Therriault Riparian Revegetation 2008 Monitoring Report

Task Order #0803

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Introduction

This report describes monitoring of the first phase of the Therriault Creek riparian revegetation project implemented in October and November 2007. Monitoring was completed on July 17, 2008. Details on the project background, project site and revegetation strategies and treatments can be found in two separate documents, *Therriault Creek Riparian Revegetation Plan* prepared for Kootenai River Network (Geum Environmental Consulting, Inc. 2007a) and *Therriault Creek Implementation Report* prepared for Montana Fish, Wildlife and Parks (Geum Environmental Consulting Inc. 2007b). Three types of monitoring are necessary to establish the integrated monitoring and adaptive management program. These include: baseline, as-built, and effectiveness monitoring. ***Baseline monitoring*** documents the pre-restoration condition and is described in the revegetation plan prepared for the project. ***As-built monitoring*** documents the restoration project as completed and is documented in the as-built report prepared for the project (Geum Environmental Consulting, Inc. 2007b). ***Effectiveness monitoring*** addresses whether project objectives are being met, determines maintenance needs, and provides inputs into decision pathways for adaptive management. This is the focus of this monitoring report.

This report describes the methods and results of monitoring the first phase of a multi-year riparian revegetation effort at the site. As described in the reports mentioned above, to successfully convert the riparian vegetation along Therriault Creek within the project reach to native shrubs and trees will require a multi-year phased approach. The intention of the initial phase, implemented in Fall 2007, was to implement a range of treatments based on a detailed evaluation of existing site conditions and ecological processes driving vegetation succession at the site. Monitoring the effectiveness of these treatments will provide a basis for determining which treatments are most successful and appropriate for achieving project goals and implementing in the next phase of revegetation. This report explains the results of 2008 effectiveness monitoring and provides recommendations for (1) project maintenance and (2) treatments that should be implemented during the 2009 project phase (Phase II).

Effectiveness monitoring data were collected for all revegetation treatments implemented in 2007. Monitoring methods, results and discussion are reported for each treatment in the following sections. The following riparian revegetation treatments were implemented during the initial revegetation phase within the project reach.

- Residual shrub protection
- Containerized planting
- Solarization
- Vegetated soil lifts
- Live willow fascines
- Woody debris jams
- Coir log fascines
- Herbicide application targeting reed canarygrass and Canada thistle

Table 1 provides a brief description of each treatment, the purpose of the treatment and the quantity installed. Figure 1 shows the as-built documentation for the treatments. These data provide the baseline for project effectiveness monitoring.

Table 1. Overview of riparian revegetation treatments implemented in the first phase (2007) of riparian revegetation efforts along Therriault Creek..

Treatment	Treatment Description	Treatment Purpose	Quantity Installed	Photograph
Residual Shrub Protection	Woody vegetation establishment technique consisting of placing four foot tall rigid plastic mesh browse protectors and three foot by three foot brush blankets around surviving shrubs and trees planted during channel construction (2005).	Protect previously installed plant material from browse and reduce competition from aggressive pasture grasses.	250	
Containerized Planting	Woody vegetation establishment through the installation of one and two gallon native shrubs and trees in select areas along the channel. Treatment includes placing four foot tall rigid plastic mesh browse protectors, three foot by three foot brush blankets and eight inch rigid plastic vole protectors around each plant.	Establish native trees and shrubs along channel to provide stability and habitat, and create long term seed sources.	1,028	
Solarization	Weed control technique consisting of installing woven black fabric in target areas to heat kill live plants and seed. May be temporary (non-planted) or long term (planted with native woody vegetation).	Reduce the cover of aggressive pasture grasses and weeds such as reed canarygrass and create conditions to allow establishment of native trees and shrubs in areas otherwise dominated by undesirable species.	8,120 square feet (4,920 square feet temporary and 3,200 square feet long-term, planted)	
Vegetated Soil Lift	Streambank stabilization and woody vegetation establishment technique that incorporates layers of coir fabric, soil, and dormant willow cuttings.	Provide stability on high stress or high risk outer meander bends to encourage the establishment of native woody vegetation that will in turn provide long term natural channel stability.	120 feet	

Treatment	Treatment Description	Treatment Purpose	Quantity Installed	Photograph
Live Willow Fascines	Woody vegetation establishment technique using willow cuttings tied together to form a linear bundle and installed in depositional areas along the channel.	Establish native woody vegetation on depositional areas where willows and cottonwoods would naturally recruit, provide roughness to capture floating seed, debris, and fine sediments.	800 feet	
Woody Debris Jams	Instream and floodplain habitat enhancement technique using whole trees, logs and other organic large woody debris to create interlocking debris jams in the channel and extending onto adjacent floodplain surfaces.	Enhance habitat, provide roughness features to trap floating organic material and seed and encourage over-bank flooding, retention of flood waters in adjacent floodplains and deposition of fine sediments, creating microsites for woody vegetation to establish.	5 structures	
Coir Logs	Streambank woody vegetation establishment technique consisting of high density coir logs (twelve inch by ten foot coconut fiber bales) and dormant willow cuttings placed between the coir logs and pasture grass sod at the land water interface.	Provide a stable point at the land water interface and beneath the pasture grass sod to create conditions for willows to establish. Coir biodegrades over 5-7 years allowing willow roots to provide natural long-term channel stability.	400 feet	
Herbicide Application	Application of herbicide to reduce cover of noxious weeds or other undesirable species.	Reduce cover of noxious weeds or other aggressive species such as Canada thistle and reed canarygrass to reduce competition with desired grasses, forbs and planted shrubs and trees.	Infestations along approximately 4,000 feet of channel were treated	

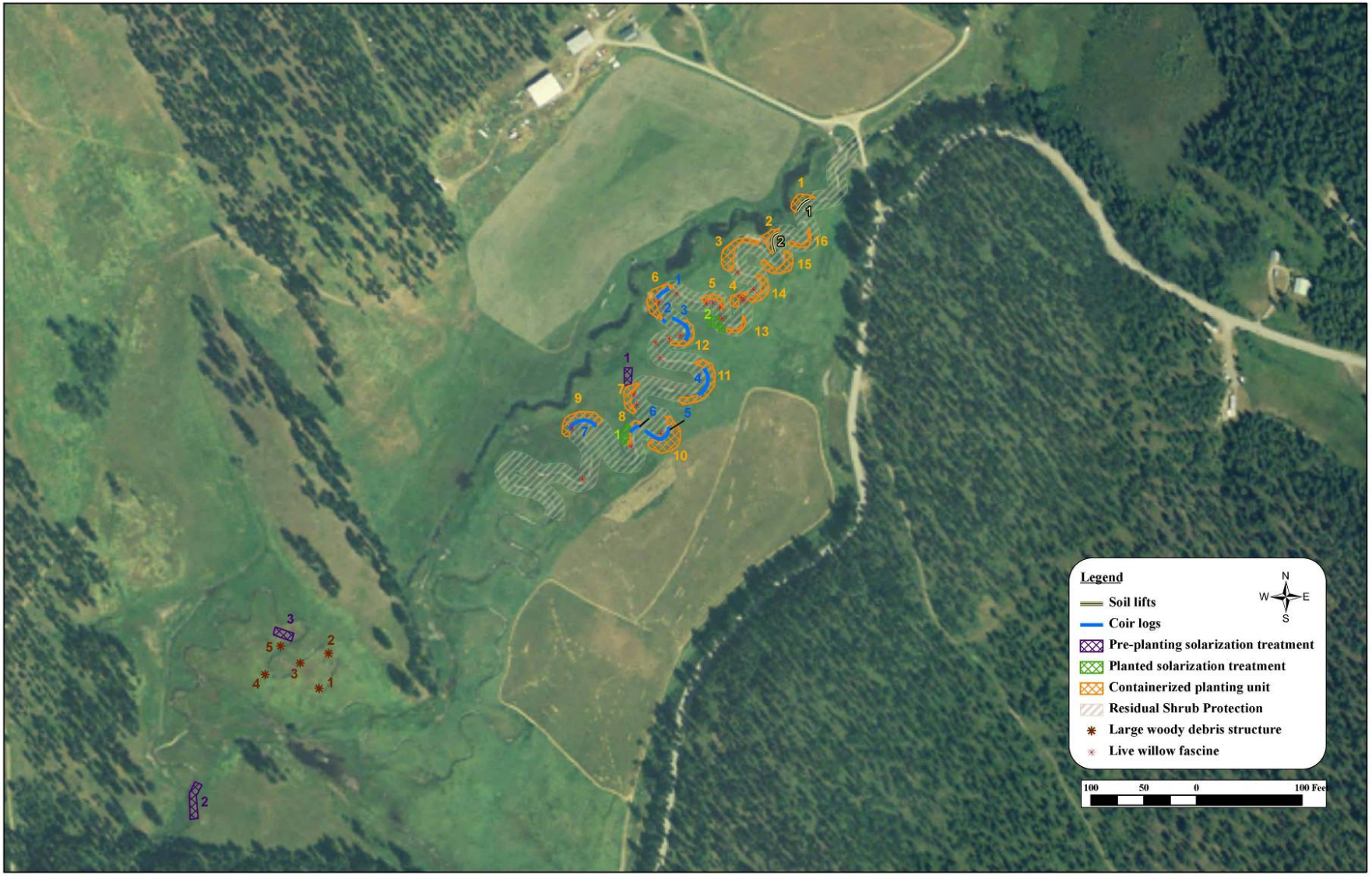

Figure 1. Locations of riparian revegetation treatments implemented in 2007 along Therriault Creek.

2008 Effectiveness Monitoring

Monitoring Methods

Residual Shrub Protection

To evaluate effectiveness of protecting shrubs planted during initial channel construction (residual shrubs) from browse and weed competition, two residual shrub effectiveness monitoring plots were established within the project reach (Figure 2). Plot locations were determined based on areas with concentrations of surviving shrubs that included both treated and untreated plants. Plots were marked at the upstream and downstream ends with wooden stakes and flagging. Within each plot, the number of residual plants was recorded. For each plant, the presence or absence of browse protection and presence or absence of browse on current year growth was recorded. Data were collected on paper field forms and entered into an Excel spreadsheet for comparison. Photographs comparing protected and unprotected residual plants were taken at each plot.

Containerized Planting

To evaluate effectiveness of containerized plantings installed in 2007, seven of the sixteen planting units were monitored for containerized plant survival (Figure 2). Plant survival was recorded by species for each planting unit. For each planting unit, a list of weedy species and dominant herbaceous species present was also recorded. Data were collected on paper field forms and entered into an Excel spreadsheet for analysis. A photograph point was established for each survival monitoring plot.

Solarization

To evaluate effectiveness of solarization treatments installed in 2007, both long-term, planted solarization plots were monitored for containerized plant survival (Figure 2). Plant survival was recorded by species for all installed plants. The height and caliper diameter was also recorded for each live plant. These data were used to calculate a relative growth metric (height multiplied by πr^2) for individual plants. This growth metric represents an overestimate of volume, but allows for simple linear comparisons of relative plant growth. Data were collected on paper field forms and entered into Excel spreadsheets for analysis. Photographs were taken at each planted solarization plot.

No effectiveness monitoring was completed for temporary solarization plots. Because these plots target reed canarygrass, a particularly aggressive species that forms dense root mats, this treatment is not likely to be effective until it has been in place for at least two growing seasons. These plots will be monitored for effectiveness in 2009.

Vegetated Soil Lifts

To evaluate effectiveness of vegetated soil lifts installed in 2007, both vegetated soil lifts were monitored (Figure 2). The following data were collected for each soil lift: willow survival, percent cover of willows, percent cover of native species, percent cover of weedy species, percent degradation of coir fabric and rips or tears observed in coir fabric. Data for each metric were recorded in five foot increments starting from the upstream end

of the soil lift. Percent cover of willow was recorded for the front face of the soil lift. Percent cover of weeds and native herbaceous species was recorded extending from the front edge of the soil lift to three feet behind the edge of the soil lift. Percent of fabric degradation included an estimate of the percent of total exposed area of coir fabric with signs of substantial fraying or discoloration, indicating the fabric had begun to degrade. The number of rips or tears in the fabric was also recorded for each five-foot increment. Data were collected on paper field forms and entered into an Excel spreadsheet for analysis. Photographs were taken at each soil lift site.

Willow Fascines

To evaluate effectiveness of willow fascines installed in 2007, each willow fascine site was relocated and evaluated in 2008 (Figure 2). General observations and notes were recorded for each site. Observations of the following conditions were noted: amount and type of deposition that may have accumulated on or around buried fascines; amount of scour that occurred around willow fascines, potentially exposing buried stems; and estimation of percent of total willow stems surviving at each site. Notes were recorded on paper field forms and entered into an Excel spreadsheet for comparison. Photographs were taken at each fascine treatment site.

Large Woody Debris Structures

To evaluate effectiveness of large woody debris structures installed in 2007, all structures were monitored (Figure 2). The purpose of these structures is to provide roughness features to encourage over-bank flooding and retention of flood waters in adjacent floodplain and riparian areas. This flooding creates conditions where native riparian plant communities, including willows and sedges to establish. Therefore, to monitor the effectiveness of these structures, three transects were established perpendicular to the channel within the reach where structures were installed to evaluate shifts in plant community composition associated with the placement of large woody debris structures (Figure 2). Transects varied between 100 and 200 feet in length and were placed either immediately upstream of, or through a woody debris structure. The ends of each transect were marked with wooden stakes and flagging. The location of end stakes were recorded with a GPS for relocation during monitoring in subsequent years. Along each transect, the following data were collected in ten foot by five foot (50 ft^2) increments: percent cover of dominant species, water depth, and a photograph documenting existing conditions. Data were recorded on paper field forms and entered into an Excel spreadsheet for analysis.

When this treatment is monitored in the future, observations of additional variables should also be recorded for each woody debris structure. These include: fine sediment deposition in and around organic debris placed within the channel and colonization of these areas by woody and herbaceous vegetation. Due to high water at the time of 2008 effectiveness monitoring, we were unable to record these observations.

Coir Logs

To evaluate effectiveness of coir logs installed in 2007, five of the seven coir log fascine structures were monitored (Figure 2). The following variables were measured for each log (ten foot lengths) in each structure: total number of willow stems; number of live

willow stems; average total water depth (measured at three points on each log and extending from the water surface at the time of sampling to the channel bottom); average depth of the coir log (measured at three points on each log and extending from the top of the coir log to the channel bottom); average depth of undercut (measured at three points underneath each log and extending from the face of the coir log to the streambank); percent natural colonization (measured as percent of the coir log surface covered with naturally recruited vegetation); and percent fine sediment deposition (measured as percent of the coir log surface covered with fine sediment deposition). Data were collected on paper field forms and entered into an Excel spreadsheet for analysis. Photographs were taken at each monitored coir log fascine site.

Herbicide Application

Herbicide applications targeting reed canarygrass and Canada thistle were completed on July 19 and September 29 and 30 2008. Effectiveness monitoring of these applications, including mapping remaining infestations and comparing with baseline mapping (see Geum 2007a), should be completed in early summer 2009. This information will be used to determine if and where additional applications are needed. General observations of herbicide application effectiveness were made in August and October 2008 and are described in the 'Monitoring Discussion' section of this report.

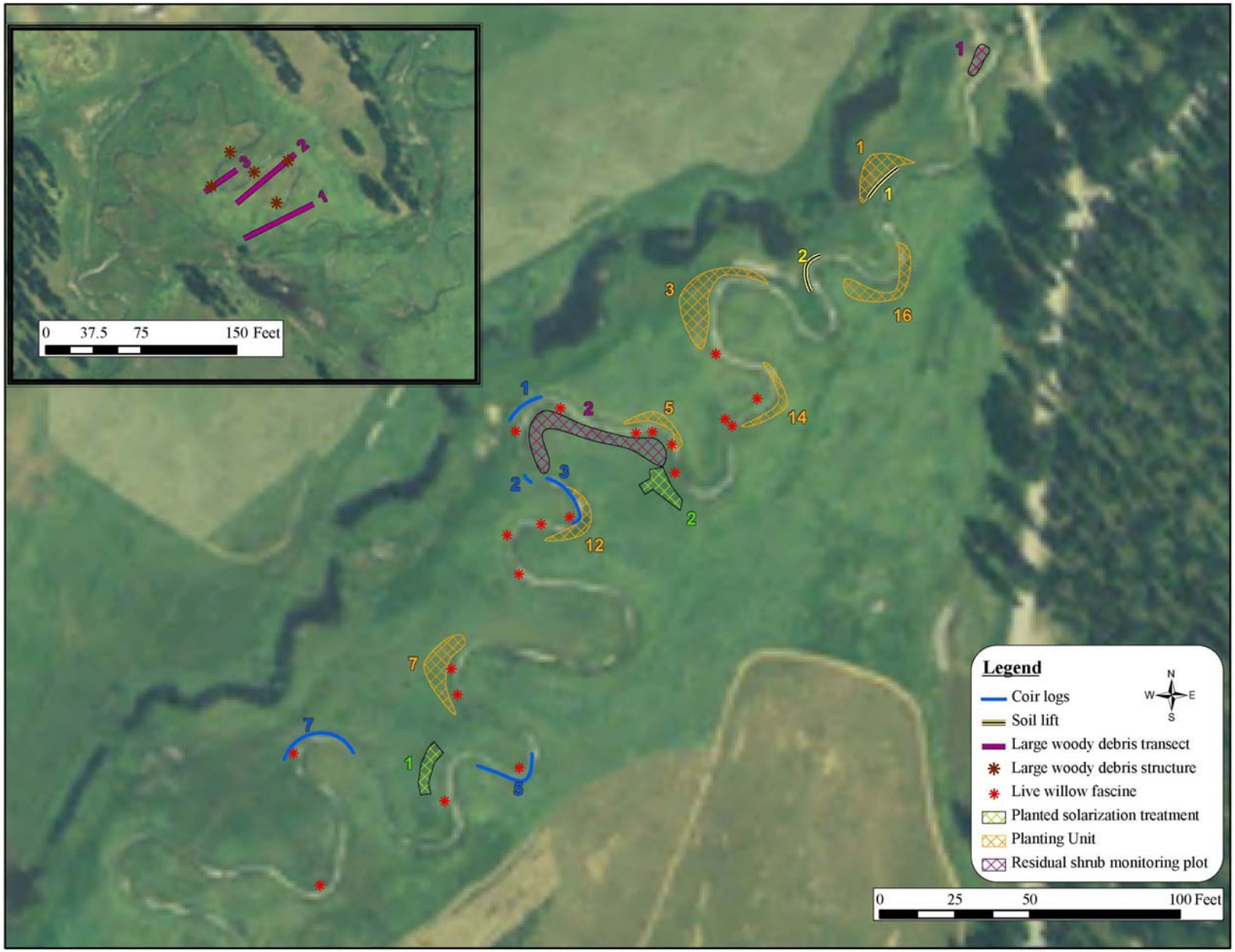

Figure 2. Locations of effectiveness monitoring completed in 2008 for riparian revegetation treatments implemented along Therriault Creek in 2007.

Monitoring Results

Residual Shrub Protection

Figure 3 shows the results of residual shrub protection effectiveness monitoring for the two monitoring plots (RS1, RS2). Figure 4 compares the height difference between protected and unprotected red-osier dogwood shrubs. No browse was observed on current year growth of protected residual shrubs within plots RS1 and RS2. Browse was observed on a total of 67% of residual shrubs left unprotected within plots RS1 and RS2.

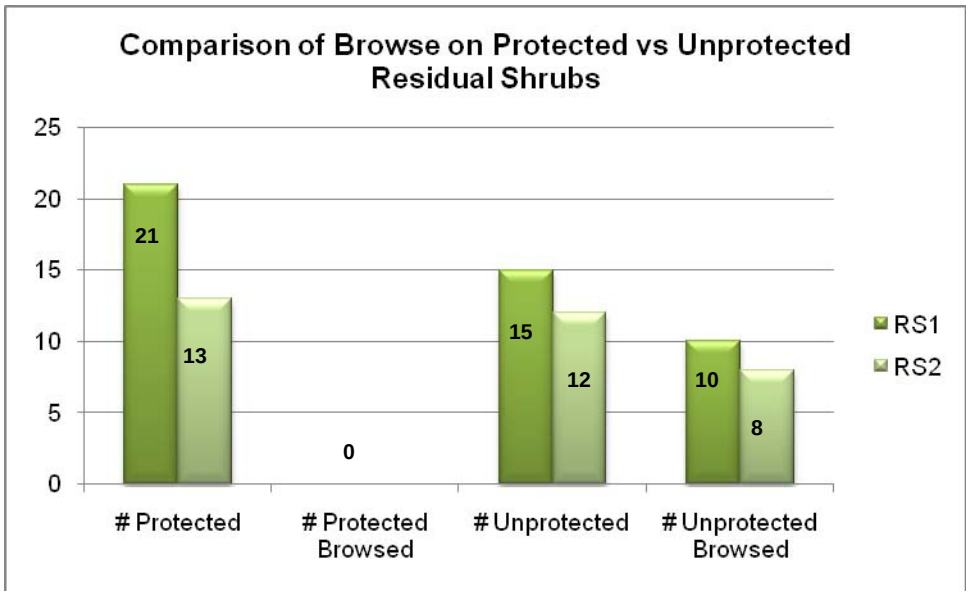

Figure 3. Results of residual shrub protection effectiveness monitoring showing total number of residual protected and unprotected shrubs monitored in each plot and the number of shrubs with observed browse.

Figure 4. Comparison of residual shrub with browse and weed protection measures (left) and without (right).

Containerized Planting

Results of containerized planting survival monitoring are shown in Tables 2 and 3. Table 2 summarizes total survival for each monitored planting unit. Table 3 summarizes percent survival by species for all monitored planting units. Appendix A provides a breakdown of these results by monitored planting unit. Table 4 provides a list of common herbaceous species found within monitored planting units.

Four hundred and fourteen plants were sampled, approximately forty percent of the total installed. All species, with the exception of Englemann spruce (*Picea engelmannii*) (18% survival), had 90 to 100 percent survival after the first growing season. Existing, aggressive pasture grasses were still common in planting units, but the three foot by three foot brush blankets installed around planted shrubs and trees appear to be limiting competition between planted species and the pasture grasses (Figure 5). There was no observed evidence of vole damage to any containerized plants installed in 2007.

Table 2. Total containerized plant survival by planting unit.

Planting Unit	Total Percent Survival
1	100
3	98
5	97
7	95
12	96
14	90
16	93

Table 3. Total percent survival by species, combined for planting units 1, 3, 5, 7, 12, 14, and 16.

Scientific Name	Common Name	Percent Survival
Alnus incana	Mountain alder	91
Amelanchier alnifolia	Western serviceberry	94
Betula occidentalis	Water birch	92
Cornus sericea	Red-osier dogwood	100
Crataegus douglasii	Black hawthorn	100
Picea engelmannii	Engelmann spruce	18
Populus balsamifera	Black cottonwood	100
Populus tremuloides	Quaking aspen	100
Prunus viginiana	Common chokecherry	95
Rosa woodsii	Wood's rose	91
Salix bebbiana	Bebb willow	100
Salix drummondiana	Drummond's willow	100
Salix exigua	Sandbar willow	100
Salix geyeriana	Geyer's willow	100
Salix spp	Willow species	100
Spiraea betulifolia	White spirea	100
Symphoricarpos occidentalis	Common snowberry	100

Table 4. List of common herbaceous plants found within monitored planting units.

Planting Unit	Scientific Name	Common Name
Planting Unit 1	*Bromus inermis***	Smooth brome
	*Poa pratensis***	Kentucky bluegrass
	*Phleum pratense***	Common timothy
	*Phalaris arundinacea**	Reed canarygrass
	*Cirsium arvense**	Canada thistle
	*Linaria vulgaris**	Yellow toadflax
Planting Unit 3	*Bromus inermis***	Smooth brome
	*Poa pratensis***	Kentucky bluegrass
	*Phleum pratense***	Common timothy
	Carex bebbii	Bebb's sedge
	Carex stipata	Sawbeak sedge
	*Cirsium arvense**	Canada thistle
Planting Unit 5	*Elymus repens***	Quackgrass
	Carex bebbii	Bebb's sedge
	Carex stipata	Sawbeak sedge
	*Poa pratensis***	Kentucky bluegrass
	*Cirsium arvense**	Canada thistle
Planting Unit 7	*Poa pratensis***	Kentucky bluegrass
	*Phleum pratense***	Common timothy
	*Elymus repens***	Quackgrass
	*Cirsium arvense**	Canada thistle
Planting Unit 12	*Elymus repens***	Quackgrass
	*Poa pratensis***	Kentucky bluegrass
	*Cirsium arvense**	Canada thistle
Planting Unit 14	*Bromus inermis***	Smooth brome
	*Poa pratensis***	Kentucky bluegrass
	*Phleum pratense***	Common timothy
	Carex bebbii	Bebb's sedge
	Carex species	sedge species
	*Cirsium arvense**	Canada thistle
Planting Unit 16	*Phalaris arundinacea**	Reed canarygrass
	*Bromus inermis***	Smooth brome
	*Elymus repens***	Quackgrass
	Carex bebbii	Bebb's sedge
	*Cirsium arvense**	Canada thistle

*Weedy or invasive species
**Non-native pasture grass

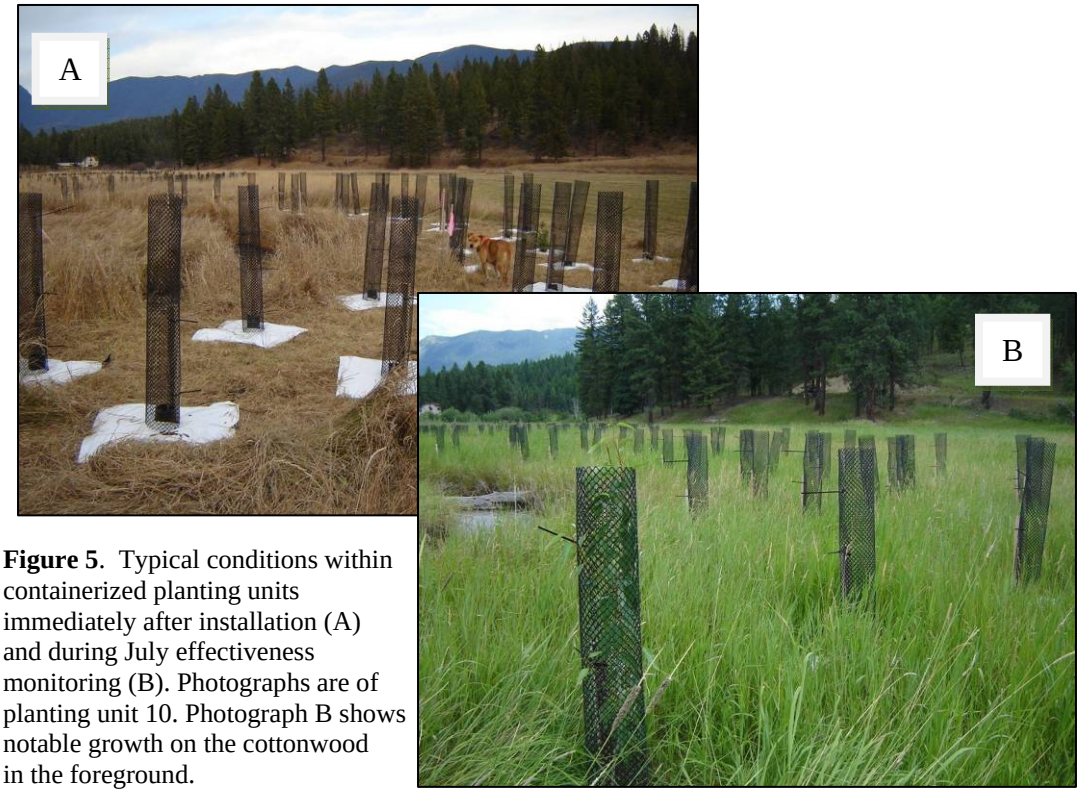

Figure 5. Typical conditions within containerized planting units immediately after installation (A) and during July effectiveness monitoring (B). Photographs are of planting unit 10. Photograph B shows notable growth on the cottonwood in the foreground.

Solarization

Table 5 shows the results of effectiveness monitoring conducted for the two planted solarization plots. This table provides the total growth metric and total percent survival by species. These data are combined for both planted solarization plots. Figure 6 shows the sum of the growth metric for each species. Figure 7 compares conditions in solarization planting plot 1 immediately after installation and during July 2008 effectiveness monitoring.

The majority of species had 100% survival with the exception of Englemann spruce (33%) and Mountain alder (*Alnus incana*) (80%) (Table 5). Total values for the growth metric varied widely by species. In general, quaking aspen (*Populus tremuloides*) and Drummond's willow (*Salix drummondiana*) showed the highest growth metric value with Wood's rose (*Rosa woodsii*) and Englemann spruce the lowest growth metric value.

Table 5. Percent survival and total growth metric for containerized stock installed within solarization plots.

Scientific Name	Common Name	Growth Metric	Percent Survival
Alnus incana	Mountain alder	3.29	80
Amelanchier alnifolia	Western serviceberry	25.91	100
Betula occidentalis	Water birch	20.39	100
Cornus sericea	Red-osier dogwood	15.10	100
Crataegus douglasii	Black hawthorn	36.67	100
Picea engelmannii	Engelmann spruce	0.79	33
Populus tremuloides	Quaking aspen	92.24	100
Rosa woodsii	Wood's rose	0.36	100
Salix drummondiana	Drummond's willow	70.76	100
Salix exigua	Sandbar willow	6.15	100
Salix spp	Willow species	1.28	100
Spiraea betulifolia	White spirea	0.69	100

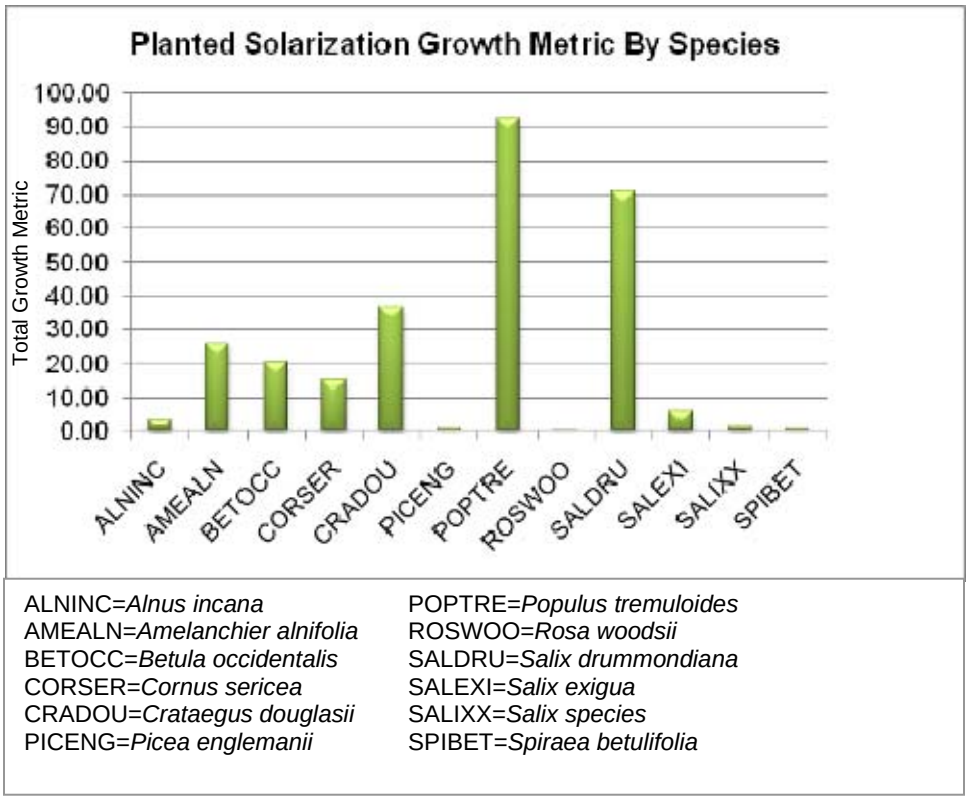

Figure 6. Comparison of growth metric values between species in planted solarization plots 1 and 2. Total represents the sum of growth metric values (height x πr^2) for each species.

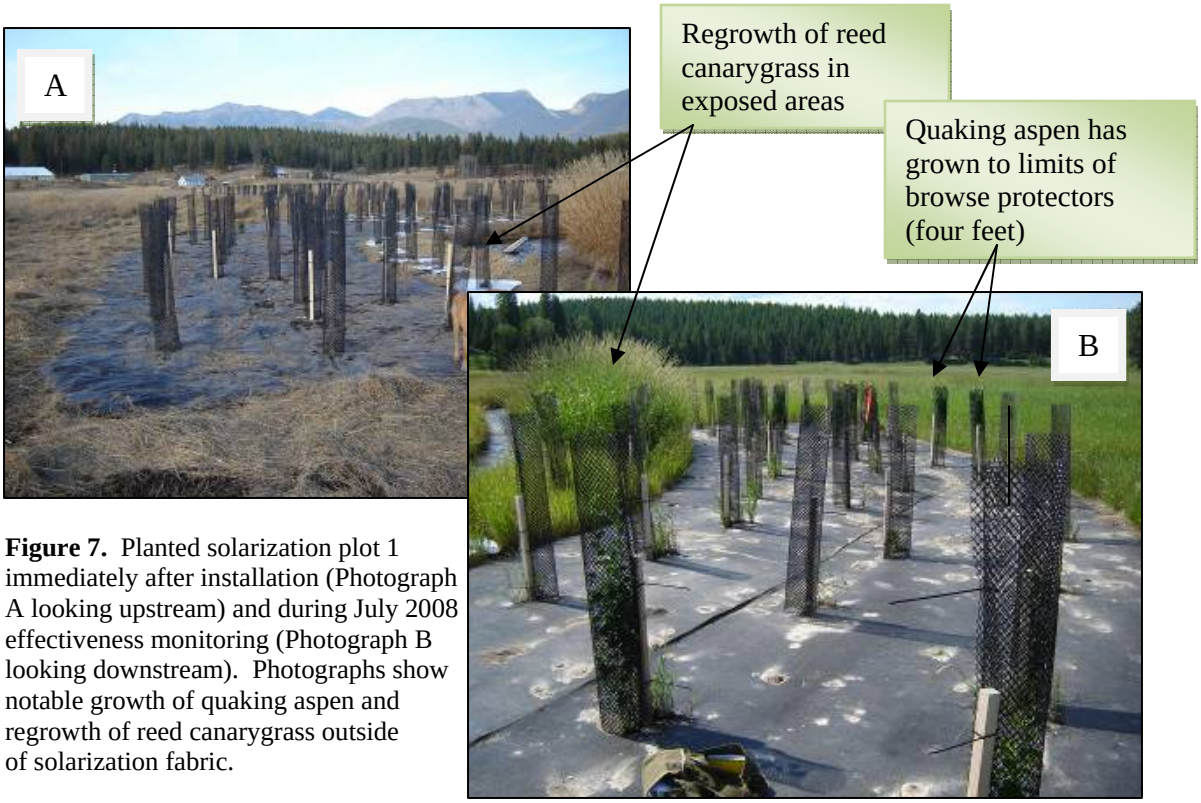

Figure 7. Planted solarization plot 1 immediately after installation (Photograph A looking upstream) and during July 2008 effectiveness monitoring (Photograph B looking downstream). Photographs show notable growth of quaking aspen and regrowth of reed canarygrass outside of solarization fabric.

Vegetated Soil Lifts

Results of vegetated soil lift monitoring are shown in Table 6. This table summarizes the average values of each monitored variable for each soil lift. Table A-2 in Appendix A provides the values of each metric by five foot increment. Figure 8 shows photographs of Soil Lift 1 immediately after construction and during July 2008 effectiveness monitoring. Figure 9 shows photographs of Soil Lift 2 immediately after construction and during July 2008 effectiveness monitoring.

Percent cover of willows ranges from one to 15 per five foot increment for both Soil Lifts 1 and 2. Willow stem survival was generally high on both soil lifts, with the exception of willows placed under Soil Lift 1. There were no rips in the fabric and fabric degradation was estimated to be 10 percent for both lifts. The percent cover of herbaceous species was much higher on Soil Lift 2. Herbaceous species consisted mainly of non-native pasture grasses such as smooth brome (*Bromus inermis*), quackgrass, and orchard grass (*Dactylis glomerata*). Weed coverage, mainly Canada thistle and reed canarygrass, was slightly higher on Soil Lift 1.

Table 6. Summary data collected during July 2008 monitoring of Soil Lifts 1 and 2. Data is the average of all five-foot increments monitored at each site.

Metric	Soil Lift 1 Above	Soil Lift 1 Below	Soil Lift 2 Above	Soil Lift 2 Below
Number rips/tears in fabric	0		0	
Percent cover willow	8.1	22.4	3.9	0
Percent cover herbaceous species	34.5		76	
Percent cover weedy species	4.4		3.9	
Percent biodegradation of fabric	10		10	
Percent survival of willow stems	94	54	76	89

Figure 8. Soil Lift 1 immediately after implementation (A) and during July 2008 effectiveness monitoring (B). Willow growth and survival was good on the upper half of the lift, but minimal on the lower half. This is likely due to the lower half being partially submerged during monitoring.

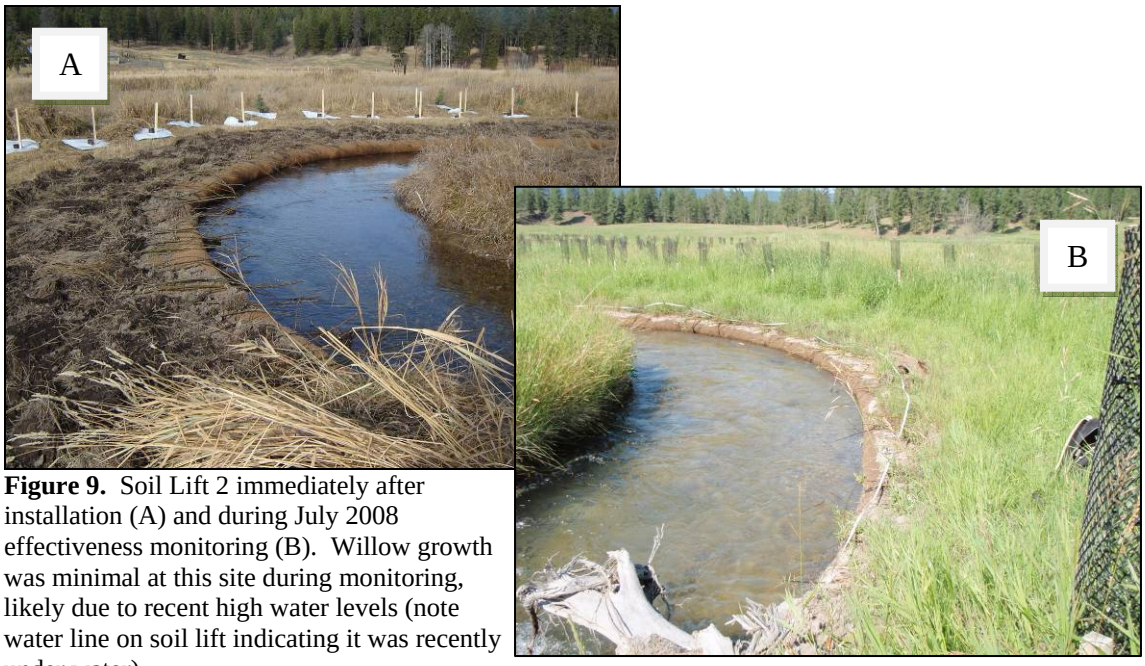

Figure 9. Soil Lift 2 immediately after installation (A) and during July 2008 effectiveness monitoring (B). Willow growth was minimal at this site during monitoring, likely due to recent high water levels (note water line on soil lift indicating it was recently under water).

Willow Fascines

Results of willow fascine monitoring are provided in Table A-4 in Appendix A. All but one site was found during July 2008 effectiveness monitoring. Figure 10 provides an example comparison of willow fascines immediately after installation and during July monitoring.

No scour occurred at any of the observed buried willow fascine sites. Fine sediment deposition was observed at almost all of the sites, either at the downstream end or throughout the entire site. Some of the willow fascines had trapped and retained organic matter or woody debris. Willow survival was generally high (between 75 and 100 percent), although many of the fascines were still under water and survival was not able to be determined at the time of monitoring.

Figure 10. Typical conditions of willow fascine sites immediately after installation (A) and during July 2008 effectiveness monitoring (B, C). Photographs B and C show examples of fine sediment deposition and willow growth on willow fascines.

Large Woody Debris Structures

The results of large woody debris structure monitoring transects are provided in Tables A-5 through A-7 in Appendix A. Figures 11 through 13 display the major transitions in plant communities observed along the three transects. All transects were dominated by non-native pasture grasses. Transects one and two had inclusions of wetter species such as sedges, mannagrass (*Glyceria* spp.) and spikerush (*Eleocharis* spp.).

Water depth along Transect 1 ranged from 0 to 6 inches. Water depth along transect 2 ranged from 0 to 6 inches. No standing water or saturated surfaces were present along transect 3.

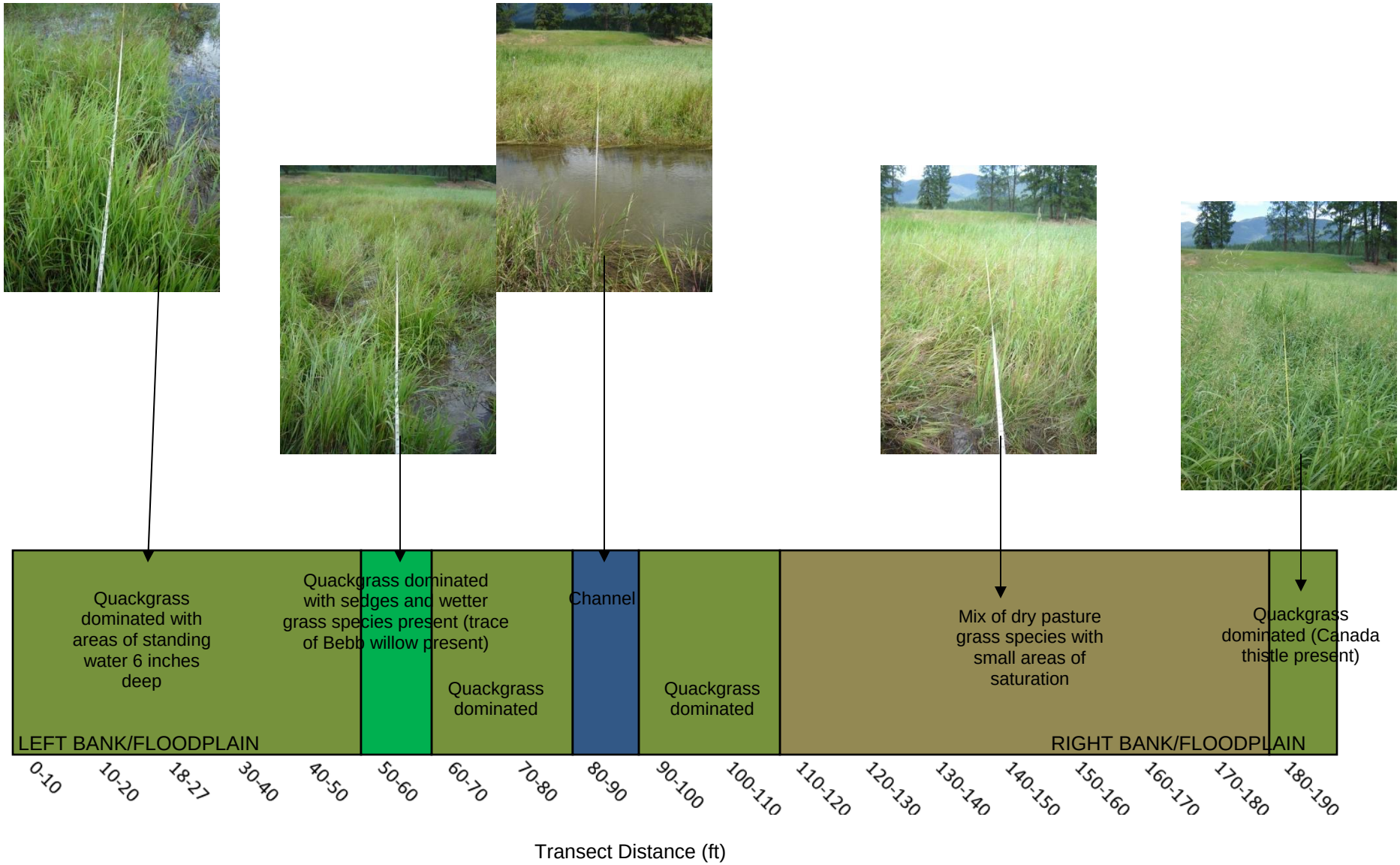

Figure 11. Display of Large Woody Debris Transect 1 showing major vegetation breaks recorded along the transect**.**

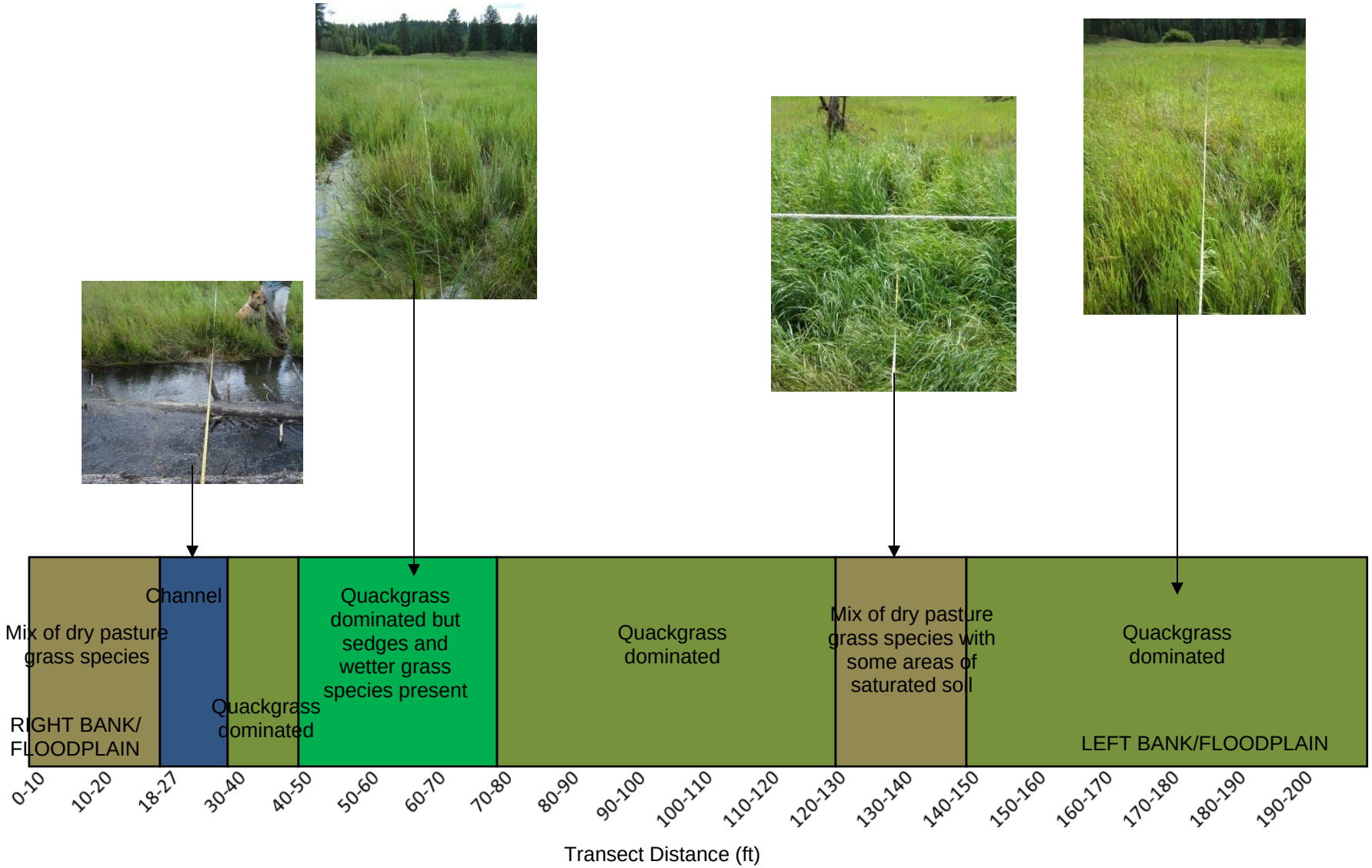

Figure 12. Display of Large Woody Debris Transect 2 showing major vegetation breaks along the transect**.**

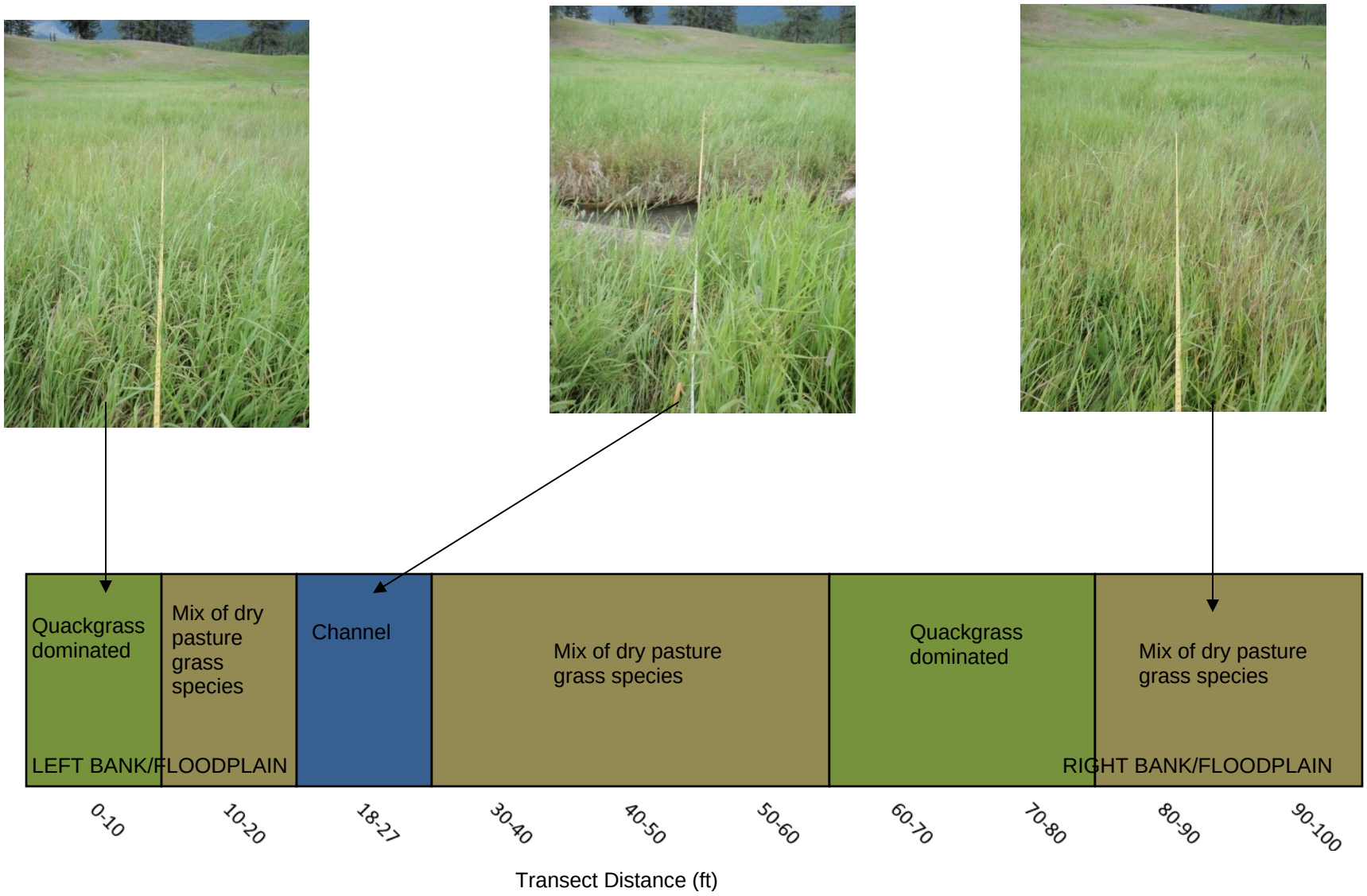

Figure 13. Display of Large Woody Debris Transect 3 showing major vegetation breaks along the transect**.**

Coir Logs

Results of coir log monitoring are provided in Table A-3 in Appendix A. Table 7 provides a summary of the results for all coir logs in each monitored structure. Figures 14 and 15 compare coir logs immediately after installation and during July 2008 monitoring.

Willow survival was generally high on all monitored coir log fascines. The average undercut below installed coir logs ranged from 0 to 6 inches with a combined average undercut of 3 inches. Fine sediment deposition and natural colonization was minimal on all monitored coir logs.

Table 7. Summary of coir log treatment effectiveness monitoring data collected July 2008.

Metric	CL1	CL2	CL3	CL5	CL7
Average percent willow cuttings alive	60	75	74	85	85
Average total water depth (inches)	16	13	10	11	10.7
Average coir log depth (inches)	16	17	11	17	15
Average undercut below coir log (inches)	2	4	2	4	2.8
Average percent cover natural colonization	0	0	0	0	0
Average percent of log with fine sediment deposition	40	10	53	NR	34

NR: data not recorded

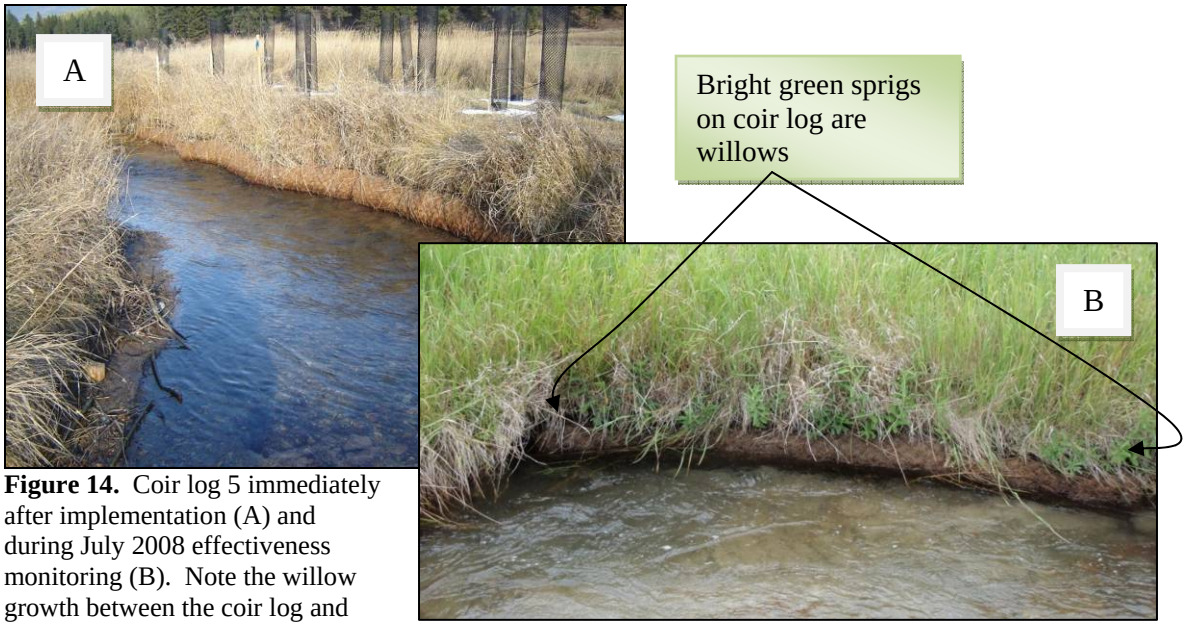

Figure 14. Coir log 5 immediately after implementation (A) and during July 2008 effectiveness monitoring (B). Note the willow growth between the coir log and existing pasture grass plant community in photograph B.

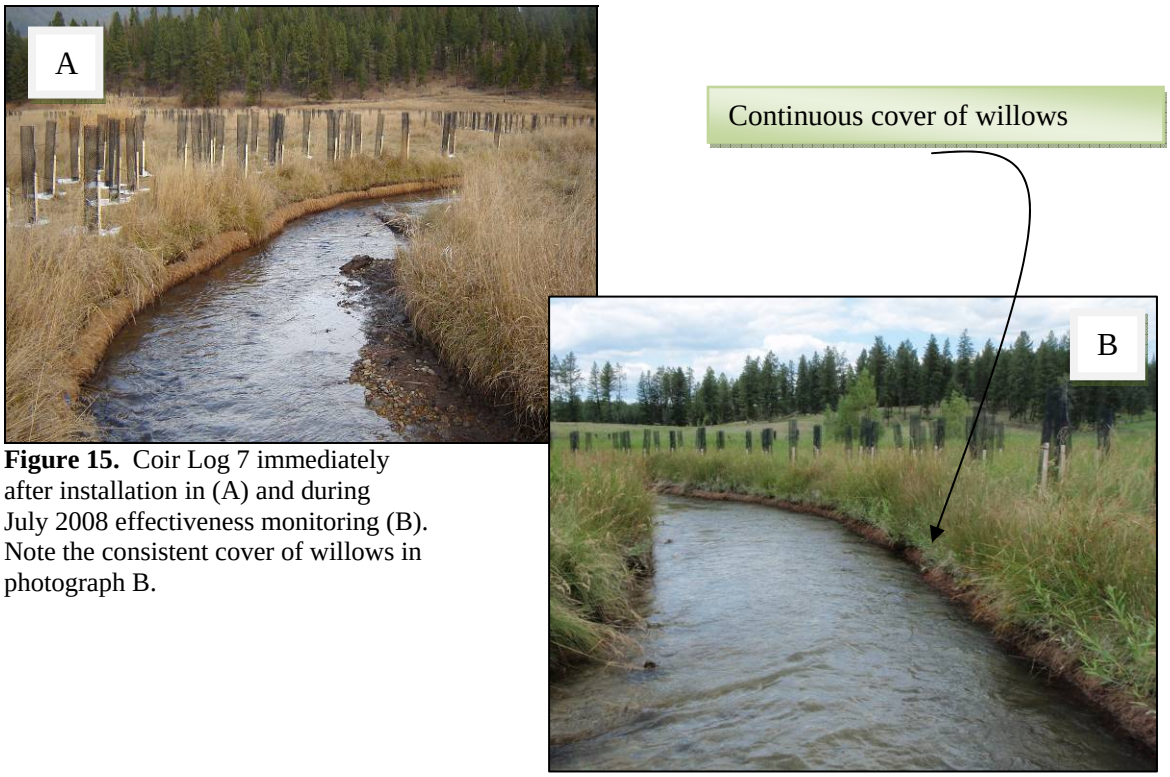

Figure 15. Coir Log 7 immediately after installation in (A) and during July 2008 effectiveness monitoring (B). Note the consistent cover of willows in photograph B.

Herbicide Application

Herbicide applications completed in July and September 2008 have not been monitored for effectiveness. General observations of herbicide application were made in August and October 2008. Figures 16 through 19 illustrate the effectiveness of herbicide applications targeting Canada thistle and reed canarygrass.

Figure 16. Photograph taken one week after July herbicide application of treated Canada thistle plant.

Figure 17. Photograph taken one week after July herbicide application of Canada thistle treated within a residual shrub protection area.

Figure 18. Photograph of reed canarygrass taken one week after July herbicide application. Applicators indicated the grass was not tall enough to be located in July and therefore not treated in the July application.

Figure 19. Photograph showing clump of reed canarygrass observed approximately 10 days after September herbicide application. Yellowing of grass indicates that herbicide was applied.

Monitoring Discussion

The purpose of this section is to summarize the key observations made about each riparian revegetation treatment that was monitored for effectiveness in July 2008. The purpose of monitoring is to determine the effectiveness of implemented treatments in terms of restoring or creating conditions to support a diverse mosaic of native riparian plant communities that can be driven and maintained by naturally occurring processes along Therriault Creek. Therefore, the discussion provided in this section is aimed at evaluating (1) how the implemented treatments are beginning to respond to site conditions and (2) whether treatments should be repeated in a second phase of revegetation or if further monitoring is warranted prior to implementing additional treatments.

Residual Shrub Protection

Based on the results of 2008 effectiveness monitoring, it appears that installing browse protectors on existing residual shrubs is an effective way to prevent the extensive browse that had been occurring on plants installed during initial channel construction. The following key observations about this treatment include:

- Residual shrubs surviving from initial revegetation efforts had been subject to severe levels of annual browse. Protected shrubs now generally exhibit high vigor. This indicates that extensive root systems, needed to support healthy vegetative growth, are in place. New growth of more than two or three feet observed on some protected shrubs indicates this treatment is effective and that plants are healthy (Figure 20).
- Brush blankets were not installed around residual shrubs that were greater than two feet tall because it was assumed that they were not necessary since the root systems likely already exceed the rooting depth of the pasture grass sod. This was confirmed by the amount of new growth observed on protected shrubs.
- Moderate to severe browse is still occurring on previously planted but unprotected shrubs and trees.
- Maintenance needs are minimal at this time; however, a variety of maintenance needs were identified for these treatments. These include: re-securing browse nets to posts, expanding the size of browse protectors for shrubs with significant growth or shrubs that are being browsed above the height of the browse protection net, and straightening browse protectors posts. Maintenance should be completed in late spring or early summer 2009.
- Protecting these plants is a relatively easy way to promote vegetative growth and ensure long-term survival of these plants. Installing browse protectors on the remaining residual shrubs will provide those shrubs the protection needed to grow above browse height and resist pressure from browse.

Figure 20. Previously planted sandbar willow fitted with browse protection and showing approximately two feet of new growth during the 2008 growing season (photograph was taken during July 2008 effectiveness monitoring).

Containerized Planting

The results of effectiveness monitoring showed a very high survival rate for containerized shrubs and trees planted in 2007. Because of the aggressive agricultural plant communities currently dominating the riparian area within the project reach, the containerized plants installed along the channel will set the stage for ecological community development at the site. As the trees and shrubs grow they will provide seed, microsites, organic matter for soil development, and shade for the in-stream and near-stream environment. The following key observations of this treatment include:

- Containerized plant survival was documented to be 90 percent or higher for all planted species except Englemann spruce. Based on observations of other sites along Therriault Creek, spruce is thought to be a late successional species for the site. Observations of adjacent drainages in the area further indicate that spruce may be an early successional species in some riparian areas. The poor spruce survival may be a result of transplant shock, inappropriate soil conditions, or lack of available microsite conditions, particularly shade. Spruce should not be included in the species mix in future plantings until the site conditions have shifted to a condition that would be more favorable for spruce establishment.
- There was no evidence that voles or other animals were girdling plant stems. Stem girdling was a primary cause of poor plant survival during initial revegetation efforts.
- Very few grasses or weeds are growing immediately adjacent to any plants where brush blankets were installed.
- Despite minimal maintenance irrigation in 2008, plant survival is very high. A prolonged run-off resulting in a high water table extending later in the season (i.e. flows were still relatively high during July effectiveness monitoring), cool temperatures and rainfall events likely resulted in adequate soil moisture at the site.

Further, many of the planted shrubs were grown in tall one-gallon containers which creates a longer root system. The combination of these factors may have resulted in a reduced need for supplemental irrigation in 2008. Conditions in 2009 may require supplemental irrigation.

- Some leaf damage was observed on containerized plants. Because the damage was primarily observed on terminal leaves it is likely the damage was due to late season frosts rather than lack of soil moisture.
- During July effectiveness monitoring, little to no browse of leaves or stems extending beyond the height of the browse protection net was observed. However, during subsequent visits to the site in August and October, plants had been browsed above the height of the browse protector net (Figure 21). This type of browse is not detrimental in the first years after planting and may even stimulate root system development in some species such as willows; however, careful observation of the extent of this browse will need to be made prior to removal of browse protection in later project phases.

Figure 21. Photograph showing browse of new growth extending above browse protection net in containerized planting unit.

Solarization

The results of effectiveness monitoring in planted solarization plots also showed very high survival of containerized plants. Planted solarization plots promote the development of native woody vegetation while limiting competition from weeds and aggressive pasture grasses, a major limiting factor in the project reach. Solarization fabric has been shown to effectively reduce weed and pasture grass cover while also reducing the seed bank of these non-desirable species. Further, containerized plants installed in areas of continuous fabric have shown accelerated growth in the first few years post planting (Geum Environmental Consulting, Inc. unpublished data). This is beneficial because it allows plants to grow to a larger size quicker reducing concerns about weed competition and browse. The following key observations of this treatment include:

- Quaking aspen and Drummond willow had the highest percent survival and highest total growth metric values in the solarization plots.
- Growth metric values varied considerably between planted species in solarization plots. This variation is in part a result of using different size container stock at the

time of planting. The 2008 growth metric data can be used as a baseline for determining growth response to the solarization treatment monitored in 2009 or later. This data can then be used to guide the selection of species for installation within planted solarization plots in other locations within the project reach.

- Solarization fabric is effectively controlling growth of weeds and aggressive pasture grasses, with the exception of areas immediately around containerized plants where holes were cut in the fabric to install plants (Figure 22).
- Maintenance needs for this treatment include: hand pulling weeds and grasses growing through the fabric at the base of containerized plants; supplemental irrigation twice a month in August and September (depending on site conditions); and expanding browse protectors on species that have grown out of the current browse protector size.
- Although the temporary solarization plots were not monitored in 2008, no maintenance needs were observed at these sites. The extent to which reed canarygrass and other grasses have been killed at these sites should begin to be monitored in 2009.

Figure 22. Photograph of planted solarization plot showing growth of grass species through holes cut to plant containerized plants.

Vegetated Soil Lifts

Based on the results of 2008 effectiveness monitoring, it appears that vegetated soil lifts have provided stable areas within the high stress land-water interface allowing the dormant willows used in this treatment to take root and sprout. The following key observations of this treatment include:

- Overall survival and growth of willow cuttings was less than desirable at both sites. If survival or growth decreases, supplementing each lift with additional willow cuttings should be considered. Another growing season should pass before re-evaluating the need to install more willow cuttings. If coverage does not increase or large gaps in coverage become evident, supplemental willow cuttings may be installed.
- Willow stem survival was slightly higher for cuttings installed above the soil lift compared with cuttings installed under the soil lift. The likely reason for this was

prolonged high water, which led to inundation of the bottom row of willows and a portion of the lift well into July. However, observations made after the water receded showed that many of these cuttings did survive (Figure 23).

- Herbaceous species coverage was very high at both sites; however, species consist mainly of non-native pasture grasses and may compete with establishing willow cuttings.
- Weedy species such as Canada thistle and reed canarygrass are present on both lifts but is higher on Soil Lift 1.
- No browse of new growth was observed during July effectiveness monitoring; however, in subsequent visits to the site, particularly October 2008, significant browse of new willow growth was observed. This type of browse is not likely to be detrimental to willow survival in the first two or three years and may actually stimulate root development, but if it continues beyond this time it is likely to reduce plant survival, root development and plant reproduction. Although browse protection of these sites would be difficult, if browse continues, measures to reduce browse of establishing willows should be evaluated and implemented.
- Maintenance needs for 2009 consist of hand pulling or spot spraying Canada thistle. Willow cuttings installed on the top layer often sprout further back on the stem, at the interface of the cutting with soil (Figure 23). Given the aggressive nature of the grasses and weeds colonizing this same area, it may be necessary to install some type of weed suppression mat along the back edge of the soil lifts until willow cuttings are tall enough to resist competition.
- There are no fabric or structural repairs needed at either site.

Figure 23. Soil lift site 1 observed in October 2008. Note the growth of willow cuttings installed under the soil lift (photograph left). These cuttings were under water during the July effectiveness monitoring. Photograph right shows willow growth further back on the stem.

Willow Fascines

Based on the results of 2008 effectiveness monitoring, it appears that willow fascines are a quick and cost effective way to establish woody vegetation within and near the channel. Willow fascines also accumulate debris, sediment, and seed, providing conditions for recruitment and establishment of woody species. The following key observations about this treatment include:

- Most fascines have remained in their original locations.
- Fine sediment and woody debris have accumulated around the fascines providing substrate for seedling establishment.
- Willow cutting survival appeared to be high, although collection of these data was hindered because many of the fascines were still under water during July monitoring. Willows that were still submerged at the time of monitoring may begin to grow once water levels reach base flow conditions.
- Future observations during different seasons may provide more information on the effectiveness of this treatment.
- No maintenance is required.

This treatment should be considered for the second phase of revegetation because it is inexpensive, quick and easy to install, and is low maintenance. The treatment also appears to capture debris and sediment within the channel margins and promote woody vegetation establishment in dynamic environments along the channel. This treatment is only appropriate where areas of sediment deposition are exposed each year.

Large Woody Debris Structures

Channel spanning large woody debris structures influence the hydrologic connectivity between the floodplain and channel. Encouraging overbank flows and retaining water on the floodplain for longer periods of time will shift the species composition and increase organic matter in the floodplain environment. The following key observations of this treatment include:

- The woody debris structures appear to be trapping a significant amount of sediment and organic matter. This is resulting in a 'check' of the water behind each structure. This appears to be resulting in increased overbank flows and inundation of adjacent floodplain areas.
- Standing water was observed in the floodplain transects at all but one site during July 2008 effectiveness monitoring. No other areas of floodplain inundation were observed during monitoring.
- Although non-native pasture grasses are the dominant species along all transects, inclusions of wetter species were observed at all sites. Monitoring the increased abundance of these species will be key in determining treatment effectiveness.
- Due to high water levels during July monitoring, the extent of fine sediment accumulation in and around large woody debris structures could not be evaluated. Observing sediment deposition, particularly at channel margins, will be important in future years to determine the potential for woody shrub recruitment.
- No maintenance is required.

This treatment requires a longer monitoring timeframe in order to accurately assess its effectiveness in shifting species composition and recruiting woody species. Monitoring should continue for at least two more seasons. The areas around the woody debris jams have had an increase in water saturation and retention. If this continues, the vegetation communities will most likely shift from undesirable pasture grasses to desirable native grasses, sedges, and forbs.

Coir Logs

Coir log fascines promote woody vegetation establishment in areas that are difficult to revegetate due to lateral erosion or competition from aggressive species. Coir logs retain high amounts of water late into the growing season. This provides a favorable site for willow cutting growth and natural seedling recruitment and establishment. The following key observations about this treatment include:

- Overall survival of willow cuttings used in this treatment is high.
- Fine sediment accumulation and natural colonization on the coir logs was low; however, both processes were observed and are likely to increase in coming years creating diverse plant communities at these sites.
- The average undercut and water depth below the logs should continue to be monitored and evaluated for habitat potential.
- No maintenance needs were identified for this treatment. However, given the location of this treatment on high stress outer meander bends, evaluation should continue on a yearly basis. Possible maintenance may include: re-securing coir logs into bank, mending large tears in outer mesh, installing supplemental willow cuttings, and removing invasive or weedy species that may colonize the surface of the logs.

This treatment should be considered for use in future revegetation phases. However, because it is relatively expensive to implement, the effectiveness of this treatment should be monitored for another year before repeating in downstream reaches.

Herbicide Application

Initial herbicide application targeting Canada thistle and reed canarygrass was completed in July and September 2008. General observations of herbicide applications include:

- Preliminary observations suggest that the treatment was effective at knocking back Canada thistle infestations. Fall treatments of reed canarygrass also appeared to be effective.
- Effectiveness monitoring of this treatment should occur in late summer 2009 by re-mapping infestations.
- Although effectiveness of this treatment has not been monitored, subsequent herbicide applications should be scheduled for 2009 starting in June.
- Application was concentrated along the stream and within planting units. Numerous plants outside of this zone were observed indicating the target area should be expanded during future applications (Figure 24).
- Yellow toadflax has increased considerably since initial weed mapping. Although some plants were sprayed during the initial application, most were not (Figure 25). These expanded infestations should be included in future applications.
- Fall application targeted Canada thistle and reed canarygrass. Preliminary observations of the reed canarygrass showed some yellowing in response to the herbicide application. Effectiveness monitoring should continue to fully evaluate the effectiveness of the treatment.

Figure 24. Photograph showing an example of target species Canada thistle that was missed during the initial herbicide application during July 2008. Target areas should be expanded for future herbicide applications.

Figure 25. Photograph showing expanding infestation of yellow toadflax.

Adaptive Management

As described in the *Therriault Creek Riparian Revegetation Plan* (Geum Environmental Consulting, Inc. 2007a) the revegetation treatments implemented in 2007 were intended to be the first phase of a multi-year effort to convert the project reach to desired riparian plant communities. The effectiveness monitoring data described in previous sections will provide a baseline for evaluating treatment effectiveness in the following years. While two or three years of evaluation may be necessary to determine if project goals and objectives are being met, evaluation of the data already collected provides some immediate insight about treatment effectiveness at achieving riparian revegetation objectives at Therriault Creek. This section describes how evaluation of effectiveness monitoring data collected in July 2008, and described in previous sections, is being used to determine maintenance needs (2009 maintenance) and recommendations for the next phase of revegetation efforts at the site (Therriault Riparian Revegetation Phase II).

2009 Maintenance

One result of annual effectiveness monitoring is to identify potential maintenance needs for treatments that have already been implemented. Maintenance is often necessary to achieve project goals. Table 8 provides a summary of potential maintenance needs by treatment observed during July 2008 monitoring. These maintenance needs should be addressed during spring or summer 2009.

Table 8. Summary of maintenance needs for 2009 based on 2008 effectiveness monitoring.

Treatment	2009 Maintenance Needs
Residual shrub protection	Straightening, securing or replacement of browse protectors. Expansion of browse protectors around plants that have outgrown existing nets.
Containerized shrubs	Supplemental irrigation. Straightening, securing or replacement of brush blankets, browse protectors and vole protectors. Expansion of browse protectors around plants that have outgrown existing nets.
Solarization (long-term, planted)	Supplemental irrigation. Straightening, securing or replacement of browse protectors and vole protectors. Weeding of grasses in fabric openings around plants. Expansion of browse protectors around plants that have outgrown existing nets. Resecure staples where needed.
Solarization (temporary)	Resecure staples where needed.
Vegetated soil lifts	None
Live willow fascines	None
Large woody debris structures	None
Herbicide application	None
Coir logs	None

Therriault Riparian Revegetation Phase II

Based on the results of 2008 monitoring, observations made during post implementation site visits and the adaptive management criteria described in the Results section of this report, the following recommendation for Phase II riparian revegetation efforts along Therriault Creek include:

- Implement maintenance needs described in Table 8.
- Protect remaining residual shrubs with rigid mesh browse protectors.
- Schedule and implement two herbicide applications targeting Canada thistle, reed canarygrass and yellow toadflax.
- Repeat live willow fascine treatment in all depositional areas downstream of Phase I.
- Schedule and implement 2009 effectiveness monitoring.

Table 9 summarizes the adaptive management framework for the Therriault Creek riparian revegetation project. This table provides a framework in which decisions about future revegetation treatments can be made based on monitoring results and observations.

Table 9. Therriault riparian revegetation adaptive management framework describing treatments and monitoring implemented during Phase I and decision pathway and recommendations for Phase II.

	PHASE I		PHASE II	
Treatment	**Treatments Implemented in Fall 2007**	**2008 Effectiveness Monitoring**	**Decision Pathway for Phase II**[1]	**Result of Decision Pathway: 2009 Treatments and Recommendations**
Residual shrub protection	250 residual shrubs protected	Two Residual Shrub monitoring plots installed including a total of 61 plants.	(1) If new growth is observed, repeat this treatment in additional downstream reaches. (2) If browse protectors are not effective, additional measures will need to be evaluated based on observing browsed plants and animal use patterns (exclosures may be necessary, but only if the situation warrants). If mulch mats are not effective, concentrated herbicide application or larger or heavier duty weed barriers may be necessary.	Browse protectors have proven effective. Repeat treatment on other areas with residual shrubs in 2009 and continue to maintain and monitor.
Containerized plantings	1,028 plants installed (16 planting plots)	Survival by species and presence of dominant herbaceous species monitored in Planting Units 1,3,5,7,12,14, and 16.	(1) If survival of containerized shrubs is good and maintenance of shrubs (irrigation, weeding around plants) is effective and affordable, consider supplemental planting in downstream reaches. (2) If survival is poor determine if additional irrigation or weed suppression measures are needed or if other site conditions are precluding growth (e.g. soils). Do not plant additional plants.	Containerized plant survival high for first year. Maintenance needs identified for 2009 minimal. Continue to monitor for one more season before installing additional plants. Spruce plantings unsuccessful; eliminate spruce from planting mix until site conditions (soil, shade, moisture) can support spruce seedlings/saplings.

	PHASE I		PHASE II	
Treatment	**Treatments Implemented in Fall 2007**	**2008 Effectiveness Monitoring**	**Decision Pathway for Phase II**[1]	**Result of Decision Pathway: 2009 Treatments and Recommendations**
Solarization	Temporary (4,920 ft^2)	No monitoring conducted in 2008.	These treatment sites should be left in place through 2008. Monitoring should be done in late fall 2008 or preferably in summer 2009. (1) If the treatment has effectively killed aggressive grasses, the fabric should remain in place until Fall 2009. At that time, the fabric should be removed and the site should be seeded with desired native shrubs, sedges, rushes, grasses or forbs. Fabric should be moved to an adjacent treatment site. (2) If grasses have not been killed or significantly suppressed, the fabric should remain in place for one additional year. In Summer 2010, the sites should be monitored for suppression of grasses. If treatment is still not effective, consider use of herbicide in place of this treatment.	Monitor in 2009.
	Planted (3,200 ft^2, 64 plants)	Survival by species and growth metric monitored in both planted solarization plots. Survival was very high. Growth cannot be determined until 2009.	(1) If survival is good continue to monitor and maintain plots. Do not repeat treatment until survival monitoring has been high (greater than 80%) for two years. (2) If survival is poor, try to determine causes.	Survival and growth appear good for first year. Continue to monitor and maintain. Identify locations for repeating treatment in 2010.

	PHASE I		PHASE II	
Treatment	**Treatments Implemented in Fall 2007**	**2008 Effectiveness Monitoring**	**Decision Pathway for Phase II[1]**	**Result of Decision Pathway: 2009 Treatments and Recommendations**
Vegetated soil lifts	Two sites; 120 feet total	Both soil lifts monitored for willow survival and percent cover, percent cover of weeds, percent cover of herbaceous species, rips and tears, percent fabric degradation.	If willow survival is poor, consider adding supplemental cuttings in spring 2009. Implement weed control or supplemental seeding if necessary.	Monitoring willow cutting survival in 2009 before adding supplemental cuttings. Include lifts in spot spraying for Canada thistle, yellow toadflax and Canada thistle.
Coir logs	400 feet (40, 10 foot logs)	Percent of live willow cuttings, water depth, scour depth, percent natural colonization, and percent fine sediment deposition recorded for coir logs 1,2,3,5, and 7	(1) If willow survival is good and minimal scour and slumping has occurred, consider additional coir log placement in Fall 2008 or Spring 2009. (2) If willow survival is poor, add supplemental willow cuttings to all coir logs in late fall 2008 or early spring 2009. Do not repeat treatment, but continue to monitor supplemental cuttings. (3) If significant scour or slumping occurs, add additional earth anchors to all logs where needed. Do not repeat treatment, but continue to monitor for stability and effectiveness.	Willow survival is high, no scour has occurred, fine sediment is accumulating, and structures remain stable. Continue to monitor for one more season before implementing downstream.

	PHASE I		PHASE II	
Treatment	**Treatments Implemented in Fall 2007**	**2008 Effectiveness Monitoring**	**Decision Pathway for Phase II[1]**	**Result of Decision Pathway: 2009 Treatments and Recommendations**
Live willow fascines	800 feet	All but one live willow fascines found and monitored for percent willow survival, percent scour and type of sediment deposition.	(1) If survival appears to be good and new growth is apparent in late spring/summer 2008 and only a small number of bundles have been scoured, repeat this treatment in depositional areas downstream of treated sites. (2) If most fascines are scoured or very little new growth is apparent, bury exposed cuttings, but do not repeat the treatment.	Willow survival is good and deposition is occurring on and around fascines. Repeat treatment in additional depositional areas.
Woody debris jams	5 structures	Three 100-200 foot transects established in floodplain upstream of WDJ 1through 4. Percent cover dominant species and water depths were recorded.	(1) If numerous positive trends (e.g. colonizing depositional areas, scour and/or deposition in the floodplain are observed in Summer 2008, consider adding more woody debris to the channel in Fall 2008 or Spring 2009. Also, consider supplemental containerized planting or dormant willow cutting installation around debris structures and in wetter areas of the floodplain adjacent to these sites. (2) If little to no change is observed, do not repeat treatment and continue to monitor.	Continue to monitor for shifts in vegetation communities, deposition, and woody species recruitment.
Herbicide application	Applications in Summer and Fall 2008	General observations recorded after initial application	Continue to monitor new infestation of Canada thistle and reed canarygrass.	Schedule follow-up treatments for summer and fall 2009. Monitor current and new infestations of Canada thistle, reed canarygrass, and yellow toadflax and compare to baseline.

[1] This decision pathway is from the original revegetation plan: *Therriault Creek Riparian Revegetation Plan* (Geum Environmental Consulting, Inc. 2007a).

Phase II Estimated Costs

Table 10 provides estimated costs for implementing Therriault Creek riparian revegetation Phase II. Costs are for Geum Environmental to provide all services. Project costs could be reduced if project partners are able to conduct monitoring or maintenance activities.

Table 10. Summary of estimated costs associated with implementing Therriault Creek riparian revegetation Phase II.

Therriault Creek Riparian Revegetation Phase II Estimated Costs	
Task	**Total Estimate Cost**
Project management, logistics and oversight	$4,000.00
Travel Costs: Geum Environmental	$1,000.00
Travel Costs: Labor Crew	$2,000.00
2009 Maintenance[1]	$5,000.00
2009 Revegetation treatments[2]	
Herbicide Application (2)	$6,000.00
Residual shrub protection (100)	$1,500
Willow fascines (500 feet)	$1,500
2009 Monitoring & Reporting	$7,000.00
Total Estimated Cost	**$28,000**

[1]Includes all maintenance activities described in Table 8. This cost is approximate because the extent of maintenance still needs to be determined.
[2] Includes all revegetation treatments described in Section Table 9 for 2009.

References

Geum Environmental Consulting, Inc. 2007a. Therriault Creek Riparian Revegetation Plan. Internal report prepared for Kootenai River Network, Libby, Montana.

Geum Environmental Consulting, Inc. 2007b. Therriault Creek Implementation Report. Internal report prepared for Montana Fish, Wildlife and Parks, Libby, Montana. Contract #080067.

Appendix A: 2008 Effectiveness Monitoring Data

Table A-1. Containerized plant survival by species within monitored planting units.

Species	Data	Planting Unit 1	Planting Unit 12	Planting Unit 14	Planting Unit 16	Planting Unit 3	Planting Unit 5	Planting Unit 7	Grand Total
Alnus incana	Number Alive	2	1	4	2	4	2	5	20
Mountain alder	Number Dead	0	1	1	0	0	0	0	2
Amelanchier alnifolia	Number Alive	3	2	1	1	6	2	2	17
Serviceberry	Number Dead	0	0	0	1	0	0	0	1
Betula occidentalis	Number Alive	3	0	0	0	6	3	0	12
River birch	Number Dead	0	0	0	0	1	0	0	1
Cornus sericea	Number Alive	1	7	10	5	9	2	3	37
Red-osier dogwood	Number Dead	0	0	0	0	0	0	0	0
Crataegus douglasii	Number Alive	4	13	0	13	7	0	0	37
Black hawthorne	Number Dead	0	0	0	0	0	0	0	0
Picea engelmannii	Number Alive	0	0	1	0	1	0	0	2
Englemann spruce	Number Dead	0	1	4	3	0	0	1	9
Populus balsamifera	Number Alive	2	7	6	4	2	2	3	26
Black cottonwood	Number Dead	0	0	0	0	0	0	0	0
Populus tremuloides	Number Alive	0	0	0	0	0	2	3	5
Quaking aspen	Number Dead	0	0	0	0	0	0	0	0
Prunus virginiana	Number Alive	0	1	3	9	4	1	0	18
Common chokecherry	Number Dead	0	0	0	0	0	1	0	1
Rosa woodsii	Number Alive	0	0	3	0	4	8	5	20
Wood's rose	Number Dead	0	0	0	0	0	0	2	2
Salix bebbiana	Number Alive	0	0	0	2	2	0	10	14
Bebb willow	Number Dead	0	0	0	0	0	0	0	0
Salix drummondiana	Number Alive	1	2	2	3	10	5	4	27
Drummond's willow	Number Dead	0	0	0	0	0	0	0	0

Species	Data	Planting Unit 1	Planting Unit 12	Planting Unit 14	Planting Unit 16	Planting Unit 3	Planting Unit 5	Planting Unit 7	Grand Total
Salix exigua	Number Alive	13	2	8	1	8	4	13	49
Sandbar willow	Number Dead	0	0	0	0	0	0	0	0
Salix geyeriana	Number Alive	6	0	0	0	5	0	2	13
Geyer's willow	Number Dead	0	0	0	0	0	0	0	0
Salix spp	Number Alive		12	0	2	1	5	15	35
Willow species	Number Dead		0	0	0	0	0	0	0
Spiraea betulifolia	Number Alive	0	4	7	10	9	4	4	38
White spirea	Number Dead	0	0	0	0	0	0	0	0
Symphoricarpos occidentalis	Number Alive	18	1	2	3	1	2	1	28
Common snowberry	Number Dead	0	0	0	0	0	0	0	0
Total Number Alive		**53**	**52**	**47**	**55**	**79**	**42**	**70**	**398**
Total Number Dead		**0**	**2**	**5**	**4**	**1**	**1**	**3**	**16**

Table A- 2. Vegetated soil lift effectiveness monitoring data collected in July 2008.

Soil Lift	Layer	Metric	Distance (ft)												
			0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70
SL-1	above	Fabric rips/tears	0	0	0	0	0	0	0	0	0	0				
SL-1	above	% cover willow	1	10	5	5	0	15	15	15	10	5				
SL-1	below	% cover willow	20	60	70	70	1	1	0	1	0	1				
SL-1	above	% cover herbaceous	50	80	60	50	25	15	20	15	10	20				
SL-1	above	% cover weeds	10	10	5	5	1	1	5	1	1	5				
SL-1	above	% biodegradation	10	10	10	10	10	10	10	10	10	10				
SL-1	above	Survival of stems	3/3	8/9	8/10	8/8	6/7	7/7	8/8	8/8	7/8	4/4				
SL-1	below	Survival of stems	2/4	3/14	4/15	5/11	5/8	14/14	9/16	7/13	8/14	5/8				
SL-1	above	% stem survival	100	89	80	100	86	100	100	100	88	100				
SL-1	below	% stem survival	50	21	27	45	63	100	56	54	57	63				
SL-2	above	Fabric rips/tears	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-2	above	% cover willow	5	5	1	1	1	5	1	5	5	10	5	5	1	5
SL-2	below	% cover willow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-2	above	% cover herbaceous	70	70	70	80	70	70	80	80	80	80	80	80	80	80
SL-2	above	% cover weeds	10	10	10	0	1	5	0	5	0	1	1	1	1	10
SL-2	above	% biodegradation	10	10	10	10	10	10	10	10	10	10	10	10	10	10
SL-2	above	Survival of stems	3/4	5/5	4/5	5/10	9/11	9/9	6/12	12/15	9/10	12/13	9/11	7/8	2/13	7/9
SL-2	below	Survival of stems	0/1	2/4	3/3	5/5	2/2	2/2	2/2	3/3	1/1	1/1	3/3	4/4	3/3	4/4
SL-2	above	% stem survival	75	100	80	50	82	100	50	80	90	92	82	88	15	78
SL-2	below	% stem survival	0	50	100	100	100	100	100	100	100	100	100	100	100	100

Table A- 3. Coir log fascine data collected during July 2008 monitoring.

Coir Log	Metric	Distance									
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
1	Number alive willow cuttings/total number of installed willow cuttings	9/10	3/10								
	Total water depth (inches)	13	18								
	Coir log depth (inches)	16	16								
	Undercut below coir log (inches)	0	4								
	Percent cover natural colonization	0	0								
	Percent of log with fine sediment deposition	20	60								
2	Number alive willow cuttings/total number of installed willow cuttings	9/12									
	Total water depth (inches)	13									
	Coir log depth (inches)	17									
	Undercut below coir log (inches)	4									
	Percent cover natural colonization	0									
	Percent of log with fine sediment deposition	10									
3	Number alive willow cuttings/total number of installed willow cuttings	2/8	8/10	7/8	6/10	4/6	6/6	8/8			
	Total water depth (inches)	5	5	12	12	8	14	16			
	Coir log depth (inches)	7	7	13	13	9	13	14			
	Undercut below coir log (inches)	0	0	3	3	3	4	4			
	Percent cover natural colonization	0	0	0	0	0	0	0			
	Percent of log with fine sediment deposition	80	80	60	80	50	10	10			

Coir Log	Metric	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
5	Number alive willow cuttings/total number of installed willow cuttings	9/9	9/9	10/10	6/9	6/9	9/11	7/8	6/9	8/8	
	Total water depth (inches)	8	12	7	12	17	9	12	12	8	
	Coir log depth (inches)	16	18	13	20	NR	15	17	19	15	
	Undercut below coir log (inches)	3	3	2	5	3	2	6	5	3	
	Percent cover natural colonization	0	0	0	0	0	0	0	0	0	
	Percent of log with fine sediment deposition	NR	NR	NR	NR	NR	NR	NR	NR	NR	
7	Number alive willow cuttings/total number of installed willow cuttings	9/9	7/8	11/12	12/12	12/12	10/12	9/15	17/18	9/11	6/12
	Total water depth (inches)	9	8	8	13	6	8	13	12	14	16
	Coir log depth (inches)	14	14	15	17	12	13	14	13	18	20
	Undercut below coir log (inches)	3	3	2	4	2	1	1	2	6	4
	Percent cover natural colonization	0	0	0	0	0	0	0	0	0	0
	Percent of log with fine sediment deposition	50	20	20	5	5	20	60	40	60	60

NR: Data not collected

Table A- 4. Live willow fascine effectiveness monitoring data collected during July 2008.

Willow Fascine ID	Percent Scour	Percent Willow Survival	Deposition Type
1	0	5	Fine sediment and sand accumulation around debris deposited on fascine
2	0	80	Fine sediment and sand accumulated at downstream end of fascine
3	0	100	Fine sediment and sand completely covering buried portion of fascine
4	0	N/A, under water	Fine sediment and sand deposition
5*	N/A	N/A	N/A
6	0	N/A, under water	Fine sediment deposition
7	0	N/A	Minimal fine sediment deposition
8	0	N/A	Minimal fine sediment deposition
9	0	N/A	Minimal fine sediment deposition
10	0	100	Fine sediment deposition throughout site
11	0	80	Minimal fine sediment deposition
12	0	75	Fine sediment deposition throughout site
13	0	N/A, under water	Fine sediment deposition throughout site
14	0	N/A, mostly buried	Upstream portion of fascine covered with gravel, downstream portion covered with fine sediment
15	0	N/A, buried	Sand, fine sediment, and small debris accumulation on fascine
16	0	N/A	Minimal fine sediment deposition
17	0	50	Fine sediment deposition at downstream end
18	0	N/A	Fine sediment, sand, organic matter, and debris accumulation on fascine
19	0	N/A	Fine sediment, organic matter and debris accumulation on fascine
20	0	N/A	Good coverage of fine sediment and debris throughout site
21	NA	N/A	N/A

*Willow fascine not located during 2008 effectiveness monitoring

Table A-5. Woody Debris Transect 1 data collected during July 2008 monitoring.

Distance (ft)	Species	Species (Common Name)	Percent Cover*	Water Depth (in)
0-10	*Elymus repens*	Quackgrass**	F	4
10-20	*Elymus repens*	Quackgrass**	9	6
	Phleum pratense	Common timothy**	1	
	Bromus inermis	Smooth brome**	1	
20-30	*Elymus repens*	Quackgrass**	9	2
	Phleum pratense	Common timothy**	1	
	Polygonum	Smartweed	<1	
30-40	*Elymus repens*	Quackgrass**	9	4
	Phleum pratense	Common timothy**	1	
	Polygonum	Smartweed	<1	
40-50	*Elymus repens*	Quackgrass**	9	4
	Phleum pratense	Common timothy**	1	
50-60	*Elymus repens*	Quackgrass**	8	2
	Carex stipata	Owlfruit sedge	T	
	Glyceria species	Mannagrass species	T	
	Eleocharis palustris	Common spikerush	T	
	Carex bebbii	Bebb's sedge	T	
	Phleum pratense	Common timothy**	1	
60-70	*Elymus repens*	Quackgrass**	8	saturated
	Phleum pratense	Common timothy**	1	
	Poa pratensis	Kentucky bluegrass**	P	
	Carex utriculata	Northwest Territory sedge	1	
70-80	*Elymus repens*	Quackgrass**	7	saturated
	Bromus inermis	Smooth brome**	2	
	Cirsium arvense	Canada thistle*	T	
	Poa pratensis	Kentucky bluegrass**	1	
	Phleum pratense	Common timothy**	T	
	Salix bebbiana	Bebb willow	T	
80-90	Channel	N/A		>36
90-100	*Elymus repens*	Quackgrass**	7	saturated
	Bromus inermis	Smooth brome**	2	
	Phleum pratense	Common timothy**	1	
	Cirsium arvense	Canada thistle*	T	
100-110	*Nepeta cataria*	Catnip	T	saturated
	Carex stipata	Owlfruit sedge	T	
	Bromus inermis	Smooth brome**	2	
	Cirsium arvense	Canada thistle*	T	
	Elymus repens	Quackgrass**	7	
	Carex microptera	Small fruited sedge	T	

Distance (ft)	Species	Species (Common Name)	Percent Cover*	Water Depth (in)
110-120	*Carex stipata*	Owlfruit sedge	T	0
	Bromus inermis	Smooth brome**	6	
	Nepeta cataria	Catnip	T	
	Elymus repens	Quackgrass**	4	
120-130	*Elymus repens*	Quackgrass**	5	0
	Bromus inermis	Smooth brome*	5	
	Poa pratensis	Kentucky bluegrass**	T	
130-140	*Elymus repens*	Quackgrass**	7	0
	Bromus inermis	Smooth brome**	3	
	Cirsium arvense	Canada thistle*	P	
140-150	*Cirsium arvense*	Canada thistle*	P	0
	Elymus repens	Quackgrass**	9	
	Bromus inermis	Smooth brome**	1	
150-160	*Elymus repens*	Quackgrass**	6	0
	Bromus inermis	Smooth brome**	4	
160-170	*Bromus inermis*	Smooth brome**	8	0
	Elymus repens	Quackgrass**	2	
170-180	*Bromus inermis*	Smooth brome**	7	0
	Elymus repens	Quackgrass**	3	
	Cirsium arvense	Canada thistle*	P	
180-190	*Elymus repens*	Quackgrass**	8	0
	Cirsium arvense	Canada thistle*	P	
	Bromus inermis	Smooth brome**	2	

[1]Cover class codes are listed in Table 10
*Weedy or invasive species
**Non-native pasture grass

Table A-6. Woody Debris Transect 2 data collected during July 2008 monitoring

Distance (ft)	Species	Species (Common Name)	Percent Cover[1]	Water Depth (in)
0-10	*Bromus inermis*	Smooth brome**	F	
10-20	*Bromus inermis*	Smooth brome**	6	slightly saturated
	Phleum pratense	Common timothy**	1	
	Elymus repens	Quackgrass**	2	
18-27	Channel	N/A		>36
30-40	*Elymus repens*	Quackgrass**	9	1
	Phleum pratense	Common timothy**	1	
	Poa pratensis	Kentucky bluegrass**	T	
	Cirsium arvense	Canada thistle*	T	
40-50	*Carex microptera*	Small fruited sedge	T	3
	Elymus repens	Quackgrass**	7	
	Phleum pratense	Common timothy**	2	
	Poa pratensis	Kentucky bluegrass**	P	
	Carex stipata	Owlfruit sedge	T	
	Glyceria species	Mannagrass species	T	
50-60	*Phleum pratense*	Common timothy**	1	6, max 10
	Elymus repens	Quackgrass**	4	
	Carex stipata	Owlfruit sedge	2	
	Geum macrophyllum	Large-leaved avens	T	
	Eleocharis palustris	Common spikerush	1	
	Glyceria species	Mannagrass species	T	
	Carex microptera	Small fruited sedge	1	
	Carex utriculata	Northwest Territory sedge	1	
60-70	*Phleum pratense*	Common timothy**	2	4, max 12
	Eleocharis palustris	Common spikerush	1	
	Elymus repens	Quackgrass**	7	
70-80	*Elymus repens*	Quackgrass**	8	saturated
	Poa pratensis	Kentucky bluegrass**	1	
	Phleum pratense	Common timothy**	1	
80-90	*Elymus repens*	Quackgrass**	8	
	Bromus inermis	Smooth brome**	1	
	Phleum pratense	Common timothy**	P	
	Poa pratensis	Kentucky bluegrass**	T	
90-100	*Elymus repens*	Quackgrass**	8	1
	Phleum pratense	Common timothy**	1	
	Poa pratensis	Kentucky bluegrass**	1	
100-110	*Elymus repens*	Quackgrass**	7	saturated
	Poa pratensis	Kentucky bluegrass**	2	

Distance (ft)	Species	Species (Common Name)	Percent Cover[1]	Water Depth (in)
	Carex microptera	Small fruited sedge	T	
	Phleum pratense	Common timothy**	1	
110-120	*Carex microptera*	Small fruited sedge	T	2
	Poa pratensis	Kentucky bluegrass**	1	
	Elymus repens	Quackgrass**	7	
	Phleum pratense	Common timothy**	2	
120-130	*Phleum pratense*	Common timothy**	7	2
	Elymus repens	Quackgrass**	3	
	Poa pratensis	Kentucky bluegrass**	P	
130-140	*Elymus repens*	Quackgrass**	6	2
	Phleum pratense	Common timothy**	4	
140-150	*Elymus repens*	Quackgrass**	7	1
	Bromus inermis	Smooth brome**	2	
	Phleum pratense	Common timothy**	2	
	Cirsium arvense	Canada thistle*	T	
150-160	*Elymus repens*	Quackgrass**	8	saturated
	Phleum pratense	Common timothy**	2	
	Bromus inermis	Smooth brome**	P	
160-170	*Elymus repens*	Quackgrass**	9	1
	Phleum pratense	Common timothy**	1	
170-180	*Elymus repens*	Quackgrass**	9	2
	Phleum pratense	Kentucky bluegrass**	1	
180-190	*Elymus repens*	Quackgrass**	F	4
	Cirsium arvense	Canada thistle*	T	
190-200	*Elymus repens*	Quackgrass**	9	4
	Phleum pratense	Kentucky bluegrass**	1	

[1]Cover class codes are listed in Table 10
*Weedy or invasive species
**Non-native pasture grass

Table A-7. Woody Debris Transect 3 data collected during 2008 monitoring

Distance (ft)	Species	Species (Common Name)	Percent Cover[1]	Water Depth (in)
0-10	*Elymus repens*	Quackgrass**	7	0
	Phleum pratense	Common timothy**	2	
	Poa pratensis	Kentucky bluegrass**	2	
10-20	*Phleum pratense*	Common timothy**	4	0
	Elymus repens	Quackgrass**	5	
	Poa pratensis	Kentucky bluegrass**	1	
	Cirsium arvense	Canada thistle*	T	
20-30	*Cirsium arvense*	Canada thistle*	T	0
	Phleum pratense	Kentucky bluegrass**	4	
	Bromus inermis	Smooth brome**	1	
	Elymus repens	Quackgrass**	5	
26-36	Channel	N/A		>36
40-50	*Bromus inermis*	Smooth brome**	5	0
	Elymus repens	Quackgrass**	4	
	Cirsium arvense	Canada thistle*	1	
50-60	*Elymus repens*	Quackgrass**	4	0
	Bromus inermis	Smooth brome**	6	
	Cirsium arvense	Canada thistle*	T	
60-70	*Elymus repens*	Quackgrass**	7	0
	Bromus inermis	Smooth brome**	3	
	Cirsium arvense	Canada thistle*	T	
70-80	*Elymus repens*	Quackgrass**	7	0
	Bromus inermis	Smooth brome**	3	
	Phleum pratense	Common timothy**	T	
	Rumex crispus	Curly dock	T	
	Cirsium arvense	Canada thistle*	T	
80-90	*Rumex crispus*	Curly dock	P	0
	Phleum pratense	Common timothy**	4	
	Poa pratensis	Kentucky bluegrass**	3	
	Elymus repens	Quackgrass**	3	
90-100	*Elymus repens*	Quackgrass**	5	0
	Phleum pratense	Common timothy**	3	
	Poa pratensis	Kentucky bluegrass**	2	

[1]Cover class codes are listed in Table 10
*Weedy or invasive species
**Non-native pasture grass

Table A-8. Cover class codes used during data collection along woody debris jam transects.

Code	Percent Cover	Midpoint Percent
T	<1	0.5
P	1<5	3
1	5<15	10
2	15<25	20
3	25<35	30
4	35<45	40
5	45<50	50
6	55<65	60
7	65<75	70
8	75<85	80
9	85<95	90
F	95-100	97.5