MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Spring Creek
Flathead County, Montana

Prepared for:

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MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT:

YEAR 2013

Spring Creek
Flathead County, Montana

MDT Project Number: NH-MT 5-3(59) 109
Control Number: 2038

USACE Permit: NWO-2009-01808-MTM

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1.0 INTRODUCTION

As part of the construction of the Kalispell Bypass U.S. Highway 2 South, the Montana Department of Transportation (MDT) modified a portion of Spring Creek upstream of the Ashley Creek Highway 93 North Bridge crossing. The intention of the Spring Creek stream mitigation project is to create, enhance, restore, and maintain permanent, naturally self-sustaining, native, or native-like stream and riparian habitat. The project is designed to protect the functional values of riparian lands, floodplains, wetlands, and uplands for the benefit of fish and wildlife habitat, water quality, floodwater retention, groundwater recharge, open space, aesthetic values, and environmental education. This project purpose is to provide compensatory mitigation for stream impacts associated with the widening of a segment of U.S. Highway 93 in the Missoula District.

The reconstruction of Spring Creek was approved in U.S. Army Corps of Engineers (USACE) permit NWO-2009-01808-MTM on November 6, 2009, and the project was built in 2010. Specific project objectives outlined in the joint permit application for Spring Creek included constructing 990 feet of new stream channel, bankfull width channel slopes of 0.5:1 side slopes, bottom widths varying depending upon riffle or pool sections, and floodplain widths from approximately 15 to 21 feet.

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 streambank stability and the success of riparian vegetation establishment.

<u>Quantitative success criteria include:</u>

1. **Riparian Buffer Success** will be achieved when woody and riparian vegetation becomes established, and noxious weeds do not exceed 10% cover within the riparian buffer areas. Any area within the creditable buffer area disturbed by the project construction must have at least 50% aerial cover of non-noxious weed species by the end of the monitoring period.
   a. **Vegetation Success** will be achieved where combined aerial cover of riparian and streambank vegetation communities is ≥70% and Montana State-listed noxious weeds do not exceed 10% cover.
   b. **Woody Plants** planted trees and shrubs will be considered successful where they exhibit 50% survival after 5 years.

2. **Vegetation along Streambanks** 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).

3. **Streambank 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.

Non-quantitative success criteria include:

4. **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 streambanks.

Additional monitoring requirements include:

5. **Photo Document Success** of restored stream channel and streambank vegetation community development showing distinct positive changes from pre-construction to final monitoring year in comparison with the establishment reference reach.

6. **Weed Control** will be based upon annual monitoring of the site to determine weed species and degree of infestation with the site, and control measures based upon the monitoring results will be implemented by MDT in cooperation with the Flathead County Weed District to minimize and/or eliminate the intrusion of Montana State Listed Noxious weed species within the site.

This report includes the first year of monitoring results of the Spring Creek project site. The report provides results of riparian and stream bank vegetation inventory, streambank erosion monitoring, survey results at four perpendicular transects, photo-documentation of the project site, a map indicating locations of riparian belt and perpendicular transect surveys, and a map of vegetation communities and noxious weeds.

2.0 SITE LOCATION

The project site is located in Section 13, Township 7 North, Range 22 West, in Flathead County, Montana (Figure 1). The project reach includes approximately 900 feet of reconstructed Spring Creek channel east of the U.S. Highway 93 ALT corridor.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on September 11, 2013 while survey crews visited the site on October 16, 2013. The following data were collected at the Spring Creek stream mitigation site:

3.1. Riparian Vegetation Inventory - Belt Transects

Two riparian belt transects were established; one on each side of the stream channel. The riparian transect on the right (west) bank runs parallel to the channel for 223 feet, while the riparian transect on the left (east) bank is 296 feet long (Figure 3, Appendix A). GPS points were logged at riparian transect endpoints, and each endpoint of the riparian transects was marked with t-posts to allow for relocation during subsequent monitoring events. Field data collection at each transect included aerial percent cover of total vegetation, woody vegetation, and noxious weeds across a 25 foot wide belt centered on the transect line.

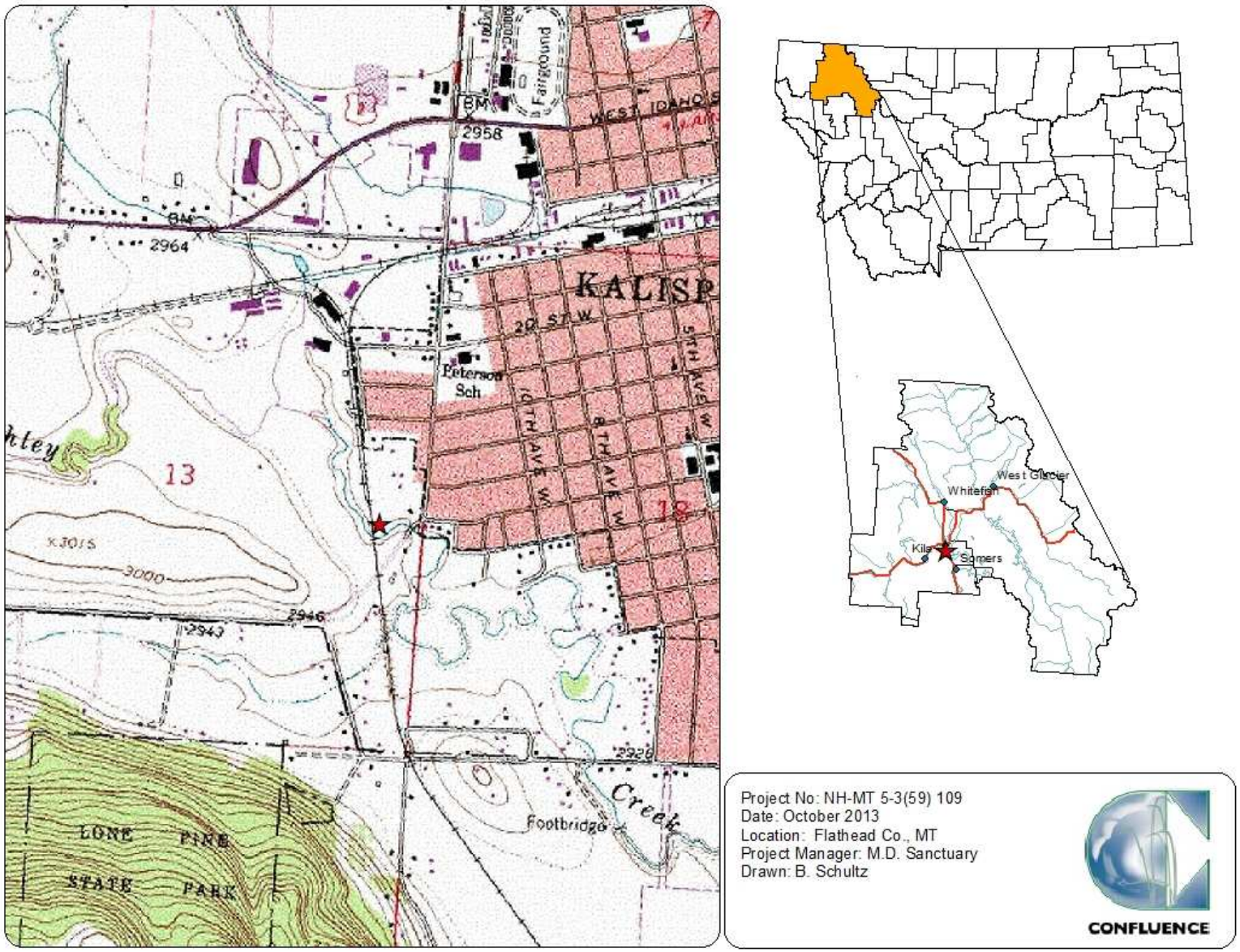


Figure 1. Project location of Spring Creek stream mitigation site.

3.2. Stream Bank Vegetation Inventory

A vegetation inventory was conducted along both stream banks, and included documenting dominant species, percent cover of each species, and compiling a list of all species encountered within three feet of the active channel. The vegetation inventory was performed along the entire length of both banks within the project reach.

3.3. Noxious Weed Inventory

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 weeds were noted in the species lists, but not mapped.

3.4. Woody Plant Survival Inventory

The project area was visually inspected to document survival rates of woody vegetation plantings. The inspection included recording the total number of live and dead woody plantings observed.

3.5. Vegetation Community Mapping

Dominant vegetation communities within the project area were mapped on aerial photographs to document vegetative establishment within both upland and riparian zones.

3.6. Perpendicular Transects

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.

3.7. 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.

3.8. 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.

3.9. 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.

4.0 RESULTS

4.1. Riparian and Streambank Vegetation Inventory

The two riparian belt transects included a 223-foot long by 25-foot wide transect on the right (west) side of the channel and a 296-foot long by 25-foot wide transect on the left (east) side of the channel (Figure 3, Appendix A). Riparian transects results are in Appendix C. The streambank vegetation inventory included the entire 995-foot length of both banks (3 feet wide) within the project site. Table 1 summarizes percent cover of total vegetation, woody vegetation, and noxious weeds for each riparian and streambank transect. Subtotals for the combined riparian and combined streambank inventories are provided, as well as an area weighted total for riparian and streambank zones. No bare ground was observed within any of the vegetation transects. Total non-noxious vegetative cover was 97% (100% total cover minus 3% noxious weed cover).

Table 1. Percent cover of vegetation transects at Spring Creek in 2013.

Belt Transect	Length (ft)	Total % Vegetation Cover	% Woody Cover	% Noxious Weed Cover
Right (West) Riparian	223	100%	35%	2%
Left (East) Riparian	296	100%	57%	2%
Riparian Subtotal		100%	47%	2%
Right (West) Streambank	995	100%	38%	6%
Left (East) Streambank	995	100%	100%	4%
Streambank Subtotal		100%	69%	5%
Area Weighted Total		100%	54%	3%

These results indicate the riparian and streambank areas along Spring Creek have become densely vegetated following construction of the new channel. No bare ground was observed within the entire project reach, and both the riparian and streambank transects exhibited a diversity of herbaceous and woody vegetation species. Noxious weeds were sporadically found along both banks, and covered approximately 3% of the inventoried transects. Additional detail on weed species observed is included in Section 4.3.

Dominant species recorded along the riparian and streambank transects were combined with visual observations in other areas to develop a vegetation community map (Figure 4, Appendix A). The upper side slopes are dominated by wild rye (*Elymus spp.),* while the lower slopes and riparian zones are dominated by willows (*Salix spp.*),

reed canary grass (*Phalaris arundinacea*), and sunflower (*Helianthus maximiliani*). A small patch of chokecherry (Prunus virginiana) and alder (Aluns spp) exists just north of the culvert outlet at the upstream extent of the project reach. As the planted shrubs mature and become larger over time, the corridor is expected to become more dominated by woody species.

Table 2 is a comprehensive list of vegetative species identified within the two belt transects, two streambank transects, and other incidental plants observed on site. In 2013, 54 plant species were observed within the Spring Creek stream mitigation site.

Table 2. Comprehensive vegetative species list for Spring Creek in 2013.

Scientific Name	Common Name
Agropyron cristatum	Crested Wheatgrass
Agrostis gigantea	Black Bent
Algae, green	Algae, green
Alnus incana	Speckled Alder
Alopecurus arundinaceus	Creeping Meadow-Foxtail
Alopecurus pratensis	Field Meadow-Foxtail
Artemisia biennis	Biennial Wormwood
Beckmannia syzigachne	American Slough Grass
Betula papyrifera	Paper Birch
Bromus inermis	Smooth Brome
Carduus nutans	Nodding Plumeless Thistle
Centaurea maculosa	Spotted knapweed
Chenopodium album	Lamb's-Quarters
Cirsium arvense	Canadian Thistle
Cirsium vulgare	Bull Thistle
Convolvulus arvensis	Field Bindweed
Cornus alba	Red Osier
Elymus canadensis	Nodding Wild Rye
Elymus repens	Creeping Wild Rye
Epilobium ciliatum	Fringed Willowherb
Glyceria grandis	American Manna Grass
Glyceria striata	Fowl Manna Grass
Helianthus maximiliani	Maximilian's Sunflower
Helianthus nuttallii	Nuttall's Sunflower
Lemna minor	Common Duckweed
Linaria vulgaris	Butter and Eggs
Lupinus arbustus	Longspur Lupine
Medicago lupulina	Black Medick

Scientific Name	Common Name
Medicago lupulina	Black Medick
Medicago sativa	Alfalfa
Melilotus officinalis	Yellow Sweet-Clover
Onopordum acanthium	Scotch Cottonthistle
Pascopyrum smithii	Western-Wheat Grass
Phalaris arundinacea	Reed Canary Grass
Pinus ponderosa	Ponderosa Pine
Poa palustris	Fowl Blue Grass
Poa pratensis	Kentucky Blue Grass
Populus angustifolia	Narrow-Leaf Cottonwood
Prunus virginiana	Choke Cherry
Pseudoroegneria spicata	Blue-Bunch Wheatgrass
Pseudotsuga menziesii	Douglas-Fir
Rosa woodsii	Woods' Rose
Rumex crispus	Curly Dock
Salix bebbiana	Gray Willow
Salix exigua	Narrow-Leaf Willow
Salix lasiandra	Pacific willow
Shepherdia argentea	Silver Buffalo-Berry
Silene vulgaris	Maidenstears
Sonchus arvensis	Field Sow-Thistle
Symphoricarpos albus	Common Snowberry
Tanacetum vulgare	Common Tansy
Trifolium repens	White Clover
Urtica dioica	Stinging Nettle
Verbascum thapsus	Great Mullein
Vicia americana	American Purple Vetch

4.2. Stream Bank Vegetation Composition

Twenty-eight plant species were observed along the streambanks, defined as the zone within 3 feet of the active stream channel (Table 3). Stability ratings were assigned to each species observed along the banks to help determine overall bank stability. Stability ratings (1-10 scale) indicate a plant's ability to resist erosive forces based on root characteristics (Winward 2000). Fifteen of the twenty-eight species observed have

stability indices provided by Winward, while the remaining thirteen species do not. Scores for plants without stability indices are listed in Table 3 as N/A. Twelve of the fifteen species (80%) with stability indices scored 6 or higher. The most prevalent species observed along the banks was reed canary grass (*Phalaris arundinacea*), covering approximately 56% of the stream banks, and has an assigned stability index of 9. Two additional dominant species, pacific willow (*Salix lasiandra*) and sandbar willow (*Salix exigua*) covered a minimum of 32% of the streambanks and these species have stability indices of 7 and 8 respectively.

Table 3. Comprehensive list of plant species and accompanying stability index values found along Spring Creek in 2103 (stability score from Winward, 2000).

Streambank Species	Left bank	Right bank	NWPL R9 Indicator**	Stability Index
*Phalaris arundinacea**	x	x	FACW	9
Betula papyrifera	x		FAC	8
Cornus alba	x		FACW	8
Poa palustris	x	x	FAC	8
Salix exigua	x	x	FACW	8
Alnus incana		x	FACW	7
Salix lasiandra	x	x	FACW	7
Alopecurus arundinaceus	x		FAC	6
Cirsium arvense	x	x	FAC	6
Elymus canadensis		x	FAC	6
Elymus repens	x		FAC	6
Rosa woodsii	x		FACU	6
Artemisia biennis	x	x	FACW	4
Agrostis gigantea	x		FAC	3
Bromus inermis	x	x	FAC	3
Chenopodium album	x		FACU	N/A
Convolvulus arvensis	x	x	UPL	N/A
Helianthus maximiliani	x	x	UPL	N/A
Linaria vulgaris		x	UPL	N/A
Medicago lupulina		x	FACU	N/A
Medicago sativa		x	UPL	N/A
Onopordum acanthium	x	x	UPL	N/A
Shepherdia argentea		x	FACU	N/A
Sonchus arvensis	x		FACU	N/A
Symphoricarpos albus	x		FACU	N/A
Tanacetum vulgare	x	x	FACU	N/A
Verbascum thapsus	x		FACU	N/A
Vicia americana	x	x	FAC	N/A

*Dominant vegetation along Spring Creek banks

***National Wetland Plant List Region 9 Wetland Plant Indicator Status.*

4.3. Noxious Weed Inventory

The Spring Creek field assessment identified the presence of five noxious weeds including Canadian thistle (*Cirsium arvense*), common tansy *(Tanacetum vulgare),* spotted knapweed (*Centaurea maculosa*), butter and eggs *(Linaria vulgaria),* and field bindweed *(Convolvulus arvensis).* All weed infestations observed were less than 1% cover. The extent of Canadian thistle, common tansy, and spotted knapweed infestations were notable, and locations of these infestations are illustrated on Figure 4, Appendix A. Observations of butter and eggs and field bindweed were considered isolated or uncommon, and therefore not included on Figure 3.

4.4. Woody Plant Survival Inventory

Pacific willow, gray willow, coyote willow, black cottonwood, alder, snowberry, red osier dogwood, and Wood's rose were observed on site as planted woody vegetation species. Table 4 indicates the total number of plants inspected and survival rates. Due to their relatively small size to date, the planted woody shrubs were difficult to find within to the extremely dense stands of sunflower growth along both banks. Many additional shrubs likely exist along the planted corridor than are reported. Overall, very few (0.7%) dead shrubs were found, resulting in very high survival rates.

Table 4. Woody plant survival at the Spring Creek stream mitigation site in 2013.

Total Plants Inspected	Surviving Plants	Plant Survival Percentage
600	596	99.3%

4.5. Channel Form

The formation of pool and riffle habitats within the project reach may be analyzed from the results of pool and riffle transect surveys. Transect surveys were conducted at two locations designated as pools and two riffles habitats on the design plans. Maximum depth and bankfull widths for each transect are shown in Table 5. These results indicate the average pool depth is approximately 0.4 feet deeper than the average riffle depth. The relatively low variability in channel depths 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 5. Spring Creek maximum depths and bankfull widths in 2013.

Transect	Type	Max Depth (ft)	Bankfull Width (ft)
1	Pool	3.1	8.8
2	Riffle	2.6	9.1
3	Pool	2.5	9.1
4	Riffle	2.1	6.3
Average Riffles		2.4	7.7
Average Pools		2.8	9

The spring creek and urban runoff hydrology of this channel are also unlikely to generate deep pools over time. The hydrologic factors at play in Spring Creek generally do not result in flashy or snowmelt driven runoff events. As a result of these hydrologic factors, natural development of deep pool features is unlikely to occur within the reconstructed section of Spring Creek.

4.6. Bank Erosion Inventory

No eroding stream banks were observed at the Spring Creek stream mitigation site. All banks were well vegetated with no signs of bank sloughing or instability.

4.7. Wildlife Documentation

Table 6 provides a list of the observed wildlife during the 2013 monitoring event. One mammal and three bird species were observed within the project area. The low number of species observed may be attributed to the proximity to the Highway 93 corridor and high temperatures during mid-day field visit.

Table 6. Wildlife species observed during the 2013 site visit.

Common Name	Scientific Name
Birds	
Common Raven	*Corvus corax*
Mallard	*Anas platyrhynchos*
Song Sparrow	*Melospiza melodia*
Mammals	
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 performance standards outlined in the Army Corps 404 permit issued for the project. The first year of monitoring suggests all 6 quantitative performance standards are being met, including combined vegetation establishment, vegetative cover of riparian and streambank vegetation, woody plant survival, root stability indices, and streambank stability (Table 7). Channel form success is considered a qualitative criterion, and is discussed in more detail in the following section. Reporting requirements including photo documentation of the project site and results of noxious weed surveys have also been included in this annual monitoring report.

Table 7. Performance criteria and Reporting Requirements for Spring Creek mitigation site.

Monitoring Requirement	Type	Parameter	Performance Standard	Status
1	Performance Criteria	Riparian Buffer Success	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	**98%** of riparian zones have revegetated with non-noxious species
1	Performance Criteria	Riparian Buffer Success	Noxious weeds do not exceed 10% cover within the riparian buffer areas.	**3%** of the project area exhibits noxious weeds
1a	Performance Criteria	Vegetation Success	Combined aerial cover of riparian and stream bank vegetation communities is at least 70%	Combined riparian and streambank vegetation cover is **100%**
1b	Performance Criteria	Vegetation Success	Planted trees and shrubs must exhibit 50% survival after 5 years	Planted shrub surveyes indicate over **99%** of shrub survival
2	Performance Criteria	Vegetation along Streambanks	Majority of plants on the river bank must have root stability indexes of at least 6	**80%** of species with root stability indices scored 6 or higher.
3	Performance Criteria	Streambank Stability Success	Less than 25% of bank length is unstable and classified as eroding bank. 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 (rock, woody debris) to inhibit erosion	**0%** of the banks within the project reach are eroding or unstable
4	Qualitative Criteria	Channel Form	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.	Channel form narrative included in 2013 Monitoring Report
5	Reporting Requirement	Photo Documentation	Photo document success of restored stream channel and streambank vegetation community development showing distinct positive changes from pre-construction to final monitoring year in comparison with the establishment reference reach	Photo Documentation included in Appendix D
6	Reporting Requirement	Weed Control	Will be based on annual monitoring of the site to determine weed species and degree of infestation within the site, and control measures based on the monitoring results will be implemented by MDT in cooperation with the Flathead County Weed District to minimize and/or eliminate the intrusion of State Listed noxious weed species within the site.	Species and percent cover of noxious weeds included in 2013 Monitoring Report

* Performance criteria has been met three years following construction. Additional monitoring is required to meet 5-year survival standard

5.1. Woody Plant Survival

Woody vegetation plantings indicated a survival rate of 99% three years following construction. The performance criteria states 50% of the woody plants installed must survive five years following construction; therefore, additional monitoring is necessary to meet this criterion. Woody plants remain relatively small but should provide increased percent cover of the site as they mature. Extremely dense vegetation growth within the riparian corridor made locating smaller woody plantings difficult; however very few dead woody plantings were observed throughout the project site.

5.2. Vegetation Along Streambanks

Streambank vegetation inventories along Spring Creek identified that the majority (83%) of species had stability scores ≥6 when compared to all species with stability scores. The most prevalent species observed along the banks was reed canary grass, covering approximately 56% of streambanks and having a stability index of 9. Two additional dominant species on the streambanks, pacific willow and sandbar willow, covered a minimum of 32% of the streambanks and are woody species with high stability indices. Given these root stability scores and the absence of eroding banks observed, these results indicate the criteria for streambank vegetation is currently being met and any future erosion observed is not likely due to the vegetative composition along Spring Creek.

5.3. Streambank Stability

The streambank inventory did not identify any stream segments with eroding or unstable banks. All banks were very well vegetated with many willow cuttings within five feet of the channel providing additional bank protection. As a result, the performance criterion for streambank stability is currently being met.

5.4. Channel Form Success

The reconstructed segment of Spring Creek appears to have stabilized following construction, as evidenced by a dense stand of riparian and streambank vegetation, and lack of lateral or vertical erosion. No vertical head cuts or bank erosion was evident, and the channel does not appear to have migrated following construction.

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.

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. The stream banks have grown in with woody and herbaceous species that will provide additional habitat features in the form of woody debris and potentially undercut banks as vegetation continues to mature and coir rolls eventually decay.

Riffle and pool transect 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. It should be noted the existing channel planform and habitat elements is 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 2-year flood event. Evidence of pool and riffle habitats is marginal based on the monitoring data collected to date; additional monitoring of these habitat features is recommended.

5.5. Photo Documentation

Four permanent photo documentation locations were established during the first monitoring event to document changes in vegetation community and site conditions over time. Photographs were take upstream, downstream, and toward the left and right banks at each of the four perpendicular transects. All photographs of the Spring Creek mitigation site have been cataloged in Appendix D.

5.6. Weed Control

This monitoring report includes documentation of five noxious weed species within the Spring Creek mitigation site. Infestations of common tansy, spotted knapweed, and Canadian thistle have been mapped (Figure 4, Appendix A) for future weed spraying efforts. Isolated occurrences of butter and eggs and field bindweed were also observed, but not mapped. Riparian and stream bank vegetation transects indicated the site has approximately 2% cover of noxious weeds. MDT and the Flathead County Weed District will determine the most appropriate methods to minimize occurrence of noxious weeds within the Spring Creek mitigation site.

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

6.1. Riparian and Floodplain Zones

The reconstructed channel segment 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 width 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.

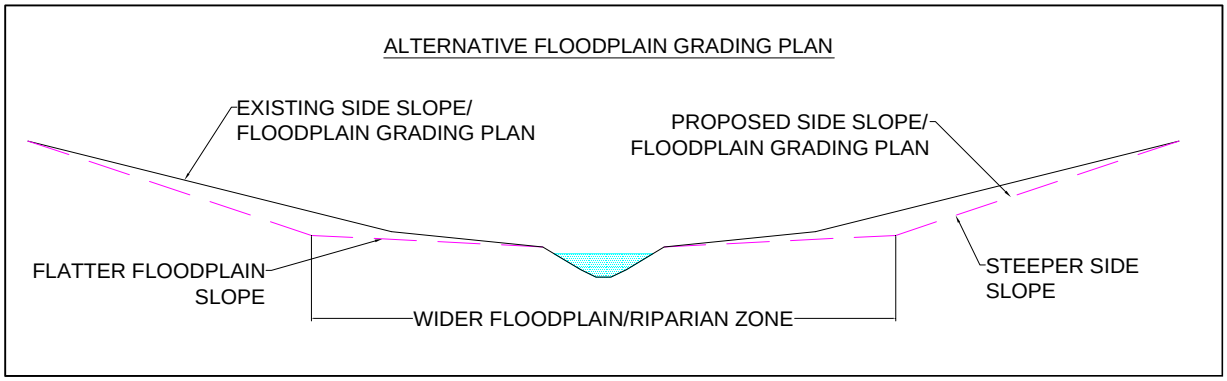


Figure 2. Alternative grading plan to increase floodplain and riparian areas.

6.2. Willow Cutting and Riparian Plug Establishment

The hydrology of Spring Creek is influenced by urban runoff, creating a difficult scenario for predicting typical discharges. During the site visit, Spring Creek was running nearly to the top of its banks, a notable level given the timing of the monitoring event (late August) and the lack of recent precipitation. Design plans called for installing willow cuttings and riparian plugs within the newly constructed stream banks. No willow stems were observed sprouting from within the coir logs and no sedges were observed growing on the inside bends of the pool features, although these features were under water during the site visit. Willow cuttings were very successful establishing just outside of the active channel along the graded floodplain. It is possible the willow cuttings and wetland plugs installed within the active channel did not survive due to long periods of inundation in these planting areas. Verification of vegetation survival in these areas could be conducted when the channel has less water and the banks are more exposed. Overall vegetative growth immediately adjacent to the channel provides excellent protection from bank scour and erosion, and planting techniques employed on this project should be considered for future, similar stream reconstruction plans.

6.3. 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 Transportation, 2008. Montana Wetland Assessment Method. Helena, Montana.

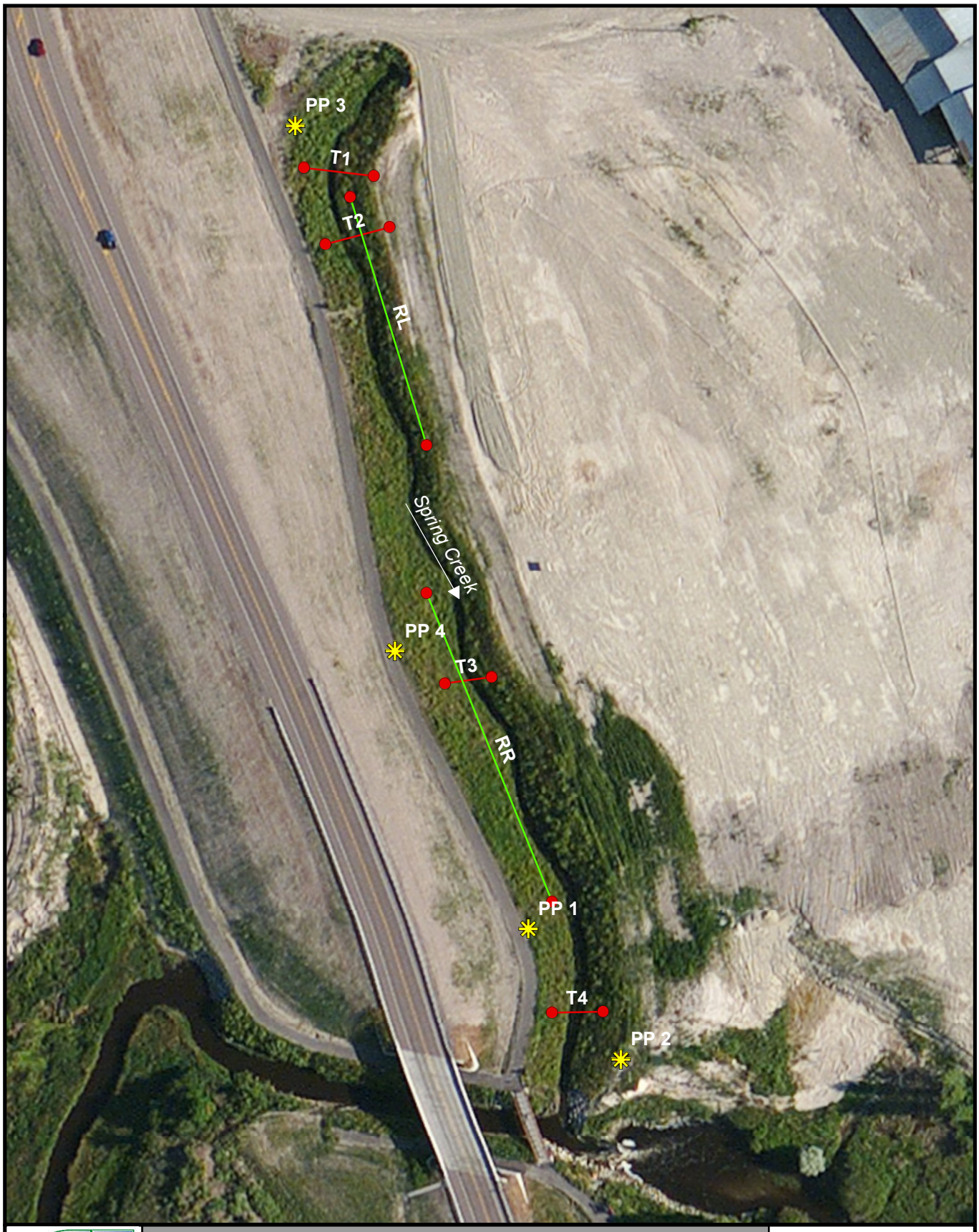
Montana Department of Transportation, 2010. Kalispell Bypass MDT Project #NH-MT 5-3(59)109 FST, CN 2038 On-Site Stream Mitigation Plan, Flathead County, Montana.

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
- Riparian Transects
- Pool and Riffle Transects

N

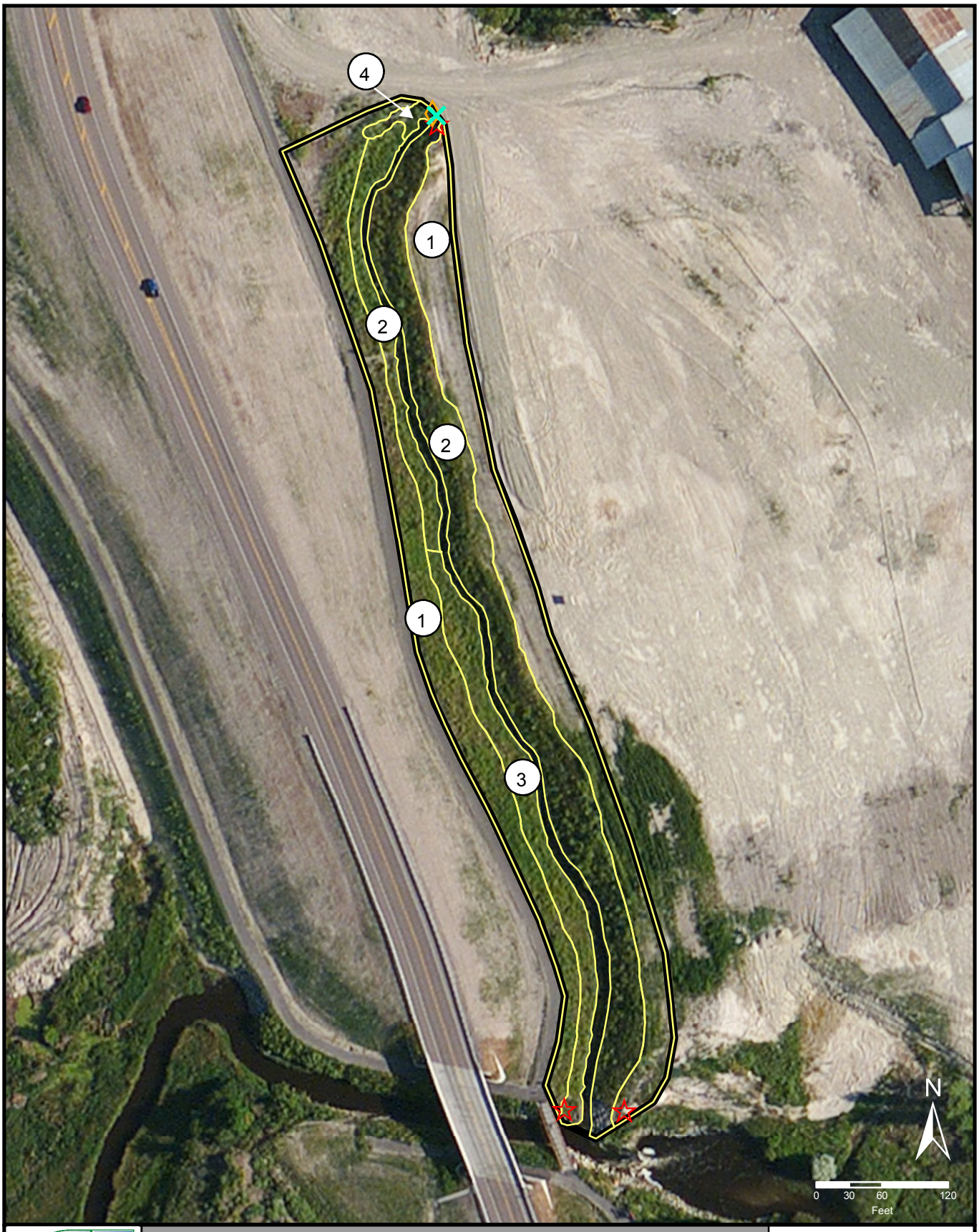
0 25 50 100
Feet

2013 Monitoring Spring Creek

Figure 3

Date: 10/15/2013

X:/MDT_.007/mains



CONFLUENCE
consulting incorporated

Legend

- Project Boundary
- Vegetation Community Boundary
- Centaurea maculosa
- Cirsium arvense
- Tanacetum vulgare
- 1 Elymus Community
- 2 Salix/Helianthus Community
- 3 Salix/Phalaris Community
- 4 Prunus/Alnus Community

2013 Monitoring
Spring Creek

Figure 4

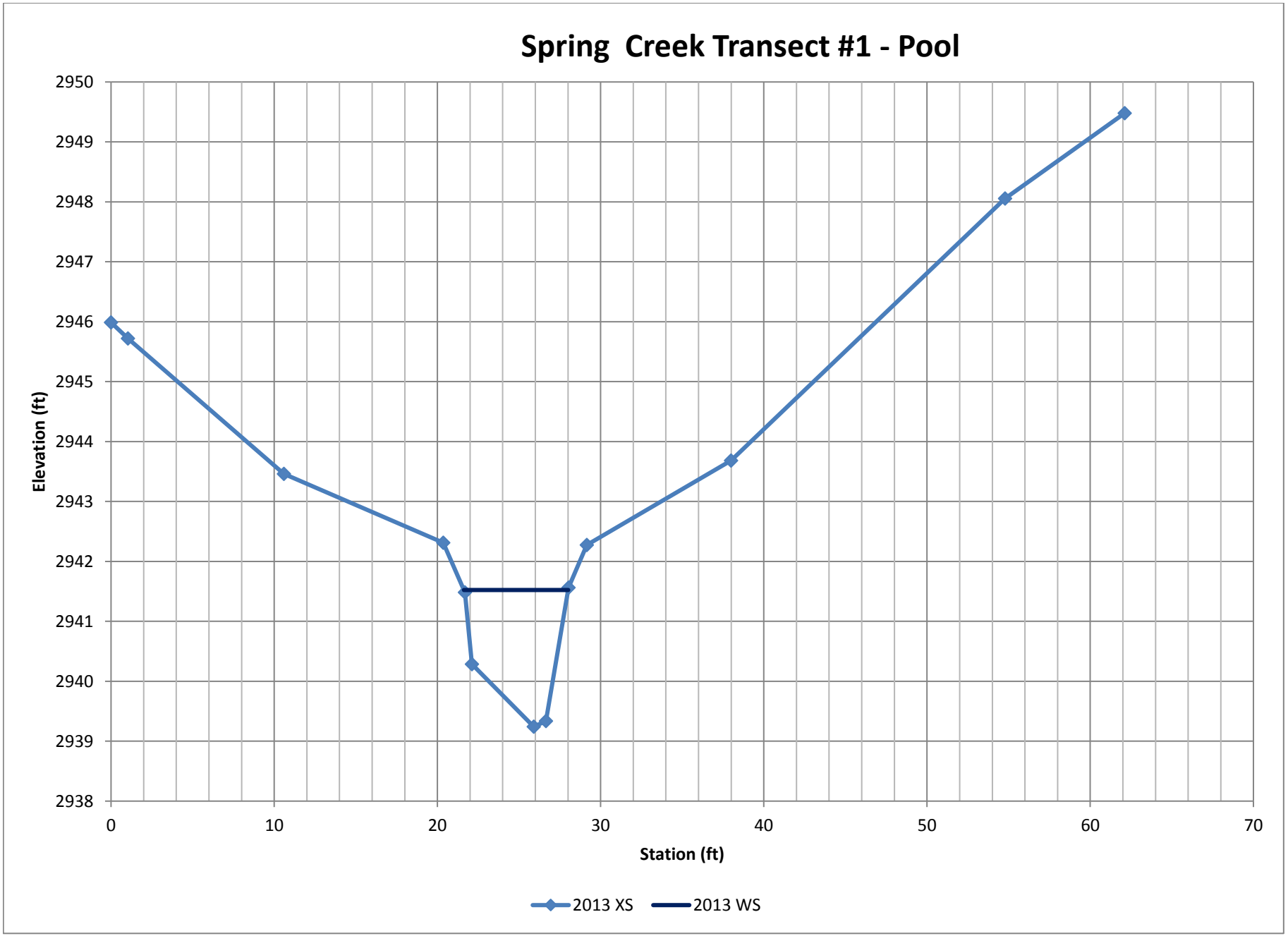
Date: 11/06/2013

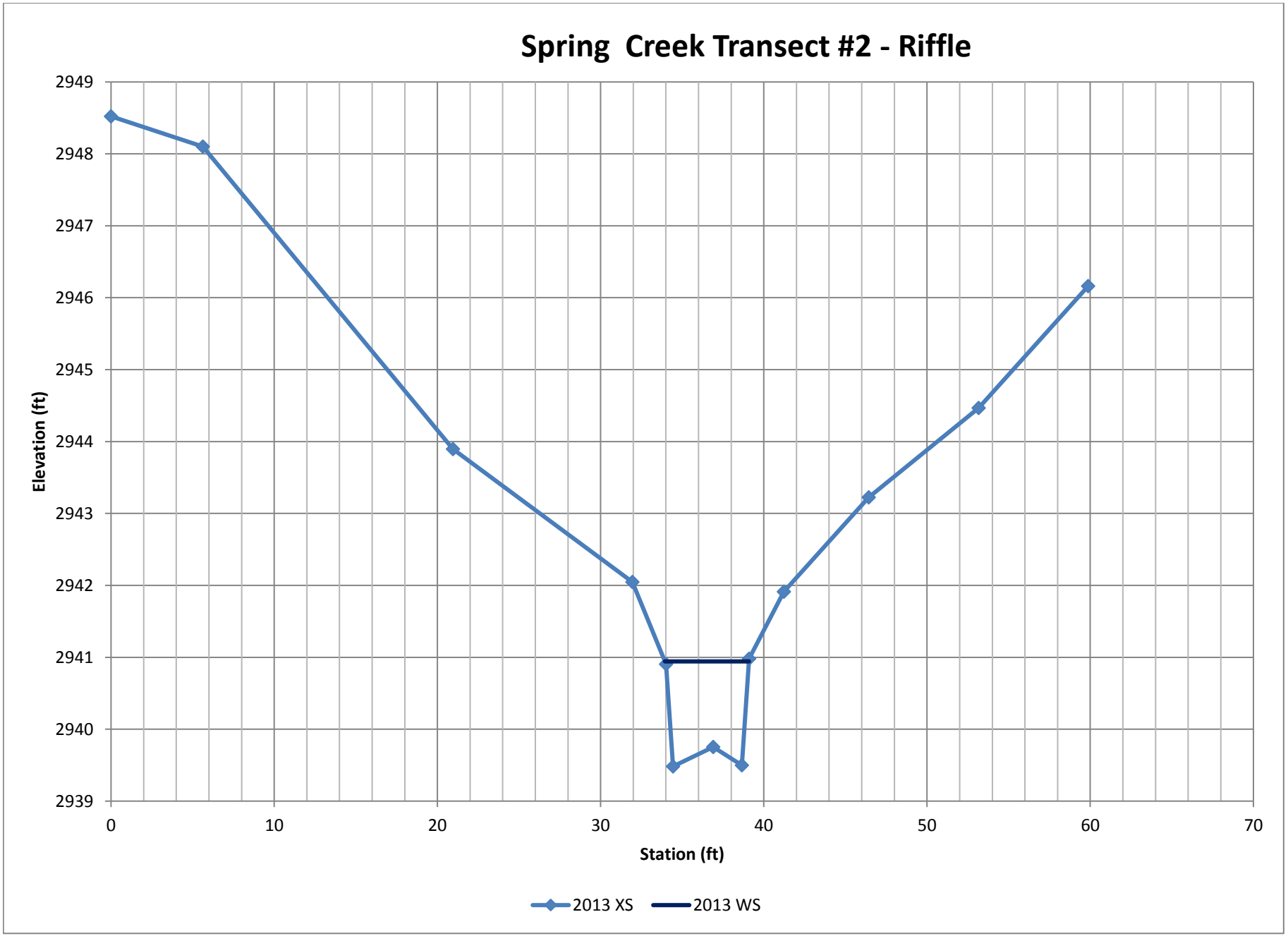
X:/MDT_.007/mains

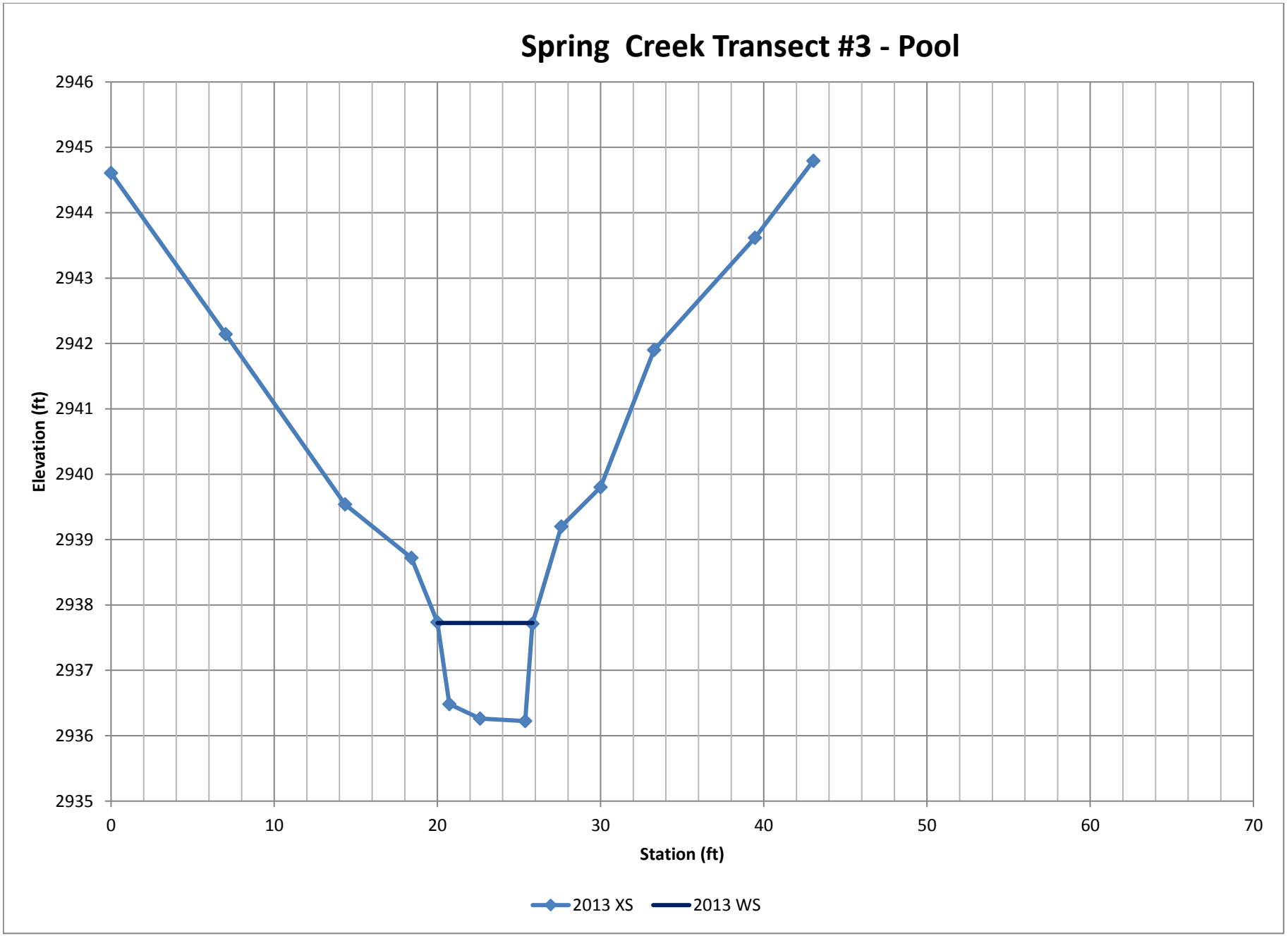
Appendix B

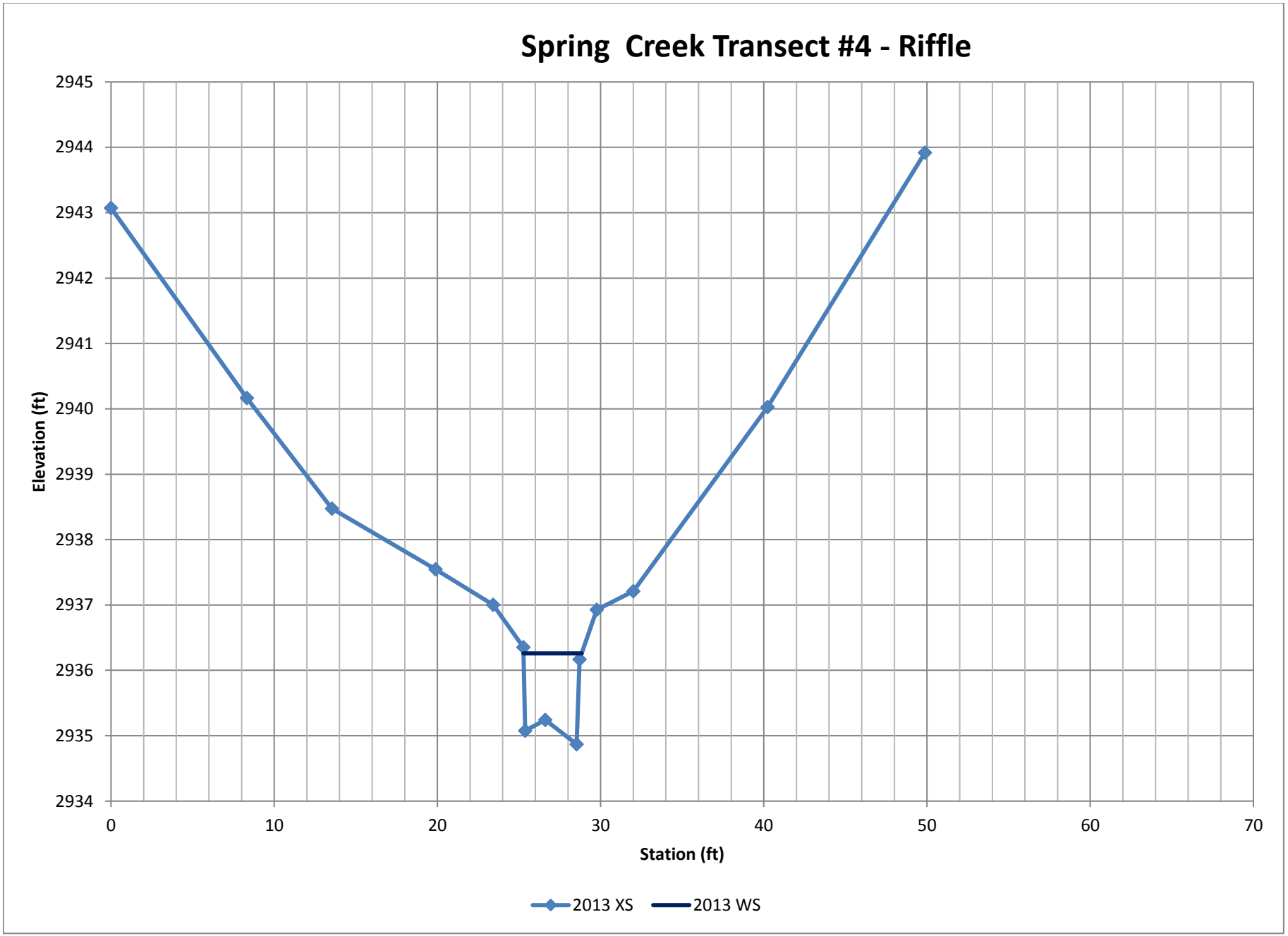
Perpendicular Transect Plots

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana


Spring Creek Transect #1 - Pool
Elevation (ft)
2950
2949
2948
2947
2946
2945
2944
2943
2942
2941
2940
2939
2938
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS


Spring Creek Transect #2 - Riffle
Elevation (ft)
2949
2948
2947
2946
2945
2944
2943
2942
2941
2940
2939
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS


Spring Creek Transect #3 - Pool
Elevation (ft)
2946
2945
2944
2943
2942
2941
2940
2939
2938
2937
2936
2935
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS


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)
2013 XS
2013 WS

Appendix C

Riparian Vegetation Transect Results

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana

Interval Data Summary Report

Site: **Spring Creek**

date: 9/11/2013 8:18:28 AM

Transect Number: 1 **Compass Direction from Start:**

Interval Data:

Ending Station 223 **Community Type:** /

Species	Cover class	Species	Cover class
Agrostis gigantea	2	Alopecurus arundinaceus	2
Artemisia biennis	0	Betula papyrifera	0
Bromus inermis	2	Chenopodium album	0
Cirsium arvense	0	Convolvulus arvensis	0
Cornus alba	1	Elymus repens	2
Helianthus maximiliani	5	Onopordum acanthium	1
Phalaris arundinacea	5	Poa palustris	1
Rosa woodsii	0	Salix exigua	3
Salix lasiandra	3	Sonchus arvensis	0
Symphoricarpos albus	0	Tanacetum vulgare	0
Verbascum thapsus	0	Vicia americana	3

Transect Notes:

Left riparian transect

Transect Number: 2 **Compass Direction from Start:**

Interval Data:

Ending Station 296 **Community Type:** /

Species	Cover class	Species	Cover class
Alnus incana	1	Artemisia biennis	0
Bromus inermis	2	Cirsium arvense	0
Convolvulus arvensis	0	Elymus canadensis	4
Helianthus maximiliani	3	Linaria vulgaris	0
Medicago lupulina	1	Medicago sativa	2
Onopordum acanthium	1	Phalaris arundinacea	5
Poa palustris	2	Salix exigua	4
Salix lasiandra	3	Shepherdia argentea	0
Tanacetum vulgare	0	Vicia americana	3

Transect Notes:

Right riparian transect

Appendix D

Project Site Photos

MDT Stream Mitigation Monitoring
Spring Creek
Flathead County, Montana

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: September 11, 2013

CONFLUENCE

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

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

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

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

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

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

PHOTO INFORMATION

PROJECT NAME: Spring Creek Stream Mitigation Site

DATE: September 11, 2013

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

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

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

Photo 2
Description: Hose in stream channel.
Compass: 130 (Southeast)

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Photo Point 12 (PP3) Looking South

Photo Point 12 (PP3) Looking North

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 1 West

Transect 1 Right Looking Down stream South

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 1 Right Downstream South

Transect 2 West

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 2 Right Looking East

Transect 2 Right Looking Upstream North

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 2 Right Looking Downstream South

Transect 1 East

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 1 Left Looking West

Transect 1 Left Looking Downstream South

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 2 East

Transect 2 Left Looking West

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 2 Left Looking Upstream North

Transect 2 Left Looking Downstream South

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Riparian Transect Point 8 Looking Upstream North

Transect 3 West

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 3 Right Looking Downstream South

Transect 3 Right Looking Upstream North

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Photo Point 4 (PP4) Looking East

Photo Point 4 (PP4) Looking Downstream South

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Photo Point 4 (PP4)Looking Upstream North

Photo Point 3 (PP3) Looking East

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Photo Point 3 (PP3) Looking Downstream south

Transect 3 East

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 3 Left Looking West

Transect 4 East

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 4 Left Looking West

Transect 4 Left Looking Upstream North

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 4 Left Looking Downstream South west

Transect 4 West

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 4 Right Looking East

Transect 4 Right Looking Downstream South

PROJECT NAME: MDT Stream Mitigation Spring Creek

DATE: October 16, 2013

Transect 4 Right Looking Upstream North

Appendix E

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

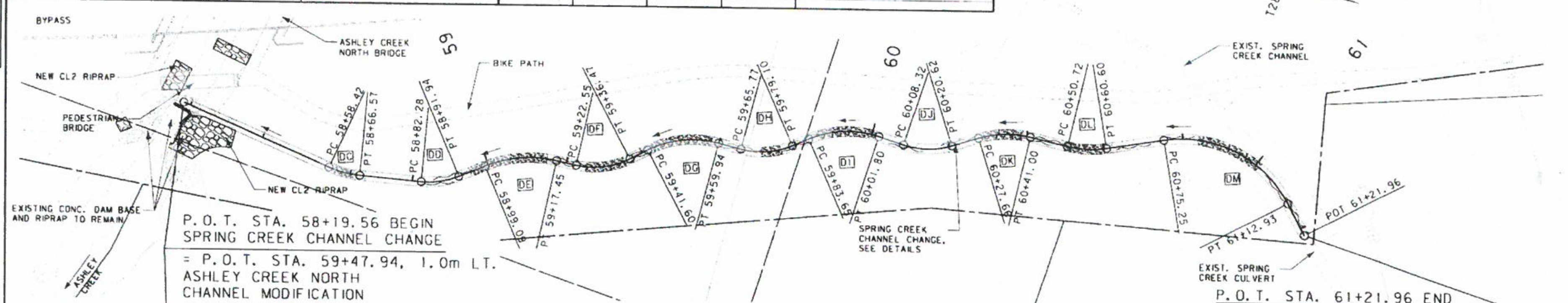
STREAM POOL SECTION

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



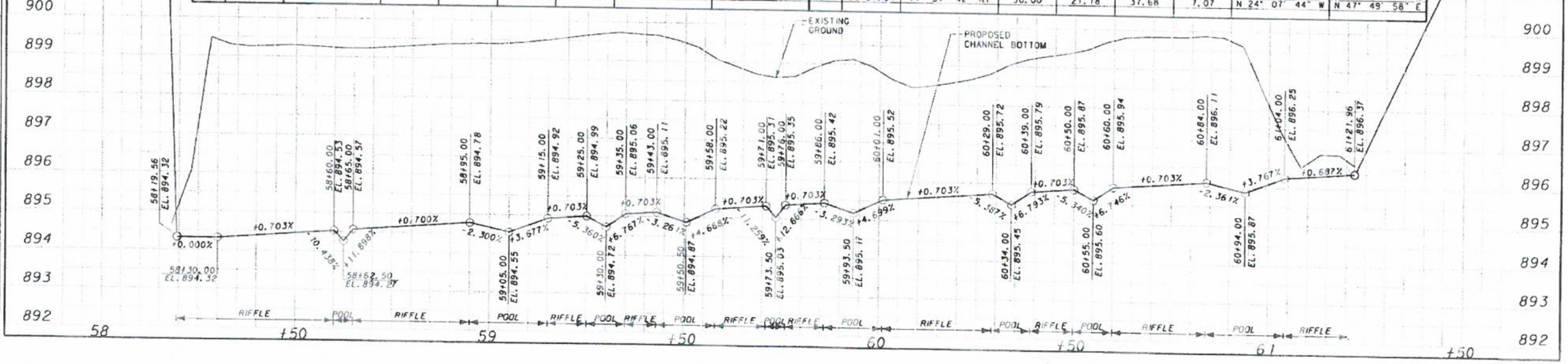
P.O.T. STA. 58+19.56 BEGIN
SPRING CREEK CHANNEL CHANGE

= 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



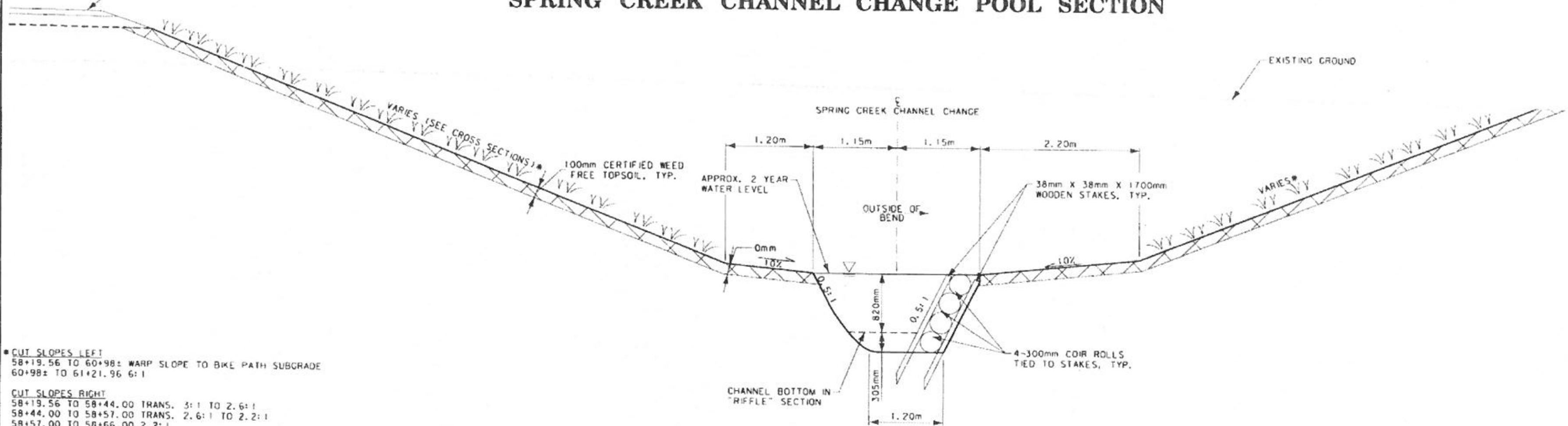
MONTANA DEPARTMENT OF TRANSPORTATION
MONTANA CADD
SE Sterling Engineers, Inc.
DESIGNED BY
REVIEWED BY
CHECKED BY
10/6/2009
11:16:35 AM
EPS U2160

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

CSF = 0.999470385

DETAIL

SPRING CREEK CHANNEL CHANGE POOL SECTION

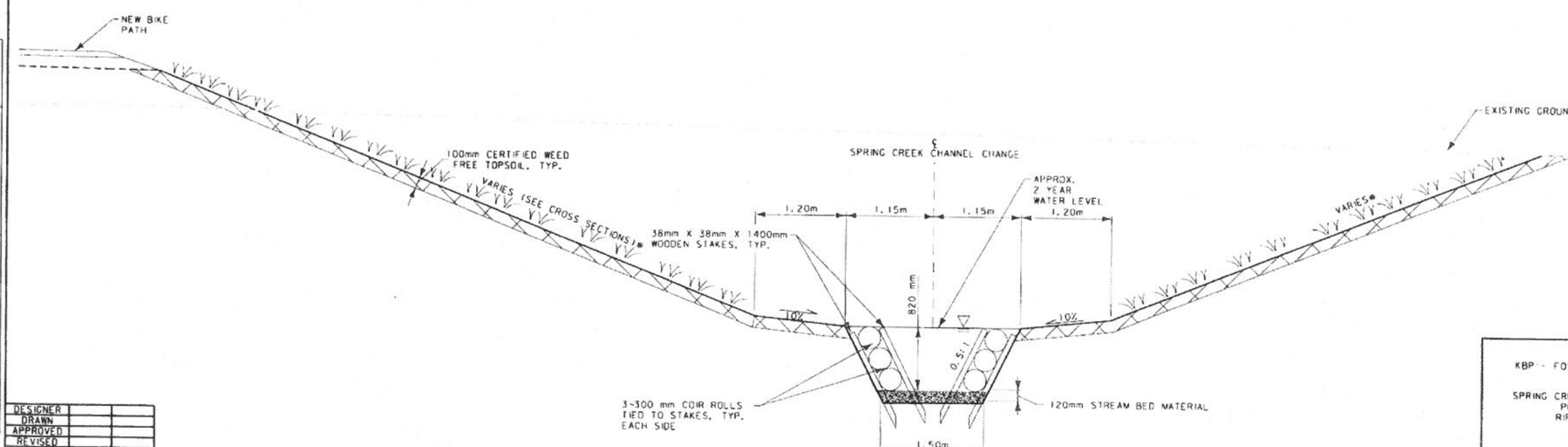


* CUT SLOPES LEFT
58+19.56 TO 60+98± WARP SLOPE TO BIKE PATH SUBGRADE
60+98± TO 61+21.96 6:1

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

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

KBP - FOYS LAKE RD TO US 2

SPRING CREEK CHANNEL CHANGE
POOL SECTION
RIFFLE SECTION

NO SCALE

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

DESIGNED BY
REVIEWED BY
CHECKED BY
10/6/2009
11:16:40 AM
KPS - 02160