GRAVE CREEK RIPARIAN REVEGETATION 2008 AS-BUILT AND 2009 MONITORING REPORT

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Introduction

Initial restoration efforts within the Grave Creek project area began in 2001, and early revegetation efforts that were part of this restoration work had limited success due to existing limiting factors and constraints. In 2005 and 2006, these limiting factors and constraints were evaluated and additional revegetation treatments were designed and implemented in association with channel restoration work. In 2007 and 2008, these new revegetation treatments were more formally evaluated as part of an effectiveness monitoring program, resulting in the *Grave Creek Riparian Revegetation and Monitoring Plan* (2008 Revegetation Plan) (Geum Environmental Consulting, Inc. 2008). This report is a summary of revegetation work and monitoring implemented under the 2008 Revegetation Plan.

Revegetation activities described in the 2008 Revegetation Plan were completed between October 6 and October 16 2008, and followed up with additional monitoring between July 27 and 30, 2009. This report describes the adaptive management process that led to the implementation of the 2008 Revegetation Plan, results of 2008 effectiveness monitoring, as-built conditions of the 2008 revegetation treatments, and results of 2009 effectiveness monitoring. In addition, recommendations for future project phases are included.

Restoration and revegetation efforts within the Grave Creek project area completed to date include:

- 2001 channel restoration to restore proper form and function of the river channel through reconstruction of a large gravel to small cobble, meandering, riffle-pool stream type.
- 2001 revegetation efforts, implemented in conjunction with channel work, used whole sod and shrub transplants, containerized root stock, sprigs and dormant pole plantings, broadcast seeding, and organic compost application.
- 2005 supplemental riparian revegetation including stream bank bioengineering techniques, such as vegetated soil lifts; planting a small number of containerized shrubs; and enhancement of constructed floodplain areas to promote natural floodplain processes such as sediment storage, erosion control, and plant community succession. Floodplain enhancement techniques included construction of floodplain swales, planting of containerized shrubs in select swale features, and placement of large woody debris on floodplain surfaces.
- 2006 assessment of the effectiveness of 2005 treatments.
- 2006 implementation of refined techniques in response to how treatments were functioning along Grave Creek. Technique modifications in vegetated soil lift designs included constructing a cobble toe below the face of the vegetated soil lift to prevent scour and constructing soil lifts between other bank stabilization structures, such as woody debris jams.
- 2007 monitoring and site assessment to evaluate effectiveness of 2005 and 2006 revegetation efforts, determine the presence or absence of ecological processes related to riparian plant community succession, identify site constraints, and guide planning for the next phase of restoration activities.

- 2008 monitoring and final design to verify 2007 effectiveness monitoring results and refine recommended treatments for 2008 treatments.
- 2008 implementation of revegetation treatments identified during 2007 and 2008 monitoring and site assessments.
- 2009 effectiveness monitoring of treatments implemented between 2005 and 2008.

The 2008 Revegetation Plan provides details on the project background, existing and desired future conditions for the site, limiting factors to revegetation, and recommendations for treatments to address limiting factors. The 2008 Revegetation Plan also includes a monitoring plan for the project reach. This report describes the results of summer 2008 effectiveness monitoring and final design for treatments implemented in fall 2008 and provides as-built documentation for the revegetation treatments implemented during 2008. This report also includes the results of 2009 effectiveness monitoring, which evaluated treatments installed in fall 2008.

The 2008 revegetation treatments represent the latest phase of a multi-year riparian revegetation effort at the site. As described in the 2008 Revegetation Plan, restoring the riparian and floodplain environment along Grave Creek within the project reach will require a multi-year, phased approach. The project goal is to create conditions that will support the establishment of diverse plant communities capable of sustaining floodplain ecological processes. These ecological processes include: plant community succession, sediment storage, flood water retention, and long-term channel stability. The purpose of the latest treatment phase, implemented in fall 2008, was to install a range of treatments that are likely to overcome limiting factors and support ecological processes based on effectiveness monitoring results from the Grave Creek site and other similar sites. Continuing to monitor treatment effectiveness will help project partners determine if treatments are helping to achieve project goals and will guide decisions concerning maintenance and additional treatment needs.

This document is organized as follows:

- 2008 Effectiveness Monitoring Results and Comparison with 2007 Results
- Adaptive Management and Final Design: 2008 Treatments
- 2008 Riparian Revegetation Treatments: As-Built Documentation
- 2009 Effectiveness Monitoring Results and Comparison with 2007-2008 Monitoring Results
- Recommendations for Future Riparian Revegetation Project Phases

2008 Effectiveness Monitoring Results and Comparison with 2007 Results

This section describes the results of effectiveness monitoring data collected in August 2008. The purpose of this monitoring cycle was to verify site conditions and trends observed during December 2007 effectiveness monitoring and refine the riparian revegetation treatments included in the 2008 Revegetation Plan developed for the site. This section briefly summarizes the monitoring completed in 2008. Results of 2008 monitoring are included in Appendix A and provided in electronic spreadsheets accompanying this document. The following sections discuss how data were used to refine the revegetation treatments included in the 2008 Revegetation Plan. The summer 2008 effectiveness monitoring included observations of sites monitored in December 2007 and evaluated the following treatments:

- Riparian planting areas
- Vegetated soil lifts
- Constructed point bars

Methods for monitoring each of these treatments are described in the 2008 Revegetation Plan. Results are described below. The same treatments were monitored in 2007 and 2008, with the addition of one point bar (Point Bar 5). Figure 1 shows monitoring locations within the project area.

Riparian Planting Area Survival Monitoring

Results of containerized planting survival monitoring for planting areas at Sites 3, 5, 10, and 12 are shown in Table 1. Table 1 compares percent survival by planting unit for 2007 and 2008. Because no baseline data were recorded for the number of plants installed when these areas were planted in 2005, percent survival is based on the number of live and dead plants recorded for each year. Table A-1 in Appendix A provides detailed results for survival monitoring of containerized planting sites.

Table 1. Percent survival of containerized plants in monitoring plots for 2007 and 2008 monitoring cycles.

Planting Area Monitoring Plot	Percent Survival 2007	2008
Planting Area Monitoring Plot 1 (Site 3)	77% (n=60)	78% (n=53)
Planting Area Monitoring Plot 2 (Site 5)	96% (n=48)	76% (n=49)
Planting Area Monitoring Plot 3 (Site 12)	86% (n=14)	85% (n=13)
Planting Area Monitoring Plot 4 (Site 10)	85% (n=54)	65% (n=49)

The following is a summary of results and observations made of planting areas during winter 2007 monitoring:

- Plant growth is being suppressed and/or contorted by damage to browse protectors from ice and debris (Figure 2).

- At most planting sites, the adjacent streambank showed significant amounts of lateral erosion which resulted in the loss of up to one-third of the plants originally installed at each site.
- Most plants have only grown as tall as the browse protectors, with all growth above this protection browsed.
- Plants in Planting Area Monitoring Plot 2 were installed through solarization fabric and had a higher relative survival rate and appeared to be taller compared with plants in all other monitored plots.
- Solarization fabric was very effective at killing undesirable grasses in planting sites where it was used.

Monitoring results and observations made during 2008 concur with most of the results and observations made during 2007. The one difference in observations and recorded results is the higher percent survival in the solarization plot, Planting Area Monitoring Plot 2, recorded in 2007. Results from 2007 show a high percent survival, 96 percent, compared with the 2008 results of 76 percent survival. This discrepancy may be a result of monitoring during different seasons. 2007 monitoring was conducted during winter when no leaves were present, while 2008 monitoring was conducted during summer. Monitoring during the growing season is generally more accurate than monitoring during dormancy. It may also be possible that plant survival did decrease between winter 2007 and late summer 2008.

The differences in total number of plants observed in each monitoring plot between 2007 and 2008 may be due to the amount of the lateral erosion observed at most sites. There was evidence of plant loss due to bank erosion in 2007. Although bank erosion was not measured it is possible that more plants were lost as a result of bank erosion occurring in 2008 as well. The results of monitoring continue to indicate that planting riparian shrubs adjacent to the channel within the project reach may not be an effective treatment to meet project goals. Planting containerized stock is expensive both initially and to maintain. Given the high levels of browse observed in the project reach, the loss of plants due to lateral erosion and damage to plants due to ice and debris flows, additional containerized planting on streambanks was not included as a preferred treatment in the 2008 Revegetation Plan.

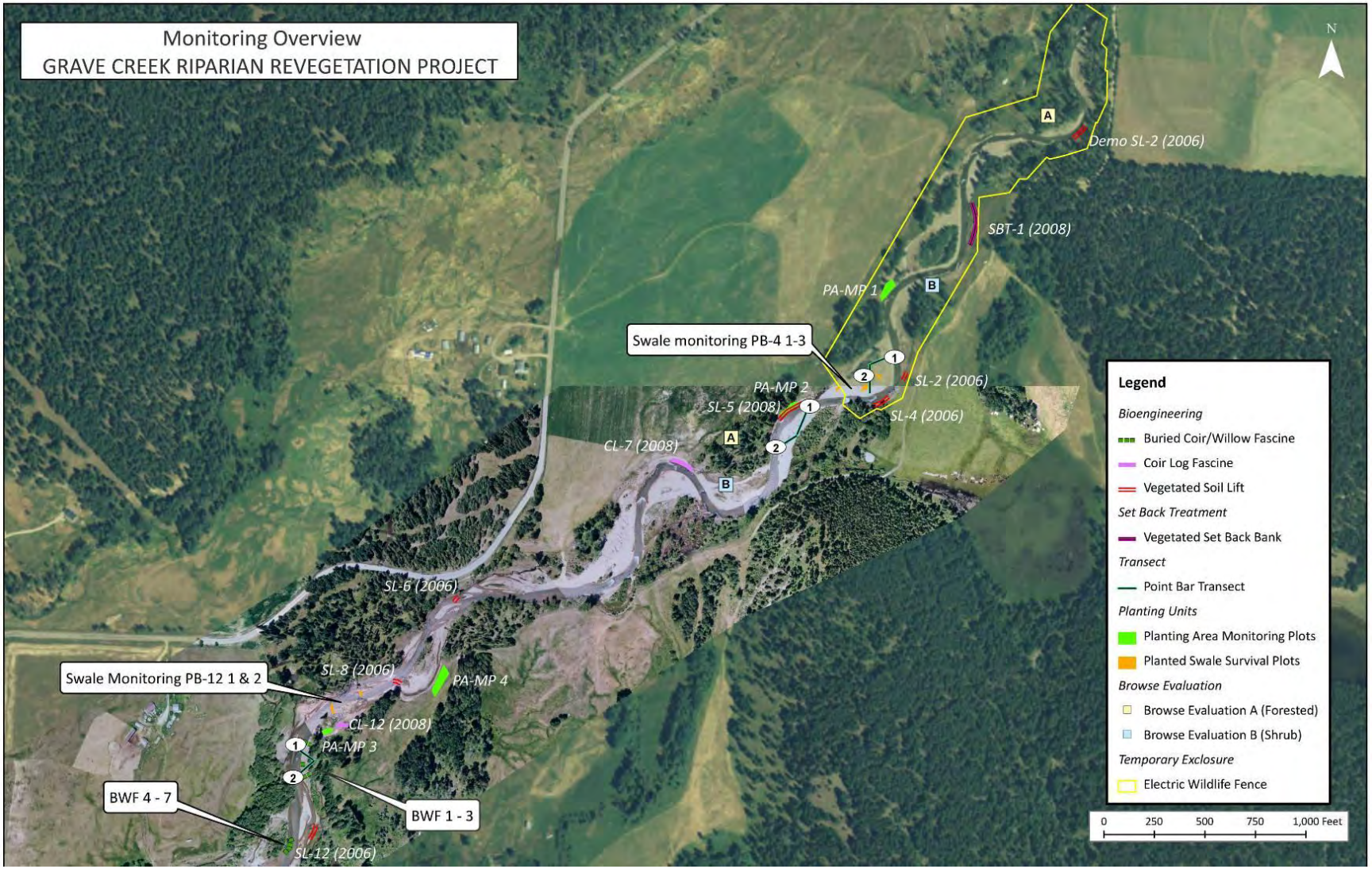

Figure 1. Overview figure of the Grave Creek project reach showing the locations of revegetation treatments monitored in 2007, 2008 and 2009.

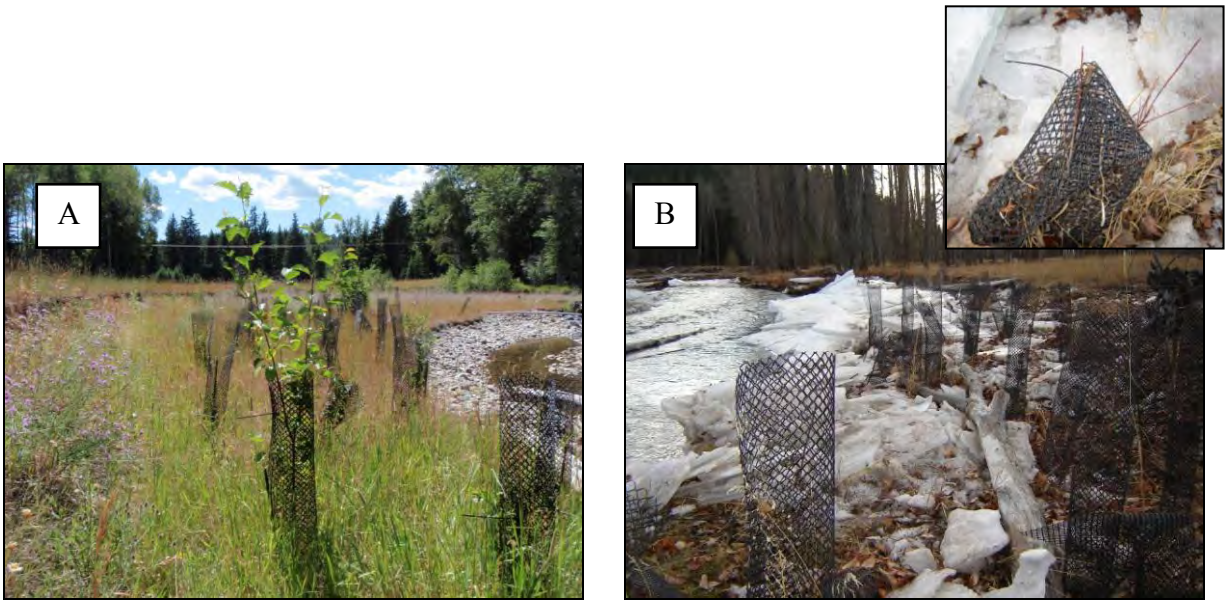

Figure 2. Planting Area Monitoring Plot 4 (Photograph A) is located at the downstream end of the project reach and browse protectors have remained relatively intact compared with Planting Area Monitoring Plot 1 (Photograph B), which is located at the upstream end of the project reach where ice is more prevalent.

Vegetated Soil Lift Monitoring

A summary of summer 2008 vegetated soil lift effectiveness monitoring results is provided in Table 2. This table summarizes the average value of each variable measured at monitored soil lift sites. Table A-2 in Appendix A presents the complete data set for each metric by five-foot increment. Vegetated soil lifts 2, 4, 6, 8, and 12 were monitored in December 2007 and August 2008 (Figure 1). Because plants were dormant in December 2007, more detailed observations were made during the August 2008. Because it is difficult to accurately assess survival and growth during dormancy, observations and data on survival and growth collected during the August 2008 monitoring event are more likely to represent actual conditions than the data collected during December 2007. Metrics such as scour and fabric degradation, however, can be assessed during any season, and these exhibited similar results between 2007 and 2008 monitoring.

The following is a summary of results and observations about vegetated soil lifts during winter 2007 effectiveness monitoring:

- Significant browse of willow cuttings and rooted plant materials is occurring at all sites.
- Minor rips and tears, assumed to be the result of ice formation and break up, are present on soil lifts in the upstream portion of the project reach.
- Outer coir fabric shows some signs of degradation on lifts installed in 2006 and very minimal degradation for lifts installed in 2005.
- Complete toe scour occurred on lifts installed in 2005.
- No toe scour occurred on lifts installed in 2006.
- Percent cover by desirable forbs and grasses, assumed to be the species seeded at the time of installation, is much higher than percent cover of invasive species on lifts installed in 2005. Minimal herbaceous cover is present on lifts installed in 2006.

- The number of obviously dead willow stems was much greater on the 2005 soil lifts compared with 2006 lifts; however, some 2005 lifts had numerous stems that appeared to be dead but had significant amounts of new growth near the base of the stem (Figure 3).
- Average shoot growth on surviving willows was between three and 24 inches and average growth was higher on lifts where woody debris was placed as a browse barrier.

The following is a summary of results and observations made of vegetated soil lifts during summer 2008 effectiveness monitoring that concur with results and observations made during 2007 monitoring:

- Average shoot height (new growth) of willows ranges from four to 24 inches.
- Percent of browse on current year willow shoot growth is as high as eighty to ninety percent.
- There are no rips/tears or accelerated degradation on any 2006 soil lifts.
- Complete toe scour occurred on lifts installed in 2005 (Figure 4).
- No toe scour occurred on lifts installed in 2006 (Figure 4).
- Percent cover of weeds is relatively low, ranging from one to ten percent.

The following is a summary of results and observations made of vegetated soil lifts during summer 2008 effectiveness monitoring for metrics that were not collected in 2007 or that differ compared with 2007 monitoring:

- Overall survival of containerized plants placed vertically in vegetated soil lifts appeared to be low with only a few species (willow, cottonwood and dogwood) surviving.
- Survival and cover of willows is high but browse is limiting vertical growth (Figure 4).
- Percent cover of seeded native species ranges from one to 20 percent with a few areas reaching as high as 50 percent cover (Figure 5).
- Percent cover by species that have colonized naturally such as clovers, Kentucky blue grass, and smooth brome ranges from one to as high as 80 percent.

Based on the results of this monitoring and other observations of these structures, it appears that vegetative soil lifts effectively establish near-bank woody vegetation and create near-term bank stability. This is particularly true of structures installed after 2005 that included a reinforced rock and log toe.

Figure 3. Photograph showing vegetated soil lift installed in 2005 with new willow shoot growth near the base of the stems.

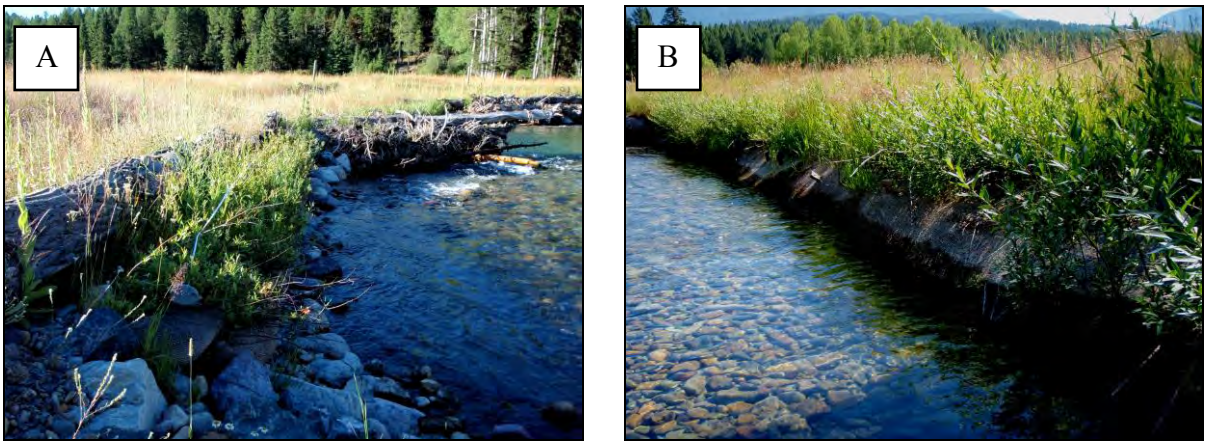

Figure 4. Photograph A shows soil lift 2 constructed in 2006 with a log and rock toe. Photograph B shows soil lift 4 constructed in 2005 without only a cobble toe. Soil lift 4 has more than 80% toe scour and soil lift 2 has 0% toe scour. Willow survival is high on both vegetated soil lifts. Willows growing in the top layer of both lifts had signs of browse.

Table 2. Summary of vegetated soil lift data collected during December 2007 and August 2008 monitoring.

Structure ID	SL2 (2006)				SL4 (2005)				SL6 (2006)				SL8 (2006)				SL12 (2006)			
Monitoring Year	2007		2008		2007		2008		2007		2008		2007		2008		2007		2008	
Layer	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Metric[1]																				
Rips/tears (inches)	0	NR	0	0	1	NR	1	0	0	NR	0	0	0	0	0	0	0	0	0	0
Percent toe scour	0	NR	0	0	81	NR	0	0	0	NR	0	0	0	0	0	0	0	0	0	0
Percent cover willow	NR	NR	40	54	NR	NR	56	35	NR	NR	11	57	NR	NR	28	13	NR	NR	33	31
Percent cover seeded species	26	NR	2	10	68	NR	7	19	19	NR	8	1	3	8	12	5	1	2	1	3
Percent cover other herbaceous species	NR	NR	1	11	NR	NR	1	42	NR	NR	19	7	NR	NR	20	28	NR	NR	15	23
Percent cover weeds	5	NR	0	4	2	NR	0	2	5	NR	5	0	0	1	5	29	0	0	1	2
Number of alive stems (container plants)	NR	NR	1	1	NA	NA	NA	NA	NR	NR	0	0	NR	NR	0	0	NR	NR	0	0
Number of dead stems	2	NR	0	1	4	NR	2	0	4	NR	3	1	2	1	3	1	2	2	1	2
Percent browsed	NR	NR	5	41	NR	NR	12	51	NR	NR	18	50	NR	NR	21	12	NR	NR	12	33
Average willow shoot height (in)	8	NR	13	10	17	NR	26	19	4	NR	5	9	9	5	9	7	7	4	10	9

NR = not recorded, NA = not applicable, container plants not installed

[1] Methods for these metrics are described in Geum Environmental Consulting, Inc. (2008).

Figure 5. Photograph shows the back edge (floodplain side) of soil lift 4, where species such as yarrow and clover are abundant.

Point Bar Monitoring

Three constructed point bars were monitored in August 2008 (Figure 1). Monitoring data collected at each site is provided in Table A-3 in Appendix A. The results of this monitoring indicate that constructed point bars are creating conditions where desired pioneer plants can colonize and plant community succession has the potential to progress. Results of effectiveness monitoring data collected in August 2008 were similar to those collected in December 2007 except that a greater amount of cottonwood seedlings were observed on all point bars in 2008 (Figure 6).

The following is a summary of results and observations made of constructed point bars during 2007 monitoring:

- Constructed swales vary significantly in hydroperiod and ability to retain moisture during base flows. Primary factors influencing hydroperiod may include: location on the point bar, with swales located on the upstream portion of point bars appearing to have a shorter hydroperiod; distance from the channel, with swales closer to the channel having a longer hydroperiod; and elevation relative to baseflows, with swales with bottom elevations within one foot of adjacent channel baseflow elevations having a longer hydroperiod.
- Point bars are accumulating variable amounts of flood and wind-distributed organic matter.
- Large woody debris placed on point bars is promoting floodplain scour and sediment deposition.
- Large woody debris placed on point bars is creating microsites where woody vegetation is establishing. Shrub densities may be greater where woody debris (including wood

greater than four inches in diameter, less than four inches in diameter and accumulations of small pieces) is more abundant.
- Although cottonwood recruitment was observed on a variety of surfaces, it appears that cottonwood recruitment may be greatest in areas where sand deposition occurs.
- At both monitored point bars, swale bottoms were rarely at or below baseflow elevations. Shrub survival in swales appeared high up to one and a half feet above baseflow elevation.
- Evidence of scour and deposition is present more than two feet above baseflow elevation.
- Cottonwood recruitment was much higher at point bar 13, although floodplain elevations were not that different relative to baseflow levels compared with point bar 4, where no cottonwood recruitment was observed.
- Browse was observed on all naturally recruited and planted woody vegetation.

Monitoring results and observations made during August 2008 were similar to those made during December 2007 with the following exceptions:

- Cottonwood recruitment was observed on the majority of point bar and constructed floodplain surfaces throughout the project reach. This is likely a result of the characteristics of 2008 runoff, which occurred very near cottonwood seed release and had a gradual peak and recession. The characteristics of spring hydrographs are very closely tied to natural recruitment of cottonwood seedlings.
- Cottonwood recruitment was observed on a variety of substrates including sandy deposits, mineral soils, and gravel and cobble of various sizes.
- Although a wide range of conditions were observed in constructed swales, it appears that the majority of swales provide adequate moisture and protection for woody and herbaceous plants to establish. This was difficult to observe outside of the growing season.
- Herbaceous species density and diversity is much greater in swales than on other floodplain surfaces.
- Weeds appear to be increasing in cover and diversity. Species include knapweed, houndstongue, oxeye daisy, and yellow toadflax.

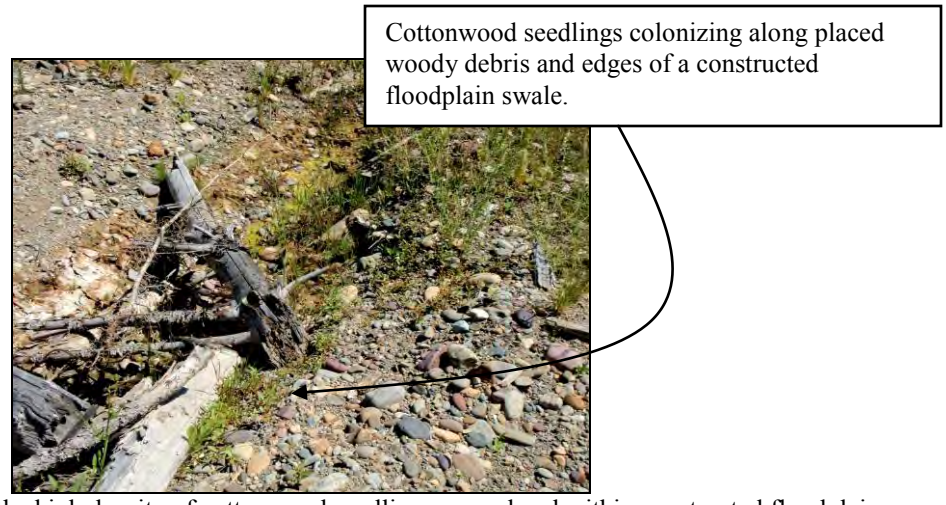

Figure 6. Photograph shows the high density of cottonwood seedlings around and within constructed floodplain swales observed during 2008 monitoring.

Based on the results of this monitoring, the treatments implemented on constructed point bars (grading, swale construction, placement of woody debris, planting and seeding) are achieving the designed goal of creating conditions to support natural recruitment and establishment of desired vegetation.

Adaptive Management and 2008 Final Design

The 2008 Revegetation Plan describes in detail how the results of December 2007 effectiveness monitoring were used to develop the treatments included in that plan. The plan also describes the treatments in detail. This section describes how the results of August 2008 effectiveness monitoring were used to verify and finalize the riparian revegetation treatments implemented in the Grave Creek Phase I and II project reaches in October 2008. As described earlier and in the 2008 Revegetation Plan, results and observations from 2007 monitoring helped further identify the primary constraints to revegetation and determined the 2008 phase of revegetation treatments. Because 2007 monitoring was completed in December, when many site conditions could not be observed and because 2008 implementation was to occur after the 2008 spring run-off, additional monitoring was completed in 2008 to verify the treatments identified in winter 2007 and observe any additional changes that may require adjustments to treatment types or locations. This section is organized by treatment. The treatment categories included in the final design for the Fall 2008 riparian revegeatation phase of the project include:

- Riparian fencing
- Maintenance of existing planting areas
- Floodplain treatment
- Point bar revegetation
- Bioengineering
- Weed control
- Vegetated Set Back Bank
- Channel vane repairs

Riparian Fencing

Browse, which has eliminated most younger age class trees and shrubs, was identified as a major limiting factor to plant community succession and development within the project area. Many of the other limiting factors to achieving the desired future conditions along Grave Creek (stream bank and floodplain instability, limited point bar plant community succession, and the influx of weeds) are directly related to the lack of a structurally diverse native plant community. Observations made during December 2007 effectiveness monitoring suggested that ungulate browse was one of the main limiting factors for achieving desired riparian plant communities within the project reach. The 2008 Revegetation Plan proposed either constructing a new fence that would exclude wildlife use of the entire Phase I and II project reaches or supplementing the existing riparian fence to limit wildlife use. During project development in the winter and spring of 2008 it appeared that this option would not be feasible based on assumed costs. Therefore, a wide range of alternative treatments were evaluated. These included constructing smaller exclosures on certain point bars; and noise, visual and odor deterrents. However, based on researching these treatments and discussing the issue with fencing and wildlife experts, it was concluded that they would not be effective given the scale and degree of browse occurring in the

project reach. Ultimately, an 8-strand electric slant rail wildlife fence was chosen to address this factor. More details on this treatment are provided in the 2008 as-built documentation in the following section.

Monitoring and observations made during August 2008 did not lead to any changes in fence recommendations as fencing was already in progress when 2008 monitoring occurred. However, browse levels observed in August were not as severe as were observed in December 2007. During August, cottonwood seedlings were abundant on point bar and floodplain areas throughout the project area. Although most of these seedlings were recruited during spring 2008, very few had been browsed by August. The landowner indicated that browse pressure by deer begins to increase in late August and is high throughout early fall.

Maintenance of Existing Riparian Planting Areas

Observations and the results of 2007 monitoring led to the recommendations found in the 2008 Revegetation Plan for maintenance of existing riparian planting areas. Proposed maintenance treatments included removing all browse protection measures and solarization fabric within each planting area. The growth of containerized plants installed along Grave Creek in 2005 was being limited not only by browse, but also by damage to browse protectors from ice and high flow events. Observations and results from 2008 monitoring led to adjustments to the maintenance treatments included in the 2008 Revegetation Plan.

Browse continues to affect planted containerized stock. Treatments proposed in the 2008 plan included removal of all browse protectors placed around containerized plants to reduce the damage to plants resulting from ice flows bending and distorting the rigid mesh protectors. Based on the 2008 observations, this treatment was modified to expand existing browse protectors in locations where ice damage was minimal and remove browse protectors in areas closest to the channel and vulnerable to ice damage.

Floodplain Treatment

During 2007 monitoring, areas of localized channel incision were observed in the project reach. Channel incision reduces floodplain connectivity, which inhibits fluvial processes such as sediment and seed deposition on bare surfaces and reduces hydrologic floodplain recharge. Lack of hydrologic floodplain recharge limits plant community succession within the floodplain. The results of 2007 monitoring and other observations of the project reach led to including treatments that address the constraints posed by localized channel incision and lack of hydrologic connection within the floodplain in the 2008 Revegetation Plan. Treatments in the 2008 Revegetation Plan originally included minor grading, construction of floodplain swales and the addition of large woody debris at Sites 2, 4, 8, and 10. After observing point bar conditions at these sites during August 2008 monitoring, it became apparent that many desired floodplain processes, such as extensive recruitment of cottonwood seedlings, and woody debris and organic matter accumulation, had occurred during the 2008 spring run-off. Because it was undesirable to disturb these areas, treatments were adjusted so that floodplain grading occurred at Site 8 only.

Point Bar Revegetation

During 2007 monitoring, very little natural regeneration of woody vegetation was observed on constructed point bars and floodplain surfaces. Survival of shrubs planted in constructed

floodplain swale features was uncertain in December 2007. Browse, lack of floodplain connectivity, and uniform point bar surfaces were identified as potential factors limiting plant community succession in the project area. August 2008 monitoring and general observations made during that period showed widespread distribution of cottonwood seedlings on point bar surfaces and in swales compared with observations made during 2007. Further, many of the plants previously installed in floodplain swales appear vigorous, although they are slightly browsed. Point bar revegetation treatments, including seeding and planting of large containerized shrubs in existing constructed swales, were originally planned for Sites 4, 9, 10, and 12. Results and observations made during 2008 monitoring led to the following adjustments to the point bar revegetation treatment:

- The number of constructed and naturally occurring swales scheduled for seeding was increased, but using a lighter seeding rate due to the amount of natural recruitment already occurring.
- Cottonwood poles originally planned for swales were removed as a treatment because extensive natural recruitment of cottonwoods is occurring within and around swales.
- Because of the high levels of browse, and to provide plants with shade and moisture, woody debris placement around containerized plants within swaleswas added to this treatment.

Bioengineering

During 2007 monitoring, a number of streambanks were observed to exhibit accelerated lateral erosion, limiting the development of desired plant communities on outer meander bends. Further observations and results from 2008 monitoring led to adjustments to the revegetation plan treatments as follows:

- Although surviving containerized plants in the 2006 vegetated soil lifts appear healthy and are contributing to diversity at those sites, overall survival of these plants appeared to be low; therefore, no containerized plants were specified to be installed in 2008 vegetated soil lifts.
- Dormant willow cuttings on the bottom layer of soil lifts were removed from soil lift designs due to poor survival observed during 2008 monitoring.
- 2008 monitoring verified the need for large sized toe material at all streambank bioengineering structures in the project area, and cobble ranging from eight to 18 inches was specified for all bioengineering sites.

Weed Control

Observations made during August 2008 monitoring indicated that weed infestations had become common throughout the project reach. Competition for resources such as light, nutrients, moisture, and space by weed species limits the ability of native plants to colonize and become established in areas where weed infestations are severe. No weed control treatments were included in the 2008 Revegetation Plan. Many of the infestations were observed at sites that also supported high densities of newly recruited cottonwood seedlings. These observations led to the following adjustment to treatments included in the 2008 revegetation treatments:

- Hand pulling was recommended for a select number of sensitive areas in an attempt to limit competition with establishing cottonwood seedlings.

Vegetated Set Back Bank Treatment

During 2007 monitoring, accelerated lateral erosion resulting in an approximately six-foot high actively eroding bank was observed (Site 2) (Figure 7). This site has been identified as a potentially major contributor of fine sediment in the project reach. Streambank instability and lateral erosion limit the establishment of woody vegetation and prevent plant community succession from occurring. The 2008 Revegetation Plan included treating the site by constructing a vegetated setback bank in the anticipation of continued erosion. A vegetated set back bank establishes woody vegetation parallel to, and set back from, the eroding stream bank. The setback distance allows woody species time to develop dense root systems that will provide structure to the stream bank as the channel migrates toward the setback bank.

Because of uncertainties concerning the rate and causes of erosion, a variety of additional options were discussed for addressing the erosion at this site during project planning and 2008 monitoring. One option discussed with project partners was to allow the erosion to continue. This option posed an unacceptable risk to the reconstructed channel because of existing channel and streambank structures immediately downstream of the bank that could be compromised if erosion continues. Another option was to create a bankfull bench at the existing streambank location using bioengineering techniques. While feasible, this option would have been costly and would not have addressed risks from potential channel changes upstream of the eroding bank.

After considering these options, project partners selected the vegetated setback bank as the most cost-effective option for Site 2. This would allow the channel to continue to migrate and adjust without compromising either existing channel structures or the long-term stability of the project reach.

Figure 7. Photograph shows Site 2 eroding bank in December 2007.

Channel Structure Repairs

During 2007 monitoring, areas of localized channel incision were observed. This was of particular concern in one section of stream where channel incision occurred when the river flanked two channel structures (Figure 8). The purpose of these structures is to maintain the channel elevation and form temporarily while streambank vegetation establishes and channel

substrates are sorted. Therefore, repairs to these structures were included in the 2008 Revegetation Plan. During August 2008 monitoring and final design, two additional woody debris jams were added at this site to reduce scour of an eroding floodplain terrace and allow for construction of a vegetated soil lift to establish woody vegetation.

Figure 8. Photograph A shows the structure at Site 7 requiring repairs due to flanking behind the structure arm resulting in accelerated lateral bank erosion. Photograph B shows the structure at Site 8 requiring repairs also due to flanking behind the structure arm.

2008 Riparian Revegetation: As-built Documentation

This section describes work that was completed between October 6 and October 16, 2008 to implement the 2008 Revegetation Plan, including the revised treatments described in the previous section. The 2008 Revegetation Plan, completed in February 2008 under contract with Kootenai River Network, Inc., identified a variety of limiting factors and the strategies and techniques that would address those limiting factors. This section is organized by treatment category, similar to the previous section. The following treatments were implemented in October 2008:

- Riparian fencing
- Maintenance of existing planting areas
- Floodplain treatment
- Point bar revegetation
- Bioengineering
- Weed control
- Vegetated Set Back Bank
- Channel vane repairs

This section provides details on each of the riparian revegetation treatments completed during October 2008. Table 3 lists the treatments and quantities implemented at each site. These treatments are described in detail in the 2008 Revegetation Plan. Specific tasks associated with the treatments are described in more detail under the treatment sub-headings below. To document as-built conditions, all treatment locations were recorded using a resource-grade global positioning system (GPS) unit. Locations were imported into ArcView 9.2 and georeferenced to a 2005 National Agriculture Imagery Program (NAIP) aerial photo of the project site. The as-built survey is shown in Figure 9. Detail sheets showing as-built conditions are shown in Figures B1-B3 in Appendix B.

Table 3. Revegetation treatments and quantities implemented within the Grave Creek project reach during October 2008.

2008 Treatment and Treatment Location	**As-built Quantity**	
Riparian Fencing	**Length (feet)**	
All	6,000	
Riparian Planting Area Maintenance		
Site 3	1	
Site 5	1	
Site 7	1	
Site 10	1	
Site 11	1	
Total	**5**	
Floodplain Treatment	**Number of logs**	
Site 8	5	

2008 Treatment and Treatment Location	**As-built Quantity**	
Point Bar Revegetation	**Seeding (pounds)**	**2-5 gallon containerized plants**
Site 2	2	
Site 3	2	
Site 4	5	17
Site 5	2	
Point Bar Revegetation	**Seeding (pounds)**	**2-5 gallon containerized**
Site 6	2	
Site 8	5	
Site 9	2	22
Site 11	2	
Site 10	10	18
Site 12	10	18
Site 13	2	
Site 14	2	
Total	**46**	**75**
Bioengineering	**Length (feet)**	
Soil lifts		
Site 3	120	
Site 5	120	
Site 7	100	
Site 10	30	
	370	
Coir logs		
Site 1	40	
Site 7	110	
Site 12	50	
Total	**200**	
Buried coir log/willow fascine		
Site 13	100	
Site 14	100	
	200	
Weed Control	**Area (acres)**	
Site 7	1	
Site 10	2	
Site 12	2	
Total	**5**	
Vegetated Set Back Bank Treatment	**Length (feet)**	
Site 2	300	

2008 Treatment and Treatment Location	As-built Quantity	
Other		
Site 7 vane repairs	1	
Site 8 vane repairs	1	
Harden return flow Site 1	1	
Site 10 woody debris jams	2	

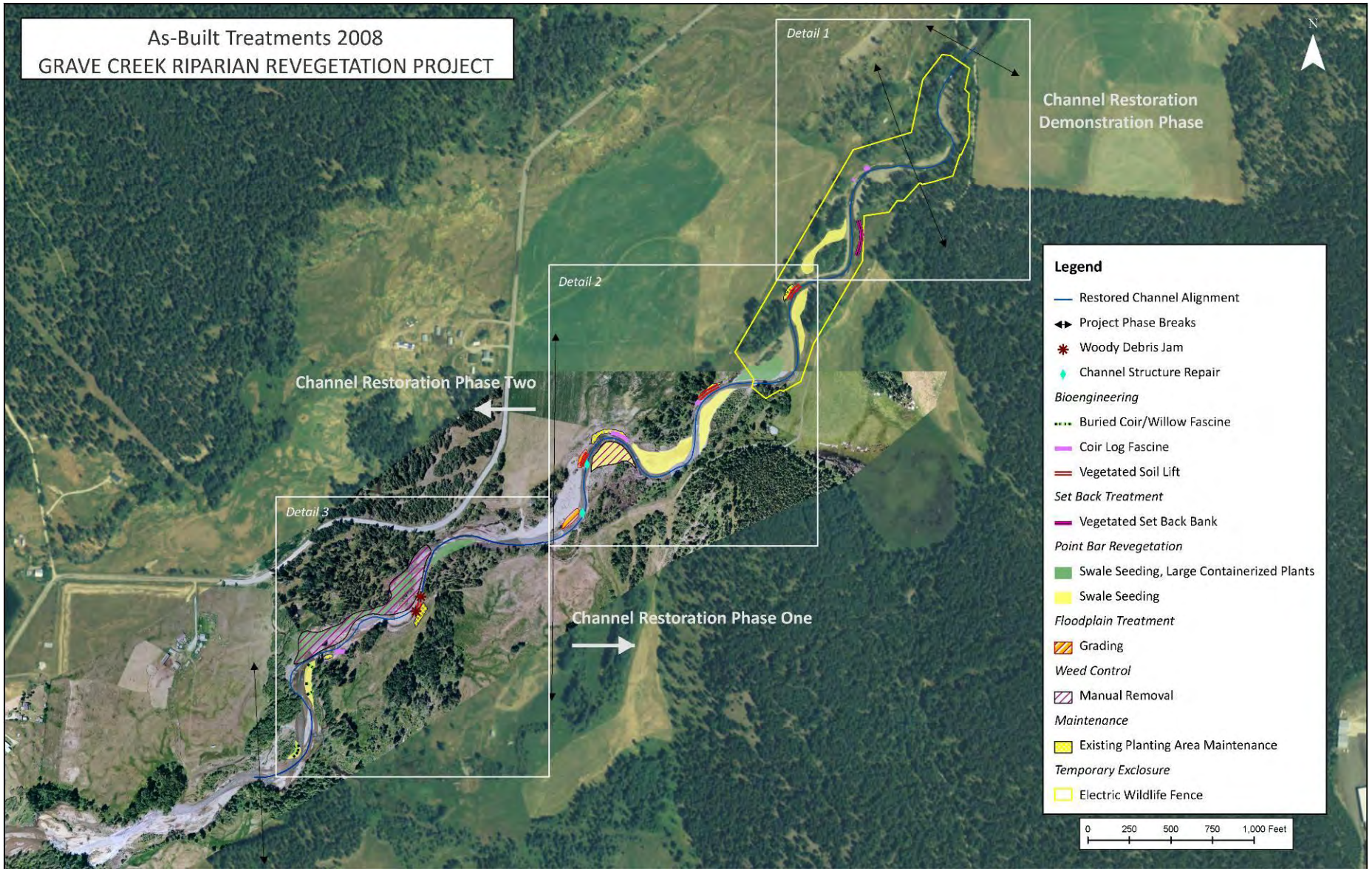

Figure 9. Overview figure showing as-built locations of 2008 revegetation treatments installed in Phase I and II in October 2008. Detail sheets are provided in Appendix B.

Riparian Fencing

Riparian fencing was constructed to limit deer and elk access to the riparian area and allow the understory vegetation to establish and create the desired plant community structure. Approximately 4,000 feet of fence enclosing 20 acres of riparian vegetation was constructed in August 2008. The fence is an eight strand electric slant rail fence (Figure 10). The fence encloses the riparian area within the Demonstration reach and extends downstream to Site 4 within the Phase I project reach. The location of the fence is shown in Figure 9.

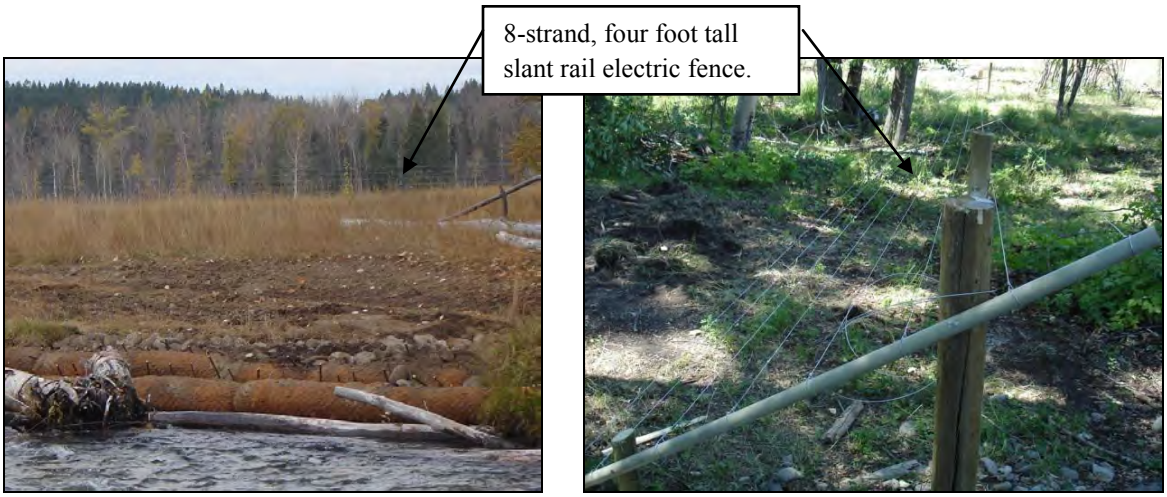

Figure 10. Photographs showing the electric slant rail fence installed during August 2008 to reduce wildlife browse within the project reach.

Maintenance of Existing Riparian Planting Areas

Containerized plants and solarization fabric were installed at various locations within the project reach in 2005. Maintenance of all planting areas (Sites 3, 5, 7, 10 and 12) was completed during October 2008. Figures 11 and 12 provide examples of before and after conditions within planting units. A combination of the seed mixes listed in tables 4 and 5 was used on exposed bare soils after removal of solarization fabric at Sites 5 and 7. Maintenance activities included:

- Removing and/or re-fitting damaged browse protectors at all sites.
- Removing solarization fabric from Sites 5 and 7.
- Seeding newly exposed mineral soils at Sites 5 and 7.
- Placement of woody debris around plants at Sites 5 and 7 to provide microsites where seed can germinate.

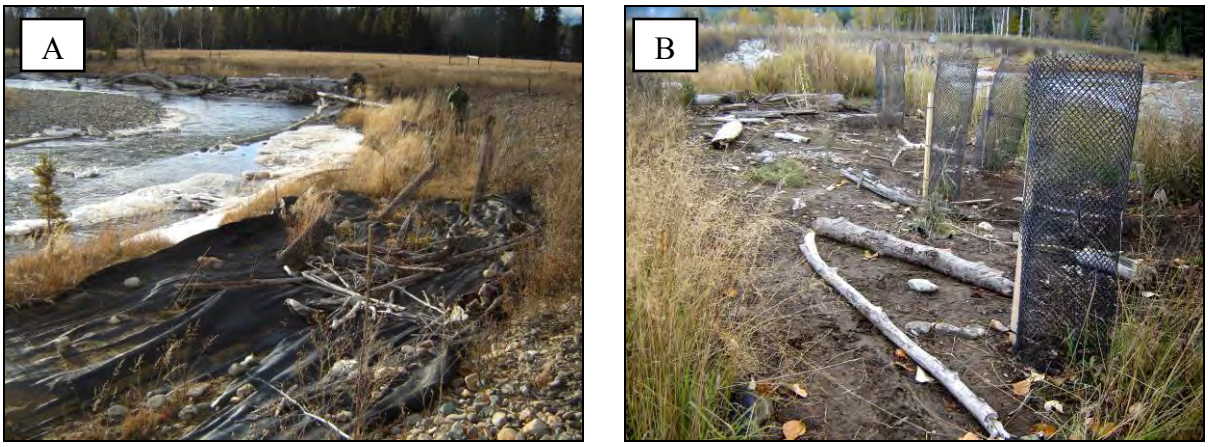

Figure 11. Photograph A shows Planting Area 2 before 2008 maintenance and Photograph B shows Planting Area 2 after 2008 maintenance. Most browse protectors were removed, while others were adjusted to allow plants to expand. Wooden stakes were used as support instead of rebar. Rebar bent during ice flows resulting in damage and constriction to plants.

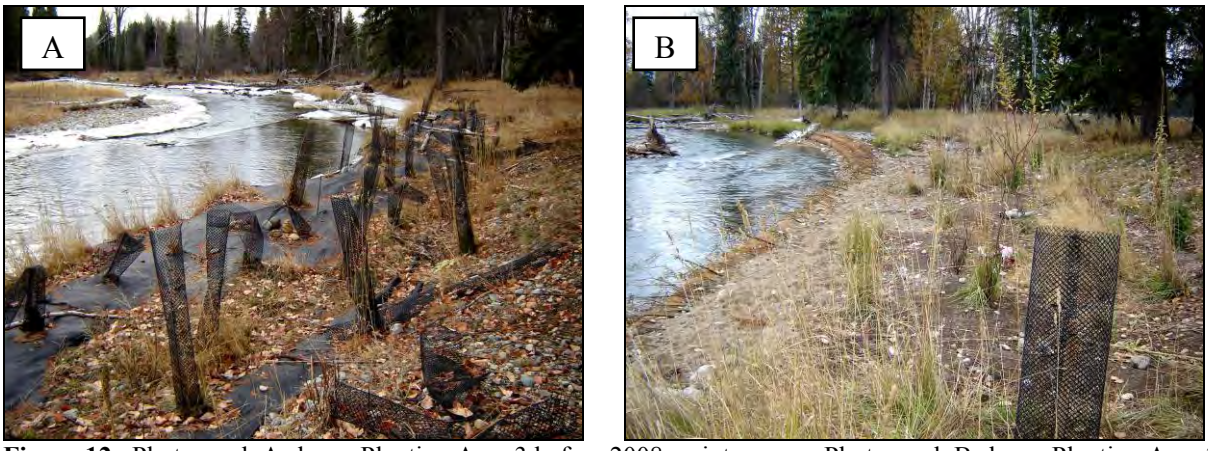

Figure 12. Photograph A shows Planting Area 3 before 2008 maintenance. Photograph B shows Planting Area 3 after maintenance and construction of a vegetated soil lift.

Floodplain Treatment

A small amount of floodplain grading occurred at Site 8 to address limiting factors such as reduced connectivity with the channel and simple, uniform floodplain surfaces. The localized channel incision occurring between Sites 7 and 8 resulted in the left point bar surface being at a slightly higher elevation than the channel and reducing the potential for the surface to be accessed by overbank flows (Figure 13). Any existing native vegetation within the grading area was salvaged and replanted either directly on the newly graded surface or behind the vegetated soil lift at Site 7. The material removed during grading was used to backfill the decommissioned water gap at Site 7 (Figure 14). All construction disturbance areas were seeded with an erosion control seed mix (Table 4).

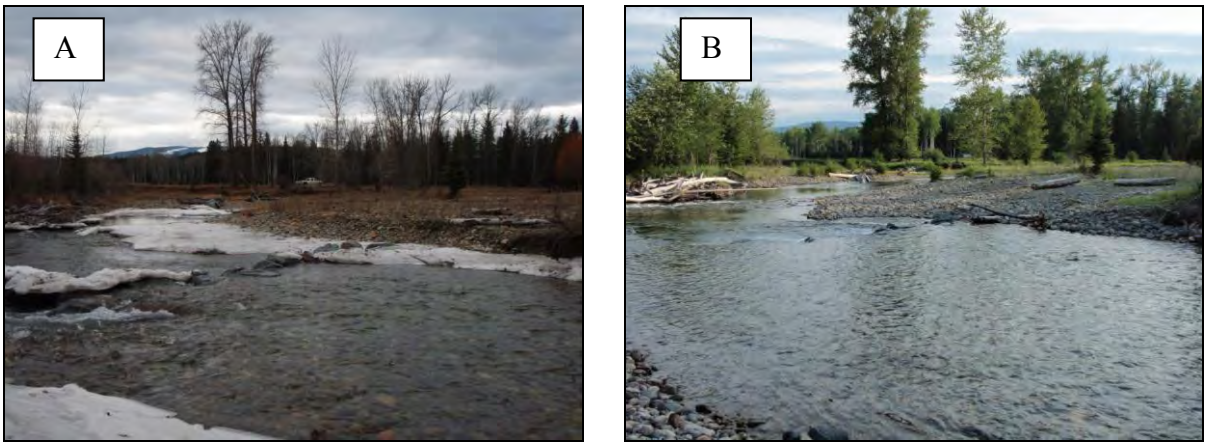

Figure 13. Photograph shows Site 8 before grading (A). Minor channel incision has reduced the potential hydrologic connection between the channel and floodplain. Photograph B shows the site the summer following grading.

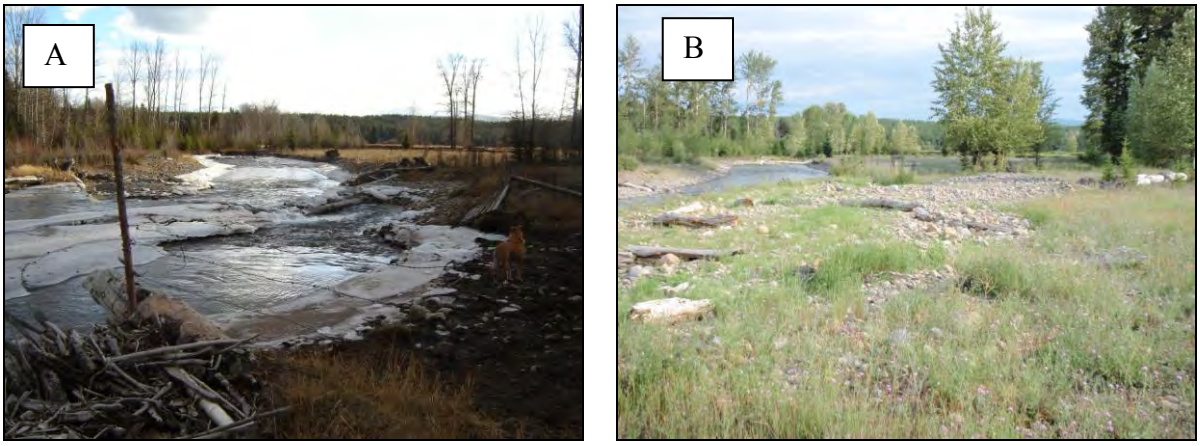

Figure 14. Photograph A shows the cattle water gap prior to construction. Photograph B shows the site the summer following construction of a soil lift and back-filling the access ramp. Material removed from Site 8 shown in Figure 13 was used at this site.

Table 4. Erosion control seed mix used in disturbed areas of the project.

Scientific Name	Common Name
Agropyron riparium	Streambank wheatgrass
Elymus trachycaulus	Slender wheatgrass
Achillea millefolium	Common yarrow
Epilobium angustifolium	Fireweed

Point Bar Revegetation

Point bar revegetation treatments were implemented at Sites 2 through 6 and 8 through 14 to address site constraints such as limited plant community succession, weed competition, and browse. Seeding and large container plants were incorporated into previously constructed floodplain swales to stimulate plant community succession. Large container plant material has a well developed root system and large diameter stems that are better able to withstand browse pressure and provide immediate root stability to the site. Locations of sites where point bar revegetation treatments were completed are shown on Figure 9. A floodplain seed mix (Table 5)

was broadcast spread by hand in constructed point bar swales and natural depressions that exhibited conditions likely to support germination of the seeded species. Seeding of existing floodplain swales occurred at Sites 2 through 6 and 8 through 14. Swales at Sites 4, 9, 10 and 12 were planted with two and five gallon container plants (Figures 9 and 15). Woody debris was placed around the base of selected plants to provide moisture retention and shade and create barriers to browse. Table 6 lists the plant species installed. Table 3 provides the quantity of plants installed at each Site.

Table 5. Floodplain seed mix used for seeding swales as part of the point bar revegetation treatment.

Scientific Name	Common Name
Cornus sericea	Redosier dogwood
Betula occidentalis	Water birch
Carex stipata	Sawbeak sedge
Carex utriculata	Beaked sedge
Juncus ensifolius	Daggerleaf rush
Deschampsia cespitosa	Tufted hairgrass
Glyceria grandis	American mannagrass
Poa palustris	Fowl bluegrass
Prunus virginiana	Chokecherry
Juncus balticus	Baltic rush
Betula occidentalis	Water birch
Agropyron riparium	Streambank wheatgrass
Elymus trachycaulus	Slender wheatgrass

Table 6. Species mix used to plant swales as part of the point bar revegetation treatment at sites 4, 9, 10 and 12.

Scientific Name	Common Name	Size (gallons)	Quantity
Salix exiuga	Sandbar willow	5	10
Salix bebbiana	Bebb's willow	5	25
Cornus sericea	Red-osier dogwood	2	25
Populus balsamifera	Black cottonwood	2	15
		Total	**75**

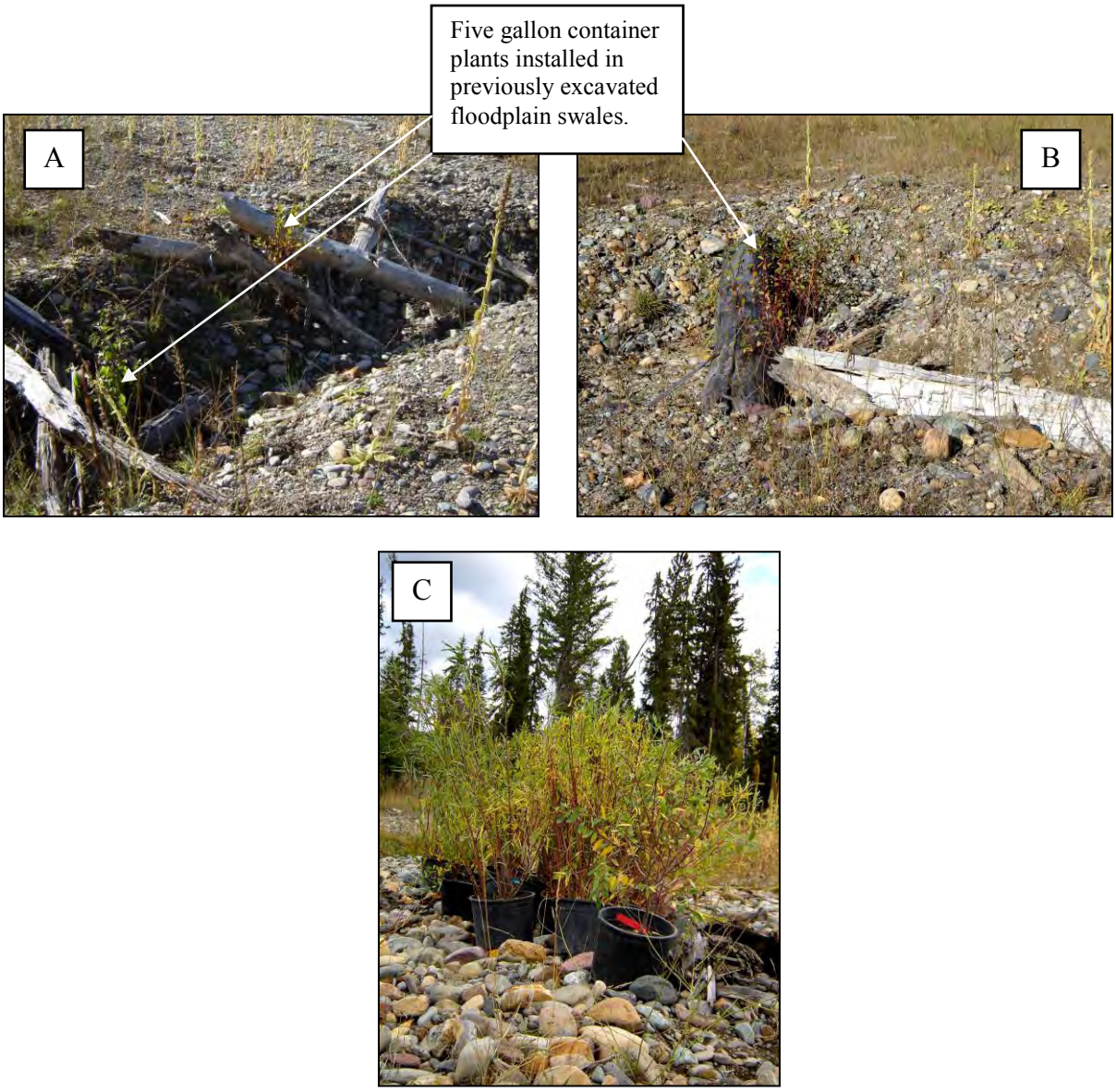

Figure 15. Two and five gallon container plants (Photograph C) were installed within previously excavated floodplain swales at Sites 4, 9, 10, and 12. Photographs A and B illustrate how woody debris was placed around plants to create moisture and shaded microsites as well as to protect the base of shrubs from browse.

Bioengineering

Two types of streambank bioengineering structures (vegetated soil lifts and coir log fascines) were installed in high priority areas where accelerated streambank erosion was observed. In addition, one type of floodplain bioengineering structure, a buried coir log/willow fascine, was installed on selected point bar surfaces.

Bioengineering structures were installed at Sites 1, 3, 5, 7, 10, 12, 13 and 14. Figure 9 shows the location of each structure within the project reach. Table 7 lists the type and length of bioengineering installed at each site. As-built details, provided by type of bioengineering structure, are provided in the following sections.

Table 7. Summary of bioengineering treatments installed in Grave Creek project Phases 1 and 2 in October 2008.

Site	Treatment	Length (feet)
1a	Coir log fascine – double layer	30
1b	Coir log fascine – single layer	10
3	Vegetated soil lift – double layer	100
5	Vegetated soil lift – double layer	120
7	Coir log fascine – double layer	110
7	Vegetated soil lift – double layer	80
10	Vegetated soil lift – triple layer	30
12	Coir log fascine – single layer	50
	Total length of bank treated (feet)	**530**
13	Buried coir/willow fascine	100
14	Buried coir/willow fascine	100
	Total length (feet)	**200**

Vegetated Soil Lift

Vegetated soil lifts (soil lifts) were installed at Sites 3, 5, 7, and 10. All soil lifts were constructed between existing bank structures, such as engineered debris jams or log J-hook vanes. Each soil lift was constructed with a rock toe to prevent scour and slumping (Figure 16). The size of the toe material ranged from eight to 18 inches. Approximately two hundred dormant willow cuttings were layered between and on the top layer of each soil lift. The bottom layer of each soil lift was faced with seven pound density coir logs and the top layers were faced with four pound density coir wattles (Figure 17) with the exception of the Site 3 soil lift which was constructed with seven pound density coir logs on both the top and bottom layers. Soil lifts were backfilled with top soil salvaged from Site 2 in preparation for other revegetation treatments at that site (Figure 17). Figure 15 shows Site 5 before and after construction of a soil lift. Two sixteen-inch, high density coir logs were also installed at Site 5. Coir logs were installed along a small area of floodplain scour that was back-filled during work at this site to reduce the potential for continued scour behind the vane installed at this site.

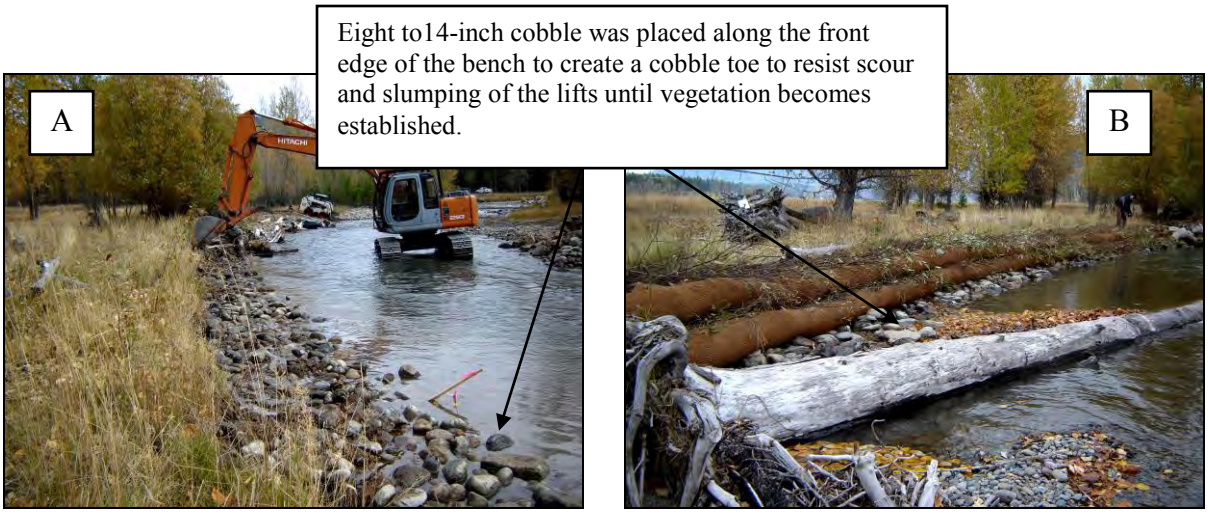

Figure 16. Vegetated soil lift at Site 3 during (Photograph A) and after (Photograph B) construction.

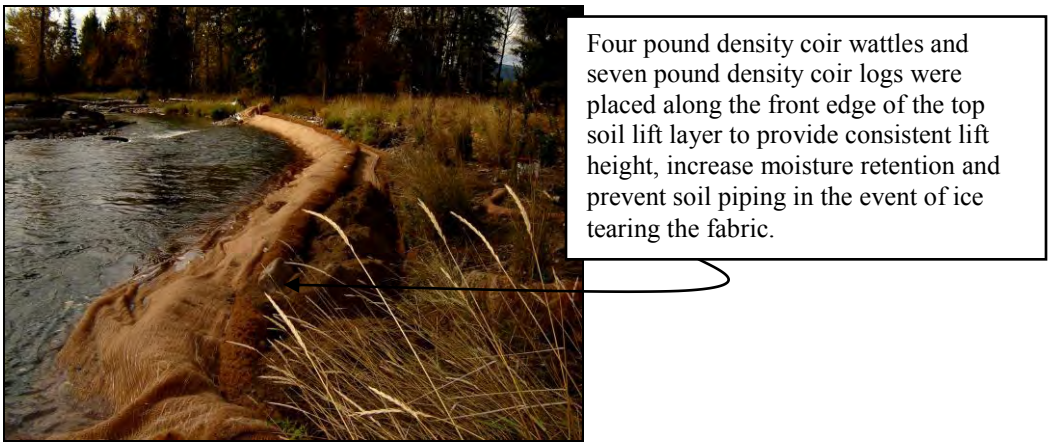

Figure 17. Photograph shows the vegetated soil lift at Site 5 during construction.

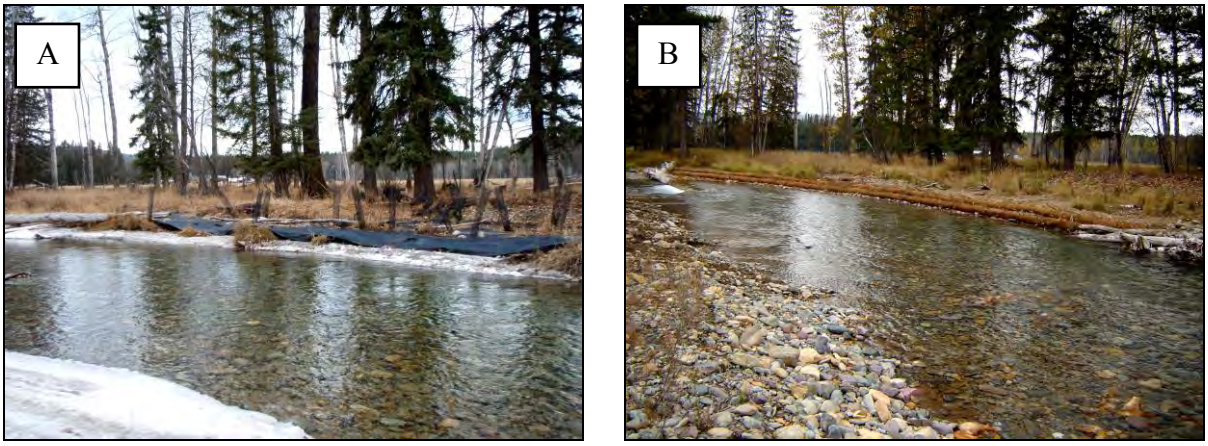

Figure 18. Photographs showing Site 5 vegetated soil lift and planting area before (Photograph A) and after (Photograph B) construction and maintenance.

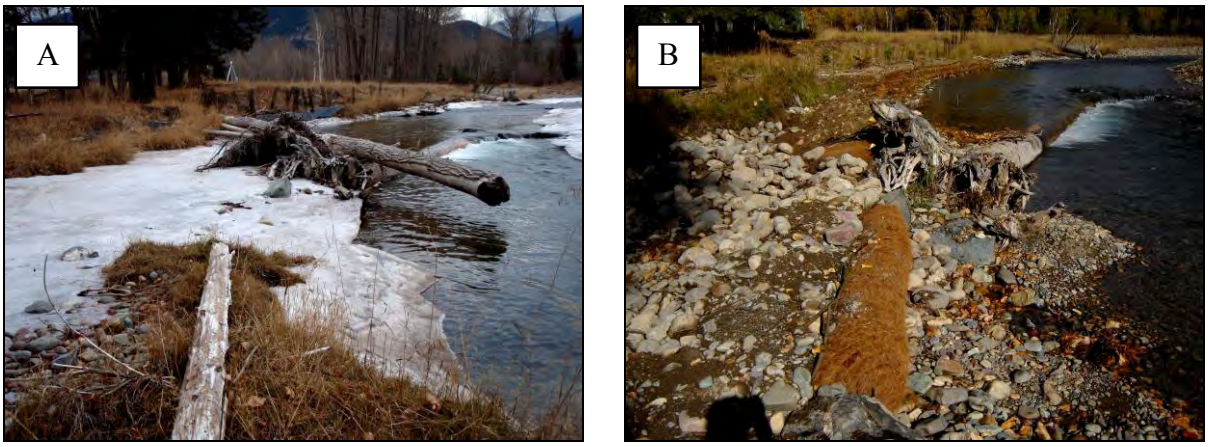

Figure 19. Photograph A shows the downstream end of Site 5 before construction. The ice accumulation represents the area that scoured behind and downstream of the log j-hook channel structure. Photograph B shows the downstream end of Site 5 after the installation of 16-inch, 9 pound density coir logs in the scour area (foreground) and a vegetated soil lift to reconstruct the bank line upstream of the J-hook channel structure (background).

Coir Log Fascine

Coir log fascines were installed along streambanks at Sites 1, 7, and 12. Figure 9 shows the location of coir log fascines installed in the project reach during October 2008. Sixteen-inch diameter, nine pound per cubic foot density coir logs were installed on constructed cobble benches with a rock toe. Duckbill earth anchors and wire cable were used to secure the coir logs in place. Dormant willow stakes, two to three feet in length, were installed at one-foot intervals behind the coir logs. Figure 20 shows Site 7 before and after coir log fascine construction. Figure 21 shows Site 12 before and after construction.

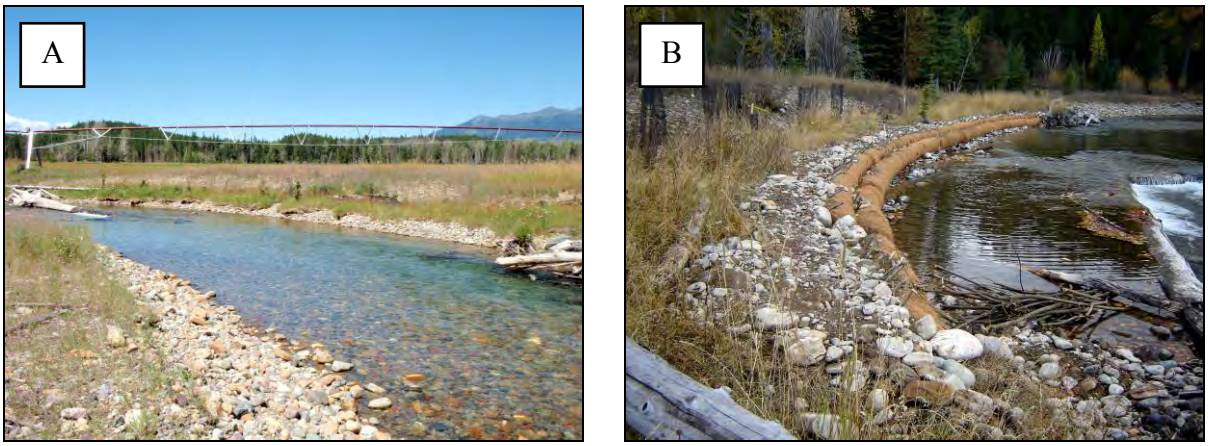

Figure 20. Photographs show Site 7 before (Photograph A) and after (Photograph B) construction of coir log fascine. Photograph A is taken from the left bank looking downstream. Photograph B is taken from the right bank looking upstream.

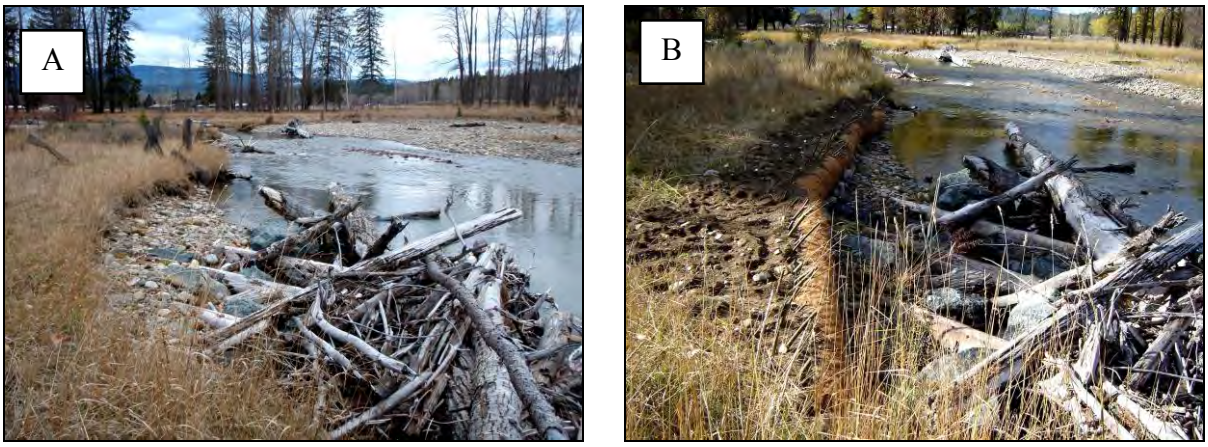

Figure 21. Photographs show Site 12 before (Photograph A) and after (Photograph B) construction of coir log fascine.

Buried Coir/Willow Fascine

Buried coir/willow fascines were installed on depositional point bar surfaces at Sites 13 and 14. Figure 9 shows the locations of buried coir log fascines within the project reach. Three, 20-foot fascines and one, 30-foot fascine were installed at Site 13. Two, 40-foot fascines and one, 20-foot fascine were installed at Site 14. Fascines were constructed by excavating four-foot wide by two- to four-foot deep trenches of varying lengths on the point bars at Sites 13 and 14. Each treatment site includes between 50 and 150 four to six-foot long dormant willow cuttings placed vertically along the upstream edge of each trench. Seven pound density coir logs were placed horizontally within the trench near the base of the willow cuttings (Figures 22 and 23). Duckbill earth anchors were used to secure the ends of the two outer most coir logs within the constructed trenches and coir twine was used to tie the interior portions of each coir log together. The purpose of this anchoring is to keep the willows and coir logs in place in the event of a large flow resulting in scour of newly constructed floodplain surfaces. Both floodplain surfaces were constructed during 2006 channel maintenance and repair work. Groundwater of varying depths was encountered during excavation of most trenches. At sites where a significant amount of groundwater was encountered, the depth appeared to be very near the baseflow water elevation in the adjacent channel. Sites where little or no groundwater was encountered were located a greater distance from the active channel compared with other, wetter sites. Figures 22 and 23 illustrate the construction process for buried coir log fascines.

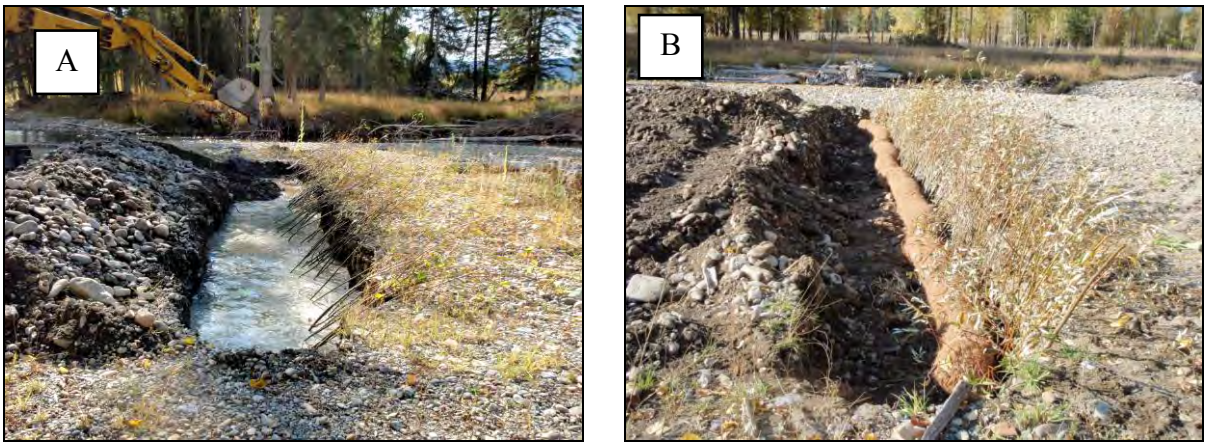

Figure 22. Photographs show the construction process for the installation of buried coir log fascines at Sites 13 and 14. Photographs A and B provide examples of the variation in the amount of ground water encountered during construction. The trench shown in Photograph A was located closer to the channel and further upstream on the point bar compared with the trench shown in Photograph B.

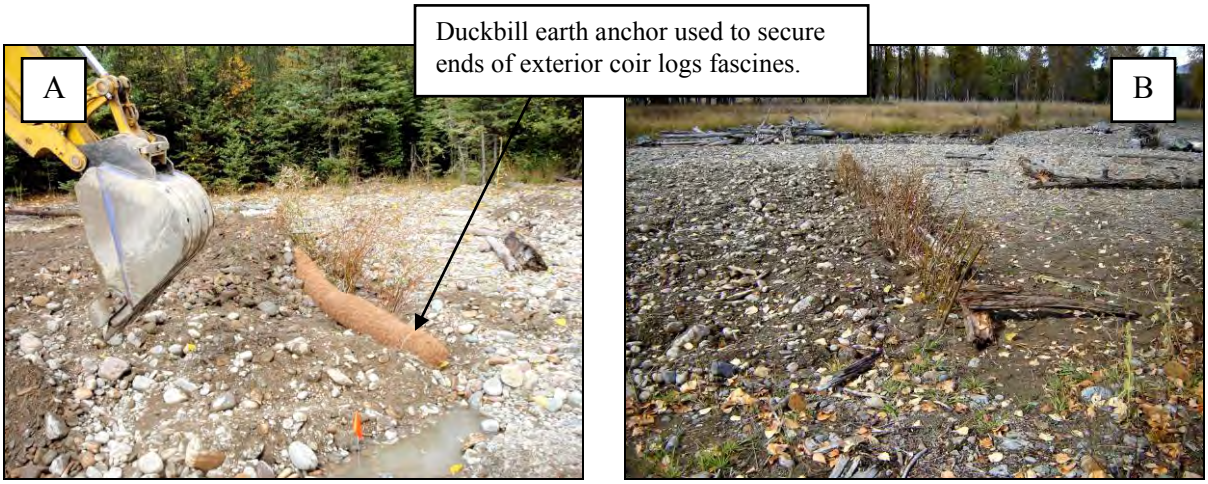

Figure 23. Photograph A shows a buried coir log fascine during final stages of construction. Photograph B shows a completed buried coir log fascine.

Weed Control

Knapweed (*Centaurea spp.*) occurs in dense patches on the majority of point bar surfaces throughput the project reach. Other noxious weeds occurring within the project reach include oxeye daisy (*Chrysanthemum leucanthemum*), yellow toadflax (*Linaria vulgaris*), and houndstongue (*Cynoglossum officinale*). Sensitive areas with abundant natural recruitment of native plants (point bars) were targeted for a weed removal effort during August 2008 while the plants were still in flower and were in the initial stages of setting seed. Weed control efforts focused on point bar and floodplain surfaces at Sites 7, 10, and 12 where densities of both knapweed and cottonwood seedlings were high (Figure 9). Weeds were removed by hand, bagged, and disposed of off-site. The weed control effort at Site 7 focused on clearing knapweed away from individual cottonwood seedlings. The weed control effort at Sites 10 and 12 concentrated on clearing all knapweed from the entire point bar surface. Figure 24 illustrates the degree of knapweed infestation on point bar and floodplain surfaces before and during weed removal.

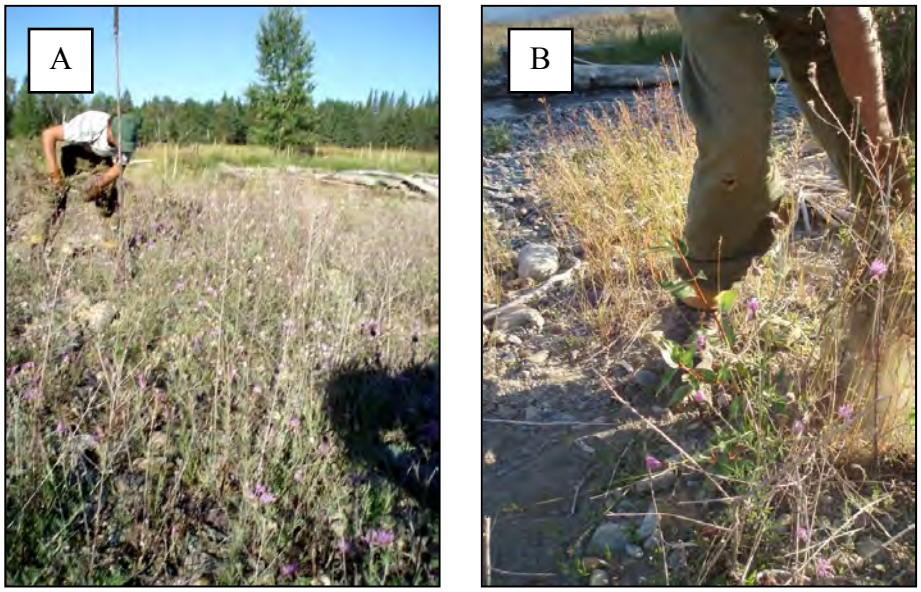

Figure 24. Photograph A is an example of a knapweed infestation occurring on a floodplain surface within the project reach. Photograph B demonstrates how the method of pulling weeds by hand allows for the removal of weeds from sensitive areas, such as where cottonwood seedlings are establishing.

Vegetated Set Back Bank Treatment

A vegetated set back bank was constructed at Site 2 to address streambank instability and lateral erosion occurring at this site. The location of the vegetated set back bank is shown in Figure 9. The vegetated set back distances were determined by evaluating the existing channel dimensions and estimating future migration patterns. Prior to vegetated set back bank construction, key elevations (approximate bankfull, channel bed, and existing ground surface within the set bank trench location) were identified using a laser level. These elevations were used to determine cut depths at intervals along the vegetated set back bank. Design elevations for the bottom of the set back bank trench were set at the approximate channel scour depth, estimated to be three feet below bankfull. Design elevations for the final surface of the set back bank were set at the approximate bankfull elevation.

The vegetated set back bank was constructed by excavating a trench parallel to the existing channel. As-built cut elevations in middle portions of the vegetated set back bank match the current estimated scour depth of the channel (i.e. three feet below bankfull) so that woody debris placed in the bottom of the vegetated set back bank is at an effective depth to provide structure to the stream banks and channel bed as the channel migrates toward the vegetated set back bank. Elevations at the upstream and downstream ends of the trench bottom ranged from one to four feet below bankfull. Total cut depths ranged from four to nine feet below the existing ground surface. Groundwater was observed during excavation in portions of the upstream end of the trench and throughout the entire length of the downstream portion of the trench. The constructed trench averaged six feet in width.

The trench was constructed in approximately 10-foot segments. Large woody debris, ranging in size from 10 to 24 inches and three to six feet in length, was placed in the bottom of each trench segment. Logs were placed in the trench bottom to provide structure in the form of temporary

toe protection to the future stream bank (Figure 25, Photo A). The sides of the trench were sloped back to approximately 45-degree angles. Dormant willow cuttings and cottonwood poles were placed on the 45-degree slopes on both the front and back edges of the trench with the rooting ends of the cuttings at or just above the depth of the woody debris (Figure 25, Photo B). Approximately 1,000 dormant willow cuttings and 40 cottonwood poles were placed within the vegetated set back bank. The tops of the willow cuttings and cottonwood poles extend above the top surface of the trench (existing ground surface). The trench was then filled using material initially excavated from the trench to the approximate bankfull elevation of the current channel. Containerized plants were then installed into the backfill material. Coarse woody debris was scattered and seed was broadcast by hand on the trench surface (Figure 25, Photo C). Table 8 lists the species and quantity of containerized plants installed within the vegetated set back bank. Table 9 provides the seed mix used.

Figure 25. Photographs A through C show the sequence of constructing the vegetated set back bank at Site 2. The trench is excavated to the desired depth, woody debris is placed in the bottom of the trench for structure (Photograph A) and dormant and live plants placed in the trench (Photograph B). The trench is then back-filled to approximately bankfull elevation of the existing channel and container plants are installed and woody debris and seed scattered on the top surface (Photograph C).

Table 8. Container plants installed within the vegetated set back bank at Site 2.

Scientific Name	Common Name	Quantity
Cornus sericea	Red-osier dogwood	20
Salix bebbiana	Bebb willow	30
Prunus virginiana	Chokecherry	15
	Total	**65**

Table 9. Seed mix used to reclaim the top surface of the vegetated set back bank.

Scientific Name	Common Name
Agropyron riparium	Streambank wheatgrass
Elymus trachycaulus	Slender wheatgrass
Achillea millefolium	Common yarrow
Epilobium angustifolium	Fireweed

Channel Structure Repairs

Two existing channel structures were repaired and two new woody debris jams were constructed as part of the 2008 phase of the riparian revegetation project. Existing log J-hook structures at Sites 7 (Figure 26) and 8 were repaired by back-filling the flanked vane arms and adjusting the height of the riffle downstream of the scour pool below each structure. Figure 27 shows the woody debris jams installed at Site 10.

Figure 26. Vane at Site 7 after repairs showing the filled vane arm and reconstruction of the bank line along the decommissioned cattle water gap.

Figure 27. Woody debris jams constructed at Site 10 to reduce bank erosion at the site and allow willow cuttings in the soil lift establish.

2009 Effectiveness Monitoring Results and Comparison with 2007-2008 Results

This section describes the results of effectiveness monitoring data collected in July 2009. The purpose of this monitoring was to evaluate the effectiveness of revegetation treatments installed between 2005 and 2008. This section summarizes the results of 2009 monitoring and compares those results with previous monitoring completed in 2007 and 2008. Detailed results of 2009 monitoring are included in Appendix C and provided in electronic spreadsheets accompanying this document. July 2009 effectiveness monitoring repeated monitoring of sites monitored in December 2007 and August 2008 as well as a sub-set of the treatments installed in October 2008. The following treatments were monitored between July 27 and July 30 2009:

- Riparian planting areas
- Point bar revegetation (swale planting and seeding)
- Bioengineering structures (vegetated soil lifts, coir log fascines, buried coir log fascines)
- Constructed point bars
- Browse control (electric wildlife fence)
- Vegetated set back bank treatment

Methods for monitoring the riparian planting areas, bioengineering (vegetated soil lifts and coir log fascines), and constructed point bars are described in the 2008 Revegetation Plan. Methods not described in the 2008 Revegetation Plan are described in the following sections under the specific treatment headings. Effectiveness monitoring locations for the project are shown in Figure 1.

Riparian Planting Area Survival Monitoring

A comparison of the results of containerized planting survival monitoring for planting areas at Sites 3, 5, 10, and 12 is provided in Table 10. Table 10 compares percent survival by planting area for 2007, 2008 and 2009. Because no baseline data were recorded for the number of plants installed in 2005, percent survival is based on the number of live and dead plants recorded for each year, except for Sites 3 and 5 in 2009. Browse protectors were removed from Sites 3 and 5 during fall 2008 so no markers remained for dead plants; therefore, the total number of plants recorded in 2007 or 2008 was used to calculate percent survival at Sites 3 and 5 for 2009. Table C-1 in Appendix C provides detailed results of survival monitoring at these sites.

Table 10. Percent survival of containerized plants in monitoring plots for 2007, 2008 and 2009.

Monitoring Plot	Percent Survival 2007	2008	2009
Planting Area Monitoring Plot 1 (Site 3)	77%	78%	57%
Planting Area Monitoring Plot 2 (Site 5)	96%	76%	59%
Planting Area Monitoring Plot 3 (Site 12)	86%	85%	71%
Planting Area Monitoring Plot 4 (Site 10)	85%	65%	61%

The following is a summary of results and observations made of planting areas during July 2009 monitoring:

- Plants at Sites 3 and 5 were released from their browse protectors because growth was being restricted by the browse protectors that had been damaged by ice flows. These plants, although stressed by browse and ice damage over the last few years, are re-sprouting from their bases. These plants may be trending toward a released-type architecture (Keigley and Frisina 1998) (Figure 28).
- Plants with expanded browse protectors have increased in width, and some have grown above the height of the browse protector despite continued browse pressure (Figure 28).
- There was no evidence of recent lateral erosion of the bank along planting areas. Bioengineering was installed in October 2008 at most of these sites and has prevented further lateral erosion.
- Solarization fabric installed in 2005 and removed in October 2008 was very effective at killing undesirable grasses in planting sites where it was used.
- Seeded grasses appear to be germinating in planting areas where solarization fabric was removed during October 2008, but species identification was difficult due to growth stage of grasses and herbaceous vegetation. Cottonwood seedlings are also colonizing these newly exposed mineral soils (Figure 29).
- Weed species such as houndstongue, knapweed, toadflax, and oxeye daisy are also colonizing the newly exposed soil within the solarization plots.

Figure 28. Photograph A shows a shrub that was released from browse protection in October 2008. Although damaged by ice and browse since being planted in 2005, the shrub has begun to re-sprout. Photograph B shows planted shrubs that were retro-fitted with larger browse protectors in October 2008. Many of these shrubs have expanded within the larger browse protectors and grown in both width and height.

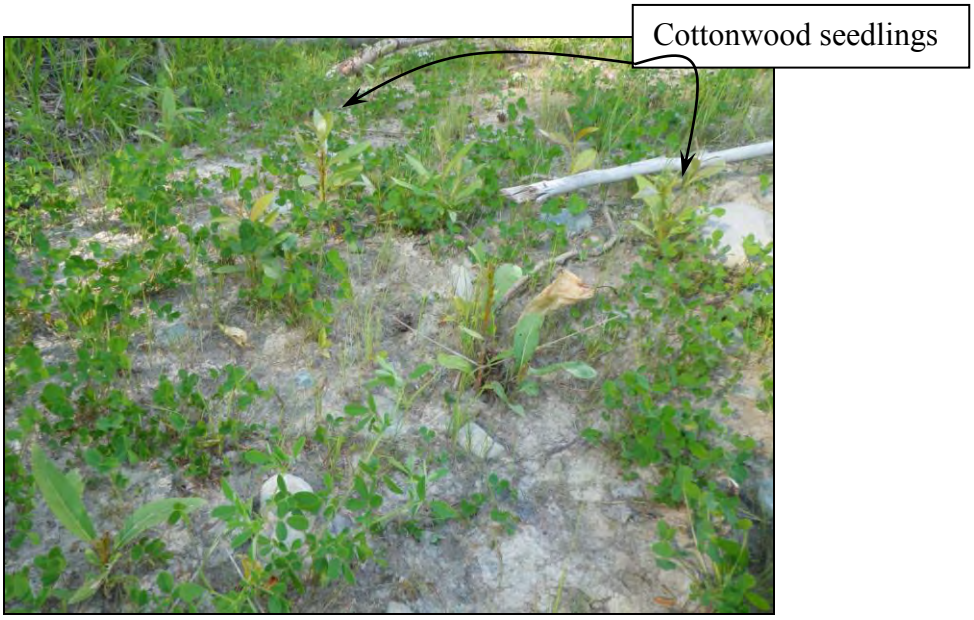

Figure 29. Photograph of mineral soil at Planting Area Monitoring Plot 2 exposed and seeded after removal of solarization fabric installed in this plot in 2005. Young grass shoots, assumed to be seeded species, are establishing along with naturally recruited cottonwood seedlings.

Monitoring data show steadily decreasing survival rates for each of the monitored planting areas. Observations made within non-monitored planting plots show good survival and growth on protected shrubs that were not installed directly adjacent to the channel or were installed along the channel in a location less vulnerable to scour and ice flows.

Survival monitoring is a useful metric to determine planting success during the first few growing seasons and helps determine maintenance needs such as re-planting, watering, weeding or browse control. However, survival typically reaches a plateau after three to four years and as maintenance activities are implemented, percent survival becomes a less useful metric. General observations for maintenance purposes remain a useful means of evaluating site conditions. After the first three to five years, other metrics such as canopy cover and plant community composition may be more useful to evaluate progress toward project goals and objectives.

Monitoring continues to indicate that planting directly along outer meander streambanks, within a system as dynamic and vulnerable to disturbance by ice flows as Grave Creek, is only marginally effective as a revegetation treatment, especially considering the high cost of installation and maintenance. Installing containerized plants within natural or created microsites and other protected locations within the floodplain appears to be more effective at this site. The following section provides data that supports containerized plant installation within constructed floodplain topography.

Point Bar Revegetation

Constructed swales were monitored for container plant survival, percent cover of herbaceous species, and percent of woody plants showing evidence of browse. Five swales were monitored at two sites; three at Site 4 and two at Site 12 (Figure 1). Two of the monitored swales are located within the perimeter of the electric wildlife fence installed in August 2008. Table C-2 in Appendix C provides the results of survival monitoring in these plots and Table C-3 provides the species composition within each swale.

The following is a summary of results and observations made of constructed swales during July 2009 monitoring:

- Survival of containerized plants installed in October 2008 is 100 percent.
- Container plants installed in swales inside the fence are not browsed, while container plants installed in swales outside the fence had slight to moderate browse (Figure 30 and 31). On average, shrubs and trees planted in swales inside the fence are one to two feet taller than those planted in swales outside of the fence.
- Woody debris placed around planted shrubs, in combination with the steep sides of the constructed swales, appears to protect portions of plants from browse. This is evidenced by the browse patterns on the plants; upper, exposed branches are browsed and lower protected branches are not.
- Grasses and forbs, as well as naturally recruited and seeded shrubs, are colonizing the bottom and sides of constructed swales (Figures 32 and 33). Introduced pasture grasses have the highest percent cover in most of the swales, but native forbs and cottonwood seedlings are also present.
- Some swales support high densities of recruited cottonwood seedlings. In some locations, cottonwood densities are much higher in and adjacent to swale features compared with adjacent floodplain surfaces (Figure 32).
- Weed species are present but not dominant within the swales.

Monitoring of floodplain revegetation continues to indicate that this treatment is effective at creating conditions to support desired riparian species within the Grave Creek project reach. As described in the 2008 Revegetation Plan, this treatment was installed to create islands of diverse shrubs and trees within constructed floodplain surfaces. As these areas mature, the desired function is to provide floodplain stability and seed sources for natural expansion of riparian plant communities.

Figure 30. Photograph of planted swale at Site 12 (outside the electric fence). Plants installed during 2008 have a high rate of survival but show signs of slight to moderate browse. Plants within these swales are one to two feet shorter than those within the electric wildlife fence. Inset photos are examples of the browse occurring within swales outside of the electric fence.

Figure 31. Photograph of a planted swale at Site 4 (inside the electric fence). Inset photo shows a five gallon container plant installed during fall 2008 that has been protected from browse and exhibits an uninterrupted growth form.

Figure 32. Photograph showing naturally recruited cottonwood seedlings surrounding a constructed floodplain swale. Grasses and forbs cover the bottom of the swale and planted shrubs are protected from browse by hand placed woody debris.

Figure 33. Photograph showing a chokecherry seedling growing in a constructed swale at Site 4. The chokecherry germinated from seed applied during fall 2008.

Bioengineering Monitoring

Three bioengineering treatments were monitored in July 2009; vegetated soil lifts, coir log fascines, and buried coir log fascines. Results of monitoring are summarized below by type of bioengineering.

Vegetated Soil Lifts and Coir Log Fascines

In July 2009, vegetated effectiveness monitoring of soil lifts 2, 4, 6, 8, and 12 was repeated (Figure 1). In addition to these structures, coir log fascines 7 and 12 and vegetated soil lift 5, all installed in October 2008, were also included in July 2009 effectiveness monitoring (Figure 1, Figure 40). Tables 11 and 12 provide a summary of the results of July 2009 bioengineering effectiveness monitoring. Data in these tables is summarized by the average value of each variable measured at monitored sites. Table C-4 in Appendix C provides the complete data set for each metric, which was recorded in five-foot increments at each structure.

The following is a summary of results and observations made of bioengineering structures during July 2009 effectiveness monitoring:

- Average shoot height (new growth) recorded for willows in 2005 and 2006 structures ranged from 12 to 72 inches (Table 11). The maximum height recorded during 2008 monitoring was 36 inches.
- Average shoot height recorded for willows in 2008 structures ranged from two to 18 inches on coir log fascines and six to 18 inches on the vegetated soil lift (Table 12).
- No new rips or tears were recorded.
- No new toe scour was recorded.
- Total percent cover of willows on 2005 and 2006 structures ranged from 23 to 93 percent (Figure 36).

- Total percent cover of willows on the 2008 soil lift was 53 percent.
- Total percent cover of willows on the 2008 coir log fascines was 27 percent on CL-7 and 46 percent on CL-12 (Table 12).
- There was no evidence of browse on any of the bioengineering structures located within the electric wildlife fence. Browse was recorded on structures outside the electric fence. Recorded browse levels were much higher in 2008 compared with 2009 (Figure 37). Browse pressure is documented as being highest in late August through September. Therefore, it is possible that 2009 browse had not occurred prior to July 2009 monitoring.
- Weed cover at soil lift sites remained similar to 2008 levels except for SL-6 and SL-8 which showed an increase in weed cover between 2008 and 2009 (Figure 38). SL-6 and SL-8 also have the lowest total percent cover of willows.
- Structures installed during 2008 have minimal weed cover ranging from 0 to 1 percent (Table 12).
- Percent cover of seeded species was not recorded during July 2008 monitoring because it is too difficult to accurately distinguish between seeded species and naturally establishing species. Percent cover of all herbaceous species, including grasses and forbs but excluding weeds, was recorded. Cover by grasses and forbs on 2005 and 2006 soil lifts is up to 100 percent (Figure 39).
- Desirable species such as sedges, rushes and native forbs are becoming more abundant on some of the 2006 soil lifts, particularly at sites such as Demo SL-2 and SL-4 which have more shade.

In general, browse was reduced on all structures but most significantly on structures located within the electric wildlife fence. However, because browse pressure typically increases starting in August and lasting through the fall these structures should be observed again in the fall to determine if maintenance of browse protection measures may be necessary. In general, percent cover of willows has increased on most bioengineering structures, but again, most significantly on structures within the electric wildlife fence. Weed species and densities remain similar to 2008 except for increases on the soil lifts with less willow and other herbaceous cover.

Monitoring continues to indicate that bioengineering structures are effectively establishing near-bank woody vegetation. Long-term, as woody debris jams begin to decompose and coir fabric degrades, it is expected that bank under-cutting and channel migration at these sites will occur.

Table 11. Summary of effectiveness monitoring data collected during July 2009 for 2005 and 2006 bioengineering structures. Data shown in this table is the average of all of the five-foot increment values recorded for each structure.

	Demo Lift 2 (2006)				SL-2 (2006)				SL-4 (2005)				SL-6 (2006)				SL-8 (2006)				SL-12(2006)			
Monitoring Year	**2008**		**2009**		**2008**		**2009**		**2008**		**2009**		**2008**		**2009**		**2008**		**2009**		**2008**		**2009**	
Layer	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Metric[1]																								
Average percent cover willow	71	34	83	93	40	54	75	88	56	35	61	88	11	57	45	23	28	13	31	30	33	31	29	57
Percent cover seeded	3	14	NR	NR	2	10	NR	NR	7	19	NR	NR	8	1	NR	NR	12	5	NR	NR	1	3	NR	NR
Average percent cover other	2	33	32	94	1	11	11	91	1	42	15	91	19	7	34	70	20	28	67	65	15	23	24	48
Average percent cover weeds	1	5	0	4	0	4	0	5	0	2	0	2	5	0	1	14	5	29	19	47	1	2	0	5
Total number alive stems planted	12	6	4	4	10	7	6	3	NA	NA	NA	NA	37	0	4	2	37	1	2	0	6	2	5	6
Total number dead stems	2	3	13	5	1	11	16	9	27	3	13	7	3	2	29	41	3	1	30	16	15	18	57	26
Average percent browsed	60	100	0	0	5	41	0	0	12	51	0	0	18	50	20	20	21	12	0	7	12	33	8	3
Average shoot height (inches)	20	14	34	41	13	10	26	31	26	19	56	56	5	9	17	14	9	7	26	19	10	9	18	24

[1] Methods for these metrics are described in Geum Environmental Consulting, Inc. (2008).

Figure 34. Comparison of average willow shoot height of willows in vegetated soil lifts between 2008 and 2009. For each structure, the bottom layer is designated as '1' and the top layer is designated as '2'.

Figure 35. Photographs show Demo SL-2 in 2008 (top left) and in 2009 (top right) and SL-4 in 2008 (bottom left) and 2009 (bottom right). Both the Demo SL-2 and SL-4 are located within the electric wildlife fence.

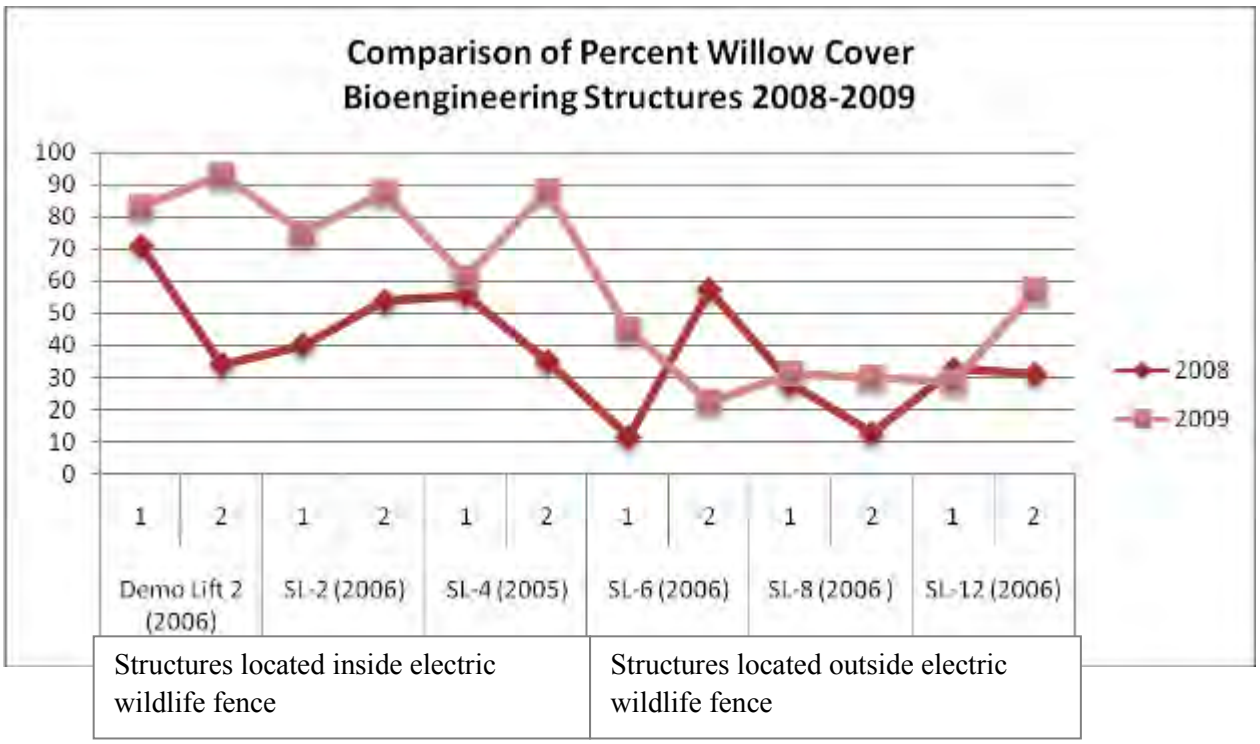

Figure 36. Comparison of percent cover of willows on vegetated soil lifts in 2008 and 2009. For each structure, the bottom layer is designated as '1' and the top layer is designated as '2'.

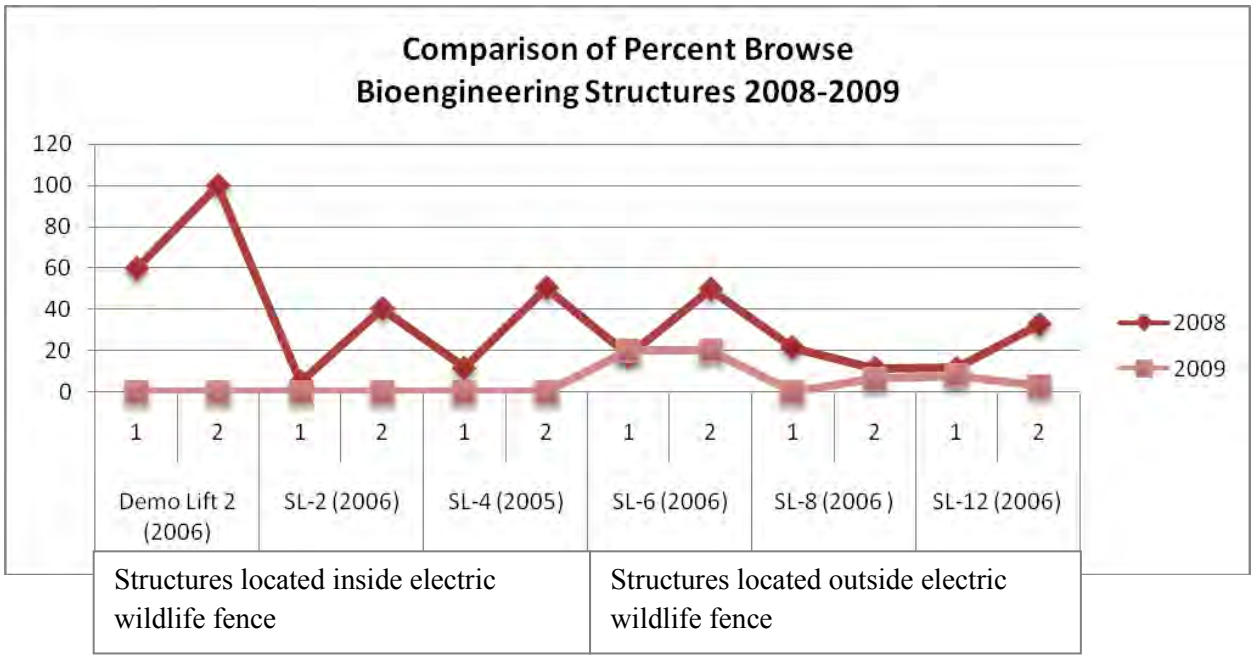

Figure 37. Comparison of percent of willows showing signs of browse on vegetated soil lifts in 2008 and 2009. For each structure, the bottom layer is designated as '1' and the top layer is designated as '2'. Top layers have higher percent of stems browsed because they are more easily accessed.

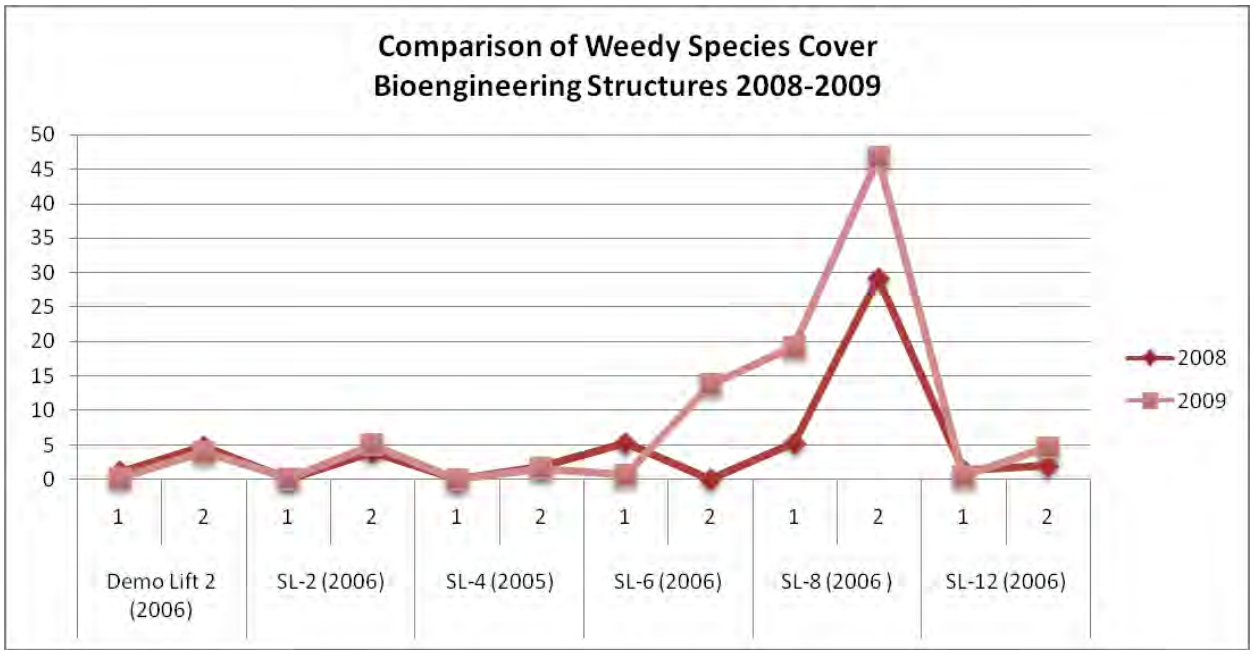

Figure 38. Comparison of weedy species cover on vegetated soil lifts 2008 and 2009. For each structure, the bottom layer is designated as '1' and the top layer is designated as '2'. Top layers have higher percent cover of weedy species.

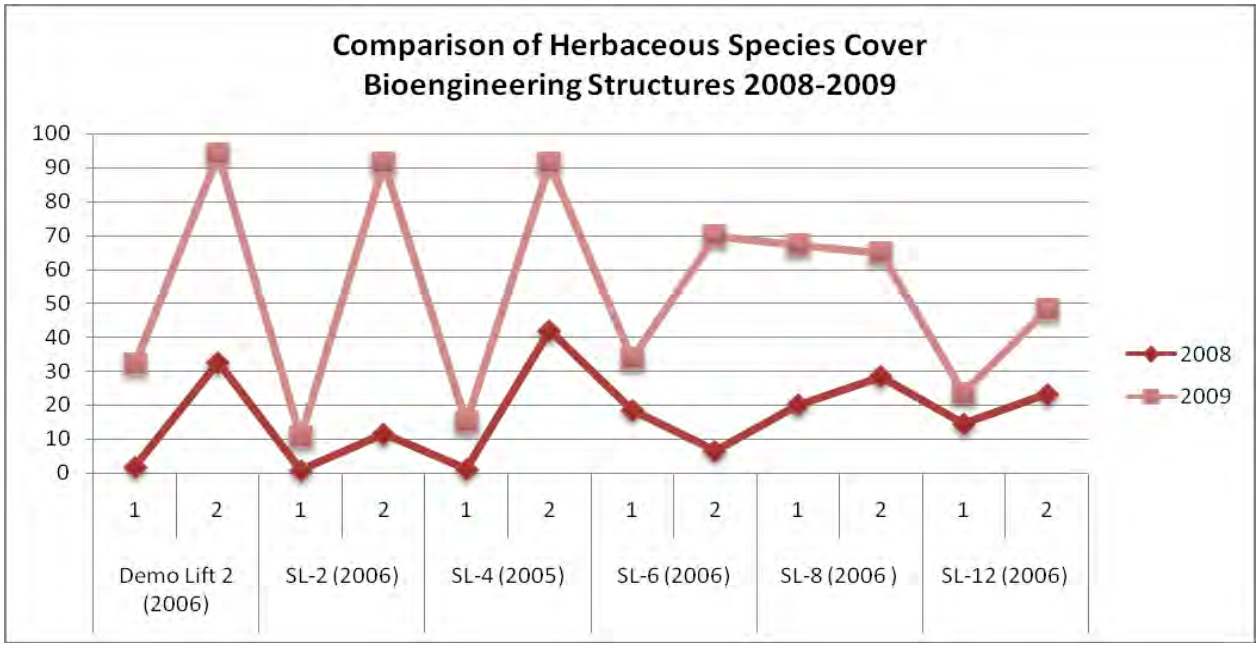

Figure 39. Comparison of herbaceous species cover on vegetated soil lifts 2008 and 2009. For each structure, the bottom layer is designated as '1' and the top layer is designated as '2'. Top layers have higher percent cover of herbaceous species.

Table 12. Summary of effectiveness monitoring data collected in July 2009 for a sub-set of bioengineering structures installed in October 2008. Data shown in this table is the average of all of the five-foot increment values recorded for each structure.

Structure ID	CL-7 (2008)		CL-12 (2008)	SL-5 (2008)	
Monitoring Year	2009		2009	2009	
Layer	1	2	all	1	2
Metric[1]					
Average percent cover willow	9	28	46	52	57
Average percent cover other	2	6	15	0	10
Average percent cover weeds	0	0	1	0	0
Total number dead stems	20	2	2	14	10
Average percent browsed	0	10	98	10	25
Average shoot height (inches)	10	14	14	12	10

[1] Methods for these metrics are described in Geum Environmental Consulting, Inc. (2008).

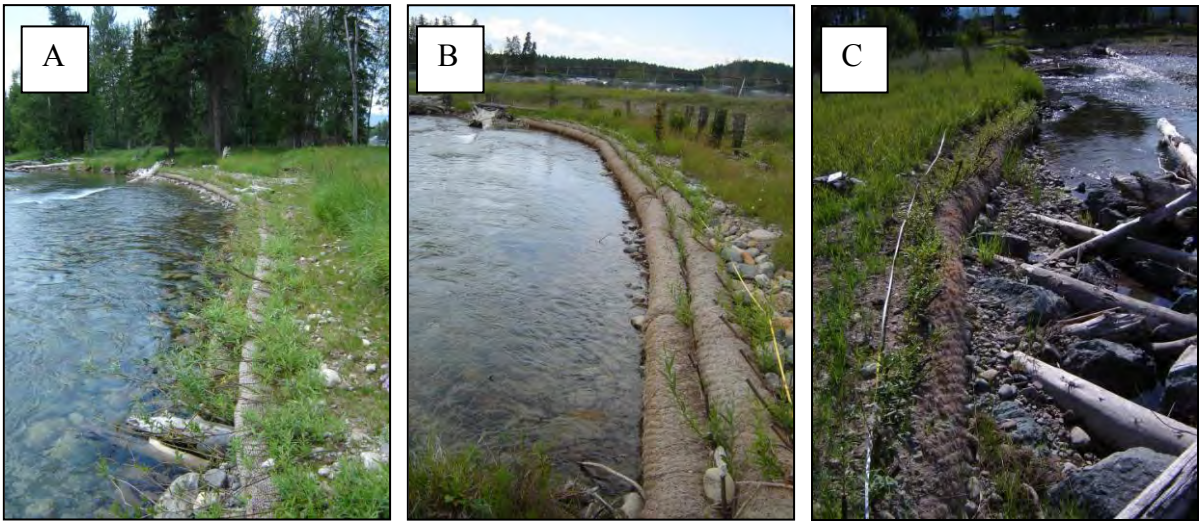

Figure 40. Photographs showing bioengineering structures installed in October 2008 and included in July 2009 effectiveness monitoring. Photograph A is SL-5 (2008), Photograph B is CL-7 (2008) and Photograph C is CL-12 (2008).

Buried Coir/Willow Fascines

Effectiveness monitoring methods for buried coir log fascines are similar to those for other bioengineering structures. Data were collected in five-foot increments along the length of each buried coir/willow fascine (Figure 41). Data collected for each five-foot increment included: general willow survival (number of obvious dead stems), percent cover of willows, average height of new willow growth; percent of willows with signs of browse; and percent cover of herbaceous species (recorded for the area of trench back-fill which includes the line of willows and extends approximately four feet in a downstream direction). In addition to these data, general observations of the amount and type of debris accumulating at each structure, colonization of cottonwoods or other woody species in the substrate around each structure and general condition of willows was recorded. A summary of the results of July 2009 effectiveness

monitoring is provided in Table 13. Table 13 summarizes the average value of each metric measured (i.e. average of all values recorded by five-foot increment for each structure). Table C-5 in Appendix C provides the complete data for each metric by five-foot increment.

The following is a summary of results and observations made of buried coir log fascines structures during July 2009 effectiveness monitoring:

- Total percent willow cover ranged from 18 to 53 percent (Table 13).
- Herbaceous species cover is low. Over time, as the structures trap more sediment and debris there will likely be an increase in herbaceous species.
- The number of dead stems is relatively low given the number of willow cuttings installed with each fascine (total number of willow stems was not recorded).
- Total percent of browse on willow cuttings ranged from 30 to 50 percent (with the range for five-foot increments between 10 and 100%). At the sites where this treatment was used the coir/willow fascines are the densest concentration of vegetation on the point bar and browse is expected to be high.
- New willow growth ranged from 2 to 11 inches.

In general, willow survival and growth is good but browse may affect growth over the long term. Small metal browse cages (four-feet by four-feet), provided by the land owner, were placed over portions of the fascines during July monitoring to evaluate the effects of browse that occurs in late August and fall 2009. Overall, minimal amounts of organic matter and woody debris have accumulated around the fascines.

The buried coir/willow fascine treatment appears to be effective in establishing islands of willows on constructed point bar surfaces. Continued monitoring is needed to determine the effectiveness of this treatment at providing long-term point bar stability and promoting other succession processes such as trapping fine sediment, debris and seed.

Table 13. Summary of buried coir/willow fascine data collected during July 2009 monitoring. Data shown in this table is the average of all of the five-foot increment values recorded for each structure.

	Structure ID						
Metric[1]	**BWF - 1**	**BWF - 2**	**BWF - 3**	**BWF - 4**	**BWF - 5**	**BWF - 6**	**BWF - 7**
Percent cover willow	51	53	25	30	39	40	18
Percent cover other	5	8	12	1	1	0	0
Number dead stems	9	4	6	3	1	1	9
Percent browsed	30	30	30	50	50	50	50
Average shoot height (inches)	10	11	7	4	5	8	2

[1] Methods for these metrics are described in Geum Environmental Consulting, Inc. (2008).

Figure 41. Photograph showing buried coir/willow fascine at Site 13. Effectiveness monitoring data were collected in five-foot increments along each structure.

Point Bar Monitoring

Three constructed point bars were monitored in July 2009 (Figure 1). Monitoring methods for these sites are described in the 2008 Revegetation Plan. Data collected at each site are provided in Table C-6 through C11 in Appendix C. Many of the swales constructed in 2005 support a variety of grasses, forbs, and shrubs and provide the highest and most diverse concentration of vegetation on the point bars. The following is a summary of results and observations made at constructed point bars during 2009 monitoring and comparisons with 2008:

- Cottonwood recruitment was lower in 2009 than in 2008, but survival of the 2008 recruited seedlings is high, with some seedlings growing up to eight inches (Figure 42).
- Swale hydrology is variable with some swales having standing water or signs of recent ponding.
- Wind and flood deposited debris and organic matter continues to accumulate on constructed point bar and floodplain surfaces, particularly around placed woody debris and within swales.
- Large woody debris (greater than 4 inches diameter), both placed and naturally deposited by floods, is providing microsites and browse protection for planted, seeded, and naturally recruited shrubs. The amount of large and coarse woody debris was similar to 2008 but the locations of the debris cover changed slightly on some transects. This may indicate that debris is getting re-distributed during high flow events.
- The 2009 data show an increase in grass and forb cover, especially in swales.

- The overall weed cover was similar to 2008. The data shows slight increases or decreases along sections of transects.
- The 2009 data show an increase in the number of shrubs compared with the 2008 data. Shrubs, such as dogwood and chokecherry, are establishing from seed hand broadcasted in swales and on floodplain surfaces during fall 2008 implementation (Figures 43 and 44).
- Browse was recorded along transects at Sites 5 and 13, but not 4, which is located inside the electric wildlife fence.

The results of this monitoring continue to indicate that the treatments installed on constructed point bars (swales, woody debris, seeding, container plants) appear to provide the structure that supports ecological processes necessary for desired pioneer plants to colonize and plant community succession to occur. Survival of container plants is high; native shrubs, trees, and forbs are colonizing in swales and other microsites; and flood deposited sediment and debris is accumulating around woody debris.

Figure 42. Photograph of surviving cottonwood seedlings on Point Bar 13 Transect 1.

Figure 43. Photograph shows a seeded chokecherry in a woody debris microsite within a constructed swale on Point Bar 4 Transect 1.

Figure 44. Photograph shows dogwood shrubs on at Site 13 that germinated from seed.

Riparian Fencing

Paired monitoring points (one inside of the fence perimeter and one outside of the fence perimeter) were established to evaluate the effectiveness of the electric wildlife fence installed in August 2008. Paired points were established in two distinct vegetation types thought to represent desired vegetation communities along Grave Creek in the project area. One set of points was established for within mature cottonwood areas (forested) and the second set of points was established in wetter, shrub dominated areas (shrub). At each point, two photo locations were established and marked with rebar, survey caps and flagging. A series of panoramic photographs were taken and cardinal directions recorded at each photo location. At each monitoring point, percent cover of shrubs was recorded as well as general observations of browse and natural recruitment.

Percent cover data are reported in Table C-12 in Appendix C. Photographs are provided on electronic media accompanying this report. Forested plots consist of mature cottonwood trees and an understory dominated by pasture grasses with some inclusions of understory shrubs such as dogwood, buckthorn, rose, snowberry, and alder. Each forested evaluation point includes both open and closed canopy areas to evaluate regeneration and plant community succession. Shrub evaluation points consist of willows, cottonwood, alder, birch, and raspberry. These points are located at lower elevations near the channel and are frequently inundated by overbank flows.

The following is a summary of observations made of the browse evaluation plots during July 2009:

- Plants located within the electric fence show signs of browse release as indicated by the absence of browse on the current year's growth and the presence of previously browsed older stems.
- New shoot growth on plants located within the electric fence is up to approximately twelve inches.
- Plants located outside the electric fence continue to show signs of moderate to severe browse as indicated by the presence of browse on current and previous year's growth.
- Cottonwood regeneration is occurring in both forested plots but has been limited by the severe browse pressure.

Figure 45 compares the difference in shrub growth form for shrubs within the fence and outside of the fence. Shrubs within the fence have un-browsed new shoot growth while plants outside the fence still exhibit an arrested-type architecture. Figure 46 provides a comparison of the shrub browse evaluation point located within the perimeter of the fence before the fence was installed and one season after the fence was installed. Willows have grown vertically and appear to be expanding horizontally as well at this point.

Because browse is directly tied to the number of animals utilizing an area and utilization is often cyclic, it is too early to determine how effective the fence is at helping meet project goals and objectives. Although it is still too early to evaluate the effectiveness of the fencing treatment, the photographs and observations indicate that the areas within the fence are trending toward recovery from intense browse pressure. Continued monitoring is needed to fully evaluate the effectiveness of this treatment.

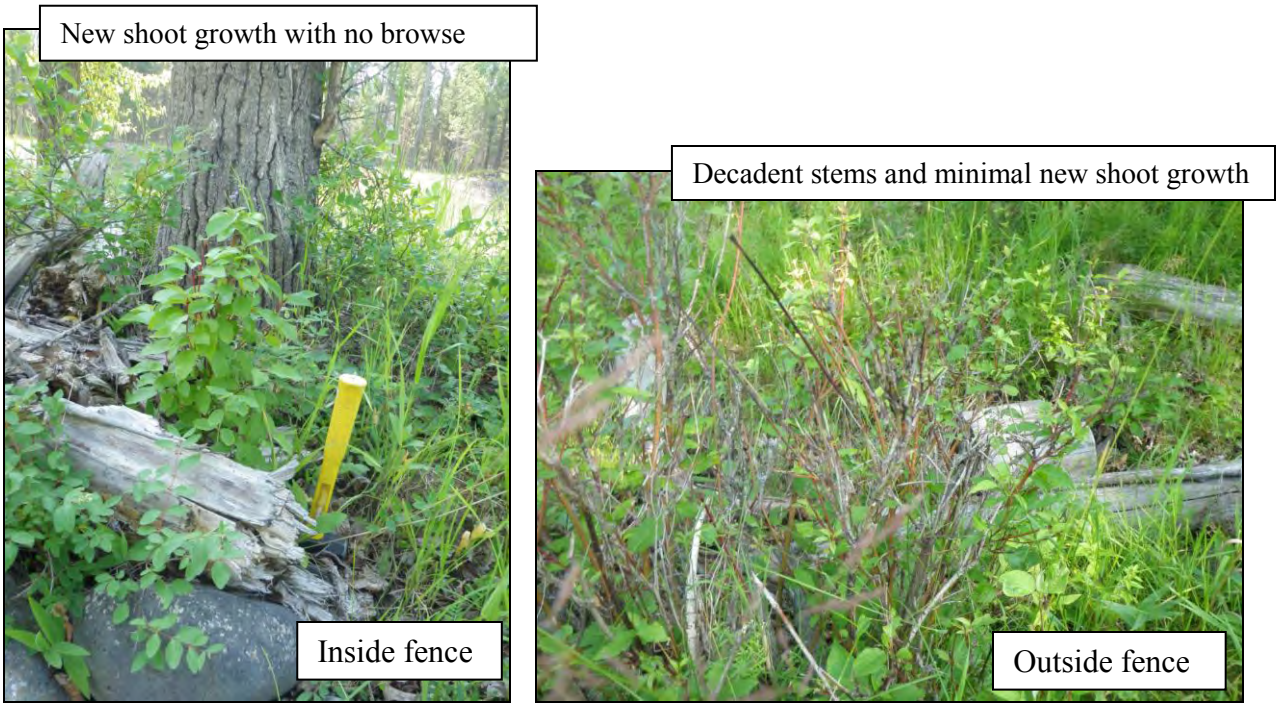

Figure 45. Photographs showing the difference in growth form of dogwoods found in (left) and outside of (right) the electric fence. Dogwood are highly palatable plants and thus a good indicator of browse pressure.

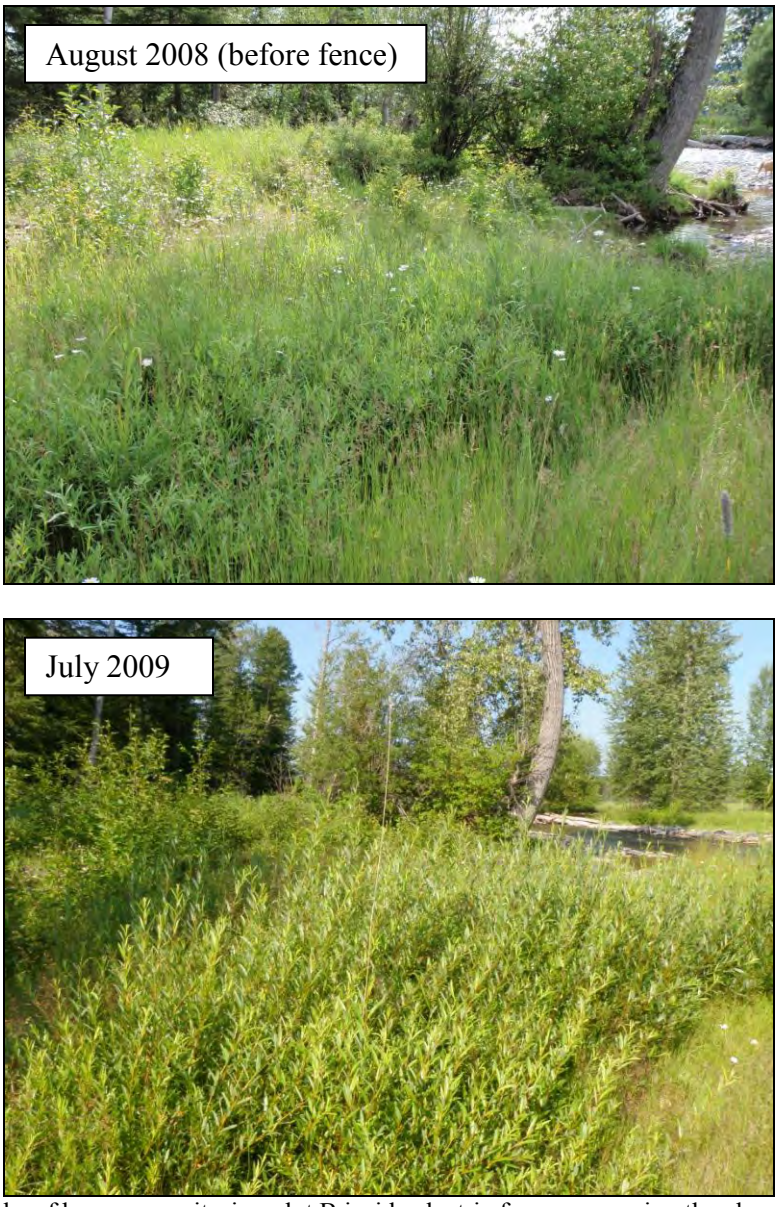

Figure 46. Photographs of browse monitoring plot B inside electric fence comparing the change in willow growth between August 2008 and July 2009.

Vegetated Set Back Bank Treatment

The vegetated set back bank was monitored for effectiveness in July 2009. Photographs were taken every twenty feet along the entire trench to document conditions and observations on weeds, herbaceous species and general site conditions were recorded. No other data were collected, but general observations were made related to willow survival and growth and cover of seeded and weed species within the trench. Photo documentation of the set back bank is provided on the electronic media accompanying this report.

The following is a summary of observations made of the vegetated set back bank during July 2009:

- Willow survival along the edges of the trench was estimated to be between 80 and 90 percent. There are a few sparse patches but these may fill in over time depending on overall survival (Figure 47).
- Containerized plant survival also appears to be high and is estimated to be greater than 80 percent.
- The majority of the cottonwood pole cuttings installed in the trench are re-sprouting from the base while others have new growth along the entire pole (Figure 48).
- Weed cover within the trench is low, but the surrounding area has high densities of knapweed and oxeye daisy.
- Seeded grass cover is low, but grasses were beginning to germinate in the bottom of the trench. Pasture grasses are also present.
- Herbaceous species found within the trench include yarrow and clover.

Figure 47. Photograph showing the downstream portion of the vegetated set back bank treatment. Willow growth along the side closest to the channel is dense and seeded grasses are establishing on the bottom of the trench.

Figure 48. Photographs showing the conditions within the vegetated set back bank. Photograph A shows a cottonwood pole sprouting from the base and Photograph B shows a cottonwood pole sprouting from the top.

Future Riparian Revegetation Project Phases

The treatments installed in October 2008 represent the third phase of riparian revegetation as part of the Grave Creek Restoration project. Other phases were implemented in 2005 and 2006. As described earlier in this document, each phase has focused on addressing specific limiting factors and treatment designs have been adjusted based on the effectiveness of the treatments implemented in previous phases. Understanding how restoration actions are affecting ecological processes specific to the Grave Creek project reach is key to determining project success, knowing when intervention is necessary to maintain a trajectory towards a desired future condition and knowing when treatments and maintenance are no longer necessary. This is the purpose of the effectiveness monitoring included in the 2008 Revegetation Plan and described in earlier sections of this document.

The 2008 Revegetation Plan includes a monitoring framework for collecting and interpreting data within the project reach to guide management decision and determine the need for additional treatments based on data collected. The 2008 Revegetation Plan also describes the monitoring results for treatments installed during earlier project phases and provides recommendations for continued monitoring and potential additional revegetation actions through 2010 (see Table 9 in 2008 Revegetation Plan). Table 14 builds off of this framework providing updated trends and recommendations for the site based on the results 2009 effectiveness monitoring described in the previous section. Table 14 is organized by treatment category similar to the rest of this report.

In addition to the recommendations provided in Table 14, the following are the key recommendations related to project monitoring:

- Riparian revegetation treatment data and monitoring should be integrated into a multi-discipline monitoring program including channel geomorphology and habitat quality.
- Riparian revegetation effectiveness monitoring in 2010 should continue, but can be minimal, relying primarily on visual observations of treatment effectiveness and maintenance needs. The exception to this would be collecting detailed baseline effectiveness monitoring data for any treatments installed in fall 2009 or spring 2010.
- Monitoring should be completed again in 2011. At this point, the hope would be that monitoring will determine the site is on a trajectory towards the desired future condition of a diverse, self-sustaining mosaic of riparian plant communities with only minimal annual maintenance required.

Table 14. Adaptive management decision making framework for Grave Creek Riparian Revegetation Project.

Treatment	2005-2008 Treatments	Results of 2009 Effectiveness Monitoring	Next Phase Recommendations	Monitoring 2010
Electric Wildlife Riparian Fencing	Approximately 4,000 feet of electric wildlife fence installed along the upstream portion of the project reach.	2009 effectiveness monitoring showed browse release of some areas of shrubs and vegetated soil lifts within the fenced area. At the time of monitoring browse outside of the fenced area was moderate.	Wildlife fence should remain in place for a minimum of five years and removal should be based on monitoring vegetation community development. Although 2009 monitoring suggests that the fence is effective at limiting browse and allowing plant community succession and natural regeneration to occur, continued monitoring is recommended given the expense and upkeep associated with fencing.	Repeat photo points and continue to monitor changes of understory shrub composition and development of young age classes and growth of containerized plants and willow cuttings. Additional fencing should only be installed if monitoring shows a clear trend toward a younger age class of woody plants developing inside the exclosure.
Bioengineering: Soil lifts and Coir Log Fascines	Four soil lifts constructed in 2005; 15 Soil lifts constructed in 2006 using reinforced wood and rock toe and four soil lifts constructed at Sites 3, 5, 7 and 10 in 2008. Coir log fascines constructed at Sites 1, 7, and 12 in 2008.	Monitoring continues to suggest these structures are effective at establishing woody vegetation on high priority streambanks.	All high priority sites were treated in 2009. No additional treatments are recommended. No maintenance is required in 2009.	Continue to monitor effectiveness of bioengineering treatments. Starting in 2010 visual observations of soil lift effectiveness and maintenance needs should be sufficient.
Bioengineering: Buried Coir Log Fascines	Buried coir log fascines installed on depositional point bar surfaces at Sites 13 and 14 in 2008	Monitoring indicates good survival but little evidence of other functions such as trapping sediment, debris and seed.	Monitoring has not determined treatment effectiveness and no additional treatments are planned.	Continue to monitor effectiveness of treatment. In 2010 visual observations of buried coir log fascine effectiveness and maintenance needs should be sufficient.

Treatment	2005-2008 Treatments	Results of 2009 Effectiveness Monitoring	Next Phase Recommendations	Monitoring 2010
Point Bar Revegetation	Planting of small container plants in swales in 2005. Large sized container plants installed within previously constructed floodplain swales at Sites 4, 9, 10, and 12 in 2008. Seeding within previously constructed floodplain swales at Sites 2 through 6 and 8 through 14 in 2008.	Monitoring continues to document high survival and growth of container plants in swales. Most swales support diverse plant communities including naturally recruited cottonwood seedlings. Monitoring indicates this treatment is effective.	Seeding and planting within swales appears effective, especially in areas within the electric fence. If funding allows, treatment should be repeated in fall 2009 or spring 2010 in additional swales in the project reach. Treatments should be implemented in the Demonstration Phase.	Continue to monitor effectiveness of treatment. In 2010 visual observations of effectiveness and maintenance needs should be sufficient. If additional treatments are installed, baseline monitoring should be conducted. Formal monitoring should be repeated in 2011.
Floodplain Treatment	Most point bars treated in 2005. Point bars 4, 13 and 14 treated in 2006. Point bar grading at Site 8 was completed in 2008.	Monitoring continues to document natural processes occurring where floodplains are connected to the channel and provide diverse microtopgraphy.	This treatment has been applied to most constructed point bar and floodplain surfaces. Allow natural processes to occur and create similar conditions over time. Treatments should be implemented in the Demonstration Phase.	Continue to monitor effectiveness of treatment. In 2010 visual observations of effectiveness and maintenance needs should be sufficient.
Vegetated Set Back Bank Treatment	Vegetated set back bank treatment implemented at Site 2.	Photo documentation and general observations of willow survival and herbaceous species cover indicate high initial survival.	No additional treatments anticipated. Supplemental willow cuttings and supplemental seeding may be necessary if survival decreases. Supplemental irrigation will be necessary during the dry summer months. Allow lateral erosion to continue and plants to establish in vegetated set back bank.	Continue to document plants establishing at this site and monitor streambank erosion.

Treatment	2005-2008 Treatments	Results of 2009 Effectiveness Monitoring	Next Phase Recommendations	Monitoring 2010
Existing Riparian Planting Area Maintenance	Outer meander planting areas were installed in 2005. Browse protector maintenance completed at Sites 3, 5, 7, 10 and 12 in 2008. Solarization removed and newly exposed ground seeded at Sites 5 and 7 in 2008.	Due to a lack of accurate baseline data, survival monitoring is inconclusive. Solarization was effective at killing invasive grasses.	No additional outer meander planting is recommended. Supplemental seeding of areas where solarization was removed may be necessary if native species establishment is poor. Continued maintenance of browse protectors and weed control may also be necessary in these areas	Continue to monitor effectiveness of treatment. In 2010 visual observations of effectiveness and maintenance needs should be sufficient.
Weed Control	Manual control of knapweed completed at sites 7, 10, and 12 in 2008. Weed infestations were mapped in 2008.	Weed infestations were mapped in 2008. No prior weed mapping had been completed. Effectiveness of hand-pulling was observed. There appeared to be a decrease in percent cover but not in infested area size.	Development and implementation of an integrated weed management plan, which is currently being developed for the project reach. Repeat hand-pulling of areas treated in 2008.	Continue to monitor effectiveness of various weed control treatments.

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Keigley, R.B. and M.R. Frisina. 1998. Browse evaluation by analysis of growth form: Volume 1: Methods for Evaluating Condition and Trend. Fieldbook publication produced by Montana Fish, Wildlife and Parks.

Appendix A: 2008 Effectiveness Monitoring Results

Table A- 1. Monitoring results from 2008 for containerized planting areas

Monitoring Plot	Alive	Dead	Percent Survival	Notes	Photograph (August 2008)
Planting Area Monitoring Plot 1 (Site 3)	49	14	78%	Average shrub height was approximately 2.5 feet. Average height of spruce was 18 inches. Most browse protectors were maintained during monitoring. Other maintenance needs include possible supplemental irrigation needs and browse protector removal or re-fitting.	
Planting Area Monitoring Plot 2 (Site 5)	37	12	77%	Solarization Plot. Average shrub height was four to six feet. Average height of spruce was two to three feet. The tallest willow was six feet. Maintenance needs include: browse protector removal and adjustment and possible supplemental irrigation. Weed species on top of and around fabric include houndstongue, oxeye daisy, and toadflax.	
Planting Area Monitoring Plot 3 (Site 12)	11	2	85%	Average shrub size was approximately three feet. Average spruce height was approximately 18 inches. Maintenance needs include possible supplemental irrigation.	
Planting Area Monitoring Plot 4 (Site 10)	32	17	65%	Average shrub height was approximately three feet. Average height of spruce was two feet. Possible maintenance needs include: browse protector removal or straightening and possibly supplemental irrigation.	

Table A- 2. Monitoring data collected for vegetated soil lifts 2, 4, 6, 8, and 12 during August 2008 monitoring.

Structure ID	Layer	Metric[1]	Distance (feet)																
			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	70-75	75-80	80-85
SL-2	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
		Percent cover willow	50	50	50	50	20	40	30	30	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	1	1	5	5	1	1	1	1	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species	0	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
		Percent cover weeds	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	2	2	1	1	2	1	1	0	-	-	-	-	-	-	-	-	-
		Number dead stems	0	0	0	0	0	0	0	1	-	-	-	-	-	-	-	-	-
		Percent browsed	20	0	0	0	0	10	0	10	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	10	12	18	12	12	12	12	18	-	-	-	-	-	-	-	-	-
SL-2	2 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
		Percent cover willow	60	80	80	50	60	20	60	20	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	20	10	10	5	10	10	10	5	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species		5	5	10	5	5	10	40	-	-	-	-	-	-	-	-	-
		Percent cover weeds	10	5	1	10	1	0	0	5	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	0	1	1	0	0	1	2	2	-	-	-	-	-	-	-	-	-
		Number dead stems	8	0	0	0	1	0	0	2	-	-	-	-	-	-	-	-	-
		Percent browsed	80	0	10	5	20	50	80	80	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	6	12	18	12	10	10	6	6	-	-	-	-	-	-	-	-	-

Structure ID	Layer	Metric[1]	Distance (feet)															
			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	70-75	75-80	80-85
SL-4	1 above	Rips/tears (inches)	0	0	6	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0
		Percent cover willow	80	90	90	20	1	N/A	N/A	N/A	N/A	N/A	N/A	20	60	70	90	90	0
		Percent cover seeded species	10	5	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	10	50
		Percent cover other herbaceous species	5	5	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	1	0	1
		Percent cover weeds	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0
		Number alive stems planted (container plants)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Number dead stems	4	0	1	4	7	N/A	N/A	N/A	N/A	N/A	N/A	5	5	1	0	0	0
		Percent browsed	50	50	10	10	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	10	0
		Average shoot height (inches)	36	24	36	24	2	N/A	N/A	N/A	N/A	N/A	N/A	24	36	36	36	36	0
SL-4	2 above	rips/tears (inches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
		Percent cover willow	60	60	40	50	40	20	20	20	10	10	50	20	50	20	40	50	-
		Percent cover seeded species	10	10	20	20	20	20	50	20	20	10	10	10	20	20	20	30	-
		Percent cover other herbaceous species	20	25	40	30	35	60	30	60	70	45	40	60	25	60	40	30	-
		Percent cover weeds	1	5	1	0	5	0	0	1	1	5	1	1	5	1	1	1	-
		Number alive stems planted (container plants)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
		Number dead stems	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	-
		Percent browsed	90	50	50	90	80	80	50	20	20	80	10	20	20	20	80	50	-
		Average shoot height (inches)	24	12	18	12	12	12	18	18	18	18	24	24	24	24	18	24	-

Structure ID	Layer	Metric[1]	Distance (feet)																
			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	70-75	75-80	80-85
SL-6	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent cover willow	20	5	20	10	5	10	10	-	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	1	5	10	30	5	0	5	-	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species	20	10	30	20	10	20	20	-	-	-	-	-	-	-	-	-	-
		Percent cover weeds	5	5	10	5	10	1	1	-	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	0	1	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-
		Number dead stems	4	3	1	3	5	0	4	-	-	-	-	-	-	-	-	-	-
		Percent browsed	10	10	5	0	50	50	0	-	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	4	4	6	4	4	4	6	-	-	-	-	-	-	-	-	-	-
SL-6	1 below	Rips/tears (inches)	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent cover willow	20	20	80	80	60	60	80	-	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	1	1	1	0	5	0	1	-	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species	5	5	1	5	20	5	5	-	-	-	-	-	-	-	-	-	-
		Percent cover weeds	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	1	0	0	1	0	0	0	-	-	-	-	-	-	-	-	-	-
		Number dead stems	2	3	1	0	1	1	2	-	-	-	-	-	-	-	-	-	-
		Percent browsed	0	10	50	80	80	80	50	-	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	12	12	12	8	6	6	10	-	-	-	-	-	-	-	-	-	-

Structure ID	Layer	Metric[1]	Distance (feet)																
			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	70-75	75-80	80-85
SL-8	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
		Percent cover willow	10	10	50	5	20	50	50	-	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	5	5	10	30	20	5	10	-	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species	10	30	20	30	20	20	10	-	-	-	-	-	-	-	-	-	-
		Percent cover weeds	5	1	1	10	10	5	5	-	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	0	0	0	1	1	1	0	-	-	-	-	-	-	-	-	-	-
		Number dead stems	2	5	3	3	2	2	2	-	-	-	-	-	-	-	-	-	-
		Percent browsed	50	0	50	50	0	0	0	-	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	6	10	12	4	10	10	10	-	-	-	-	-	-	-	-	-	-
SL-8	2 above	Rips/tears (inches)	0	0	0	0	0	0		-	-	-	-	-	-	-	-	-	-
		Percent toe scour	0	0	0	0	0	0		-	-	-	-	-	-	-	-	-	-
		Percent cover willow	5	10	10	10	10	30		-	-	-	-	-	-	-	-	-	-
		Percent cover seeded species	1	1	5	5	10	10		-	-	-	-	-	-	-	-	-	-
		Percent cover other herbaceous species	10	10	10	80	40	20		-	-	-	-	-	-	-	-	-	-
		Percent cover weeds	60	20	60	5	10	20		-	-	-	-	-	-	-	-	-	-
		Number alive stems planted (container plants)	1	0	0	0	0	0		-	-	-	-	-	-	-	-	-	-
		Number dead stems	1	1	2	1	0	1	-	-	-	-	-	-	-	-	-	-	-
		Percent browsed	0	50	10	5	5	0	-	-	-	-	-	-	-	-	-	-	-
		Average shoot height (inches)	6	4	6	6	10	10	-	-	-	-	-	-	-	-	-	-	-

Structure ID	Layer	Metric[1]	Distance (feet)															
			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	70-75	75-80	80-85
SL-12	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-
		Percent cover willow	10	0	10	60	70	30	50	30	15	20	20	30	30	80	-	-	-
		Percent cover seeded species	1	1	1	0	0	1	0	0	1	5	5	1	1	1	-	-	-
		Percent cover other herbaceous species	5	1	1	1	5	5	10	20	20	50	40	20	20	5	-	-	-
		Percent cover weeds	0	0	0	0	1	1	1	0	5	5	1	0	5	0	-	-	-
		Number alive stems planted (container plants)	0	0	0	0	0	0	1	1	0	1	1	1	0	1	-	-	-
		Number dead stems	0	0	0	3	1	1	0	0	1	3	2	2	2	0	-	-	-
		Percent browsed	80	0	20	0	0	0	0	0	5	0	10	20	20	10	-	-	-
		Average shoot height (inches)	12	0	12	18	12	10	18	12	8	6	10	6	6	12	-	-	-
SL-12	2 above	Rips/tears (inches)	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	-	-	-
		Percent toe scour	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	-	-	-
		Percent cover willow	N/A	N/A	N/A	20	20	10	50	30	30	50	50	40	30	10	-	-	-
		Percent cover seeded species	N/A	N/A	N/A	1	0	5	5	5	1	1	1	5	5	1	-	-	-
		Percent cover other herbaceous species	N/A	N/A	N/A	1	5	70	10	10	40	30	20	20	20	30	-	-	-
		Percent cover weeds	N/A	N/A	N/A	0	0	5	4	1	0	5	0	1	5	1	-	-	-
		Number alive stems planted (container plants)	N/A	N/A	N/A	0	0	0	0	0	0	0	2	0	0	0	-	-	-
		Number dead stems	N/A	N/A	N/A	2	2	1	2	1	2	0	1	4	1	2	-	-	-
		Percent browsed	N/A	N/A	N/A	5	10	5	10	10	50	80	80	50	50	10	-	-	-
		Average shoot height (inches)	N/A	N/A	N/A	10	6	10	18	12	10	6	6	8	10	4	-	-	-

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).

Table A- 3. Results of July 2008 point bar monitoring for Point Bar 4 Transect 1.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 inches	Number LWD >4 inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/Trees	Substrate[2]	Deposition Type and Percent Cover	Other Notes (apply to entire transect)
4	Distance (ft)									
Transect 1	0-10	8	4	40	10	50	1/0	OM, 6-10	leaves 30, OM 20	All trees are black cottonwood unless otherwise noted. If there were more than five seedlings, categories of >5,>10,>20, etc, were used.
	10-20	4	3	10	20	15	0/0	1-4, sand below	leaves 5	
	20-30	6	4	20	30	20	3/0	1-4	leaves 20	
	30-40	1	1	5	20	5	0/0	1-6, sand below	leaves 20	
	40-50	3	6	40	1	1	0/0	1-6, few 10, sand	leaves 5	
	50-60	3	0	30	1	1	1/0	1-6, few 8, sand	leaves 10	
	60-70	3	5	50	1	5	0/8	1-6, some 10, sand	leaves 10, OM 1	Weed species include toadflax, knapweed, oxeye daisy, and houndstongue.
	70-80	3	5	50	1	1	4/4	1-4	leaves 10, OM 10	A swale starts at the transect distance of 73 feet. Shrubs inside the swale include wood's rose, willows, red-osier dogwood, and snowberry. Cottonwood seedlings are abundant along the swale edges. Forbs such as mint are present in the bottom of the swale.
	80-90	4	2	30	1	1	5/4	1-6, silt-loam	leaves 10, OM 20	
	90-100	0	0	20	<1	1	1/4	0.5-2, some 4-6, sand	OM 10	
	100-110	0	0	0	<1	<1	0/<20	0.25-6, silt	N/A	
	110-120	0	0	0	0	0	0/0	0.25-6, some 10	N/A	
	120-130	0	3	20	0	0	0/0	0.25-2, some 4-6, silt	OM<1	
	130-140	0	0	0	0	0	0/0	1-6, some 10, sand	N/A	
	140-150	0	0	0	0	0	0/0	1-6, some 10, sand	leaves <1	
	150-160	0	0	0	0	0	0/0	1-6, some 10	N/A	The waters' edge is at 159 feet.

[1] Monitoring methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table A- 4. Results of July 2008 point bar monitoring for Point Bar 4 Transect 2.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 Inches	Number LWD >4 Inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/Trees	Substrate[2]	Deposition Type and Percent Cover	Other Notes (apply to entire transect)
4	**Distance (ft)**									
Transect 2	0-10	2	5	20	1	50	5/0	2-4, 4-6, some OM and mineral soil	leaves 10, OM 5	A swale is located at transect distance 60 feet to 66 feet. Seven planted shrubs are contained within this swale. Cottonwood recruits are present in swale.
	10-20	3	2	30	20	10	0/0	4-6, some<2, sand	leaves 1, OM 5	
	20-30	0	1	15	5	<1	0/1	4-6, some 10	leaves 5	
	30-40	0	1	5	0	5	0/>10	0.25-4, sand	N/A	
	40-50	0	0	1	20	10	0/1	0.25-2, some 4-6	N/A	
	50-60	0	1	<1	20	10	0/0	0.25-2, some 4-8	N/A	
	60-70	0	3	5	5	10	3/2	0.25-4, some 6-8, sand	leaves 5	
	70-80	0	1	25	5	10	0/4	4-6, some 8-10	N/A	
	80-90	0	0	1	0	<1	0/4	4-6, some 2, sand	N/A	A swale is located at transect distance 90 feet to 101 feet. Six planted shrubs are contained within this swale. Forbs such as mint are present in the bottom of the swale.
	90-100	0	0	<1	5	20	7/2	4-6 top of swale, 2-4 edge swale, OM in swale	OM 50	
	100-110	0	1	<1	10	5	1/>5	0.25-2, some 4-6	N/A	
	110-120	1	0	5	5	10	1/0	sand, 2-4, few 4-6	sand 75	LWD at transect distance 110 feet is part of constructed rock and log weir.
	120-130	0	0	<1	0	<1	0/0	sand, 0.25-2, some 4	sand 90	
	130-140	0	0	<1	<1	5	7/5	sand, 4-6	sand 40	
	140-150	0	0	5	0	0	0/0	2-4, some 4-6, sand	OM <1	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table A-5. Results from July 2008 point bar monitoring for Point Bar 13 Transect 1.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 Inches	Number LWD >4 Inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/Trees	Substrate[2]	Deposition Type and Percent Cover	Other Notes (apply to entire transect)
13	**Distance (ft)**									
Transect 1	0-10	0	0	<1	<1	1	3/2	<0.5, some 0.5-2	leaves 20	
	10-20	0	0	<1	1	5	0/4	<0.5 and 0.5-2 with some OM	N/A	
	20-30	0	0	<1	<1	1	0/0	<0.5-2, silt	leaves <1	
	30-40	0	0	0	1	5	1/>20	2-4, some 4-6, few 8	leaves 20, sand 10	
	40-50	1	5	30	1	1	0/>50	2-6, sand	leaves 1, OM <1	
	50-60	1	2	10	<1	<1	0/>100	4-6, sand, some 2-4	sand 1	
	60-70	1	3	20	5	5	0/>100	4-6, some 8, sand	sand 5	
	70-80	1	5	40	10	20	0/>20	sand	sand 90, OM 10	A swale is located at transect distance 70 feet to 77 feet.
	80-90	2	0	5	5	5	0/>200	2-4, sand	OM 10, leaves 1	
	90-100	0	0	<1	<1	<1	0/>200	2-4, some 4-6, sand	N/A	
	100-110	0	0	<1	<1	1	0/>100	2-4, some 4-6, few 8	OM<1, sand 1	Cottonwood recruits stop at transect distance 105 feet then start again at 120 feet.
	110-120	0	0	0	0	<1	0/0	2-4, 4-6, some 8	N/A	
	120-130	0	0	0	0	<1	0/>50	2-4 some 4-6, sand	N/A	Waters' edge is at transect distance 128 feet.

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table A- 6. Results of 2008 point bar monitoring for Point Tar 13 Transect 2.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 Inches	Number LWD >4 Inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/Trees	Substrate[2]	Deposition Type and Percent Cover	Other Notes (apply to entire transect)
13	**Distance (ft)**									
Transect 2	0-10	0	2	10	<1	5	5/2	silt, <0.5	leaves 60	
	10-20	0	2	10	1	5	0/>50	<0.5-2		
	20-30	0	0	0	1	5	0/>100	0.5-2, silt		
	30-40	0	0	<1	5	40	0/>50	silt, 2-4	leaves 20	
	40-50	0	0	10	10	60	2/0	silt, well developed soil	leaves 10	
	50-60	5	2	40	5	60	6/0	sand, silt, well developed soil	leaves 5, sand 25	
	60-70	6	2	40	0	1	0/0	sand ,silt, OM	sand 50, OM 20	
	70-80	7	8	80	<1	1	0/0	silt, OM	OM 10, sand 1	A swale is located at transect distance 78 feet to 90 feet.
	80-90	1	4	30	1	5	1/0	sand, silt, OM	OM 5	
	90-100	3	2	20	1	5	0/0	4-6, some 2, few 8		
	100-110	2	0	5	0	<1	0/0	2-4 some 6-8, sand	sand 1	
	110-120	0	0	0	0	1	0/>10	2-4, 4-6		
	120-130	0	0	<1	0	<1	0/>5	0.5-2 with 2-4 and sand	sand 5	
	130-140	0	0	0	0	0	0/0	2-4, some 6-8 with sand		
	140-150	0	0	0	0	0	0/0	2-4 some 6-8		Waters' edge is at transect distance 155 feet.

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table A- 7. Results from 2008 point bar monitoring for Point Bar 5 Transect 1.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 Inches	Number LWD >4 Inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/ Trees	Substrate[2]	Deposition Type and Percent Cover	Other Notes (apply to entire transect)
5	**Distance (ft)**									
Transect 1	0-10	0	0	<1	1	5	14/>20	0.5-2, 6-8, silt, some 2-4	leaves <1, OM 10	Three spruce are located along this transect segment. (Spruce greater than 1 inch tall were counted).
	10-20	0	0	0	10	10	10/>10	2-4, 6-8, silt	OM 10	One spruce is located between 10 feet and 20 feet.
	20-30	0	0	1	20	30	0/7	OM, well developed soil, some 2-4	OM 30	Cottonwoods along this transect segment are 3 feet tall.
	30-40	0	0	0	10	10	3/10	0.5-2, 2-4, silt, well developed soil	OM 20	Three willow clumps and two spruce are located along this transect segment (a clump = >40% cover).
	40-50	0	1	1	20	1	2/0	silt, 2-4	OM <1	Two willow clumps and six spruce are located along this transect segment.
	50-60	0	1	1	5	10	5/0	silt, 2-4, few 4-6	OM 5	
	60-70	0	1	5	5	30	0/1	OM bottom swale, 2-4 and <0.5 side swale	OM 20	A swale is located at transect distance 59 feet to 73 feet.
	70-80	0	1	5	1	1	0/3	silt, 2-4, some 6-8	OM 1	Shrub species include red-osier dogwood, willow, alder, and raspberry. Weed species include knapweed, oxeye daisy, houndstongue, and toadflax.
	80-90	0	0	<1	<1	10	2/<10	silt, 0.5-2, 2-4, few 6-8	OM 1	
	90-100	0	1	5	1	1	>40	silt, few 0.5-2, 6-8, 2-4	OM1	
	100-110	0	0	0	<1	1	>50	2-4 on point bar terrace, 6-8 slope to water	OM 1	Waters' edge is located at transect distance 112.5 feet.

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2] Numbers represent substrate size ranges in inches, OM = organic matter

Table A- 8. Results from 2008 point bar monitoring for Point Bar 5 Transect 2.

Point Bar ID	Monitoring Parameter[1]	Number LWD <4 Inches	Number LWD >4 Inches	Percent LWD	Percent Weeds	Percent Grasses and Forbs	Number Shrubs/Trees	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
5	**Distance (ft)**									
Transect 2	0-10	0	0	<1	1	30	3/10	6-8 some 4-6	OM 1	
	10-20	0	0	0	<1	5	1/>10	2-4, some 0.5-2, few 6-8	N/A	
	20-30	0	0	0	0	1	1/1	2-4, 4-6, few 0.5	N/A	
	30-40	0	1	5	1	5	0/>5	2-4, 4-6, some 8	N/A	A swale is located at transect distance 37 feet to 57 feet. Willows are located within this swale. Substrate in the swale is a mix of 2-4 and 6-8, with some 10 and OM/algae, and silt.
	40-50	0	1	20	<1	5	10/2	2-4, 4-6, 8, OM	OM 10	
	50-60	0	1	20	5	1	2/>5	4-6, some 0.5-2, 6-8	OM 5	
	60-70	0	2	10	<1	5	4/>50	0.5-2, 2-4, some 6-8	OM 5	A small swale is located at transect distance 63 feet to 68 feet.
	70-80	0	0	0	1	1	0/>5	0.5-2, 2-4, few 8	N/A	
	80-90	0	0	0	5	1	4/>10	2-4, some 6-8, few 10, few 0.5	N/A	
	90-100	0	0	0	<1	<1	3/>20	0.5-2, 2-4, few 8 and sand below	N/A	
	100-110	0	0	0	<1	<1	0/5	4-6, 6-8	N/A	Edge of water is located at transect distance 107 feet.

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Appendix B: 2008 As-built Detail Sheets

Figure B-1. Detail sheet showing as-built conditions for the 2008 Grave Creek riparian revegetation project.

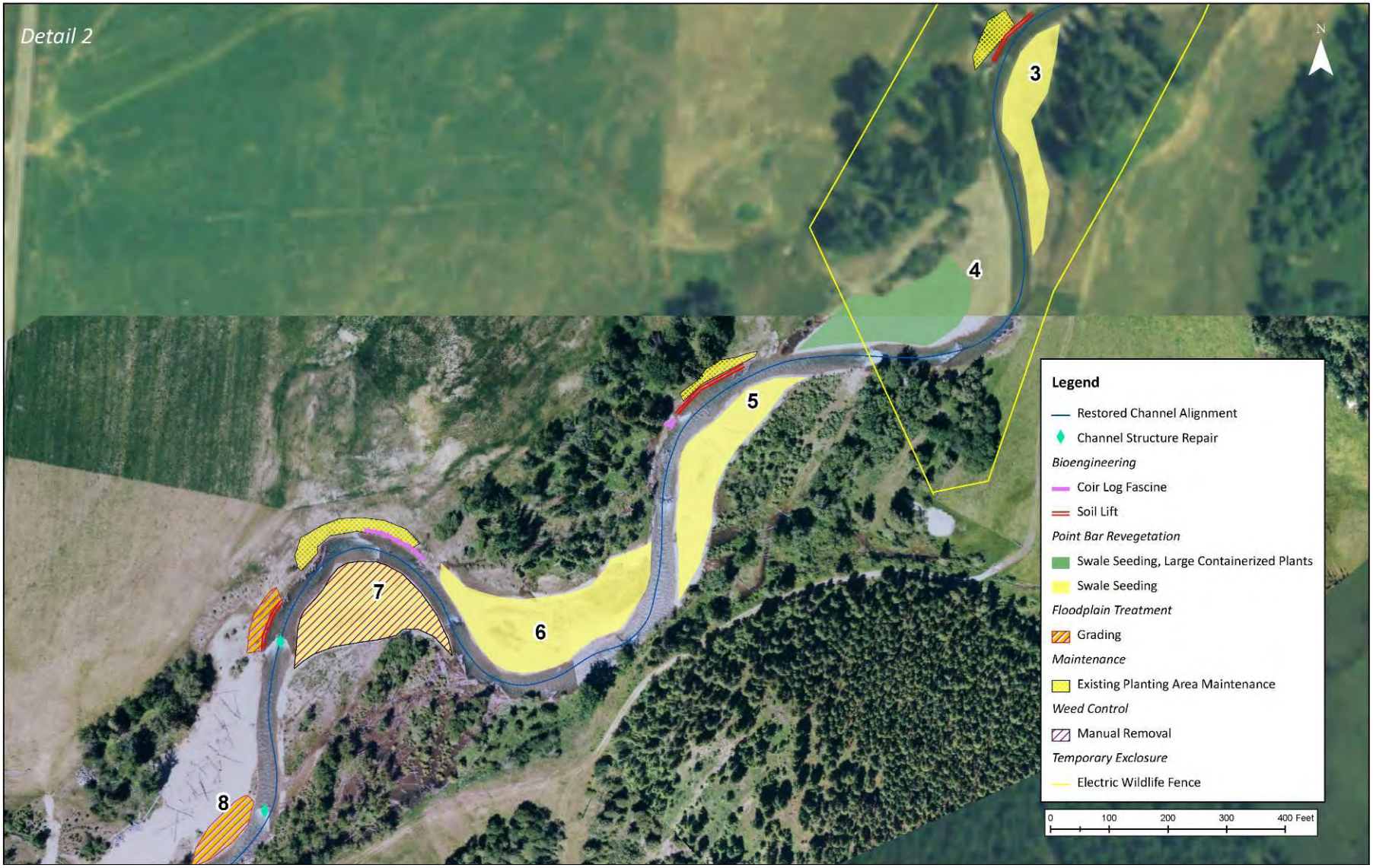

Figure B-2. Detail sheet showing as-built conditions for the 2008 Grave Creek riparian revegetation project.

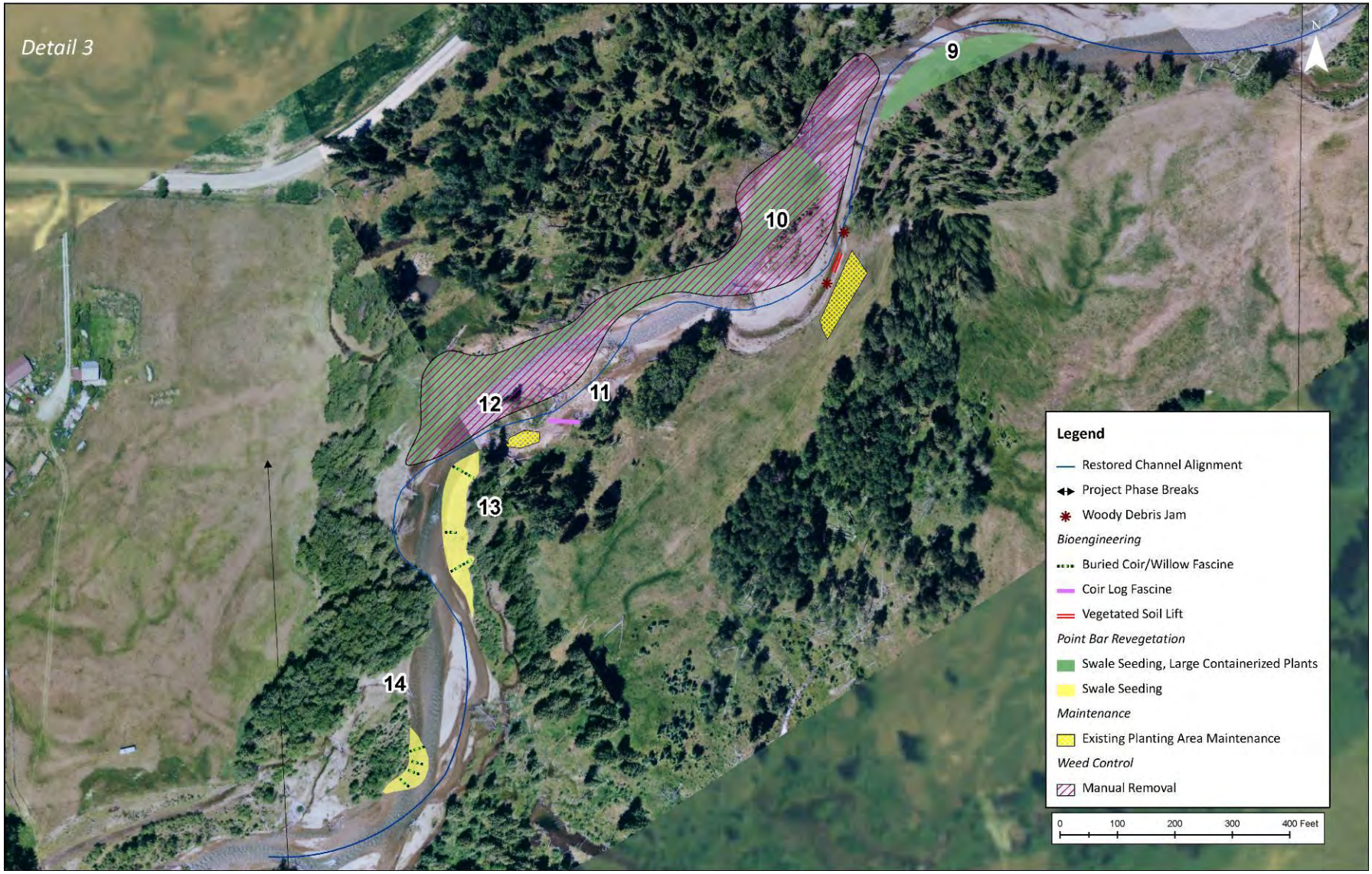

Figure B-3. Detail sheet showing as-built conditions for the 2008 Grave Creek riparian revegetation project.

Appendix C: 2009 Effectiveness Monitoring Results

Table C-1. Planting area survival results from July 2009 Monitoring

Monitoring Plot	Alive	Dead	Notes	Photograph August 2008	Photograph July 2009
Planting Area Monitoring Plot 1	36	27	Browse protectors were removed during 2008 maintenance. Re-locating containerized plants difficult, especially dead plants. Few plants approximately four feet tall. Many plants re-sprouting from base after ice and browse damage.		
Planting Area Monitoring Plot 2	29	20	Solarization plot. Shrub height is four to six feet, but many are browsed. Seeded grasses appear to be germinating. Other species colonizing the newly exposed mineral soil include forbs such as clovers, goldenrod, annual mustards, asters, mullein, yarrow, and field horsetail; weeds such as oxeye daisy, knapweed, and houndstongue; pasture grasses such as redtop and timothy. Cottonwood seedlings are also colonizing the exposed surface.		
Planting Area Monitoring Plot 3	10	2	Browse protectors were removed during fall 2008. Shrubs and trees remain small and appear to be growing more slowly than other plots. This may be due the high and dry location of this planting area. Average spruce height is approximately two feet.		
Planting Area Monitoring Plot 4	33	11	Browse protectors were expanded. Shrub height ranges from three to six feet. Average height of spruce is approximately three feet.		

Table C-2. Container plant survival for planted swales monitored in July 2009.

Scientific Name	Common Name	Alive	Dead
Planted Swale Site 4 Plot 1 Inside Fence			
Salix bebbiana	bebb willow	3	0
Salix exigua	sandbar willow	1	0
Cornus sericea	red-osier dogwood	3	0
Populus balsamifera	black cottonwood	2	0
Salix drummondiana	Drummond willow	2	0
Salix spp	willow species	1	0
Crataegus douglasii	black hawthorne	2	0
Total		14	0
Planted Swale Site 4 Plot 2 Inside Fence			
Salix bebbiana	bebb willow	2	0
Salix exigua	sandbar willow	3	0
Cornus sericea	red-osier dogwood	3	0
Populus balsamifera	black cottonwood	1	0
Prunus virginiana	chokecherry	4	0
Salix species	willow species	4	0
Crataegus douglasii	black hawthorne	1	0
Symphoricarpos spp	snowberry species	1	0
Total		19	0
Planted Swale Site 4 Plot 3 Outside Fence			
Salix bebbiana	bebb willow	2	0
Cornus sericea	red-osier dogwood	7	0
Salix species	willow species	3	0
Salix drummondiana	Drummond's willow	5	0
Crataegus douglasii	black hawthorne	1	0
Total		18	0
Planted Swale Site 12 Plot 1 Outside Fence			
Salix bebbiana	bebb willow	1	0
Cornus sericea	red-osier dogwood	3	0
Total		4	0
Planted Swale Site 12 Plot 2 Outside Fence			
Salix exigua	sandbar willow	1	0
Salix bebbiana	bebb willow	2	0
Cornus sericea	red-osier dogwood	1	0
Total		4	0

Table C- 3. Herbaceous species composition and percent cover for planted swales monitored in July 2009.

	Scientific Name	Common Name	Percent Cover
Planted Swale Site 4 Plot 1 Inside Fence	*Agrostis gigantea*	redtop	6
	Phleum pratense	timothy	2
	Phalaris arundinacea	reed canarygrass*	P
	Cirsium arvense	Canada thistle*	P
	Prunella vulagaris	self heal	P
	Centaurea maculosa	knapweed*	1
	Achillea millefolium	yarrow	P
	Trifolium spp	clover species	P
	Poa pratensis	Kentucky bluegrass	1
	Aster spp	aster species	P
	Populus balsamifera	cottonwood	1
	Verbascum thapsus	mullein	P
	*Elymus spp***	wheatgrass species	P
Planted Swale Site 4 Plot 2 Inside Fence	*Agrostis gigantea*	redtop	3
	Phleum pratense	timothy	P
	Phalaris arundinacea	reed canarygrass*	T
	Centaurea maculosa	knapweed*	P
	Trifolium spp	clover	P
	Poa pratensis	Kentucky bluegrass	1
	Aster spp	aster	T
	Populus balsamifera	cottonwood	1
	Verbascum thapsus	mullein	T
	*Elymus spp***	wheatgrass species	P
	Leucanthemum vulgare	oxeye daisy*	P
	Solidago canadensis	Canada goldenrod	P
	Medicago lupulina	medic	T
	Campanula rotundifolia	harebells	T
	Taraxacum officinale	dandelion	P
	Prunella vulagaris	self heal	P
	Geum macrophyllum	large leaf avens	T
Planted Swale Site 4 Plot 3 Outside Fence	*Agrostis gigantea*	redtop	2
	Phleum pratense	timothy	3
	Phalaris arundinacea	reed canarygrass*	P
	Trifolium spp	clover	T
	Poa pratensis	Kentucky bluegrass	P

	Scientific Name	Common Name	Percent Cover
	Aster spp	aster	T
	Populus balsamifera	cottonwood	1
	Verbascum thapsus	mullein	P
	Leucanthemum vulgare	oxeye daisy*	P
	Taraxacum officinale	dandelion	T
	Prunella vulagaris	self heal	T
	Plantago spp	plantain species	T
Planted Swale Site 12 Plot 1 Outside	*Agrostis gigantea*	redtop	2
	Phleum pratense	timothy	1
	Centaurea maculosa	knapweed*	P
	Trifolium spp	clover	P
	Dactylis glomerata	orchard grass	P
	Aster spp	aster	T
	Populus balsamifera	cottonwood	1
	Verbascum thapsus	mullein	P
	Leucanthemum vulgare	oxeye daisy*	P
	*Elymus spp***	wheatgrass species	P
	Solidago canadensis	Canada goldenrod	T
	Potentilla recta	sulphur cinquefoil*	T
	*Poa spp***	bluegrass species	T
Planted Swale Site 12 Plot 2 Outside	*Agrostis gigantea*	redtop	1
	Equisetum spp	horsetail species	P
	Leucanthemum vulgare	oxeye daisy*	P
	Verbascum thapsus	mullein	P
	Phleum pratense	timothy	P
	Trifolium spp	clover	P
	*Elymus spp***	wheatgrass species	T
	Epilobium spp	epilobium species	T
	Populus balsamifera	cottonwood	2
	*Poa spp***	bluegrass species	T
	Campanula rotundifolia	harebells	T
	Centaurea maculosa	knapweed*	T
	Dactylis glomerata	orchard grass	T

*Noxious weed species
**Possible seeded species

Table C- 4. Monitoring data collected for vegetated soil lift and coir log fascine bioengineering structures in July 2009.

Structure ID	Layer	Metric[1]	Distance (feet)									
			0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Demo SL-2	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	100	70	70	90	100	90	80	90	100	40
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	50	30	10	30	40	20	10	30	40	60
		Percent cover weeds	0	1	0	0	0	0	0	0	0	1
		Number alive stems planted (container plants)	0	1	0	0	2	0	1	0	0	0
		Number dead stems	2	0	3	0	0	1	1	1	0	5
		Percent browsed	0	0	0	0	0	0	0	0	0	0
		Average shoot height (inches)	30	30	42	42	42	42	30	30	30	24
Demo SL-2	2 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	60	100	100	100	100	100	100	100	100	70
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	60	80	100	100	100	100	100	100	100	100
		Percent cover weeds	5	10	2	5	5	1	1	1	5	5
		Number alive stems planted (container plants)	0	1	1	0	0	0	0	1	1	0
		Number dead stems	0	0	0	0	1	2	0	1	0	1
		Percent browsed	0	0	0	0	0	0	0	0	0	0
		Average shoot height (inches)	48	42	48	42	48	42	36	36	36	30

Structure ID	Layer	Metric[1]	Distance (feet)							
			0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
SL-2	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0
		Percent cover willow	30	70	100	90	90	90	70	60
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	10	20	20	10	10	5	5	5
		Percent cover weeds	0	0	0	0	1	0	0	0
		Number alive stems planted (container plants)	2	1	0	1	1	1	0	0
		Number dead stems	4	2	0	1	1	2	3	3
		Percent browsed	0	0	0	0	0	0	0	0
		Average shoot height (inches)	18	24	30	36	30	24	24	24
SL-2	2 above	Rips/tears (inches)	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0
		Percent cover willow	70	100	100	100	100	80	80	70
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	90	90	100	100	100	80	90	80
		Percent cover weeds	5	5	5	5	10	0	0	10
		Number alive stems planted (container plants)	0	0	0	0	0	0	1	2
		Number dead stems	1	1	1	1	0	1	1	3
		Percent browsed	0	0	0	0	0	0	0	0
		Average shoot height (inches)	24	30	36	36	36	30	30	24

Structure ID	Layer	Metric[1]	Distance (feet)															
			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	70-75	75-80
SL-4	1 above	Rips/tears (inches)	0	0	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0
		Percent toe scour	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0
		Percent cover willow	48	80	90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50	70	30
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	30	30	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	10
		Percent cover weeds	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0
		Number alive stems planted (container plants)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Number dead stems	3	3	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	2	0
		Percent browsed	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0
		Average shoot height (inches)	60	48	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	48	60	60
SL-4	2 above	Rips/tears (inches)	18	0	0	0	24	18	0	12	0	0	0	all	all	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	70	100	100	90	100	90	100	70	70	100	70	80	100	90	100	80
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	70	100	100	90	100	90	100	100	100	100	70	70	100	90	100	80
		Percent cover weeds	0	0	5	1	1	0	0	0	1	5	0	1	1	5	5	0
		Number alive stems planted (container plants)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Number dead stems	0	1	0	2	2	0	0	0	0	0	0	0	0	2	0	0
		Percent browsed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Average shoot height (inches)	48	42	48	42	48	42	48	48	48	60	60	72	72	72	72	72

Structure ID	Layer	Metric[1]	Distance (feet)							
			0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
SL-6	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0
		Percent cover willow	20	10	40	70	30	80	60	50
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	70	60	10	10	80	20	10	10
		Percent cover weeds	5	0	0	0	0	0	0	0
		Number alive stems planted (container plants)	1	0	1	1	0	0	1	0
		Number dead stems	3	7	5	1	3	4	4	2
		Percent browsed	20	20	20	20	20	20	20	20
		Average shoot height (inches)	24	12	18	24	12	18	12	18
SL-6	1 below	Rips/tears (inches)	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0
		Percent cover willow	30	10	20	20	20	30	10	40
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	90	70	70	80	40	70	70	70
		Percent cover weeds	10	5	20	10	20	20	20	5
		Number alive stems planted (container plants)	0	1	1	0	0	0	0	0
		Number dead stems	4	9	5	7	6	4	3	3
		Percent browsed	20	20	20	20	20	20	20	20
		Average shoot height (inches)	18	12	12	18	12	12	12	18

Structure ID	Layer	Metric[1]	Distance (feet)						
			0-5	5-10	10-15	15-20	20-25	25-30	30-35
SL-8	1 above	Rips/tears (inches)	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0
		Percent cover willow	30	10	30	20	50	30	50
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	70	70	50	90	70	70	50
		Percent cover weeds	10	5	10	20	20	50	20
		Number alive stems planted (container plants)	0	0	0	1	1	0	0
		Number dead stems	2	5	5	7	3	5	3
		Percent browsed	0	0	0	0	0	0	0
		Average shoot height (inches)	24	24	24	24	30	30	24
SL-8	2 above	Rips/tears (inches)	0	0	0	0	0	0	
		Percent toe scour	0	0	0	0	0	0	
		Percent cover willow	20	40	20	40	10	50	
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	
		Percent cover other herbaceous species	70	50	60	80	60	70	
		Percent cover weeds	60	50	80	50	20	20	
		Number alive stems planted (container plants)	0	0	0	0	0	0	
		Number dead stems	3	3	2	4	3	1	
		Percent browsed	10	10	10	10	0	0	
		Average shoot height (inches)	18	18	12	18	24	24	

Structure ID	Layer	Metric[1]	Distance (feet)													
			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-12	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	20	5	30	20	20	30	50	40	20	40	20	40	30	40
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	10	10	20	5	5	10	20	40	30	60	40	50	20	10
		Percent cover weeds	0	1	0	0	0	2	0	0	1	1	0	0	1	0
		Number alive stems planted (container plants)	1	0	0	0	0	0	0	1	0	0	1	2	0	0
		Number dead stems	2	0	0	4	7	7	7	4	4	4	4	6	5	3
		Percent browsed	10	10	0	10	10	0	10	10	10	0	10	10	10	10
		Average shoot height (inches)	24	8	30	12	10	24	18	18	18	24	18	18	18	18
SL-12	2 above	Rips/tears (inches)	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	N/A	N/A	N/A	50	50	60	50	60	60	60	60	60	60	60
		Percent cover seeded species	N/A	N/A	N/A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	N/A	N/A	N/A	30	30	50	50	60	60	60	50	40	50	50
		Percent cover weeds	N/A	N/A	N/A	0	5	10	10	5	5	5	0	5	5	1
		Number alive stems planted (container plants)	N/A	N/A	N/A	0	0	0	0	1	0	0	3	1	1	0
		Number dead stems	N/A	N/A	N/A	2	1	3	4	2	3	2	3	2	2	2
		Percent browsed	N/A	N/A	N/A	0	0	0	0	0	0	0	0	10	10	10
		Average shoot height (inches)	N/A	N/A	N/A	24	24	30	30	30	30	24	24	18	18	12

ID	Layer	Metric[1]	Distance (feet)																					
			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	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115
SL-5	1 above	Rips/tears (inches)	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	30	40	50	40	30	50	40	60	50	50	70	40	80	60	40	40	70	70	60	50	40	60	70
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover weeds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Number dead stems	0	1	0	1	0	0	0	0	0	0	3	2	0	3	1	1	1	0	0	1	0	0	0
		Percent browsed	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		Average shoot height (inches)	12	18	12	12	12	12	12	12	12	12	12	10	6	12	12	12	12	18	12	10	12	12	12
SL-5	2 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	60	60	50	40	50	40	50	70	50	40	50	80	70	60	70	60	50	70	60	50	40	60	70
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	10	10	20	20	20	20	20	10	10	10	20	30	20	5	1	5	1	0	0	0	0	0	0
		Percent cover weeds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Number dead stems	1	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0	1	0	1	2	1	0	0
		Percent browsed	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
		Average shoot height (inches)	12	10	10	12	10	10	6	10	6	10	10	10	10	10	12	12	12	12	12	6	6	6	10

ID	Layer	Metric[1]	Distance (feet)																				
			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	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110
CL-7	1 above	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	10	10	10	10	5	5	20	10	10	10	10	5	5	10	10	10	5	1	10	10	10	20
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
		Percent cover weeds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
		Number dead stems	2	1	2	0	1	1	0	2	0	2	0	1	2	0	0	0	0	4	0	1	1	0
		Percent browsed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Average shoot height (inches)	18	12	12	8	12	12	12	12	6	10	6	6	6	12	12	12	12	6	6	6	12	12
CL-7	2 above	Rips/tears (inches)	0	0	0	0	0	0	12	12	0	0	0	0	0	0	0	0	0	0	0	0		
		Percent toe scour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Percent cover willow	10	20	10	10	20	30	30	30	30	30	30	30	40	30	30	30	30	40	30	40		
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
		Percent cover other herbaceous species	1	0	1	1	5	50	20	1	0	1	10	0	10	5	5	1	5	1	0	1		
		Percent cover weeds	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	1	0	0	0		
		Number dead stems	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Percent browsed	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
		Average shoot height (inches)	12	18	18	18	12	12	12	12	12	12	12	16	18	12	12	18	12	12	12	12		

Structure ID	Layer	Metric[1]	Distance (feet)									
			0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
CL-12	ALL	Rips/tears (inches)	0	0	0	0	0	0	0	0	0	0
		Percent toe scour	0	0	0	0	0	0	0	0	0	0
		Percent cover willow	60	60	40	40	30	40	40	60	60	30
		Percent cover seeded species	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Percent cover other herbaceous species	70	20	20	20	10	10	1	1	1	1
		Percent cover weeds	1	1	1	0	1	1	0	1	0	0
		Number dead stems	1	0	0	0	0	0	1	0	0	0
		Percent browsed	100	75	100	100	100	100	100	100	100	100
		Average shoot height (inches)	12	12	12	12	12	18	18	18	18	12

[1] Monitoring methods are described in Geum Environmental Consulting, Inc. (2008).

Table C- 5. Monitoring data collected at buried coir/willow fascine sites in July 2009.

Structure ID	Metric	Distance (feet)							
		0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
BWF - 1	Percent cover willow	30	30	70	60	70	60	50	40
	Percent cover other	0	5	5	1	0	1	1	30
	Number of dead stems	0	0	0	0	1	1	4	3
	Percent browsed	30	30	30	30	30	30	30	30
	Average shoot height (inches)	12	12	12	12	8	12	6	6
BWF - 2	Percent cover willow	70	70	50	20				
	Percent cover other	1	1	10	20				
	Number of dead stems	0	1	1	2				
	Percent browsed	30	30	30	30				
	Average shoot height (inches)	12	12	8	12				
BWF - 3	Percent cover willow	30	50	20	40	10	5	20	
	Percent cover other	5	10	20	20	10	10	10	
	Number of dead stems	0	0	1	1	2	1	1	
	Percent browsed	30	30	30	30	30	30	30	
	Average shoot height (inches)	6	10	10	10	4	6	6	
BWF - 4	Percent cover willow	30	30	30	40	20			
	Percent cover other	1	5	0	0	0			
	Number of dead stems	0	1	1	0	1			
	Percent browsed	50	50	50	50	50			
	Average shoot height (inches)	4	4	4	4	2			
BWF - 5	Percent cover willow	5	20	60	70				
	Percent cover other	0	1	1	1				
	Number of dead stems	1	0	0	0				
	Percent browsed	50	50	50	50				
	Average shoot height (inches)	2	4	4	10				
BWF - 6	Percent cover willow	60	20	60	20				
	Percent cover other	0	1	0	0				
	Number of dead stems	0	0	1	0				
	Percent browsed	50	50	50	50				
	Average shoot height (inches)	10	6	8	6				
BWF - 7	Percent cover willow	30	10	10	20				
	Percent cover other	0	0	0	0				
	Number of dead stems	0	3	1	5				
	Percent browsed	50	50	50	50				
	Average shoot height (inches)	4	1	2	2				

Table C- 6. Point bar monitoring data collected during July 2009: Point Bar 4 Transect 1.

Point Bar 4	Monitoring Parameter[1]	Number LWD <4"	Number LWD >4"	Percent LWD	Percent Weeds	Percent Grass and Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
	Distance (ft)										
Transect 1	0-10	6	4	30	10	50	2	0	OM, 2-4, 6-10	OM 50	Cottonwood seedlings surround the edges of the swales.
	10-20	7	3	15	20	15	0	2	OM, 1-4	OM 20	
	20-30	4	8	30	30	15	2	2	OM 1-4, 4-6	OM 10	Sedges are present in swale.
	30-40	2	1	5	20	1	0	1	<1, 1-6	OM <5	
	40-50	3	6	40	5	1	0	3	<1, 1-6, few 8	OM <5	OM includes leaves and other litter.
	50-60	1	5	20	1	1	1	3	1-6, few 8	OM <5	
	60-70	3	6	20	5	5	0	>10	1-6, 8-10	OM <5	Shrub species include: red-osier dogwood, raspberry, willow species, wood's rose, snowberry.
	70-80	4	4	20	10	10	3	20	sand, 1-6, few 8	OM 10	
	80-90	5	7	50	1	20	7	6	silt, OM, few 8-10	OM 10	Weed species include: oxeye daisy, houndstongue, knapweed, Canada thistle, yellow toadflax, and reed canarygrass.
	90-100	10	6	40	10	20	8	>20	sand, OM, 2-8	OM 10	
	100-110	1	0	<1	0	1	0	>20	sand 2-4, some 8	sand 20	
	110-120	20	3	10	0	0	0	0	sand 2-6, some 8	sand 1, OM 5	
	120-130	>20	6	60	0	<1	0	3	sand, 1-4	sand 10, OM 5	
	130-140	0	2	1	0	0	0	6	<1, 1-4, few 6-8	sand 1	
	140-150	0	0	0	0	<1	0	0	2-6, some 8-10		

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 7. Point bar monitoring data collected during July 2009: Point Bar 4 Transect 2.

Point Bar 4	Monitoring Parameter[1]	Number LWD <4"	Number LWD >4"	Percent LWD	Percent Weeds	Percent Grass and Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
	Distance (ft)										
	0-10	10	4	20	20	50	2	0	OM, 2-4	OM 40	Weed species include: knapweed, oxeye daisy, houndstongue.
	10-20	4	5	40	20	5	1	0	sand, OM, 1-6, some 8	OM 10	Transect has an abundance of knapweed rosettes.
	20-30	3	3	20	5	<1	0	5	OM, 4-6, 8-10, <1 below	OM 5	
	30-40	2	2	5	10	<1	0	>10	<1, 2-6	OM 1	Shrub species include: red-osier dogwood, alder, willows, wood's rose, currants, serviceberry, snowberry, raspberry, and chokecherry.
	40-50	1	1	5	40	0	0	0	<1. 2-4, some 6-8	OM 1	
	50-60	2	0	1	30	0	1	0	<1, 2-4, some 8	OM 1	The swale between 59'-92' has damp OM and evidence of ponding.
Transect 2	60-70	1	2	10	10	1	5	5	OM, 2-8	OM 5	
	70-80	2	3	30	10	1	0	10	<1, 2-4, 8-10		
	80-90	1	1	5	1	1	0	4	2-6, 8-10		
	90-100	4	8	30	1	20	7	1	OM, <1, 2-6, some 10	OM 5	
	100-110	5	1	5	15	5	9	>10	sand, <1, 2-4, few 10	sand 20	
	110-120	2	1	30	20	5	7	2	sand, <1, 2-6, 10	sand 30, OM 5	
	120-130	7	2	5	1	1	1	0	sand, 2-6, some 8	sand 30, OM 5	
	130-140	10	1	10	1	10	8	>10	sand, 2-6, some 10	sand 40	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2] Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 8. Point bar monitoring data collected during July 2009: Point Bar 5 Transect 1.

Point Bar 5	Monitoring Parameter[1]	Number LWD <4"	Number LWD >4"	Percent LWD	Percent Weeds	Percent Grass and Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
Transect 1	**Distance (ft)**										
	0-10	0	1	1	5	5	14	>20	silt, <1, 2-6	OM 1	A swale is located between 57'- 71'.
	10-20	0	0	0	10	20	9	>10	silt, <1, 2-4, some 6	OM 5	
	20-30	0	0	0	10	40	7	5	silt, 2-4	OM 10	Shrubs and trees include: spruce, red-osier dogwood, willow, alder, cottonwood (2' or taller), raspberry.
	30-40	0	0	0	10	5	10	1	sand, 2-4	OM 5, sand 5	
	40-50	0	1	1	10	1	4	0	silt, <1, 2-4	OM 1, silt 30	Willow between 30'-40' is a large clump equaling about 40% cover.
	50-60	0	1	5	5	20	2	3	silt, OM, 2-6	OM 10	
	60-70	0	1	5	1	75	0	>10	silt, OM, 2-4	OM 5, silt 10	
	70-80	0	1	5	5	5	0	5	OM, <1, 2-4, some 8	OM 1	
	80-90	0	0	0	5	10	2	8	2-6	OM 1	
	90-100	1	0	1	1	5	1	>20	<1, 2-6, some 10	OM 1	
	100-110	0	0	0	1	5	1	>30	<1, 2-6, some 10	OM 1	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 9. Point bar monitoring data collected during July 2009: Point Bar 5 Transect 2.

Point Bar 5	Monitoring Parameter[1]	Number LWD <4"	Number LWD >4"	Percent LWD	Percent Weeds	Percent Grass & Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
Transect 2	**Distance (ft)**										The swale located at 37' has standing water. Shrubs are browsed. A micro swale is located at 63.'
	0-10	0	0	0	1	30	3	>10	4-6, 6-8	OM 1	
	10-20	0	0	0	1	10	1	>20	2-6, some 8	0	
	20-30	0	0	0	1	5	2	2	<1, 2-6, few 8	0	
	30-40	0	1	5	5	5	3	>10	2-4, 6-8	0	
	40-50	0	1	10	1	5	9	8	<1, 2-6, some 8	OM 5	
	50-60	0	1	15	5	5	2	>10	<1, 2-6, some 8	OM 1	
	60-70	0	2	20	1	5	2	>20	<1, 2-6, some 8	OM 1	
	70-80	0	0	0	10	1	0	0	2-6, some 8	0	
	80-90	0	0	0	10	<1	2	>10	2-4, 6-8	0	
	90-100	0	0	0	1	1	3	>20	2-4, 6-8, some 10	0	
	100-110	0	0	0	1	1	2	>10	>1, 2-4, 6-8 on slope break to water	0	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 10. Point bar monitoring data collected during July 2009: Point Bar 13 Transect 1.

Point Bar 13	Monitoring Parameter[1]	Number LWD <4"	Number LWD >4"	Percent LWD	Percent Weeds	Percent Grass & Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
Transect 1	**Distance (ft)**										Swale at 67' has lots of sand deposition.
	0-10	5	0	1	<1	1	4	7	OM, <1, 2-4	OM 5	
	10-20	3	0	<1	1	5	0	0	<1,2-4, OM	OM 1	Abundant cottonwood seedlings are surviving from previous year.
	20-30	1	0	<1	1	<1	0	0	silt, <1, 2-4, some 6	OM 1	Cottonwood seedlings stop at 110' and begin again at 120'. The bare area is where water flows over the point bar.
	30-40	1	0	1	5	10	0	>50	OM, sand, 2-4, 6-8	OM 20, sand 10	
	40-50	1	7	30	1	5	0	>50	sand, OM, <1, 2-6, some 10	sand 20, OM 10	Weeds include oxeye daisy, knapweed, Canada thistle, reed canarygrass.
	50-60	7	2	10	1	1	0	>75	OM, sand, 2-4, 6-8	OM 5	Forbs include large leaf avens, goldenrod, yarrow, clover.
	60-70	2	5	20	5	10	1	>75	silt, 4-6, some 10	OM 1, sand 5	
	70-80	2	8	40	5	40	1	>100	sand 2-4	sand 40, OM 5	
	80-90	1	2	5	5	1	0	>200	sand, <1, 2-4	sand 10	Shrubs include currant, dogwood, raspberry, serviceberry, rose and buckthorn.
	90-100	2	0	<1	<1	1	1	>200	<1, 2-4, some 6	0	
	100-110	0	0	<1	<1	5	2	>200	sand 2-4, some 8-10	0	
	110-120	0	0	0	<1	<1	0	7	2-6, some 10	0	
	120-130	0	0	0	<1	<1	0	>50	2-4, few 10, some 6-8	sand 1	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 11. Point bar monitoring data collected during July 2009: Point Bar 13 Transect 2.

Point Bar 13	Monitoring Parameter[1]	Number LWD <4	Number LWD >4	Percent LWD	Percent Weeds	Percent Grass & Forbs	Number Shrubs &Trees	Number POPBAL seedlings	Substrate[2]	Deposition Type & Percent Cover	Other Notes (apply to entire transect)
Transect 2	Distance (ft)										Weeds include oxeye daisy, knapweed, Canada thistle.
	0-10	5	2	10	<1	5	8	7	OM, <1, some 2	OM 30	
	10-20	0	2	5	1	5	0	>10	OM, <1, 2, some 4	OM 10	
	20-30	1	0	1	<1	10	0	>100	OM, <1, 2-4	OM 10	
	30-40	1	0	1	1	30	3	>50	OM, silt, 2-4	OM 20	
	40-50	7	0	10	1	60	3	0	OM, few 8	OM 30	Seeded species that appear to be germinating include sedges, rushes, and fireweed.
	50-60	3	4	30	1	60	10	0	sand, OM	sand 20, OM 10	
	60-70	10	3	30	1	5	1	0	sand, OM	sand 50, OM 5	
	70-80	5	10	50	0	1	0	0	sand, OM	OM 20, sand 10	
	80-90	5	5	10	1	10	3	3	sand, OM, silt	OM (algae) 40, sand 40	Forbs include wild bergamot, goldenrod, horsetail, cow parsnip, field mint, aster, curly doc, large leaf avens, self heal.
	90-100	5	2	5	<1	10	3	10	2-4, 6-8	OM 1	
	100-110	4	0	1	0	1	0	12	2-8	0	
	110-120	0	1	1	<1	1	1	10	2-8	0	
	120-130	2	0	<1	<1	5	4	5	sand, <1, 2-4, some 8	sand 1	

[1] Monitoring parameter methods are described in Geum Environmental Consulting, Inc. (2008).
[2]Numbers represent substrate size ranges in inches, OM = organic matter

Table C- 12. Percent cover of woody species in browse evaluation plots.

Plot ID	Scientific Name	Common Name	Percent Cover
Browse Plot A Outside	*Cornus sericea*	red-osier dogwood	T
	Rosa woodsii	Wood's rose	P
	Populus balsamifera	black cottonwood	1
	Rubus idaeus	American red raspberry	T
Browse Plot A Inside	*Cornus sericea*	red-osier dogwood	1
	Rhamnus alnifolia	alderleaf buckthorn	2
	Symphoricarpos spp	snowberry species	5
	Rosa woodsii	Wood's rose	3
	Populus balsamifera	black cottonwood (seedling)	T
	Populus balsamifera	black cottonwood (mature)	3
Browse Plot B Outside	*Cornus sericea*	red-osier dogwood	T
	Populus balsamifera	black cottonwood	3
	Picea englemannii	Engleman spruce	P
	Salix spp	willow species	1
	Alnus incana	alder	T
	Betula occidentalis	water birch	T
Browse Plot B Inside	*Cornus sericea*	red-osier dogwood	P
	Alnus incana	alder	P
	Picea englemannii	Engleman spruce	T
	Rosa woodsii	Wood's rose	1
	Rubus idaeus	American red raspberry	P
	Salix spp	willow species	3
	Symphoricarpos spp	snowberry species	P
	Populus balsamifera	black cottonwood	T
	Amelanchier alnifolia	Western serviceberry	T
	Ribes spp	currant species	T

Appendix D: 2005-2008 Treatment Overview and Detail Sheets

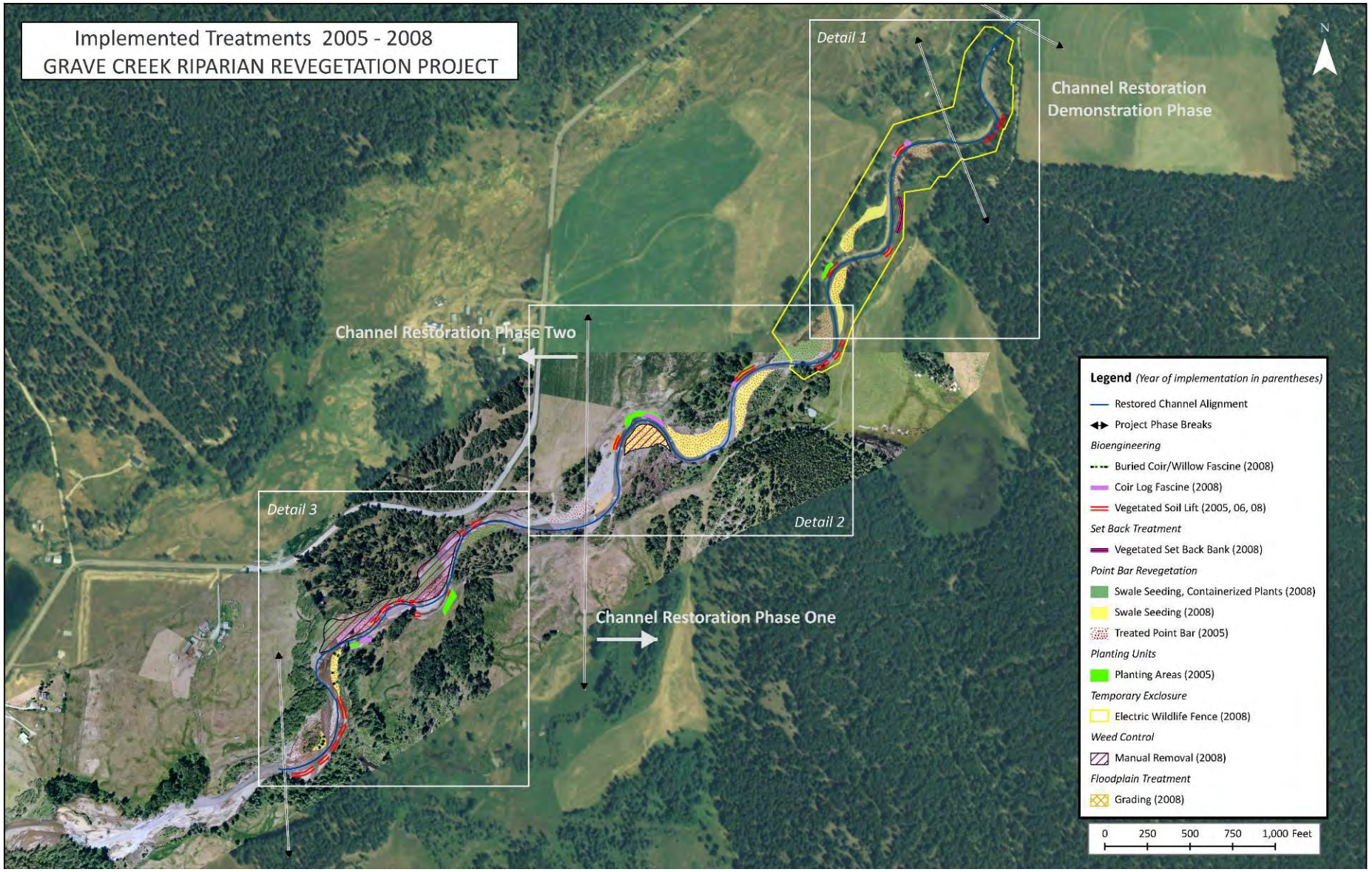

Figure D- 1. Overview figure of all revegetation treatments implemented within Grave Creek project reaches 2005-2008.

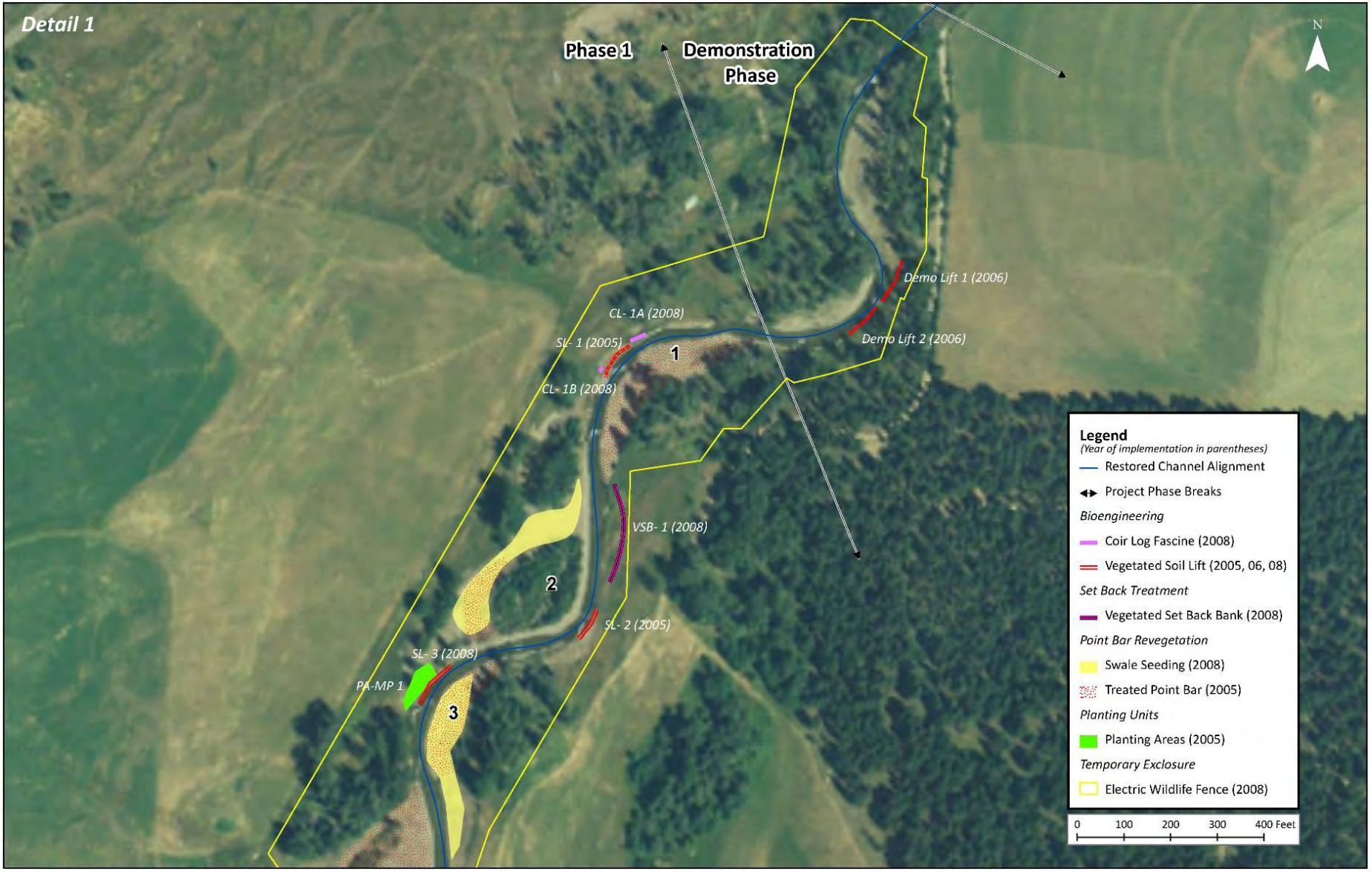

Figure D- 2. Detail sheet showing all revegetation treatments implemented within Grave Creek project reaches 2005-2008.

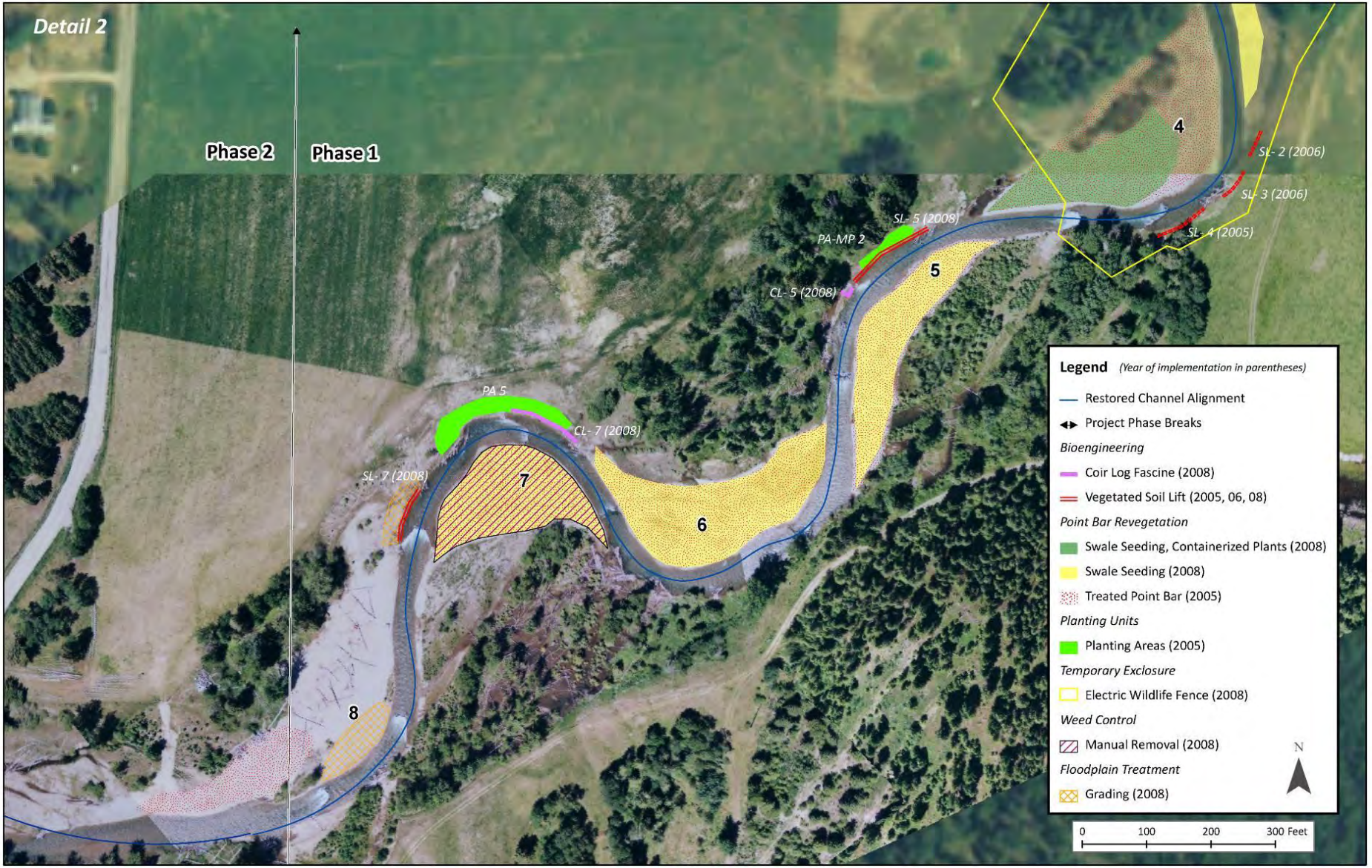

Figure D- 3. Detail sheet showing all revegetation treatments implemented within Grave Creek project reaches 2005-2008.

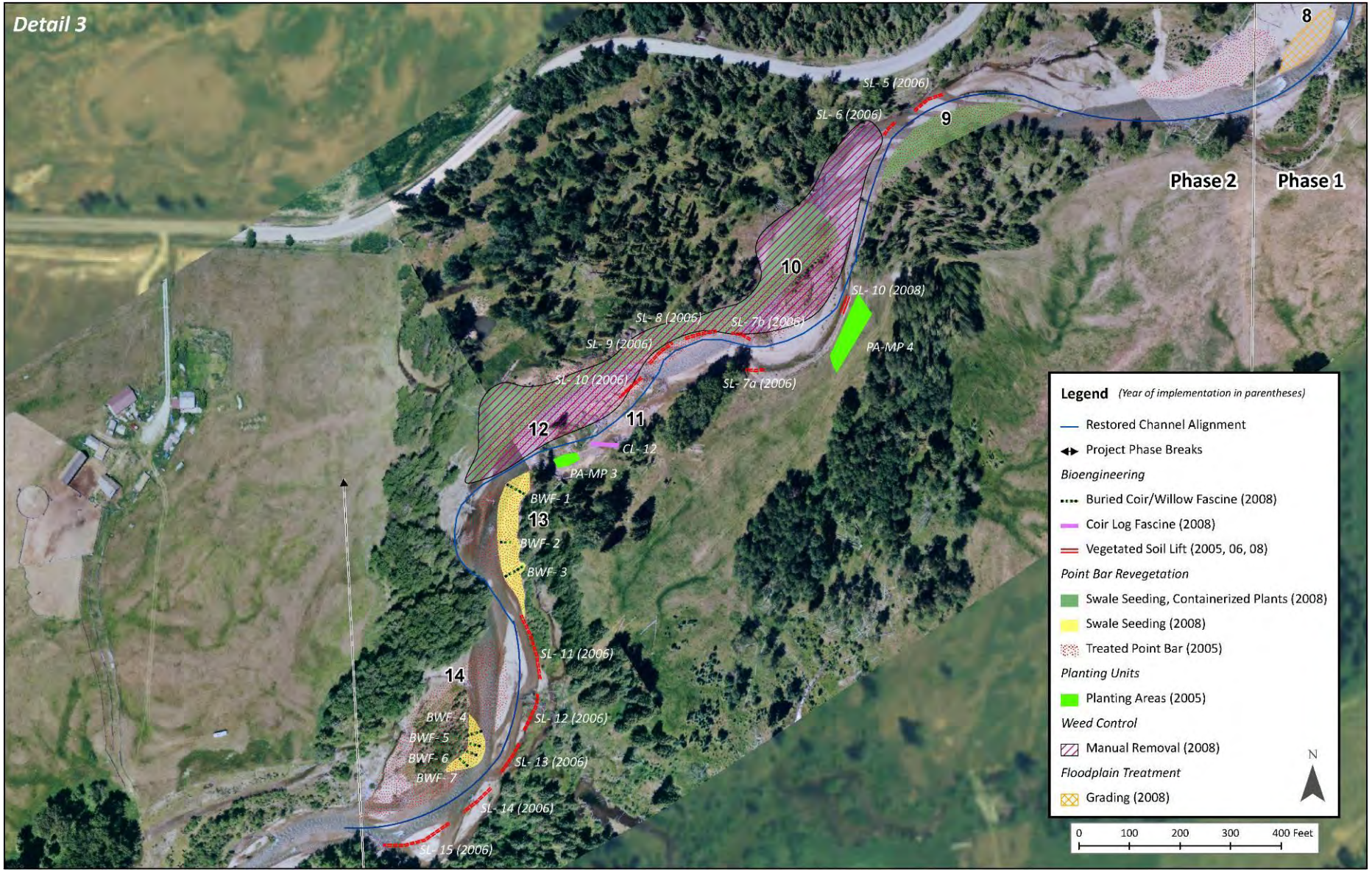

Figure D- 4. Detail sheet showing all revegetation treatments implemented within Grave Creek project reaches 2005-2008.