THERRIAULT CREEK RESTORATION PROJECT

FIVE-YEAR VEGETATION MANAGEMENT PLAN

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Prepared For
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Introduction and Project History

This document provides a prescriptive vegetation management plan for a 9,500 foot long reach of Therriault Creek, a tributary to the Tobacco River located about six miles south of Eureka, Montana. This reach of Therriault Creek was restored between 2004 and 2005. The goal of restoration was to reduce nonpoint source pollution to Therriault Creek and the Tobacco River through mitigation of chronic instream sources of sediment and to restore native fish habitat to adjust slowly over time as a natural, dynamic stream system (Water Consulting Inc., 2003). The stream channel was deeply incised through this reach and restoration included relocating the stream and restoring connectivity with the adjacent floodplain.

To support initial restoration work, 5,000 riparian shrubs, 10,000 dormant willow cuttings and seeding occurred during restoration work. In response to very poor survival of riparian shrubs and dormant willow cuttings, Geum Environmental Consulting (Geum) was contracted to develop a revegetation plan to restore woody riparian vegetation to the site (Geum, 2007a). This revegetation plan identified several revegetation treatments and techniques and established the following revegetation objectives:

- Protect the stability of the restored channel using native woody vegetation.
- Enhance habitat for native fish populations through use of native woody vegetation.
- Limit invasion and continued spread of Canada thistle and other noxious weeds.
- Protect surviving containerized plantings from initial revegetation efforts.
- Create conditions that will promote natural revegetation by native species.

To achieve these objectives, several phases of revegetation and site evaluation have occurred at the project site (Site) and are described in the following section.

Summary of Completed Revegetation Treatments and Adaptive Management

Several phases of revegetation have been completed at the Site since completion of the initial revegetation plan in 2007. An adaptive management program tied to effectiveness monitoring and annual site evaluations guide the maintenance and revegetation treatments completed at the Site. This section describes the revegetation treatments, maintenance and monitoring that has been completed at the Site since 2007. Table 1 summarizes the revegetation treatments and maintenance activities completed at the Site by year. Locations of revegetation treatments completed at the Site are provided in Attachment A.

2007 Revegetation Plan

The 2007 Revegetation Plan provided specific objectives and revegetation strategies and techniques appropriate for the Site. The primary factors causing low survival of planted shrubs and trees identified during plan development were browse by voles and ungulates and competition from aggressive introduced pasture grasses. Given the constraints and limiting factors to converting the Site to woody riparian vegetation, the plan identified the need for a multi-year phased approach to riparian restoration. The 2007 plan identified broad vegetation communities present at the site, assigned revegetation strategies to each and also identified specific treatment locations for the first phase of revegetation treatments.

The following revegetation treatments were implemented at the Site between October 22 and November 3, 2007:

- Protection of 250 residual (originally planted) riparian shrubs.
- Planting of 1,028 riparian shrubs and trees, including installation of a weed mat, vole protector (filled with wood mulch), and individual browse protector (8-inch diameter) on each plant.
- Installation of 8,120 square feet of solarization treatment (4,920 square ft temporary and 3,200 square ft long-term, planted).
- Installation of 120 feet (2 sites) of vegetated soil lifts including 6-ft dormant willow and dogwood cuttings.
- Installation of 800 feet of live willow fascines consisting of bundles of 6-ft dormant willow cuttings.
- Construction of 5 channel-spanning woody debris jams.
- Installation of 40 (400 feet) high density coir logs including ½-inch x 2-ft dormant willow cuttings.

These treatments are documented in *Therriault Creek Riparian Revegetation Completion Report Contract #080067* (Geum, 2007b).

2008 Monitoring Report

In 2008, the revegetation treatments that were installed in 2007 were monitored for effectiveness. Effectiveness monitoring data showed high survival of planted shrubs and trees and dormant willows installed in soil lifts, coir logs, and willow fascines. Browse on planted shrubs and trees was low because all plants had browse protectors. It was not feasible to protect willow cuttings used in streambank treatments; therefore, browse of these plants was high.

The 2008 report identified maintenance needs for each treatment and recommended the following treatments for 2009: weed control, protection of additional residual shrubs, installation of more live willow fascines in depositional areas, and continued monitoring of treatment effectiveness.

The following maintenance actions and revegetation treatments were implemented at the Site in 2008:

- Herbicide applications targeting reed canarygrass and Canada thistle (July and September).

The 2008 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek Riparian Revegetation Monitoring Report Contract #0803* (Geum, 2008).

2009 Maintenance and Monitoring Report

In 2009, effectiveness monitoring of revegetation treatments installed in 2007 was completed and maintenance needs identified and implemented. Effectiveness monitoring data showed that survival of planted shrubs and trees had decreased but remained high overall. Dormant willows installed in soil lifts and willow fascines also continued to have high survival, although growth continued to be suppressed by browse. Survival of dormant willow cuttings in coir logs had decreased. Many planted shrubs and trees had reached the capacity of the browse protectors. Solarization fabric had effectively killed invasive grasses in a few areas and large wood structures were beginning to trap sediment and increase high flow access to the riparian area.

The 2009 report identified maintenance needs for each treatment and recommended a continued but reduced treatment effectiveness monitoring effort. Based on the results of 2008 and 2009 monitoring, the 2009 report also recommended additional revegetation treatments, including: protect additional residual shrubs and trees, install 1,000 to 2,000 additional plants downstream of the first phase of

planting, potentially remove additional solarization fabric, install additional solarization fabric, and continue weed control.

Weed mapping to document weed distribution and density as a baseline for evaluating weed treatment effectiveness was completed in 2009. This mapping showed that the 2008 and 2009 weed control treatments had reduced the cover and density of Canada thistle at the Site and common toadflax cover had increased. The 2009 report recommended continued weed control.

The following maintenance actions and revegetation treatments were implemented at the Site in 2009:

- Maintenance of installed revegetation treatments including: watering of planted trees and shrubs (mid-August and early September); browse protector repair and expansion; and maintenance of solarization plots including re-securing edges and seams and hand-pulling weeds.
- Installation of 60 additional residual shrub browse protectors – 16-inch diameter compared to original 6-inch diameter protectors.
- Removal and expansion of solarization fabric in one unit and seeding of exposed area with native seed mix.
- Installation of 115 additional willow cuttings in coir logs with low survival.
- Herbicide applications targeting primarily reed canarygrass and Canada thistle but also sulfur cinquefoil, houndstongue, and yellow toadflax (July and September).

The 2009 monitoring, maintenance, and adaptive management recommendations and actions are documented in *Therriault Creek Riparian Revegetation Monitoring 2009 Report Task Order #0907* (Geum, 2009).

2010 Monitoring, Maintenance, and Phase III Implementation Report

In 2010, effectiveness monitoring of revegetation treatments installed in 2007 was completed and maintenance needs were identified and implemented. Effectiveness monitoring of treatments installed in 2007 was completed at a reduced level of effort. Effectiveness monitoring showed that residual shrubs continued to grow rapidly after browse protection was installed. Planted trees and shrubs survival was still high but many plants were being hedged by browsing and constrained by browse protectors. Solarization fabric had effectively killed undesirable grasses but both seeded species and undesirable species had recolonized the exposed soils. Willows in soil lifts and fascines were still being suppressed by browse. Large woody debris structures continued to trap debris and sediment but only minimal changes to adjacent riparian vegetation had occurred.

Several revegetation treatments were installed at the Site in 2010 based on the recommendations provided in the 2009 report. The 2010 report recommended continued monitoring and maintenance of revegetation treatments and continued weed control.

The following maintenance actions and revegetation treatments were implemented at the Site in 2010:

- Maintenance of installed revegetation treatments including: watering of planted trees and shrubs; browse protector repair and expansion; maintenance of solarization plots including re-securing edges and seams and hand-pulling weeds; and re-securing soil lift stakes and hand-pulling weeds from soil lifts.
- Installation of 154 additional residual shrub browse protectors.

- Planting of 1,100 riparian shrubs and trees, including installation of a weed mat, vole protector (larger than 2007 planting and filled with wood mulch), and individual browse protector (16-inch diameter) on each plant.
- Installation of 1,580 square feet of planted solarization treatment.
- Evaluation and re-location of 600 feet of 3-strand barbed wire riparian livestock fence where it was installed too close to the stream.
- Herbicide applications targeting primarily reed canarygrass and Canada thistle but also sulfur cinquefoil, houndstongue, and yellow toadflax (July and September).

The 2010 monitoring, maintenance, and treatments are documented in *Therriault Creek Riparian Revegetation 2010 Monitoring, Maintenance and Phase III Implementation Report Contract #11032* (Geum, 2010).

2011 Maintenance and Monitoring Report

In 2011, effectiveness monitoring of revegetation treatments installed in 2007 and 2010 was completed and maintenance needs were identified and implemented. 2011 was marked by prolonged high flows that inundated much of the riparian zone late into July. Sediment deposition and standing water were present in many areas and generally increased in a downstream direction. Effectiveness monitoring showed that residual shrubs continued to grow rapidly after browse protection was installed. Many had outgrown browse protectors. Overall survival of trees and shrubs planted in 2007 was lower (some units dropped to 60%) than previous years. In 2011, it was noted that shrubs planted in 2010 had become very robust in some areas and were beginning to provide shade and habitat. Survival of trees and shrubs planted in 2010 was high (ranging from 80% to 100% survival). Plants installed in solarization units continued to have high survival and robust growth, and fabric had effectively killed grasses and root systems under the fabric. One of the unplanted solarization sites where fabric had been removed had high cover of native, seeded species including willow, dogwood and chokecherry seedlings. The other unplanted solarization site, however, had dense cover of grasses, both native seeded and aggressive pasture grasses that recolonized. Willow growth on soil lifts increased greatly in 2011 due to prolonged high flows and high summer moisture. Flows were still high during site monitoring in 2011 and large woody debris structures were promoting prolonged floodplain inundation and elevated surface water levels, promoting a shift to wetter herbaceous species in these areas. Observations made in 2011 also noted increased cover of sedges in the riparian area and greatly reduced cover of mature noxious weed plants at the Site. These shifts were likely influenced by abundant moisture in 2011.

Based on the results of 2011 monitoring, the 2011 report also recommended additional revegetation treatments, including removal of solarization fabric and seeding bare soil and weed control. The 2011 report also recommended continued monitoring and maintenance of revegetation treatments, repeating weed mapping in 2012, and on-going weed control.

The following maintenance actions and revegetation treatments were implemented at the Site in 2011:

- Maintenance of installed revegetation treatments including: watering of select trees and shrubs planted in 2010 (once in August); browse protector repair, removal and expansion; installation of small exclosures around clumps of residual shrubs using recycled browse protectors; and maintenance of solarization plots including re-securing edges and seams and hand-pulling weeds.

- Removal of solarization fabric from two unplanted and two planted units, and seeding of bare soil with native grasses and forbs. One unplanted plot was planted with dormant willow cuttings.
- Herbicide application targeting Canada thistle, sulfur cinquefoil, houndstongue, and yellow toadflax (July).

The 2011 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek Riparian Revegetation 2011 Monitoring and Maintenance Report Contract #120001* (Geum, 2011).

2012 Maintenance and Monitoring Report

In 2012, effectiveness monitoring of revegetation treatments installed in 2007 and 2010 was completed and maintenance needs identified and implemented. 2012 was marked by a very high peak flow that moved significant amounts of sediment in the channel, plugging the channel in one location and forcing flows out of bank, resulting in the start of a possible main channel avulsion. A large amount of gravel was deposited in the floodplain at this location, but only minimal floodplain deposition occurred overall in 2012. Effectiveness monitoring showed that residual shrubs continued to grow rapidly after browse protection was installed and continued to out-grow browse protectors. Residual shrubs, particularly willows, had expanded greatly in a few areas in response to 2011 and 2012 high flows. Overall survival of trees and shrubs planted in 2007 remained unchanged from 2011. Some stems of the larger shrubs were being restricted by the installed vole protectors. Survival of trees and shrubs planted in 2010 dropped to 75% in 2012. Prolonged inundation in 2011 in many of these units resulted in uprooting of several plants that had not rooted in yet. Heavy browse of all planted and residual shrubs and trees remained a problem. Removal of fabric in planted solarization units, combined with prolonged inundation in 2011, led to the loss of several shrubs due to instability around the plant roots. Many shrubs that had been large and robust were leaning or partially uprooted. The bare sediment and inundation of these areas, however, resulted in natural recruitment of sandbar willow. All of the solarization fabric had been removed in 2011 from planted and unplanted sites. Although heavily seeded, cover of undesirable grass species had increased to 10% or greater at most sites. The willow and dogwood seedlings observed in one plot in 2011 had mostly been lost to browse and grass competition by 2012. The willow cuttings installed in one unplanted solarization plot were mostly lost due to prolonged inundation and heavy browse. Browse increased on soil lifts again in 2012; however, the robust growth in 2011 had made them more resistant to browse. Gravel deposition occurred around large woody debris structures and some of the deposition was colonized by sandbar willow. The percentage of wetland species in the riparian area adjacent to these structures, particularly within 30 feet of the channel also increased greatly.

In addition, in 2012, weeds and vegetation communities were mapped at the Site. Weed mapping showed that Canada thistle was still wide spread at the site in small patches with the only large infestations occurring in the hayfield east of the Site and on a low terrace upstream of the Site. Weed mapping identified the presence of oxeye daisy adjacent to the site and showed that sulfur cinquefoil had been eradicated from the Site. Reed canarygrass was still widespread at the site, but the only large infestation occurred at the downstream end of the Site. Vegetation community mapping showed a dramatic shift in shrub and sedge cover at the Site since 2007.

The 2012 report also summarized progress made towards meeting the objectives outlined in the 2007 Revegetation Plan. It also recommended continued monitoring and maintenance of revegetation treatments and on-going weed control.

The following maintenance actions and revegetation treatments were implemented at the Site in 2012:

- Maintenance of installed revegetation treatments including: watering of select trees and shrubs planted in 2010 (once in August); browse protector repair, removal and expansion; installation of small exclosures around clumps of shrubs using recycled browse protectors; securing of large shrubs that were leaning or falling over after removal of solarization fabric; and maintenance of solarization plots including re-securing edges and seams and hand-pulling weeds.
- Installation of 14 additional residual shrub browse protectors.
- Planting of dormant willow cuttings in sites where solarization fabric was removed and installation of browse exclosures around each site.
- Herbicide application targeting Canada thistle, sulfur cinquefoil, houndstongue, and yellow toadflax (July).

The 2012 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek Riparian Revegetation 2012 Monitoring and Maintenance Report Contract #130013* (Geum, 2012).

2013 Maintenance and Monitoring Report

In 2013, effectiveness monitoring of revegetation treatments installed in 2007 and 2010 was completed and maintenance needs identified and implemented. Protected residual shrubs continued to thrive. Survival of trees and shrubs planted in 2007 was similar to 2012. Survival of trees and shrubs planted in 2010 continued to decrease for unknown reasons. Survival of trees and shrubs planted in the one remaining planted solarization unit was 87%. Fabric removal in other planted units resulted in the loss of most of the plants in these units. The fabric in the remaining planted unit has fine sediment deposition on it from 2011 and 2012 that was observed to be growing reed canarygrass in 2013. Despite this, fabric was left in place to protect planted shrubs and trees. Herbaceous cover in unplanted solarization plots continued to increase, dominated by seeded species but with cover of introduced grasses increasing. The willow cuttings installed in two of these plots had high survival and 1-2 feet of new growth in 2013 due to protection with small fences. Willow cover on soils lifts, coir logs, and willow fascines was similar to 2012. Some scour occurred around coir logs in 2011 and 2012, but no coir logs were lost and where coir logs were in place, the deep undercut bank was retained. Significant changes occurred at large woody debris structures sites during the 2011 and 2012 high flows including creation of diverse substrates and depths. Browse of all woody vegetation continued to be one of the primary concerns at the Site.

Based on several years of observation and 2013 monitoring results, the 2013 report recommended that a 10-foot tall riparian protection fence be constructed around the Site. Browse continued to be a major factor limiting woody vegetation growth at the Site. Many plants needed browse protectors removed but were not yet resistant to browse pressure, and the effort to maintain individual protectors was becoming a challenge. The 2013 report indicated that Canada thistle had been effectively controlled at the Site, but large dense infestations in the adjacent hayfield would continue to pose a threat to re-infestation. Perennial pepperweed was a new invader identified and treated at the site in 2013. The 2013 report also included several observations of increased use of the Site by wildlife including osprey,

ducks, great blue herons, songbirds and muskrats. Also notable in 2013 was the construction of a drainage ditch in the hayfield adjacent to the Site that is converting this area to drier conditions.

The following maintenance actions and revegetation treatments were implemented at the Site in 2013:

- Maintenance of installed revegetation treatments including: browse protector repair, removal and expansion; and installation of small exclosures around clumps of shrubs using recycled browse protectors.
- Installation of a 10-foot tall riparian protection fence on the existing livestock fence that encloses most of the Site.
- Herbicide application targeting Canada thistle, houndstongue, yellow toadflax, perennial pepperweed, and reed canarygrass (August). Bull thistle and common mullein were also treated.

The 2013 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek Riparian Revegetation 2013 Monitoring and Maintenance Report Contract #140025* (Geum, 2013).

2014 Maintenance and Monitoring Report

In 2014, effectiveness monitoring of revegetation treatments installed in 2007 and 2010 was completed and maintenance needs were identified and implemented. Little change occurred between 2013 and 2014 in terms of woody vegetation survival or cover. The solarization units remained dominated by seeded grasses (70% cover) and willow cuttings still had high survival but were being heavily browsed due to collapse of the small fences constructed around the areas. Additional drying of the floodplain in response to the drainage ditch constructed in the adjacent hayfield was observed in 2014. This resulted in some areas of dense sedges drying and being invaded by reed canarygrass. The 10-foot riparian protection fence was constructed in 2013 using angle-iron extensions placed on existing livestock fence posts. Many of these bent in the winter of 2013 -2014 requiring the fence be reconstructed using 10-foot t-posts. The fence was not re-built until the fall of 2014 so ungulate browse and damage to riparian shrubs and trees at the site continued to be an issue in 2014. Willow cover on soil lifts, coir logs, and willow fascines increased greatly in 2013 due to the partial browse protection provided by the fence. Cover on some coir logs remained low due to poor initial cutting survival. The 2014 report also indicated that Canada thistle had been effectively controlled at the Site, but that large dense infestations in the adjacent hayfield would continue to pose a threat to re-infestation. Yellow toadflax also increased at the site in 2014.

Based on the results of 2014 monitoring, the 2014 report recommended that weed control and fence maintenance continue at the site. Recommendations also included no longer collecting effectiveness monitoring data for revegetation treatments and documented how the site was on a trajectory towards meeting revegetation objectives in many areas. The 2014 report recommended landowner outreach to ensure that weed infestations were controlled and the drainage ditch be filled in or a headgate installed to only allow drainage for a short period of time.

The following maintenance actions and revegetation treatments were implemented at the Site in 2014:

- Removal of remaining browse protectors and vole protectors from trees and shrubs planted in 2008.

- Removal of browse protectors around clumps of residual shrubs from within the 10-foot riparian protection fence.
- 10-foot riparian protection fence reconstruction and repair.
- Herbicide application targeting Canada thistle, houndstongue, yellow toadflax and isolated patches of reed canarygrass (August).

The 2014 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek Riparian Revegetation 2014 Monitoring and Maintenance Report Contract #150017* (Geum, 2014).

2015 Maintenance and Monitoring Summary

In 2015, a site review was completed to document site conditions and annual maintenance needs. 2014 and 2015 were both years of low moisture and conditions observed in 2015 were likely in response to the low moisture. Surviving shrubs and trees continued to grow and expand in growth form and produce seed. Vegetation expansion beyond the individual planted shrubs was still only occurring on low elevation inside meanders where residual shrubs had been protected and activation by high flows in 2011 and 2012 created conditions for suckering of these plants. The solarization units remained dominated by seeded grasses (70% cover) and willow cuttings still had high survival but were still being heavily browsed. Vegetated soil lifts and willow fascines continued to support dense willow cover. Coir logs continued to have variable willow cover, but continued to support undercut banks.

In 2015, Canada thistle adjacent to the Site remained a key concern to address. Canada thistle densities in this area had increased due to the drainage ditch and additional disturbance from allowing livestock to graze the area, which had not been done up to this point. Common toadflax density continued to increase in 2015, potentially in response to lower Canada thistle densities, killing of clumps of reed canarygrass, or due to the difficulty to see plants in the dense grasses when not in flower. Other annual weeds, such as mustard species, were observed at the Site in 2015. These species had not been observed in the past, possibly due to drier site conditions. The drier site conditions resulted in the loss of additional planted riparian shrubs and trees in 2015, particularly in higher elevation planted areas.

The 2015 memo recommended continued maintenance of the riparian protection fence and continued removal, expansion, and repair of browse protectors. The 2015 memo also recommended that continued use of herbicide at the site should be discussed and specific weed related objectives established for the Site as there were no remaining infestations and only sporadic occurrence of noxious weeds within the Site. The memo identified the weed infestations in the adjacent hayfield as a continued threat.

The following maintenance actions and revegetation treatments were implemented at the Site in 2015:

- Removal of browse protectors and vole protectors from select plants planted in 2010 and located within the riparian protection fence.
- Installation of recycled browse protectors around clumps of plants upstream of riparian protection fence.
- Riparian protection fence repairs.
- Raking and seeding of herbicide killed reed canarygrass patches.
- Installation of 100 feet of coir logs in three locations.

- Removal of patches of fabric around the base of plants in the one remaining planted solarization unit.
- Herbicide application targeting Canada thistle, houndstongue, and yellow toadflax (July, September, October).

The 2015 monitoring, maintenance, and adaptive management recommendations are documented in *Therriault Creek 2015 Maintenance and Monitoring Summary Task Order #16-504* (Geum, 2015).

2016-2017 Maintenance

No site evaluations were completed in 2016 and 2017. The following maintenance actions were implemented at the Site in 2016 by Watershed Restoration Group:

- Removal and repair of browse protectors outside of the 10-foot fence.
- Removal of browse protectors and vole protectors within the wildlife exclosure fence.
- Riparian protection fence repairs.

In 2017, Montana Fish Wildlife and Parks completed the following maintenance at the site:

- Riparian protection fence repairs.
- Very selective control of yellow toadflax.

Table 1. Summary of revegetation treatments and maintenance work completed at the Therriault Creek Restoration Project Site.

Year	Revegetation Treatments Installed	Maintenance Completed
2007	Residual shrub protection Riparian tree and shrub planting Solarization (planted and unplanted) Vegetated soil lifts, willow fascines and coir logs Large woody debris structures	None
2008	Weed control	None
2009	Weed control (summer, fall) Residual shrub protection Removal and expansion of solarization fabric	Watering Browse protector maintenance Solarization fabric maintenance Supplemental willow cuttings in coir logs
2010	Weed control (summer, fall) Residual shrub protection Riparian tree and shrub planting Solarization (planted)	Watering Browse protector maintenance Solarization fabric maintenance Livestock fence relocation
2011	Weed control (summer) Solarization fabric removal and seeding	Watering Browse protector repair, expansion, and installation of small exclosures
2012	Weed control (summer) Residual shrub protection Planting willow cuttings at solarization sites	Watering Browse protector repair, expansion, and installation of small exclosures Solarization fabric maintenance
2013	Weed control (summer) Installation of 10-foot riparian protection fence	Browse protector repair, expansion, and installation of small exclosures
2014	Weed control (summer) Reconstruction of 10-foot riparian protection fence	Browse protector removal, repair, and expansion Vole protector removal
2015	Weed control (summer) Coir logs Removal of patches of solarization fabric	Fence repairs Browse protector removal, repair, and expansion Vole protector removal
2016	Selective weed control[1]	Fence repairs Browse protector removal, repair, and expansion
2017	Selective weed control[1]	None
2018	None	Fence repairs and relocation of downstream segment of fence Browse protector removal, repair, and expansion

[1] Completed by Montana Fish Wildlife and Parks

Existing Site Conditions and Limiting Factors

This section summarizes the current riparian conditions at the Therriault Creek Restoration Project Site and factors still limiting achieving vegetation objectives. The Site was observed on September 11, 2018 to evaluate current site conditions and progress toward meeting vegetation objectives. These observations, combined with observations and monitoring data collected over the past 10 years, were used to determine factors still limiting the site from achieving revegetation objectives. Photographs of current conditions of treatments implemented at the site are provided in Attachment B.

Overall, the Site continues to be dominated by introduced pasture grasses. Lower elevation areas have converted to sedges and native wetland grasses. Dense sedge cover is present in many locations, particularly around the ponds where the abandoned channel was located, on low inside meander bends and streambanks, and low elevation areas of the floodplain. It is likely that any transition to wetland vegetation in response to relocating the channel to connect to the historic floodplain has already occurred. Elevation is the key factor influencing natural conversion of pasture grasses to wetland vegetation at the Site. Visual observations indicate that as little as one foot of elevation difference means the difference between introduced pasture grasses and native sedges and grasses. To shift more of the site to wetland vegetation naturally would require further raising the water table or lowering surfaces to connect more fully to the constructed channel. The channel varies from well-connected to moderately entrenched along the length of the project, with less entrenched sections supporting sedges and undercut banks and more entrenched sections supporting pasture grasses and fewer undercut banks (Figure 1). Relocating and restoring connectivity between the channel and floodplain also resulted in a large area of the hayfield immediately east of the Site converting to wetland graminoids and forb species. The drainage ditch constructed in 2013 was likely in response to this shift in vegetation as sedges are not as high quality hay species as grasses. This drainage ditch has effectively drained this area, converting it back to introduced pasture grasses (Figure 2). In 2018, this area was grazed by cattle and is now heavily disturbed (Figure 3).

Although the Site is predominantly herbaceous vegetation, woody vegetation cover has increased since initial revegetation treatments were installed in the fall of 2007. Riparian shrubs and trees were planted in 2005 when the channel was originally built, in the fall of 2007, and in the fall of 2010. In 2005, plants were installed in a narrow band along the channel and most were lost to vole browse, grass competition, or deer browse. Surviving plants were very difficult to see because of continued browse by deer. Between 2007 and 2012 all of the original plants that could be located were protected with individual browse protectors. Almost all of these plants grew significantly within one to two years after being protected and have contributed greatly to the current woody vegetation cover at the site, particularly on inside meander bends where there is a high water table and occasional disturbance by floods (Figure 4, Figure 5, Attachment B). In 2007 and 2010 plants were installed on outside meander bends where woody vegetation is needed most to support channel stability. Survival of these planted trees and shrubs has varied greatly. Survival in general has been lower in the 2010 planting units and therefore cover of woody vegetation decreases in a downstream direction. In general, right bank (west side of the channel) planting units have lower survival compared to left bank units. These survival trends influence woody vegetation cover at the Site. The highest woody vegetation cover is in the upper third of the Site where 2007 revegetation treatments were focused and there are lower floodplain surfaces. Figure 17 shows woody vegetation cover in 2012 and 2018 illustrating that woody vegetation

is naturally expanding primarily on low elevation inside meander bends. Cover of woody vegetation in several 2010 planting units was also great enough in 2018 to be mapped as shrub vegetation rather than herbaceous vegetation. Woody vegetation represented 2.2 acres of the Site in 2012 and increased to 3.5 acres in 2018, an increase of 1.3 acres.

Although woody vegetation cover has increased at the Site in the last ten years, many of the surviving trees and shrubs still show signs of stress. Several factors have contributed to the poor establishment or continued stress of shrubs and trees at the Site. Grass competition and browse are the primary factors stressing plants. Insects and fungus have also been widespread at the Site and have increased in seasons with high moisture. Soils are also likely a contributing factor to plant stress as there are extensive layers of clay in some areas of the project. This was more likely a cause of initial plant loss than continued stress on plants. The measures installed to protect plants from browse including individual browse protectors and vole protectors have also caused issues with plant vigor. The 2007 plantings were fit with very small protectors (6-inch diameter). Although these were expanded to larger sizes within two years after planting, most of the plants still exhibit suppressed growth form from these protectors (Figure 7). Vole protectors, consisting of corrugated plastic pipe placed around the base of plants and filled with wood mulch, also cause plant stress including stems rotting from too much moisture and altering stem form on large shrubs that filled the capacity of the protector (Figure 6). The latter primarily occurred on alder plants. Most vole protectors have been removed from the 2007 planting area but some still remain in the 2010 planting area.

The treatments utilizing dormant willow cuttings also contribute to woody vegetation cover at the Site. In general, survival of willow cuttings has been high or the growth of surviving willow cuttings has created dense patches of willow cover along the channel where these treatments were used (Figure 8, Attachment B). Willow growth was initially suppressed by browse, but installation of the riparian protection fence allowed willow cuttings within the fence to grow rapidly, and willows in many of these treatments have grown four to five feet in the four growing seasons since the fence was installed. This willow cover is concentrated in a narrow band along the channel where the dormant willow cutting treatments were installed. Dense grasses in the adjacent floodplain have limited the expansion of these willows away from the channel.

The riparian protection fence encloses all but seven planting units and has reduced overall browse pressure; however, the fence is only partially effective and deer enter through several points, primarily by going under the fence. The fence was down in several locations in 2018. In 2018, it was apparent that the downstream end of the fence was blocking a wildlife movement corridor as there were rips in both ends of the fence where the fence intersected a well-defined trail with deer, elk, and bear scat. In addition, a gate was left open near the downstream end and the fence at this location was rolled up allowing easy access for deer to enter the Site. It is possible this was opened to allow deer inside the fence to leave. It is likely that deer also enter at the channel crossings, although these did not seem like major access routes based on 2018 observations. Deer trails, beds, and scat were observed throughout the Site. A few deer were spooked from within the fence near the downstream end in the dense stand of reed canarygrass. Although high levels of browse were observed throughout the area within the fence, it was particularly heavy in the 2010 planting units. There were numerous deer trails and beds in this area (Figure 9).

In addition, there was evidence that cattle also entered inside the riparian protection fence in 2018. This occurred right below the water gap/stream crossing. Where cattle accessed the planting area, grass had been grazed, soil was pugged, and manure was present. No damage to streambanks was observed. In response to cattle access, it appears the landowner installed metal panels to replace the net fencing where the cows had accessed the site (Figure 10). This was the first year cattle grazing was observed at the Site. In the past, only a few horses utilized the pasture west of the Site and water gap and little to no livestock use occurred in the hayfield east of the Site.

Several treatments have been implemented to attempt to shift site conditions to allow areas to naturally transition from pasture grasses to native vegetation, including solarization fabric and large woody debris structures. The effectiveness of solarization treatments has been variable. In areas where solarization was used adjacent to reed canarygrass the sites have slowly re-colonized with reed canarygrass and are now dominated by undesirable species again. In areas where solarization fabric was placed adjacent to drier pasture grasses such as smooth brome or Kentucky bluegrass, the sites continue to support native seeded species or have been colonized by sedges (i.e. 2008 Plot 1 – see Attachment A). Photographs of solarization plots are provided in Attachment B. Attempts to establish woody vegetation in these plots using dormant cuttings have not been successful. Two plots had sandbar willow colonize the bare surfaces naturally but the seedlings have mostly been lost to browse or grass competition. Large woody debris structures have created significant diversity in channel depth and substrate size in the vicinity of each structure. Along channel margins, a small number of willows have colonized around large woody debris structures where gravel and sand has deposited. These structures have raised the water table immediately adjacent to the structures, allowing sedges to establish. Large woody debris structures have not greatly increased out of channel flows or disturbance, and while effects of these treatments have been beneficial, the effects are very localized.

Cover and density of Canada thistle has increased greatly at the site since the last herbicide application in 2015. Within the Site itself, cover of Canada thistle was low in 2015, with few to no mature plants remaining. The hayfield east of the Site was treated several times, but also missed in some years allowing the Canada thistle infestations in this area to persist. These infestations have never been controlled completely and were likely a major contributor to reinfestation of the Site. Dewatering of this area combined with heavy grazing has created significant disturbance, allowing Canada thistle infestations to expand and become denser (Figure 11). Attachment B provides maps of weed distribution and density in 2009 and a map of weed distribution and density observed in 2018. These maps show the significant increase in Canada thistle cover at the site between 2015 and 2018. There are several large, dense infestations of Canada thistle at the Site (Figure 12 and Figure 13). However, there are some large areas on the west side of the channel that still have low densities of Canada thistle. Dense patches mostly occur along the channel, expand out from the edges of the channel, or expand towards the channel from the dense infestations in the hayfield to the east of channel. Canada thistle is well distributed within planting units, within natural willow expansion areas, and throughout areas consisting of dense sedges and willows. These areas will be difficult to treat without damaging desirable vegetation.

In addition to noxious weeds, aggressive introduced graminoids, such as reed canarygrass, quackgrass, orchardgrass, meadow foxtail, and to a lesser extent common timothy, redtop, Kentucky bluegrass and smooth brome, dominate the Site. Of these, reed canarygrass is the most invasive in riparian floodplain environments. The density of reed canarygrass in the very downstream portion of the Site has always

been very high. It appears to have spread to this area through old irrigation ditches and several old swales and channels in this area have allowed it to expand and dominate. In 2018, there were several new patches of reed canarygrass upstream of the large infestation (Figure 14). Reed canarygrass has always had much lower cover in the rest of the Site. It is primarily found on streambanks and in small patches away from the channel. Greater cover on both streambanks and areas further from the channel was observed in 2018 in response to the lack of herbicide treatment in 2016 and 2017. Attachment B provides a map of reed canarygrass distribution and density observed in 2018.

Table 2 summarizes the current status of vegetation objectives for the Therriault Creek Restoration Project. Overall, the site is characterized by a lack of natural flood disturbance necessary to create new surfaces and substrates for riparian shrubs to colonize, and to stimulate plants to sucker and expand. There are plenty of seed sources of desirable woody riparian species, but the conditions necessary for germination and establishment are lacking. Even the large magnitude flows that have occurred at the Site since 2007 resulted in little water outside of the active channel. This is further affected by a large irrigation diversion upstream of the Site which often reduces the peak flows that enter the project reach. The two floods that occurred in 2011 and 2012 activated the few low inside meander bends in the project area, allowing extensive expansion of riparian shrubs, particularly sandbar willow. Gravel deposition occurred on the floodplain in 2011 and was colonized by red-osier dogwood and some willows. The area quickly became infested with reed canarygrass and woody seedlings were suppressed by browse. Some red-osier dogwood seedlings were still present in 2018; but all were suppressed by browsed (Figure 15). The scarcity of disturbance processes to create new habitats, combined with a predominance of aggressive graminoids and ungulate browse have created static conditions at the Site which greatly limit the potential for the Site to naturally convert to woody riparian vegetation (Figure 16).

Revegetation treatments installed to date have attempted to work within these limitations with varying degrees of success. A few areas have enough woody riparian vegetation cover to increase shade, reduce grass cover, and shift site conditions. This trend will continue slowly at the site in areas where woody vegetation is present; however, there is little sign that woody riparian vegetation will expand naturally except on low elevation inside meander bends. To increase woody vegetation cover at the Site will require additional active restoration or increased disturbance in the floodplain to open up habitats within the pasture grass dominated areas. Natural disturbance can be induced by increasing connectivity between the floodplain and the channel (i.e. constructing side channels, raising the channel bed by installing channel spanning structures, lowering the floodplain, removing grass sod, etc.).

Based on the September 11, 2018 site observations, the main factors limiting vegetation objectives include:

- Canada thistle infestations
- Reed canarygrass and other aggressive introduced graminoids (pasture grasses)
- Ungulate browse
- Lack of floodplain connectivity and natural disturbances

These factors should be the focus of continued vegetation management at the Site.


Figure 1. Uniform riffle with good floodplain connection resulting in dense sedges (left photo) compared with uniform riffle with less connection and domination by pasture grasses (right photo).


Figure 2. Drainage ditch constructed in 2013 in hayfield east of Site showing heavy use by cattle (left photo). Culvert at end of ditch with no outlet gate but plugged with sediment (right photo).

Figure 3. Heavy grazing in hayfield east of Site.

Figure 4. Residual shrubs outside of riparian protection fence near upstream end of Site.

Figure 5. Left photo shows dense sandbar willow cover on well-connected inside meander bend near upstream end of Site. Right photo shows sandbar willow expansion from residual protected shrubs just downstream of where the channel turns northwest and leaves the riparian protection fence. This is one of the few downstream areas where willows have expanded naturally.

Figure 6. Surviving shrubs showing signs of stressed conditions resulting in poor vigor. Top photos show heavy browse on dogwoods and death of younger stems possibly from competing for resources with dense grasses. Middle left photo shows rust fungus on a willow, a common occurrence on willows throughout the Site. Middle right photo shows mature shrubs with altered growth forms from initial browse protection measures and then continued browse of lower stems. Bottom photo shows stem damage and rotting from vole protector.

Figure 7. Dogwoods and hawthorns planted in 2007 that still exhibit altered growth forms from browse protection. The lower branches of these shrubs continue to be heavily browsed.

Figure 8. Willow height on soil lift 1 located outside of riparian protection fence (left photo) and willow height on soil lift 2 located inside of riparian protection fence (right photo).

Figure 9. Large deer bed inside riparian protection fence at break between 2007 and 2010 work.

Figure 10. Wire paneling installed by landowner at upstream end of riparian protection fence. In 2018, this livestock crossing and hayfield east of the Site had much more use by livestock than in the past

Figure 11. Dense infestation of Canada thistle in hayfield on east side of Site (thistle infestation is white band in middle of photo).

Figure 12. Canada thistle infestations in the upstream portion of Site.

Figure 13. Thistle infestations in the downstream portion of the Site.

Figure 14. Expansion of reed canarygrass from large infestation at the downstream end of the Site. Reed canarygrass is the lighter yellow vegetation in the photograph.

Figure 15. Red-osier dogwood seedlings on gravel deposition from 2012 flood.

Figure 16. Stagnant channel with static floodplain vegetation (dense pasture grasses) near middle of Site.

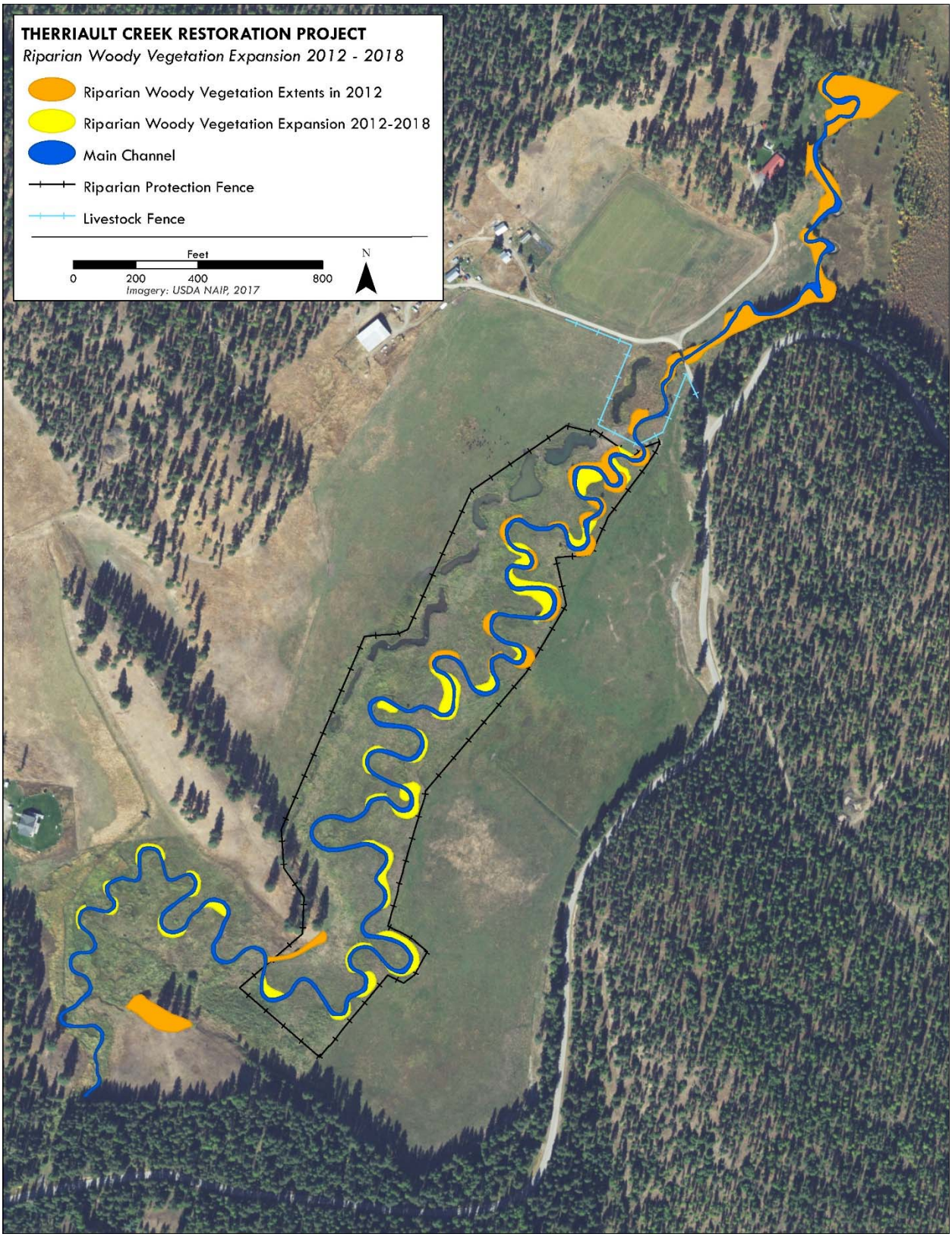

Figure 17. Woody vegetation cover within the Therriault Creek Restoration Project in 2012 (orange) and 2018 (orange and yellow).

Table 2. Current status of Therriault Creek Restoration revegetation objectives.

Vegetation Objective	Status
Protect the stability of the restored channel using native woody vegetation	This objective has been partially achieved. The restored channel has been very stable since restoration in 2005. Revegetation treatments including containerized plants, vegetated soil lifts, coir logs, and willow fascines have all increased woody vegetation cover along the streambanks. However, woody vegetation cover is only present on a very small percentage of the streambanks Site wide. The constructed stream channel has a high level of stability even without the presence of woody vegetation, with herbaceous vegetation providing significant stability.
Enhance habitat for native fish populations through use of native woody vegetation	This objective has been partially achieved. Revegetation treatments including containerized plants, vegetated soil lifts, coir logs, and willow fascines have all increased woody vegetation cover along the streambanks resulting in increased shade, cover, pool depths, and increased input of organic material to the channel. Coir log treatments have retained deep undercut banks that have been lost in other areas. Large woody debris structures have created significant diversity of depth and substrate in the channel. Numerous fish are spooked from these treatments each time they are observed. Most of the Site, however, is characterized by streambanks dominated by herbaceous vegetation and uniform channel habitat.
Limit invasion and continued spread of Canada thistle and other noxious weeds	This objective has not been achieved. In 2015, Canada thistle was well under control at the site with only sporadic occurrences of young plants. Common toadflax distribution and density had increased possibly in response to reduced Canada thistle cover. Reed canarygrass was under control in most areas of the Site except the downstream end which supports large infestations that are too dense and in too diverse of topography to effectively treat. Due to a lack of Site wide weed control in 2016 and 2017, Canada thistle densities in 2018 were as high or higher than they were at the start of the project. Reed canarygrass has increased along streambanks in the upper portion of the Site and is expanding into previously unoccupied (treated) portions of the floodplain in the lower portion of the Site.
Protect surviving containerized plantings from initial revegetation efforts	This objective has been achieved. All residual shrubs that could be relocated have been protected from browse and represent the most robust areas of shrub cover at the Site.
Create conditions that will promote natural revegetation by native species.	This objective has been partially achieved. Reconnection of the channel with the historic floodplain has been the most effective treatment for creating conditions for natural revegetation. By 2012, a large portion of the Site had converted naturally to dense sedges and wetland grasses through reactivation of the historic floodplain water table. Construction of the drainage ditch in the adjacent hayfield in 2013 combined with drought conditions in 2014 and 2015, reverted some of these areas back to a drier grass species. Introduced pasture grasses are still dominant at the Site. Natural expansion of woody vegetation has occurred on inside meander bends in the 2007 treatment area. Solarization fabric opened some new habitat within pasture grass areas. Some of these sites have converted to native grasses while others have converted back to introduced pasture grass. Attempts to establish woody vegetation in these locations with dormant willow cuttings were unsuccessful due to browse and grass competition. Large woody debris structures have also helped convert pasture grass areas to native sedges; however, these effects are localized to the area around each structure.

Five-Year Vegetation Management Plan

This section describes a five-year vegetation management plan for the Therriault Restoration Project Site. This management plan includes strategies to address the factors still limiting achieving vegetation objectives, provides an approximate schedule for implementing preferred strategies for the five year time period, and provides specific recommendations for work to be completed in 2019. This section also describes how the existing adaptive management process should be used to continue to evaluate the Site.

Project partners should have realistic expectations about how much woody vegetation can be established at the site in a cost effective manner. As described in the Existing Conditions section, the dense cover of introduced pasture grasses at the site greatly limits natural establishment of woody riparian vegetation. Woody vegetation has established well in a few areas, where site conditions are most supportive (i.e. low elevation inside meander bends). These conditions, however, are not present throughout much of the Site and the site will mostly likely remain a mosaic of riparian shrubs and trees, areas of wetland graminoids and forbs, and introduced pasture grasses for many years to come. This five-year vegetation management plan focuses on establishing additional woody riparian vegetation in areas where it is not currently present and is feasible to do with minimal additional maintenance and plant protection. If pockets of woody riparian vegetation are spread throughout the Site this will allow conditions to shift slowly over time by increasing shade and available local seed sources.

Vegetation Management Strategies

To address the existing limiting factors to riparian vegetation, this section describes continued vegetation management strategies for the Site. The recommended vegetation management strategies can be broken down into the following categories and are described below:

- Weed Control
- Browse Control
- Induced Disturbance
- Streambank Treatments

Weed Control

Weed control is the highest priority vegetation management action for the Site. Weed control should be completed each year of the five-year management period. Due to the extensive infestations of Canada thistle at the site, treating weeds with herbicide is the only option to regain control. Some of the area can be treated with broadcast spraying but much of the area will need to be treated with handlines or backpacks to avoid damage to desired vegetation. Weed treatments should target all noxious weeds. To date the following noxious weeds have been identified at the Site: Canada thistle, sulfur cinquefoil, houndstongue, yellow toadflax, oxeye daisy, and perennial pepperweed. Only Canada thistle and yellow toadflax are widely distributed.

Canada thistle spreads by both vegetative roots and seed and each shoot can produce more than 1,000 seeds. Seeds of Canada thistle can remain viable in the soil for up to 20 years. It is one of the more difficult weeds to control and requires a long-term, integrated approach. The plants have large root reserves that provide energy to the plant allowing it to put out new growth in the spring, when the ground is disturbed, and when moisture increases in the fall after the plants have mostly gone dormant. The key to controlling it is to stress the plant and deplete its root reserves, which can take several years.

That is why control in both the spring and fall will be important over the next five years, to effectively control it, the reserves must be depleted before plants over-winter.

In addition to noxious weeds, aggressive introduced graminoids, such as reed canarygrass, quackgrass, orchardgrass, and meadow foxtail, and to a lesser extent common timothy, redtop, Kentucky bluegrass and smooth brome, are also problematic. Of these, reed canarygrass is the most invasive in riparian floodplain environments. The other species will often phase out as shade cover increases or in areas with high water tables. Reed canarygrass is also intolerant of shade but competes more aggressively with establishing riparian shrubs and trees. Reed canarygrass is challenging to control and can be labor intensive and expensive at large sites like Therriault. For this reason, reed canarygrass management at the site has focused on reducing spread rather than eradication. The density of reed canarygrass in the very downstream portion of the Site has always been very high and the diversity of topography (old channels and wetland features) in this area would make it impossible to treat effectively. The focus on this area has always been to prevent the upstream spread from this dense infestation and that should continue to be the strategy for the next five years. All treatable patches of reed canarygrass not immediately on streambanks should be treated with herbicide. Reed canarygrass has always had lower cover in the rest of the Site, compared to the downstream portion. It is increasing along streambanks and wetland ponds on the west side of the Site where the abandoned channel is present. Herbicide applications targeting small clumps of reed canarygass in the past have greatly limited the spread of reed canarygrass into the riparian floodplain. However, increased reed canarygrass cover was observed in 2018 due to the lack of herbicide treatment in 2016 and 2017. For the most part, these areas were not too big to still effectively treat with herbicide, so continued herbicide treatment should be part of the five-year plan. Treating reed canarygrass along the streambanks is more problematic because killing reed canarygrass with its dense root system could destabilize the streambank. Where possible, on streambanks dominated by reed canarygrass, streambank treatments should be considered that remove the plant and root system and re-build the bank with treatments that allow willows to establish.

It is important that project partners coordinate with the landowner to ensure that weed infestations and disturbances leading to weed infestations adjacent to the Site are controlled. Project partners should expect weed control to be necessary beyond 2022.

Browse Control

Browse pressure at the Site is very high and the large meadow environment will always make the project a desirable location for deer, elk, and moose. The dense pasture grasses create an ideal habitat for rodents, such as voles, which can aggressively feed on small seedlings of woody plants. Browse, combined with grass competition, were the main factors contributing to low survival of the shrubs initially installed in 2005. Significant resources have been put into protecting the residual surviving shrubs and the additional shrubs and trees installed in 2008 and 2010. In general, these protection measures have successfully allowed plants to establish, but have also created new problems affecting plant health and growth including restricting growth, altering plant form, and causing roots and stems to rot. These browse protection measures have also required significant maintenance effort, including annual removal from dead plants, increasing the size of protectors when they become outgrown, and removing vole protectors when they start to affect stem growth.

Although some loss of planted trees and shrubs was observed (but not quantified) between 2015 and 2018, the trees and shrubs that are still surviving at the site can probably be expected to survive at this

point. Continued browse is affecting the height and vigor of these plants and efforts should continue to protect these plants from browse to allow them to fully expand and grow until they are resistant to browse pressure. When well maintained, the riparian protection fence keeps enough deer and elk from the area it encloses to allow shrubs to grow and expand. Continued maintenance of the riparian protection fence to ensure its effectiveness is therefore a very high priority for the next five years. In fall 2018, the lower end of the fence was relocated to allow animals to move through the area more easily and reduce pressure on the fence. For trees and shrubs outside of the riparian protection fence, on-going protection is still needed. To date, efforts have been made to re-use the browse protection materials available on the site rather than importing new materials. However, most browse protectors currently require expansion to larger sizes, and the existing materials are not rigid enough to expand to a large enough size. To ensure longer-term protection of shrubs and trees outside of the riparian protection fence, black polyethelene browse protectors and small exclosures should be replaced with wire fence and t-posts.

Induced Disturbance

Grasses are a major constraint to woody vegetation establishment and expansion at the Site. The dominance of introduced grasses, combined with a lack of natural disturbance, creates static conditions that resist change and natural revegetation of the site by native, desirable species. Some areas have transitioned to native species through reconnection of the channel with the historic floodplain, but woody vegetation establishment will always be naturally limited in this reach of Therriault Creek. Active restoration is required to expand shrub cover. In areas where woody vegetation can become dominant, it will shift the conditions at the site over time by shading out grasses, increasing surface roughness and providing litter that will slowly create conditions that will allow the Site to support more diverse vegetation communities. Currently, acceptable woody vegetation cover is limited to portions of the Site that were treated in 2007. Little expansion of woody vegetation on inside meanders occurs in the 2007 planting area due to the high elevation of inside bend streambanks.

Planting has been shown to be problematic at the Site. Plants require extensive protection measures to protect them from deer, elk, voles, and grass competition. This makes large scale planting very expensive and a long-term maintenance commitment. Survival of planted trees and shrubs has also been variable, making it unclear if the benefit is worth the cost. Therefore, other options to increase woody cover at the site naturally should be considered. Several of the treatments installed at the Site to date have aimed to do this. Solarization fabric has effectively heat killed the aggressive pasture grasses where it has been used but establishing desired woody vegetation through cuttings and natural recruitment has been problematic due to rapid re-colonization of grasses or browse. Planting through solarization fabric seemed very effective the first several years, but significant loss of plants occurred after removal of fabric in these areas. Solarization remains a viable treatment at the site, but more aggressive revegetation with woody vegetation after fabric removal would be required. Large woody debris structure treatments also aimed to create disturbance and increase flooding in the adjacent riparian floodplain to increase sediment deposition creating new, bare surfaces for woody vegetation to establish. This is happening at a small scale within the channel along these structures, but minimal sediment deposition has occurred outside the channel at these structures. These structures, however, have helped convert the graminoid community to a wetter, more native mix of species.

The following treatments are options to induce disturbance at the site in the next five years. Treatments would be focused downstream of the 2007 planting areas where woody vegetation cover

has not increased as greatly. Treatment sites would be located within the riparian protection fence to ensure they are protected from browse.

Point bar expansion

Point bar expansion is a treatment that would increase the low elevation area along the channel. Point bar expansion involves lowering the existing ground on the inside of meander bends in select areas. These areas are almost all dominated by dense cover of aggressive grasses. No planting of riparian shrubs and trees has been done in these areas. The size of the lowered area can vary. Areas would be lowered between one and two feet and gently slope from the channel bed to existing ground. This treatment would remove the dense pasture grasses, exposing bare substrates and creating areas that can be colonized by woody riparian shrubs, primarily willows, alder, and dogwood. In addition, these areas would increase connectivity with the channel, allowing high flows to create natural disturbances necessary for riparian vegetation community initiation. These surfaces would also be closer to the late season water table supporting riparian shrub expansion. This treatment would attempt to mimic the conditions where sandbar willow expansion has occurred in the upstream portion of the Site. Willow fascines (bundles of 5-ft long ½-inch diameter willow cuttings) could be buried in the lowered surface to jump start woody vegetation establishment. Figure 18 shows examples of inside bends where point bar expansion would apply.

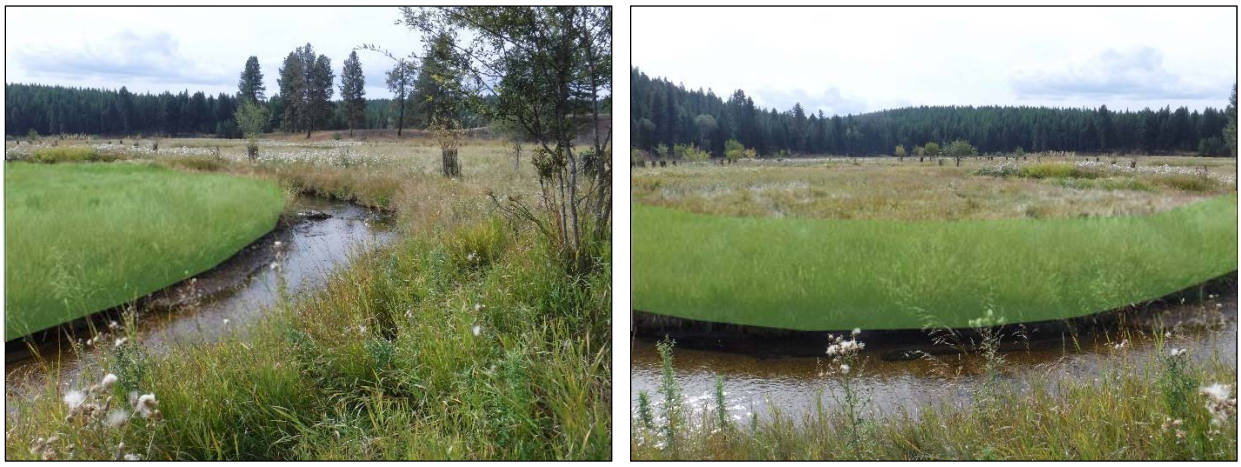

Figure 18. Example of an inside meander bend areas dominated by dense cover of introduced pasture grasses that could be lowered to increase floodplain connectivity and create a surface capable of supporting woody riparian shrubs. Areas highlighted in green are approximate extents of surface lowering.

Sod scalping and mass planting of small willows

Sod scalping is a treatment that would remove the aggressive grass species and expose the bare mineral soil underneath. It creates conditions similar to solarization fabric, but creates these bare soil conditions instantly, and it would be possible to remove more of the residual roots and seedbank. The exposed soil would be aggressively planted with small containerized willows to ensure willows can establish prior to grasses recolonizing the disturbed area. Annual hand-pulling of weeds would be necessary to ensure willow establishment.

Beaver dam analogs

Beaver dam analog structures span the channel, mimicking the effects of natural beaver dams – accumulating sediment and organic matter, ponding water in the channel, and increasing flows outside of the channel. For Therriault Creek, the purpose of these structures would be to activate and create

disturbance in the floodplain, creating openings in the dense pasture grasses for woody vegetation to colonize. There are numerous ways to build these structures, but most methods require re-building or re-fortifying the structures each year. The large woody debris structures installed at the lower end of the Site were designed to have a similar effect and while they have created habitat diversity and increased localized water table, they have not done much to allow woody vegetation expansion. The channel is somewhat entrenched in many areas which may make it difficult for these treatments to effectively spread flows out across the floodplain. For these reasons, beaver dam analog structures should remain an option for inducing disturbance at the Site, but are not included in the five-year treatment plan.

Streambank Treatments

The vegetated soil lift, coir log, and willow fascines treatments have all worked well at the Site because they either replace aggressive grasses (vegetated soil lifts) or add willows below the dense sod mats (coir logs and willow fascines). The densest streambank woody vegetation cover occurs where these treatments were installed. For this reason, additional streambank treatments are proposed for the lower portion of the reach to establish more woody vegetation cover in this area. Streambank treatments should be located within the riparian protection fence so they are protected from browse. To increase aquatic habitat and mimic natural streambank conditions (in addition to increasing woody vegetation), a streambank treatment that incorporates woody brush material is proposed. This treatment will remove aggressive pasture grasses on the streambank and re-build the bank using a mix of brush, excavated materials and dormant willow cuttings. Figure 19 shows a photo of a constructed brush matrix streambank treatment. Figure 20 shows the types of streambanks that could be rebuilt using this treatment at the Site.

Figure 19. Brush matrix streambank treatment.

Figure 20. Example of streambanks where brush matrix streambank treatment would greatly increase aquatic habitat and vegetation conditions.

Five-Year Vegetation Management Schedule

This section describes a proposed schedule for implementing the vegetation management strategies described in the previous section for a five year period: September 2018 through June 2022. Weed control should occur twice a year, in the spring/summer and fall of each year. An annual maintenance visit to verify conditions and treatments should occur in July or August of each year. Maintenance and additional revegetation treatments would occur in the fall of each year during vegetation dormancy. The specific revegetation treatment actions for the first year, 2019, are described in the following section. Additional year actions would be determined using the Adaptive Management framework developed for the project. Table 3 provides a list of the possible maintenance and revegetation actions to occur over the five year period.

2019 Vegetation Management and Treatments

Several actions were identified during the September 11, 2018 site assessment to address limiting factors to achieving vegetation objectives at the Site and are described in the previous section. This section provides specific details on vegetation management treatments recommended to implement in 2019. In 2019, the following specific actions are recommended:

- Weed control in summer and fall targeting all noxious weeds and any treatable clumps of reed canarygrass.
- Riparian protection fence repairs.
- Browse protector removal, repair, and replacement – replace black polyethelene protectors outside of the riparian protection fence with metal cages.
- Induced disturbance – point bar expansion in two locations near middle of Site.
- Streambank treatments – brush matrix along 500 feet of streambank near middle of Site.
- Induced disturbance - sod scalping in two areas dominated by pasture grasses.
- Planting - small containerized willow planting in sod removal areas.
- Willow fascines – installation of willow fascines on expanded point bars.
- Landowner coordination to ensure that weeds outside of the Site are treated and the wetland drainage ditch is filled in or allowed to retain moisture in adjacent areas outside of the period of active haying.

The location of proposed 2019 revegetation treatments are shown on Figure 21.

Table 3. List of possible five-year maintenance actions and revegetation treatments for the Therriault Creek Restoration Project Site, including approximate year of completion and quantities.

Year/Season	Maintenance Actions and Revegetation	Approximate Quantity
Fall 2018	Weed control Fence repairs Browse protector repairs	20 acres 500 linear feet 100
Spring/Summer 2019	Weed control	20 acres
Fall 2019	Weed control Fence repairs Browse protector removal and repair Brush matrix streambank treatment Point bar expansion Sod scalping Containerized plant installation (10 cubic inch) Willow fascine installation Metal cage installation	20 acres 500 linear feet 100 500 linear feet 3,000 square feet 5,000 square feet 2,000 plants 40 fascines 100 cages
Spring/Summer 2020	Weed control	20 acres
Fall 2020	Weed control Fence repairs Hand weeding 2019 planted areas	20 acres 500 linear feet 5,000 square feet
Spring/Summer 2021	Weed control	20 acres
Fall 2021	Weed control Pont bar expansion Sod scalping Containerized Plant Installation (10 cubic inch)	20 acres 2,000 square feet 3,000 square feet 2,000 plants
Spring/Summer 2022	Weed control Fence repairs Hand weeding 2019 and 2021 planted areas	20 acres 500 linear feet 10,000 square feet

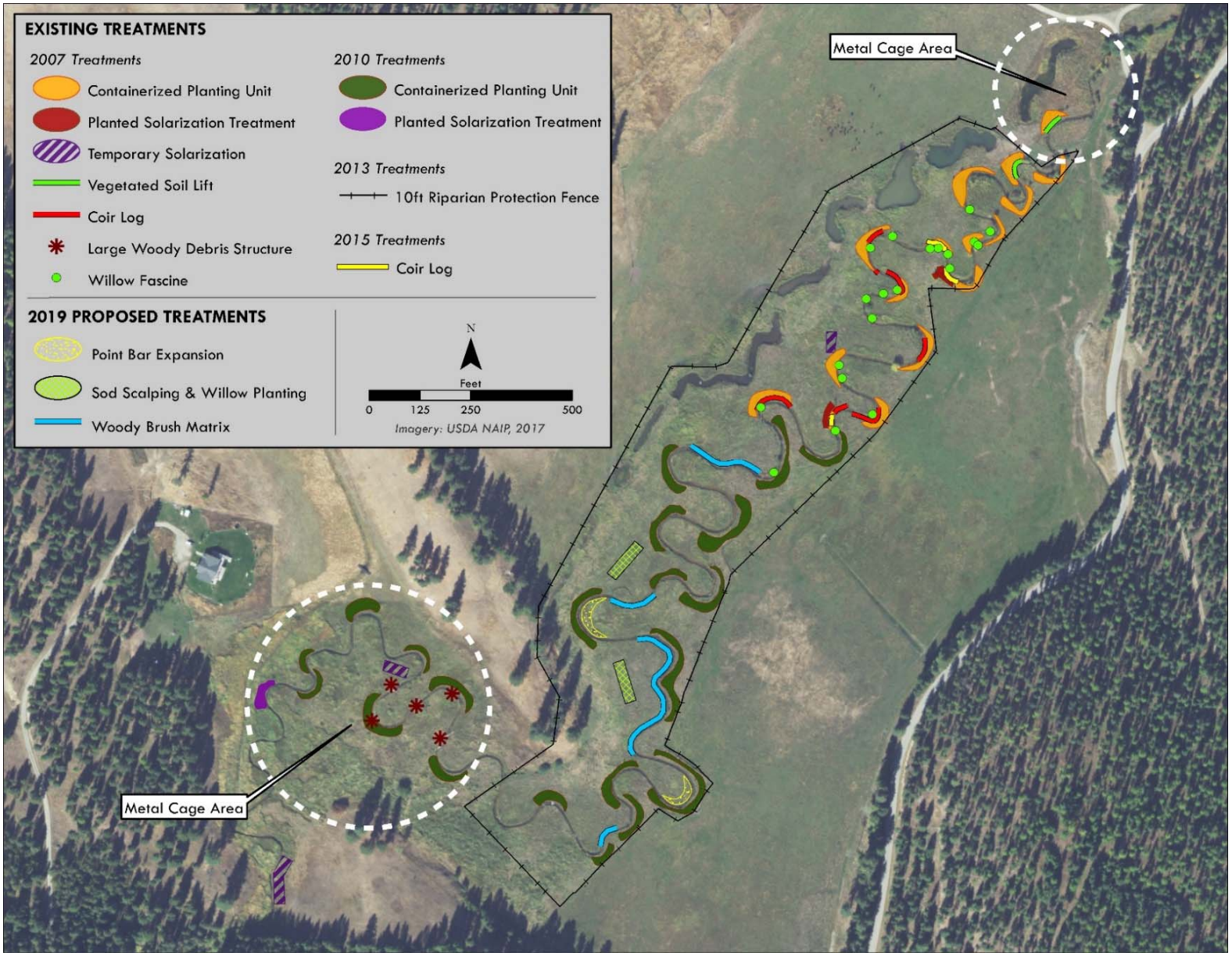

Figure 21. Proposed 2019 revegetation treatments for the Therriault Creek Restoration Project.

Adaptive Management

An adaptive management process for the site has been in place since the initial Revegetation Plan was developed and implemented. This process involves conducting monitoring each year and documenting site trends towards meeting vegetation objectives. Monitoring has included collection of quantitative data and qualitative observations. Photographs of each treatment are taken each year. Annual monitoring determines the maintenance activities that are needed each year and evaluates the effectiveness of each implemented treatment. It also documents overall site trends and identifies issues that need to be addressed to keep the site on a trajectory towards achieving objectives.

For the five-year management plan, the same adaptive management program will be used. Each year the site will be visited, treatments qualitatively evaluated, and treatments and site conditions documented with photographs. The monitoring site visit will determine the exact locations and quantities of additional revegetation treatments. Based on the site review, project partners may determine what actions to take that year. Site observations, completed maintenance activities, and implemented revegetation treatments will be documented in a report or memorandum at the end of each year.

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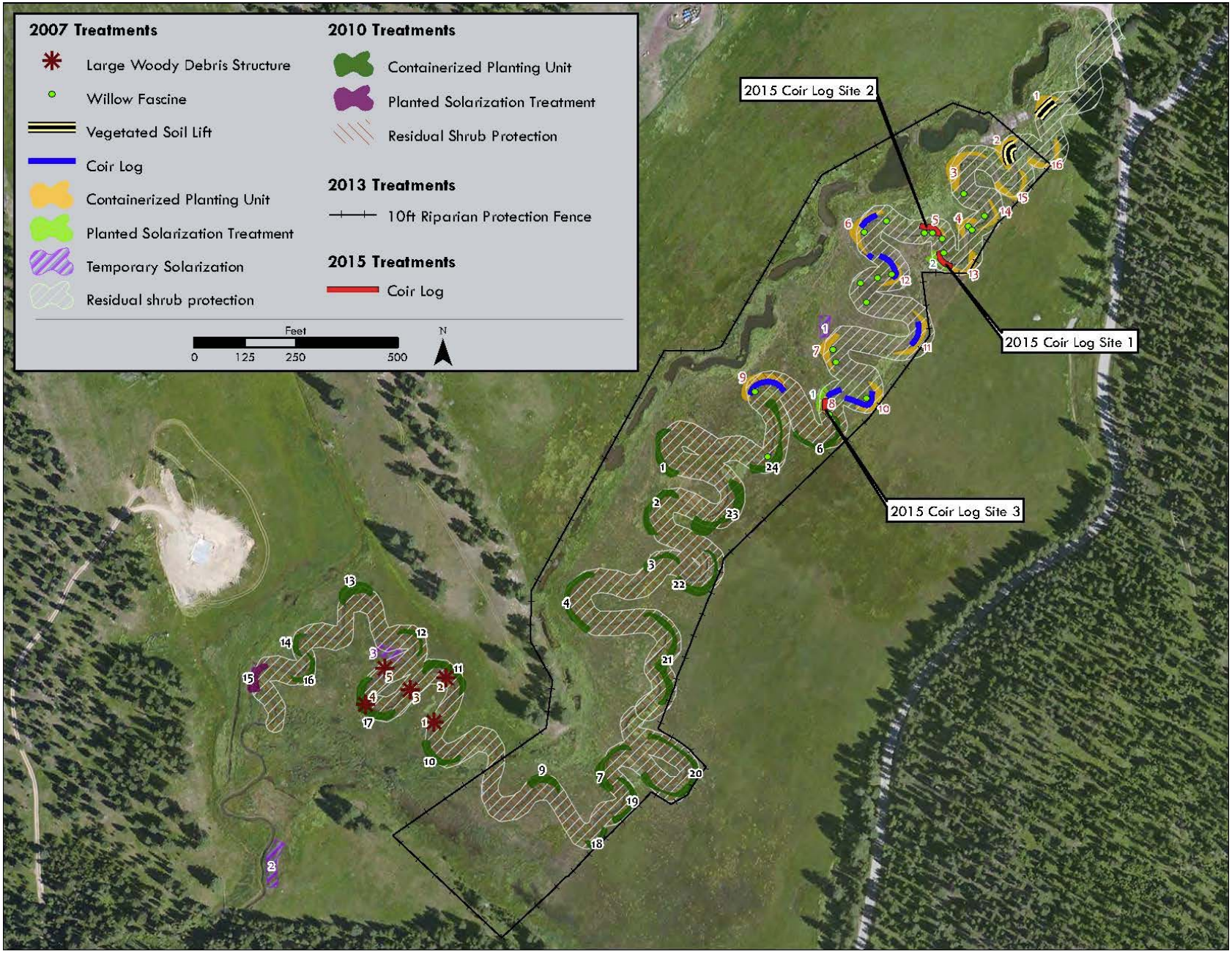
Geum Environmental Consulting, Inc. 2013. Therriault Creek Riparian Revegetation 2013 Monitoring and Maintenance Report Contract #140025. Internal Report prepared for Montana Fish, Wildlife and Parks, Libby, Montana.

Geum Environmental Consulting, Inc. 2014. Therriault Creek Riparian Revegetation 2014 Monitoring and Maintenance Report Contract #150017. Internal Report prepared for Montana Fish, Wildlife and Parks, Libby, Montana.

Geum Environmental Consulting, Inc. 2015. Therriault Creek Riparian Revegetation 2015 Maintenance and Monitoring Summary. Internal memorandum prepared for Montana Fish, Wildlife and Parks, Libby, Montana.

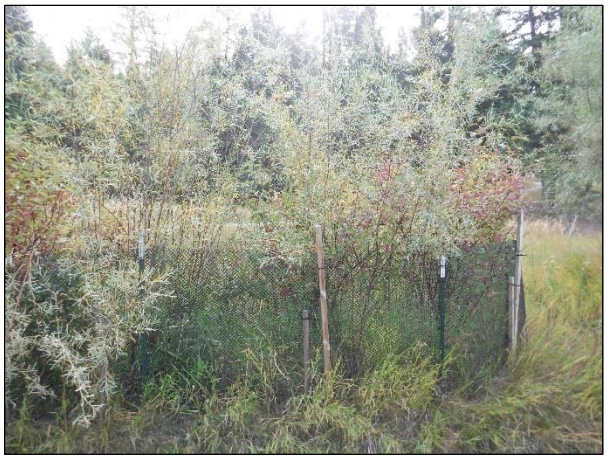
Geum Environmental Consulting, Inc. 2019. Therriault Creek Riparian Revegetation 2018 Maintenance Summary. Internal memorandum prepared for Montana Fish, Wildlife and Parks, Libby, Montana.

Attachment A: Map of Revegetation Treatments Completed to Date


2007 Treatments
Large Woody Debris Structure
Willow Fascine
Vegetated Soil Lift
Coir Log
Containerized Planting Unit
Planted Solarization Treatment
Temporary Solarization
Residual shrub protection
2010 Treatments
Containerized Planting Unit
Planted Solarization Treatment
Residual Shrub Protection
2013 Treatments
10ft Riparian Protection Fence
2015 Treatments
Coir Log
Feet
0
125
250
500
N
2015 Coir Log Site 2
2015 Coir Log Site 1
2015 Coir Log Site 3

Attachment B. 2018 Photographs of Revegetation Treatments

Residual Shrub Protection



2007 Planting Units

PLANTING UNIT 1

PLANTING UNIT 2

PLANTING UNIT 3

PLANTING UNIT 4

PLANTING UNIT 5

PLANTING UNIT 6

PLANTING UNIT 7

PLANTING UNIT 8

PLANTING UNIT 9

PLANTING UNIT 9
middle of unit

PLANTING UNIT 10

PLANTING UNIT 11 downstream end

PLANTING UNIT 11 middle of unit

PLANTING UNIT 11 upstream end of unit

PLANTING UNIT 12

PLANTING UNIT 13

PLANTING UNIT 14

PLANTING UNIT 14 large alder at upstream end with altered growth form from browse protectors

PLANTING UNIT 15 downstream end

PLANTING UNIT 15 upstream end

PLANTING UNIT 16

2010 Planting Units

PLANTING UNIT 1 on right bank with heavy browse and some residual shrub expansion on left bank

PLANTING UNIT 2

PLANTING UNIT 3

PLANTING UNIT 4

PLANTING UNIT 6

PLANTING UNIT 7

PLANTING UNIT 9

PLANTING UNIT 10

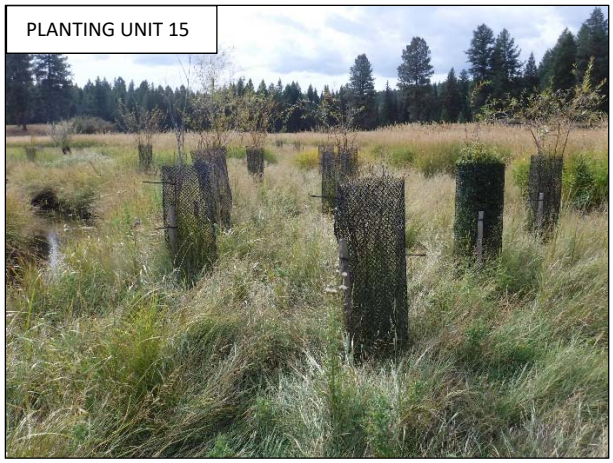
PLANTING UNIT 11

PLANTING UNIT 12

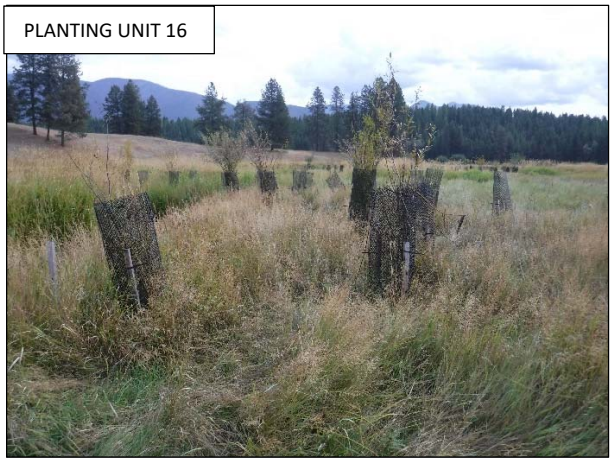
PLANTING UNIT 13

PLANTING UNIT 14

PLANTING UNIT 15



PLANTING UNIT 16



PLANTING UNIT 17

PLANTING UNIT 18

PLANTING UNIT 19

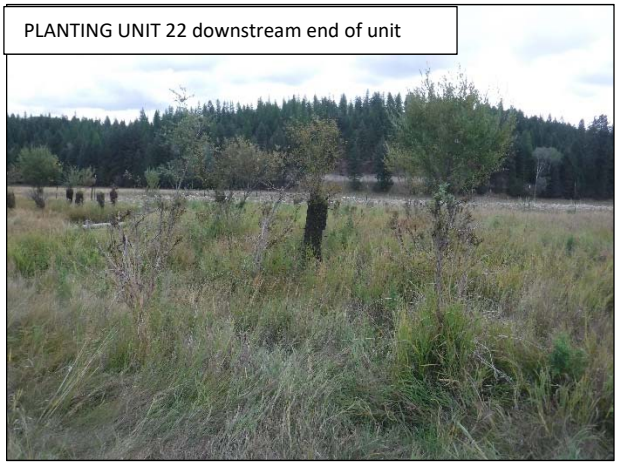
PLANTING UNIT 20

PLANTING UNIT 21 downstream end of unit

PLANTING UNIT 21 mid-way through unit

PLANTING UNIT 21 upstream end of unit

PLANTING UNIT 22 downstream end of unit



PLANTING UNIT 22 mid-way through unit

PLANTING UNIT 22 upstream end of unit, there are numerous young sandbar willow in the fore ground of the photo that are heavily browsed

PLANTING UNIT 23 downstream end of unit

PLANTING UNIT 23 upstream end of unit

PLANTING UNIT 24 downstream end of unit

PLANTING UNIT 24 upstream end of unit

Vegetated Soil Lifts

SOIL LIFT 1 – left photo is looking downstream, right photo is looking upstream
This soil lift is located outside of the riparian protection fence and although willow cover is dense, willow height is greatly suppressed. The streambank across from the soil lift is dense reed canarygrass.

SOIL LIFT 2 – left photo is looking downstream, right photo is looking upstream
This soil lift is located inside of the riparian protection fence and willow cover and height has been protected from browse for four growing seasons. Willows have grown between four and five feet since being released and produce significant amounts of seed each year. Cattle trespass and openings in the fence resulted in some browse of the willows, but only around the edges of the structure. The streambank across from the soil lift is dense reed canarygrass. No willow expansion into the floodplain behind the structure has occurred due to the dense cover of pasture grasses.

Coir Logs

2008 COIR LOG 1

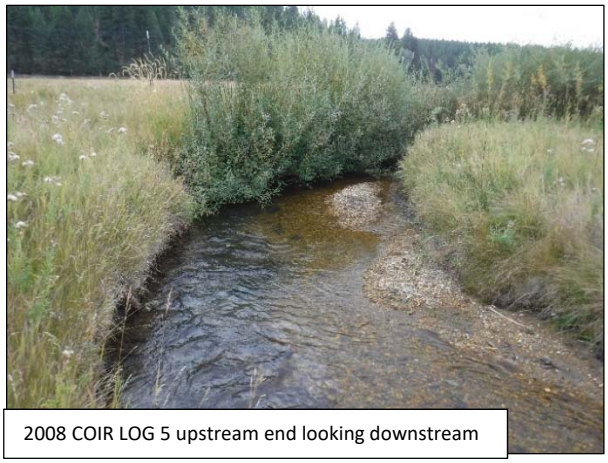
2008 COIR LOG 2 on right bank and willow fascine on left bank

2008 COIR LOG 3 on left bank with residual shrub expansion on right inside meander bend

2008 COIR LOG 3 downstream end

2008 COIR LOG 4 on left bank upstream end

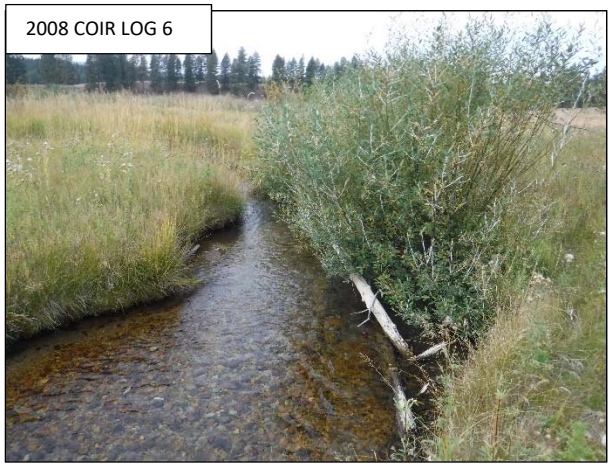
2008 COIR LOG 5 on right bank with residual shrub expansion on left inside meander bend



2008 COIR LOG 5 upstream end looking downstream

2008 COIR LOG 5 creating instream cover

2008 COIR LOG 6



2008 COIR LOG 7

2015 COIR LOG 1 with reed canarygrass on bank

2015 COIR LOG 1 scour of coir log and slumping

20015 COIR LOG 2

2005 COIR LOG 3 on right bank with good willow growth in front of dense stand of reed canarygrass

Willow Fascines






Solarization - Unplanted

Plot 1 is dominated by sedges with a few willows. Very low cover of introduced pasture grasses. Canada thistle cover has increased significantly.

Plot 2 has been recolonized by reed canarygrass. No living willow cuttings were found.

Plot 3 has been recolonized by reed canarygrass.

Solarization – Planted

Planted Solarization Plot 1 is dominated by bluejoint reedgrass. There are very few surviving shrubs despite high survival and vigorous growth prior to fabric removal.

Planted Solarization Plot 2 is where the channel filled with gravels and flowed across the floodplain. The gravel plug was removed and the channel put back into its constructed alignment. This is the only location in the project where gravels have deposited on the floodplain surface. The gravel was colonized by numerous red-osier dogwood seedlings but few willows. These seedlings are still present but suppressed by browse. The gravels have been colonized by reed canarygrass and pasture grasses.

Large Woody Debris Structures

STRUCTURE 1

STRUCTURE 1 willow growing in structure mid-channel

STRUCTURE 2 looking downstream from upstream with sandbar willow expansion on left bank and reed canarygrass on right bank

STRUCTURE 2 looking upstream from downstream

STRUCTURE 3

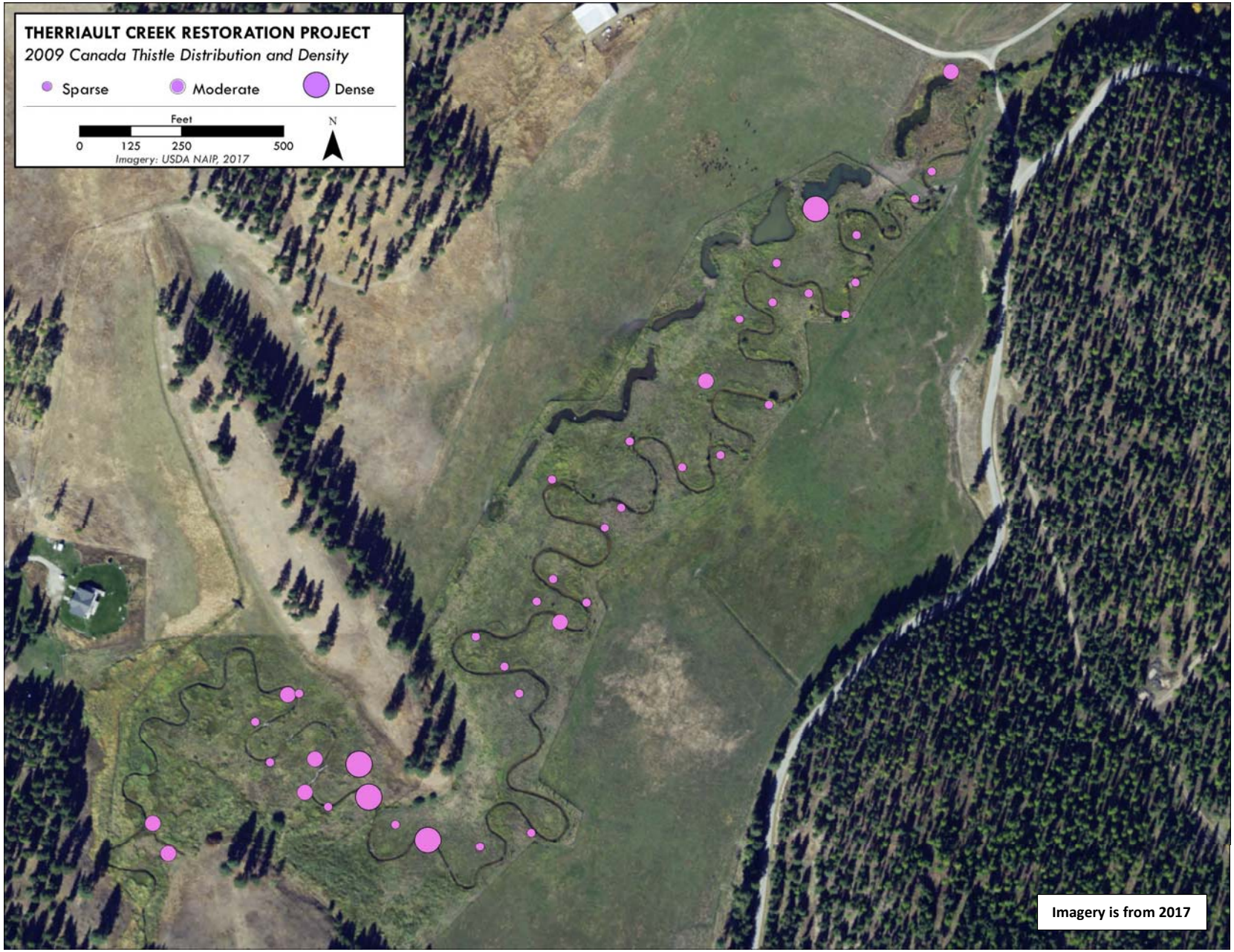
STRUCTURE 4

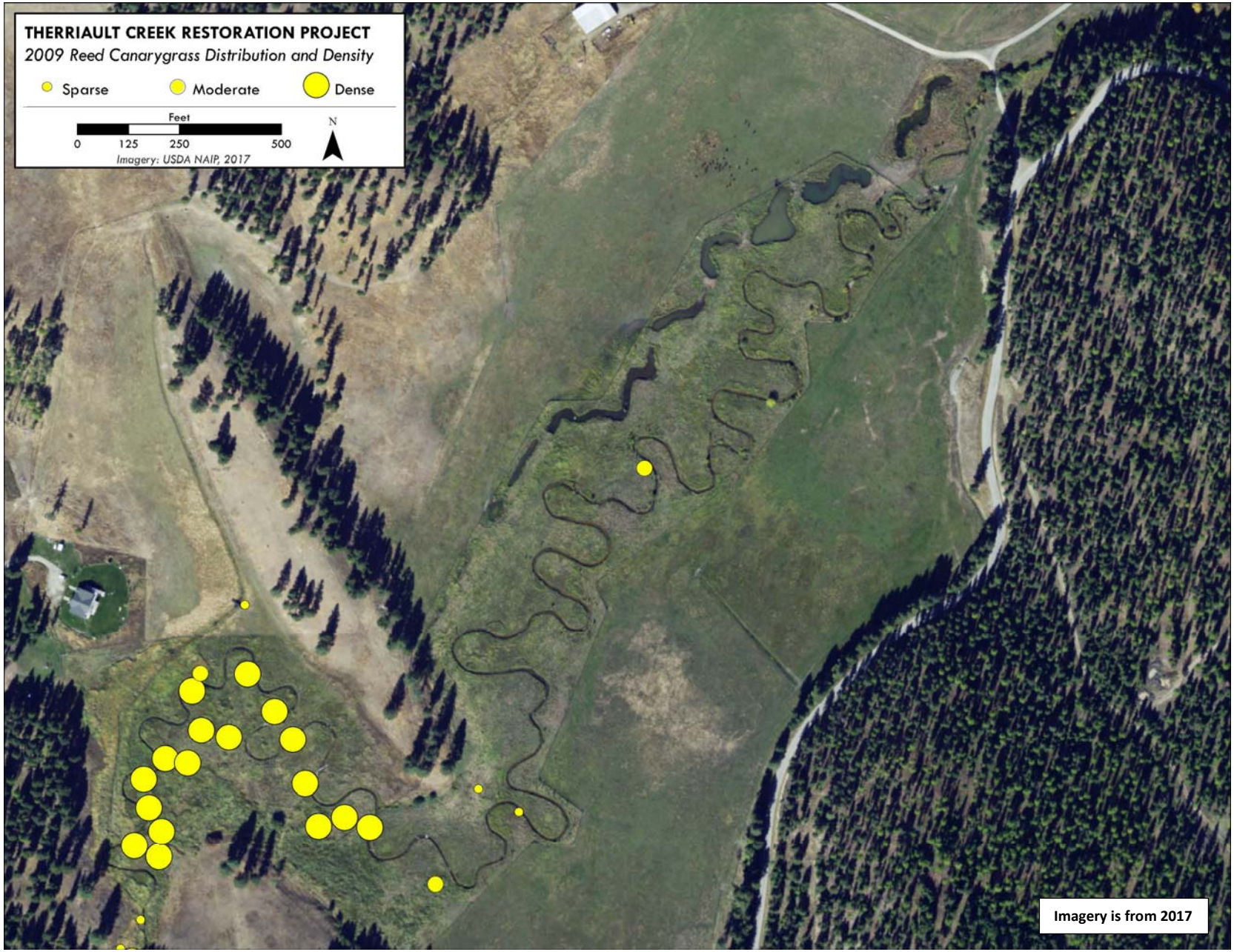
STRUCTURE 4 substrate diversity

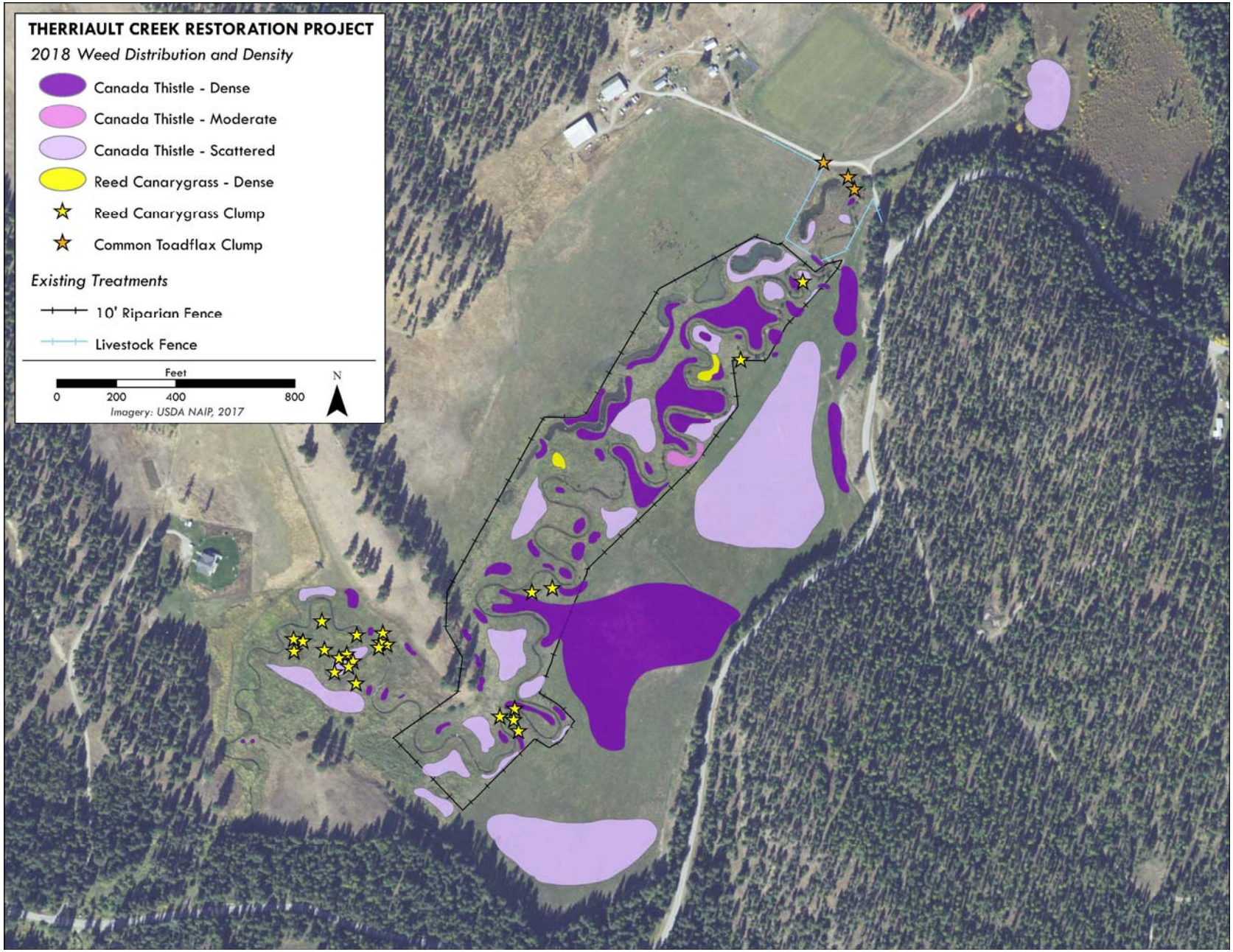
STRUCTURE 5 upstream looking downstream

STRUCTURE 5 downstream looking upstream

Attachment C: 2009 Weed Mapping, 2012 Weed Mapping and 2018 Canada Thistle Densities


THERRIAULT CREEK RESTORATION PROJECT
2009 Canada Thistle Distribution and Density
Sparse
Moderate
Dense
Feet
0
125
250
500
N
Imagery: USDA NAIP, 2017
Imagery is from 2017


THERRIAULT CREEK RESTORATION PROJECT
2009 Reed Canarygrass Distribution and Density
Sparse
Moderate
Dense
Feet
0
125
250
500
N
Imagery: USDA NAIP, 2017
Imagery is from 2017


THERRIAULT CREEK RESTORATION PROJECT
2018 Weed Distribution and Density
Canada Thistle - Dense
Canada Thistle - Moderate
Canada Thistle - Scattered
Reed Canarygrass - Dense
Reed Canarygrass Clump
Common Toadflax Clump
Existing Treatments
10' Riparian Fence
Livestock Fence
Feet
0
200
400
800
N
Imagery: USDA NAIP, 2017