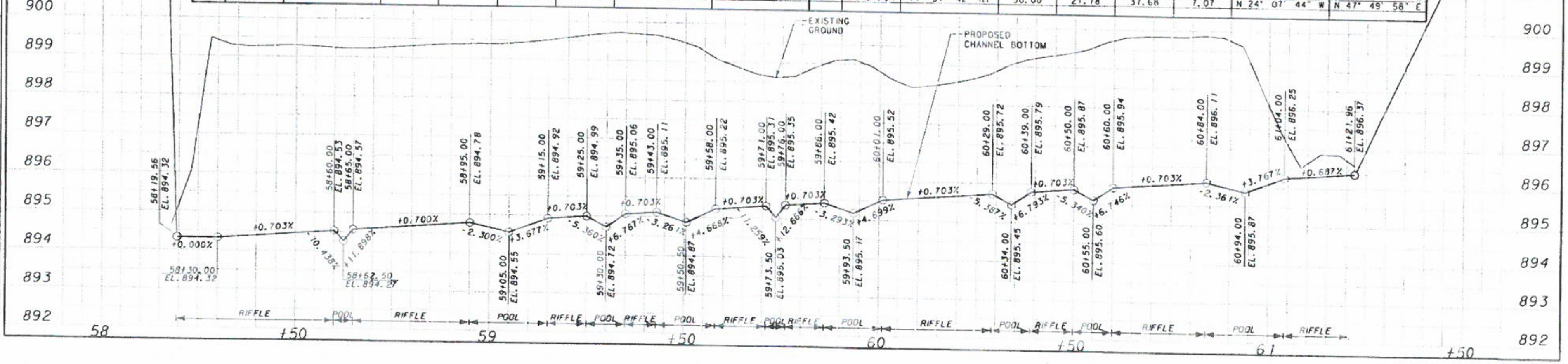
P.O.T. STA. 58+19.56 BEGIN SPRING CREEK CHANNEL CHANGE

= 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.

DESIGNED BY	
REVIEWED BY	
CHECKED BY	
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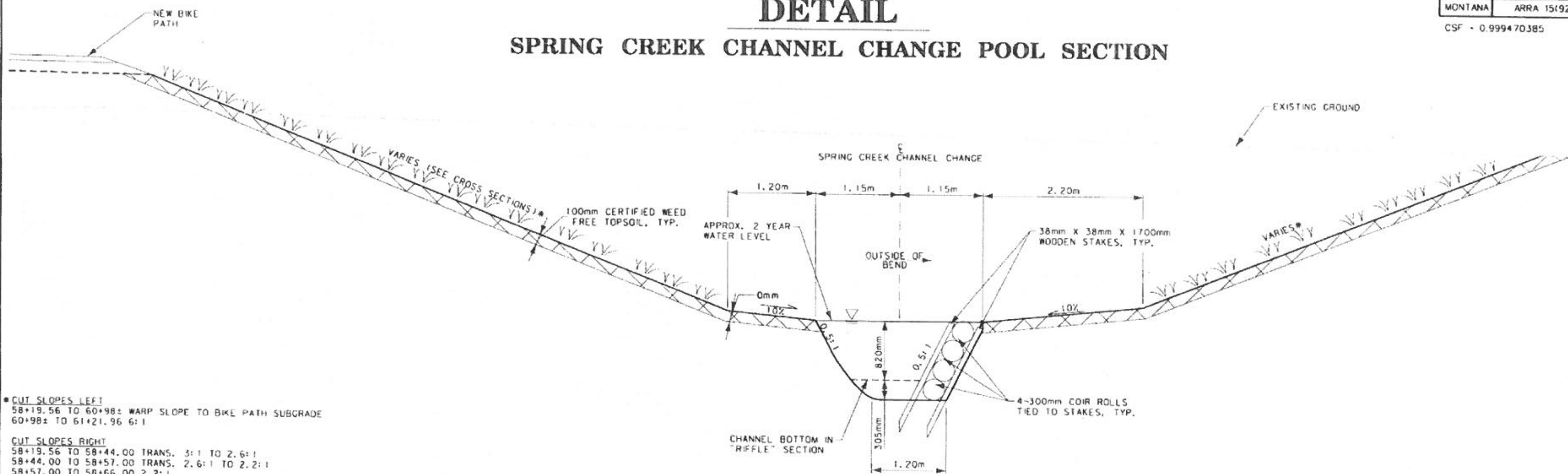
10/6/2009
11:16:35 AM

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

CSF = 0.999470385

DETAIL

SPRING CREEK CHANNEL CHANGE POOL SECTION

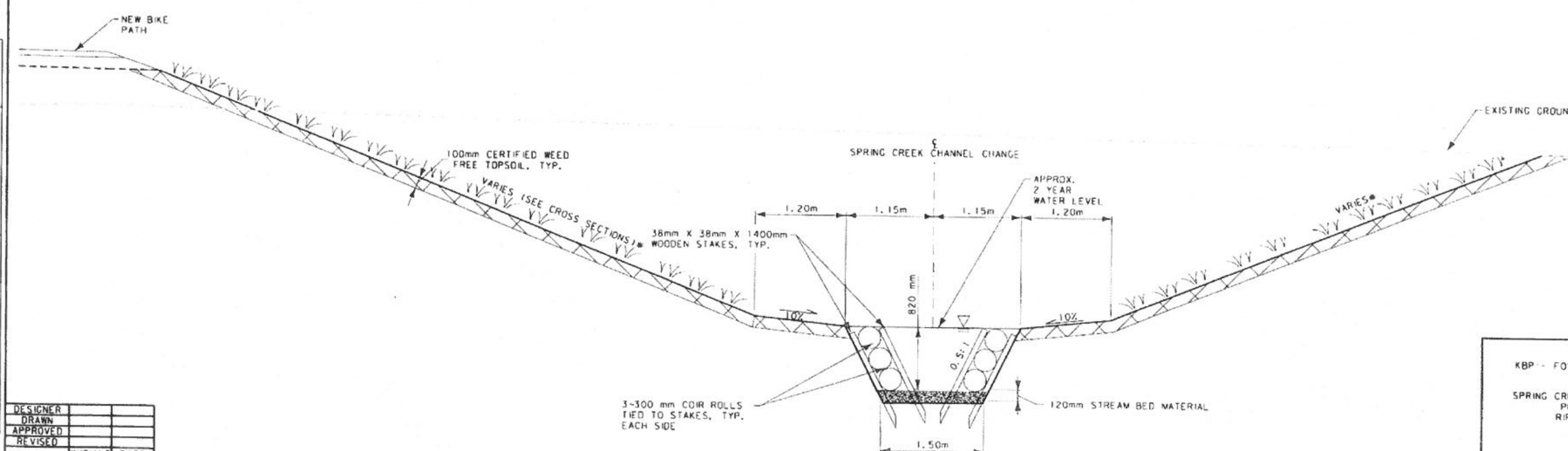

NEW BIKE PATH
EXISTING GROUND
SPRING CREEK CHANNEL CHANGE
1.20m
1.15m
1.15m
2.20m
VARIES (SEE CROSS SECTIONS)*
100mm CERTIFIED WEED FREE TOPSOIL, TYP.
APPROX. 2 YEAR WATER LEVEL
OUTSIDE OF BEND
38mm X 38mm X 1700mm WOODEN STAKES, TYP.
VARIES*
0mm
10%
10%
0.5:1
0.5:1
820mm
305mm
1.20m
4-300mm COIR ROLLS TIED TO STAKES, TYP.
CHANNEL BOTTOM IN "RIFFLE" SECTION

NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

* 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

SPRING CREEK CHANNEL CHANGE RIFFLE SECTION


NEW BIKE PATH
EXISTING GROUND
SPRING CREEK CHANNEL CHANGE
100mm CERTIFIED WEED FREE TOPSOIL, TYP.
VARIES (SEE CROSS SECTIONS)*
APPROX. 2 YEAR WATER LEVEL
1.20m
1.15m
1.15m
1.20m
VARIES*
38mm X 38mm X 1400mm WOODEN STAKES, TYP.
820 mm
10%
10%
0.5:1
3-300 mm COIR ROLLS TIED TO STAKES, TYP. EACH SIDE
120mm STREAM BED MATERIAL
1.50m

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		

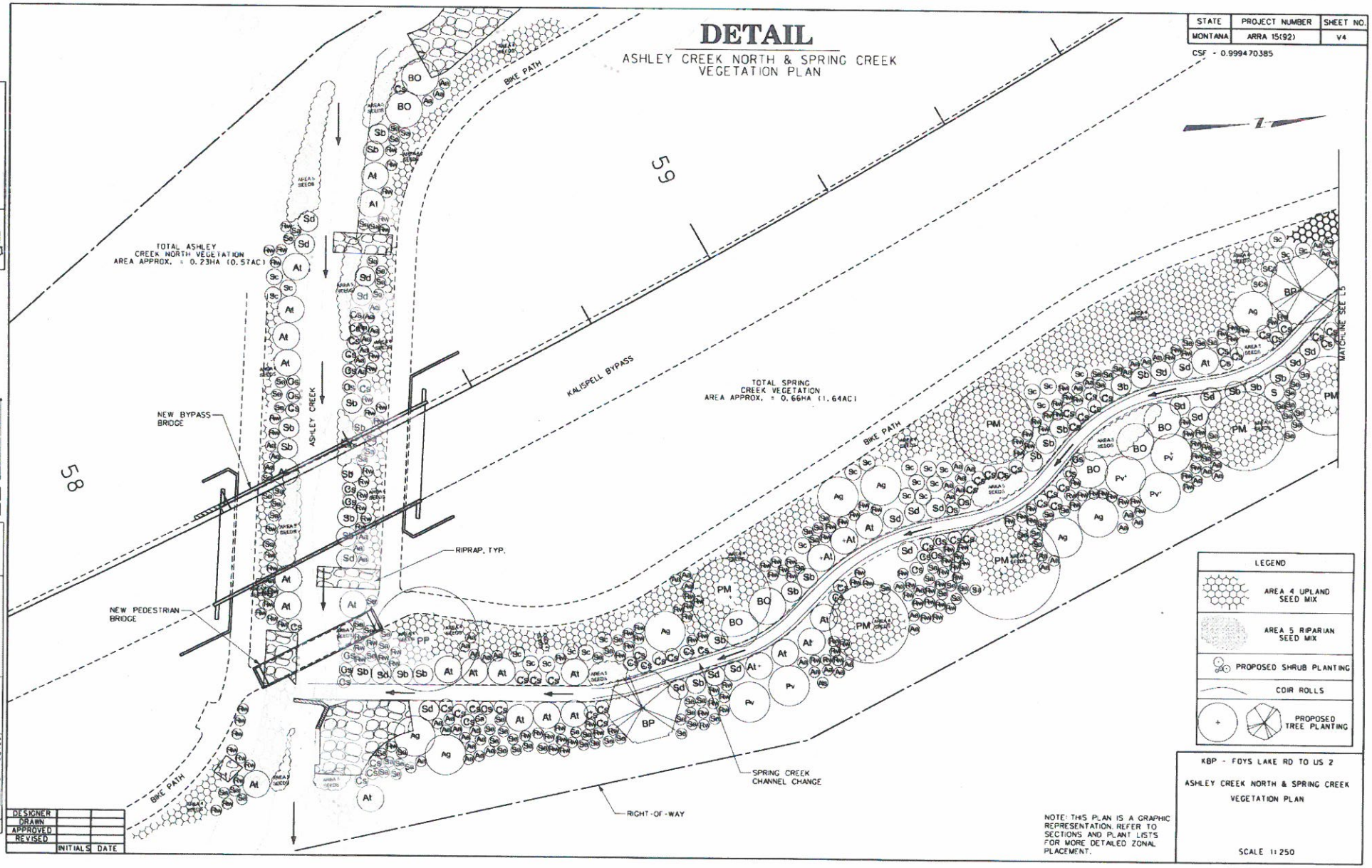
MONTANA DEPARTMENT OF TRANSPORTATION
MONTANA CADD
SE Stelling Engineers, Inc.

DETAIL

ASHLEY CREEK NORTH & SPRING CREEK
VEGETATION PLAN

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	V4

CSF - 0.999470385



LEGEND

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

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

KBP - FOYS LAKE RD TO US 2

ASHLEY CREEK NORTH & SPRING CREEK VEGETATION PLAN

SCALE 1:250

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stalling Engineers, INC.

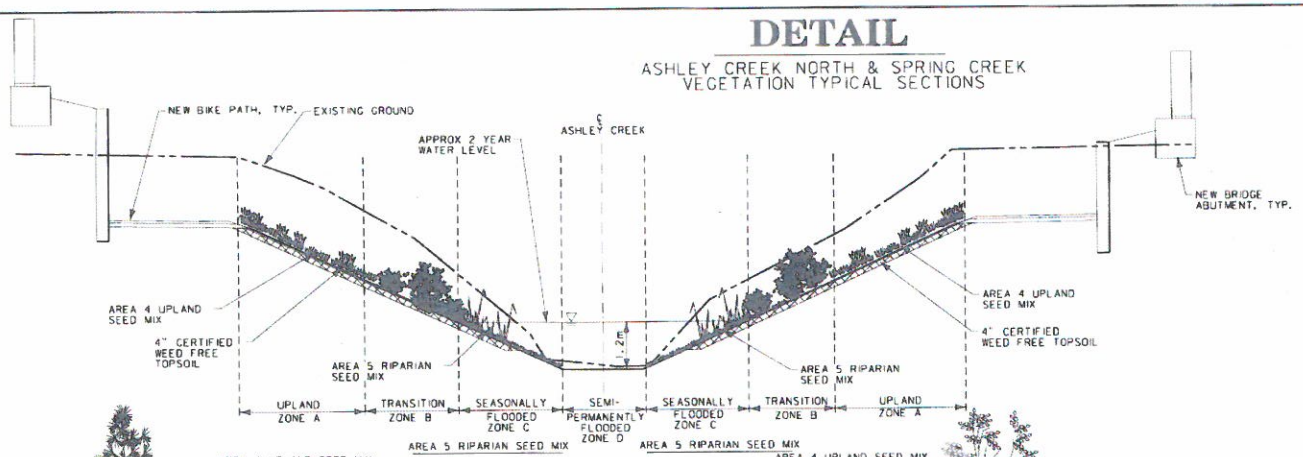
DETAIL

ASHLEY CREEK NORTH & SPRING CREEK VEGETATION TYPICAL SECTIONS

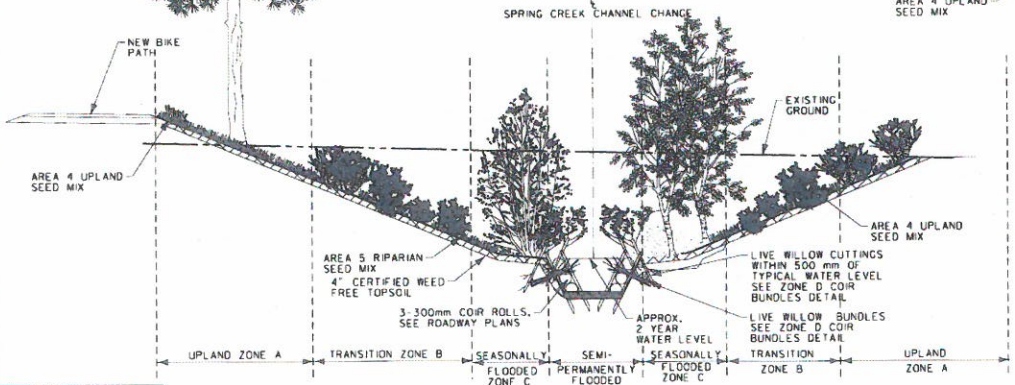
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	ARRA 15(92)	V3

CSF = 0.999470385

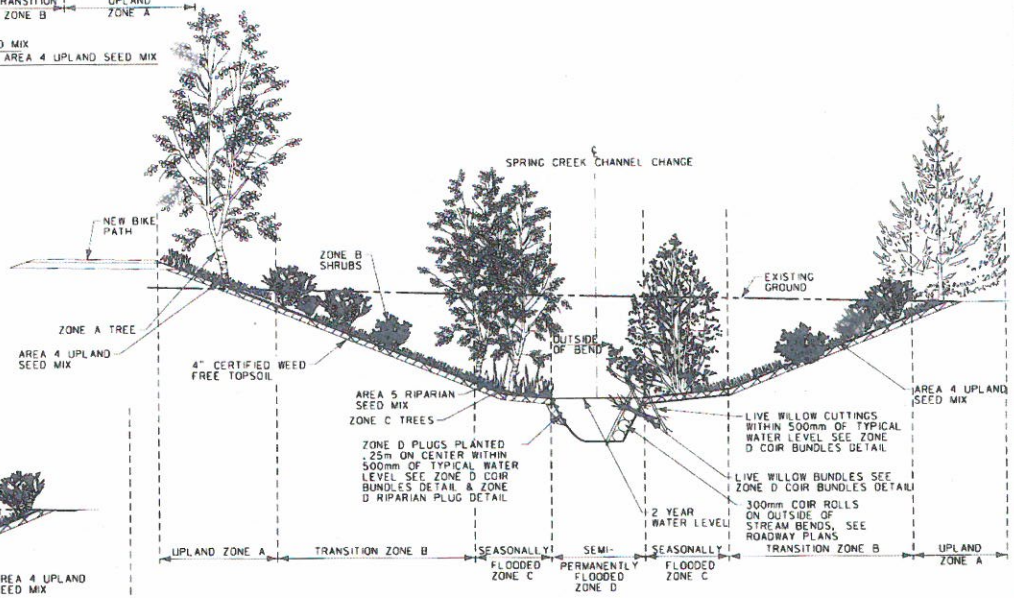
NOTES: 1. SEE ROADWAY PLANS FOR CHANNEL CONSTRUCTION DETAILS.
2. TYPICAL SECTIONS ARE GENERAL CONCEPTUAL DESIGN. FOR INFORMATION ONLY



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

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stalling Engineering, Inc.

DETAIL

ASHLEY CREEK NORTH & SPRING CREEK
VEGETATION SUMMARY & DETAILS

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

CSF = 0.999470385

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 *

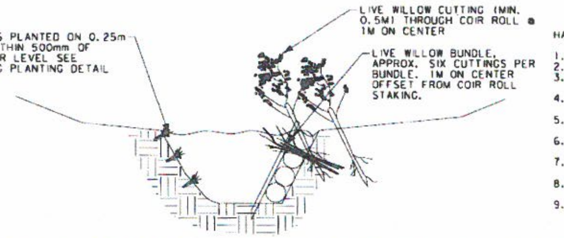
TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
ZONE A UPLAND				
TREES				
BP	BETULA PAPYRIFERA	PAPER BIRCH	4	10' B&B
PP	PINUS PONDEROSA	PONDEROSA PINE	3	7' B&B
PM	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	8	6' B&B
ZONE B TRANSITIONAL				
SHRUBS				
Aa	AMELANCHIER ALNIFOLIA	SASKATOON SERVICEBERRY	108	1 GAL.
Pv	PRUNUS 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				
BO	BETULA OCCIDENTALIS	WATER BIRCH	11	15 GAL.
SHRUBS				
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)				
Sd	SALIX DRUMMONDIANA	DRUMMOND WILLOW	500	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	500	CUTTINGS
COIR ROLL LAYERING (SPACE 6 CUTTINGS PER BUNDLE @ 1m ON CENTER)				
Sd	SALIX DRUMMONDIANA	DRUMMOND WILLOW	1500	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	1500	CUTTINGS
STREAMBANK PLUGS				
	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 FROM	STATION TO	square meters
58+19.56	61+31.96	6372
TOTAL		6372

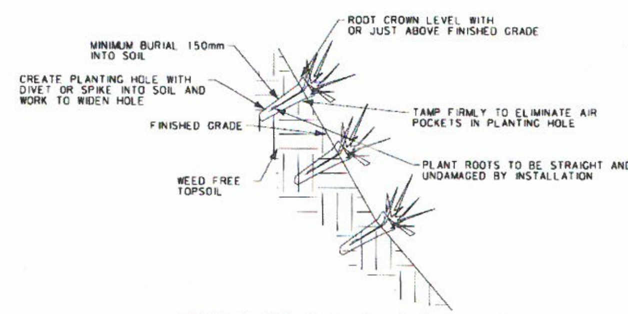
* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".


ZONE D PLUGS PLANTED ON 0.25m ON CENTER WITHIN 500mm OF TYPICAL WATER LEVEL SEE RIPARIAN PLUG PLANTING DETAIL
LIVE WILLOW CUTTING (MIN. 0.5M) THROUGH COIR ROLL @ 1M ON CENTER
LIVE WILLOW BUNDLE, APPROX. SIX CUTTINGS PER BUNDLE. 1M ON CENTER OFFSET FROM COIR ROLL STAKING.

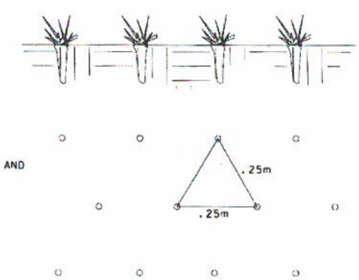
ZONE D COIR BUNDLES WITH WILLOW CUTTINGS AND LAYERING
SCALE: NOT TO SCALE

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.


ROOT CROWN LEVEL WITH OR JUST ABOVE FINISHED GRADE
MINIMUM BURIAL 150mm INTO SOIL
CREATE PLANTING HOLE WITH DIVET OR SPIKE INTO SOIL AND WORK TO WIDEN HOLE
FINISHED GRADE
TAMP FIRMLY TO ELIMINATE AIR POCKETS IN PLANTING HOLE
PLANT ROOTS TO BE STRAIGHT AND UNDAMAGED BY INSTALLATION
WEED FREE TOPSOIL

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

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MONTANA DEPARTMENT OF TRANSPORTATION
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