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# Elk River Alliance – Cottonwood Restoration Project: Rehabilitation Prescription

## Keefer Ecological Services

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# 1.0 Introduction

The Elk River Alliance (ERA) contracted Keefer Ecological Services (KES) to map potential cottonwood restoration sites, conduct site assessments, and provide streamside restoration prescriptions at ground-assessed locations along the Elk River between Blue Lake Recreation Site (50°11'12.33"N 114°59'3.78"W) and the Elk River Delta where it flows into Lake Koocanusa (49°10'28.40"N 115°10'32.68"W). The objectives of the project, including restoration treatments, include:

- Identify present black cottonwood (*Populus trichocarpa*) stands and floodplain sites that may have previously had cottonwood stands along the Elk River and major tributaries;
- Assess on the ground cottonwood sites along the Elk River to understand the current extent of the species in the Elk Valley;
- Provide an up-to-date historical context of cottonwood behaviour in the Elk Valley;
- Improve and increase habitat value at the restoration site(s);
- Increase flood mitigation and prevent erosion at restoration site(s); and
- Prevent invasive species from spreading.

# 2.0 Mapping and Site Assessment

Prior to field work being conducted, mapping of existing and potential cottonwood stands was completed. This mapping utilized provincial Vegetation Resource Inventory (VRI) data to locate stands where cottonwood was either the leading species or a significant portion of the stand. The VRI mapping was queried within the riparian area that was mapped by combining the Elk Valley Cumulative Effects Management Framework (EV CEMF, 2018) and valley-bottom riparian raster layers provided by the BC Ministry of Environment. This riparian area was refined using imagery, as the EV CEMF riparian mapping included considerable upland (non-floodplain) and steeply sloping gullied riparian areas unsuitable to cottonwood restoration as envisaged by ERA. The area that was deemed suitable for cottonwood restoration are mid-bench floodplain ecosystems that have been cleared of cottonwood forest and are typically grass-dominated at present. The mapping revealed 1,742 ha of mid-bench floodplain along the main stem of the Elk River from near Elkford to the confluence with the Koocanusa Reservoir that could benefit from cottonwood restoration. Within the riparian area, we found 909 ha of stands where cottonwood is dominant and 1,201 ha of stands where cottonwood is a secondary species.

We attempted to visit and assess as many of these potential restoration sites as access allowed. Many sites are located on private land that, at this juncture in the project, many were deemed inaccessible. Features assessed at potential restoration sites included:

- Soil characteristics;
- Dominant vegetation;
- Presence of invasive species;
- Wildlife or domestic animal use;
- Presence of eroding banks;

- Height above river level;
- Depositional processes; and
- Limiting factors for restoration.

We assessed 91 sites, along the Elk River, Alexander Creek, and Michel Creek.

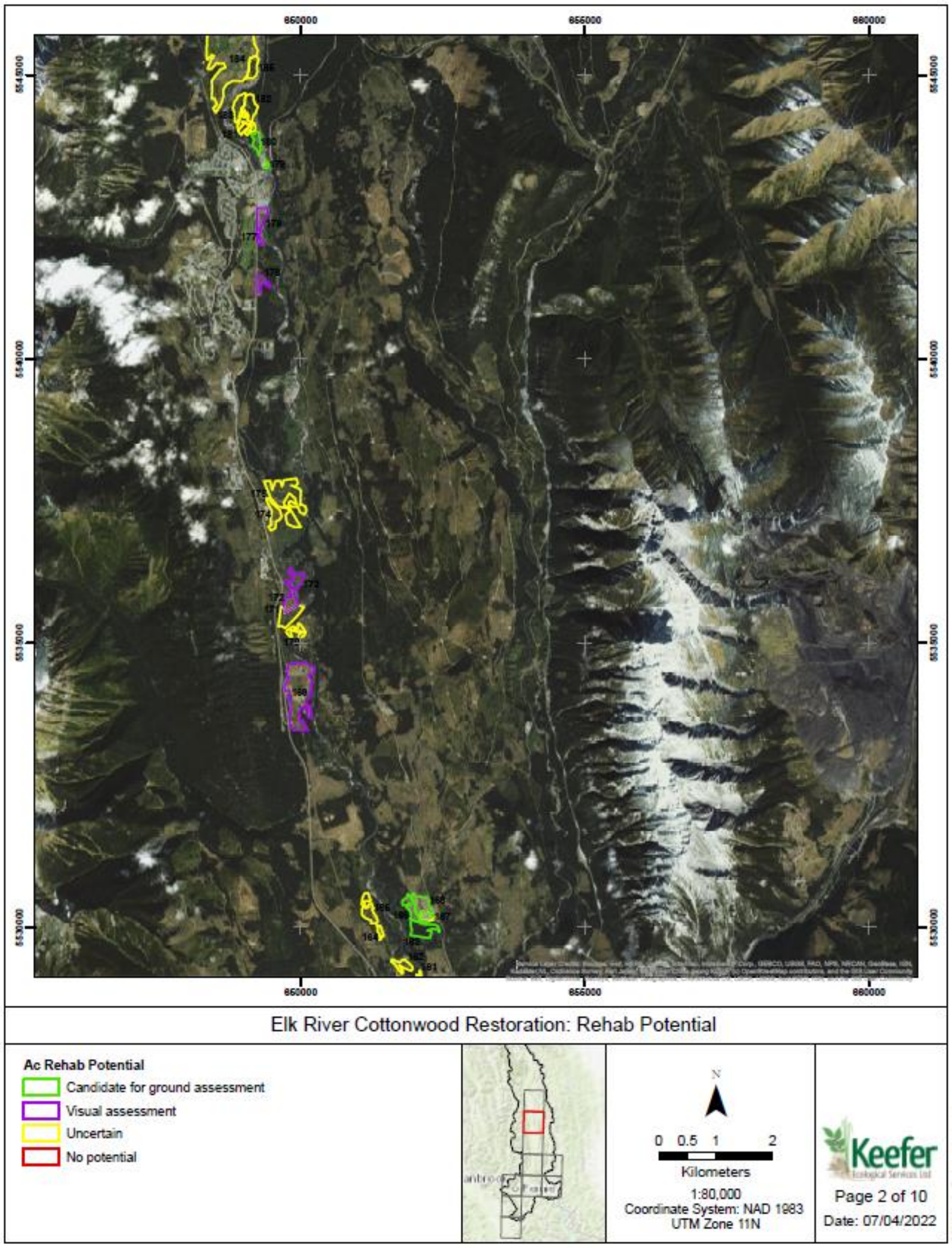


Figure 1. Example of mapping developed for site assessments. Areas were deemed accessible (candidate), visual assessment only, uncertain of access, and no potential.

## 3.0 Rehabilitation Sites

Following mapping and site assessments, three sites were selected for large-scale rehabilitation activities. These sites were chosen because:

- They are devoid of shrubs and trees resulting in decreased bank stability and experiencing some bank erosion along portions of the site (Figures 2 and 3);
- The size and accessibility of the restoration area;
- Relatively flat ground, therefore easier site preparation to conduct; and
- The landowners desire to work with ERA to improve habitat values along the Elk River.

Additional smaller sites have also been considered for restoration in future years. For the purposes of this prescription, these sites have not been included in this report. Rehabilitation site locations are shown in Figure 2 and include:

- Nature Conservancy of Canada (NCC) Morrissey Meadows;
- Nature Trust of BC (NTBC) Big Ranch Conservation Complex; and
- Private property approximately 6 km north of Elkford.

Each property will utilize restoration techniques which are detailed below. Maps and images of the sites are provided in section 6.0.

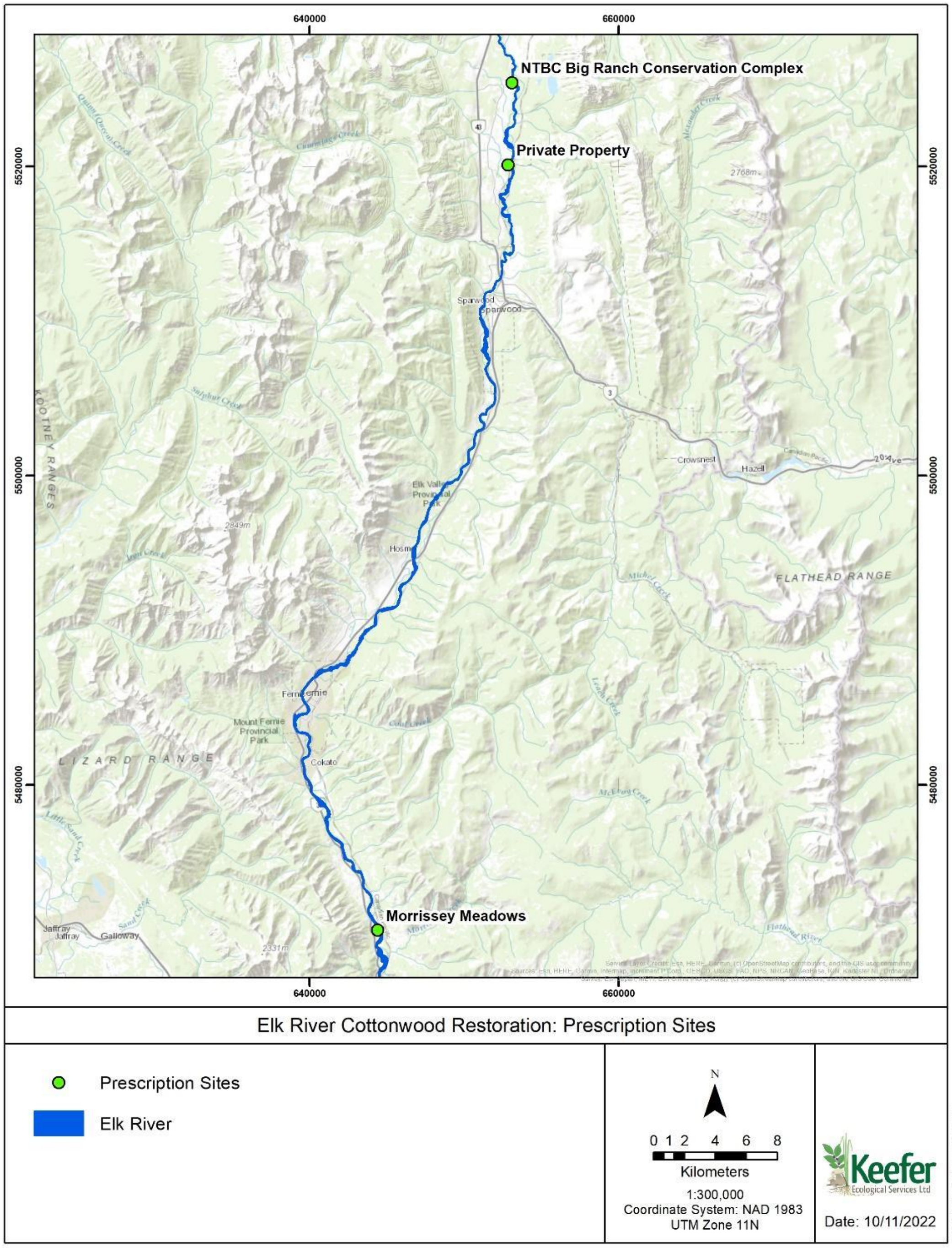


Figure 2. Elk River Cottonwood Rehabilitation Prescription Site Locations.

Figure 3. Private property site demonstrating low bank stability and exhibiting no woody vegetation and a strong need for restoration.

Figure 4. NTBC Big Ranch Conservation Complex rehabilitation site demonstrating current vegetation cover.

# 4.0 Rehabilitation Methods

The following rehabilitation methods will be used as part of an experimental treatment design. As with any ecosystem and rehabilitation work, climatic conditions will factor into the success of the treatment. Specifically for this project, identified areas of risk include:

- **Drought**. If weather conditions limit the amount of rainfall at the rehabilitation sites, there is the possibility that the live stakes and/or seedlings will not receive enough moisture to survive.
    - Extreme drought conditions may be limited through watering the live stakes and seedlings at site(s). Watering requirement will be determined annually and may be funding dependant.
- **Flood**. Extreme flooding along the Elk River has occurred in 1995 and 2013 which changed the course of the river. If extreme flooding occurs the year following rehabilitation, this has the opportunity to increase erosion further.
- **Pathogens**. The project is not resistant to insects and diseases being introduced and potentially disrupting the success of planting.

## 4.1 Live Palisades and Streamside Planting

Live palisade is a trench/row style planting technique using cottonwood live stakes[1] that aims to create a dense root network to protect the bank from future erosion (Polster, 2005; Figures 5 and 6). Using an excavator, a trench will be dug 2 – 5 m from the eroding river. Planting away from the bank allows the stream to naturally erode prior to reaching the root network. The trench will be dug down to the water table, approximately 1 m deep, however this is site specific and will be determined by digging a test hole prior to excavation[2]. The trench will be dug in the spring, during freshet, to know the maximum height of the water table. Live stakes will then be planted to capture spring moisture, with the goal that roots will follow the required moisture at the minimum water table height. Collected live stakes (collection methods and storing are discussed in section 5.0), will be approximately 3 m in length to ensure they are planted deep enough into the water table so they can draw water to thrive after planting, as well as leaving a minimum of 1 m above ground. Planting will be spaced every 50 cm to promote the formation of an underground 'fence' (Polster, 2005). Once the live stakes have been installed, the trench will be backfilled using material previously cleared. Over time, as the trees mature, the cottonwood will provide increased shade and leaf litter for the steam as well as large woody debris for habitat (Polster, 2005) and the trapping of sediments. The live palisade will not be fenced (protected) from wildlife herbivory because it will not be cost-effective and is not deemed necessary.

[1] Live stakes are portions of stems taken during the dormant season and planted directly into soil.

[2] A dig test will be performed by digging a hole with an excavator or auger until water begins flowing into the hole (maximum depth of 1.2 m). This will be left for 1 hour to allow water to fill the hole. Where the level the water settles will determine the water table depth.

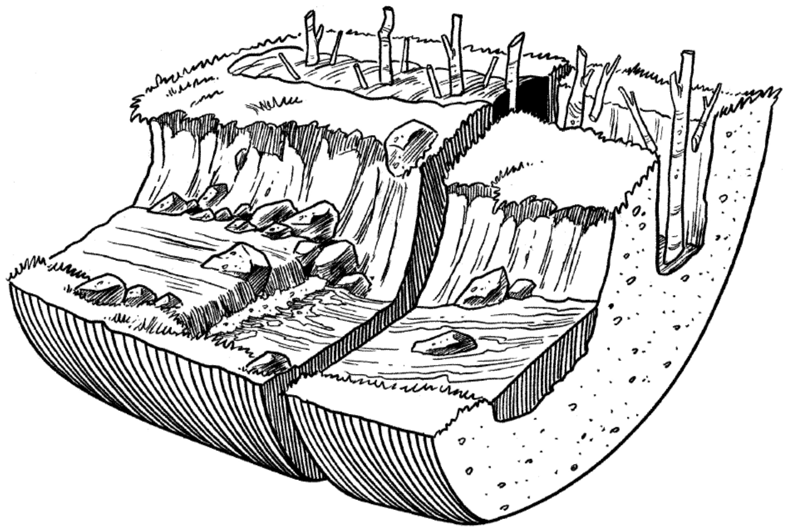

Figure 5. Example of live palisade design for streamside restoration (Polster, 2005).

Figure 6. Live palisade method used for streamside restoration. Image shows work conducted by Polster Environmental Services along the Bulkley River (Polster, 2005).

To reinforce attempts to slow erosion, additional red-osier dogwood (*Cornus sericea)* and willow (*Salix spp)* seedlings will be densely planted along the bank in front of the palisade. Species will be planted every 50cm following the length of the bank (i.e., the same length as the live palisade). Seedlings will be purchased from a local nursery and planted during the spring or fall.

## 4.2 Enclosures

Each site will have two or three enclosures (also referred to as replicates). Specific numbers are identified in section 6. Typically, enclosures will be 50 m x 100 m in size, however they will vary in size slightly depending on site location (also identified in section 6.0).

Enclosures will begin a minimum of 10 m behind the live palisade. To better understand the effects herbivory may have on rehabilitation efforts, primarily from Elk (*Cervus canadensis),* one replicate will not be fenced at each site. Replicates that will be fenced will utilize eight-foot wire fencing. This will be braced in each corner and every 8 – 12 feet. Machinery will be used to dig holes for the posts/braces. Fencing will stay for up to five years (or until the live stakes are large enough to survive browsing).

Each replicate will be divided into four even sections (25 m x 50 m). Live stakes will be planted in one half, while the remaining area will be planted with seedlings bought from a local nursery. Scarification and non scarified areas will also be within these enclosures. To increase diversity at the site(s), red-osier dogwood and willow seedlings will be planted between the cottonwood.

Figure 7 and below identify the four different treatments taking place within each replicate.

- Cottonwood live stakes
- Cottonwood live stakes and scarification
- Cottonwood seedlings
- Cottonwood seedlings & scarification


Figure 7. Rehabilitation design for all enclosures (fenced and not fenced).

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### 4.2.1 Disking and Live stakes

Site preparation will include using machinery to break up the soil (i.e., disking the soil). Disking will disturb existing soil and vegetation which is mostly comprised of agronomic grasses such as smooth brome (*Bromus inermis)* and Canada thistle (*Cirsium arvense).* This will damage the rhizomes whilst leaving the dead substrate on site. Disking will take place within certain areas of the enclosure (2 x 25 m x 50 m sections). By preparing the soil it aims to promote growth of newly planted live stakes and/or seedlings and reduce competition with the dense grass cover that is currently present at all sites.

Following disking, machinery, e.g., a small rubber tracked excavator, will be used to dig holes in preparation for planting live stakes in scarified and non-scarified areas of the enclosure. Holes will be spaced approximately every 2 m (i.e., a live stake every 4 $m^2$). One live stake will be planted at each hole. The hole will *not* be dug down to the water table to minimize ground disturbance at the site. After planting and before the holes are backfilled, one cup (~100 g) of a slow-release balanced fertilizer[3] will be added to promote growth and survival of the live stake. The fertilizer will be placed at the bottom of each hole during backfilling, so it is low in the soil and close to, but not immediately adjacent to, the stem of each plant. The fertilizer will be placed lower in the soil profile to ensure that any remaining grass roots cannot reach the fertilizer, therefore will not benefit from the nutrients that will be released.

Site preparation and live staking will take place in the spring.

### 4.2.2. Non-Disked Land, Seedlings, Additional Planting in Enclosures

Areas of land that will not receive disking will not require extensive site preparation. Cottonwood seedlings will be planted manually using a shovel. Spacing will be the same as planted live stakes (every 4 $m^2$). Teabag fertilizer packs (~10g of fertilizer) will be added for each seedling.

All additional planting of dogwood and willow species will be planted manually. These species will be spaced roughly every 1 m to supplement rehabilitation efforts.

Due to concerns of increasingly hot, dry summers over the past few years, seedling planting will take place in the fall so that seedlings are able to actively develop roots in either the fall or in the early spring of the following season to promote a higher number of seedling survival.

[3] Approximately one cup of an appropriate fertilizer will be used for each live stake. Soil samples and analysis of the 10 cm, 30 cm, and 50 cm soil profiles of each restoration site will be collected to ensure an appropriate fertilizer mix is being used.

# 5.0 Live Stake Collection, Storing & Supplemental Planting

Live stakes will be collected when cottonwood trees are dormant (i.e., spring or fall). If live stakes are collected in the spring, planting will take place approximately 2 weeks post collection. Live stakes will be kept shaded during this time and if conditions allow, they will be soaked under a sprinkler for a 24-hour period prior to planting. If collection takes place in the fall, live stakes will be stored on loose wood/matting (dunnage) to keep plants off the ground. Further, they will be covered and stored in a non-windy area to ensure they do not dry out over the winter months and early spring season. Prior to planting fall collected species, they will be soaked overnight in preparation for planting. The tops of the live stakes will be painted to identify which end needs to be planted.

If resources allow, additional live stake planting outside of the enclosure and palisade will be implemented. This will be determined on a site-by-site basis after all other prescription methods have been applied. Further, additional understorey species per the LMH 71 may be planted in future years following initial rehabilitation efforts.

# 6.0 Specific Site Prescriptions

## 6.1 NCC Morrisey Meadows

Morrissey Meadows is located approximately 14 km south-west of Fernie along the Elk River in the ICHmk4 biogeoclimatic (BGC) zone. Rehabilitation efforts will enhance previously conducted rehabilitation work at the site. There is approximately 100 m of streamside that will receive live stakes and seedlings through bank planting, live palisade, and two enclosures requiring site preparation and planting[4]. Figures 7 and 8 demonstrate the rehabilitation prescription for the Morrissey Meadows site. Due to a cattle fence approximately 30 m from the edge of the bank, one enclosure is narrower than desired. Table 1 demonstrates the length or size of each treatment method at the site and the number of live stakes for all identified species necessary for rehabilitation.

[4] This prescription outlines phase 1 of rehabilitation efforts at Morrissey Meadows. It is hoped that additional work will be conducted in the future to rehabilitate areas outside of the proposed site.

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Figure 8. NCC Morrissey Meadows Rehabilitation Area, September 2022.

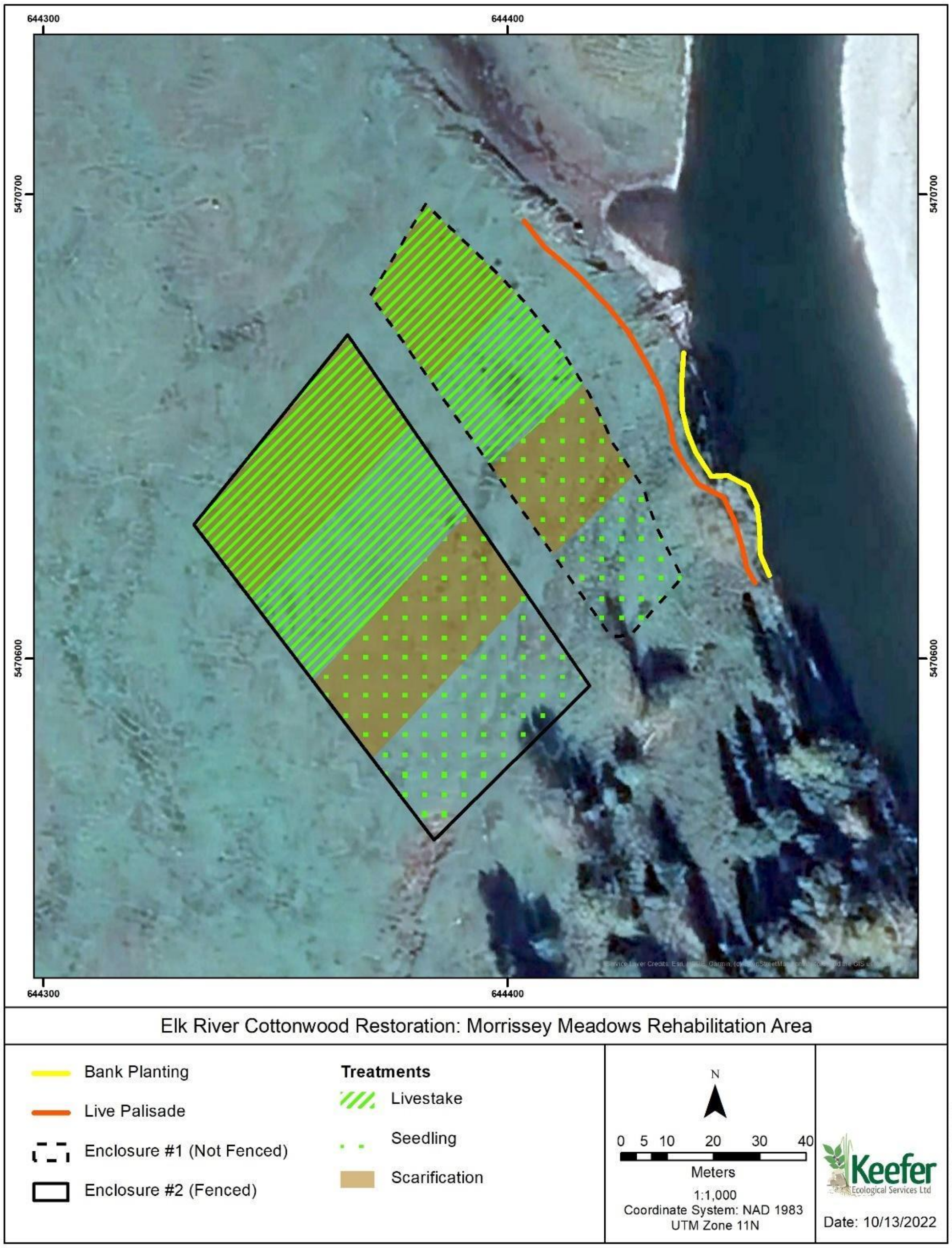


Figure 9. NCC Morrissey Meadows Rehabilitation Prescription.

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Table 1. Number of seedlings or live stakes required for Morrissey Meadows rehabilitation work.

| Method | Spacing | Planting Measurement | # cottonwood live stakes | # cottonwood seedlings | # red-osier dogwood | # willow spp |
|---|---|---|---|---|---|---|
| Bank planting | 50 cm | Length: 55 m | - | - | 55 | 55 |
| Live palisade | | Length: 55 m | 200 | - | | |
| Enclosure #1 | 4 $m^2$ | Area: 0.2 ha<br>Perimeter: 240 m | 250 | 250 | 300 | 300 |
| Enclosure #2 | | Area: 0.5 ha<br>Perimeter: 300 m | 625 | 625 | 750 | 750 |
| **Total** | | | **1075** | **875** | **1105** | **1105** |

## 6.2 NTBC Big Ranch Conservation Complex

NTBC's Big Ranch Conservation Complex is approximately 15 km north of Sparwood along Highway 43 in the MSdk1 BGC. Rehabilitation activities at the property aims to improve habitat for fish and wildlife as well as prevent erosion. There is approximately 355 m of streamside that will receive live stakes and seedlings through bank planting, live palisade, and three enclosures requiring site preparation and planting.

One long (355 m) live palisade will be created. One palisade, rather than two, will prevent the possibility of a 'nick' point within the rehabilitation project. Although the live palisade will be large, it is not expected that all the live stakes will survive, therefore maintaining gaps in the palisade for wildlife to pass through. Three enclosures of various size are planned for the site. All enclosures will follow methods discussed in section 4.2.

Figures 9 and 10 show the rehabilitation site and prescription for the property. Table 2 demonstrates the length or size of each treatment method at the site and the number of live stakes for all identified species necessary for rehabilitation.

Figure 10. NTBC Big Ranch Conservation Complex rehabilitation site.

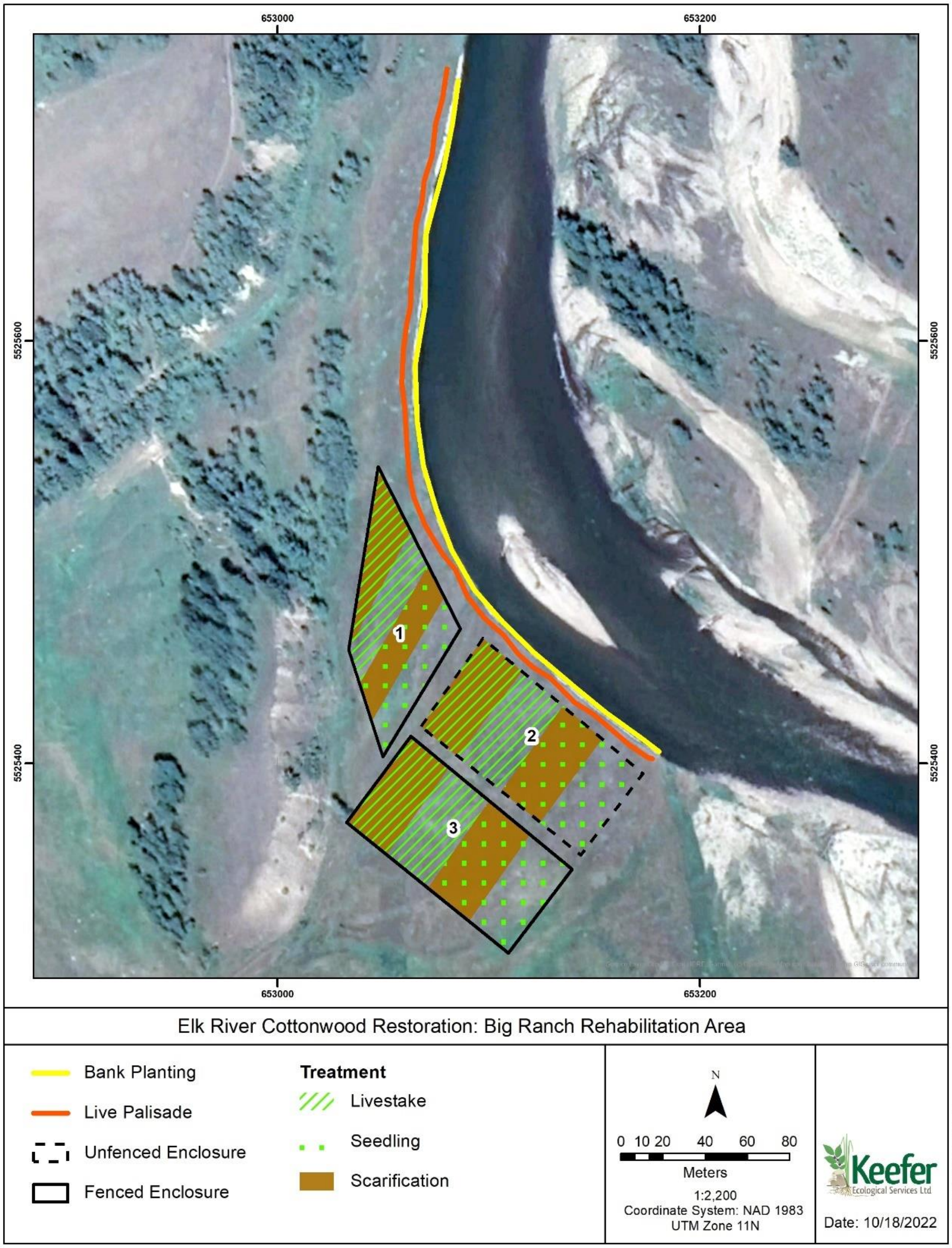


Figure 11. Rehabilitation Prescription for the Big Ranch Property.

Table 2. Number of seedlings or live stakes required for Big Ranch Conservation Complex rehabilitation work.

| Method | Spacing | Planting measurement | # cottonwood live stakes | # cottonwood seedlings | # red-osier dogwood | # willow spp |
|---|---|---|---|---|---|---|
| Bank planting | 50 cm | Length: 355 m | - | - | 355 | 355 |
| Live palisade | | Length: 355 m | 710 | - | - | - |
| Enclosure #1 | 4 $m^2$ | Area: 0.4 ha<br>Perimeter: 300 m | 500 | 500 | 600 | 600 |
| Enclosure #2 | | Area: 0.5 ha<br>Perimeter: 300 m | 625 | 625 | 750 | 750 |
| Enclosure # 3 | | Area: 0.5 ha<br>Perimeter: 300 m | 625 | 625 | 750 | 750 |
| **Total** | | | **2460** | **1750** | **2455** | **2455** |

## 6.3 Private Property

The private property proposed for rehabilitation efforts is approximately 9 km north of Sparwood along Highway 43 in the MSdk1 BGC. Rehabilitation activities at the property aims to improve habitat for fish and wildlife as well as prevent erosion. There is approximately 210 m of streamside that will receive live stakes and seedlings through bank planting, live palisade, and three enclosures requiring site preparation and planting.

Similarly to NTBC Big Ranch, one long (210 m) live palisade will be created. Two enclosures, 0.5 ha in size, are planned for the site. Both enclosures will follow methods discussed in section 4.2, and one will have fencing installed, the other will not.

Figures 12 and 13 show the rehabilitation site and prescription for the property. Figure 12 specifically demonstrates the lack of woody vegetation, thus making the area susceptible to erosion. Table 3 demonstrates the length or size of each treatment method at the site and the number of live stakes for all identified species necessary for rehabilitation.

Figure 12. Private property site for proposed rehabilitation work.

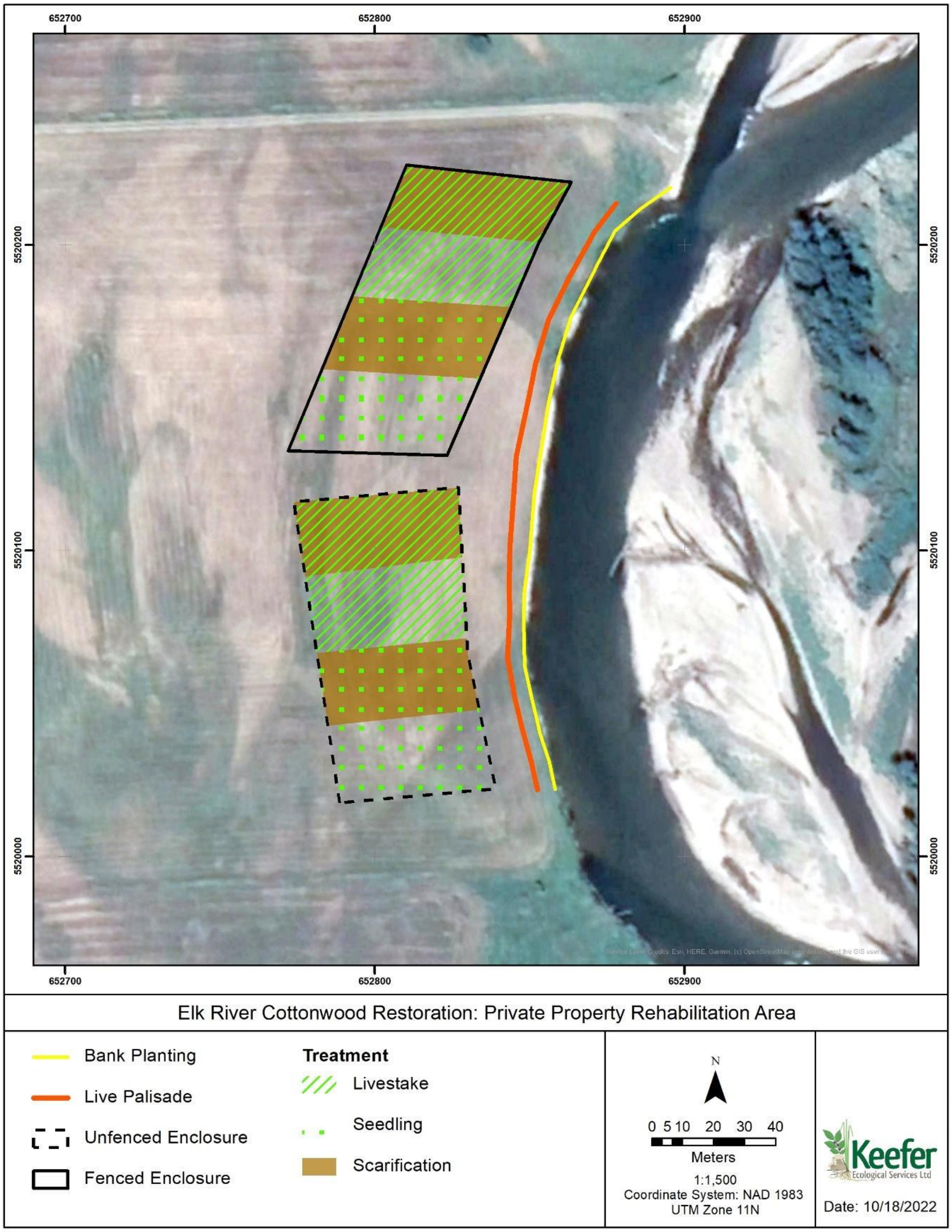


Figure 13. Private property rehabilitation prescription.

Table 3. Number of seedlings or live stakes required for the private property rehabilitation work.

| Method | Spacing | Planting measurement | # cottonwood live stakes | # cottonwood seedlings | # red-osier dogwood | # willow spp |
|---|---|---|---|---|---|---|
| Bank planting | 50 cm | Length: 210 m | - | - | 210 | 210 |
| Live palisade | | Length: 210 m | 420 | - | - | - |
| Enclosure #1 | $4\ m^2$ | Area: 0.5 ha<br>Perimeter: 300 m | 625 | 625 | 750 | 750 |
| Enclosure #2 | | 0.5 ha<br>Perimeter: 300 m | 625 | 625 | 750 | 750 |
| **Total** | | | **1670** | **1250** | **1710** | **1710** |



## 6.4 Summary

Table 4 demonstrates the total amount of live stakes, seedlings, fencing, and fertilizer that will be required for all three rehabilitation sites.

Table 4. Total number of seedlings and live stakes required for rehabilitation work on all three properties.

| Property | # cottonwood live stakes | # cottonwood seedlings | # red-osier dogwoods | # willow spp | Length of fencing | Fertilizer (kg) |
|---|---|---|---|---|---|---|
| NCC Morrissey Meadows | 1025 | 875 | 1105 | 1105 | 540 | 962.5 |
| NTBC Big Ranch Conservation Complex | 2460 | 1750 | 2455 | 2455 | 900 | 1925 |
| Private Property | 1670 | 1250 | 1710 | 1710 | 600 | 1375 |
| **Total** | **5155** | **3875** | **5270** | **5270** | **2340**[5] | **4262.5** |

[5] Additional fencing length has been added to account for fencing to wrap around corner posts.

# 7.0 Monitoring Program

## 7.1 Vegetation Monitoring

Vegetation monitoring is important to evaluate the effectiveness of restoration/rehabilitation work that has been implemented. Monitoring will also help guide project development and to provide feedback to ERA to adjust rehabilitation strategies if needed. Specifically, the monitoring program will provide an indication of any necessary adjustments in site preparation, fertilizer application, species selection or if invasive species control measures are required, and will demonstrate progress (or lack thereof) towards the goals and objectives of the rehabilitation project identified in section 1.0.

Permanent plots will be installed across the Project area to assess vegetation trajectories over time. In addition, photo plots will be used to enhance long-term monitoring measures. The number of permanent and photo monitoring plots at each site will vary due to the various size of each rehabilitation area. Proposed vegetation monitoring plots are shown in Table 5.

Table 5. Vegetation Monitoring at Rehabilitation Sites.

| **Property** | **# permanent plots** | **# photo plots** |
|---|---:|---:|
| NCC Morrissey Meadows | 8 | 3 |
| NTBC Big Ranch Conservation Complex | 12 | 4 |
| Private Property | 8 | 3 |
| **Total** | **28** | **10** |

Live palisade monitoring will utilize counting and measuring the caliper, height, and vigour of live stakes of approximately 10% of the palisade.

### *Permanent Monitoring Plots*

Vegetation plots provide numerical information on species populations and will identify trends at sites to assist with future management efforts. Linear transects 30 m in length will be installed at each treatment method (i.e., live stakes, seedlings, scarified and not, fenced and un-fenced) to gather data for ground cover, graminoid, forb and shrub components of the ecosystem. All sites are relatively flat, however if the transect is located on a slope, it will run parallel with the contour of that slope to avoid any swales. Along the length of each transect, the intercept length for each shrub or tree/live stake that touches or comes within 1 centimeter (cm) of the transect line will be recorded. Recorded information will include if the shrub or tree/live stake is alive or dead, its vigor and height.

To collect understorey data, each transect will incorporate 15 micro-plots placed uniformly along its length. A 4 $m^2$ (2 x 2 m) micro-plot will be used to estimate the cover of shrubs and trees less than 2 m tall. A 0.1 $m^2$ (20 x 50 cm) nested plot within the 4 $m^2$ plot will be used to estimate the cover of low shrubs (less than 0.5 m tall), forbs and grasses. Ground cover estimates will be observed for total vegetative cover, exposed soil, moss and lichen, rock and coarse woody debris in the 0.1 $m^2$ nested plot.

To collect tree data, tree plots will be established at the understorey transect origin. Tree caliper, height, and vigour will be collected in 5 m x 5 m plots for species over 2 m tall. Photos will be captured at each monitoring plot to capture the structure and composition of each site. Transect start and ends will be permanently marked by rebar (or similar material) for relocation purposes. Data will be collected at years 1, 3, 5, 7, and 10 at a similar time each year to accurately compare information collected. If necessary, monitoring frequency may vary depending on results.

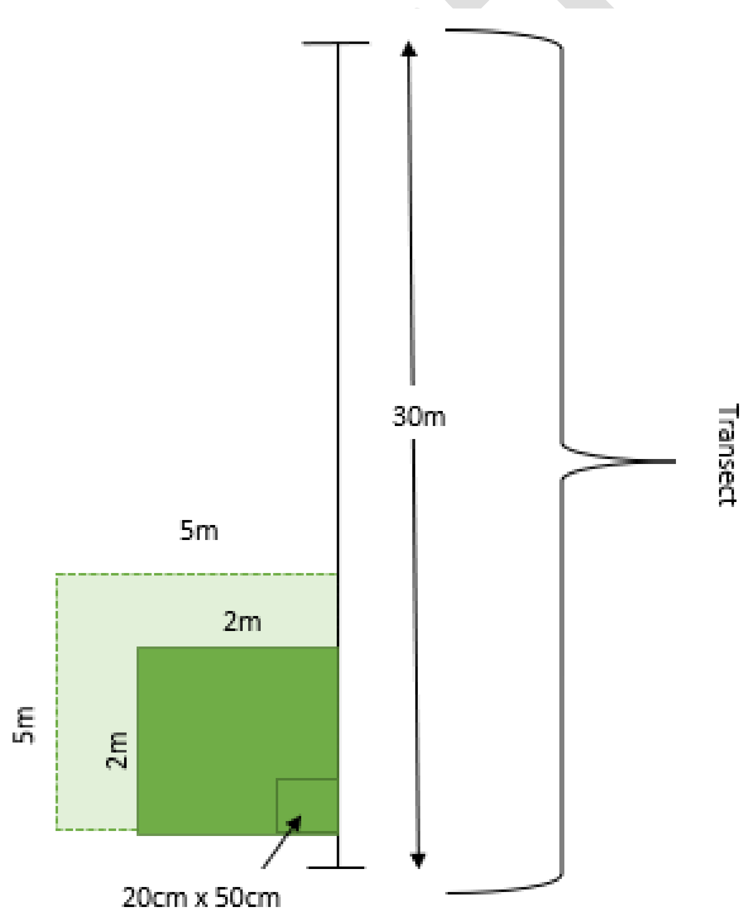


Figure 14. Example of permanent monitoring plot layout

### *Photo Monitoring Plots*

Photo plots will be installed at the south-east corner of each treatment method. Images will be collected using the Theodolite (or similar) application (e.g., AR Navigation Viewfinder, Hunter Research and Technology, LLC) on an iPhone, iPad or similar Tablet. The Theodolite application records the UTM Zone, latitude and longitude, date, time and other information on each image. Images will be taken as often as possible (i.e., each time the site is visited). This will gradually build a database overtime that can easily be referenced.

## 5.2 Stream Monitoring

### *Streambank Stability Monitoring*

Banks will be walked annually to quantitatively assess changes in stability over time. The restored banks will be broken into segments 10 m in length and 10 m in width from the top of bank. Within each segment, the following data will be collected:

- % ground cover
- % shrub cover
- % tree cover
- shoreline stability classification from "completely unstable" to "stable", based on vegetation establishment, signs of erosion, and other bank conditions (Henshaw and Booth, 2000).

Monitoring these parameters will enable us to evaluate the relationship between bank vegetation growth and erosion pattern/behaviour over time.

### *Photo Monitoring*

Photo monitoring of banks is a powerful way to visualize changes in bank stability and vegetation growth over time. Methods will be similar to those described in the vegetation photo monitoring. However, stakes will be installed at pre-determined locations to ensure accuracy, as well as recorded using GPS tracking so they can be found for subsequent use.

### *Temperature Monitoring*

Temperature loggers will be installed upstream and downstream of each site prior to rehabilitation work. Temperature loggers will be used to monitor changes in temperature regime as vegetation grows and begins to provide shade to the creek. Loggers will be installed near banks to protect from high erosive forces, but at sufficient depths as to avoid dewatering. Loggers will be installed annually after freshet and removed during the fall before freeze up. Data will be captured during the warmer summer months, when riparian shading is most important.

# References

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