MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MONITORING REPORT

Little Rock Creek at Judith Slide Repair
Fergus County, Montana

Project Completed: 2013
Monitoring Report #3: December, 2016

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE consulting incorporated

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MONITORING REPORT #3

YEAR 2016

Little Rock Creek at Judith Slide Repair
Fergus County, Montana

MDT Project Number: STPS 426-2(12) 15
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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: Little Rock Creek looking south (upstream) at the Judith Slide Repair site in 2016.

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1.0 INTRODUCTION

As part of an emergency roadway repair, the Montana Department of Transportation (MDT) realigned a segment of Secondary Highway 426 (also known as S-426 or Hanover Road), around a land slide to provide a stable, paved roadway through the area and reduce annual road maintenance requirements. Due to the new road alignment, modification to a segment of Little Rock Creek was also necessary. This channel modification was approved by the U.S. Army Corps of Engineers (USACE) and does not require compensatory mitigation for stream impacts.

Although compensatory mitigation is not required, MDT requested monitoring of the reconstructed segments of Little Rock Creek to evaluate whether the stream restoration and revegetation techniques were successful in generating a stable, well vegetated channel with variable habitat elements. The following report provides the results of the third year of monitoring along this segment of Little Rock Creek. This project was constructed in 2013, therefore, these results provide documentation of the site's condition three years following the project's completion.

Specific project objectives outlined in the joint permit application for Little Rock Creek included:

- Removal of a 163" x 120" structural steel plate pipe and placement of a 12' x 12' reinforced concrete box culvert approximately 222 feet long to provide fish passage.
- Control spring seepage via interceptor trenches and slope armoring to route water into nearby ditches and culvert.
- Constructing 536 feet of new stream channel within the reclaimed segment of the former highway alignment.

Results of the third year of monitoring at the Judith Slide Repair site are provided in Section 4, while Section 5 provides additional site observations that were not captured by the monitoring protocols. Appendices to this monitoring report include maps indicating the endpoints of riparian belt transects, longitudinal profile and perpendicular transect surveys, vegetation communities, noxious weeds, and eroding banks; plots of perpendicular transect and longitudinal profile surveys; photo documentation of the project site; and a topographic survey of the project site (surveyed in 2014).

2.0 SITE LOCATION

The project site is located near Lewistown in the NE ¼ NE ¼ of Section 27, Township 16 North, Range 16 East, and the NW ¼ NW ¼ of Section 26, Township 16 North, Range 16 East, in Fergus County, Montana (Figure 1).

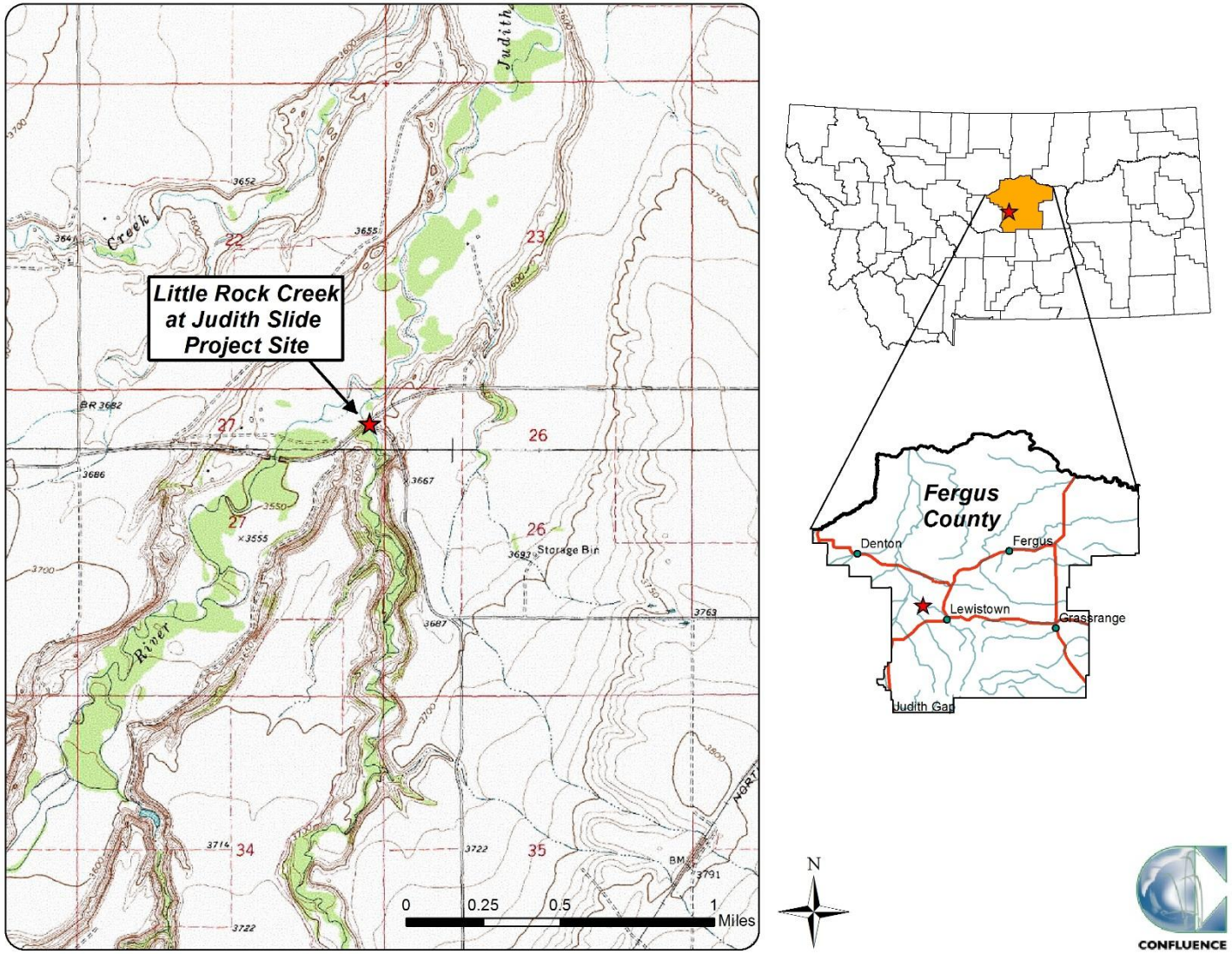

Figure 1. Project location of the Little Rock Creek at Judith Slide Repair site.

3.0 MONITORING METHODS

Monitoring and survey field crews visited the project site on July 11 and July 19, 2016, respectively. The following data were collected at the Little Rock Creek at Judith Slide Repair site:

3.1. Vegetation Inventories and Community Mapping

Two riparian belt transects established in 2014 were monitored to document riparian vegetation development and community diversity, as well as areal percent cover of total vegetation, woody vegetation, and noxious weeds within 25 feet of the newly aligned stream channel. The riparian transect on the right (east) bank runs parallel to the channel for 203 feet, while the riparian transect on the left (west) bank extends 192 feet.

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 approximately 630 feet of each bank was estimated and recorded using the classification values listed in Table 1.

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

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

Vegetation community boundaries were determined in the field during the active growing season and subsequently delineated on aerial photographs. Community types were designated based on the predominant vegetation species within each mapped polygon (Figure 3, Appendix A). Bank stability indices were then assigned to the stream bank community types (Winward 2000; Pick et al. 2004).

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

3.2. Bank Erosion Inventory

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

3.3. Channel Surveys

Four perpendicular transects (cross sections) established in 2014 were re-surveyed including two at riffles and two at pools. A longitudinal profile of the channel thalweg was also re-surveyed to document bedform complexity and aquatic habitat conditions.

3.4. Photo-Documentation

Photos were taken at all photo points established in 2014 to document riparian and stream conditions throughout the project reach. Survey crews documented stream and bank conditions by taking additional photos facing upstream, downstream, left and right from the center of the channel and at the endpoints of each of the four perpendicular transects.

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, nests, burrows, dens, feathers, etc.

4.0 RESULTS

4.1. Riparian and Stream Bank Vegetation Inventory

Table 2 summarizes the areal percent cover of total vegetation, woody vegetation, and noxious weeds observed along each riparian and stream bank transect during the 2014 through 2016 monitoring events. Both riparian vegetation transects were located downstream of the box culvert, and are representative of the reconstructed channel and associated riparian zones below the culvert outlet. Total percent cover of vegetation increased from 83% in 2015 to 88% in 2016. Total percent woody cover increased from 14% in 2015 to 17% in 2016. Percent cover of Montana State-listed noxious weeds increased from 3% in 2015 to 4% in 2016 (See Section 4.3). Vegetation upstream and downstream of the culvert is establishing well, with a diversity of stream bank and riparian vegetation developing on both sides of the channel (See Photo Point 1 and Additional Photo #1 in Appendix A).

Table 2. Percent cover of Judith Slide Repair site vegetation transects from 2014 through 2016.

Belt Transect	Length (ft)	Total % Vegetation Cover			% Woody Cover			% Noxious Weed Cover		
		2014	2015	2016	2014	2015	2016	2014	2015	2016
Right (east) Riparian	203	60%	80%	85%	0%	0%	2%	0%	4%	5%
Left (west) Riparian	192	50%	80%	85%	0%	0%	2%	0%	4%	5%
Riparian Subtotal		55%	80%	85%	0%	0%	2%	0%	4%	5%
Right (east) Stream bank	630	65%	90%	97%	47%	50%	55%	1%	2%	2%
Left (west) Stream bank	630	65%	90%	97%	47%	50%	55%	1%	2%	2%
Streambank Subtotal		65%	90%	97%	47%	50%	55%	1%	2%	2%
Area Weighted Total		**58%**	**83%**	**88%**	**7%**	**14%**	**17%**	**0.2%**	**3%**	**4%**

Table 3 includes a comprehensive list of plant species observed during the 2014 through 2016 monitoring events. In 2016, 89 plant species were identified within the project area, as compared to 69 species in 2015 and 52 species in 2014. Approximately half of the new species observed were present along the stream banks, while the other half of the new species were identified within the riparian areas adjacent to the channel. Of the 89 plants observed, 41 (46%) were considered hydrophytic based on the 2016 National Wetland Plant List (NWPL) (Lichvar *et al*., 2016). The vegetation observed within the riparian and stream bank corridor comprised a mix of native and nonnative annual, biennial, and perennial plant species.

Table 3. Plant species observed at the Judith Slide Repair site from 2014 through 2016.

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
Agastache urticifolia	Nettle-Leaf Giant-Hyssop	FACU
Agropyron cristatum	**Crested Wheatgrass**	**NL**
Agrostis stolonifera	Spreading Bent	FAC
Algae, green	Algae, green	NL
Alyssum desertorum	**Desert Alyssum**	**NL**
Arctium minus	Lesser Burrdock	UPL
Artemisia absinthium	Absinthium	NL
Bassia scoparia	Mexican-Fireweed	FAC
Bromus inermis	Smooth Brome	UPL
Bromus japonicus	Japanese Brome	NL
Bromus tectorum	**Cheatgrass**	**NL**
Calamagrostis canadensis	Reed Grass	FACW
Camelina microcarpa	**Little-Pod False Flax**	**FACU**
Campanula rotundifolia	**Bluebell-of-Scotland**	**FACU**
Carduus nutans	Nodding Plumeless-Thistle	UPL
Carex sp.	Sedge	NL
Chamaenerion angustifolium	**Narrow-Leaf Fireweed**	**FACU**
Chenopodium album	Lamb's-Quarters	FACU
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	Bull Thistle	FACU
Cynoglossum officinale	Gypsy-Flower	FACU
Descurainia sophia	Herb Sophia	NL
Eleocharis palustris	**Common Spike-Rush**	**OBL**
Elymus canadensis	Nodding Wild Rye	FAC
Elymus hispidus	Intermediate Wheatgrass	NL
Elymus repens	Creeping Wild Rye	FAC
Elymus trachycaulus	**Slender Wild Rye**	**FAC**
Epilobium ciliatum	Fringed Willowherb	FACW
Equisetum arvense	**Field Horsetail**	**FAC**
Euphorbia esula	Leafy Spurge	NL
Geum macrophyllum	**Large-Leaf Avens**	**FAC**
Glyceria grandis	American Manna Grass	OBL
Glyceria striata	Fowl Manna Grass	OBL
Glycyrrhiza lepidota	**American Licorice**	**FAC**
Helianthus annuus	Common Sunflower	FACU
Hordeum jubatum	Fox-Tail Barley	FAC
Juncus ensifolius	**Dagger-Leaf Rush**	**FACW**
Juncus sp.	Rush	NL
Juncus torreyi	**Torrey's Rush**	**FACW**
Lactuca serriola	Prickly Lettuce	FACU
*Lepidium campestre***	Field Pepper-Grass**	NL
Matricaria discoidea	Pineapple-Weed	FACU
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
Myriophyllum sp.	Water-Milfoil	NL
Nasturtium officinale	Watercress	OBL
Oenothera villosa	Hairy Evening-Primrose	FAC
Onopordum acanthium	Scotch Thistle	NL
Onosmodium molle	**Soft-hairy False Gromwell**	**NL**
Pascopyrum smithii	Western-Wheat Grass	FACU
Persicaria amphibia	Water Smartweed	OBL
Persicaria maculosa	Spotted Lady's-Thumb	FACW
Persicaria sp.	Smartweed	NL
Phalaris arundinacea	Reed Canary Grass	FACW
Phleum pratense	Common Timothy	FAC
Plantago major	**Great Plaintain**	**FAC**
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Polypogon monspeliensis	Annual Rabbit's-Foot Grass	FACW
Populus angustifolia	Narrow-Leaf Cottonwood	FACW
Prunus virginiana	Choke Cherry	FACU
Ranunculus aquatilis	**White Water-Crowfoot**	**OBL**
Ribes sp.	Currant	NL
Rosa woodsii	Woods' Rose	FACU
Rudbeckia laciniata	Green-Head Coneflower	FAC
Rumex acetosa	Garden Sorrel	FAC
Rumex crispus	Curly Dock	FAC
Rumex fueginus	Tierra del Fuego Dock	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Scirpus microcarpus	Red-Tinge Bulrush	OBL
Silene latifolia	**Bladder Campion**	**NL**
Sinapis arvensis	Corn Mustard	NL
Sisymbrium altissimum	Tall Hedge-Mustard	FACU
Solidago canadensis	Canadian Goldenrod	FACU
Sonchus arvensis	Field Sow-Thistle	FACU
Symphoricarpos albus	Common Snowberry	FACU
Symphoricarpos occidentalis	**Western Snowberry**	**FAC**
Thlaspi arvense	Field Pennycress	UPL
Tragopogon dubius	Meadow Goat's-Beard	NL
Trifolium pratense	Red Clover	FACU
Trifolium repens	**White Clover**	**FAC**
Typha latifolia	**Broad-Leaf Cat-Tail**	**OBL**
Urtica dioica	Stinging Nettle	FAC
Verbascum thapsus	Great Mullein	UPL
Veronica americana	American-Brooklime	OBL

* Based on 2016 NWPL (Lichvar *et al*., 2016)
***Lepidium latifolium* was misidentified in 2014 and was changed to *Lepidium campestre in* 2015
New species identified in 2016 are **bolded**.

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 3, Appendix A). The dominant plant species observed within the riparian zone were absinthium (*Artemisia absinthium*), nodding wild rye (*Elymus canadensis*), intermediate wheatgrass (*Elymus hispidus*), slender wild rye (*Elymus trachycaulus*), and western-wheat grass (*Pascopyrum smithii)*, which primarily occurred above the coir encapsulated soil lifts. The lower banks of the channel were dominated by narrow-leaf willow (*Salix exigua*) and reed canary grass (*Phalaris arundinacea*).

Four vegetation community types were observed in 2016 (Figure 3, Appendix A) and are included in Table 4.

Table 4. Vegetation community types observed at Judith Slide Repair site in 2016.

Community Type	Dominant Species
1	*Salix exigua* / *Phalaris arundinacea*
2	*Elymus* spp.
7	*Pascopyrum smithii* / *Elymus* spp.
8	*Artemisia absinthium* / *Pascopyrum smithii*

Vegetation community Type 1 – *Salix exigua* / *Phalaris arundinacea* was identified along both stream banks north of S-426/Hanover Road. Reed canary grass and narrow-leaf willow dominated this community type. American manna grass (*Glyceria grandis*) was also commonly observed at 6 to 10 percent cover.

Vegetation community Type 2 – *Elymus* spp. was identified in 2014 north and south of S-426/Hanover Road and was changed in 2015 to community Type 5 – *Elymus* spp*./Melilotus officinalis* to represent the addition of dominant vegetation cover by yellow sweet-clover. Yellow sweet-clover, an early colonizer on recently disturbed landscapes, no longer dominates this vegetation community and was therefore changed back to its original community Type 2 classification (Gucker 2009). Nodding wild rye, intermediate wheatgrass, and slender wild rye, also considered early successional species, dominated this community type (Simonin 2000; Sedlvec *et. al* 2011; Howard 1992). Other commonly observed species included western-wheat grass and Japanese brome (*Bromus japonicus*).

Vegetation community Type 6 – *Pascopyrum smithii/Melilotus officinalis* was identified in 2015 north of S-426/Hanover Road and was changed in 2016 to community Type 7 – *Pascopyrum smithii/Elymus* spp. and community Type 8 – *Artemisia absinthium/Pascopyrum smithii* to represent the shift in vegetation cover from a dominance of yellow sweet-clover to absinthium, nodding wild rye, intermediate wheatgrass, slender wild rye, and western-wheat grass. These species, with the exception of western-wheat grass, are considered early successional species commonly found on recently disturbed landscapes (Carey 1994; Simonin 2000; Sedlvec *et. al* 2011; Howard 1992; Gucker 2009) Western-wheat grass, while it occurs in all seral stages, is commonly described as a late successional species that persists in

mature vegetation communities (Tirmenstein 1999). Other commonly observed species in this community included smooth brome (*Bromus inermis*) and Japanese brome.

4.2. Stream Bank Vegetation Inventory

The stream bank vegetation inventory identified 37 species along the banks of Little Rock Creek (Table 5). Reed canary grass and narrow-leaf willow represented greater than 50% of the vegetation cover along both stream banks in 2016. The 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; Pick et al. 2004). If the same cover class was recorded for both dominant species in a community type, the higher stability rating was chosen. Success criteria outlined in the monitoring plan state the vegetation along the stream banks will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6. Vegetation community Type 1 – *Salix exigua/Phalaris arundinacea* was the dominant vegetation community observed along the stream banks, with an associated stability rating of 9.

Table 5. Comprehensive list of plant species and their associated cover classes along the stream banks of Little Rock Creek at the Judith Slide Repair site in 2016.

Streambank Species	Left Bank Upstream	Left Bank Downstream	Right Bank Upstream	Right Bank Downstream	WMVC Indicator Status**	Cover Class
*Phalaris arundinacea**	X	X	X	X	FACW	5
*Salix exigua**	X	X	X	X	FACW	5
Glyceria grandis		X		X	OBL	2
Agastache urticifolia		X	X	X	FACU	1
Artemisia absinthium	X	X	X	X	NL	1
Bare Ground	X	X	X	X	NL	1
Cirsium arvense		X	X	X	FAC	1
Epilobium ciliatum	X	X	X	X	FACW	1
Melilotus officinalis	X	X	X	X	FACU	1
Nasturtium officinale		X		X	OBL	1
Poa palustris		X	X	X	FAC	1
Polypogon monspeliensis		X		X	FACW	1
Scirpus microcarpus		X			OBL	1
Sonchus arvensis	X	X		X	FACU	1
Veronica americana		X		X	OBL	1
Agrostis stolonifera				X	FAC	0
Bromus inermis		X			UPL	0
Calamagrostis canadensis		X	X		FACW	0
Chamaenerion angustifolium		**X**		**X**	**FACU**	**0**
Equisetum arvense		**X**		**X**	**FAC**	**0**
Euphorbia esula		X		X	NL	0
Geum macrophyllum		**X**		**X**	**FAC**	**0**
Glyceria striata			X		OBL	0
Glycyrrhiza lepidota				**X**	**FAC**	**0**
Juncus ensifolius		**X**			**FACW**	**0**
Juncus torreyi		**X**			**FACW**	**0**
Lactuca serriola			X	X	FACU	0
Mentha arvensis		X	X	X	FACW	0
Onosmodium molle		**X**			**NL**	**0**
Persicaria amphibia	X	X	X	X	OBL	0
Prunus virginiana		X			FACU	0
Rumex acetosa		X			FAC	0
Solidago canadensis		X		X	FACU	0
Sonchus arvensis		X			FACU	0
Symphoricarpos occidentalis		**X**		**X**	**FAC**	**0**
Thlaspi arvense		X		X	UPL	0
Typha latifolia		**X**		**X**	**OBL**	**0**
Urtica dioica		X		X	FAC	0

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

4.3. Noxious Weed Inventory

Three Montana State-listed noxious weeds were observed within the reconstructed segment of Little Rock Creek in 2016 (Table 6). *Lepidium latifolium* was misidentified in 2014, and was removed in 2015 from the list of noxious weeds observed at this site. Canada thistle (*Cirsium arvense*) and leafy spurge (*Euphorbia esula*) infestations observed on site are shown on Figure 3 in Appendix A. Gypsy flower (*Cynoglossum officinale)* was observed in isolated trace amounts, and was therefore not mapped on Figure 3. The combined areal cover of all three noxious weed species identified in 2016 was estimated at 4%. The increase in noxious weeds was primarily observed in riparian areas as opposed to the stream banks. Three of the most prolific infestations were observed near the downstream end of the relocated channel segment, along both stream banks where livestock crosses the channel. Infestations of noxious weeds were observed just outside of the project site during the 2013 monitoring event, which offered a seed source for establishment of weeds within the site.

Table 6. Montana State-listed noxious weed species identified at the Judith Slide Repair site in 2016.

Category*	Scientific Name	Common Name
Priority 2B	*Cirsium arvense*	Canada Thistle
	Cynoglossum officinale	Gypsy-Flower
	Euphorbia esula	Leafy Spurge

*Based on the Montana Dept. of Agriculture's Noxious Weed List, 2015
Lepidium latifolium was misidentified in 2014 and was removed in 2015 from this list of noxious weed species.

4.4. Bank Erosion Inventory

To date one eroding bank has been observed within the project reach, which lies approximately 250 feet downstream of the newly installed culvert. The stream channel makes a relatively sharp turn northward at this location and scours along the left bank. Previous monitoring of this bank revealed an undercut forming beneath the bank and slumping soil lifts filling the void created by the undercut. Observations in 2016 indicated the lower bank has remained intact and has woody and herbaceous vegetation establishing to provide cover (See Additional Photo 2 in Appendix C). The coir fabric installed on the upper soil lifts has continued to bio-degrade and expose soils installed within these upper lifts. The upper lifts have not vegetated as well as those installed closer to the bank toe, and as a result, the exposed soils along the upper bank are beginning to slough where the undercut has formed. Lack of vegetation establishment on the upper bank is most likely due to the design calling for 1) the use of an improper, wetland seed mix on the upper-most soil lift that lies within a dry area, and 2) no seeding of the second highest soil lift. Although this bank shows some sign of instability, the eroding bank remains less than 20 feet long and does not pose a threat to the overall stability of the channel and downstream reaches of the project.

4.5. Perpendicular Transects

Plots of two riffle and two pool transects surveyed within the project reach are included in Appendix B. Maximum depth and bankfull width for each transect are provided in

Table 7. In 2016, maximum depths ranged from 3.9 to 5.0 feet while bankfull widths ranged from 19.7 to 21.8 feet. It should be noted the reported bankfull width and depth reported at Transect #2 in 2014 and 2015 have been revised based on a refinement of the bankfull elevation at this location. Channel depths remain close to the design depth of 4.0 to 4.5 feet (Channel Change Typical Section Detail, Sheet 12).

Repeated surveys at each of the established transects indicates some shallowing of the channel over the past three years. Maximum depths decreased at each of the four transects, indicating some degree of deposition at these locations following completion of the channel realignment project. Based on the annual surveys, deposition occurred primarily between 2014 and 2015, with average depth decreasing by 0.3 feet in riffles and 0.5 feet in pools during that year. In comparison, riffles and pools became shallower by 0.2 feet from 2015 to 2016. This trend may be indicative of the new channel adjusting to its incoming sediment loads. Inspection of the longitudinal profile does not indicate widespread aggradation (rise in the channel bed); therefore, the relatively minor decrease in channel depth is not of major concern. Continued monitoring will determine whether the channel is trending toward an aggradational state or if sediment transport is being maintained through the project reach.

Table 7. Widths and depths at Little Rock Creek stream mitigation site from 2014 to 2016.

Transect	Type	Maximum Depth (ft)			Bankfull Width (ft)		
		2014	2015	2016	2014	2015	2016
1	riffle	4.4	4.2	3.9	21.9	21.8	21.8
2	pool	*4.8*	*4.4*	4.1	*19.8*	*20.0*	19.7
3	riffle	4.4	4.0	3.9	21.0	20.8	20.7
4	pool	5.7	5.2	5.0	20.1	20.1	20.1
Average Riffles		**4.4**	**4.1**	**3.9**	**21.5**	**21.3**	**21.3**
Average Pools		**5.3**	**4.8**	**4.6**	**20.0**	**20.1**	**19.9**

Note: reported maximum depth and bankfull width at transect #2 for 2014 and 2015 have been modified from those reported in previous monitoring reports.

4.6. Longitudinal Profile

Two longitudinal profiles of the channel thalweg are provided in Appendix B, including one that extends 600 feet upstream and 400 feet downstream of the newly constructed channel and a second that only includes the reconstructed channel reach. The profiles reveal the presence of at least six pools within the reconstructed channel segment, which offer fish deeper habitat and slower velocities for refuge. Pool habitats are forming from the stream a) scouring against the outside meander bends, b) plunging over rock weirs (grade controls) constructed across the channel width, and c) backwatering upstream of the rock grade control features.

The weir drop immediately downstream of the culvert has filled in with a mix of gravel, sand, and silt; therefore no deep water habitat has developed through the “riprap basin pool feature” as shown in the design. Sediment deposition and subsequent vegetation establishment along the channel fringes of the riprap basin pool have resulted in the

channel narrowing down a width more closely matching the typical design channel. As noted earlier, a survey of the profile over the past three years indicates a relatively consistent channel slope with some areas of deposition. Channel gradient upstream and downstream of the project reach continues to appear closely matched with the gradient of the reconstructed channel. It should be noted the station labels shown on the profile in Appendix B are based on the survey data collected during the monitoring events and do not match those depicted on the design sheets in Appendix D.

4.7. Wildlife Documentation

Wildlife observations during the 2016 monitoring event included magpies, robins, mallard ducks, and deer tracks/scat. Six bird species, three mammal species, four fish species, and one reptile specie have either been directly or indirectly observed within the project area since the first monitoring event in 2014 (Table 8). Indirect evidence of a particular species includes scat, tracks, feathers, or other sign. In addition, a spotted frog was observed at the confluence of Little Rock Creek with the Judith River, which is approximately 500 feet downstream of the project area. Livestock, or sign of livestock, have been observed during each of the three monitoring events.

Table 8. Wildlife species observed at the Judith Slide Repair site in 2014 through 2016.

Common Name	Scientific Name
Birds	
Black-billed Magpie	***Pica hudsonia***
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Swallow sp.	*Tachycineta* sp.
American Robin	*Turdus Migratorius*
Western Kingbird	*Tyrannus verticalis*
Mammals	
Mule deer	*Odocoileus hemionus*
Deer (tracks)	*Odocoileus* sp.
Mink (tracks and scat)	*Neovison vison*
Fish	
Brown Trout	*Salmo trutta*
Fish sp.	
Mountain Whitefish	*Prosopium williamsoni*
Sculpin	*Cottus* sp.
Reptiles	
Garter Snake	*Thamnophis* sp.

New species observed in 2016 are **bolded.**

5.0 ADDITIONAL OBSERVATIONS

The following are additional observations made during the 2016 monitoring site visit:

1. Formation of a small gully to the east of the newly constructed channel was noted in 2015. This gully formation appeared to be the result of a seep and surface water runoff flowing across newly vegetated areas within the project reach. Vegetation has matured along the length of the gully, and appears to have largely stabilized the erosion noted during previous monitoring events (see Additional Photo 3 in Appendix C).
2. The project included installation of four rock weirs to provide vertical grade control through the reconstructed channel segment. Inspection of each weir during the 2016 monitoring event indicated no evidence of undercutting or scouring around the rocks placed at each of the locations. Scour downstream of the weirs is developing relatively shallow pools, but does not appear to be jeopardizing the integrity of the weirs (see Photo Points 3.1, 3.2, 4.1, and 4.3 in Appendix C).
3. Newly installed fences surrounding the project reach have remained in good condition. No gaps or downed fence strands were observed along the newly installed fences. The barbed wire fence crossing Little Rock Creek at the downstream end and along the northeast corner of the project is in poor condition and allows livestock to cross into/out of the project reach (See Additional Photo 4 in Appendix C). The segments of fence in poor condition were installed well prior to the 2013 MDT project.
4. As noted in previous monitoring reports, vegetation establishment along the upper coir fabric lifts remains relatively limited. Much of the coir fabric surfaces remain bare or have been colonized by undesirable and weedy species (See additional Photos 5-6 in Appendix C). Potential causes include 1) below average precipitation in 2015, 2) an improper seed mix, or 3) no seeding applied to this area. The design calls for seeding the area above the uppermost lift with a wetland seed mix, which may have been inappropriate for such a dry zone. The design does not call for seeding of native fill material placed within the second highest coir lift layer. Precipitation data from a nearby weather station indicated average precipitation for the 2016 water year up to the time of the monitoring event, indicating this is not likely a limiting factor in vegetation establishment (WRCC 2016).
5. Willows installed along the toe of the stream bank and between the first and second coir wrapped soil lifts have continued to show excellent survival following three runoff events (See Photo Points 3.1, 3.2, and 4.1, Appendix C).
6. No evidence of a high flow event, such as flood debris or sediment deposits was noted during the 2015 or 2016 monitoring events.
7. Although several cattle tracks were observed, evidence of livestock impacts to the channel were only expressed at the downstream end of the project reach, where cattle appear to regularly cross the channel. This cattle crossing does not

appear to be jeopardizing the success of the project or impairing any of the constructed features within the project reach.

8. The design of the "basin pool" immediately downstream of the new culvert incorporated a wider channel width, riprapped stream banks, and a weir drop at the culvert outlet. The fringes of this pool have filled with stream bed material and become densely vegetated (See Photo Point 2 and 3.1, Appendix C). Several other pools were observed throughout the reconstructed channel segment; therefore, the lack of pool formation at this location does not significantly reduce the overall habitat complexity. This pool may not have been successful due to:
    a. The invert elevation of the culvert outlet (3551.29') matches that of the elevation of the downstream riffle, providing no gradient through the pool feature.
    b. The channel through this pool is straight, and otherwise has no features against which to generate scouring forces.
    c. Channel width through this pool increases from 12' at the culvert outlet to 44' at the downstream riffle crest. Channel width then transitions back to 19' as it enters the reconstructed channel. The abrupt change in channel width within a straight alignment encourages sediment deposition along the channel fringes, which was observed during the monitoring event.
9. Sometime prior to the 2016 monitoring event, telephone line spanning the new channel alignment became separated from the support pole located just west of the creek (see Additional Photo #7 in Appendix C). This issue was reported to MDT immediately after the July 2016 monitoring event and has subsequently been repaired.

6.0 LITERATURE CITED

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Appendix A

Project Site Maps

MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

CONFLUENCE
consulting incorporated

Legend

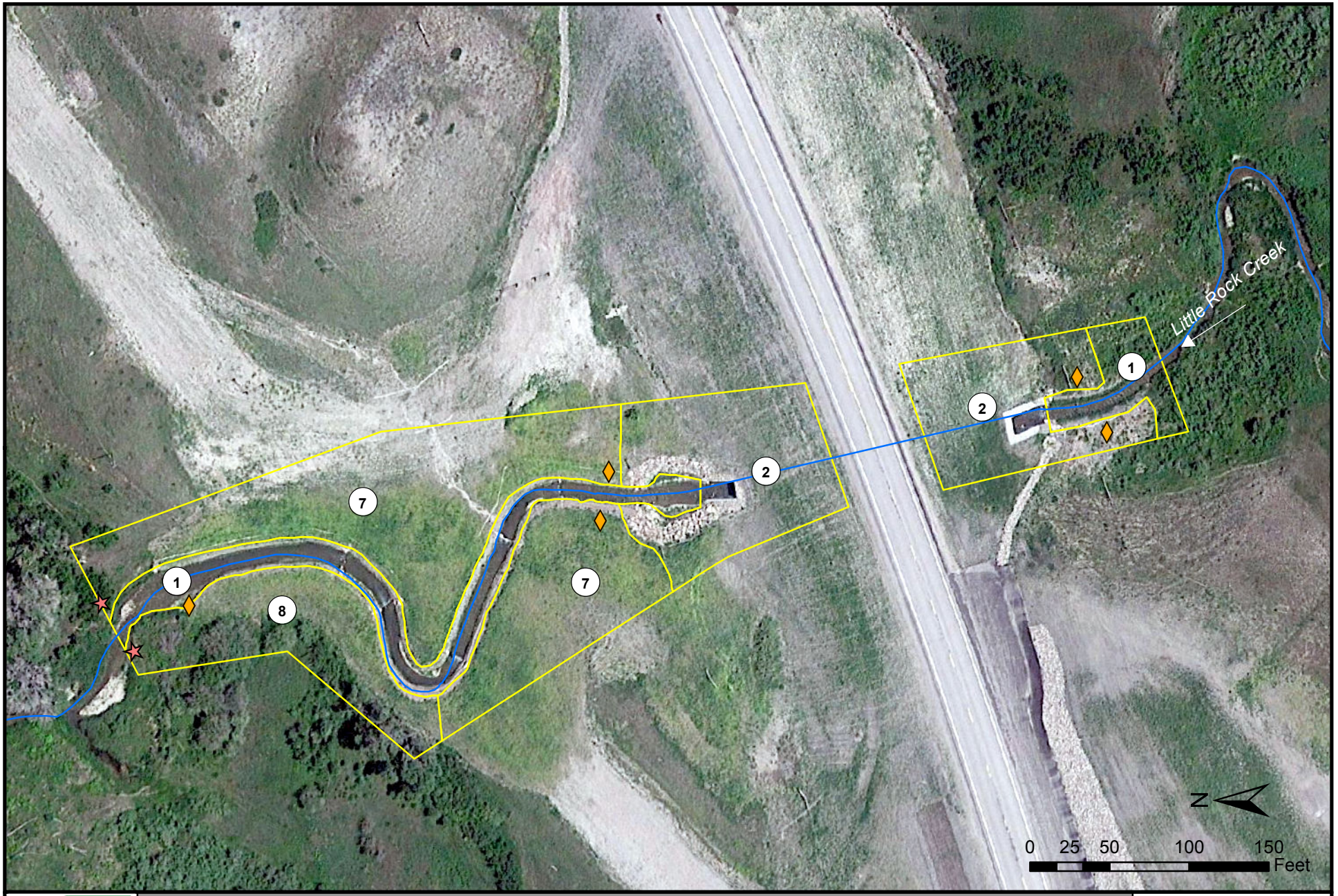
- Photo Points
- Eroding Bank
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Pool and Riffle Transects
- Riparian Transects

2016 Monitoring Little Rock Creek at Judith Slide

Figure 2

Date: 9/26/2016

Judith_features2016.mxd



CONFLUENCE
consulting incorporated

Legend

- Cirsium arvense
- Euphorbia esula
- Channel Centerline
- Vegetation Community Boundary

Note: Cynoglossum officinale (Gypsy-flower) also observed in project reach in trace amounts

1. Salix exigua/Phalaris arundinacea Community
2. Elymus spp. Community
7. Pascopyrum smithii/Elymus spp. Community
8. Artemisia absinthium/Pascopyrum smithii Community

2016 Monitoring
LIttle Rock Creek
at Judith Slide

Figure 3

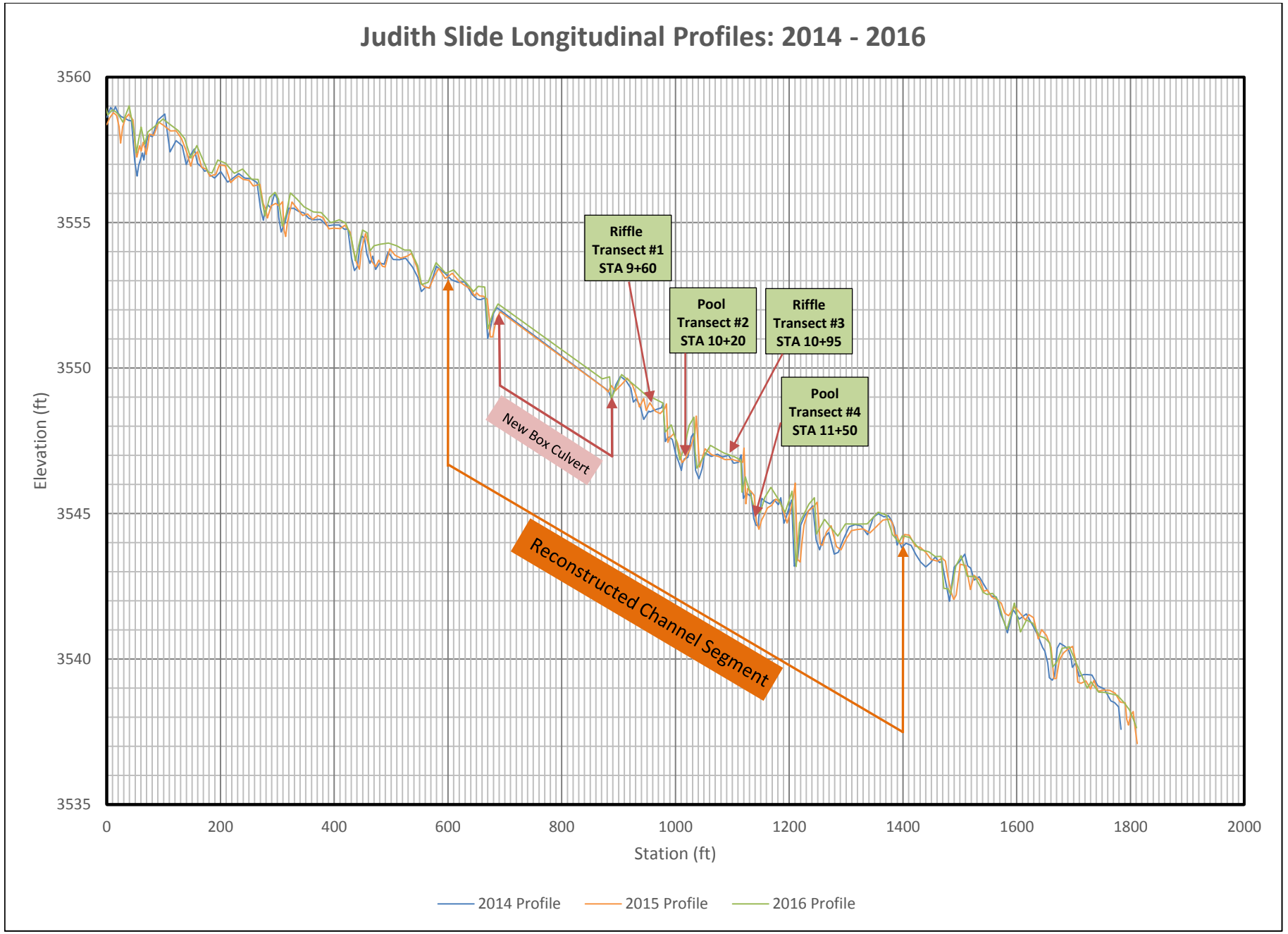
Date: 9/26/2016

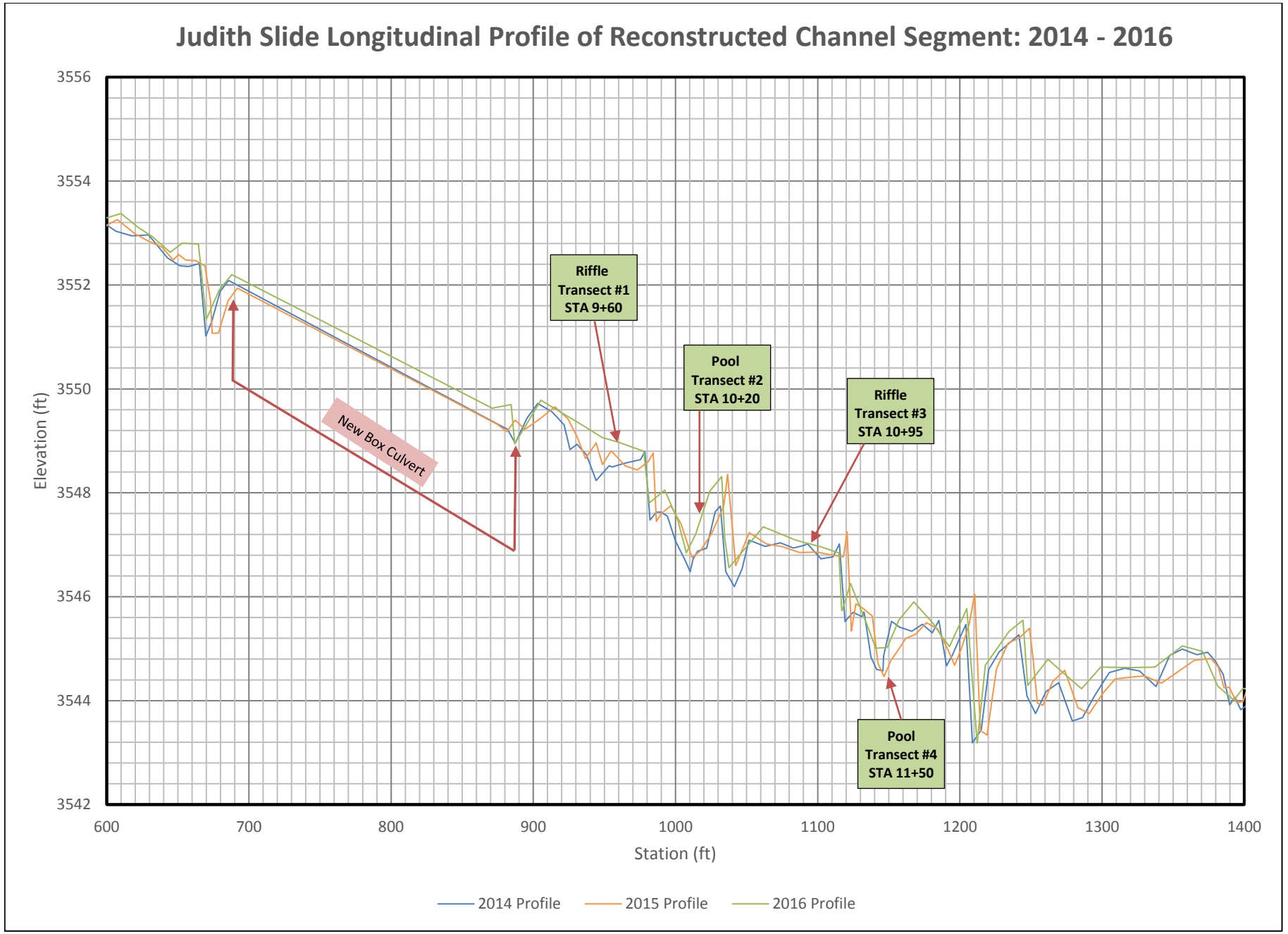
Judith_monitor2016.mxd

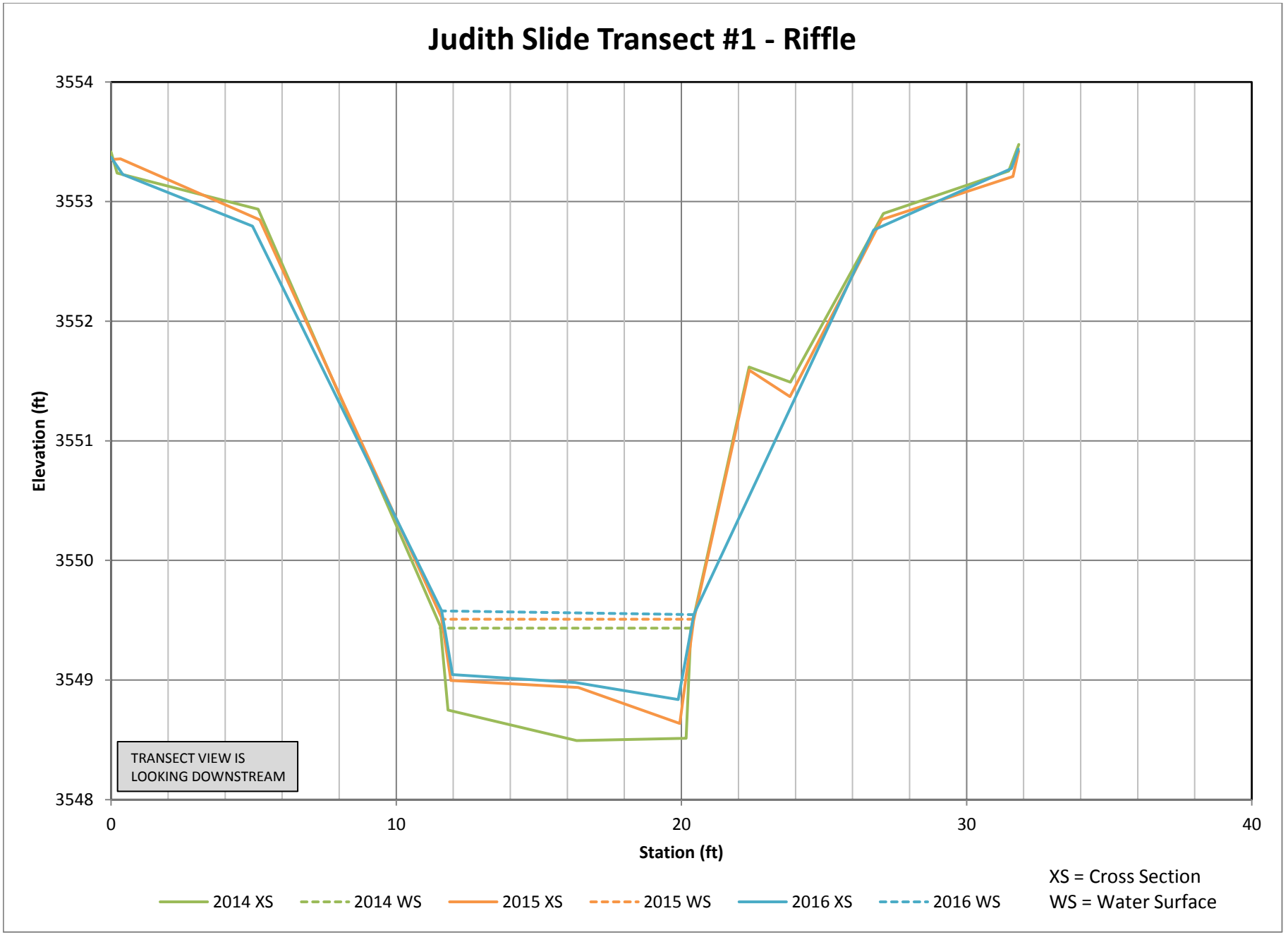
Appendix B

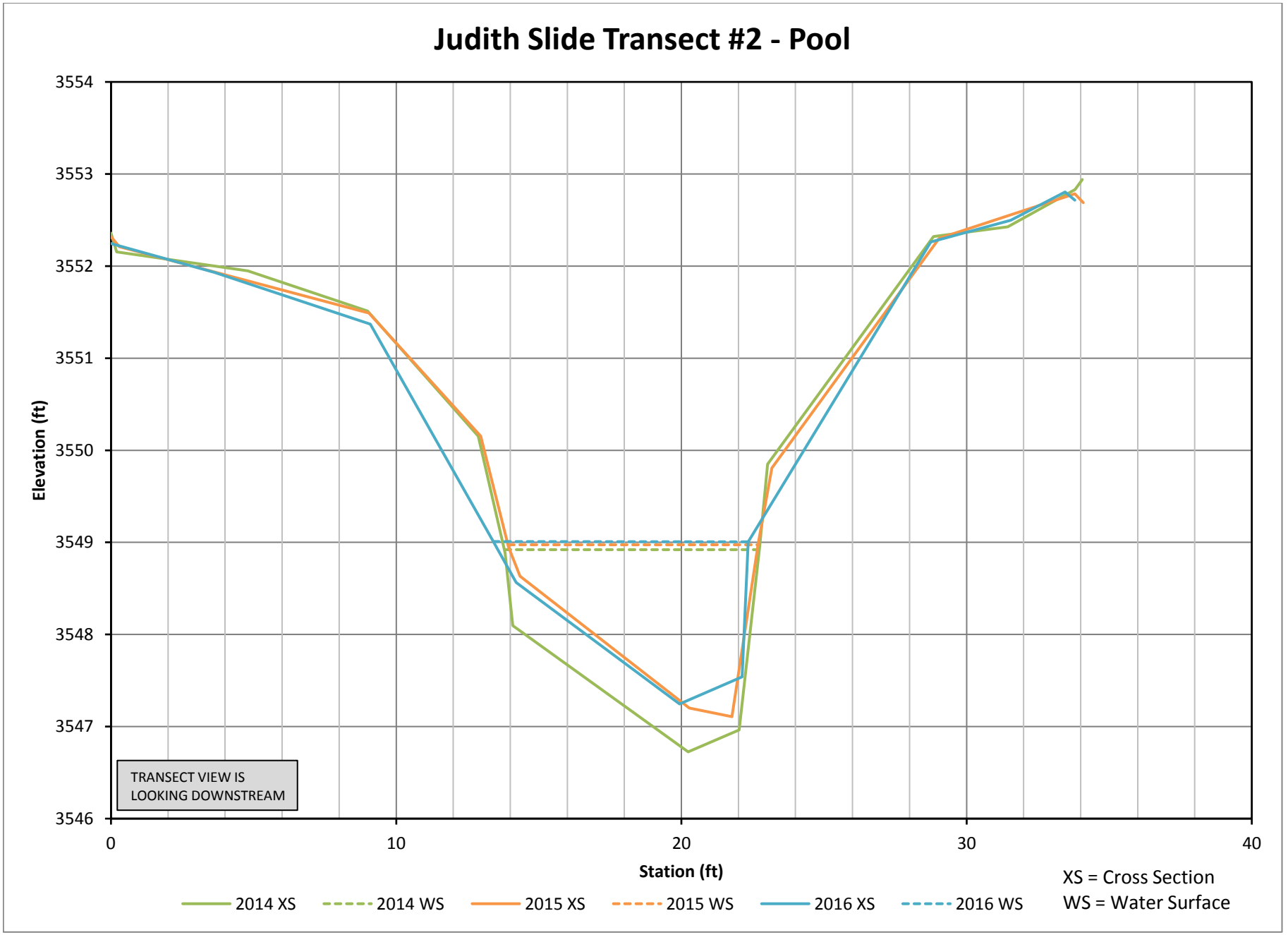
Perpendicular Transect and Longitudinal Profile Plots

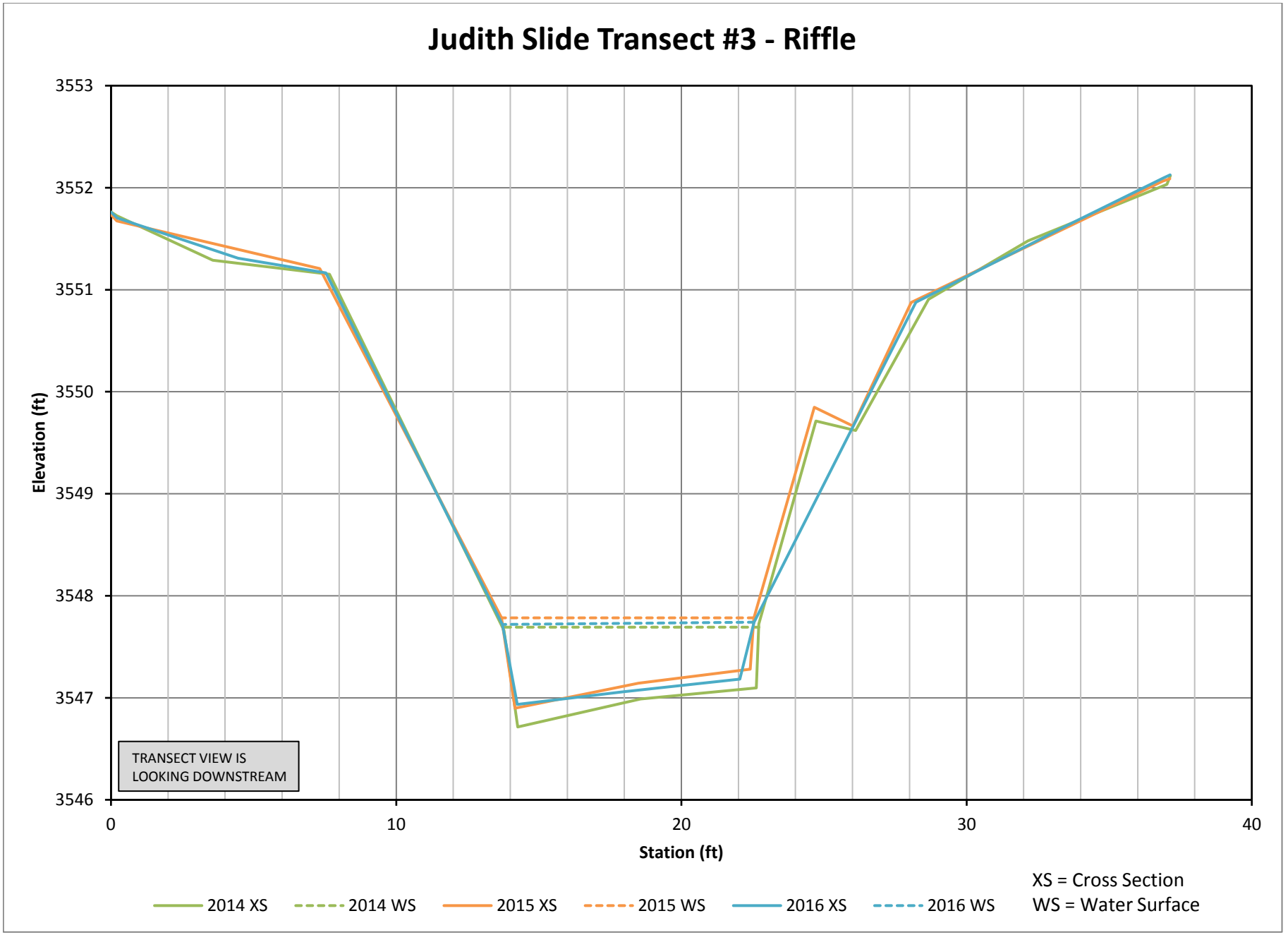
MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

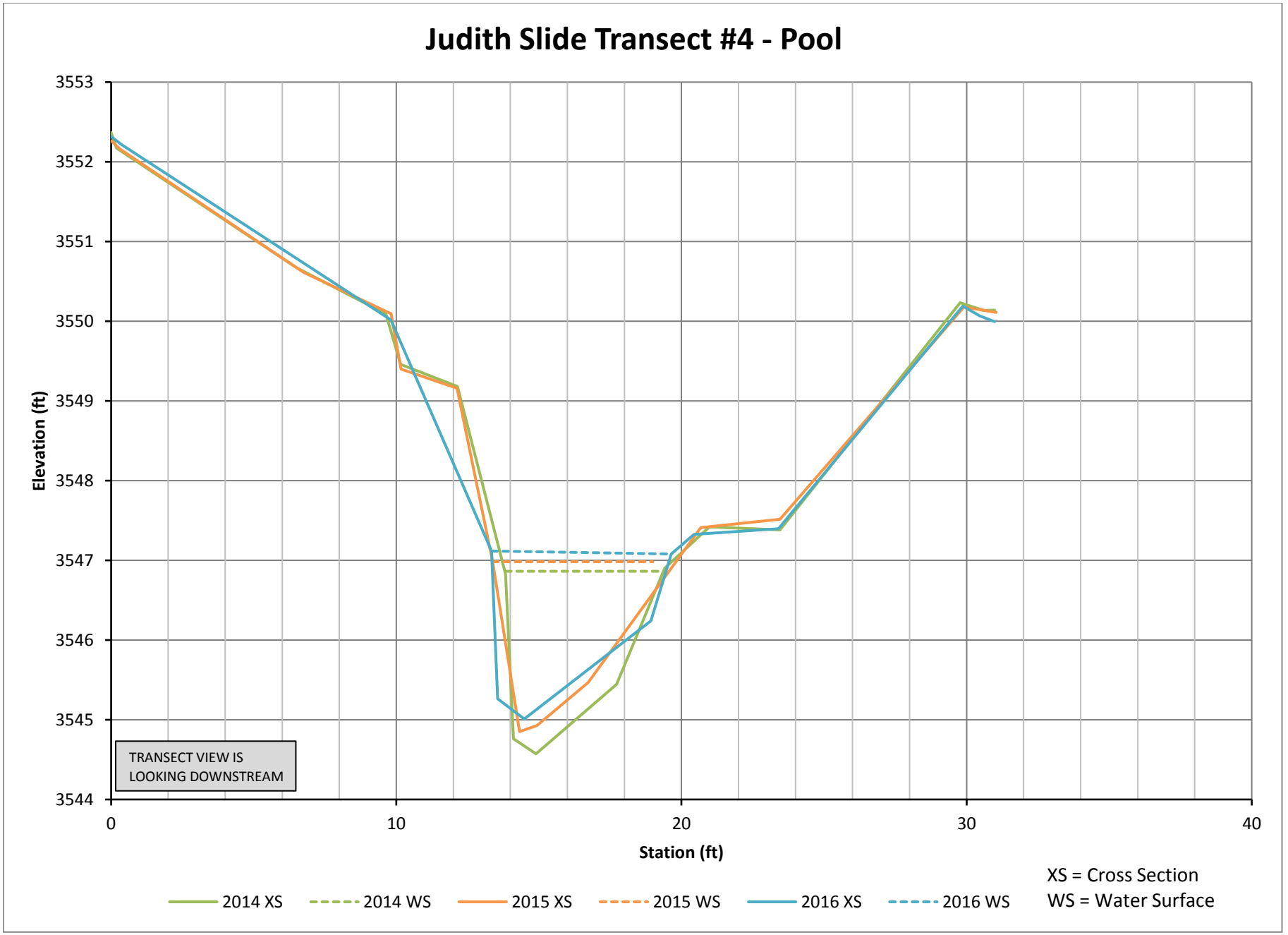

Judith Slide Longitudinal Profiles: 2014 - 2016
Elevation (ft)
3560
3555
3550
3545
3540
3535
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Station (ft)
Riffle Transect #1 STA 9+60
Pool Transect #2 STA 10+20
Riffle Transect #3 STA 10+95
Pool Transect #4 STA 11+50
New Box Culvert
Reconstructed Channel Segment
2014 Profile
2015 Profile
2016 Profile


Judith Slide Longitudinal Profile of Reconstructed Channel Segment: 2014 - 2016
Elevation (ft)
3556
3554
3552
3550
3548
3546
3544
3542
600
700
800
900
1000
1100
1200
1300
1400
Station (ft)
Riffle Transect #1 STA 9+60
Pool Transect #2 STA 10+20
Riffle Transect #3 STA 10+95
Pool Transect #4 STA 11+50
New Box Culvert
2014 Profile
2015 Profile
2016 Profile


Judith Slide Transect #1 - Riffle
3554
3553
3552
3551
3550
3549
3548
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
XS = Cross Section
WS = Water Surface


Judith Slide Transect #2 - Pool
Elevation (ft)
3554
3553
3552
3551
3550
3549
3548
3547
3546
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
XS = Cross Section
WS = Water Surface


Judith Slide Transect #3 - Riffle
3553
3552
3551
3550
3549
3548
3547
3546
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
XS = Cross Section
WS = Water Surface


Judith Slide Transect #4 - Pool
3553
3552
3551
3550
3549
3548
3547
3546
3545
3544
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS
2016 XS
2016 WS
XS = Cross Section
WS = Water Surface

Appendix C

Project Area Photos

MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2016 Monitoring Events

CONFLUENCE

Photo Point 1—2014
Description: Upstream end of project looking downstream. **Compass:** 0 (North)

Photo Point 1—2016
Description: Upstream end of project looking downstream. **Compass:** 0 (North)

Photo Point 2—2014
Description: Above culvert outlet, looking downstream.
Compass: 0 (North)

Photo Point 2—2016
Description: Above culvert outlet, looking downstream.
Compass: 0 (North)

Photo Point 3.1—2014
Description: First bend in channel, looking upstream.
Compass: 180 (South)

Photo Point 3.1—2016
Description: First bend in channel, looking upstream.
Compass: 180 (South)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2016 Monitoring Event

Photo Point 3.2—2014
Description: Looking across channel at inside bend.
Compass: 225 (Southwest)

Photo Point 3.2—2016
Description: Looking across channel at inside bend.
Compass: 225 (Southwest)

Photo Point 3.3—2014
Description: Looking downstream at left stream-bank.

Photo Point 3.3—2016
Description: Looking downstream at left stream-bank.

Photo Point 3.4—2014
Description: Looking downstream at right streambank.
Compass: 270 (West)

Photo Point 3.4—2016
Description: Looking downstream at right streambank.
Compass: 270 (West)

PHOTO INFORMATION

PROJECT NAME: Little Rock Creek at Judith Slide Repair

DATE: 2014-2016 Monitoring Event

CONFLUENCE

Photo Point 4.1—2014
Description: Looking upstream.
Compass: 90 (South)

Photo Point 4.1—2016
Description: Looking upstream.
Compass: 90 (South)

Photo Point 4.2—2014
Description: Looking upstream at right streambank.
Compass: 135 (Southeast)

Photo Point 4.2—2016
Description: Looking upstream at right streambank.
Compass: 135 (Southeast)

Photo Point 4.3—2014
Description: Looking downstream.
Compass: 90 (East)

Photo Point 4.3—2016
Description: Looking downstream.
Compass: 90 (East)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2016 Monitoring Event

CONFLUENCE

Photo Point 4.4 — 2014
Description: **Looking downstream at left stream-bank**

Photo Point 4.4 — 2016
Description: **Looking downstream at left stream-bank**

Photo Point 5.1—2014
Description: Downstream end of project, looking up-stream. **Compass:** 180 (South)

Photo Point 5.1—2016
Description: Downstream end of project, looking up-stream. **Compass:** 180 (South)

Photo Point 5.2—2014
Description: Downstream end of project, looking at cattle crossing. **Compass:** 225 (Southwest)

Photo Point 5.2—2016
Description: Downstream end of project, looking at cattle crossing. **Compass:** 225 (Southwest)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2016 Monitoring Event

CONFLUENCE

Photo Point 5.3—2014
Description: Downstream end of project looking downstream. **Compass:** 270 (West)

Photo Point 5.3—2016
Description: Downstream end of project looking downstream. **Compass:** 270 (West)

Additional Photo 1
Description: **View looking upstream of reconstructed channel immediately upstream of culvert.**

Additional Photo 2
Description: **Coir fabric stretching over short segment of eroding bank.**

Additional Photo 3
Description: **Gully formed east of new channel alignment has become better vegetated**

Additional Photo 4
Description: **Barbed wire fence on northeast corner of project reach**

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2016 Monitoring Event

CONFLUENCE

Additional Photo 5
Description: Unvegetated upper soil lift
Taken in 2016 @ STA 11+00

Additional Photo 6
Description: Unvegetated upper soil lift
Taken in 2015 looking downstream @ STA 11+00

Additional Photo 7
Power / phone line separated from support pole spanning project reach

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

PHOTO POINT 1 LOOKING DOWNSTREAM NORTH

PHOTO POINT 2 LOOKING DOWNSTREAM NORTH

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

PHOTO POINT 3 LOOKING UPSTREAM SOUTH

PHOTO POINT 3 LOOKING DOWNSTREAM NORTH

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

PHOTO POINT 4 LOOKING UPSTREAM SOUTHEAST

PHOTO POINT 4 LOOKING DOWNSTREAM EAST

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

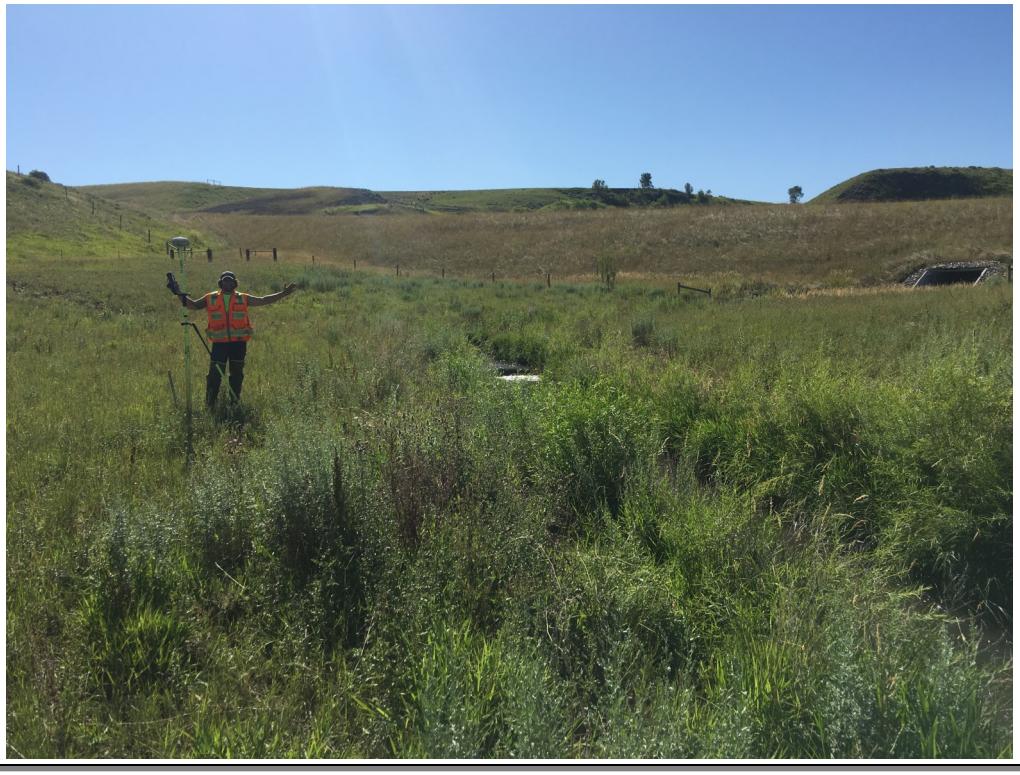
PHOTO POINT 5 LOOKING UPSTREAM SOUTH

PHOTO POINT 5 LOOKING DOWNSTREAM NORTHWEST

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

RIPARIAN TRANSECT 2 WEST T4 LT LOOKING DOWNSTREAM EAST



RIPARIAN TRANSECT 2 WEST FENCE POST LOOKING UPSTREAM SOUTH

RIPARIAN TRANSECT 1 EAST T4 RT LOOKING UPSTREAM SOUTH

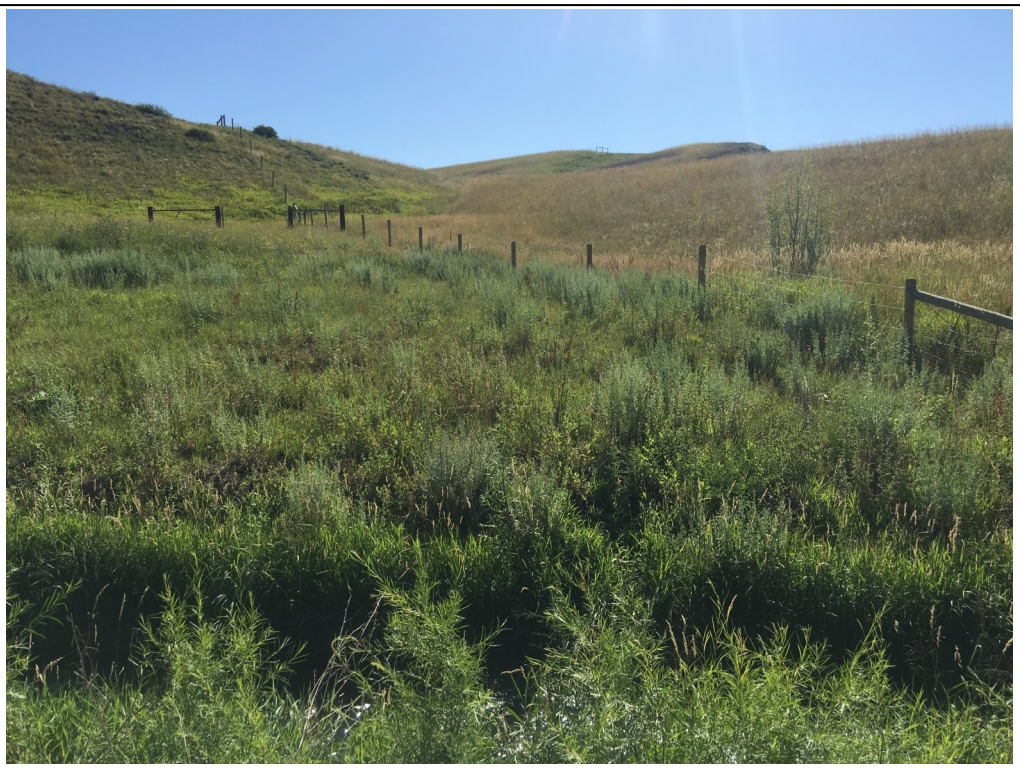
RIPARIAN TRANSECT 1 EAST FENCE POST LOOKING DOWNSTREAM

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T1 LT: LOOKING UPSTREAM SOUTH

T1 LT: LOOKING DOWNSTREAM NORTH



T1 LT: LOOKING EAST TO T1 RT:

T1 RT: LOOKING WEST TO T1 LT:

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T1: LOOKING UPSTREAM SOUTH FROM MIDDLE OF CREEK

T1: LOOKING DOWNSTREAM NORTH FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T1 RT: LOOKING UPSTREAM SOUTHWEST

T1 RT: LOOKING DOWNSTREAM NORTH

T2 LT: LOOKING UPSTREAM SOUTH

T2 LT: LOOKING DOWNSTREAM WEST

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T2 LT: LOOKING EAST TO T2 RT

T2 RT: LOOKING WEST TO T2 LT

T2: LOOKING UPSTREAM SOUTH FROM MIDDLE OF CREEK

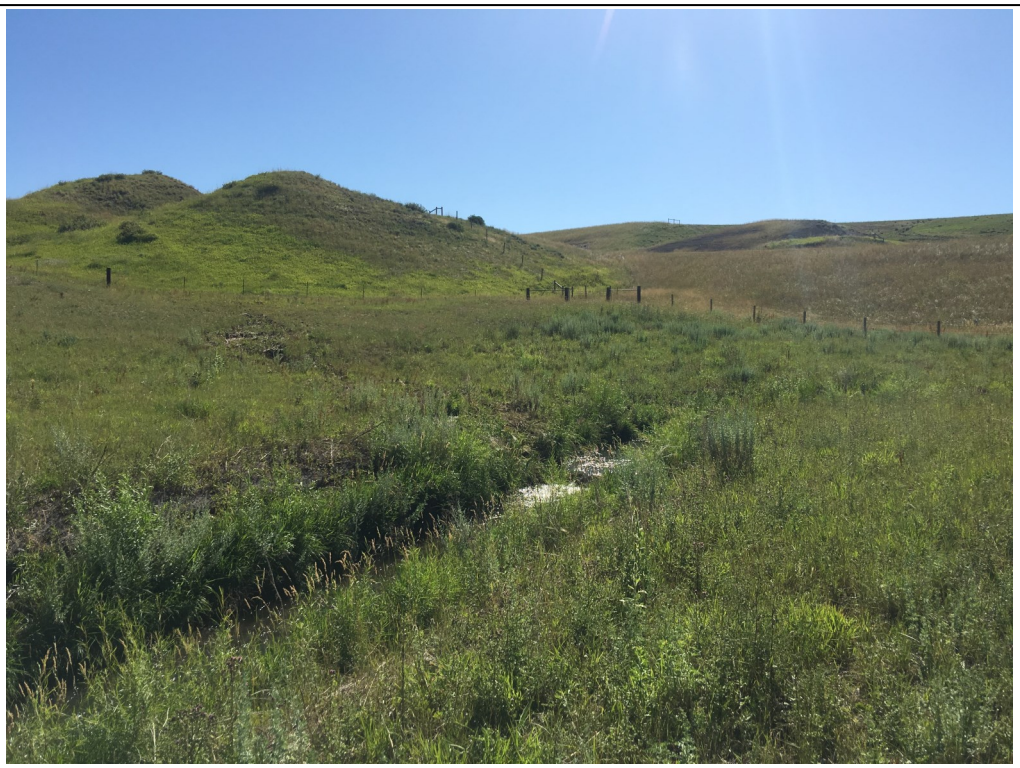
T2: LOOKING DOWNSTREAM NORTHWEST FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T2 RT: LOOKING UPSTREAM SOUTHWEST

T2 RT: LOOKING DOWNSTREAM NORTHWEST



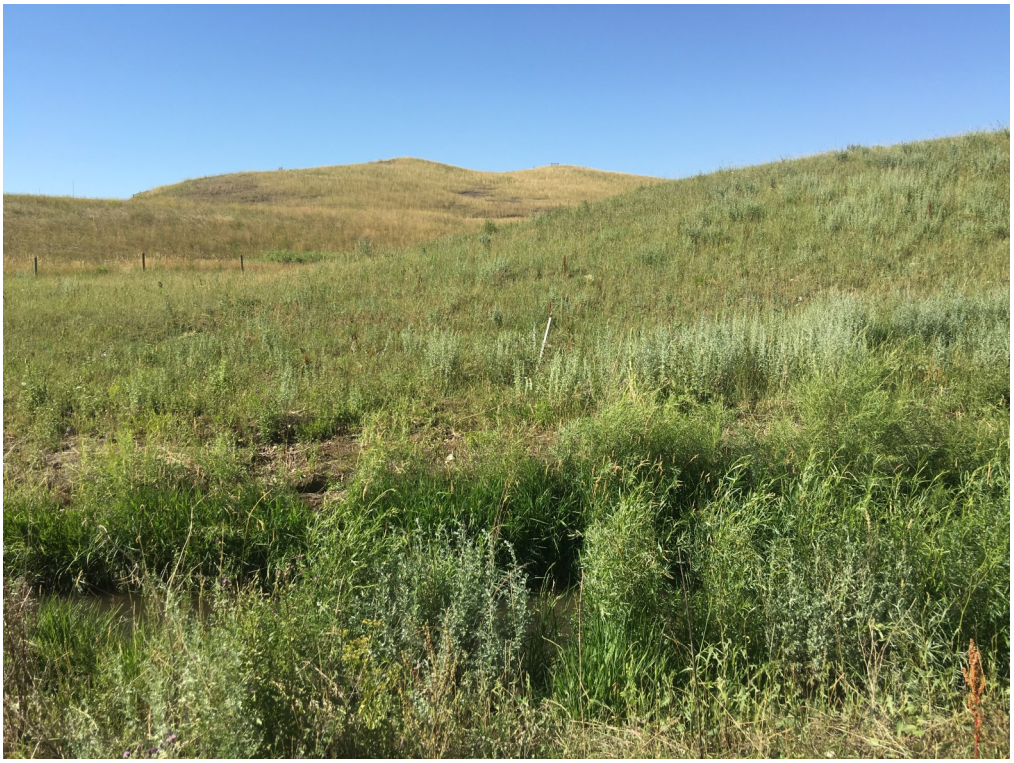
T3 LT: LOOKING UPSTREAM SOUTHEAST

T3 LT: LOOKING DOWNSTREAM NORTH

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T3 LT: LOOKING EAST TO T3 RT



T3 RT: LOOKING WEST TO T3 LT

T3: LOOKING UPSTREAM SOUTHEAST FROM MIDDLE OF CREEK

T3: LOOKING DOWNSTREAM NORTHWEST FROM MIDDLE OF CREEK

T3 RT: LOOKING UPSTREAM SOUTH

T3 RT: LOOKING DOWNSTREAM WEST

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T4 LT: LOOKING UPSTREAM SOUTHEAST

T4 LT: LOOKING DOWNSTREAM EAST

T4 LT: LOOKING EAST TO T4 RT

T4 RT: LOOKING WEST TO T4 LT

T4: LOOKING UPSTREAM SOUTHEAST FROM MIDDLE OF CREEK

T4: LOOKING DOWNSTREAM NORTHEAST FROM MIDDLE OF CREEK

PROJECT NAME: 2016 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-19-16

T4 RT: LOOKING UPSTREAM SOUTH

T4 RT: LOOKING DOWNSTREAM EAST

Appendix D

As-Built Topographic Survey (surveyed in 2014)

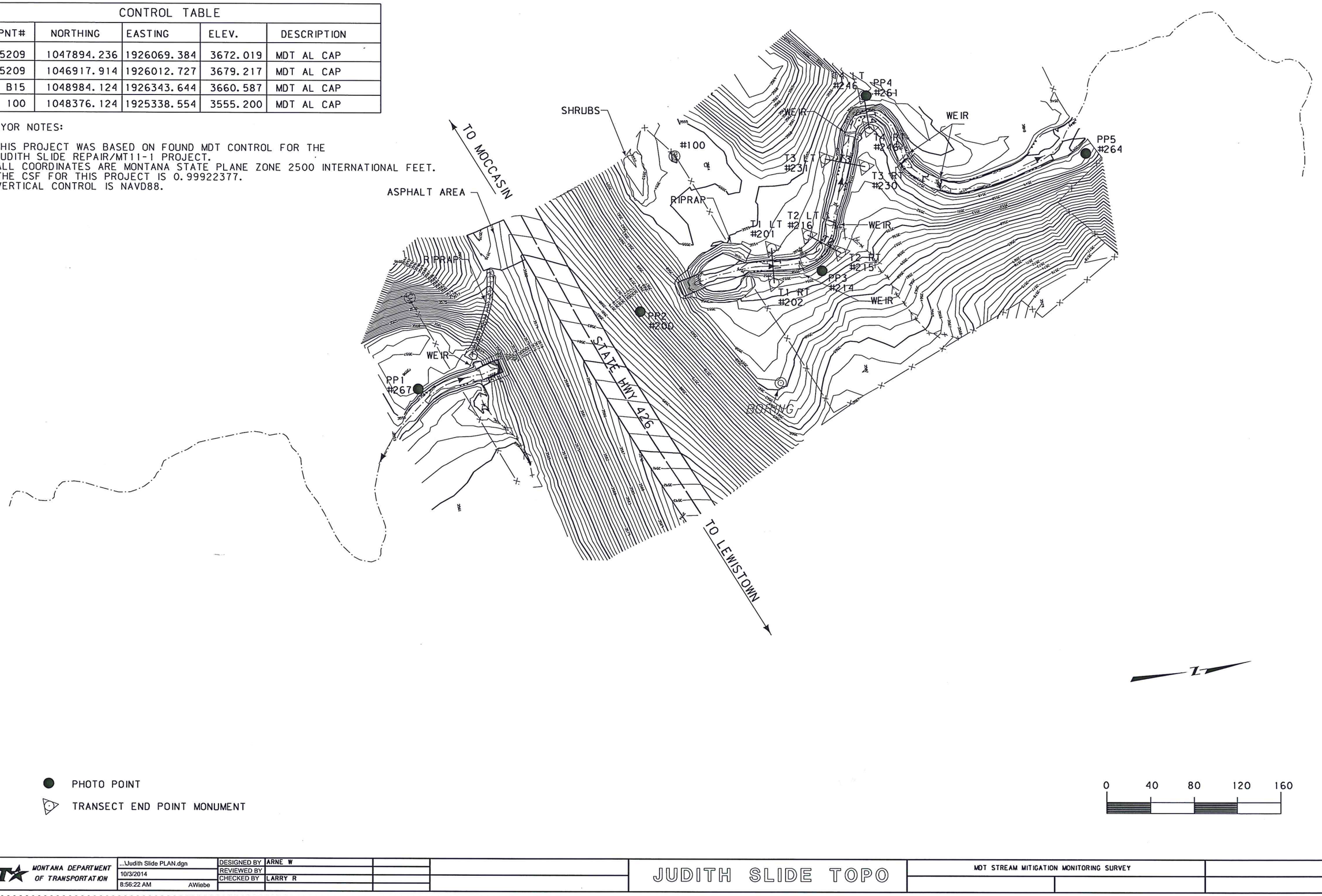
MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

CONTROL TABLE				
PNT#	NORTHING	EASTING	ELEV.	DESCRIPTION
A5209	1047894.236	1926069.384	3672.019	MDT AL CAP
B5209	1046917.914	1926012.727	3679.217	MDT AL CAP
B15	1048984.124	1926343.644	3660.587	MDT AL CAP
100	1048376.124	1925338.554	3555.200	MDT AL CAP

SURVEYOR NOTES:

1. THIS PROJECT WAS BASED ON FOUND MDT CONTROL FOR THE JUDITH SLIDE REPAIR/MT11-1 PROJECT.
   ALL COORDINATES ARE MONTANA STATE PLANE ZONE 2500 INTERNATIONAL FEET.
   THE CSF FOR THIS PROJECT IS 0.99922377.
   VERTICAL CONTROL IS NAVD88.

STAHLY ENGINEERING & ASSOCIATES
STAHLY
CIVIL ENGINEERS
STAHLY BUILDING
BILLINGS, MONTANA



● PHOTO POINT

TRANSECT END POINT MONUMENT

0 40 80 120 160

3	MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\Judith Slide PLAN.dgn	DESIGNED BY	ARNE W		JUDITH SLIDE TOPO	MDT STREAM MITIGATION MONITORING SURVEY
2		10/3/2014	REVIEWED BY				
1		8:56:22 AM AWiebe	CHECKED BY	LARRY R			