EROSION & RUNOFF MITIGATION STUDY

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Final Report
February 5, 2016

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

EXECUTIVE SUMMARY

Introduction

As part of a long-term initiative to reduce loading of phosphorus to Wasi River and Callander Bay the North Bay-Mattawa Conservation Authority (NBMCA) has initiated an Erosion and Runoff Mitigation Study to develop management strategies.

Callander Bay is the municipal drinking water supply for the Town of Callander and has elevated levels of phosphorus, increasing the risk of blue-green algae blooms, which potentially produce toxins. Although it has been found that current application of phosphorus (manure/fertilizer) is quite low, high levels of phosphorus coincide with turbidity following storm events.

Phosphorus binds to soil particles which become entrained into the system through surface runoff and/or stream channel erosion. Understanding local runoff and river processes provides an opportunity to identify potential mitigation strategies for phosphorus loading.

Callander Bay is a confined bay located at the east end of Lake Nipissing, and has a subwatershed area of approximately 285 km^2. It includes portions of five municipalities: Callander, Chisholm Township, East Ferris, Powassan, and North Bay.

Several streams outlet directly into Callander Bay, with the Wistiwasing (Wasi) River being the largest and occupying the greatest portion of the Callander Bay catchment at 82% of the total area, with a drainage area of 234 km^2. Therefore, like previous studies, Wasi River and its tributaries – Chiswick Creek (19 km^2) and Graham Creek (67 km^2) - form the primary study area.

The Wasi River drains in a northwest direction, and its headwaters originate on an escarpment characterized by mixed and deciduous forest. Below the escarpment, it flows through agricultural land of the central watershed, then through the lower portion that is characterized by forest, highway, and lightly developed areas. **Table ES.1** summarizes landcover proportions for the Wasi River. Natural landscapes have the greatest proportion, followed by agricultural at 12%.

Table ES.1 Landcover areas for Wasi River (Hutchinson Environmental Sciences Ltd., 2011)

Land Use	**Wasi River**	
	Area (km^2)	Percentage
Clear Open Water	11.2	4.8%
Forest*	145.8	62.2%
Wetland**	44.6	19.0%
Grassland	2.8	1.2%
Urban	1.61	0.7%
Agriculture °	28.3	12.1%
TOTAL	234.4	100.0

* Includes all forest types (coniferous, deciduous, and mixed)
** Includes all wetland types (marsh, swamp, and fen)
° Includes golf courses and manicured lawn areas

This Erosion and Runoff Mitigation Study aims to provide a better understanding of the fluvial processes, shoreline erosion and particulate transport in surface waters and drainage features, and to recommend appropriate and feasible mitigation practices. This executive summary identifies key issues observed through desktop and field analyses.

Study Objectives

Through this project, a sub-watershed approach to understanding hydrological and geomorphological processes was followed, focusing on the Wasi River. Primarily, general issues resulting from runoff and erosion were identified, and then appropriate, cost-effective mitigation strategies were proposed. These mitigation options could be put into practice by municipalities and private landownwers alike.

Scope and Limitations
Due to the geographic extent, limited site access (i.e. permission to enter), and necessity to convey mitigation options that may be applied for a variety of situations, the project focused on identifying general trends, and representative site examples.

Unusually high water due to ground saturation and flooding created difficulty in making observations during field assessments in November of 2014, particularly within larger segments of each watercourse. For example, toe-erosion of stream banks, or bed scour could not be discerned in these cases.

The proposed mitigation options may provide typical schemes for rehabilitation, but lack detail on a site-by-site basis. These typical options can be vetted for cost, extent of intrusion, and feasibility early in the design process, prior to the detailed design and implementation phases.

Methodology
The process of evaluating runoff and erosion trends in the study area involved a review of available background information followed by a selection of reaches to facilitate a systematic assessment of channel characteristics. Reaches are manageable lengths of channel that display similarity with respect to valley setting, channel form and process, and influencing factors (e.g. land use). Reaches were then assessed through air photo interpretation and field investigations.

Erosion and Runoff Issues, and Mitigation Options
Through the background review, air photo interpretation, and field investigations, a number of erosion and runoff issues were identified. The following summarizes the findings of the assessment and the recommended mitigation strategies for each:

<u>Channelization and Confinement</u>

Issues:

- Artificial straightening and enlargement of the cross-section to enhance flood conveyance and increase the proportion of available land for human use.
- Straightening increases channel slopes, enhancing the erosive effects of prevailing flows and flood events.
- Channel confinement disconnects the main channel from its floodplain, preventing the attenuation of erosive forces and deposition on the floodplain.
- Undercut banks were observed in some channelized reaches, but difficult to discern in larger channel segments due to high water conditions. It is assumed that in-channel erosion is common throughout channelized reaches.

Opportunities:

- Natural Channel Design
    - Can range from minor upgrades and river “training” with natural features to a full design of a meandering channel with a pool-riffle sequence.
    - Recommended for previously channelized segments of Graham Creek and Chiswick Creek, within given constraints and landowner concerns.
    - Attempts should be made to reconnect the floodplain, or alternately create floodplain features within confined reaches.

Road Crossings

Issues:

- Crossings were found to be undersized relative to prevailing flow conditions, and local channel geometry.
- Crossing alignments (skew) were occasionally misaligned with the channel planform.
- The effects on flood conveyance, erosion, and deposition were evident at some locations.
- Visual evidence of erosion and deposition was obscured at many locations due to elevated water levels.
- Recently upgraded structures could have benefited from the input of a fluvial geomorphologist to enhance river processes and reduce associated risk with undersized structures.

Opportunities:

- Road Crossing Upgrades
  - First, assess all crossings (municipal/regional) throughout contributing area.
  - Structures should be sized so that erosional and depositional risk is minimized.
  - The skew should be aligned with the upstream and downstream planform geometry of the river, preferably located at straight sections.
  - Bridges should be sized to convey a design flow of a given size (i.e. pass major floods); larger crossing conveyance reduces flooding issues upstream.

Beaver Dams/Debris Jams

Issues:

- Often considered a nuisance due to their function which impedes the longitudinal passage of flow.
- Have some benefit in channelized and confined systems by reducing the overall slope and creating zones of settling.
- Localized erosion or flow diversion around the structure can occur, requiring regular monitoring.
- 55 blockages were observed during the air photo assessment.
- One beaver dam was observed during the field investigations, but did not appear to severely impede flow, nor create large zones of backwatering.
- Wooden posts of road-barriers were found to be gnawed at by beavers along Lake Nosbonsing Road.

Opportunities:

- Assess and monitor obstructions to determine whether there is risk to property, life, and/or infrastructure.
- Small debris jams can be removed with minimal disruption.
- Larger debris jams may require localized channel works to blend the upstream and downstream slopes and geometry.

Livestock Access & Lack of Vegetated Buffer

Issues:

- Access along riverbanks by cattle tends to weaken the slope and promote the sloughing of material.
- Waste can enter swales or other drainage features on pastureland and, under saturated conditions, readily move downstream into receiving watercourses.

- A lack of a vegetated buffer: vegetation can increase bank stability through root cohesion and added bank roughness, and filter runoff.

Opportunities:

- Buffer Strips
    - Planting and expanding the riparian zone along streambanks, shorelines, tributaries, and drainage swales is a relatively easy and cost effective measure to enhance water quality, reduce erosion, and increase the adsorption and absorption of pollutants.
    - Buffer strips can provide some root stability to stream banks.
    - Where space permits, buffer strips can also be created along roadside drainage ditches, however, the implications to snow removal are not known.

<u>Road/Rail Embankments, Ditches & Runoff</u>

Issues:

- Embankments tend to be comprised of relatively loose fill, though sometimes armoured with rip rap.
- Gully erosion was observed over the steep embankments, and toe-erosion within roadside ditches was evident.
    - Runoff from roads contributes to gully erosion along road embankments.
    - Gully erosion observed along the rail embankment was due to a severed connection between drainage features (i.e. no culvert connection).
- Sand/grit application in the winter is easily transported by runoff, particularly along steep roads.
- The upper catchment is naturally steep, with steep roads and ditches. As a result, the sandy ditches are rapidly eroding.
- Land clearing was evident, which can eventually enhance runoff and sediment yield, particularly in the steep upper catchment.

Opportunities:

- For features that typically remain dry such as conveyance swales and ditches, several options are available to control flow velocities and sediment movement,
    - These control features span the channel bed, and partially up the banks, pooling water upstream, allowing it to slowly trickle downstream,
    - These are not permanent options and will require regular inspection/maintenance
- Coir logs/filter socks can be placed parallel along steep slopes to reduce rill and gully erosion, and should accompany vegetation plantings on steep embankments.

<u>Golf Course</u>

Issues:

- An open space with many drainage ditches to Chiswick Creek,
- A vegetated buffer is lacking along the creek and all drainage ditches,
- Grass was regularly mowed to the edge of Chiswick Creek (in 2014) – reduces bank stability of the soft, erodible sands,
- Two bridges were found to be at risk to channel adjustment,
- There is little floodplain connectivity throughout the property,

Opportunities:

- Avoid mowing to the edge of the stream and utilize buffer strips to minimize golf activity around the watercourse. Vegetation will also provide added stability through root cohesion.
- Evaluate bridge locations and span, and look for options to relocate them across straighter, more stable sections. In active areas, bridges may need to be widened to avoid the effects of erosion.
  - Localized channel design features to protect and stabilize the banks are another option.
- In entrenched locations with little floodplain connection, banks can be re-graded with a floodplain bench.
  - Requires a loss of land, but can be incorporated into the landscape design.

<u>General Mitigation Option: Increase On-Site Storage (Ponds, rain gardens, etc.)</u>

- Flows from drains and swales can be managed with online or end-of-pipe elements like ponds or infiltration trenches.
- Hickenbottom inlets or Water and Sediment Control Basins are recommended to control soil erosion on rural lands.
- Rain gardens or vegetated swales can be constructed in and around parking lots and buildings to receive rainwater from downspouts, or runoff from paved/compact surfaces.
  - Alternately, where such vegetation treatments are not desirable or feasible, infiltration trenches may be installed.

Conclusions and Recommendations

Several issues arise from both historical and contemporary human activity in and around watercourses, for which a variety of mitigation strategies exist. Many of these options are cost effective and may be quickly implemented. The following summarizes the key results from this assessment:

1. Channel erosion is primarily limited to channelized reaches of Graham and Chiswick Creeks;
2. Channel confinement is an issue that exists naturally and artificially, containing erosive forces within the channel;
3. Lack of a riparian buffer at multiple locations and cattle access at a few sites exacerbates bank erosion and degrades water quality;
4. Most crossings are hydraulically and geomorphically undersized, creating zones of backwater upstream and channel enlargement downstream;
5. Beaver dams and debris jams can locally reduce sediment loading downstream, however they need to be assessed for erosion issues;
6. Roadside ditches along Alderdale Road and Maple Road were found to be steep and enlarging, delivering the easily erodible sands and gravels downstream; and,
7. Road runoff is delivering sediment to watercourses where buffers are non-existent, and is causing gullying on road embankments.

Based on the above conclusions, the following recommendations are suggested:

1. Further study (data gaps)
   a. Fieldwork should be updated to confirm/update the findings of this study when possible. Limitations due to high flows, and lack of landowner permissions may have masked additional erosion or runoff issues.

   b. Expand field investigations to neighbouring catchments within the Issue Contributing Area, particularly in the more developed small catchments draining to Callander Bay.
   c. Identify areas of well-connected floodplain/wetland/swamp that can be preserved and utilized to attenuate floods and promote deposition of sediment outside of the main channel(s).
2. Inventory and Monitoring
   a. Complete a channel crossing inventory and assessment.
   b. Develop a geomorphic monitoring program for channelized locations, at road crossings, in order to prioritize remediation efforts.
   c. Assess road and rail embankments adjacent to major watercourses to identify sites for remediation (e.g. gullying, failure) as these may potentially pose major risk to human populations.
   d. Monitor beaver dams and debris jams for stability, erosion, and flooding issues
3. Construction opportunities
   a. Retrofit existing municipal parking areas with rain gardens or infiltration trenches to control/treat runoff from summer storms, and meltwater from snow piles.
   b. Develop guidelines for erosion and sediment control and actively inspect and interact with contractors to highlight their importance.
   c. Implement the use of erosion and sediment control features such as coir logs or filter socks at known areas of concern including roadside ditches and steep embankments within the public right of way.

Many of the issues identified in this study result from historical modification to the landscape, and contemporary practices in design and maintenance of the area. These issues are not unique to the study area, and are of common occurrence throughout Ontario and globally. The mitigation options and recommendations provided here present opportunities to enhance the system in a progressive manner, and are in line with several practices proposed or underway elsewhere in Ontario.

Several proposed mitigation options can be implemented on a small-scale in a cost-effective manner. Larger scale efforts such as road crossing upgrades may require external funding, but with an appropriate design, such projects may be sustainable over the long-term, requiring less maintenance. Moving forward, implementing a combination of erosion and runoff mitigation strategies can have a positive basin-wide environmental effect.

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1 INTRODUCTION

As part of a long-term initiative to reduce loading of phosphorus to Wasi River and Callander Bay the North Bay-Mattawa Conservation Authority (NBMCA) has undertaken an Erosion and Runoff Mitigation Study to develop management strategies. Callander Bay is the municipal drinking water supply for the Town of Callander and has elevated levels of phosphorus, which increases the risk of blue-green algae blooms. Of specific concern is microcystin, a toxin that can be produced by a certain taxon of blue-green algae, which can have adverse effects on human and currently threatens the Town's water supply. Phosphorus levels currently exceed Provincial Water Quality Objectives. As a part of the North Bay-Mattawa Source Protection Plan (SP Plan), five municipalities within the Callander Bay Watershed need to adopt methods to reduce phosphorus loading.

The SP Plan contains policies to enhance water quality by encouraging the adoption of best management practices (BMPs) by watershed residents through stewardship and social media programs. It is therefore essential to improve our understanding of the problem of phosphorus loading and to identify potential mitigation opportunities.

Recent studies within the Callander Bay Watershed include paleolimnology of Callander Bay (AECOM, 2009), a phosphorous budget by Hutchinson Environmental Sciences Ltd. (2011), and a survey of riparian conditions (Martens, 2012). These studies found that current land application of phosphorus (manure/fertilizer) is probably quite low, but high total phosphorus levels coincide with turbidity following storm events. In addition to historical and present application of phosphorus on the land surface, land use activities near watercourses can exacerbate erosion, enhancing the mobility of phosphorus downstream through the system.

The following report aims to provide a better understanding of the fluvial processes, shoreline erosion and particulate transport in surface waters to ensure that mitigation efforts developed as part of the SP Plan are effective.

1.1 Objectives and Tasks

The objective of the Wasi-Callander Bay Erosion and Runoff Mitigation Study is to understand processes affecting water quality, particularly as it relates to overland runoff and channel erosion. Zones contributing to poor water quality will be identified and appropriate mitigation strategies will be suggested for specific locations of concern. These will be relatively low in cost, while effective over the long term. Design concepts will be provided for specific locations, which can be adapted for general application within the study area.

Additionally, as part of the SP Plan involves community involvement to encourage the implementation of BMPs, NBMCA has put forth effort to collaborate with landowners who are interested in improving water quality. Through discussions, a local advisory group chose to focus on shoreline improvement that reduces erosion and sediment transport, with an emphasis on enhancing the riparian zone with vegetation. Interested landowners have volunteered their properties for assessment, with the potential for use as pilot sites for restoration work. Five of the volunteered sites will be selected to cover a variety of situations for which detailed planting plans can be prepared to enhance the riparian zone. Residents from each property have indicated different concerns and preferences specific to their properties, including lake access, geese deterrence and maintaining lake views.

Water's Edge will also "coach" NBMCA staff on shoreline assessments (rivers and lakes) and restoration principles with a focus on low cost applications.

1.2 Study Area

Callander Bay is a confined bay located at the east end of Lake Nipissing, and has a subwatershed area of approximately 285 km^2. The study area includes portions of five municipalities: Callander, Chisholm Township, East Ferris, Powassan, and North Bay.

Several streams outlet directly into Callander Bay, with the Wistiwasing (Wasi) River being the largest and occupying the greatest portion of the Callander Bay catchment at 82% of the total area, with a drainage area of 234 km^2. Therefore, the Wasi River and its tributaries – Chiswick Creek (19 km^2) and Graham Creek (67 km^2) - are the primary focus of the fluvial assessment. Graham Creek connects directly with the main channel of the Wasi River, approximately 4 km upstream of the Astorville stream gauge, and Chiswick Creek outlets directly into Wasi Lake. Wasi Lake is a shallow lake centrally located within the Wasi River watershed and has undergone similar issues regarding phosphorus loading and algal blooms. Graham Lake is in the upper half of the Graham Creek watershed, located entirely within private property. Graham Lake is lower in nutrients and not generally subject to algal blooms.

The requirement to assess volunteered properties for potential pilot planting sites expands the shoreline study focus area to include sites outside of the Wasi River watershed, still within the Callander Bay contributing area. Most of the volunteered sites are located along shores of Callander Bay and Wasi Lake, with one site on the Wasi River, and another along Windsor Creek, South of the Town of Callander (**Figure 1.1**).

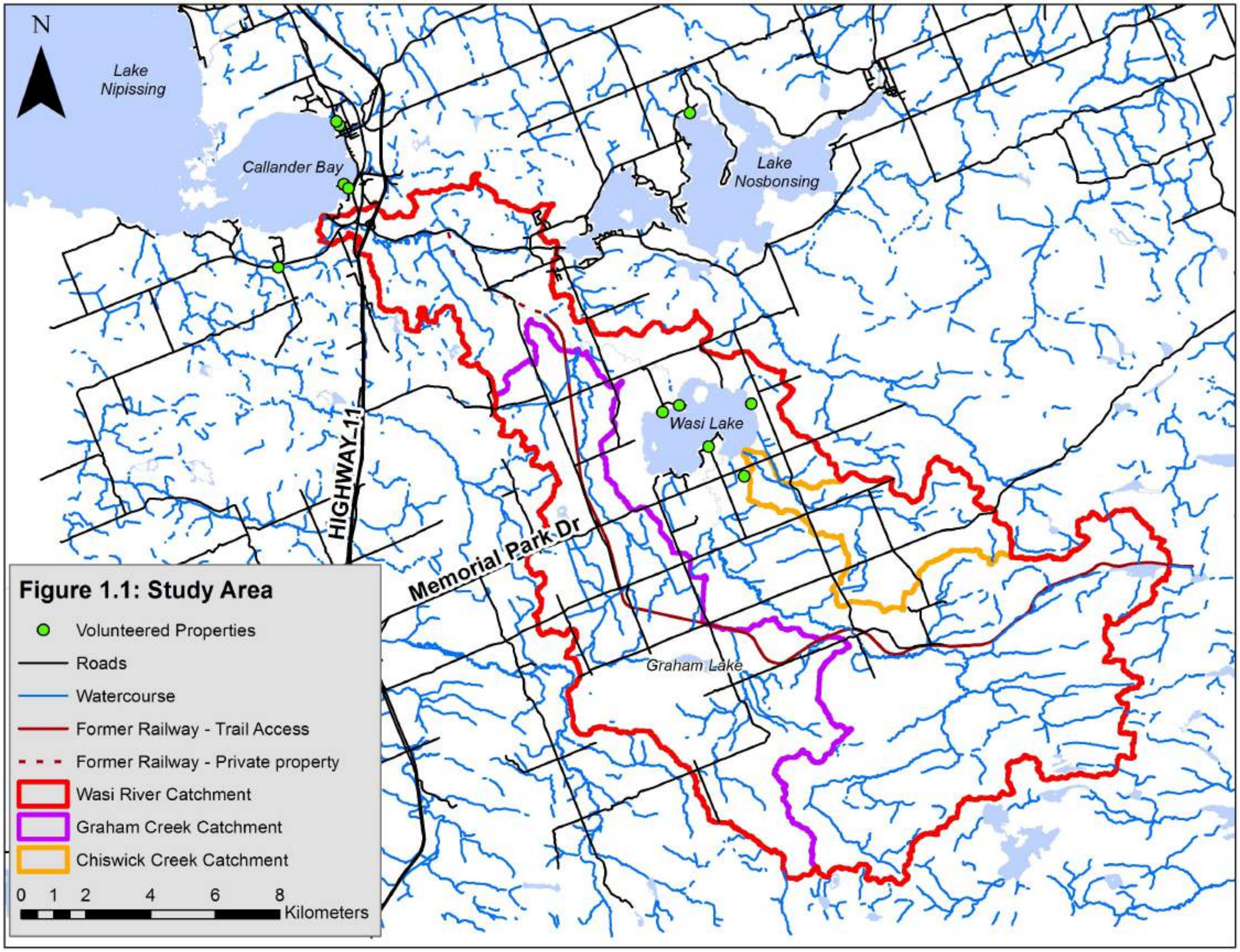


Figure 1.1: Study Area

2 DESKTOP ASSESSMENT

2.1 Background Review

Water's Edge staff completed a Background Review of the sources of information as provided by the NBMCA, and researched literature on phosphorus loading and shoreline restoration.

2.1.1 Phosphorus Loading and Sediment Supply

Phosphorus is a naturally occurring element on the land surface and within aquatic systems. It is a key nutrient to the growth of crops, plants, and algae. It naturally exists within plants/algae, and bound to soil/sediment particles and minerals. Unfortunately, human-driven industrial, urban, and agricultural activities convey excessive amounts of phosphorus to the natural environment, presenting a hazard to aquatic ecosystems and human health.

Elevated phosphorus levels stimulate the growth of both aquatic plants and algae. For the latter, this leads to the development of large blooms, directly degrading the quality of water for human and animal use. Additionally, the algal blooms indirectly impact the availability of dissolved oxygen within the system. As algae are short-lived, a dying mass of algae provides a large proportion of organic matter, which decays. Bacteria that consume this decaying mass also consume dissolved oxygen available to other organisms such as fish and invertebrates. Such detrimental effects of phosphorus create the need to understand and manage the supply from the contributing area or watershed.

The supply of phosphorus to surface water (rivers and lakes) is dependent upon the hydrological regime, atmospheric sources, land cover and land use, soil type and depth, and climate. It may also be introduced to a system through point-sources (e.g. sewage treatment plant and industrial effluent), or non-point sources (e.g. farm runoff, urban runoff, septic systems and washwater from milking centres). The latter sources are more challenging to manage as their origin is less localized, and variation in the controlling factors (e.g. landcover) adds complexity to the issue. Therefore, a suitable approach to management is to identify a specific controlling factor that can be modified to manage phosphorus in a broader spatial context.

Long term application of fertilizer to cropland is an example of non-point source phosphorus that can occupy a significant portion of a watershed. A study of the various sources of phosphorus within Southern Ontario watersheds found that 50% was supplied from runoff and erosion of cropland (OMAFRA, 2011).

Non-point source phosphorus (e.g. fertilizer) can reach surface water receptors through runoff (water erosion) and wind erosion. Both mechanisms transport particle-bound phosphorus, but runoff may also supply a dissolved load, particularly when soils are saturated or semi-frozen. Phosphorus may also occupy the subsurface water as it migrates through natural networks of pores and cracks, and drainage enhancements (e.g. tile drains). Much the same as runoff, subsurface phosphorus moves both in solution and attached to fine grained particles (e.g. clays). For cropland, the risk of phosphorous loading to surface water features becomes increased in cases where land has low infiltration rates (i.e. greater runoff), there is little protection from crop/vegetation cover, and where drains have direct connections to the surface (inlets).

Runoff and erosion are major factors contributing to phosphorus loading. Particulate phosphorus may be eroded from the seedbed and upper layers of farmland by runoff. Shear stresses imposed by sheetflow can mobilize particles, or erosional features like rills and gullies can develop where flows concentrate. Additionally, dissolved phosphorus can follow these pathways, particularly during times of saturation (e.g. storm or melt events). River channel and slope processes also supply and mobilize particle-bound phosphorus through bank/channel migration, failure of bank material (e.g. slumping), and the subsequent erosion of sloughed material. As watercourses can ultimately direct phosphorus towards a receiving waterbody, management efforts need to be developed and put into practice to reduce the supply of phosphorus to the surface water network, and further, to reduce instances of excessive erosion where possible.

2.1.2 Callander Bay and Wasi River

Background reports specific to the study area which were supplied by NBMCA, included the following:

- Wistiwasing River Management Study – Final Report (A.J. Robinson and Associates Inc., 1986)
- Wistiwasing River Management Study - Technical Report #4 Hydrology (A.J. Robinson and Associates Inc., 1986)
- Paleolimnology of Callander Bay, Lake Nipissing (AECOM, 2009)
- Callander Bay Subwatershed Phosphorus Budget (Hutchinson Environmental Sciences Ltd., 2011)
- Riparian Assessment of the Callander Bay Watershed (Martens, 2012)
- North Bay-Mattawa Source Protection Area – Assessment Report, Updates and Accompanying Documents (NBMCA, 2014)

The 1986 *River Management Study* provided general characterization of Wasi River and its tributaries, including a hydrological assessment (technical report) that addressed erosion and deposition throughout the study area.

The two main lakes within the Wasi River watershed were assessed for their hydrological impact, and in general, each lake was found to control a portion of the watershed area: Wasi Lake – 57%, and Graham Lake – 12%. Stream gradients were typically steeper in the upper reaches: 1.3% for Wasi River, 2.3% for Graham Creek, and 0.8% for Chiswick Creek. The middle stretches of Wasi River and Graham Creek show a dramatic reduction in gradient: 0.073% for Wasi River, and 0.11% for Graham Creek. Wasi River gradients then increased downstream of the Water Survey of Canada gauge at Edmond Road from 0.7% up to 3.4% at the outlet. The long profile is ultimately controlled by bedrock, and may adjust over a geologic time frame.

The hydrological assessment included 13 major structures on the Wasi River, 12 on Graham Creek, and 3 on Chiswick Creek, and identified issues pertaining to hydrology, hydraulics, and fluvial geomorphology. Several crossing structures were “improperly” designed causing flow blockage or limited flow capacity, which create potential flooding hazards, and inherently altering the erosion and deposition locally around structures.

At the time of the River Management Study, erosion was found to be localized where human activity directly intervened with the natural system. Specifically, Graham Creek was still adjusting to channelization works completed in 1980-1981, but had shown signs of re-vegetation along the banks. Erosion is of concern in this system as banks are primarily sandy and silty with low threshold values for entrainment (0.7m/s). Although vegetation can increase bank cohesion, larger flood events like the spring freshet can still erode the bank toe, undermining the vegetated bank above, causing destabilization and failure.

Several crossing structures were “improperly” designed, creating blockages (e.g. debris jams) or limiting flow capacity (e.g. undersized culvert). Such poor crossing designs create the potential for flooding hazards, and alter patterns of erosion and deposition locally around each structure.

Deposition occurs in both Wasi and Graham Lakes and along the low-gradient middle reaches of Wasi River and Graham Creek. Beaver dams were also found to cause localized water storage and sediment deposition. These lakes and beaver impoundments to a certain extent act to reduce erosive forces downstream by attenuating flood peaks lengthening the hydrograph for frequently recurring events.

The *Callander Bay Subwatershed Phosphorus Budget* (2009) prepared by Hutchinson Environmental Sciences Ltd. (HESL) provided details and recommendations regarding phosphorus loading and blue-green algae blooms in Callander Bay and Wasi Lake. They estimated that human sources accounted for 43% of the total phosphorus loading to Callander Bay and 32% of loading to Wasi Lake. They suggest that a series of “no regrets” BMPs can be implemented which will improve water quality amongst other benefits. However, despite the considerable reductions in anthropogenic phosphorus loading by BMPs, the natural phosphorus loading to Callander Bay and Wasi Lake is large enough so that these water bodies may remain relatively productive with potential for cyanobacteria blooms to occur, even if all human phosphorus sources were eliminated. Nevertheless, the implementation of BMPs to reduce phosphorus concentrations in each waterbody will *reduce the risk* of the occurrence of cyanobacteria blooms.

A recent assessment of Riparian Conditions of rivers contributing flow to Callander Bay was completed in 2012 by Tim Martens (A Sense of Place Consulting). This included Wasi River, Graham Creek, Chiswick Creek, Windsor Creek, and Burford Creek. Streams were walked, floated, and snow shoed to document sources of phosphorus, bank erosion and general riparian conditions. Sites were selected after a Google Earth review to identify obvious source locations for phosphorus (e.g. pastureland). Recommendations for each site were provided including BMPs like buffer strips to reduce erosion and limit cattle access. Photos and maps were included with this report and organized for future reference.

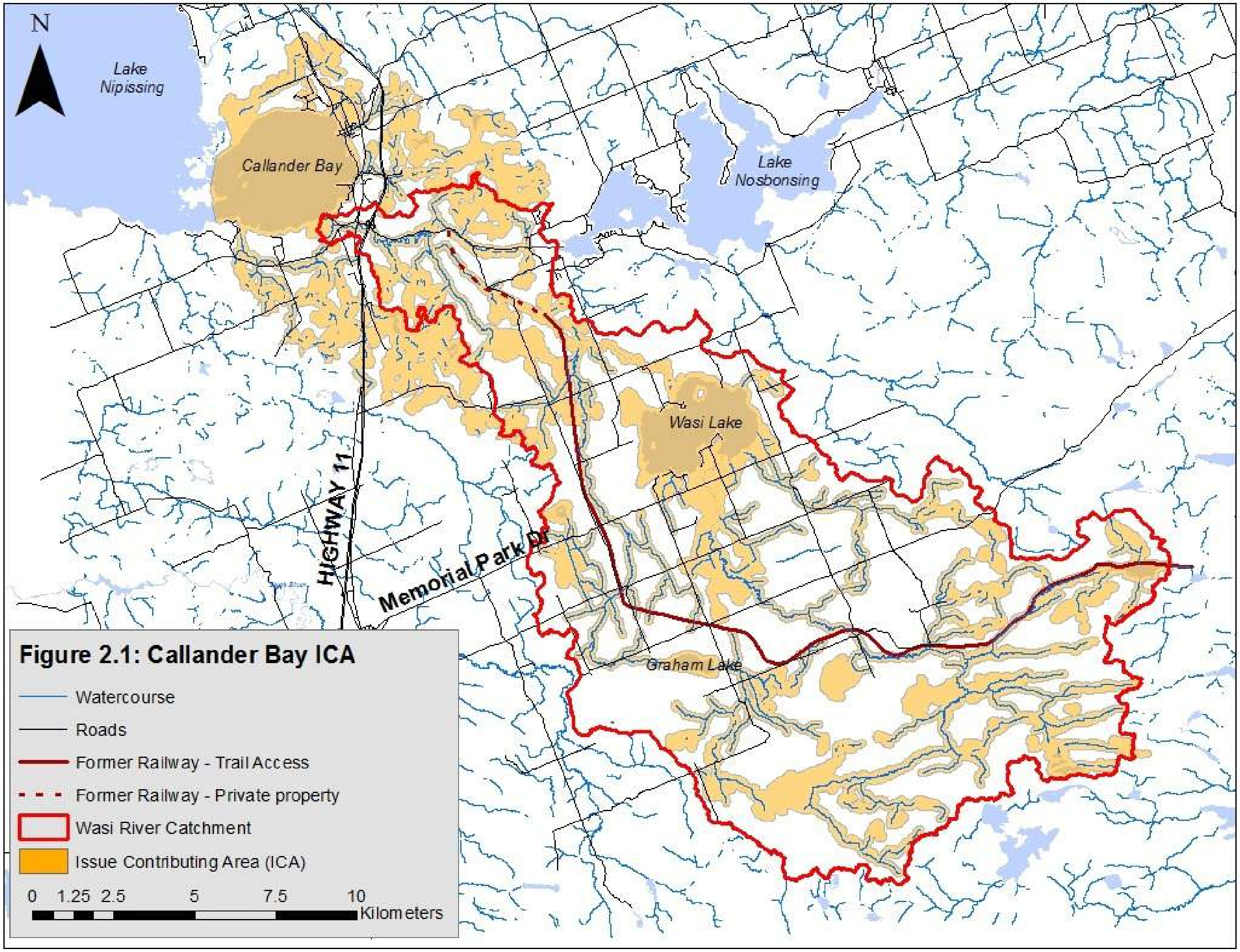
The North Bay-Mattawa Source Protection Area Assessment Report and accompanying documents presented a science-based assessment of the conditions within the North Bay-Mattawa Source Protection Area (SP Area). The purpose of Source Protection Planning is to provide the ability for communities to protect municipal drinking water supplies from overuse and contamination. Delineating vulnerable areas and identifying threats in the Assessment Report was the first step in this planning process.

The assessment report assembled data, results, and recommendations from all available reports, including those presented above. Documented occurrence of toxic blue-green algae blooms in Callander Bay was adequate evidence of exceedance in microcystin, therefore constituting a drinking water issue. As a result, any activity in the Issue Contributing Area (ICA) to Callander Bay that could deliver phosphorus is considered a threat. The ICA is the area within a 120m setback from the high water point of all watercourses which flow into Callander Bay (**Figure 2.1**).

Municipalities within the SP Area are tasked with delivering an education and outreach program to reduce phosphorus contributions to waterways. Three areas for reduction of phosphorus impacts include:

- Reduction of inputs from activities such as fertilizer and manure application;
- Reduction of inputs from historic additions of phosphorous, now bound to soil particles, by minimizing erosion, and
- Attenuation and incorporation of phosphorus already in watercourses into the biota by improving aquatic habitat for fish and organisms that feed on algae.

With the above goals in mind, and knowledge of linkages between runoff, erosion, and phosphorus supply, this fluvial assessment is necessary in understanding area and site specific processes contributing to erosion and deposition, and developing methods and plans for mitigation.


N
Lake Nipissing
Callander Bay
Lake Nosbonsing
Wasi Lake
HIGHWAY 11
Memorial Park Dr
Graham Lake
Figure 2.1: Callander Bay ICA
Watercourse
Roads
Former Railway - Trail Access
Former Railway - Private property
Wasi River Catchment
Issue Contributing Area (ICA)
0 1.25 2.5 5 7.5 10
Kilometers

2.2 Watershed Characteristics

2.2.1 Land Use and Landcover

Callander Bay has a surface area of 12.1 km^2 and is the source of drinking water for the town of Callander. Watersheds that discharge to Callander Bay include the Wasi River watershed, Greater La Vase watershed, and Windsor Creek watershed. **Table 2.1** shows the proportional land usages within the watersheds that contribute to Callander Bay.

The Wasi River drains in a Northwest direction. Its headwaters originate on an escarpment characterized by mixed and deciduous forest. Below the escarpment, it flows through agricultural land of the central watershed, then through the lower portion that is characterized by forest, highway, and lightly developed areas. **Figure 2.2** shows the land usages within the Wasi River watershed.

Four small catchments that outlet along the east and north shores of Callander Bay have been previously included in the Greater La Vase subwatershed (Hutchinson Environmental Sciences Ltd., 2011). However, the La Vase River discharges directly to Lake Nipissing, north of Callander Bay. Combined, these four small catchments cover an area of 24.0 km^2 including Cranberry and Burford Creeks, and two unnamed tributaries. The La Vase watershed originates north of Astorville and between North Bay and Callander.

The Windsor Creek watershed (25.8 km^2) originates west of Wasi Lake and east of Hwy 11 and discharges to Callander Bay along the south shoreline, to the west of the Wasi River.

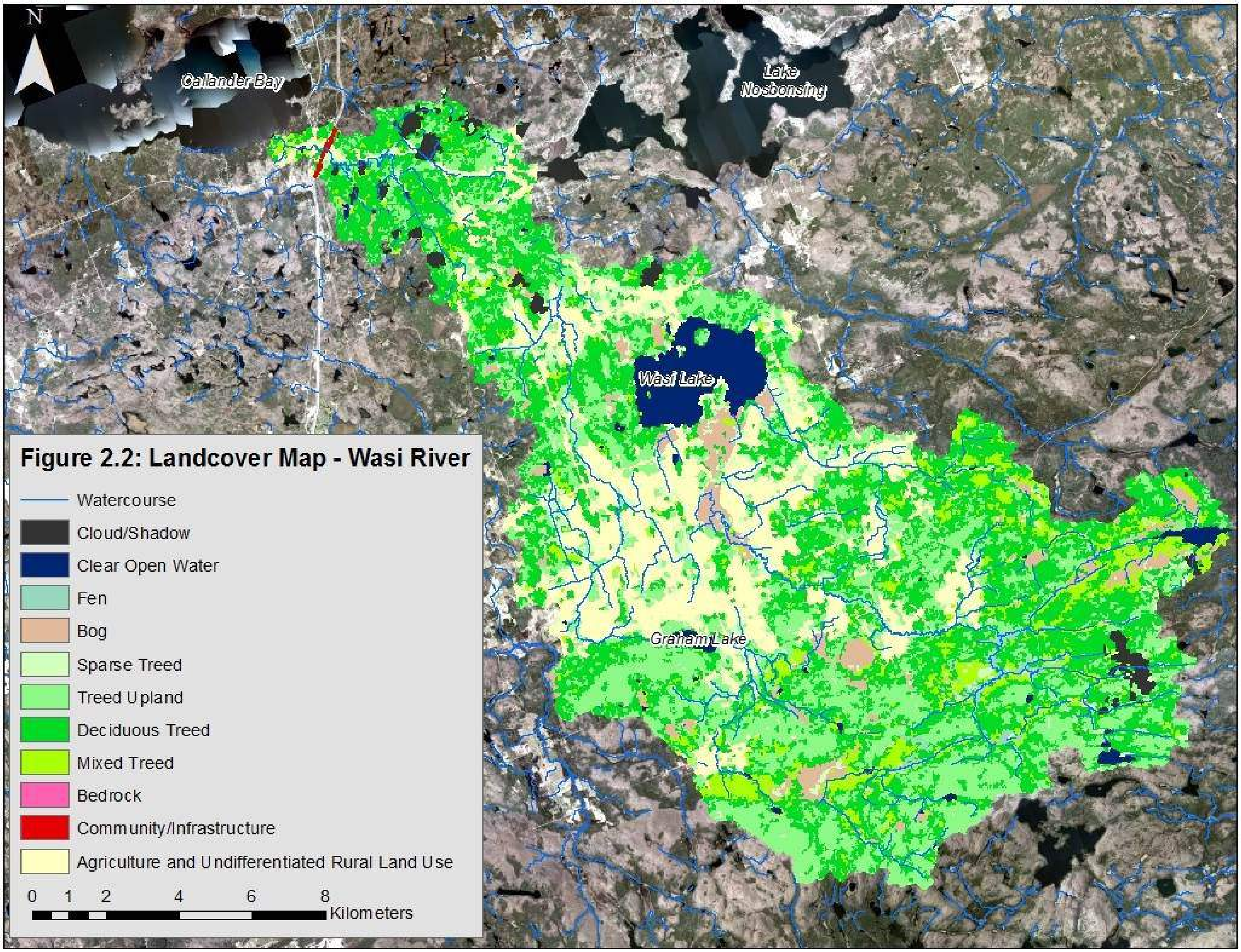
Table 2.1 Landcover areas for Wasi River, La Vase watershed (Contributing to Callander Bay), and Windsor Creek. (Adapted from Hutchinson Environmental Sciences Ltd., 2011)

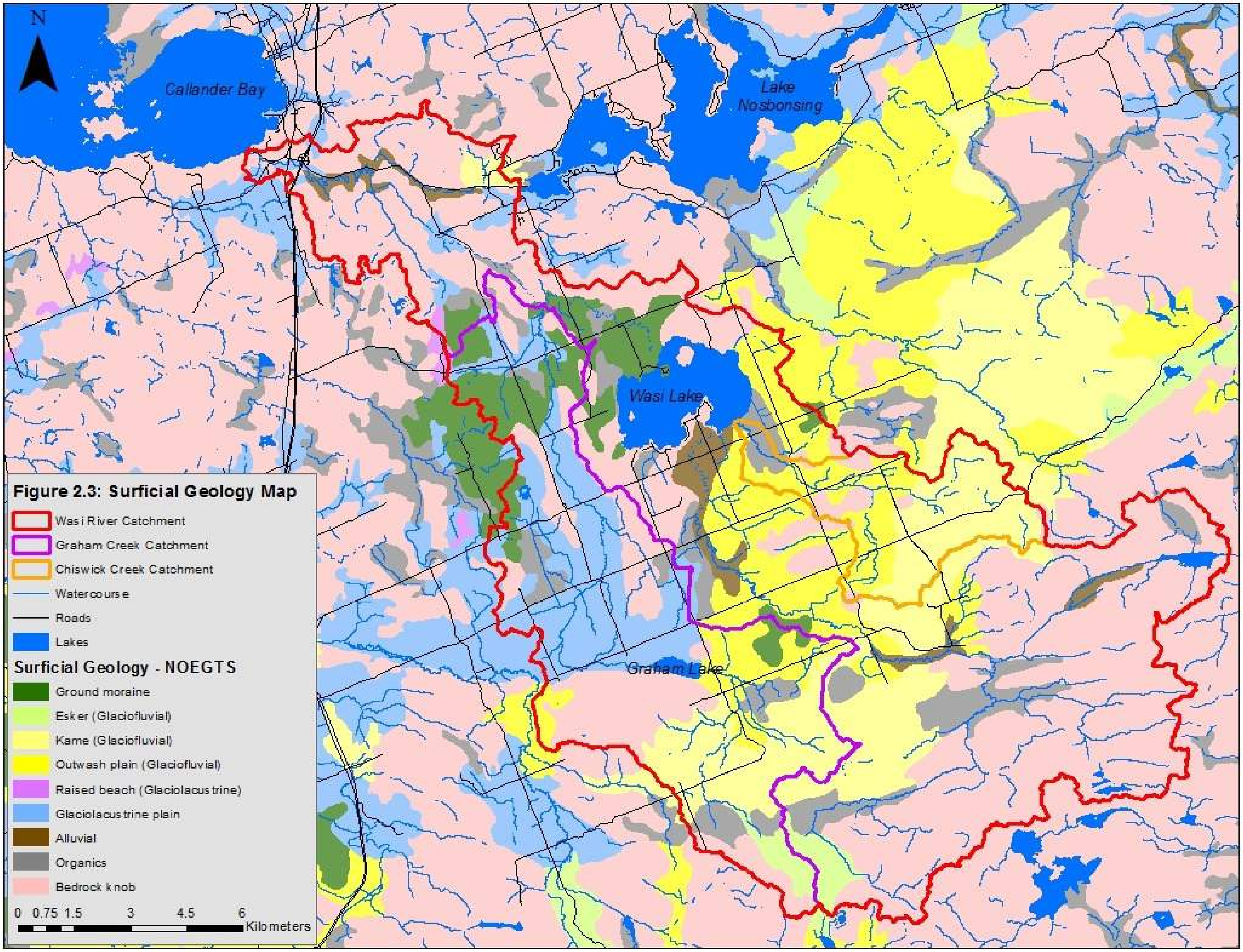
Land Use	**Wasi River**		**Greater La Vase**		**Windsor Creek**	
	Area (km^2)	Percentage	Area (km^2)	Percentage	Area (km^2)	Percentage
Clear Open Water	11.2	4.8%	1.26	5.2%	1.22	4.7%
Forest*	145.8	62.2%	10.29	42.9%	10.12	39.2%
Wetland**	44.6	19.0%	8.40	35.0%	10.33	40.0%
Grassland	2.8	1.2%	0.62	2.6%	0.77	3.0%
Urban	1.6	0.7%	1.38	5.8%	0.89	3.5%
Agriculture º	28.3	12.1%	2.05	8.5%	2.47	9.6%
TOTAL	234.3	100.0	24.0	100.0	25.8	100.0

* Includes all forest types (coniferous, deciduous, and mixed)
** Includes all wetland types (marsh, swamp, and fen)
º Includes golf courses and manicured lawn areas

2.2.2 Geology and Physiography

Reviewing the surficial materials of the study area is important in order to evaluate active channel processes. Stream channel form and sediment supply are controlled by the region's physiography and underlying surficial geology. The Wasi River watershed is situated in the northwestern part of the Grenville Province of the Canadian Precambrian Shield. The Wasi River watershed consists primarily of bedrock-drift complexes, glaciofluvial deposits, and glaciolacustrine deposits. Bedrock-drift is comprised of superficial deposits (e.g. till) over bedrock. The other physiographical land aspects that are found within the Wasi River watershed are bedrock exposures, swamp and organic deposits, and cohesive glacial till. The Graham Creek subwatershed consists of mostly glaciolacustrine deposits, and the Chiswick Creek subwatershed is primarily glaciofluvial in character (**Figure 2.3**).


N
Callander Bay
Lake Nosbonsing
Wasi Lake
Graham Lake
Figure 2.2: Landcover Map - Wasi River
Watercourse
Cloud/Shadow
Clear Open Water
Fen
Bog
Sparse Treed
Treed Upland
Deciduous Treed
Mixed Treed
Bedrock
Community/Infrastructure
Agriculture and Undifferentiated Rural Land Use
0 1 2 4 6 8
Kilometers


N
Callander Bay
Lake Nosbonsing
Wasi Lake
Graham Lake
Figure 2.3: Surficial Geology Map
Wasi River Catchment
Graham Creek Catchment
Chiswick Creek Catchment
Watercourse
Roads
Lakes
Surficial Geology - NOEGTS
Ground moraine
Esker (Glaciofluvial)
Kame (Glaciofluvial)
Outwash plain (Glaciofluvial)
Raised beach (Glaciolacustrine)
Glaciolacustrine plain
Alluvial
Organics
Bedrock knob
0 0.75 1.5 3 4.5 6
Kilometers

2.2.3 Soils

The Callander Bay watershed has a variety of soil types. The downstream end, closer to Callander Bay, is primarily composed of bedrock with some sandy loam soil. The upper portion of the watershed contains a mixture of sandy loam, sand, and organic soils, as well as bedrock. The central portion of the watershed has the greatest overburden thickness with several types of soil. Most soils found within the central watershed are sandy loam, organic, loam, silt loam with a small portion of bedrock. Coincidentally, agricultural land occupies a major proportion of the land within the central area.

2.3 Reach Delineation

Previous sections have characterized the landscape of the Callander Bay watershed, and more specifically, the Wasi River Watershed. It is evident that there is a great variation in the landscape throughout the area, which will inherently impact river form and function. In order to better characterize streams, studies tend to divide the watercourse into manageable lengths called reaches that exhibit similar form and function within their limits. Reaches have lengths from 100m up to 2000m (generally), and the limits of each reach are determined through the desktop analysis of factors such as valley setting (e.g. confined), land use, sinuosity, gradient, hydrology, and surficial geology. Reach limits may be refined during field inspections to account for substrate variability, vegetation, channel modification, backwater effects, and other characteristics that may be less obvious from mapping or aerial photography.

Each reach was delineated using available 2011 air photos provided by NBMCA. Due to the size of the study area, reaches were delineated for the main portions of each creek having defined, permanent channels. Similar planform geometry, land use, landcover, surficial geology, and the presence of hydrological inputs (tributaries) were the main factors in the reach delineation, and additionally any obvious channel modification (e.g. channelization) and road crossings. Reach limits were confirmed during field reconnaissance where observations of similar processes and substrates for example could be made.

A total of 33 reaches were delineated for the trunk channel of each system within the Wasi River Watershed: Wasi = 16, Graham = 9, and Chiswick = 8 (**Figures 2.4** through **2.6**). The decision was made to focus on the main portions of each system because most work has been completed through aerial photo interpretation over a great area, and channel visibility decreases with size. Furthermore, the project timeline does not allow for the collection of detailed data throughout the entire system. Finally, it is imperative to record observations across a range of sites of different characteristics, subject to a variety of influencing factors. Each individual site can be utilized as a representative location when guiding future mitigation strategies. For example, typical channel/shoreline treatments can be developed for a variety of sites and conditions, then used as concepts elsewhere in the Callander Bay watershed. These 33 reaches satisfy the requirement of making observations through a variety of environments.

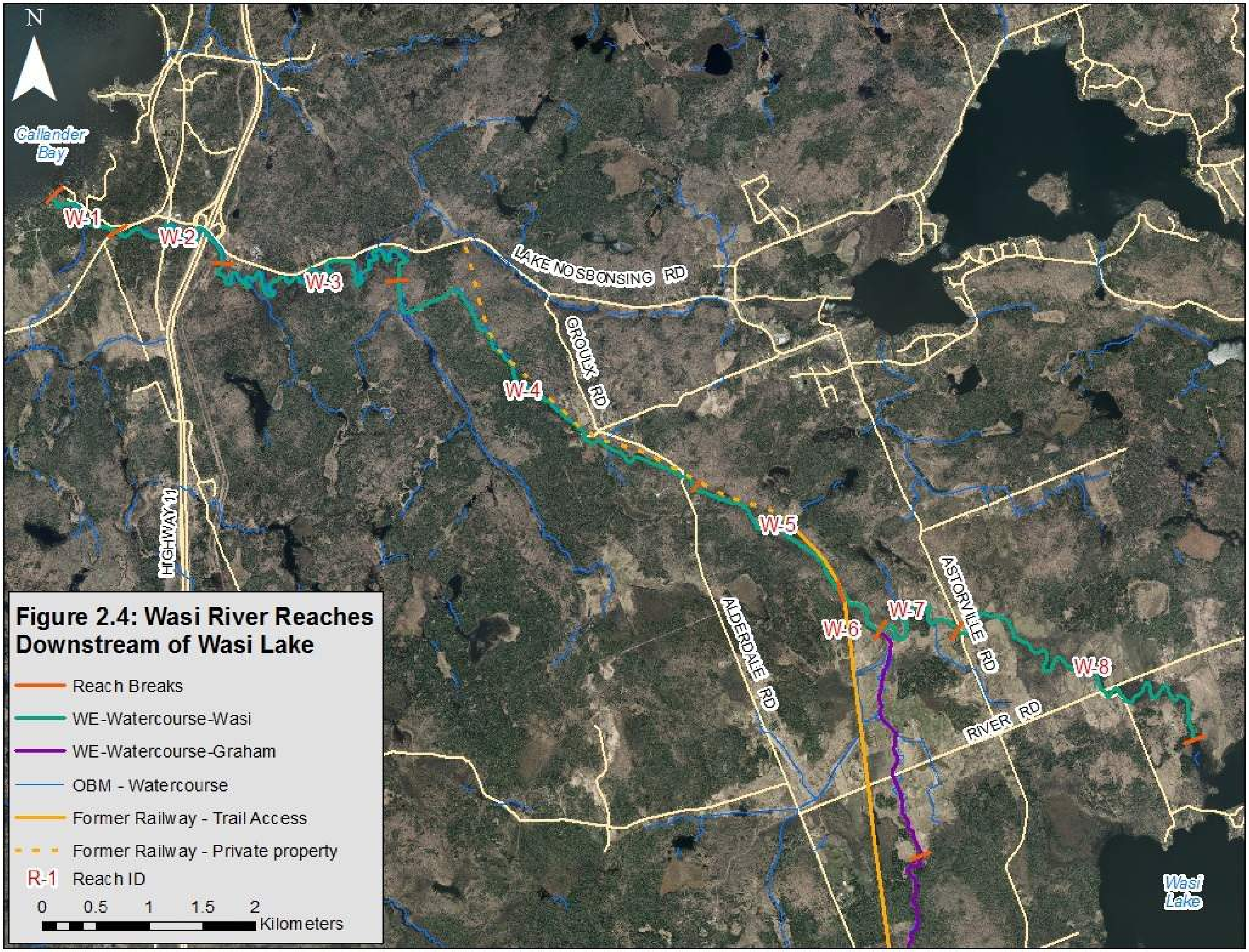


Figure 2.4: Wasi River Reaches Downstream of Wasi Lake

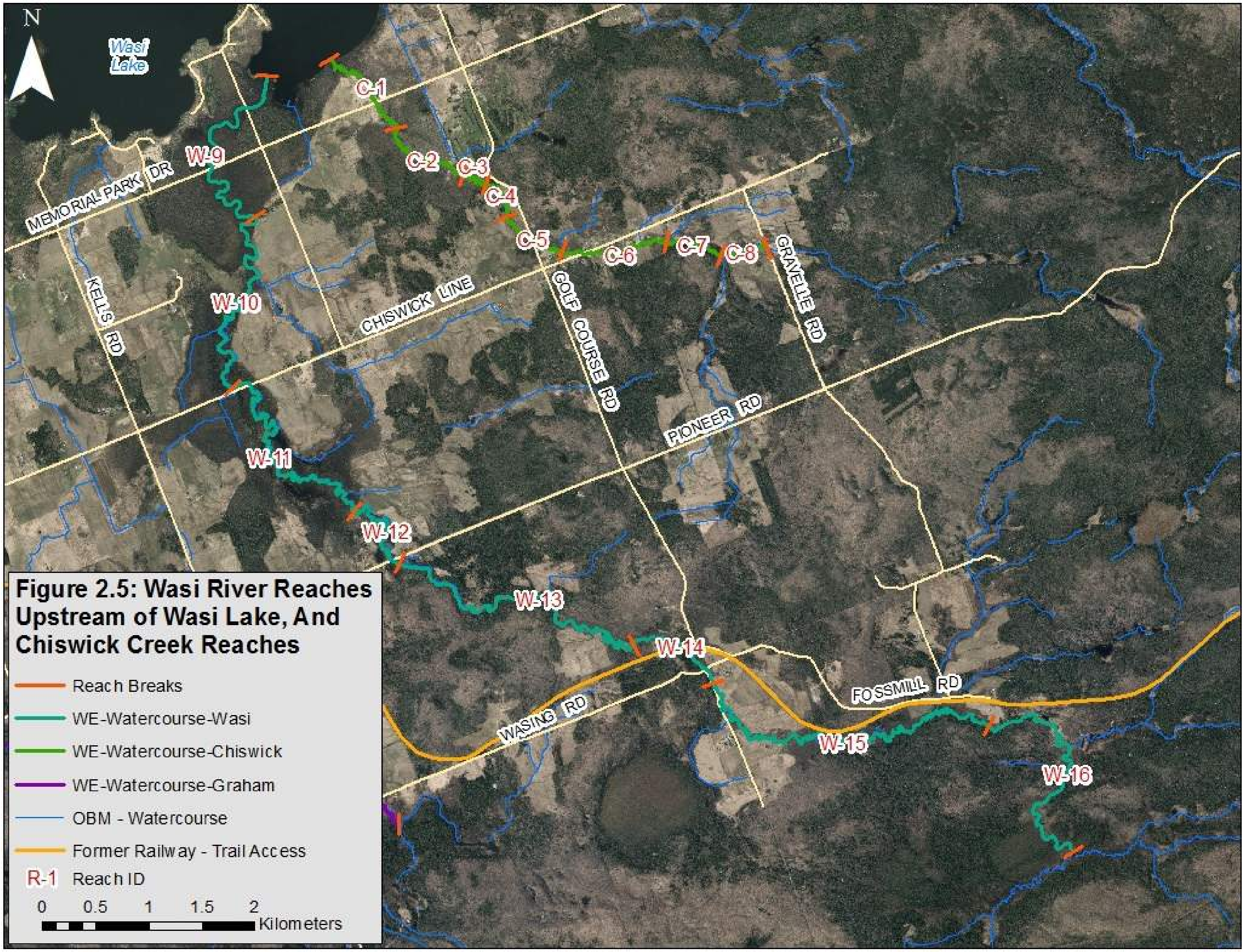


Figure 2.5: Wasi River Reaches Upstream of Wasi Lake, And Chiswick Creek Reaches

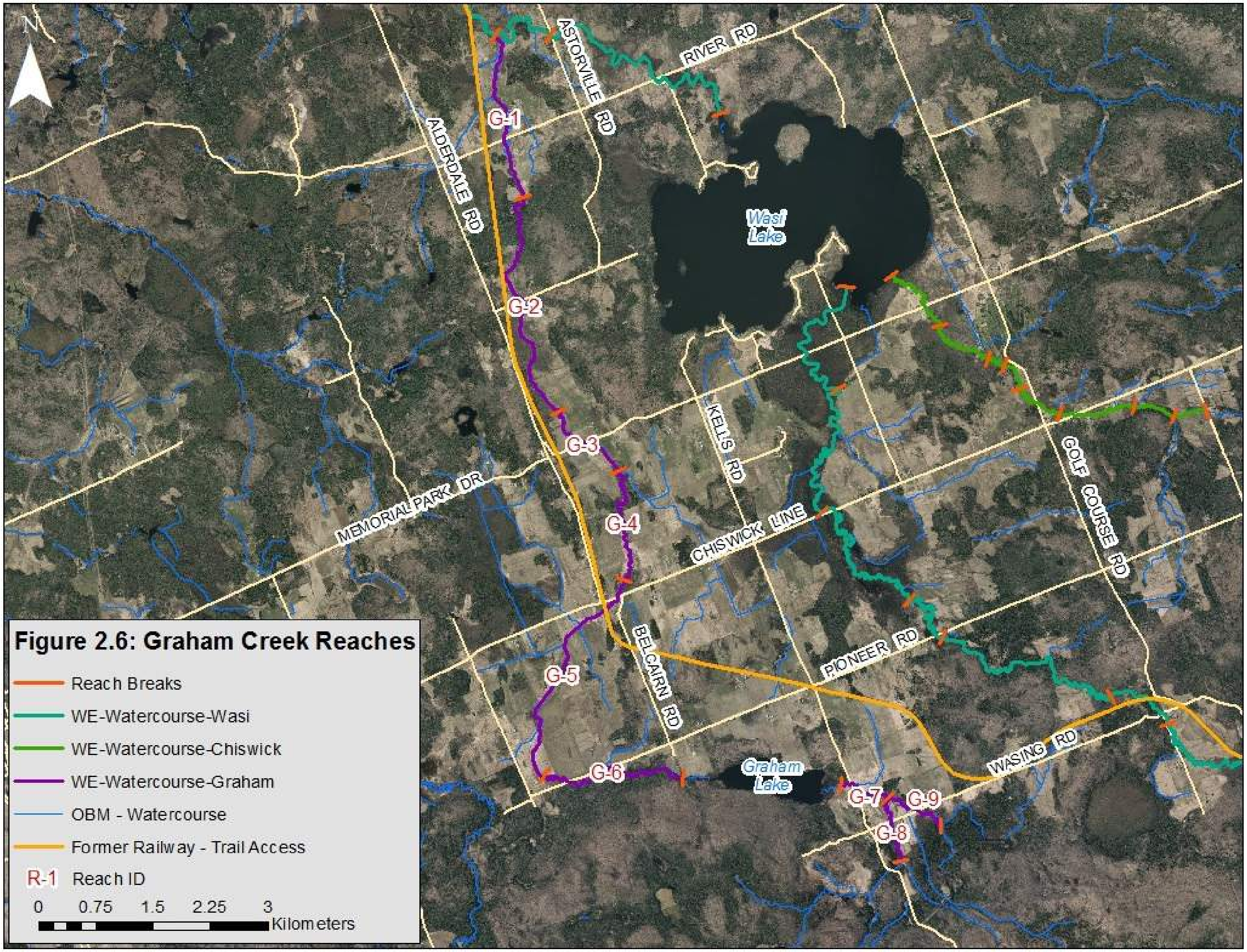


Figure 2.6: Graham Creek Reaches
Reach Breaks
WE-Watercourse-Wasi
WE-Watercourse-Chiswick
WE-Watercourse-Graham
OBM - Watercourse
Former Railway - Trail Access
R-1 Reach ID
0 0.75 1.5 2.25 3 Kilometers
N
ALDERDALE RD
ASTORVILLE RD
RIVER RD
Wasi Lake
KELLS RD
GOLF COURSE RD
MEMORIAL PARK DR
CHISWICK LINE
BELCAIRN RD
PIONEER RD
WASING RD
Graham Lake
G-1
G-2
G-3
G-4
G-5
G-6
G-7
G-8
G-9

2.3.1 Reach Characteristics from Desktop Analysis

Using a Geographic Information System (GIS), various physical characteristics of each reach was measured and calculated. A 2011 digital orthophoto for the NBMCA jurisdiction and a corresponding Digital Elevation Model (DEM) were utilized to digitize the current channel planform then calculate the length, sinuosity, and slope for each reach. Sinuosity is an index of the channel planform geometry, which is calculated by dividing the channel length by the valley length. A value of 1.0 would be indicative of a straight channel, while meandering channels tend to have values greater than 1.2. Elevations from the top and bottom of each reach were taken by finding the lowest point of the DEM along the channel centerline vector. Knowing the slope of a watercourse helps to determine the ability of the channel to convey water and sediment in a downstream direction. Additionally, slope can be used to estimate the erosive potential relative to bed and bank composition (e.g. velocity, shear, stream power). Some error is likely present in the slope calculation as the resolution between the DEM and orthophoto differ. Also, channel slopes tend to be selected for points along a profile that correspond to the same feature (e.g. riffle to riffle, or bankfull level to bankfull level). Without a long profile that contains the resolution sufficient to identify such features, it becomes difficult to accurately determine the channel slope. Some local variation of slope within a reach is likely attenuated over such large reach lengths. For example, the steep slope along a cascade or waterfall will not be as pronounced at the reach scale. If this study was more detailed, these sections would probably be treated as separate reaches. Overall, these features are located within straighter and steeper reaches, so the relative difference in slope from reach to reach will still be visible.

Tables 2.2 to **2.4** summarize measured and calculated physical parameters for each reach, with general observations of the surrounding area, and issues identified by Tim Martens during his 2012 Riparian Assessment. Throughout the entire Wasi Watershed – including Graham and Chiswick Creek reaches – sinuosity ranged from nearly straight at 1.1 to highly sinuous and meandering at 2.1. Slopes were calculated using tie-in elevations from the DEM at the upstream and downstream limits of each reach. Calculated slopes were as steep as 3% mainly due to the presence of waterfalls or cascades, and as gradual as 0% (flat), but there is possibly some error in connecting features, and perhaps a surveyed bankfull slope or riffle to riffle slope would show a greater incline. But for a relative comparison of physical characteristics between each reach, the available data and methods used are satisfactory.

Table 2.2: Wasi River - Reach Summaries

Reach	Length (m)	Sinuosity	Slope (%)	Landcover/Environment	Surficial Geology	Tim Martens (2012 Comments)	Water's Edge Comments
W-1	801	1.1	3.00	Forest	Bedrock		Multi thread around islands
W-2	1535	1.3	0.04	Forest/Former Agriculture/Urban/Transporation	Glacioacustrine	Undercut banks, "oily odour" seepage under Hwy 11	Backwater from W-1. Some plantings between Callander Bay Dr and Hwy 11. Boulder rip rap stabilizes channel banks at roads.
W-3	4274	2.0	0.15	Forest/Transportation/Road/Wetland	Alluvial	Some undercut banks	Meandering channel through floodplain, meander cutoffs evident. Cutbank contact with road.
W-4	4051	1.1	0.57	Forest/Rail Embankment/Agriculture/Road/Transportation	Bedrock/Glaciolacustrine	Banks natural, good tree cover. Significant rapids. Much of river follows abandoned rail embankment. Upstream Edmond Street, cattle grazing in woodlot. Cattail marsh buffers runoff.	Straight, numerous rapids, and backwater zones.
W-5	1966	1.2	0.13	Wetland/Forest/Transportation	Organics		Contacts former railway embankment. Good floodplain access.
W-6	610	1.2	0.08	Forest	Bedrock		Appears channelized.
W-7	1447	2.0	0.19	Forest/Agriculture	Ground Moraine	Erosion at small bridge	
W-8	3931	1.5	0.10	Agriculture/Forest	Ground Moraine/Organics		Road crossing skew out of line with channel planform. Rapids and backwater. Good floodplain access. River Road appears to constrict flow.
W-9	2619	1.8	0.04	Forested Wetland	Alluvial		Sinuous, wet. Slow moving water. Wetland, good floodplain connection.
W-10	2784	1.7	0.00	Forested Wetland	Alluvial	Grazing along banks and erosion along left (west) bank.	Sinuous, few cutbanks. Wetland, good floodplain connection.
W-11	3194	2.0	0.02	Forested Wetland	Alluvial		Sinuous, Wetland.
W-12	1485	2.1	0.05	Forest/Agriculture	Glaciofluvial		Sinuous, Wetland, Agricultural.
W-13	3665	1.5	1.01	Forest/Agriculture	Glaciofluvial		Sinuous, Agricultural, Forested
W-14	1097	1.1	0.79	Forest/Transportation	Glaciofluvial		Relatively straight.
W-15	4935	1.6	0.08	Forest/Agriculture/Transportation	Alluvial	Some areas fenced to cattle, others not. Manure application observed during site visits	Sinuous, meandering through floodplain. Cutoffs evident.
W-16	2991	1.5	0.03	Forest/Wetland	Glaciofluvial/Organics		Straighter than W-15, wide pools. Possible beaver dam, or rock riffle causing backwatering.

Table 2.3: Graham Creek - Reach Summaries

Reach	Length (m)	Sinuosity	Slope (%)	Landcover/Environment	Surficial Geology	Tim Martens (2012 Comments)	Water's Edge Comments
G-1	2322.41	1.07	0.26	Agriculture	Ground Moraine/Glaciolacustrine	Steep eroding banks, no buffer. Cattle access at downstream end	Straightened/channelized. Cross-section oversized, channel entrenched. Minimal/no buffer in sections
G-2	3454.36	1.24	0.07	Forest/Transportation	Glaciolacustrine	Parts of channel undefined through forest. Erosion around beaver dam. Upstream Grahamville, cattle graze to top of bank. Downstream fencing restricts horses.	Beaver dams/backwatering. Minimal/no buffer in sections.
G-3	1320.54	1.41	0.05	Agriculture	Glaciolacustrine	Erosion from cattle grazing, tile drainage	Minimal/no buffer in sections. Portions relocated in the past.
G-4	1945.58	1.34	0.17	Agriculture/Forest	Glaciolacustrine	Tile drain, beaver dam, cattle access, erosion	Some bar development. Bank erosion. Beaver dams, or debris jams. Minimal to no buffer in sections.
G-5	3265.7	1.09	0.12	Agriculture/Transportation	Glaciolacustrine	Channelization, some tributaries have cattle access. Some bank erosion.	Channelized. Constriction at Chiswick Line also at private crossings. Former channel evident on floodplain.
G-6	2725.8	1.51	0.16	Agriculture/Forest/Transportation	Glaciolacustrine		Sinuous, meandering through floodplain. Some close contact with Pioneer Road. Straighter through woodlot.
G-7	826.23	1.28	0.12	Agriculture	Glaciofluvial		Little to no buffer. Sinuous. Banks appear soft.
G-8	1240.86	1.46	0.30	Agriculture/Forest	Glaciofluvial		Sinuous. Little to no buffer downstream of Wasing Road.
G-9	1017.19	1.29	0.10	Agriculture/Wetland Forest	Glaciofluvial/Organics		Wet, multi channel. Poorly defined banks.

Table 2.4: Chiswick Creek - Reach Summaries							
Reach	**Length (m)**	**Sinuosity**	**Slope (%)**	**Landcover/Environment**	**Surficial Geology**	**Tim Martens (2012 Comments)**	**Water's Edge Comments**
C-1	1362.5	1.46	0.05	Agriculture/Wetland Forest	Organics/Glaciofluvial		Sinuous. Wetland, agricultural. Poorly defined banks.
C-2	1134.87	1.43	0.21	Wetland/Forest	Organics		Sinuous, wetland forest.
C-3	473.53	2.06	0.14	Forest/Golf Course	Organics	Golf course mowed to edge of water	Sinuous. Golf course mowed to edge. Banks appear to be migrating.
C-4	493.27	1.18	1.08	Forest/Agriculture	Glaciofluvial	Series of cascades	Relatively straight, thick canopy causes some obstruction.
C-5	881.57	1.40	0.74	Agriculture/Forest	Glaciofluvial		Poorly defined banks. Wet. Some bank erosion. Constriction at Golf Course Rd. Depositional features through woodlot upstream of culvert.
C-6	1266.1	1.26	0.48	Agriculture	Glaciofluvial		Straight/channelized (downstream Chiswick),sinuous upstream. Some fencing. Possible grazing. Very small buffer (minimal). Former channel evident 70m to the north. Makes right angle turn into culvert upstream of Chiswick Line. Cutbank erosion/migration.
C-7	669.06	1.21	0.35	Agriculture/Forest	Glaciofluvial/Bedrock		Poorly defined banks. Wet. Multiple threads. Relatively straight along bedrock contact.
C-8	453.15	1.04	0.64	Agriculture	Glaciofluvial		Cutoff channel, former meandering channel still on floodplain, Cattle access.

2.3.1 Erosion and Runoff Related Issues

Through the background review and photo interpretation, some erosion and runoff issues are identifiable. High water was an issue with the available photography and obscures channel processes like bank erosion that may become visible as flooding attenuates. Therefore, some issues presented below were translated from the 2012 Riparian Assessment with the assumption that the same issues remain in 2014.

Channelization/Straightening and Confinement

The act of artificially straightening a channel and defining the cross-sectional geometry to either convey floodwater downstream efficiently, and/or to make land available for human activity is referred to as “channelization”. This can result in significant reductions in channel length from a few hundred metres up to several kilometres, which increases the channel slope. Floodplain access is removed as larger flows are contained within the channelized cross-section. Thus, flow velocities tend to increase, and erosive forces are either translated downstream or focused within the channel under a range of flows – depending on the level of bank protection and grade control. This tends to create a greater risk of bank and bed erosion as the shear forces are expended within the channel, and as the channel tries to re-meander and develop a floodplain. Streams with limited or no floodplain access are referred to as being *confined*.

Graham Creek has the highest proportion of suitable agricultural land and to (presumably) maximize available land for farming/grazing, while minimizing flooding, the stream has undergone channelization though several reaches. According to the *Wistiwasing River Management Study Technical Report #4: Hydrology (1986)* channelization works took place in 1980 and 1981. Although there was not explicit documentation on the extent of the work completed at present, many photographs from the report reflect channelization at sites throughout. 2011 imagery reveals almost continuous channelization from the confluence with Wasi River to areas upstream of Graham Lake. Differences in the meander pattern, the presence of meander scars, and the lack of overhanging vegetation within a narrow corridor were used to observe the extent of channelization (**Figure 2.7**). Significant channelization and relocation was also completed for stretches of Chiswick Creek (**Figure 2.8**).

Channel confinement can occur elsewhere either naturally (e.g. incised valley, bedrock contacts) or artificially (e.g. rail/road embankment, bank hardening), and can have similar impacts locally and downstream. Throughout the rest of the watershed, there are confined portions along the former rail embankment, Highway 11, within the vicinity of road crossings, and along some portions where rip rap protection has been applied to stabilize the slope. Natural confinement is less obvious from the air photos.

Bank erosion was noted at various locations throughout channelized sections of Graham Creek in the 2012 Riparian Assessment. The aerial photography shows some locations of potential bank erosion along the outer bends in Reach W-3 adjacent to Lake Nosbonsing Road.

In addition to the effects of channelization on stream erosion, overland flow, tributary and drain or outfall connections can cause rill and gully erosion along the banks. Typically, the channelized cross section is designed with 2:1 (h:v) side slopes with flow inputs travelling over this slope to the main channel. If protection is not applied, rills and gullies can form along the bank, and at specific discharge locations like tributaries or drains, gully erosion can become a risk, particularly if an outfall channel is not designed with proper stone protection (e.g. rip rap channel). If left unattended, these channels will continue to incise until a more stable slope is attained. **Figure 2.9** contains an example of this issue where a roadside ditch joins a channelized portion of Graham Creek, and has undergone some natural adjustment at the downstream end. The area circled in **Figure 2.9** shows two small meander bends, and a tendency to laterally adjust from a presumably straight ditch alignment when originally constructed.

Crossings
Throughout the entire study area, numerous stream crossings of various types, sizes, and uses exist, from large highway bridges with piers to small farm crossings comprised of fill and corrugated steel pipe (CSP). Ideally, bridges should be sized with an appropriate span and elevation as to minimize impacts on the passage of water and sediment, and to reduce the risk of undermining and bank scour. Their geometry in relation to the existing planform is best when crossing the channel at a right angle, preferably in a straighter and more stable location. If possible, a bridge should be constructed to allow for channel and bank migration to occur without threatening the structural integrity and function, or neighbouring properties.

Two issues that were evident from the desktop assessment were the presence of undersized crossing spans, and poorly skewed crossing geometry relative to the existing planform. An undersized (narrow) crossing acts as a constriction to water and material, and can result in flooding upstream, while flow expansion downstream can cause bank and bed scour (**Figure 2.10**). Similarly, a crossing skew that is not in line with the existing planform can create flooding, erosion, and sedimentation problems, particularly scour issues around the structure (**Figure 2.11**).

Beaver Dams/Debris Jams
In-channel blockages such as debris jams and beaver dams can have some natural benefit in systems that suffer from incision and confinement. These create localized zones of backwatering that can often impact streams for several kilometres depending on the height of the impediment and overall channel gradient. In systems, such as the Wasi River that have high, fine sediment loads, these localized sediment sinks can provide benefit by retaining particles and pollutants. However, monitoring of beaver dams and debris jams is necessary to ensure that they are not causing excessive flooding or exacerbating bank erosion around and downstream of the structure. In total, 55 beaver dams and debris jams were identified within the Chiswick Creek, Graham Creek and Wasi River Catchments, with all but one located upstream of the confluence between Graham Creek and Wasi River (**Figure 2.12**). It is possible that more debris jams or beaver dams exist, but may be obscured in the imagery due to tree cover or high water levels.

Livestock Access
Certain locations through Graham Creek, Chiswick Creek, and Wasi River (upstream of Wasi Lake) had open fields for grazing with cattle access to the watercourse (**Figure 2.13**). The 2012 Riparian Assessment also found locations where there was grazing through a forest on the lower sections of Wasi River, and certain smaller tributaries in the upper reaches that cattle were crossing. Cattle movement along and down streambanks weakens the structural integrity and material can become dislodged. Direct discharge of waste is also probable in these situations. The 2012 Riparian Assessment recommended locations which should be fenced-off from cattle.

Lack of Vegetated Buffer
Sites of cattle access described above are a few of the locations where a vegetative buffer was non-existent. In addition to fencing, thick vegetation may prevent cattle access, while also controlling runoff and sediment supply from the surface. Vegetation also plays an important role in bank stability through root cohesion, bank roughness, and habitat enhancement. Vegetative buffers were minimal or not present at several sites throughout the study area sometimes up to kilometers in length, including portions of the main channel, tributaries, roadside ditches/embankments, and at channel crossings. Small drains within agricultural properties and the Clear Springs Golf Club (Chiswick Creek) are prevalent and lack any buffer or outlet control (e.g. pond). These drains can supply sediment, water, and pollutants (animal waste, fertilizer) to reaches downstream. **Figure 2.14** shows a portion of Graham Creek which lacks a vegetated buffer and is undergoing bank sloughing. The erosion observed here may be the consequence of many issues in the area, but would be reduced with some runoff control and bank vegetation.

The observations made through the desktop assessment provide guidance in focusing field efforts and anticipating the locations of various channel processes at work throughout the study area.

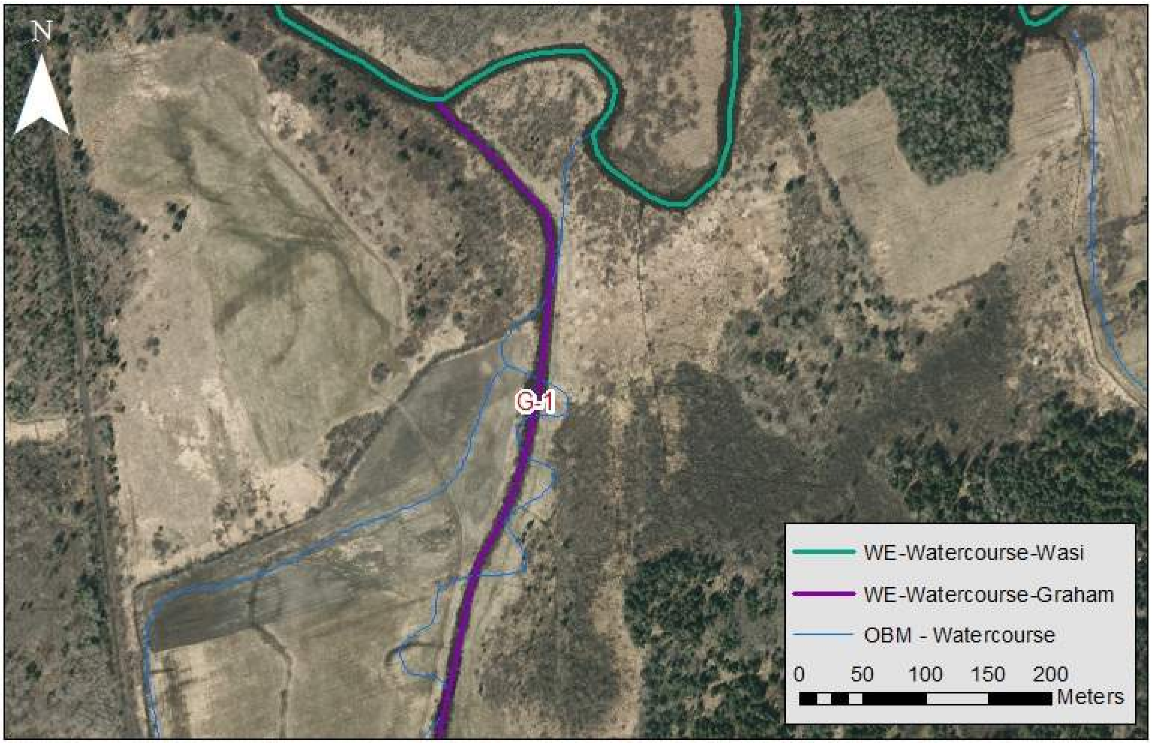


Figure 2.7: Channelization along Graham Creek.

Figure 2.8: Channelization along Chiswick Creek.

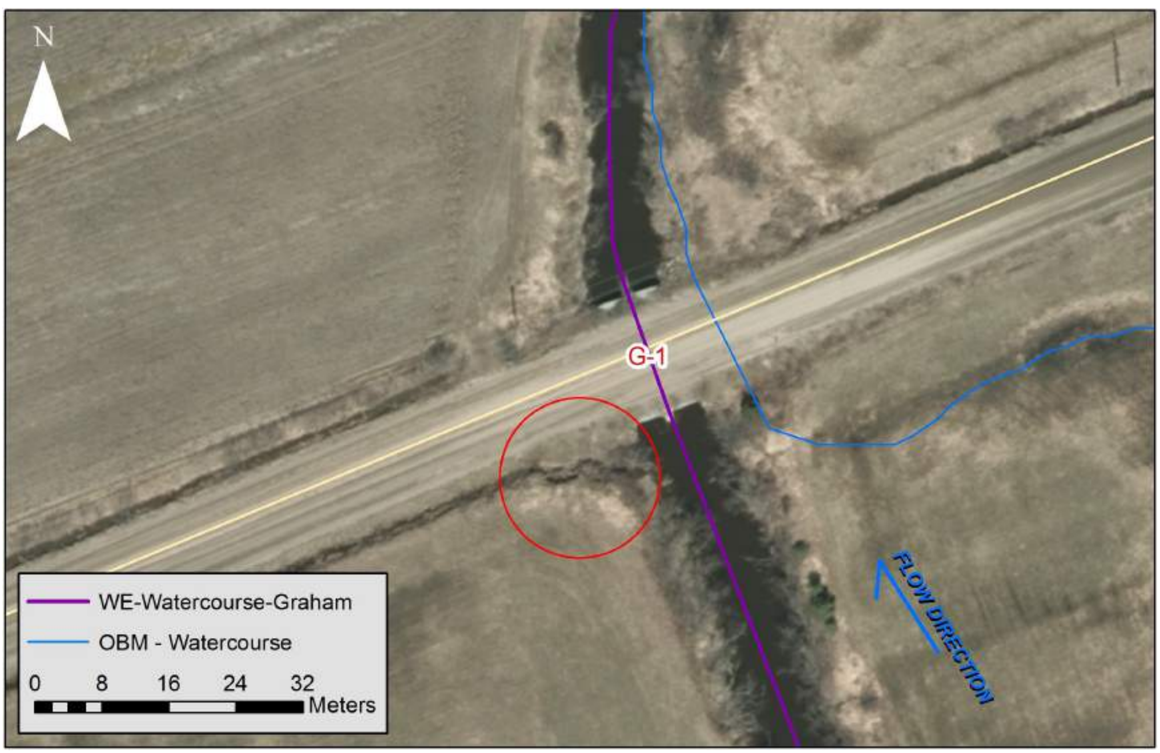


Figure 2.9: Roadside ditch eroding steep banks of channelized portion of Graham Creek (red circle).

Figure 2.10: Undersized crossing span relative to channel geometry.

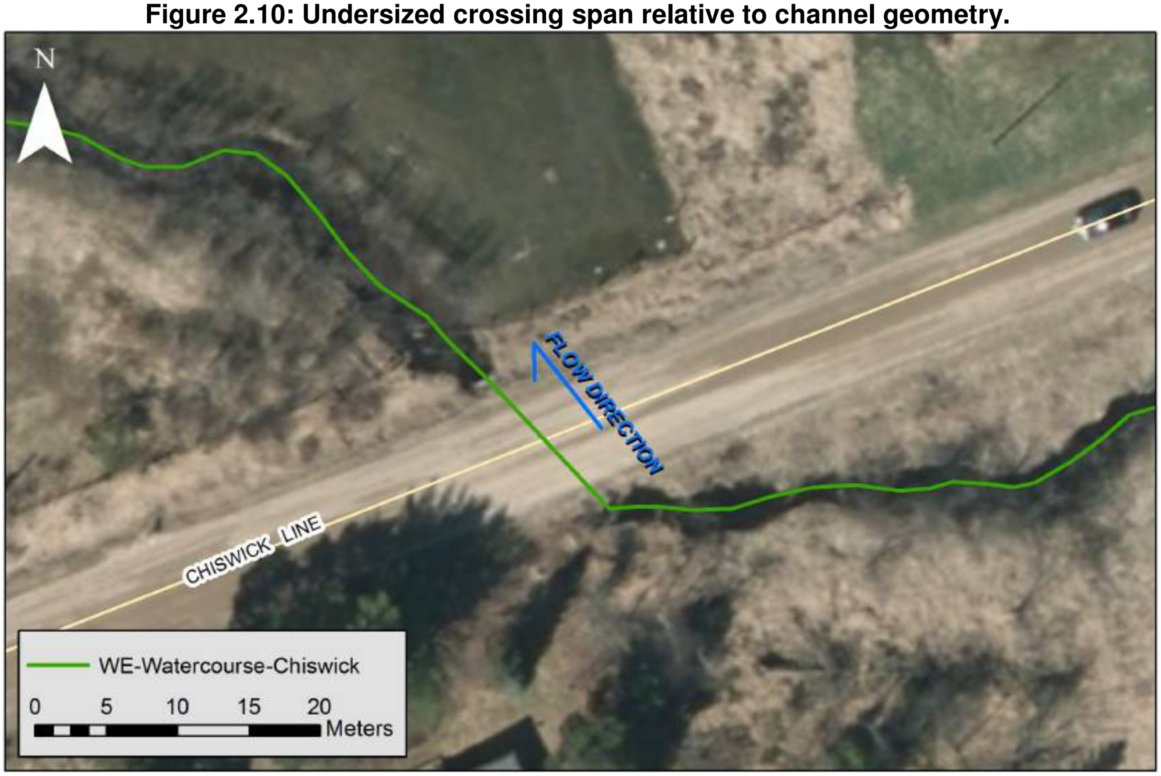


Figure 2.11: Undersized crossing span, and inappropriate skew. Tight bend at culvert inlet.

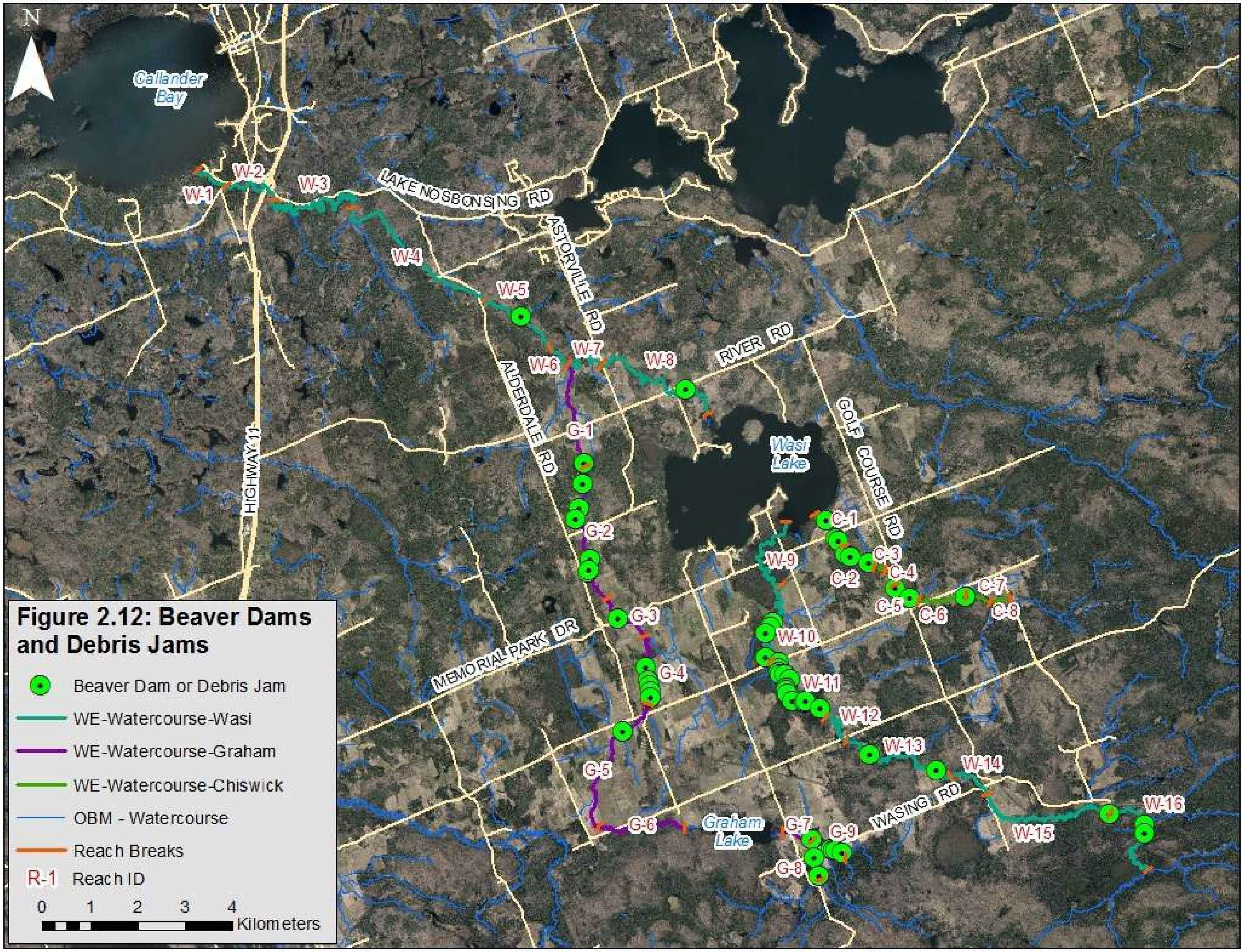


Figure 2.12: Beaver Dams and Debris Jams
Beaver Dam or Debris Jam
WE-Watercourse-Wasi
WE-Watercourse-Graham
WE-Watercourse-Chiswick
OBM - Watercourse
Reach Breaks
R-1 Reach ID
0 1 2 3 4 Kilometers
N
Callander Bay
Wasi Lake
Graham Lake
LAKE NOSBONSING RD
ASTORVILLE RD
RIVER RD
ALDERDALE RD
GOLF COURSE RD
HIGHWAY 11
MEMORIAL PARK DR
WASING RD
W-1
W-2
W-3
W-4
W-5
W-6
W-7
W-8
W-9
W-10
W-11
W-12
W-13
W-14
W-15
W-16
G-1
G-2
G-3
G-4
G-5
G-6
G-7
G-8
G-9
C-1
C-2
C-3
C-4
C-5
C-6
C-7
C-8

Figure 2.13: Bank slumping and cattle access – Graham Creek Reach G-3. (Martens, 2012).

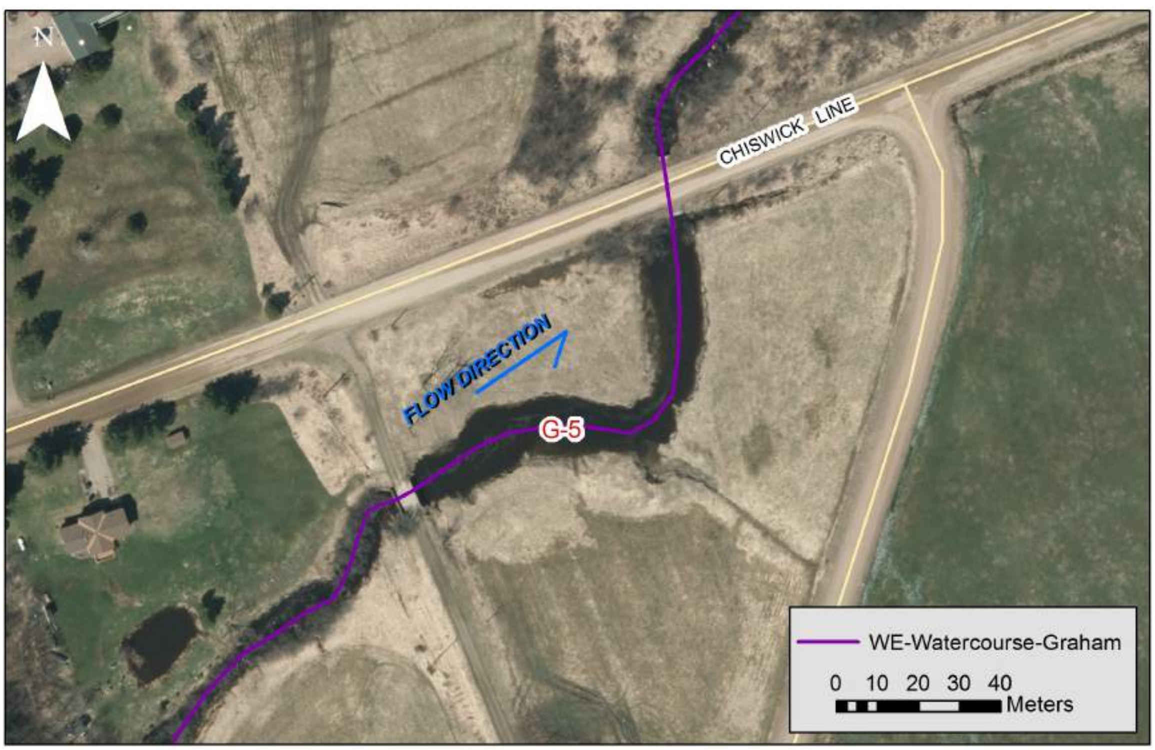


Figure 2.14: Lack of vegetated buffer, mowing to the top of bank, and bank slumping.

3 FIELD INVESTIGATIONS

In September and November of 2014, Water's Edge staff completed various levels of field data collection within the Wasi River watershed and the Callander Bay contributing area at selected sites. Previous sections noted that much of this assessment relies on desktop analysis through air photo interpretation. Field investigations were then completed to confirm findings of previous studies, verify channel processes and influencing factors identified during the desktop analysis (see **Section 2**), and further characterize the study area.

With such an expansive study area and over 66km of stream length for *only* those reaches delineated in **Section 2.3**, sites had to be carefully selected for further investigation. Prior to their selection, precursory high-level field assessments were completed through a "windshield" assessment whereby observations were made from publicly accessible locations, mainly: roads, bridges, and the former railway, a significant length of which is used as a snowmobile trail (**Figure 1.1**).

This initial "windshield" assessment was invaluable in gathering an understanding of the processes and influences beyond the desktop assessment. The area covered exceeded the reach assessment to include headwaters, roadside and drainage ditches, and other small tributaries because water, sediment, and nutrients are generally supplied from upstream. Findings were compiled and compared to the background data, and then sites were selected for potential detailed geomorphic surveys, and erosion mitigation plans. Despite having a list of specific sites for further field investigation, site access was mostly reliant on permission to enter from property owners, otherwise, access was made at public locations primarily within the road right of way (ROW).

Ideally, permissions to enter would be acquired prior to field surveys. Because this was not possible, staff attempted to gain access by knocking on doors during subsequent field visits. Therefore, site access was extremely limited.

As one of the major objectives of this study involves developing and conveying beneficial site plans to the public – primarily planting plans – a selection of 11 volunteered or municipally owned sites was provided by NBMCA with guaranteed access. Each of these 11 sites supplied were assessed (**Figure 1.1**), from which a selection of 5 were surveyed to develop site (planting) plans, and other mitigation strategies. Variation in the landscape, processes, and landowner input/concerns were all considered when selecting a site for a detailed survey. A summary table for the selected sites including: site IDs, location and landowner concerns is available in **Appendix A**. The intent is to assemble a range of properties in terms of setting and landowner concerns, so that if construction moves forward, a selection of pilot sites may be available for the reference of other property owners within the contributing area. Only two of these sites were located along an active watercourse while the rest were located along the shores of Callander Bay and Wasi Lake.

Due to an unusually wet summer and fall, land was saturated throughout the study area resulting in a long duration of high flows. This impeded fieldwork and the level of observable detail. Water levels obscured the visibility of the toe of the bank, and bedforms and materials, particularly on the Wasi River and Graham Creek. A low flow assessment should be completed in the future to characterize the channel under "normal" conditions. Despite this setback, much of the channel processes could be deduced, and issues regarding erosion and runoff could be summarized at a higher level.

3.1 Field Data Collection

Most observations made throughout the study area were high level, consisting of notes and photography. Detailed topographic and geomorphic surveys were only completed at select locations with permission to enter or of public accessibility. Reach delineation was completed for characterizing channel form and function, but the scope of the project and a lack of access limits the amount of field data that can be obtained at the reach level. Field forms were completed to provide a semi-quantitative method for assessing channel and slope stability and condition. These were completed for **one** volunteered site that had an appropriate length of active stream channel (Site CA-8). As one of the study objectives is to guide NBMCA staff on shoreline/streambank assessments, the forms completed for site CA-8 can be used as an example for future work. If these forms are applied to concern sites, mitigation efforts can be prioritized depending on the stability and condition of the channel and slopes.

3.1.1 Field Forms

Three different forms were used in the fluvial assessment for location CA-8:

1. Rapid Geomorphic Assessment (RGA)
2. Rapid Stream Assessment Technique (RSAT)
3. Slope Stability Rating Chart (from OMNR, 2012)

Rapid field assessments provide an indication of the channel stability and ecological stream condition, while also identifying primary processes in action (e.g. widening). The Rapid Geomorphic Assessment (RGA) and the Rapid Stream Assessment Technique (RSAT) together provide a thorough description of the existing channel conditions. The RGA is a checksheet that documents indicators of different modes of channel adjustment: widening, aggradation, degradation, and planform adjustment. These observations are quantified to produce a value that indicates the state of channel stability: “In Regime/Stable” (<0.20), “Transitional/Stressed” (0.21-0.40), or “In Adjustment/Unstable” (>0.40).

RSAT employs a semi-quantitative approach to characterize stream conditions whereby the user assigns a score to 6 different evaluation criteria (biotic and abiotic), which influence stream quality including:

1. Channel stability;
2. Channel scouring and sediment deposition;
3. Physical in-stream habitat;
4. Water quality;
5. Riparian habitat conditions; and
6. Biological conditions

The scores are then summed to communicate the final index of the stream condition. These values can describe the stream quality as “Excellent” (42-50), “Good” (30-41), “Fair” (16-29), or “Poor” (<16).

Slope Stability Rating Chart (OMNR, 2002)

This criterion came from the Provincial Technical Guide – River and Stream Systems in assessing unstable slopes. The field assessment sheet considers: soils stratigraphy, slope height and inclination, seepage from slope, vegetation cover, surface drainage, distance to creek, and past activity at site. The score is out of a total of 84, and has been separated into three categories relative to the potential for slope instability: “low” (<24), “slight” (25-34), and “high” (>35) potential for instability.

Sample field forms are included in **Appendix B.**

Shoreline Assessment Forms (Lakes)

During field visits in late 2014, Water’s Edge staff had visited accessible and volunteered shoreline properties that are subject to different controls and processes than that of watercourse properties. Field forms had not yet been developed to assess these shoreline properties in a similar manner to stream/slope assessments, therefore stability or condition scores were not determined. To provide a means to score and rank shoreline properties on lakes, Water’s Edge developed a checklist that works similarly to the RGA whereby observations are made as to whether a feature is present or absent. This was created by reviewing shoreline management documents for both streams and lakes in Ontario, other parts of Canada, and the United States. The sources used are included in the list of references, and a copy of the form is included in **Appendix B**.

Such a form could have been used to rank the accessible properties and then develop planting plans, but instead efforts were made to ensure that a variety of shoreline properties were selected as examples.

3.2 Field Results – Fluvial Geomorphology

Because most data was being collected at a higher level due to the project scope, size of the study area, unusually high water levels, and lack of property access, field results focus primarily on erosion and runoff issues, similar to those from the desktop assessment. Rapid assessment and survey results for Site CA-8 are included here, but volunteered lakefront properties will be described in a subsequent section where issues and mitigation strategies are presented.

3.2.1 Site CA-8

This property contains a 175m portion of Windsor Creek, outside of the Wasi River watershed, but contributing to Callander Bay (**Figure 3.1**). The property owner had indicated that beaver activity has removed trees from the site, and that bank erosion was posing some risk to property downstream of Pinecreek Road. This site was treated as a single reach with rapid assessments completed for the entire length, and a slope stability assessment was also performed for the bank slope downstream of the Pinecreek Road culvert.

This is a residentially owned property, bounded to the north and east by Hwy 654 and Pinecreek Road, respectively. There is a wet, floodplain area along the right bank (looking in a downstream direction), that is confined by road embankments with elevations approximately 2m higher than the floodplain. The land along the right bank is mostly open and composed of grasses, scrub vegetation, and clusters of short deciduous trees. The channel is mostly confined by the left bank, with some small benching. The top of the bank is roughly 1.5m higher than bankfull, with its slope mostly vegetated by grasses and scrub vegetation. Some small trees have been planted along the top of bank, however there is a mowed pathway along the top which extends down to a pointbar that the residents use to access the stream for recreation/aesthetics. An aerial view shows some ATV (4-wheeler) tracks along the top of the left bank, and through the floodplain and portions of the right bank. It is uncertain as to whether this circuit crosses the channel (**see Figure 3.1**).

This reach had many indicators of channel instability and was found to be in a state of adjustment (RGA = 0.41) with widening as the primary mode of adjustment, and aggradation as a secondary process. The RSAT score revealed that this reach is of fair condition, with riparian and in-stream habitat conditions having the poorest scores, which is complimentary to the channel instability.

Immediately downstream of Pinecreek Road a steep slope along the left bank shows signs of active erosion, and the landowner had expressed some concern with the "rapid" bank failure causing the top of slope to retreat (**Figure 3.2**). This slope was found to have a high potential for slope instability with a score of 40 due to the presence of the following indicators: previous failure, a steep slope angle, moderate vegetation cover, drainage over the surface, and the proximity to the active channel.

The Pinecreek Road culvert was apparently replaced or lined in recent years (landowner correspondence), and rip rap stone protection surrounds the structure along the road embankment (**Figure 3.3**). It is corrugated plastic, circular, with a diameter of approximately 2.0m, and the invert was located 0.1m above the water surface downstream during the field surveys. This perched culvert above the water surface exacerbates erosion issues due to the high energy of falling water. The culvert alignment (skew) roughly follows the existing planform, which is ideal for avoiding the possibility of out-flanking, or the build up of debris. However, we suggest that it is undersized relative to the channel geometry and prevailing flows. An undersized culvert tends to restrict the passage of water and material in the downstream direction, while challenging the movement of fish and animals upstream. The effect on flow velocities and sediment movement becomes a critical factor in the long-term stability of the culvert and adjacent properties.

Figure 3.1 shows that on the upstream side of the culvert (east of Pinecreek Road), the flow width is at least twice the width of the culvert. The flow appears to be within the banks, and not a major flood event. The resultant backwater effect promotes deposition of material on the bed and the accumulation of debris. Debris can also accumulate at the inlet of the culvert when larger than the opening, compounding the backwater effect and sediment accumulation. As flow converges into the culvert inlet, flow velocities increase, which in-turn causes channel enlargement as they expand downstream of the outlet.

For properly sized culverts, prevailing flows (e.g. 2 and 5-year flood events, or greater) are often conveyed without significant convergence and divergence, upstream and downstream, respectively. At the Pinecreek Road culvert, the undersized effect is also observed under lower flow events because of the circular shape of the culvert cross-section. As flow depths drop in the culvert, the cross-section area for flows to pass becomes drastically reduced towards the invert. Even under low-flow conditions, flows will likely converge into the culvert, increasing velocities, and creating the potential for erosion downstream.

In contrast to the issues observed at Pinecreek Road, the culvert at the downstream end of the property beneath Highway 654, is more appropriately sized for a greater range of flood conditions, and the local channel shape. It is a box culvert with a sufficient width to span the bankfull channel and a skew oriented in line with the existing planform, and the invert is either open bottom or embedded below the channel which enhances fish passage, and the movement of sediment and material in the downstream direction. These culverts tend to be costlier upfront, but require less maintenance over the long term.

Figure 3.1: Planview of site CA-8.

Figure 3.2: View downstream from Pinecreek Road and eroding left bank.

Figure 3.3: Pinecreek Road culvert outlet. Note the perched culvert.

3.2.2 Field Investigations – Erosion and Runoff Issues

The following sections summarize geomorphic processes within the watershed, and aim to produce some specific sites of concern that may be used as surrogate sites for inaccessible portions of the watershed. Many of these expand upon issues revealed during the desktop assessment, but some 'new' issues were also identified during site visits. The issues identified often occur in concert with each other, and henceforth share similar effects.

Channelization

From the windshield assessments, it was difficult to precisely identify the effects of channelization, particularly under high flows. It was most apparent that channelization was succeeding in confining floodwater within the channel and preventing flooding of surrounding land. However, the remaining general observations highlight some of the difficulty in making observations and interpreting channel processes during the windshield assessment, under high-flows. It appears that channelized slopes were well vegetated with grasses, shrubs, and young deciduous trees like alders. The amount and type of vegetation varied throughout, but at many locations it was difficult to observe whether there was, for example, erosion along the toe of the bank due to the presence of overbank flows. Some channelized cross-sections appeared oversized, without a low-flow or bankfull channel or any floodplain features (e.g. lateral benches/bars). Bed forms and other bed variation was submerged below a sufficient depth of water, and could not be distinguished. Road crossings provide obvious locations for observing channel properties and process, however, the presence of the crossing has a local effect on channel form both upstream and downstream, making it difficult to determine general channel adjustments following channelization. General responses to channelization could be observed further upstream and/or downstream, but were heavily dependent on sightlines.

Two sites were accessible through landowner permission, one on Graham Creek within Reach G-5, and the other on Chiswick Creek (Reach C-6). Reach G-5 is the upper limit of channelization efforts through the agricultural properties of Graham Creek. This site was selected due to some erosion noted in the 2012 Riparian Assessment. Banks were lined mainly with tall grasses, and had a buffer from the top of bank that ranged from 0.5m up to approximately 20m within a woodlot. Closer to the woodlot, banks had alders that were partially submerged, and leaning towards the channel. There was evidence of toe erosion as banks were slumping in the grassed area. Around the woodlot, cutoff channels – a result of channelization – seemed to capture and deliver some runoff from the surrounding landscape. Some large boulders were placed within the cutoff channel, though it was unclear as to whether this was to provide some erosion protection or as a means of disposing of unwanted material.

The portion of Reach C-6 that was assessed is assumed to be channelized due to the presence of some meandering patterns 40m to the north on the same property. This property is located downstream of a CSP culvert under Chiswick Line, east of Golf Course Road, and was selected due to the apparent steepness through the crossing. The size of Chiswick Creek was small enough to wade under high flow conditions. The section surveyed was bisected by a farm crossing consisting of a small CSP, and the sandy banks upstream were lined with alders, with tall grasses downstream (buffer ~2m wide). Cattle access was limited to a 3m length of bank at the crossing. The bed contained soft, unconsolidated sand bars, some cobbles, and deep pools >1m deep. Near the downstream end of the property, the outer bank of a bend was eroding with the fence along the top leaning towards the creek. Banks were undercut throughout, and wood debris had accumulated on fallen alders upstream of the small farm crossing. This channel did not have the same trapezoidal shape as sections along Graham Creek, but it was deep enough to confine flows within the cross section. Erosion through undercutting and bank slumping in this reach is providing sand and other fines to the system.

Confinement & Bank Armouring

Channel confinement with respect to channelization has already been discussed, but it occurs elsewhere in the watershed both naturally and artificially. Banks along roads, highways, rail corridors, and around crossing structures are relatively steep and have been armoured to protect essential infrastructure for the area. With bank protection, erosive forces are confined within the channel and may cause some downcutting depending on the bed composition. The former rail corridor partially confines Reach W-4 along the right bank. It appears to be well vegetated with rip rap along the toe. Channel incision or toe erosion was not observed from available vantage points. Furthermore, this is a bedrock section of Wasi River and has few natural grade controls (riffles and cascades). The rail corridor adjacent to W-4 is private property which would require permission to enter, and concrete barriers have been placed across the trail to prevent access. Just upstream of Alderdale Road, a gully was developing into the rail embankment immediately behind a concrete barrier (**Figure 3.4**). The entire length of the rail corridor should be inspected to better connect drainage features to the main channel.

Further downstream through Reaches W-3 down to W-1, road and bridge contacts were artificially designed and armoured. W-3 is a highly sinuous channel with excellent floodplain area and connectivity. Where outer banks come in close contact with the road, some dogwoods have been planted, but flows were too high to see whether any harder protection had been applied. Runoff over this steep bank slope from the road has created some rill erosion. These contacts should be monitored for channel migration. Downstream into Reaches W-2 and W-1, many banks have been protected by boulder placement up to the road level which varies in elevation from the bank toe to the top (~3m up to ~10m). Reach W-2 had floodplain connectivity for some higher flow energy to dissipate if it reaches that level. It is evidence of bank-toe and bed erosion though these locations. Grasses were present along the lower parts of armoured banks adding roughness to the system. Some scour was evident around crossing structures where the channel was confined on both sides. The channel confinement through Reaches W-3 to W-1 may be considered much localized, and where it is more prevalent underneath Highway 11, the channel should be considered semi-confined (**Figure 3.5**). Low flow surveys should be completed to confirm whether the confinement experienced though these lower reaches is detrimental.

Figure 3.4: Gullying into rail embankment (photo taken leaning over barrier).

Figure 3.5: Wasi River looking downstream under Highway 11.

Crossings
The windshield assessments observed the main channels and some tributaries primarily from road crossings, but many crossings were inaccessible, located within private property. The desktop assessment indicated that the major issue regarding channel crossings through the study area is that the majority are undersized relative to the channel planform and cross-sectional geometry. Secondarily, there were crossings that would benefit from an adjustment in the skew relative to the channel planform. During field visits, two crossings were replaced but could have benefited from the input of a fluvial geomorphologist, as detailed below. At the least, major crossings are usually sized to convey a specific flood without causing a severe backwater effect or surcharging the structure, and it is assumed that the new structures adequately convey floodwater without negatively impacting the existing conditions.

Alderdale Road crosses Wasi River, north of River Road. This crossing consists of twin culverts, and was replaced over the time of field investigations. The existing steel twin arch culverts were replaced by twin steel arch culverts of a similar size and skew. There is roughly 1m of space between the culverts, and rip rap has been placed along the road embankment from the toe of the bank in the water up over the culverts. Downstream, the left bank has been armoured with boulder material. These culverts are undersized relative to the bankfull width, and the skew relative to the upstream geometry does not run parallel to the primary flow direction (**Figure 3.6**). Scour may become a major issue around these culverts on the upstream side over time. During the replacement of road crossings, a geomorphic study should be included to inform design alternatives. All crossings in the area should be geomorphically assessed in addition to flow conveyance and fish/wildlife passage.

Figure 3.6: Wasi River looking upstream from Astorville Road.

Beaver Activity
Beaver dams and activity exist within each watershed, mainly upstream of the confluence of Wasi River and Graham Creek. Beaver dams were found during field assessments at smaller scales, damming smaller drainage ditches. Only two dams were observed during site visits, with one on

Graham Creek at Memorial Park Drive (Reach G-3), and another in a drainage ditch close to River Road near the Wasi River crossing. Within Graham Creek, beaver dams can help control the slope and flow velocities within steeper channelized sections. Within smaller ditches that are not confined, under high flows, dams can flood surrounding land, as was found along the small drainage ditch. The dam that was observed in Reach G-3 did not appear to be reducing the capacity of the channel, and the bridge immediately downstream spanned the top of the bank, and had rip rap protection to prevent any scour issues (**Figure 3.7**). The smaller beaver dam was on a drainage ditch that was not incised. The surrounding land had partially flooded, but no property of agricultural or residential use was at any significant risk. Beaver dams should be monitored for erosion issues or potential failure.

Beaver activity is not limited to damming watercourses. Tree removal by beavers should be monitored, mainly for ecological purposes, but also for bank stabilization. Within Reach W-3, beavers had begun to chew through some of the posts on the road barrier between Lake Nosbonsing Road and Wasi River (**Figure 3.8**)

Figure 3.7: Beaver Dam in Graham Creek under Memorial Park Drive.

Figure 3.8: Wasi River Reach C-3 – Beaver damage to guardrail posts.

Cattle Access

The 2012 riparian assessment provided a good review of the areas where cattle frequently access the main channels of each stream, and included some locations where drainage ditches and tributaries were accessible. During Water's Edge site inspections, cattle access was observed at one location along a main trunk of Chiswick Creek (see channelization discussion). However, it was obvious that drainage ditches on property that animals grazed upon were mainly open with no buffer or fence to prevent cattle from walking through the watercourse. As a single site, this may not present much in the way of pollutant or sediment contribution, however, if this is occurring throughout the watershed, BMPs like buffer strips should be implemented to prevent livestock access, filter runoff, and retain sediment on the land surface.

Roadside Ditches

Drainage along road embankments is a common and necessary feature where sub-surface drainage (storm sewer) networks are not constructed. Issues arise when ditches are not designed to convey the water delivered to them, or when flow is re-routed to these ditches to increase available land area for development activities. Like rivers, ditches will respond morphologically to increased flow, and are particularly susceptible to bank failure because road fill is comprised of poorly sorted, unconsolidated sands and gravels. **Figure 3.9** shows a leaning mailbox because of undercutting of the road embankment along a steep ditch parallel to Alderdale Road. A number of alternatives exist from natural channel design to implementing check dams to manage velocities and shear stress.

Figure 3.9: Undercut road embankment. Alderdale Road at River Road – Graham Creek.

Road Runoff

Sand/grit application and road fill erosion (rill and gully formation) contributes sediment to the system. This occurred throughout the system, particularly where road slopes are steep, and where banks lack cover, causing exposure to runoff and rainfall impact. **Figures 3.10 and 3.11** provide examples of rill erosion due to runoff, and sand delivery from the road, respectively. As it is unlikely that grit application will cease in an area that experiences long winters, management practices should aim to slow runoff and capture sediment above and on the bank slope.

Figure 3.10: Rill erosion along road embankment – Graham Creek.

Figure 3.11: Sand erosion and transport towards Wasi River at Wasing Road.

Clear Springs Golf Course
Golf courses are open spaces with little tree cover, and are almost entirely grasses of different (and sometimes non-native) types. Many manage runoff internally with ponds and other water hazards. From the aerial photography, Clear Springs Golf Course (GC) has a few water hazards that presumably handle some stormwater, but there are also straight channels that cut across the course to a drainage ditch that is only just within a woodlot on the west side of the property. These ditches are narrow and deep, and efficiently carry flow from the steep slopes along the drainage divide to the east. Concern with this property is mainly along the trunk portions of Reach C-3 where land is mowed to the edge of bank, and the channel is showing signs of widening, aggradation, and planform adjustment. Where a riparian buffer was observed, it was narrow (~1-2m) and consisted of grasses and some scrub vegetation. Bridges cross the creek and two are at risk of failure due to the placement along a meander bend where forces have been eroding the outer bank with a sandy composition. Through the golf course, Chiswick Creek has little floodplain connectivity. Water with high energy from the cascade at the upstream end of Reach C-3 flows through a well forested floodplain before reaching the exposed segments through Clear Springs GC. Compared to the woodlot upstream, Clear Springs GC had very little wood debris.

Upper Graham Creek
Headwaters for Graham Creek and Wasi River both originate on top of an escarpment. The upper reaches of each are relatively steep through glaciofluvial sands and gravels, or bedrock outcrops. Similarly, roads that access the upper watershed are also very steep, with rapidly eroding drainage ditches. During the windshield assessment, staff drove south on Maple Road from Pioneer Road which leads up the escarpment. This road has very steep sections with a large roadside ditch that appears to recently have been enlarged – there were bucket marks from an excavator. Sands are readily transported frequently downslope under even the slightest events (**Figure 3.12**). The runoff reaching this drainage ditch may increase as land is cleared of trees to build housing. Two upper reaches of Graham Creek intersect Maple Road at low points partially down the slope of the escarpment, where sediment is discharged (**Figure 3.13**). Eventually these two watercourses converge and discharge to Graham Lake. Grade control within the roadside ditches and possible armouring may be necessary mitigation measures. Land clearing and other construction works should have adequate erosion and sediment control plans and inspections.

Despite Graham Lake acting as a sediment sink in the upper catchment, the upstream source along Maple Road should be monitored.

Figure 3.12: Recently excavated roadside ditch along Maple Road. Fine sands are easily transported down-slope.

Figure 3.13: Sediment discharge from roadside ditch to Graham Creek – Maple Road.

4 RUNOFF AND EROSION MITIGATION OPTIONS

There are various strategies available to address the issues that have been identified in this and previous reporting, including:

Natural Channel Design

The main objective in any natural channel design is to restore, and where possible, enhance the form and function of a stream system. Additionally, the design channel should convey existing or predicted storm events, accommodate local settlement and natural heritage constraints. Depending on the constraints and existing issues, the design channel can be dynamic and adjust over time. These adjustments are a natural maintenance process for form and function as the channel tries to maintain equilibrium with prevailing flow and sediment regimes. Cross-section geometry should consider the bankfull stage and allow for frequent overtopping into the floodplain.

Natural channel design is recommended for previously channelized portions of Graham Creek and Chiswick Creek (see **Figures 2.7** and **2.8** for examples). It may not be feasible to restore the channel to its previous form given the inherent losses of productive agricultural land, but options are available that apply natural channel principles within local constraints. Given that these channels have been oversized relative to the previous condition, and presumably the prevailing flow. There is an opportunity to construct a bankfull channel with a floodplain bench, set within the larger channelized cross-section. Where possible, moving and regarding the channelized banks away from their current position relative to the channel centerline will not only provide more floodplain area, but should also reduce erosion losses at over-steepened bank sections. Natural plantings, wood structures, and substrates should accommodate the natural channel design. Such features provide habitat, refugia, and help control erosion.

Further reference to natural channel design in Ontario can be found in: *Adaptive Management of Stream Corridors in Ontario* (Ontario, 2001).

Road Crossing Replacement

All crossings should be assessed throughout the study area. This includes major road bridges and culverts, but may also include smaller crossings such as driveways if the roadside ditch conveys a considerable flow. Structures should be sized such that risk of erosion and deposition are minimized. Additionally, appropriately sized crossings should reduce the tendency for debris jams and upstream flooding, and downstream scour. The following criteria may be used in designing appropriate crossings:

- **Location** – If possible, crossings should be located at a straighter portion of the planform.
- **Span** – Bridge opening exceeds the width of the bankfull channel (preferably by several times), and possibly an erosion limit (e.g. 100-year migration limit). An appropriate span will allow for geomorphic processes to occur through the structure with minimal risk to structural integrity, and allow for lowered maintenance requirements on the bridge.
- **Elevation** – Bridge decking should sit above an index flood event to reduce concerns of flooding, scour and deposition, and debris collection.
- **Skew** – The crossing opening should be set perpendicular to prevailing bankfull flows, unless the span allows for larger floods and channel migration to pass through the crossing.
- **Length** – The length of the crossing should be minimized as much as possible, provided an appropriate skew and span has been selected.

Like natural channel designs, the construction of channel crossings are often subject to local constraints. In cases where there is a constraint on the design criteria (e.g. location, span) channel design at the transitions upstream and downstream of the crossing can ensure the long-term stability of the structure.

The design criteria above can be adapted for smaller crossings (e.g. driveways and private roads). It is recommended that these smaller crossings are located at straight sections and span the top of bank. If constraints limit the size of the crossing, then other options to stabilize the channel and alleviate flood impacts may be explored (e.g. bank treatments, additional culverts/spillways).

Beaver Dam & Debris Jam Removal
If an impediment such as a debris jam or beaver dam is deemed to be posing a hazard to property or infrastructure, or causing an ecological disturbance, removal and remediation may be required. Large dams may require some localized grading to transition the slope from upstream to downstream, and avoid a significant influx of sediment as the aggraded material of the impoundment becomes mobilized.

Buffer Strips
Planting and expanding the riparian zone is a relatively easy and cost effective measure to enhance water quality that also benefits riparian and aquatic ecology. The roughness created by plants slows runoff and encourages particle settling, absorption, and adsorption. Runoff contaminants (nutrients and other chemicals) can become bound to soil particles (adsorption), and plant roots and soil microbes can uptake nutrients, salts and other pollutants (biological uptake) (OMAFRA, 2004). Vegetation also enhances the capacity for soil to retain water. Buffer strips along active watercourses can add roughness to attenuate erosive forces, and provide slope stability through root cohesion.

Ideally, buffers should be 10-30m in width depending on the sensitivity of the receiving watercourse, and local constraints. The minimum width for buffer strip should be 3-5m from a watercourse, with benefits increasing with the width of the buffer. Buffer strips can be applied at all receiving waters including roadside and drainage ditches.

Rock Check Dams/Filter Socks/Straw Bales/Coir Logs
For features that typically remain dry such as conveyance swales and ditches, several options are available to control flow velocities and sediment movement (erosion and deposition). These features are temporary, and typically used in erosion and sediment control plans for construction activities around watercourses. Installation is generally quick with little disturbance. Examples include: Rock-check-dams, filter socks, straw bales, and coir logs.

These are essentially in-channel structures that span the channel bed and partially up the banks to slow flow velocities, allowing water to slowly filter-through. This encourages sedimentation, and reduces overall degradation and enlargement. Apart from rock-check-dams, each control structure has a relatively short lifespan (e.g. up to 8 years for coir logs).

To reduce the delivery of sand/grit to watercourses from roads, erosion control measures can be applied along the top of slope where road embankments form the valley slope (see **Figure 3.11**). Frequently, silt-fencing is staked along valley corridors to reduce sediment delivery from nearby construction. Natural earth-berms, coir logs with seeding, and filter socks, can be applied in a similar fashion to silt fence where road sand/grit is a potential source for excess sediment to area watercourses.

It is not the intent of these recommendations to replace typical erosion and sediment control measures for construction around watercourses and waterbodies, rather to provide quick mitigation options for existing erosion and sedimentation concerns.

On-site storage – Ponds, end of pipe, etc.
Throughout the study area, runoff is efficiently directed from the surface to receiving watercourses by agricultural drains and swales (e.g. golf course). Flow from these features can be managed with online or end-of-pipe (or drain) elements like ponds or infiltration trenches. These installations can be costly depending on the design (e.g. size), and would require additional land. Within the Clear Springs GC, water "hazards"/ponds present an opportunity to utilize existing features on the surface to manage runoff prior to discharging into Chiswick Creek. Other opportunities exist within and along the periphery of municipal parking lots to install vegetated swales or infiltration trenches to direct and retain water, reducing the effects of overland flow.

The strategies and recommendations presented here are general, and at-best provide a conceptual plan for mitigation throughout the study area. Volunteered properties were assessed and selected for detailed preliminary design recommendations based on observed processes and issues identified by each landowner.

5 DESIGN CONCEPTS FOR SELECTED PROPERTIES

Environmental stewardship is a major component of the SP Plan, and through community involvement, NBMCA had secured a list of 11 properties that were both publicly and privately owned, with a variety of landscapes and landowner concerns. After a review of these sites, five were selected and surveyed for completing cost-effective mitigation plans to reduce runoff and riverbank or shoreline erosion. Four of these properties were lakefront, and the other contained a stretch of active river channel (see **Section 3.2.1**). Detailed planting plans have been developed for the four shoreline properties and a conceptual plan for site CA-8 (**Appendix D**). Site CA-8 requires further study including additional surveying upstream of the culvert and flow details or modelling.

Planting plans that create shoreline buffers are cost-effective methods of enhancing a waterfront aesthetically, ecologically (habitat), and overall water quality (see **Section 4**). Ideally shoreline buffers should include aquatic plants, trees, shrubs, and herbaceous vegetation. This diversity helps divert runoff away from receiving waters by ponding, plant uptake, encouraging infiltration, and encouraging settling of eroded material that may be transported down slope. Aquatic vegetation in the water along a shoreline reduces the impact of wave action upon susceptible shorelines, reduces turbidity and provides root cohesion.

Shorelines throughout the Callander Bay watershed exhibit some similarities despite differences in landuse or location (e.g. river or lake property). The following paragraphs generally describe physical characteristics and landowner concerns that were considered in design:

Properties with Retaining Walls

Many shorelines within the contributing area have retaining walls (corrugated steel sheet pile, wood, and concrete). Functioning retaining walls in rivers and lakes protect land from shoreline erosion due to wave action or shear stress, and prevent material from sloughing away (e.g. slumping). These vertical, hardened shorelines deflect waves, disturbing sediment and creating conditions unsuitable for aquatic plants. On the land side, fill and material behind retaining walls can also erode when waves surcharge the height of the structure. Depending on the adjacent upland slopes, runoff may also contribute to erosion of the fill material behind the structure.

It is not recommended that aquatic vegetation be planted in front of retaining walls, unless it is a depositional zone that shows evidence of plant growth. Plantings should be completed on land behind retaining walls to slow runoff over the slope, and secure/protect material during high wave action.

Recreational Beaches

Some municipal and private properties (resorts) have sandy beaches that are utilized for recreation. Using the example of a municipal beach, it requires: access, parking, and an adequate amount of beach area (depending on traffic). Therefore, vegetated buffers can be planted some distance back from the beach where they will still intercept runoff. Since beaches are highly susceptible to gullying from runoff, directing and temporarily storing runoff in a surface depression can mitigate rills and gully formation. It is understood that parking lots at these municipal sites are often used to store snow. Therefore, we recommend that trees be planted along the boundary between the parking lot and the buffer strip to help delineate the transition and avoid snow being directly dumped into the vegetated buffer.

Boulder/Rock (rip rap) shorelines

Most shorelines observed along Callander Bay and Wasi Lake had some sort of rip rap/rock treatment. Some appeared to have been designed more recently with stable slopes in mind (3:1), while presumably older treatments were constructed with a steeper slope and exhibited evidence of failure. Depending on water depth and bed stability, vegetation may be planted along these shorelines to enhance the littoral zone.

Rock treatments should have a wide gradation of stone sizes (diameter), which allows for better packing as interstitial spaces are filled, enhancing stability. Fines should be included to provide growing-medium for shoreline vegetation. After a rip rap shoreline has been constructed of a narrow range of particle sizes (e.g. entirely boulder), interstitial spaces become more difficult to fill, but it may occur naturally.

Views and Access

Much of the attraction to having a shoreline residence is the aesthetics (views, sounds), and recreational access (e.g. boating, snowmobiling). Planting plans and buffers have been designed to maintain views and access while developing a natural shoreline. The types of vegetation that have been selected provide added aesthetics both on land and in the water.

Deterring Geese

Geese are often a nuisance when occupying private property. In addition to fecal matter, they can have territorial tendencies, especially when nesting. If geese inhabit a location at the time when they are molting, they will likely be reluctant to relocate because they do not fly during this time.

Where landowners identified geese as an issue, planting plans were created to obscure the sightlines of geese from the water to the land. The use of buffers and reduction of mowed areas along the shoreline creates an environment less favourable for geese to settle. They prefer mowed, short grass for food, and easy, close access to water. Creating a buffer may not entirely prevent geese from migrating along land between properties, nor prevent them from landing in an open grassy area following flight.

****It is illegal to disturb, damage, or destroy the nest or eggs of Canadian Geese****

Streambank Erosion

Buffer strips can be used to prevent streambank erosion by adding roughness, root cohesion, and reducing runoff from tablelands. However, depending on the existing slope stability, planting plans may only partially address an erosion situation. Vertical banks with exposed soils above the water surface, tend not to have a well-vegetated slope face. Rather there may be overhanging vegetation along the top, and younger vegetation establishing along the toe, provided material is accumulating. As bank heights increase so does the likelihood of failure. Depending on the risk to surrounding property, infrastructure, and/or habitat, bank treatments may be designed and constructed. Where risk is higher, a more robust treatment such as a block armourstone or gabion wall may be recommended. Where possible, a more natural, cost-effective, bioengineering approach is preferred and provides the most benefit to water quality and stream/shoreline ecology. An understanding of the processes and forces acting upon the streambank is required when developing designs.

Site CA-8 has an added complexity to streambank erosion due to the presence of an undersized and perched culvert immediately upstream. Here, bank erosion has been exacerbated by high velocities delivered from the culvert (see **Section 3.2.1**). A scour pool has developed and channel enlargement has oversteepened the banks, leading to frequent failures or sloughing of material. The primary recommendation at this site is to undertake a detailed assessment, and redesign this culvert to have a more appropriate span, elevation, and skew using similar design considerations as were used in the crossing at Highway 654 at the downstream end of the property. In the likely case that culvert upgrades are not feasible, a conceptual plan that utilizes bioengineering has been drafted for this site. It must be stressed that this plan is conceptual and requires further field investigations and possibly flow modelling to design a stable bank.

Examples of shoreline/bank stabilization techniques, and erosion and sediment control (ESC) methods are available in **Appendix D**.

Site plans for the selected properties are available in **Appendix E**.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on our evaluations, assessments and analyses, we can conclude that:

1. Channel erosion is primarily limited to channelized reaches of Graham and Chiswick Creeks;
2. Channel confinement is an issue that exists naturally and artificially, containing erosive forces within the channel;
3. Lack of a riparian buffer at multiple locations and cattle access at a few sites exacerbates bank erosion;
4. Most crossings are hydraulically and geomorphically undersized, creating zones of backwater upstream and channel enlargement downstream;
5. Beaver dams and debris jams can locally reduce sediment loading downstream, however they need to be assessed for erosion issues;
6. Roadside ditches along Alderdale Road and Maple Road were found to be steep and enlarging, delivering the easily erodible sands and gravels downstream; and,
7. Road runoff is delivering sediment to watercourses where buffers do not exist, and is causing gullying on road embankments.

6.2 Recommendations

Based on the desktop assessment and field investigations, we recommend that the NBMCA undertake the following:

1. Further study (data gaps)
    a. Fieldwork should be updated to confirm/update the findings of this study when possible. Limitations due to high flows, and lack of landowner permissions may have masked additional runoff issues.
    b. Expand field investigations to neighbouring catchments within the Issue Contributing Area, particularly in the more developed small catchments draining to Callander Bay.

   c. Identify areas of well-connected floodplain/wetland/swamp that can be preserved and utilized to attenuate floods and promote deposition of sediment outside of the main channel(s).
2. Inventory and Monitoring
   a. Complete a channel crossing inventory and assessment.
   b. Develop a geomorphic monitoring program for channelized locations, at road crossings, in order to prioritize remediation efforts.
   c. Assess road and rail embankments adjacent to major watercourses to identify sites for remediation (e.g. gullying, failure) as these may potentially pose major risk to human populations.
   d. Monitor beaver dams and debris jams for stability, erosion, and flooding issues.
3. Construction opportunities
   a. Retrofit existing municipal parking areas with rain gardens or infiltration trenches to control/treat runoff from summer storms, and meltwater from snow piles.
   b. Develop guidelines for erosion and sediment control and actively inspect and interact with contractors throughout the construction process.
   c. Implement the use of erosion and sediment control features such as coir logs or filter socks at known areas of concern including roadside ditches and steep embankments within the public right of way.

Many of the issues identified in this study result from historical modification to the landscape, and contemporary practices in design and maintenance of the area. These issues are not unique to the study area, and are of common occurrence throughout Ontario and globally. The mitigation options and recommendations provided here present opportunities to enhance the system in a progressive manner, and are in line with several practices proposed or underway elsewhere in Ontario.

Several proposed mitigation options can be implemented on a small-scale in a cost-effective manner. Larger scale efforts such as road crossing upgrades may require external funding, but with an appropriate design, such projects can be sustainable over the long-term, requiring less maintenance. Moving forward, utilizing a combination of mitigation strategies can have a positive basin-wide environmental effect.

All of which is respectfully submitted,
WATER'S EDGE ENVIRONMENTAL SOLUTIONS TEAM LTD.

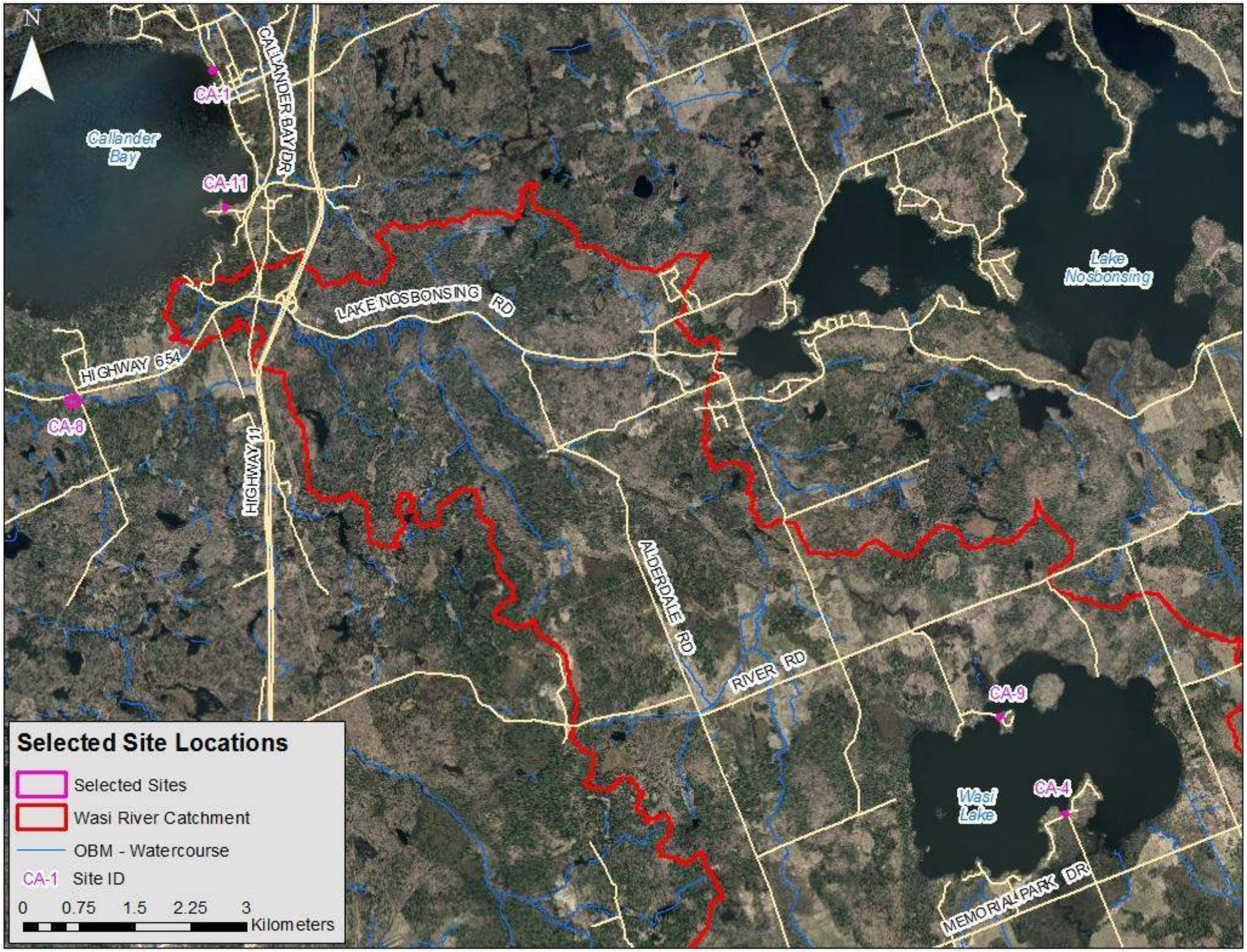
John McDonald, M.Sc.,
River Scientist

Ed Gazendam, M.Eng., P.Eng.
Sr. Geomorphologist, Project Manager

APPENDIX A:

Selected Properties from NBMCA List

Selected NBMCA Riparian Assessment Properties for Survey and Mitigation Plans					
Site ID	**Location Description**	**Address**	**Water Body**	**Site Description**	**Concerns**
CA-2	Callander Health Centre. Callander Bay Shoreline	299 Main St N, Callander, ON	Callander Bay	The site is approximately 35m by 12m. There is an adjacent parking lot for the health centre. The site may be used as public lake access.	Allow for lake access.
CA-4	Municipal beach on Wasi Lake	Bayview Dr, Chisholm, ON	Wasi Lake	The beach is approximately 60m long and 12m deep. The beach is used primarily for swimming and recreational activities. Launching boats is not allowed. The beach has a number of challenges. There is currently evidence of erosion. Snow is stored in the area over winter. There are also plans to put in horse parking.	Shoreline erosion. May have poor soils. Public access. Horse parking (manure). Snow storage (runoff).
CA-8	Rural Residential	609 Hwy 654 Callander, ON	Windsor Creek	Some evidence of erosion.	Beavers have removed trees on property.
CA-9	Rural Cottage	465 Mallard Haven Rd, Chisholm, ON	Wasi Lake	Recently left a no-mow zone of 10ft. Also tried native wildflower seed with no success. Has an access point to the lake. Moderate slope, no beaver activity no retaining wall. Willing to have local residents come take a look. Willing to have a mix of trees and shrubs with a majority of shrubs.	Needs advice for what to plant.
CA-11	Urban Residential	200 Greenwood Rd, Callander, ON	Callander Bay	Shoreline has wood retaining wall structure with stones into the water. Cat tails are present in the water. There is a boardwalk along the shoreline with lawn behind. Geese use the shore occasionally.	View of Lake. Deter Geese. Play area for grandchildren.


N
Callander Bay
CA-1
CA-11
CALLANDER BAY DR
LAKE NOSBONSING RD
HIGHWAY 654
CA-8
HIGHWAY 11
Lake Nosbonsing
ALDERDALE RD
RIVER RD
CA-9
CA-4
Wasi Lake
MEMORIAL PARK DR
Selected Site Locations
Selected Sites
Wasi River Catchment
OBM - Watercourse
CA-1 Site ID
0 0.75 1.5 2.25 3
Kilometers

APPENDIX B:

Sample Field Forms

Rapid Geomorphic Assessment

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD

Date: ______________________
Evaluator: ______________________
Stream: ______________________
Conditions: ______________________

Form / Process (1)	Geomorphic Indicator No (2)	Description (3)	Present No (4)	Present Yes (5)	Factor Value (6)
Evidence of Aggradation	1	Lobate bar			
	2	Coarse material in riffles embedded			
	3	Siltation in pools			
	4	Medial bars			
	5	Accretion on point bars			
	6	Poor longitudinal sorting of bed materials			
	7	Deposition in the overbank zone			
		Sum of Indices			
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			
	2	Exposed sanitary/storm sewer/pipeline/etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets/concrete aprons/etc.			
	5	Scour pools d/s of culverts/storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration			
	8	Terrace cut through older bar material			
	9	Suspended armour layer visible in bank			
	10	Channel worn into undisturbed overburden/bedrock			
		Sum of Indices			
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.			
	2	Occurrence of large organic debris			
	3	Exposed tree roots			
	4	Basal scour on inside meander bends			
	5	Basal scour on both sides of channel through riffle			
	6	Gabion baskets/concrete walls/etc. out flanked			
	7	Length of basal scour >50% through subject reach			
	8	Exposed length of previously buried pipe/cable/etc.			
	9	Fracture lines along top of bank			
	10	Exposed building foundation			
		Sum of Indices			
Evidence of Planimetric Form Adjustment (PI)	1	Formation of cut (s)			
	2	Single thread channel to multiple channel			
	3	Evolution of pool-riffle form to low bed relief form			
	4	Cutoff channel(s)			
	5	Formation of island(s)			
	6	Thalweg alignment out of phase meander form			
	7	Bar forms poorly formed/reworked/removed			
		Sum of Indices			
Stability Index (SI) = (AI + DI+ WI+ PI) /m					
			Condition:		

RAPID STREAM ASSESSMENT TECHNIQUE (RSAT) Evaluation

Creek Name: **RSAT Section #:**

Assessor: **Date:**

Coordinates:

Evaluation Category	Relative Significance	Criteria	Rating Excellent	Good	Fair	Poor	Score
1 Channel Stability	Indicative of hydrologic/flow regime alteration and general condition of physical aquatic habitat. Provides insight into past, present and possible future changes in channel morphometry	Bank Stability	>80%	71-80 %	50-70 %	< 50 %	
		Stream Bend Stability Outer bank height/bank overhang	<0.60 m / <0.60m	0.60 to 0.90 m / 0.60 to 0.75 m	0.90 to 1.20 m / 0.75 to 0.90 m	>1.20 m / >0.90 m	
		Exposed roots and falls	old and large / 0-1	some young / 2-3	young common / 4-5	young abundant / >6	
		Bottom 1/3 of Bank	resistant plant/soil	resistant plant/soil	highly erodable plant/soil	highly erodable plant/soil	
		Cross-Section	V or U	V or U	Trapezoidal	Trapezoidal	
		Typical Score:	**9 to 11**	**6 to 8**	**3 to 5**	**0 to 2**	

NOTES:

Evaluation Category	Relative Significance	Criteria	Excellent	Good	Fair	Poor	Score
2 Channel Scour and Sediment Deposition	Relates to level of uncontrolled stormwater runoff, sediment load and transport and degradation of instream habitat.	Riffle Embeddedness	<25% sand & silt	25-50%	50-75%	>75%	
		# of deep pools / substrate	high # / <30% fines	mod # / 30-60% fines	low-mod # / 60-80% fines	few # / >80 % fines	
		Streak marks/sediment deposits absent	marks / dep absent	uncommon	common	common	
		large sand deposits/fresh	rare / no fresh dep.	uncommon and small localized dep	common and small localized dep.	common and heavy dep along major portion	
		Point bar/vege/sand	few / well vege / none	small/well vege/little	mod-large& unstable/high am't of sand common	mod-large& unstable/high am't of sand at most bends	
		Typical Score:	**7 to 8**	**5 to 6**	**3 to 4**	**0 to 2**	

NOTES:

Evaluation Category	Relative Significance	Criteria	Excellent	Good	Fair	Poor	Score
3 Physical In-stream Habitat	Relates to the ability of a stream to meet basic physical requirements necessary for the support of a well-balanced aquatic community (eg: depth of flow, water velocity, water temperature, substrate type and quality, etc).	Wetted Perimeter	> 85% of bottom width	61-85%	40 - 60 %	< 40 %	
		Diversity of structure, velocity and depth of flow	All forms present, diverse vel. and depth of flow	Good mix of form, rel. diverse velocity and depth	Few pools, riffles and runs dominant, vel & depth gen shallow/slow	dominated by 1 type (usually runs) and 1 vel/depth (usually slow & shallow	
		Riffle substrate	cobble, gravel, rubble, boulder mix with little sand & >50 % cobble	Good mix of gravel, cobble and rubble & 25-49% cobble	predominantly small cobble, gravel and sand & 5 - 24 % cobble	Predominantly gravel with high % sand & <5% cobble	
		Riffle depth	>0.20 m	0.15 - 0.19 m	0.10 - 0.14 m	< 0.10 m	
		Large Pool Depth	> 0.60 m	0.45 - 0.59 m	0.30 - 0.44 m	< 0.30 m	
		Channel Process	No channel alteration of significant point bar formation or enlargement	Slight increase in point bar formation or slight amount of channel mod.	Mod. increase in point bars and / or channel mod.	extensive channel alteration or point bar formation / enlargement	
		Riffle-Pool Ratio	0.9 - 1.1 to 1	0.7 - 0.89 to 1 or 1.11 - 1.3 to 1	0.5 - 0.69 to 1 or 1.31 - 1.5 to 1	< 0.49 to 1 or > 1.51 to 1	
		Stream Temp. on a Summer Afternoon	< 20 ○ C	20 to 24 ○ C	24 to 26 ○ C	>27 ○ C	
		Typical Score:	**7 to 8**	**5 to 6**	**3 to 4**	**0 to 2**	

NOTES:

Evaluation Category	Relative Significance	Criteria	Excellent	Good	Fair	Poor	Score
4 Water Quality	Indicative of watershed perturbations / general level of human activity, point and non-point source loads, and aquatic habitat conditions.	Substrate Fouling (on rock underside)	None: 0 -10%	Light: 11-20%	Mod: 21 - 50 %	High >50%	
		Total Dissolved Solids (TDS)	<50mg/L	50-100 mg/L	101-150 mg/L	>150 mg/L	
		Clearness of Water	>0.90 m visibility	0.45 - 0.89 m	0.15 - 0.44 m	<0.15 m visible	
		Odour	None	Slight organic odour	Slight - Moderate odour	Moderate to strong odour	
		Typical Score:	**7 to 8**	**5 to 6**	**3 to 4**	**0 to 2**	

NOTES:

Evaluation Category	Relative Significance	Criteria	Excellent	Good	Fair	Poor	Score
5 Riparian Habitat Conditions	Provides insight into change(s) in stream energetics, temperature regime, and both aquatic and terrestrial habitat conditions	Width of Riparian Buffer	Wide > 200' with mature forests on both sides	Forested buffer >100' along major portion	Predom. Wooded but major localized gaps	Mostly non-wooded vegetation, narrow width.	
		Canopy coverage (Shading)	>80% shading	60-79% shading	50-60 % shading	<50 % shading	
		Typical Score:	**6 to 7**	**4 to 5**	**2 to 3**	**0 to 1**	

NOTES:

Evaluation Category	Relative Significance	Criteria	Excellent	Good	Fair	Poor	Score
6 Biological Indicators	Best overall indication of stream health and level of watershed perturbation	Diversity of macro-invert community	Diverse community present (mayflies, stoneflies, and cased caddisflies (few snails or leeches)	Mayflies and caddisflies (stoneflies absent)	Pollution-tolerant species; aquatic worms dominant	Poor diversity dominated by midgeflies, aquatic worms and snails.	
		Number of Individuals	Mod to High #	Mod to High #	Low - Mod #	Low #	
		Typical Score:	**7 to 8**	**5 to 6**	**3 to 4**	**0 to 2**	

NOTES:

TOTAL SCORE:

CONDITION:

Slope Stability Rating Chart

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM

Individual Problem Sites

Site Number: 1 2 3 4 5 6 7 8 9 10

Reach Number:

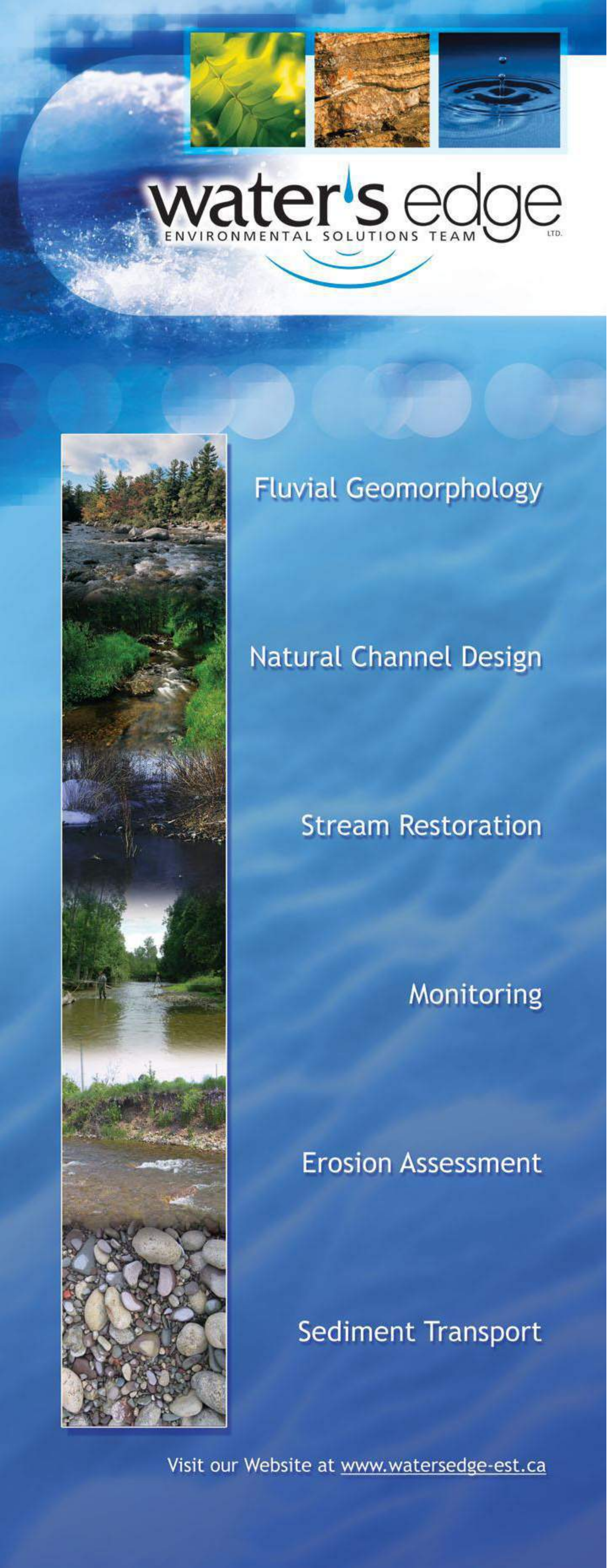
GPS #:

Slope Stability Individual Ranking Criteria Score

KEY:		[Horizontal:Vertical]			1	2	3	4	5	6	7	8	9	10
1. Slope Angle:	a) 18 or less	[3:1 or flatter]		0										
	b) 18-26	[2:1 to more than 3:1]		6										
	c) > 26	[steeper than 2:1]		16										
2. Soil Stratigraphy:														
	a) Shale, Limestone, Granite (Bedrock)	0	d) Clay, Silt	12										
	b) Sand, Gravel	6	e) Fill	16										
	c) Glacial Till	9	f) Leda Cla	24										
3. Seepage From Slope Face:														
	a) None or Near bottom only			0										
	b) Near mid-slope only			6										
	c) Near crest only or, From several levels			12										
4. Slope Height:														
	a) 2 m or less			0										
	b) 2.1 to 5 m			2										
	c) 5.1m to 10 m			4										
	d) > 10 m			8										
5. Vegetation cover on Slope Face:														
	a) Well vegetated; heavy shrubs or forested with mature trees			0										
	b) Light vegetation;mostly grass,weeds,occasional trees,shrubs			4										
	c) No vegetation, bare			8										
6. Table Land Drainage														
	a) Table Land flat, no apparent drainage over slope			0										
	b) Minor drainage over slope, no active erosion			2										
	c) Drainage over slope, active erosion, gullies			4										
7. Proximity of Watercourse to Slope Toe														
	a) 15 m or more from slope toe			0										
	b) Less than 15 m from slope toe			6										
8. Previous Landslide Activity														
	a) No			0										
	b) Yes			6										
Total Slope Instability Summary Rating Value = Total of # 1 to 8				Summary										

Shoreline Assessment Form

Component of Riparian Shoreline	Items	Impact	Present	Absent
Vegetation	Trees and shrubs	• Cushion the force of rain drops • Hold rainwater on leaves and branches • Roots stabilize soil	□	□
	Grasses and groundcover	• Slow runoff flow • Filter pollutants • Allow water to soak in along root channels	□	□
	Duff layer (leaves and twigs on soil surface)	• Covers soil • Slows runoff • Allows water to infiltrate soil	□	□
	Emergent plants (rooted in sediment but are over the water surface [ie bulrush])	• Shoreline stability • Fish habitat • Protects shore from wave action • Attracts odonates (dragonflies and damselflies, which eat mosquitoes)	□	□
	Submergent plants (plants that do not break the water surface)	• Fish habitat • Protects shore from wave action	□	□
	Floating plants (ie lily pads)	• Fish habitat • Protects shore from wave action • Attracts other wildlife	□	□
Native species	Species of plants that are endemic to the area that you live in	• Attracts wildlife • Reduces invasive species coming onto your property	□	□
Riparian width	>30 m	• The ideal riparian width for a healthy community	□	□
	>10 m to 30 m	• N/A	□	□
	5 m to 10 m	• N/A	□	□
	<5 m	• The less ideal riparian width	□	□
Natural Shoreline	No form of hard anthropogenic erosion protection measures (e.g. rip rap, armourstone, retaining wall)	• Anthropogenic structures can have adverse effects on shoreline processes	□	□
Shallow in-water material	These can include rocks, gravel, woody debris, and/or aquatic plants.	• Shoreline stability (reduces wave action) • Increases habitat value	□	□
Chemical free environment near shore	Not using harmful chemicals near shore (i.e. gasoline spills, cleaning products, pesticides ,etc.)	• Toxic chemicals can spill or leach into the lake or body of water	□	□
Buildings or septic beds distance from water	Ideally at least 30 m from the shoreline	• Runoff and human waste can leach into water	□	□
Docks	If there is a dock, should be floating, cantilever, or post construction	• Allows free passage of water and wildlife	□	□



APPENDIX C:

Field Photography

Photograph 1: Reach W-1

Photograph 2: Reach W-2

Photograph 3: Reach W-3

Photograph 4: Reach W-4

Photograph 5: Reach W-7

Photograph 6: Reach W-8

Photograph 7: Reach W-9

Photograph 8: Reach W-10

Photograph 9: Reach W-11

Photograph 10: Reach W-12

Photograph 11: Reach W-14

Photograph 12: Reach W-16


Photograph 13: Reach G-1


Photograph 14: Reach G-2

Photograph 15: Reach G-3

Photograph 16: Reach G-5

Photograph 17: Reach G-6

Photograph 18: Reach G-7


Photograph 19: Reach G-8


Photograph 20: Reach C-1

Photograph 21: Reach C-3

Photograph 22: Reach C-5

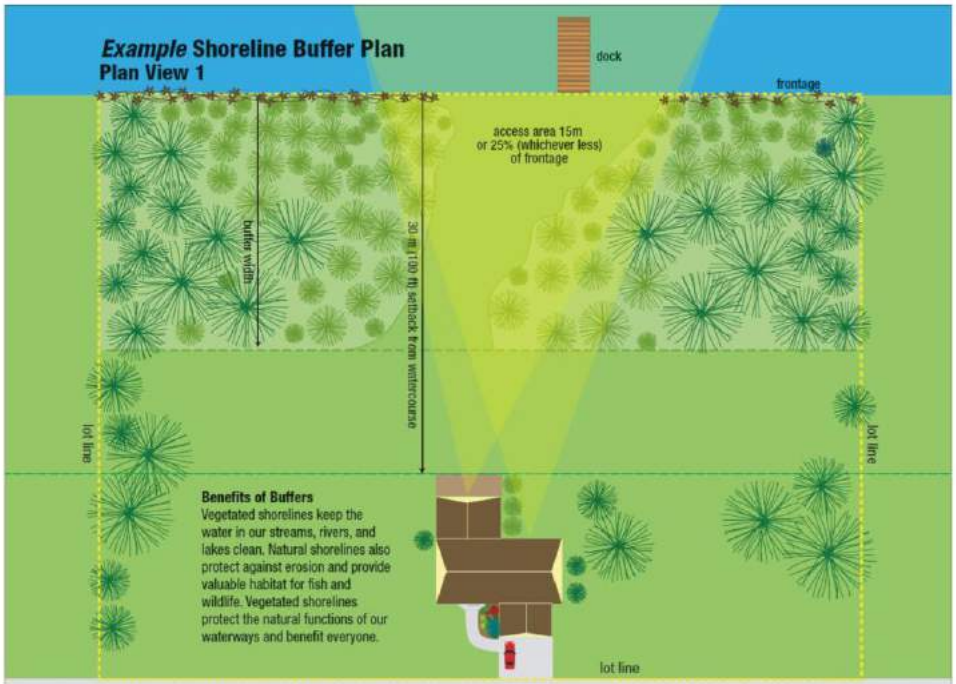
Photograph 23: Reach C-6

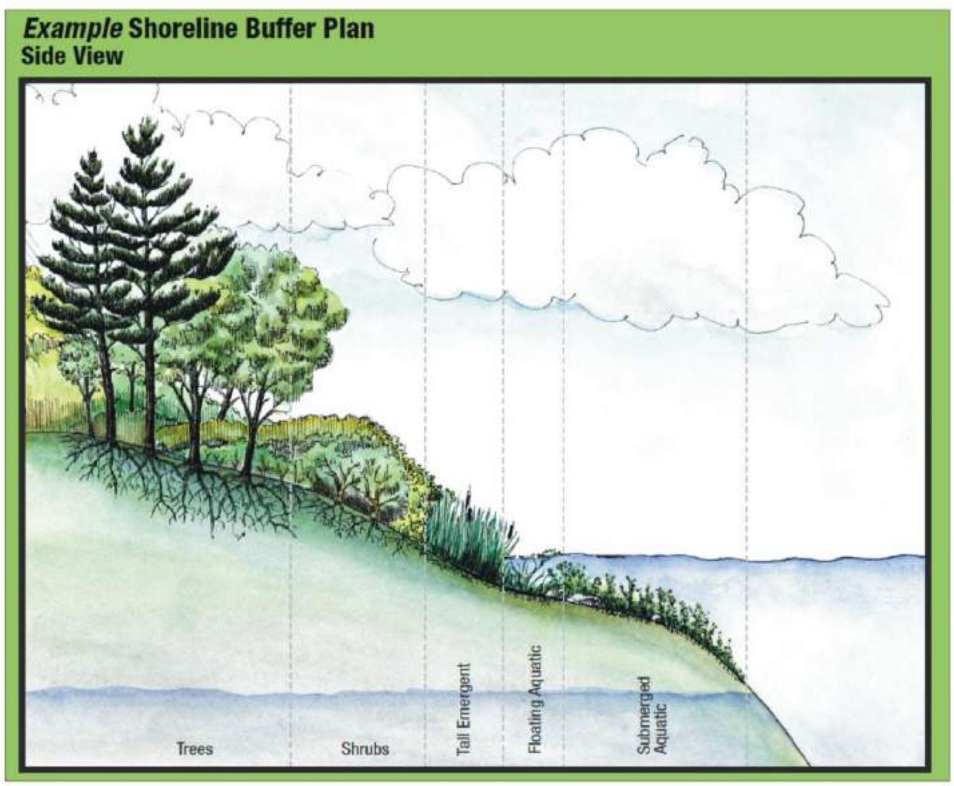
Photograph 24: Reach C-8

APPENDIX D:

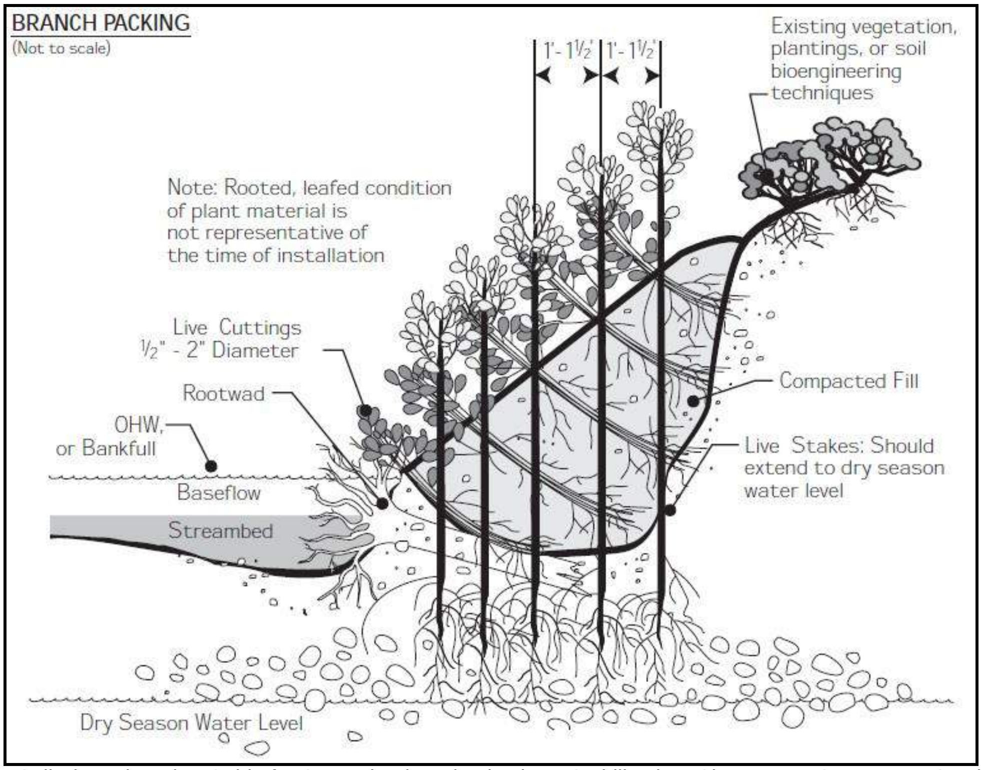
Typical Treatments & Erosion and Sediment Control Options

Bank/Shoreline Treatment Options: Typical Drawings

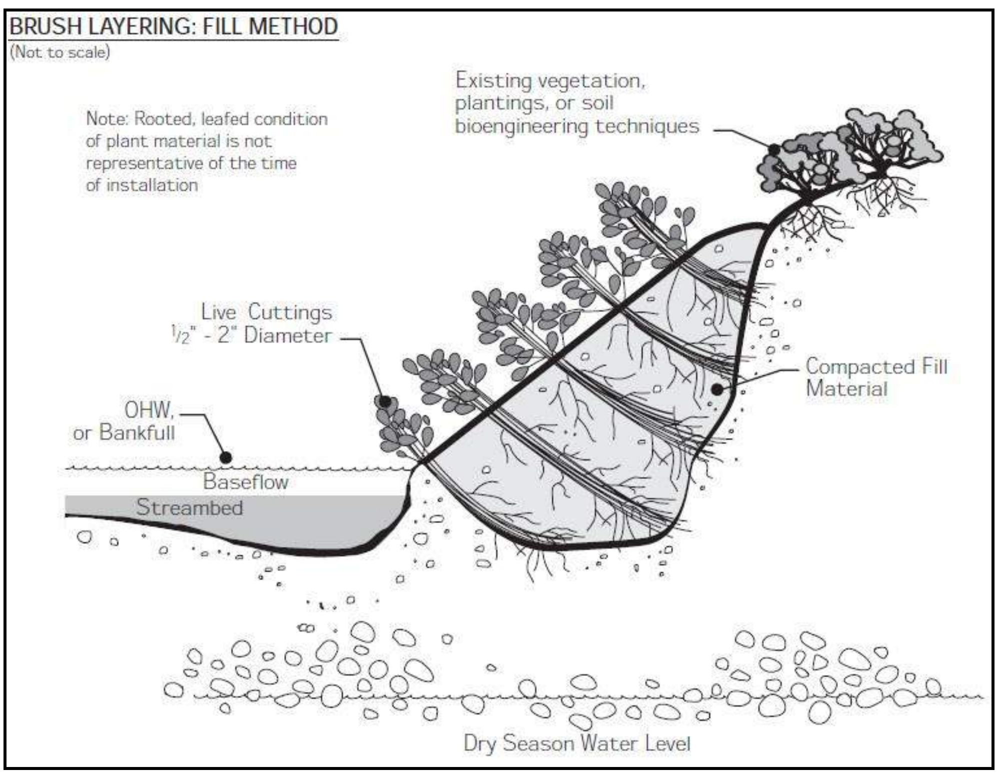




Source: http://www.rvca.ca/programs/shoreline_naturalization_program/



Source: A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization: Chapter 5, USDA Forest Service, 2002.



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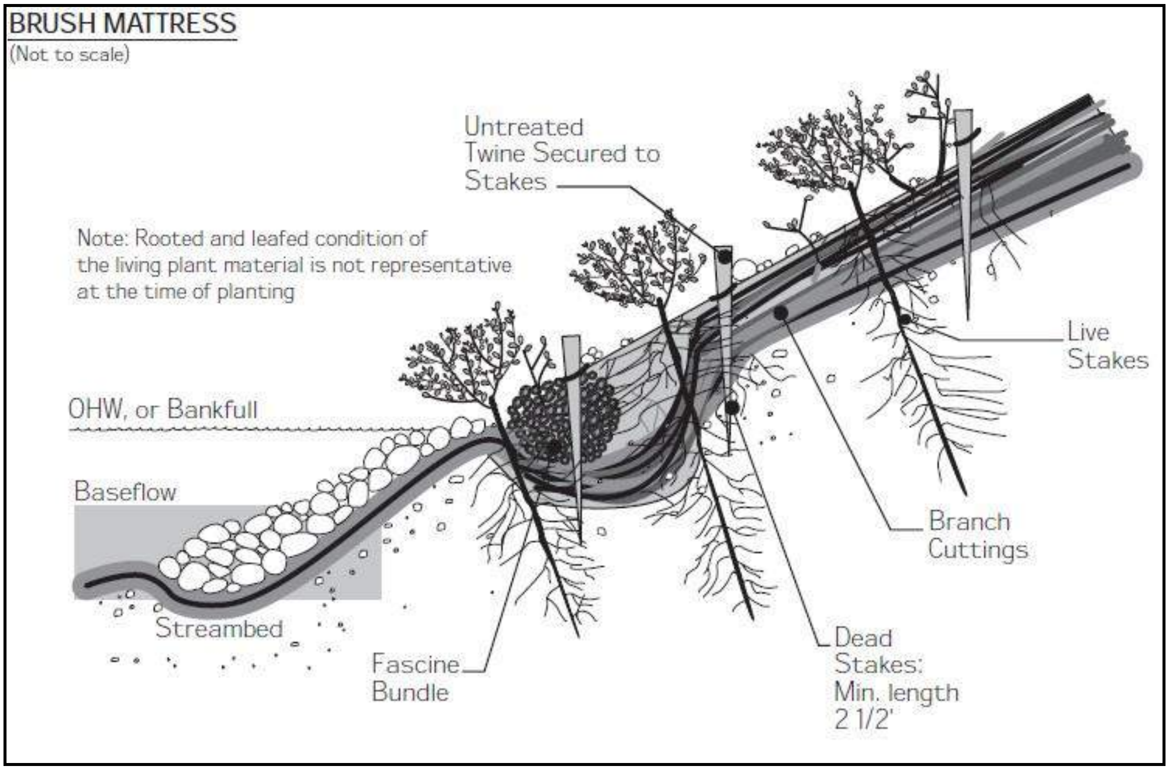

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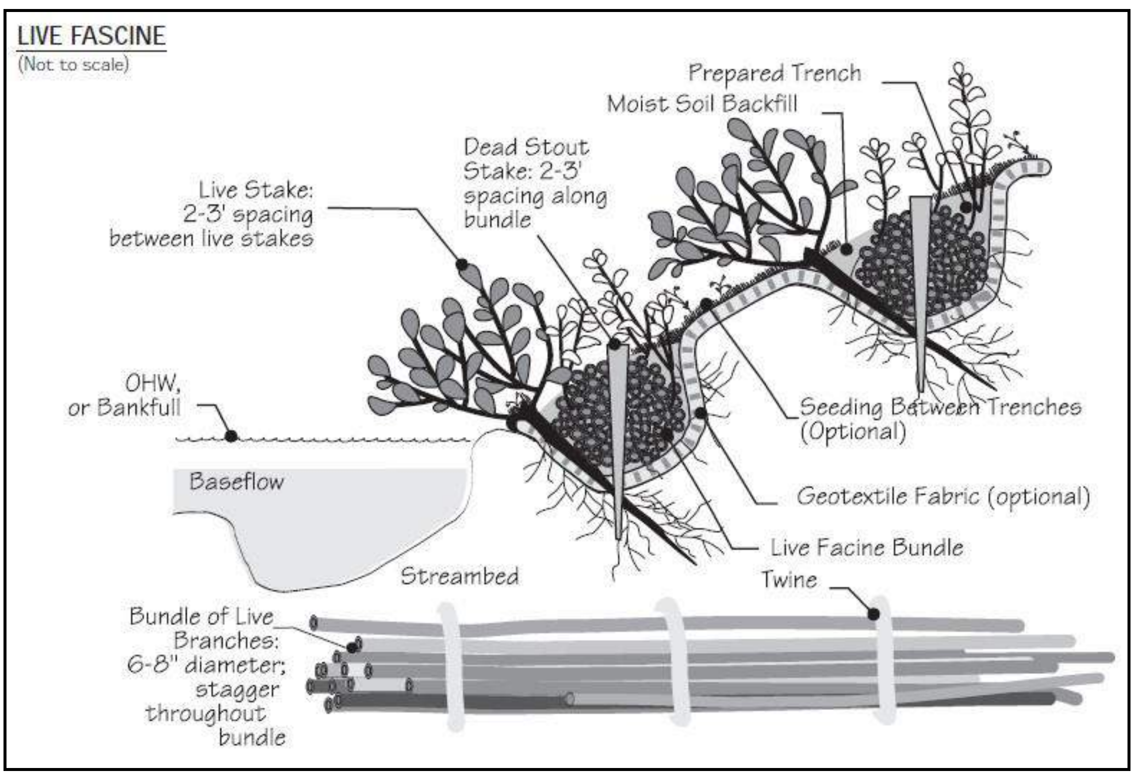

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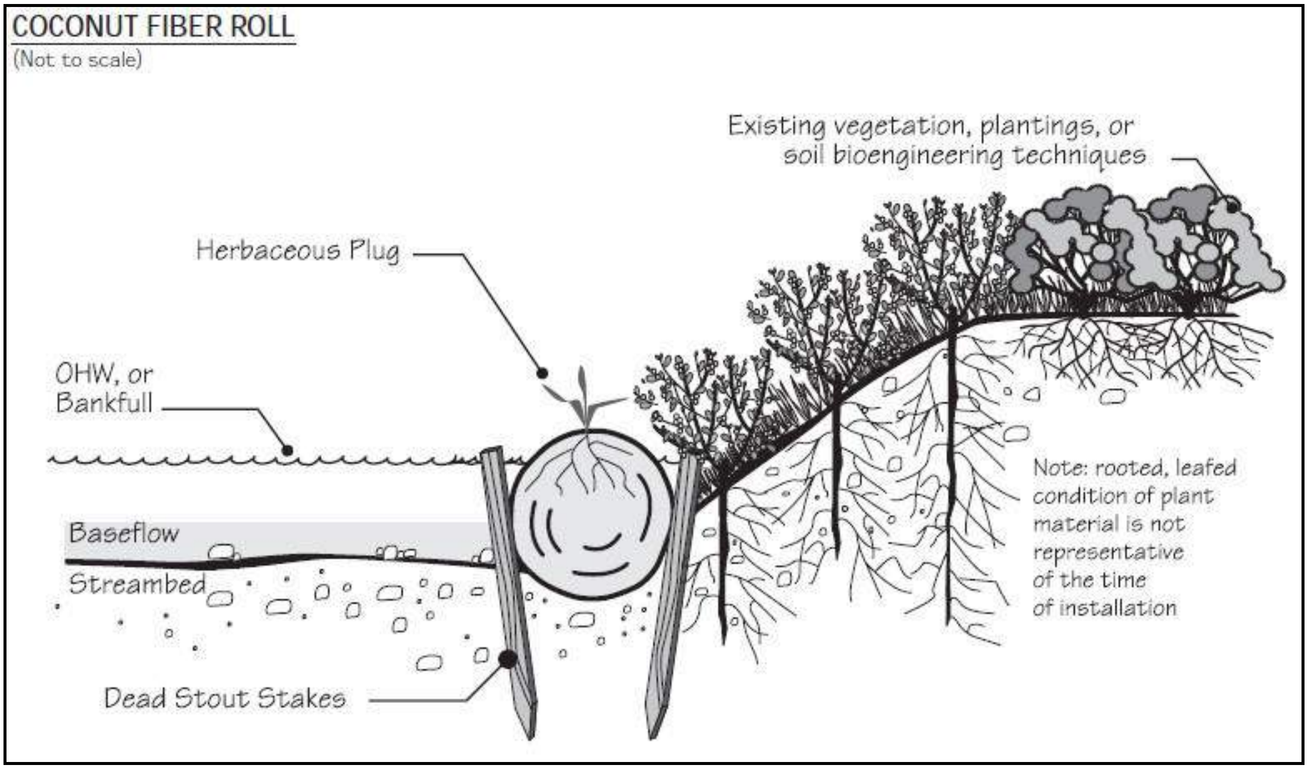

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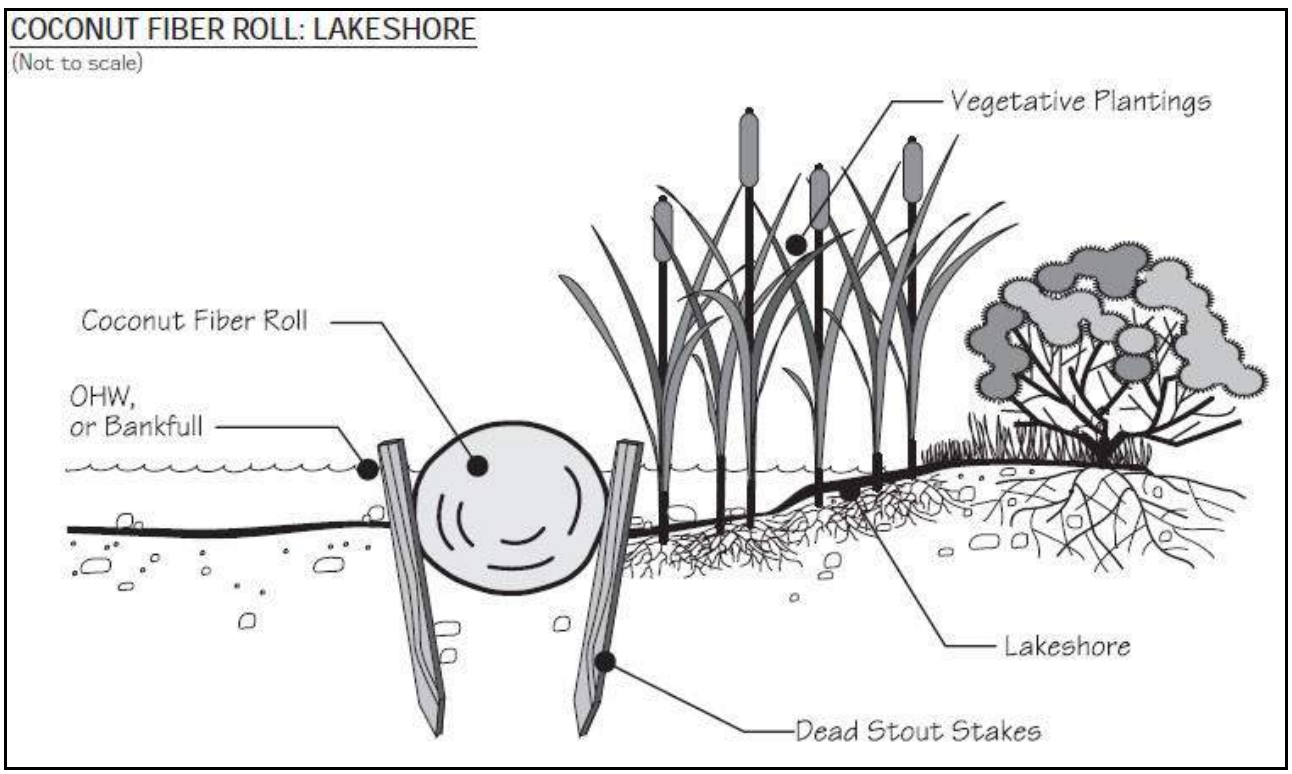

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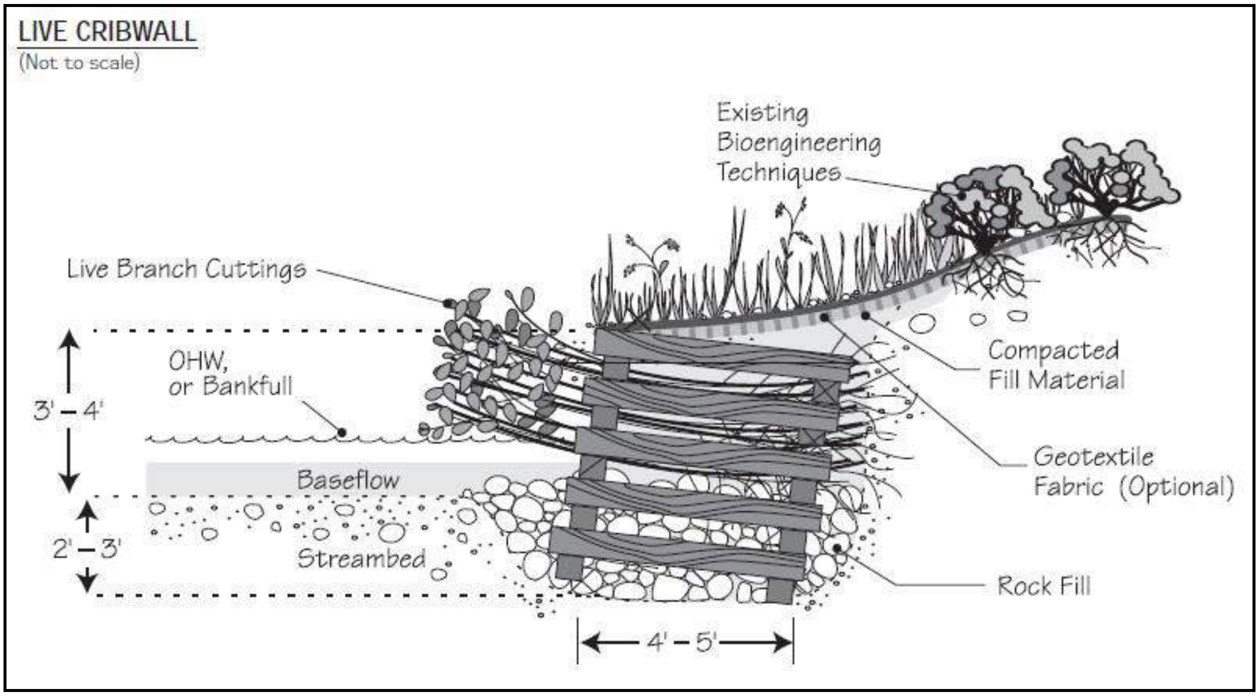

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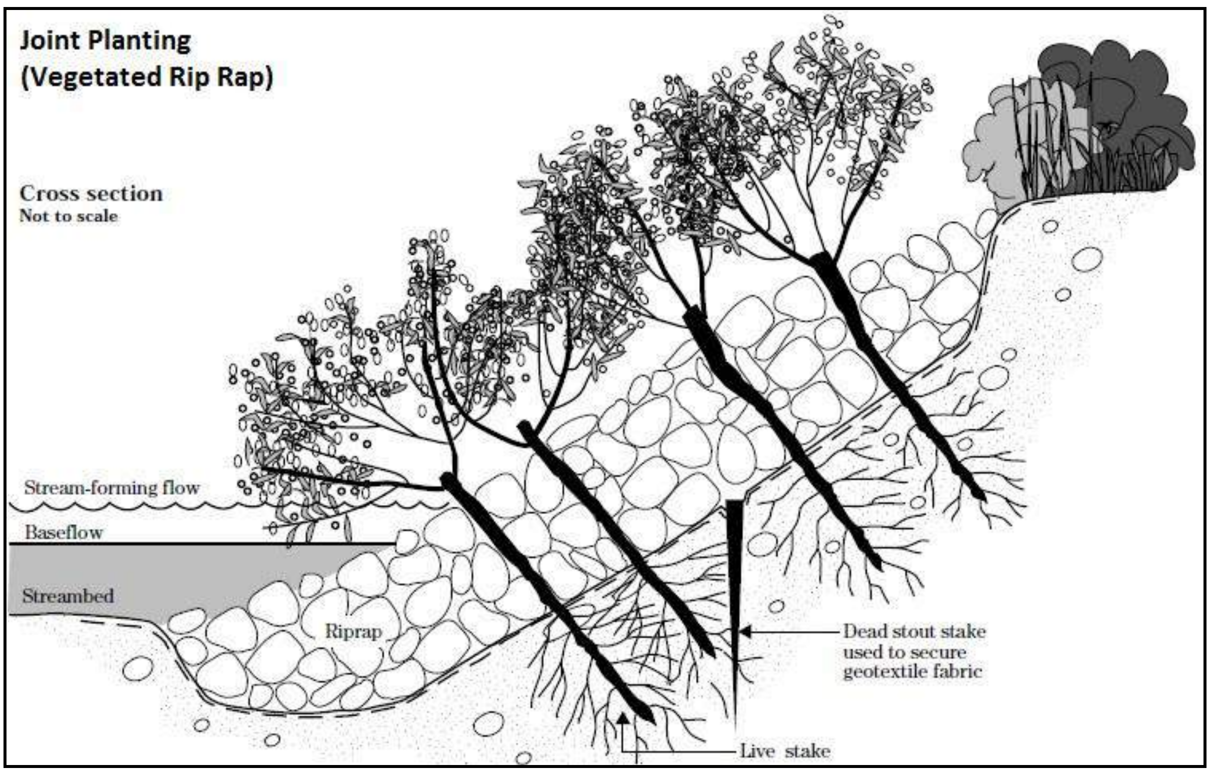
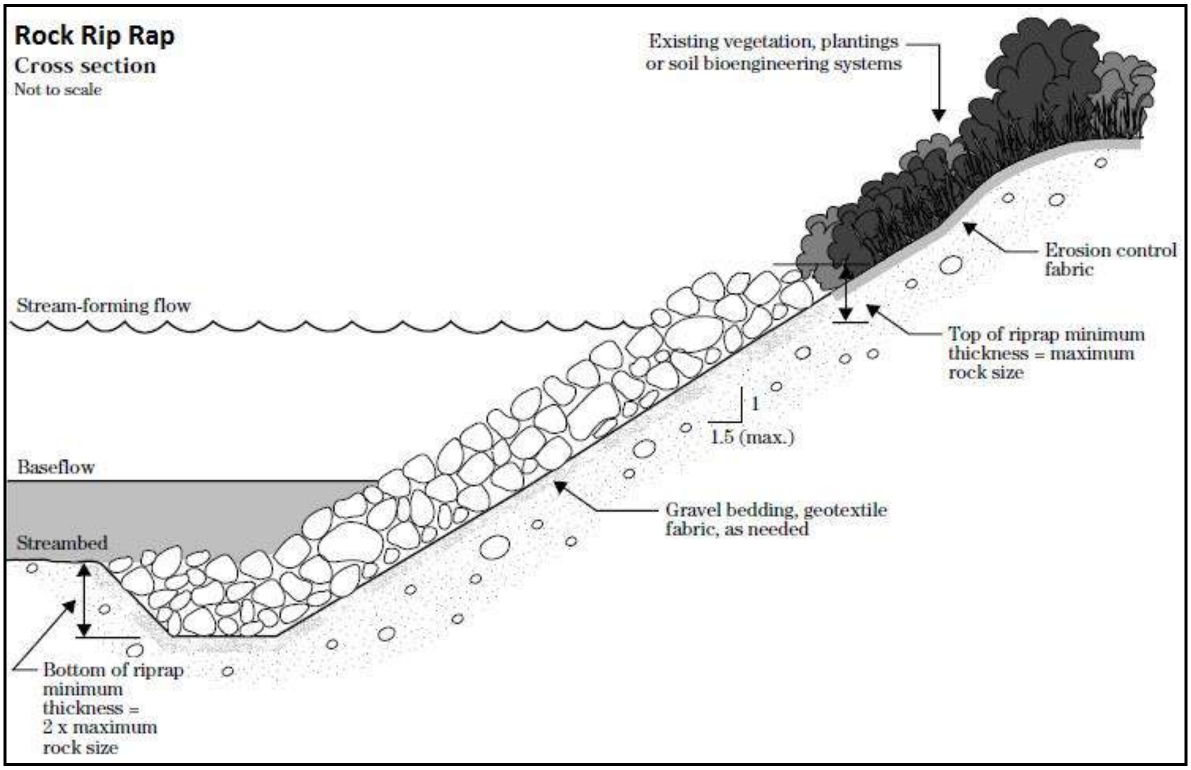


Source: Engineering Field Handbook Chapter 16: Streambank and Shoreline Protection, USDA, 1996.



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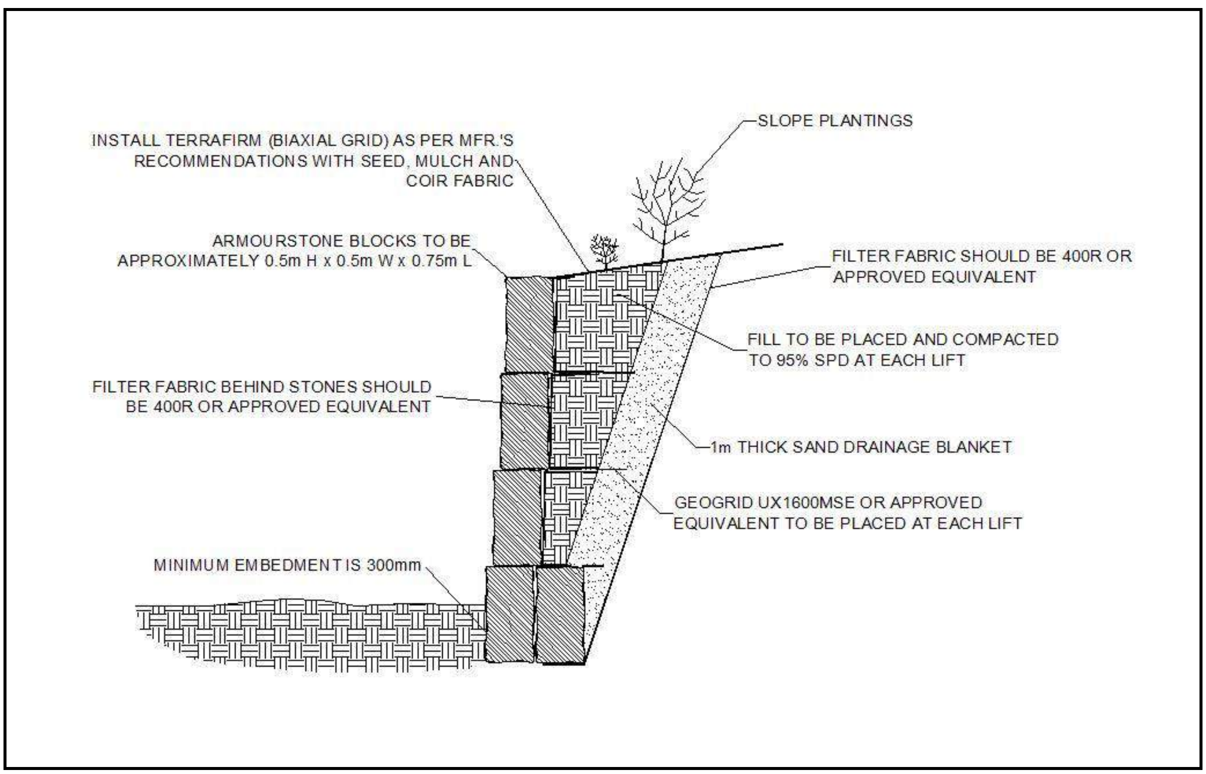
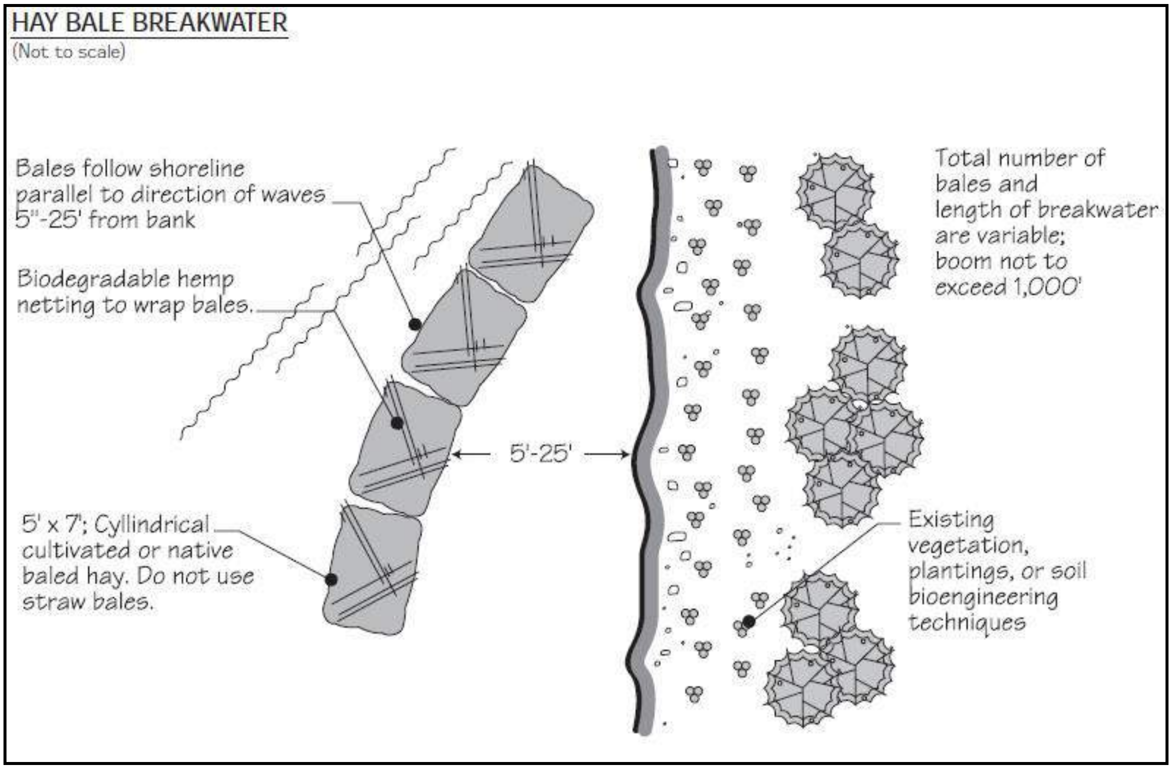


Source: Water`s Edge Environmental Soloutions Team Ltd., 2015.



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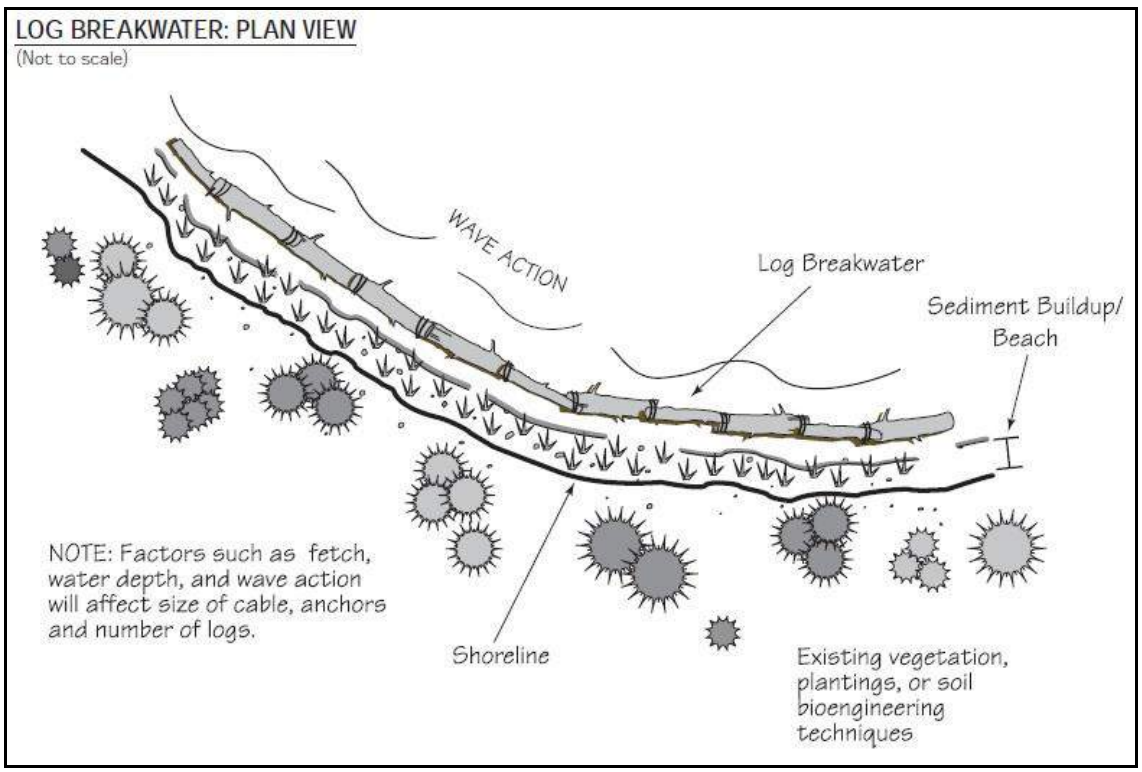


Source: A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization: Chapter 5, USDA Forest Service, 2002.

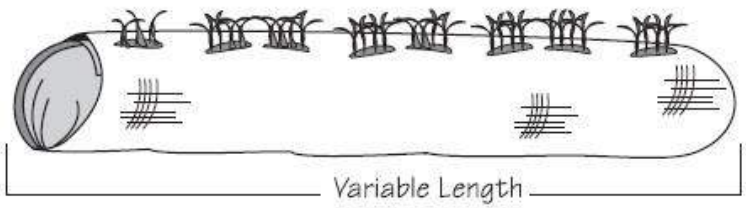
WRAPPED PLANT ROLL

(Not to scale)

Two methods of construction are illustrated.

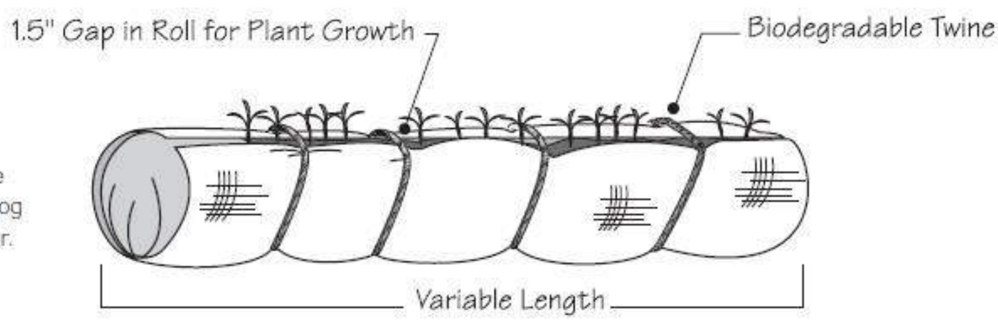
EXAMPLE 1

The plants are wrapped in burlap or coconut fiber mat. Slits are cut along the top, and the leafy portions of the plants are pulled through.



EXAMPLE 2

Burlap is pulled snugly around the plants and secured by twine wrapped around the roll, or by hog rings holding the edges together.



Source: A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization: Chapter 5, USDA Forest Service, 2002.

Erosion and Sediment Control (ESC) Examples

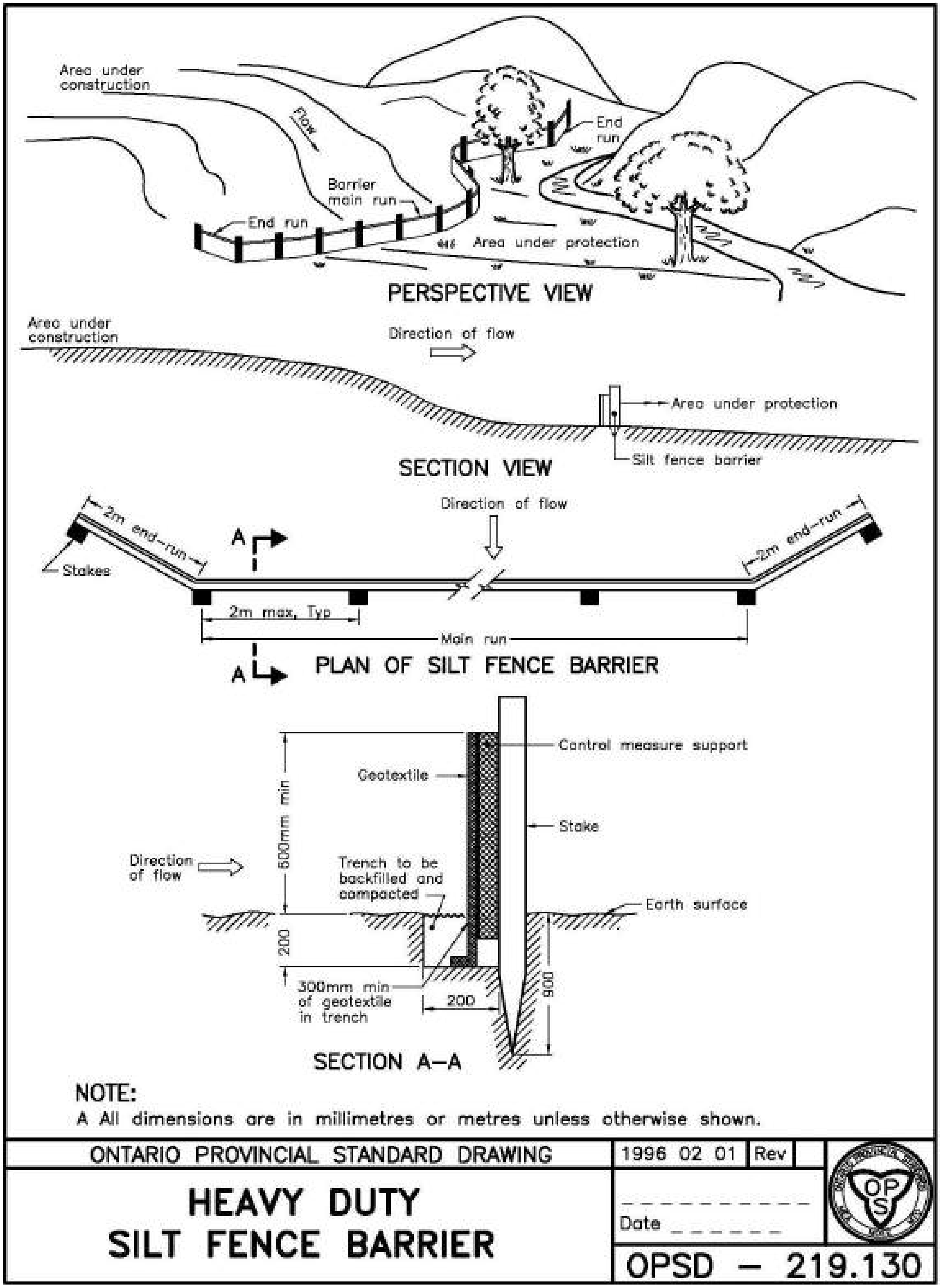
Source: Erosion and Sediment Control Guidelines for Urban Construction, Greater Golden Horseshoe Conservation Authorities, 2006.

Table D1: Erosion Control Practices

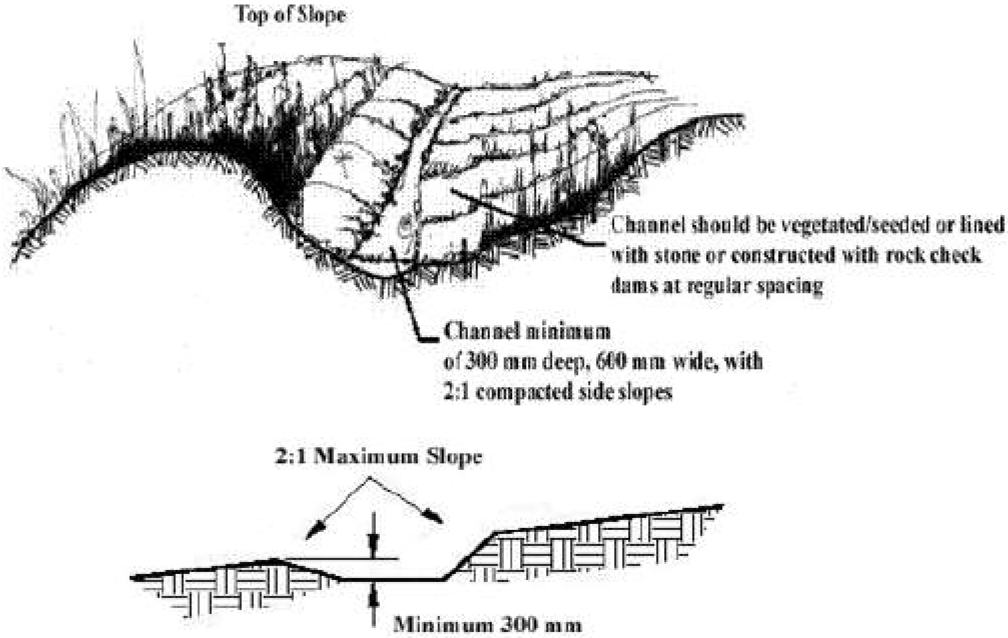
Name of Erosion Control Measure	Applicability								
	Slopes	Streams/Rivers	Surface Drainage Ways	Table Lands	Borrow/Stockpile	Adjacent Property	Temporary	Permanent	Reference Page
Vegetative Filter Strips	√	√	√	√	√	√	√		C-2
Mechanical Seeding*	√		√	√	√	√	√	√	C-3
Terraseeding*	√		√	√	√	√	√	√	C-5
Hydroseeding*	√		√	√	√	√	√	√	C-7
Top soiling	√		√	√	√	√		√	
Sodding	√		√	√	√	√		√	
Mulching	√		√	√	√	√	√	√	
Re-vegetative Systems	√		√	√	√	√	√	√	
Tree and Shrub Planting	√	√	√	√	√	√		√	
Erosion Control Matting/Blanket/Net (with Seed)	√		√	√	√	√		√	C-8
Growth Media Erosion Control Blanket	√	√	√	√	√	√	√	√	C-11
Lockdown Netting	√		√	√			√	√	C-14
Buffer/Riparian Zone Preservation		√						√	
Surface Roughening (Scarification)	√				√		√		C-16
Edge Saver	√	√		√				√	C-18

Note: * Various seeding practices.

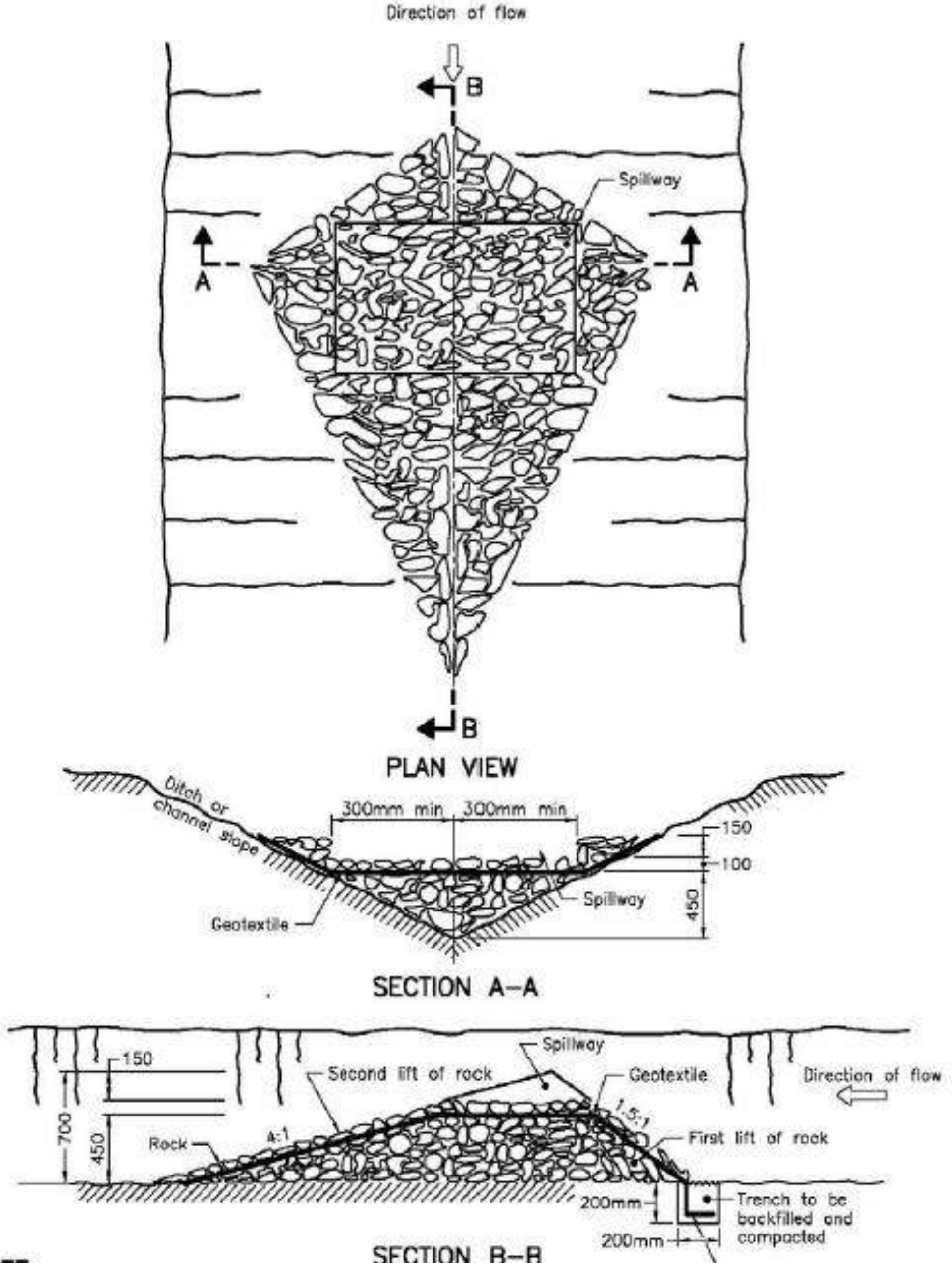
Sediment Control Practices



Example of Interceptor Swale/Dyke. Figures from Surface Water Design Manual, Appendix D (King County Department of Natural Resources, 1995); Water Related Best Management Practices in the Landscape (NRCS/USDA, 1999).



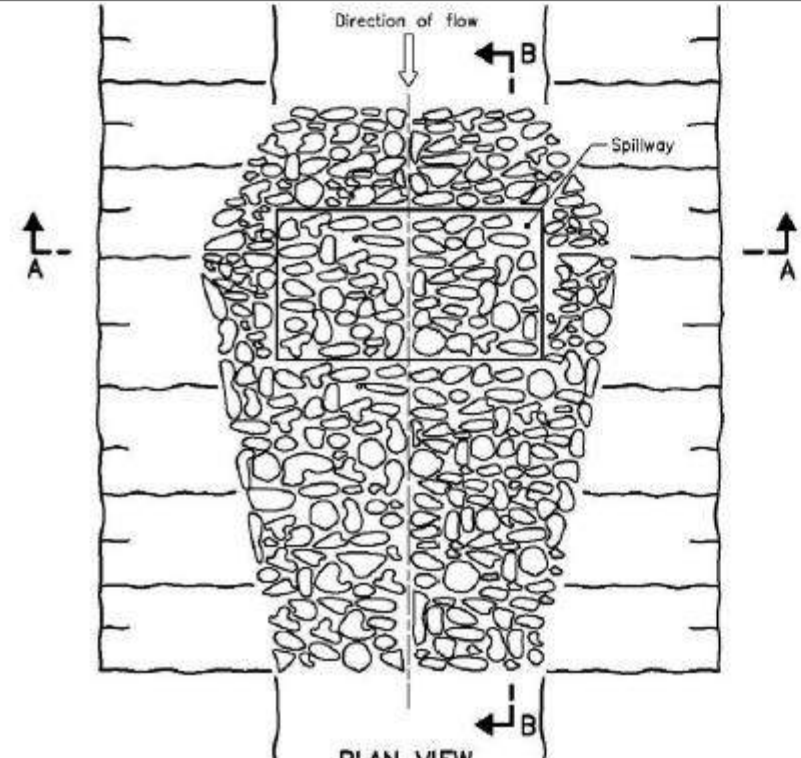
Example of Silt Soxx for Perimeter Control.



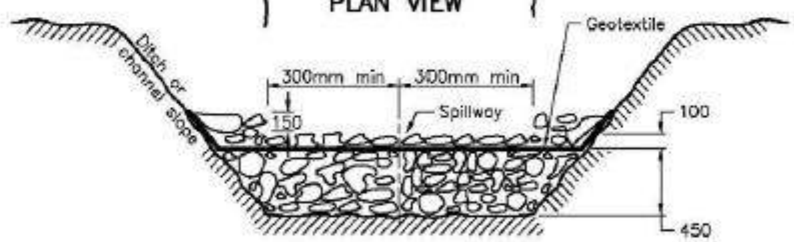
NOTE:

A All dimensions are in millimetres or metres unless otherwise shown.

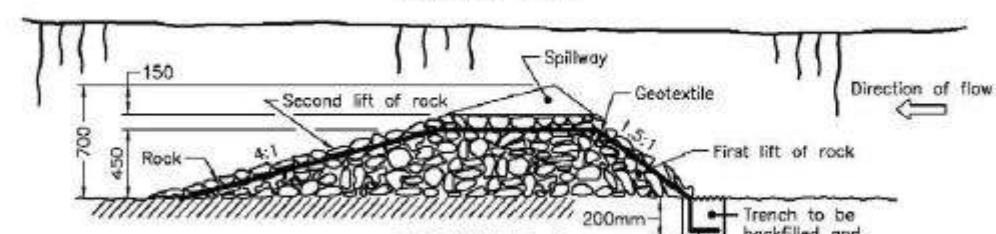
ONTARIO PROVINCIAL STANDARD DRAWING	1996 02 01 Rev
TEMPORARY ROCK FLOW CHECK V-DITCH	Date
	OPSD – 219.210



PLAN VIEW



SECTION A–A



SECTION B–B

NOTE:

A All dimensions are in millimetres or metres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

1996 02 01 Rev

TEMPORARY ROCK FLOW CHECK

FLAT BOTTOM DITCH OR CHANNEL

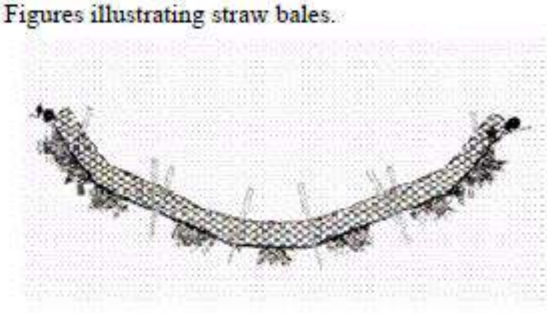
Date

OPSD – 219.211

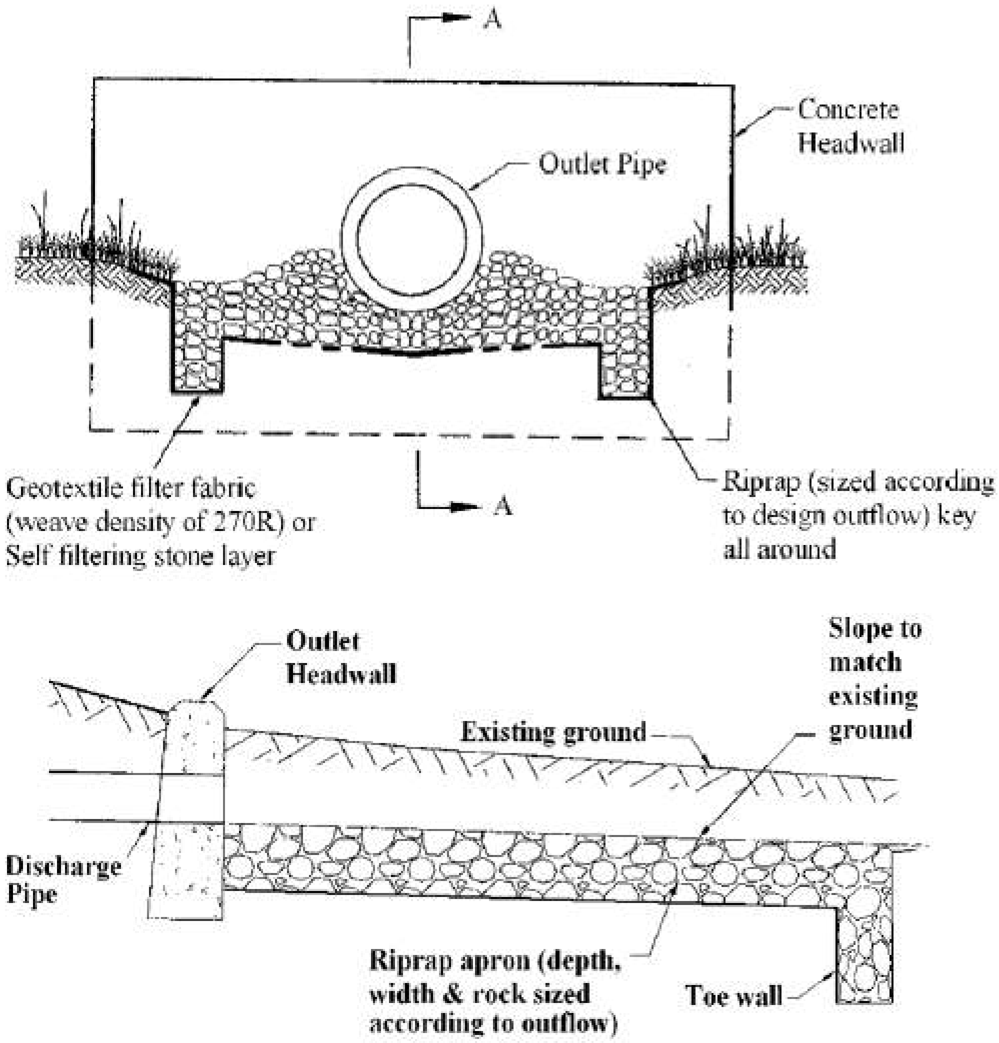
Example of Ditch Chexx™.

EXCEL Straw Logs

Figures illustrating straw bales.

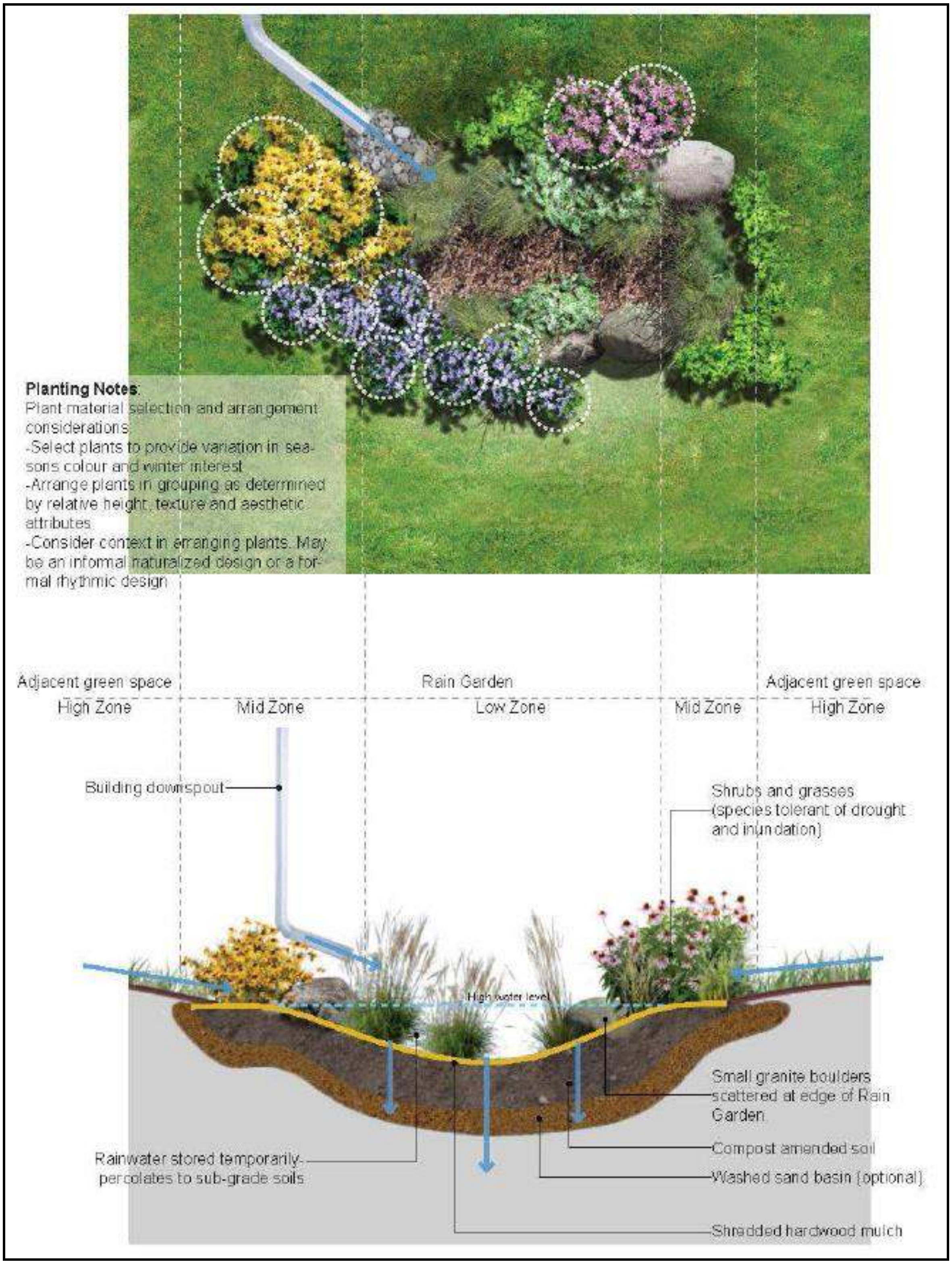


Figures illustrating a storm drain outfall protection from Sediment & Erosion Control on Construction Sites – Field Guide (University of Virgin Islands, 2003)



Low Impact Development

Rain Garden



Source: Low Impact Development Stormwater Management Planning and Design Guide. Credit Valley Conservation and the Toronto and Region Conservation Authority, 2010

Planting Notes

How to build a live stake

Live stakes should have a diameter of greater than 3 cm and must be at least 30 cm long. Stakes should be collected with fresh, live cuttings from dormant vegetation. Live stakes can be made and installed as follows (Ontario Streams, no date):

1. Trim all of the side branches with pruning shears, without damaging the bark.
2. Cut the stake to length (greater than 30 cm) by making an angled cut at the bottom of the stake.
3. Live stakes can and should be soaked in water so they do not dry out.
4. Push the stake in the ground with the slanted end down.
5. Installation should be done with a deadblow hammer (rubber mallet). Gently hit the stake into the ground at right angles to the slope. Ensure that at least 70% of the live stake is buried.

How to plant bulrushes

There are two planting techniques for bulrushes that are effective:

1. "Rootstock can easily be planted in the water with a shovel. It is easiest to plant in shallow water. However, plants may be vulnerable to wave action and ice shear if planted too close to shore. Therefore, it is recommended to plant rootstocks at a minimum depth of 18 to 20 inches out of the range of wave and ice action. Rootstock planted into hard, sandy substrate with a shovel does not require anchoring" (Shuttleworth, 1997).
2. "A more costly but promising commercial nursery technique is the bioengineering approach where nursery material is grown in coconut fiber blankets which are then rolled up and shipped. Local seeds can be collected and sent to the nursery to ensure use of local genotype. To minimize time and discomfort from working in cold water during spring transplanting, two resource managers devised a system of sewing rootstock at about one clump (3-5 stems) per square foot onto rolls of geo-jute, a decomposable fiber product. The jute can be rolled up like a carpet, transferred to the water, unrolled and weighted down with rocks" (Shuttleworth, 1997).

Spacing/Density

The following notes were selected from:
http://www.creditvalleyca.ca/wp-content/uploads/2013/05/12-205-prairiemeadow-booklet-web.pdf

"Space trees 1-3 metres apart depending on the anticipated size of the plant. Shrubs can be spaced 1/2 to 1 metre, and ground layer spacing will generally be at 15-30 cm. Before planting set your plants out where you want them to go. Then adjust according to their spacing requirements and your preferences.
For instructions about how to plant trees and shrubs, refer to CVC's How to Plant a Potted Tree or Shrub.

If seeding, follow the nursery guidelines for volume of seed and planting instructions. Most herbaceous seeds are best mixed with light soil and gently raked into the ground surface.
Gently press the seed into contact with the soil being careful not to crush the seed or compact the soil. If seeding in spring, water with a light mist until the soil is moist. Repeat the lightwatering daily, unless there is rain, until the seeds germinate. If seeding in fall, do not water as it is best if the seeds lie dormant until spring thaw."

The following notes were selected from:
http://www.creditvalleyca.ca/wp-content/uploads/2013/05/12-205-prairiemeadow-booklet-web.pdf

“Flowers and grasses will generally be spaced at 15 - 40 cm (6-16”), depending on the size and growth habit of the plants. For example, some grasses are clump-forming, others are single stemmed. Clump-forming grasses can be planted further apart. Before planting, set plants out where they will be planted. Then adjust the plants according to their spacing requirements and your preferences.
Seeding rates will vary depending on the mix of species. Always follow the seeding rates provided by your seed supplier, noting that it is better to over seed than under seed in order to avoid bare spots and discourage weeds. Approximate seeding rates are:

- Grasses - 100 g per 70 m^2
- Wildflowers - 100 g per 250 m^2
- Mixed grasses, flowers - 100 g per 100 m^2 to help ensure even coverage, rates should be increased in small areas. Extra plants can be transplanted if spacing is too dense."

Selected Plants Used in Planting Plans

Plant	Benefits	Height	Habitat Requirements	Photo Example	Sources
AQUATIC					
Pickerel Weed (*Pontederia cordata*)	Beautiful flowers and provides cover for animals	90-120 cm	Can grow in 20-30 cm deep of water (or less)		http://www.fcps.edu/islandcreekes/ecology/pickerelweed.htm http://imgkid.com/pickerel-weed.shtml
Softstem Bulrush (*Schoenoplectus tabernaemontani*)	Provides food and cover for animals	1-3 m	Can grow in 1 m deep water, prefers shallower		http://plants.usda.gov/plantguide/pdf/cs_scta2.pdf http://www.gopixpic.com/633/river-bulrush-hard-stem-bullrush/http:%7C%7Cclassconnection*s3*amazonaws*com%7C86%7Cflashcards%7C858086%7Cjpg%7Chardstembulrush1343067116650*jpg/
Dark Green Bulrush (*Scirpus atrovirens*)	Good choice for lakeshore restoration	60-150 cm	Can grow up to 30 cm deep of water Grows in the wettest of soils Full sun		http://nativeplants.evergreen.ca/search/view-plant.php?ID=00628 https://www.prairiemoon.com/seeds/grasses-sedges-rushes/scirpus-atrovirens-dark-green-bulrush.html

Broad-leaved Cattail (*Typha latifolia*)	Good restoration plant and attractant of wildlife	1-3 m	Can grow in waters 30-45 cm in depth or less		http://www.kswildflower.org/sedge_details.php?sedgeID=4 http://www.waterfordgardens.com/Cattails-Hardy-Bog-Plants-sc-238.html
HERBACEOUS LAND PLANTS					
Blue Vervain (*Verbena hastata L.)*	Attractive purple/blue flowers	60-150 cm	Prefers moist conditions Full/partial sun		http://plants.usda.gov/factsheet/pdf/fs_veha2.pdf http://www.flowerspictures.org/flower-pictures/blue-vervain_1.html
Purple-stemmed Aster (*Symphyotrichum puniceum*)	Attractive wildflower	60-150 cm	Prefers wet soil conditions Full sun		http://ontariowildflowers.com/main/species.php?id=15
Square-stemmed monkey flower (*Mimulus ringens*)	Pretty violet irregular flower	45-90 cm tall	Wet habitats Full sun		http://ontariowildflowers.com/main/species.php?id=560 http://www.ontariowildflower.com/lakeedge.htm

Tall Mannagrass (*Glyceria elata*)	Rapidly establishing native species suitable for restoration of swamps, creeks and shores	100-180 cm tall	Moist to wet soil conditions Full sun		http://plants.usda.gov/factsheet/pdf/fs_glel.pdf http://calphotos.berkeley.edu/cgi/img_query?where-genre=Plant&where-taxon=Glyceria+elata
Virginia Wildrye (*Elymus virginicus*)	Cool season grass Good for native seed mixes	60-90 cm	Can tolerate moist habitats Full sun to partial shade		http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/stpmcfs0758.pdf http://www.pwrc.usgs.gov/history/herbarium/elymus_virginicus.htm
Blue Flag (*Iris versicolor*)	Very showy iris flower (purple)	60-90 cm	Moist to wet soils Full sun to partial shade		http://www.wildflower.org/plants/result.php?id_plant=IRVE2 http://en.wikipedia.org/wiki/Iris_flower_data_set
Wild Bergamot (*Monarda fistulosa*)	Pretty blue/violet flowers	60-120 cm tall	Drier soils (fields and open areas) Full sun		http://ontariowildflowers.com/main/species.php?id=245 https://webapps8.dnr.state.mn.us/restoreyourshore/plants/plant_detail/239
Black-eyed Susan (*Rudbeckia hirta L.)*	Attractive yellow flower Attracts birds and butterflies	30-90 cm	Dry to moist soils Full sun to full shade		http://www.wildflower.org/plants/result.php?id_plant=RUHI2 http://www.ufseeds.com/How-to-Grow-Black-Eyed-Susans-U1.html

SHRUBS					
Common Juniper (*Juniperus communis var depressa*)	Can be used for erosion control Evergreen species	120 cm	Dry/normal conditions Can grow in sand Lakeshores, rocky bluffs, alvars Full sun to light shade		http://nativeplants.evergreen.ca/search/view-plant.php?ID=01754 http://www.skeetchestn.ca/Natural%20Resources%20Website/florapages/commonjuniper.html
Ninebark (*Physocarpus opulifolius*)	Can be used for erosion control in riparian areas	2-3 m	Moist/normal/dry Can grow on lake shores (sand/loam) Full sun to partial shade		http://nativeplants.evergreen.ca/search/view-plant.php?ID=00496 http://de.wikipedia.org/wiki/Physocarpus
Nannyberry (*Viburnum lentago*)	Bird attractant Berries are edible	2-4 m	Can grow in dry normal or moist soils (can grow in sand) Full sun to partial shade		http://nativeplants.evergreen.ca/search/view-plant.php?ID=00739 http://search.millcreeknursery.ca/11050005/Plant/498/Nannyberry
Red-osier Dogwood (*Cornus stolonifera*)	Can be used for erosion control in riparian areas	1.6-4 m	Can grow in normal, moist to wet soils Full sun to partial shade (Bark goes bright red in winter)		http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c300 http://science.halleyhosting.com/nature/gorge/4petal/dog/creek.html

Speckled Alder (*Alnus incana*)		2-4 m	Prefers moist/wet soils Full sun to partial shade		http://www.borealforest.org/shrubs/shrub3.htm http://www.cedarcreek.umn.edu/conservation/habitats/images/shrubs2
TREES					
Balsam Fir (*Abies balsamea*)		Up to 30 m	Tolerates different moisture and shade levels		http://www.ontario.ca/environment-and-energy/balsam-fir http://www.woodlotinfoshop.ca/index.php?r=SBCms/page_57
White Cedar (*Thuja occidentalis*)		Up to 15 m	Prefers moist soil Full sun to partial shade		http://www.borealforest.org/trees/tree14.htm http://galleryhip.com/eastern-white-cedar-leaf.html
Tamarack (*Larix laricina*)	Can be used as erosion control on lakeshores and riparian areas	Up to 18 m	Prefers moist/wet soils Can grow in dry and shallow over bedrock Full sun to full shade		http://nativeplants.evergreen.ca/search/view-plant.php?ID=00388 http://commons.wikimedia.org/wiki/File:Larix_laricina_Kanadanlehtikuusi_Kanada_l%C3%A4rk_C_DSC03087.JPG

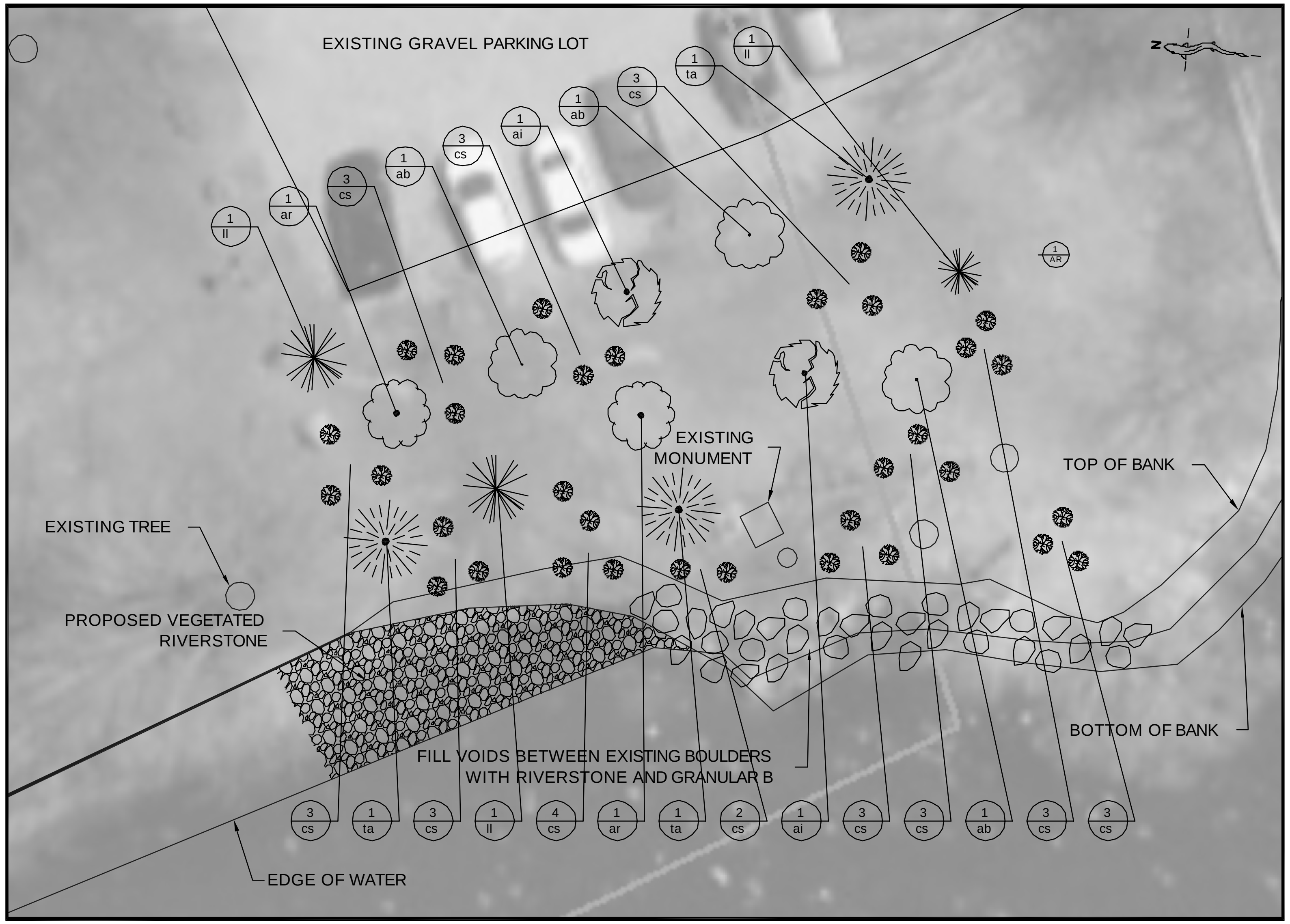
Red Maple (*Acer rubrum*)	Can be used as erosion control in riparian areas	12-25 m	Prefers moist to wet soils Can grow in full sun, partial shade, and shade (Leaves turn bright red in fall)		http://nativeplants.evergreen.ca/search/view-plant.php?ID=01760 http://www.horsedvm.com/disease/red-maple-toxicosis/

A comprehensive list of native plants, and their growing requirements and tolerances is available in: *Shoreline Restoration Using Native Plants* by the Haliburton County Master Gardeners (www.haliburtonmastergardener.ca). Available online at: http://cohpoa.org/Native%20Trees,%20Shrubs%20and%20Plants%20for%20Shoreline.pdf

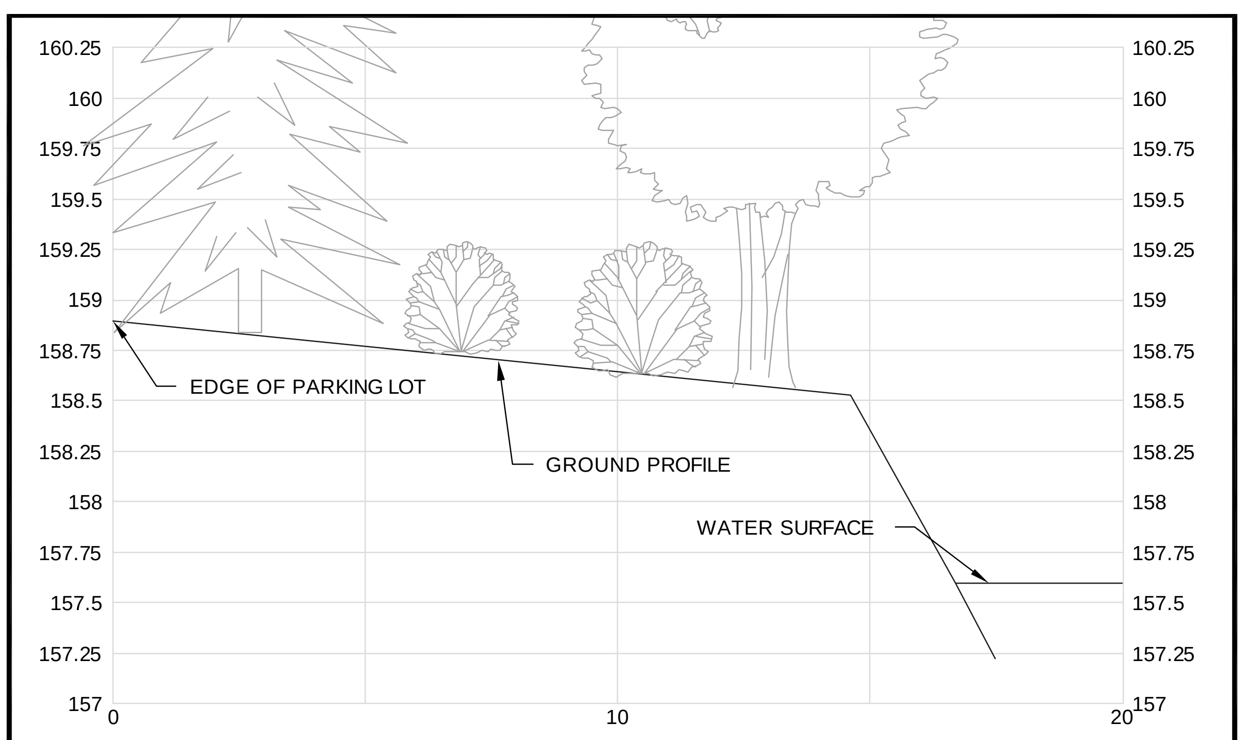
APPENDIX E:

Site Plans

PLAN
SCALE - 1:200



PROFILE
SCALE - 1:150



SITE REVEGETATION:

ALL DISTURBED AREAS, INCLUDING ACCESS ROUTES, STAGING AREAS AND WORK ZONES ARE TO BE CLEARED (PLANT MATERIAL TO BE SALVAGED) PRIOR TO CONSTRUCTION AND REVEGETATED WITH SPECIFIED SEED MIX AND SALVAGED PLANT MATERIAL UNLESS DIRECTED OTHERWISE BY DESIGN DETAILS.

AREA STABILIZATION:

EROSION CONTROL BLANKETS ARE TO BE PLACED TO CONTROL EROSION AFTER SEEDING. ECB TO BE KoirMat 400 OR APPROVED EQUIVALENT AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

CONSTRUCTION SUPERVISION:

THE PROJECT MANAGER SHALL BE ON SITE OR AVAILABLE DURING ALL PHASES OF CONSTRUCTION AND IN-WATER WORKS.

FISHERIES TIMING WINDOW:

THERE SHALL BE NO IN-WATER WORK OR ACTIVITY FROM APRIL 1 TO JUNE 30.

SITE 1 PLANTING PLAN

THIS SITE IS UNDERGOING HEAVY EROSION BESIDE THE RETAINING WALL. ADDITIONALLY THERE ARE CONCERNS OF RUNOFF FROM THE PARKING LOT NEAR THE SHORE.

INSTRUCTIONS:

1. INSTALL VEGETATED RIVERSTONE ALONG THE ERODED BANK BETWEEN THE RETAINING WALL TO THE NORTH AND LARGE BOULDER BANK TO THE SOUTH. ENSURE THAT VOID SPACES ARE FILLED WITH FINE MATERIAL (GRANULAR B), AND CONTINUE TO FILL INTERSTITIAL SPACES OF THE EXISTING BOULDER BANK WITH A SURFICIAL APPLICATION OF COBBLES, GRAVELS, AND GRANULAR MATERIAL.

2. LAKE ACCESS ALONG THIS BANK HAS BEEN CONTRIBUTING TO EROSION, THEREFORE WE RECOMMEND CONSTRUCTING A DOCK OVER THE VEGETATED RIVERSTONE, OR IF POSSIBLE, AT THE RETAINING WALL ON THE ADJACENT PARK PROPERTY (BOTH PROPERTIES ARE MUNICIPALLY OWNED).

3. PLANTINGS: FOR LARGE TREES AND SHRUBS PLANT APPROXIMATELY 3 METERS APART. FOR SMALL TREES AND SHRUBS PLANT 1-2 METERS APART. FOR HERBACEOUS PLUGS PLANT 20-60 CM APART. PLEASE, RECEIVE LOCALLY SOURCED PLANTS FOR GENETIC DIVERSITY.

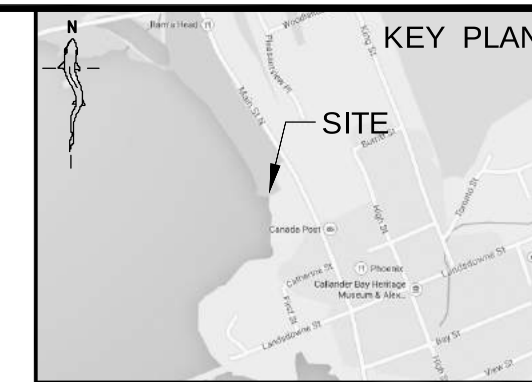
4. PLANT LIVE POTTED AND PLUG PLANTS DURING THE SPRING AND EARLY SUMMER.

5. SEED MIXES SHOULD BE PLANTED IN THE FALL. PLANTING IN THE FALL IS NEEDED TO ALLOW FOR FREEZING TO INITIATE GERMINATION, HOWEVER IF THE SEEDS HAVE ALREADY BEEN PREPARED FOR GERMINATION PLANTING IN THE SPRING CAN BE DONE. THE SEED MIX USED IN THIS PLAN IS GEARED MORE TOWARD GRASSES (TO FILTER RUNOFF FROM PARKING LOT), ONLY IF SCARIFICATION OF THIS AREA IS NECESSARY. IF SCARIFICATION HAS TO BE DONE IN THE SPRING TIME, CANADA WILD RYE SHOULD BE SEEDED TO PREVENT SOIL EROSION. "DUE TO ITS QUICK ESTABLISHMENT IT MAKES AN IDEAL NURSE CROP FOR NATIVE MEADOW PLANTINGS AS IT MATURES IN THE FIRST TO SECOND YEAR, LONG AHEAD OF OTHER LONGER LIVED WARM SEASON NATIVE GRASSES AND EVENTUALLY GIVES WAY IN COMBINED PLANTINGS TO OTHER NATIVE GRASSES" (ONTARIO SEED CO. LTD., 2015A).

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	MATURE HEIGHT (m)	MATURE SPREAD (m)	O.C. SPACING (m)	QNTY.
	TREES					
ar	Acer rubrum	Red Maple	20.0	12.0	12.0	2
to	Thuja occidentalis	White Cedar	15.0	4.0	3.0	3
ai	Alnus incana	Speckled Alder	3.0	2.5	2.0	2
ab	Abies balsamea	Balsam Fir	30	6.0	3.0	3
ll	larix laricina	tamarack	15	4.0	3.0	3
	SHRUBS					
cs	Cornus stolonifera	Red Osier Dogwood	3.0	3.0	2.0	20

KEY PLAN



LEGEND:

LIVE DOGWOOD STAKES

SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

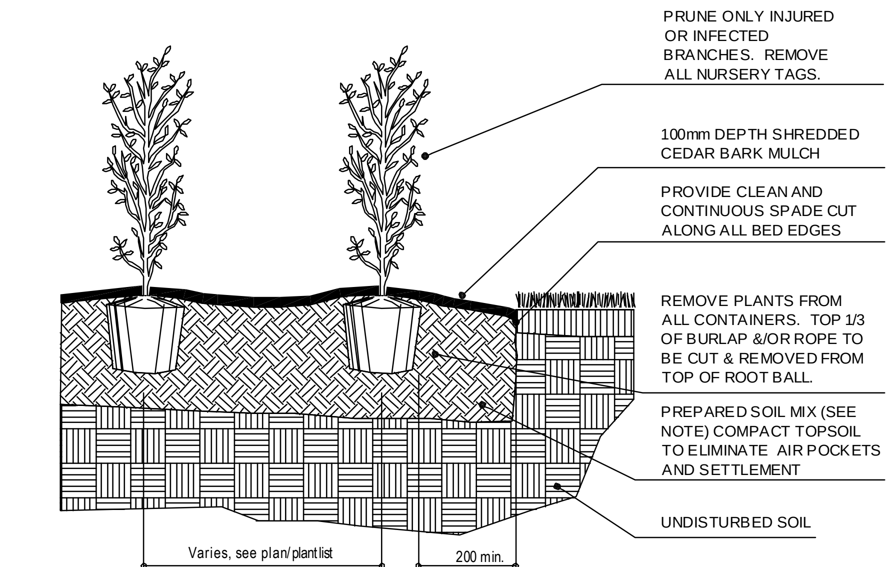
SHORELINE RESTORATION

MUNICIPAL DWG NO. WE 14045-01

CAD FILENAME PP1

SITE NO. CA-1

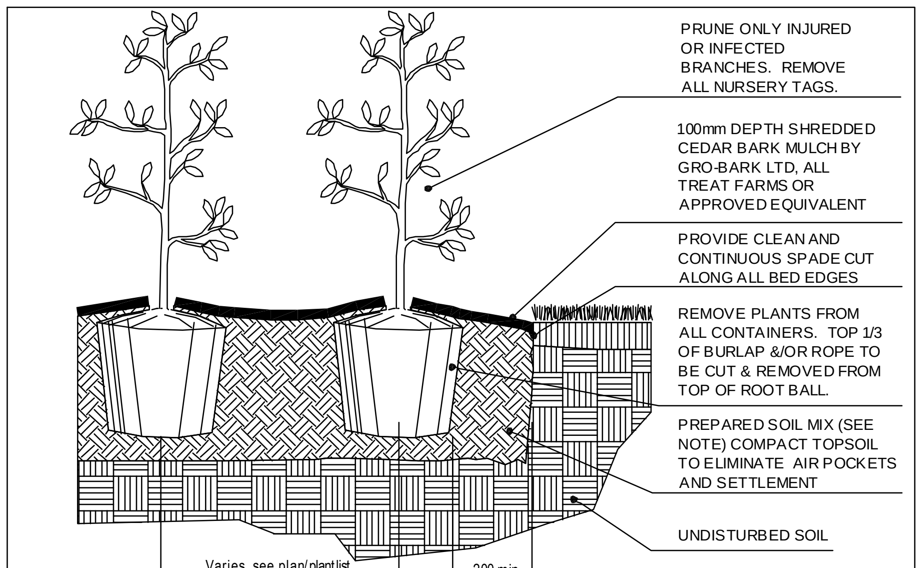
SHEET # 1 OF 2



NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D1 POTTED SHRUB (TYPICAL)
N.T.S.



NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D2 POTTED TREE (TYPICAL)
N.T.S.

CONSTRUCTION ACCESS:

1. ACCESS TO THE SITE WILL BE DETERMINED DURING THE START-UP MEETING.
2. ANY CREEK CROSSING TO CONSIST OF BRIDGE SPANNING CREEK FROM TOP OF BANK TO TOP OF BANK. BRIDGE TO BE SUPPLIED BY CONTRACTORS.
3. TREES TO BE TRIMMED OR REMOVED FROM ACCESS AS APPROVED BY PROJECT MANAGER.
4. SAFETY FENCE TO BE ERECTED AS REQUIRED TO LIMIT PUBLIC ACCESS TO TEMPORARY CONSTRUCTION ACCESS ROAD AND CONSTRUCTION SITE.
5. SITE CONSTRUCTION ACTIVITY WILL INCLUDE THE REPAIR OF THE ACCESS AND EGRESS AREAS.
6. UPON COMPLETION OF THE CONSTRUCTION, THE ACCESS WAY IS TO BE REPAIRED TO EXISTING CONDITIONS OR BETTER.
7. CONTRACTOR TO MEET ON SITE WITH PROJECT MANAGER PRIOR TO INITIATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCING AND STAGING NOTES:

1. THE CONTRACTOR SHALL PROVIDE GENERAL ARRANGEMENT DRAWINGS AND A STAGING PLAN WITH THE PROPOSED CONTROL METHODOLOGY AND DEMONSTRATE THAT THE APPROACH CAN ADEQUATELY ADDRESS THE ENVIRONMENTAL AND EXISTING SITE CONDITIONS (VARYING FLOW CONDITIONS, CHANNEL CAPACITIES, WET WEATHER RESPONSE).
2. CONSTRUCTION STAGING MUST HAVE REGARD FOR THE ENVIRONMENTAL ASPECTS OF THE PROPOSED CONSTRUCTION. THIS WILL ENSURE THAT AMPLE TIME IS PROVIDED TO ENSURE THE TIMELY ARRIVAL OF REQUIRED EQUIPMENT AND MATERIALS AND THE APPROPRIATE ALLOCATION OF RESOURCES.
3. INSTALL SILT FENCE AS REQUIRED BY SITE CONDITIONS. FENCE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE THE LIMIT OF CONSTRUCTION ACTIVITY.
4. REMOVE AND STOCKPILE EXISTING VEGETATION FOR POTENTIAL REUSE.
5. GRADE SITE AS REQUIRED.
6. COMPLETE SEEDING AND PLANTING AS PER APPROVED PLAN.
7. STABILIZE ALL SLOPES AS NOTED ON PLAN.
8. REMOVE ANY EXCESS MATERIAL STOCKPILED ON SITE.
9. REMOVE SILT FENCE ONCE ALL VEGETATION HAS BECOME SUFFICIENTLY ESTABLISHED.

EROSION AND SEDIMENT CONTROL STRATEGY :

1. PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT A DETAILED SCHEDULE AND WORK PLAN FOR REVIEW AND APPROVAL OF THE PROJECT MANAGER AND EXTERNAL AGENCIES AS REQUIRED, INDICATING HOW HE WILL IMPLEMENT SEDIMENT AND EROSION CONTROLS, AND HOW HE WILL CONTROL/DIVERT CREEK FLOWS AROUND OR THROUGH THE CONSTRUCTION AREA.
2. SEDIMENT AND EROSION CONTROL MEASURES MUST BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT ENTRY OF SEDIMENT INTO THE WATER OR RE-SUSPENDED SEDIMENT.
3. ANY STOCKPILED MATERIALS SHOULD BE STORED AND STABILIZED AWAY FROM THE WATER. EXCESS MATERIAL SHALL BE REMOVED IMMEDIATELY FROM THE CHANNEL AREA AND TEMPORARILY STOCKPILED IN SUITABLE LOCATIONS IDENTIFIED BY THE DESIGN DRAWINGS AND ON-SITE AREAS APPROVED BY THE PROJECT MANAGER.
4. ONLY CLEAN MATERIAL FREE OF FINE PARTICULATE MATTER SHOULD BE PLACED IN THE WATER.
5. ALL WORK IS TO BE PERFORMED DURING LOW FLOW CONDITIONS AND WORK IS NOT TO BE INITIATED WHEN WEATHER FORECASTS SUGGEST EXTENSIVE RAIN.
6. THE CONSTRUCTION ZONE IS TO BE ISOLATED FROM ADJACENT STREAM FLOWS THROUGH ADEQUATE SILT FENCING, STONE OR ANY OTHER METHOD AS APPROVED BY THE PROJECT MANAGER.
7. ALL WORK IS TO BE COMPLETED AS EXPEDITIOUSLY AS POSSIBLE AND ANY WORK THAT HAS BEEN INITIATED MUST BE COMPLETED WITHIN THE WORKING DAY. IF THIS IS NOT POSSIBLE, THEN THE CONTRACTOR MUST ENSURE, TO THE SATISFACTION OF THE PROJECT MANAGER, THAT THE WORK SITE IS ADEQUATELY STABILIZED.
8. ONCE EACH GRADING COMPONENT OF THE PROJECT HAS BEEN COMPLETED BY THE CONTRACTOR, THE SITE IS TO BE REVEGETATED AS PER THE PLANS AND STABILIZED.
9. ANY EROSION AND SEDIMENT CONTROLS ARE TO BE REMOVED AT THE COMPLETION OF THE PROJECT AFTER A JOINT INSPECTION BY THE CONTRACTOR AND PROJECT MANAGER.
10. ANY DEVIATIONS FROM THE APPROVED STRATEGY MUST BE APPROVED BY THE PROJECT MANAGER.
11. CONTRACTOR EQUIPMENT TO STAY OUT OF THE CHANNEL BED AND AVOID ANY UNNECESSARY DISRUPTION OF THE CHANNEL.
12. SEDIMENT LADEN DEWATERING DISCHARGE SHOULD BE PUMPED TO A SETTLING BASIN OR FILTERING SYSTEM WELL AWAY FROM THE WATERCOURSE AND ALLOWED TO SETTLE AND/OR FILTER THROUGH THE RIPARIAN VEGETATION BEFORE RE-ENTERING THE WATERCOURSE DOWNSTREAM OF THE CONSTRUCTION AREA.

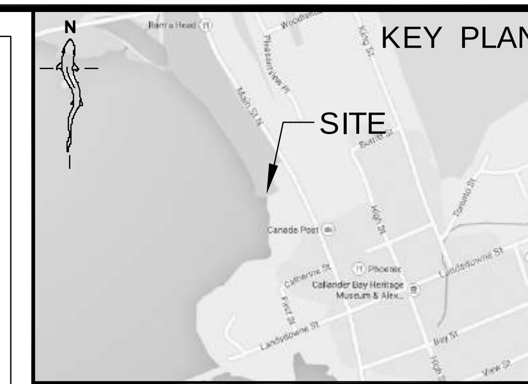
LANDSCAPE NOTES:

1. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH BY-LAWS AND CODES HAVING JURISDICTION OVER SITE LOCATION.
2. COMPLETE ALL WORK TO THE SATISFACTION OF THE PROJECT MANAGER. REPORT ANY CHANGES, DISCREPANCIES OR SUBSTITUTIONS TO THE PROJECT MANAGER FOR REVIEW. OBTAIN APPROVAL FROM THE PROJECT MANAGER BEFORE PROCEEDING.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE EXISTING SERVICE LOCATIONS.
4. EXACT LOCATIONS OF PLANT MATERIAL WILL BE DETERMINED BY PLACEMENT OF SITE SERVICES SUCH AS HYDRO VAULTS, METERS, UTILITIES ROOF RAIN WATER LEADERS, DRIVEWAYS, LIGHT STANDARDS, ETC.
5. ALL PLANT MATERIAL LOCATIONS TO BE STAKED OR MARKED OUT AND APPROVED BY PROJECT MANAGER PRIOR TO INSTALLATION.
6. SUPPLY ALL PLANT MATERIAL IN ACCORDANCE WITH THE CANADIAN STANDARDS FOR NURSERY STOCK (7TH ED.).
7. INSTALL PLANT MATERIAL ACCORDING TO DETAILS SHOWN.
8. DISTURBED SOIL AREAS AROUND TREES AND SHRUBS ARE TO BE COVERED WITH SHREDDED CONIFER BARK MULCH SUCH AS 'CANADA RED' OR 'GRO-BARK' SPM MULCH, OR APPROVED EQUIVALENT. ALTERNATIVE MULCHES MUST BE APPROVED BY THE PROJECT MANAGER.
9. CONTRACTOR TO UTILIZE LAYOUT DIMENSIONS WHERE PROVIDED.
10. PROVIDE PLANTING BED AREA AS NOTED ON THE DRAWING OR TO ACCOMMODATE MATURE SIZE OF PLANT MATERIAL.
11. ALL SUPPORT SYSTEMS MUST BE REMOVED TO THE SATISFACTION OF THE PROJECT MANAGER ONCE THE TREE IS ESTABLISHED.
12. SUPPLY AND PLACE TOPSOIL IN ACCORDANCE WITH OPSS 570 TO A MINIMUM DEPTH OR 100MM UNLESS OTHERWISE SPECIFIED.
13. SUPPLY AND PLACE SOD IN ACCORDANCE WITH OPSS 571 UNLESS OTHERWISE SPECIFIED.
14. SUPPLY AND PLACE SEED IN ACCORDANCE WITH OPSS 572 UNLESS OTHERWISE SPECIFIED.
15. CONTRACTOR TO PROVIDE NECESSARY EROSION CONTROL PROTECTION AS REQUIRED TO ENSURE SOIL STABILIZATION AND PROPER SEED GERMINATION.
16. ALL DIMENSIONS IN MM UNLESS OTHERWISE NOTED.
17. IF DISCREPANCIES ARISE BETWEEN PLANT MATERIAL COUNT SHOWN ON DRAWING AND PLANT LIST THE DRAWING SHALL BE CONSIDERED CORRECT.
18. CONTRACTOR TO PROVIDE MINIMUM 1 YEAR WARRANTY FROM DATE ACCEPTED ON ALL WORK UNLESS OTHERWISE SPECIFIED.
19. ANY SITE PLAN OR GRADING AND SERVICING SHOWN IS FOR INFORMATION ONLY. REFER TO APPROVED DRAWINGS.

ENVIRONMENTAL NOTES:

1. REFUELLING ACTIVITIES SHOULD BE CONDUCTED IN AN ENVIRONMENTALLY RESPONSIBLE MANNER. THIS INCLUDES A KEEPING THE FUELLING OPERATIONS 30 M SETBACK FROM THE WATER'S EDGE, DRAINAGE PATHWAY OR UNLESS OTHERWISE DIRECTED BY THE PROJECT MANAGER. SPILL KITS AND SUFFICIENT AMOUNT OF SORBANT MATERIAL SHOULD BE AVAILABLE ON THE FUEL OR SERVICE VEHICLES.
2. ANY PART OF EQUIPMENT ENTERING THE WATER SHOULD BE FREE OF FLUID LEAKS AND EXTERNALLY CLEANED AND DEGREASED TO PREVENT ANY DELETERIOUS SUBSTANCES FROM ENTERING THE WATER.
3. ANY SPILLS RESULTING FROM REFUELLING OPERATIONS, HYDRAULIC LEAKS, MAINTENANCE ETC. MUST BE REPORTED IMMEDIATELY TO THE PROJECT MANAGER WHO WILL THEN NOTIFY THE SPILLS ACTION CENTRE IF REQUIRED.
4. ALL MATERIALS AND EQUIPMENT USED FOR THE PURPOSE OF SITE PREPARATION AND PROJECT COMPLETION SHOULD BE OPERATED AND STORED IN A MANNER THAT PREVENTS ANY DELETERIOUS SUBSTANCE (E.G. PETROLEUM PRODUCTS, SILT, DEBRIS, ETC) FROM ENTERING THE WATER.
5. THE AREA OF DISTURBANCE WITHIN THE CHANNEL AND ON THE STREAMBANKS MUST BE KEPT TO A MINIMUM. HEAVY EQUIPMENT TRAFFIC WILL BE RESTRICTED TO ESTABLISHED TRAVEL PATHWAYS.
6. STOCKPILE AND STAGING AREAS SHOULD BE WELL REMOVED FROM THE WATERCOURSE AND CONTAINED BY APPROPRIATE SEDIMENT AND EROSION CONTROLS.
7. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE INSTALLED AND MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD. THE INSTALLED MEASURES SHOULD BE ROUTINELY INSPECTED TO ENSURE THAT THEY ARE FUNCTIONING AS INTENDED. DISTURBED SOILS SHOULD BE STABILIZED IMMEDIATELY WITH SUITABLE PLANTINGS/SEED/MAT. MAINTENANCE SHOULD CONTINUE UNTIL SUCH TIME AS THE DISTURBED AREAS ARE SUFFICIENTLY STABILIZED THROUGH VEGETATIVE GROWTH.
8. TRAFFIC MANAGEMENT PLAN OR CROSSING CONSTRAINTS - SPAN STRUCTURE ONLY. SPECIFIC DETAILS TO BE PROVIDED BY CONTRACTOR.
9. WEATHER CONDITIONS SHOULD BE MONITORED TO ADEQUATELY PREPARE THE SITE FOR RAIN EVENTS.
10. AS CONSTRUCTION ACTIVITIES IN AND AROUND WATER IS CHALLENGING, WITH A SIGNIFICANT POTENTIAL FOR ENVIRONMENTAL EFFECT, IT IS RECOMMENDED THAT THE CONTRACTOR ORGANIZE AN IN-WATER CONSTRUCTION TEAM WHICH WILL CONSIST OF AN ENVIRONMENTAL MONITOR, SUPERVISOR, SELECTED MACHINE OPERATORS AND GENERAL LABOURERS. THIS TEAM WILL BE RESPONSIBLE FOR THE CONSTRUCTION ACTIVITIES WITHIN THE CHANNEL INCLUDING THE CONSTRUCTION OF THE CHANNEL AND RE-GRADING OF THE STREAMBANKS AND FLOODPLAINS.

KEY PLAN



SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

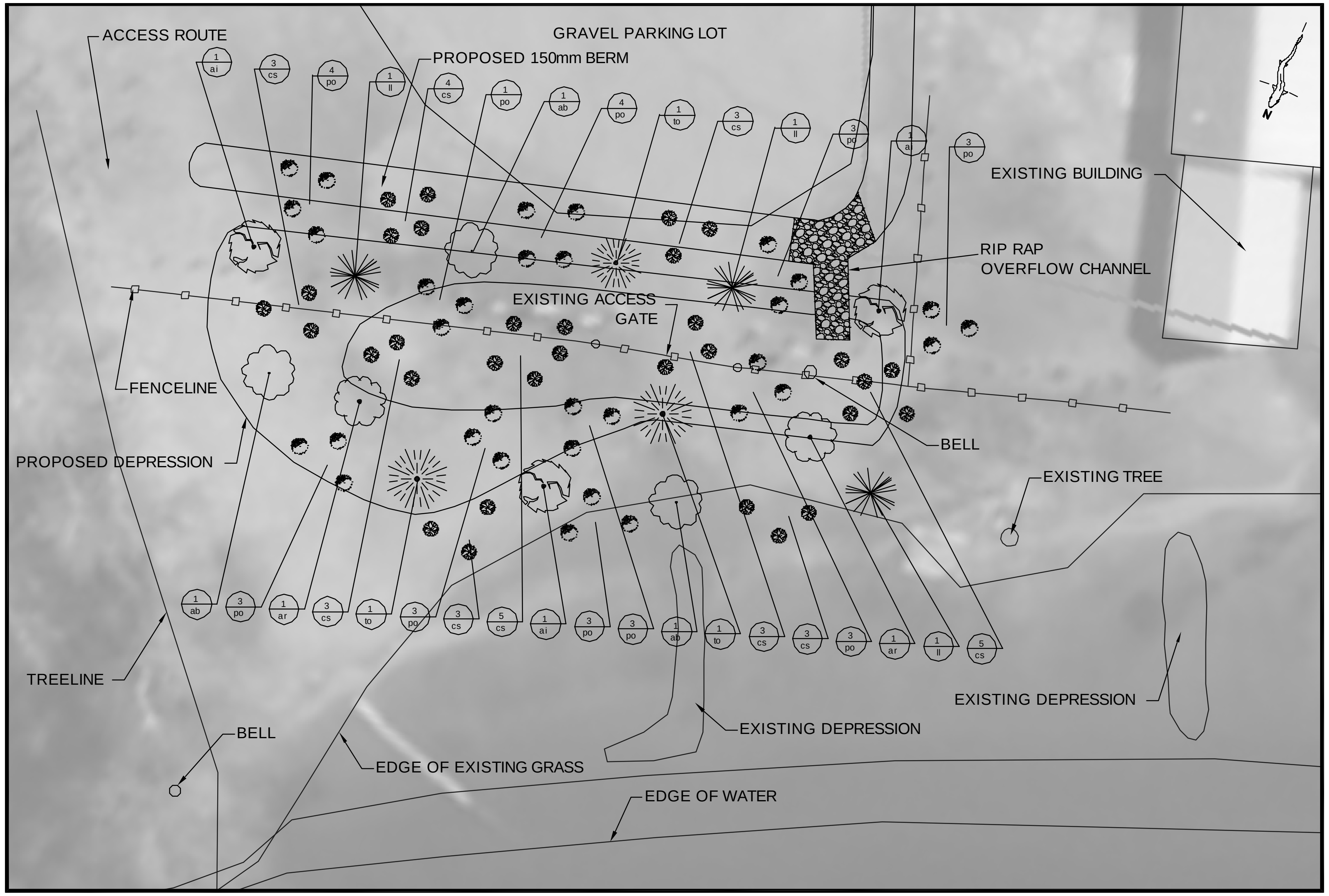
CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

SHORELINE RESTORATION

MUNICIPAL DWG NO.	CAD FILENAME
WE 14045-01	DET
SITE NO.	SHEET #
CA-1	2 OF 2

PLAN
SCALE - 1:200



PROFILE
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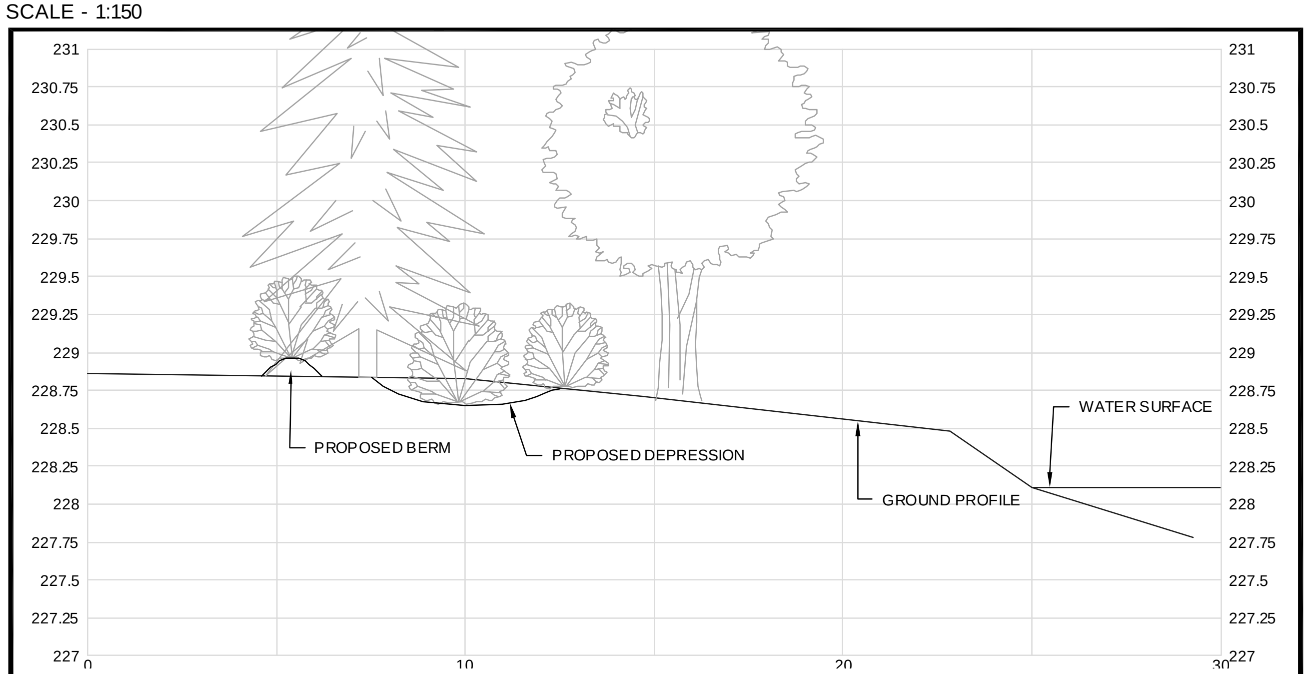


SITE REVEGETATION:

ALL DISTURBED AREAS, INCLUDING ACCESS ROUTES, STAGING AREAS AND WORK ZONES ARE TO BE CLEARED (PLANT MATERIAL TO BE SALVAGED) PRIOR TO CONSTRUCTION AND REVEGETATED WITH SPECIFIED SEED MIX AND SALVAGED PLANT MATERIAL UNLESS DIRECTED OTHERWISE BY DESIGN DETAILS.

AREA STABILIZATION:

EROSION CONTROL BLANKETS ARE TO BE PLACED TO CONTROL EROSION AFTER SEEDING. ECB TO BE KoirMat 400 OR APPROVED EQUIVALENT AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

CONSTRUCTION SUPERVISION:

THE PROJECT MANAGER SHALL BE ON SITE OR AVAILABLE DURING ALL PHASES OF CONSTRUCTION AND IN-WATER WORKS.

FISHERIES TIMING WINDOW:

THERE SHALL BE NO IN-WATER WORK OR ACTIVITY FROM APRIL 1 TO JUNE 30.

SITE 4 PLANTING PLAN

THIS MUNICIPAL SITE HAS PUBLIC ACCESS AND IS UNDERGOING SHORELINE EROSION. ADDITIONALLY, THIS SITE WILL HAVE HORSE PARKING AND SNOW STORAGE, SO RUNOFF MAY BE AN ISSUE.

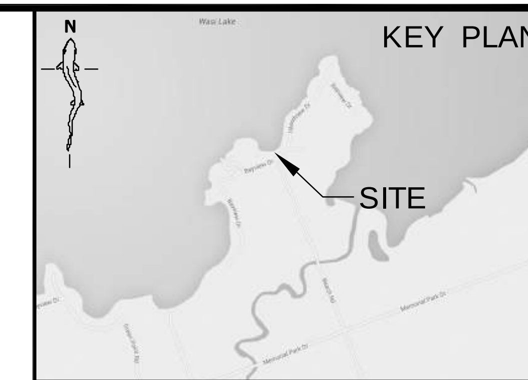
INSTRUCTIONS:

1. CONSTRUCT A DEPRESSION AND BERM ALONG THE NORTH BOUNDARY OF THE PARKING AREA. THIS IS TO CONTROL AND STORE RUNOFF AND SEDIMENT. THE BERM SEPARATES THE PARKING AREA AND DEPRESSION, AND CUT/FILL QUANTITIES SHOULD BE BALANCED.
2. PLANTINGS: FOR LARGE TREES AND SHRUBS PLANT APPROXIMATELY 3 METERS APART. FOR SMALL TREES AND SHRUBS PLANT 1-2 METERS APART. FOR HERBACEOUS PLUGS PLANT 20-60 CM APART. PLEASE, RECEIVE LOCALLY SOURCED PLANTS FOR GENETIC DIVERSITY.
3. PLANT LIVE POTTED AND PLUG PLANTS DURING THE SPRING AND EARLY SUMMER.
4. THE SEED MIX USED IN THIS PLAN IS GEARED MORE TOWARD GRASSES (TO FILTER RUNOFF FROM PARKING LOT), SEED MIXES SHOULD BE PLANTED IN THE FALL. PLANTING IN THE FALL IS NEEDED TO ALLOW FOR FREEZING TO INITIATE GERMINATION, HOWEVER IF THE SEEDS HAVE ALREADY BEEN PREPARED FOR GERMINATION PLANTING IN THE SPRING CAN BE DONE.
5. IF SCARIFICATION NEEDS TO BE DONE IN THE SPRING TIME (I.E. WHEN THE DEPRESSION IS DUG OUT), CANADA WILD RYE WILL BE SEEDED TO PREVENT SOIL EROSION. "DUE TO ITS QUICK ESTABLISHMENT IT MAKES AN IDEAL NURSE CROP FOR NATIVE MEADOW PLANTINGS AS IT MATURES IN THE FIRST TO SECOND YEAR, LONG AHEAD OF OTHER LONGER LIVED WARM SEASON NATIVE GRASSES AND EVENTUALLY GIVES WAY IN COMBINED PLANTINGS TO OTHER NATIVE GRASSES" (ONTARIO SEED CO. LTD., 2015A).

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	MATURE HEIGHT (m)	MATURE SPREAD (m)	O.C. SPACING (m)	QNTY.
	TREES					
ar	Acer rubrum	Red Maple	20.0	12.0	12.0	2
to	Thuja accidentalis	White Cedar	15.0	4.0	3.0	3
ai	Alnus incana	Speckled Alder	3.0	2.5	2.0	3
ab	Abies balsamea	Balsam Fir	30	6.0	3.0	3
ll	larix laricina	Tamarack	15	4.0	3.0	3
	SHRUBS					
cs	Cornus stolonifera	Red Osier Dogwood	3.0	3.0	2.0	20
po	Physocarpus opulifolius	Ninebark	3.0	6.0	2.0	15

KEY PLAN



LEGEND:

SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

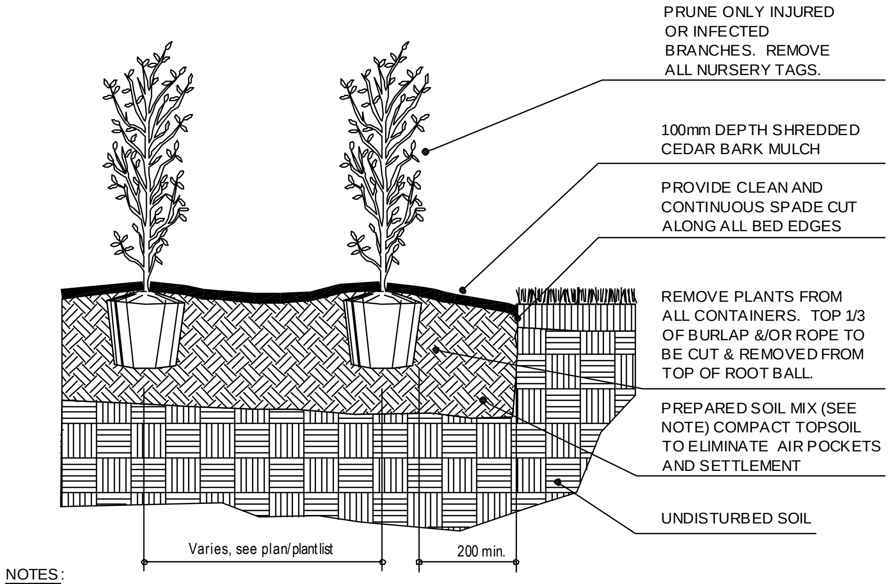
SHORELINE RESTORATION

MUNICIPAL DWG NO.: WE 14045-01

CAD FILENAME: PP1

SITE NO.: CA-4

SHEET #: 1 OF 2

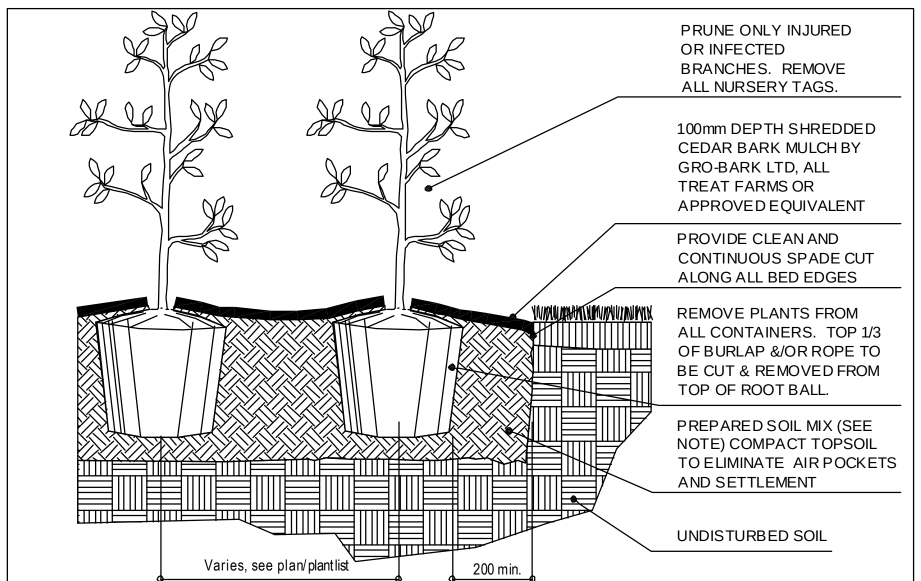


NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D1 POTTED SHRUB (TYPICAL)

N.T.S.



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5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D2 POTTED TREE (TYPICAL)

N.T.S.

CONSTRUCTION ACCESS:

1. ACCESS TO THE SITE WILL BE DETERMINED DURING THE START-UP MEETING.
2. ANY CREEK CROSSING TO CONSIST OF BRIDGE SPANNING CREEK FROM TOP OF BANK TO TOP OF BANK. BRIDGE TO BE SUPPLIED BY CONTRACTORS.
3. TREES TO BE TRIMMED OR REMOVED FROM ACCESS AS APPROVED BY PROJECT MANAGER.
4. SAFETY FENCE TO BE ERECTED AS REQUIRED TO LIMIT PUBLIC ACCESS TO TEMPORARY CONSTRUCTION ACCESS ROAD AND CONSTRUCTION SITE.
5. SITE CONSTRUCTION ACTIVITY WILL INCLUDE THE REPAIR OF THE ACCESS AND EGRESS AREAS.
6. UPON COMPLETION OF THE CONSTRUCTION, THE ACCESS WAY IS TO BE REPAIRED TO EXISTING CONDITIONS OR BETTER.
7. CONTRACTOR TO MEET ON SITE WITH PROJECT MANAGER PRIOR TO INITIATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCING AND STAGING NOTES:

1. THE CONTRACTOR SHALL PROVIDE GENERAL ARRANGEMENT DRAWINGS AND A STAGING PLAN WITH THE PROPOSED CONTROL METHODOLOGY AND DEMONSTRATE THAT THE APPROACH CAN ADEQUATELY ADDRESS THE ENVIRONMENTAL AND EXISTING SITE CONDITIONS (VARYING FLOW CONDITIONS, CHANNEL CAPACITIES, WET WEATHER RESPONSE).
2. CONSTRUCTION STAGING MUST HAVE REGARD FOR THE ENVIRONMENTAL ASPECTS OF THE PROPOSED CONSTRUCTION. THIS WILL ENSURE THAT AMPLE TIME IS PROVIDED TO ENSURE THE TIMELY ARRIVAL OF REQUIRED EQUIPMENT AND MATERIALS AND THE APPROPRIATE ALLOCATION OF RESOURCES.
3. INSTALL SILT FENCE AS REQUIRED BY SITE CONDITIONS. FENCE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE THE LIMIT OF CONSTRUCTION ACTIVITY.
4. REMOVE AND STOCKPILE EXISTING VEGETATION FOR POTENTIAL REUSE.
5. GRADE SITE AS REQUIRED.
6. COMPLETE SEEDING AND PLANTING AS PER APPROVED PLAN.
7. STABILIZE ALL SLOPES AS NOTED ON PLAN.
8. REMOVE ANY EXCESS MATERIAL STOCKPILED ON SITE.
9. REMOVE SILT FENCE ONCE ALL VEGETATION HAS BECOME SUFFICIENTLY ESTABLISHED.

EROSION AND SEDIMENT CONTROL STRATEGY :

1. PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT A DETAILED SCHEDULE AND WORK PLAN FOR REVIEW AND APPROVAL OF THE PROJECT MANAGER AND EXTERNAL AGENCIES AS REQUIRED, INDICATING HOW HE WILL IMPLEMENT SEDIMENT AND EROSION CONTROLS, AND HOW HE WILL CONTROL/DIVERT CREEK FLOWS AROUND OR THROUGH THE CONSTRUCTION AREA.
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LANDSCAPE NOTES:

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KEY PLAN

SCALE: AS NOTED	DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

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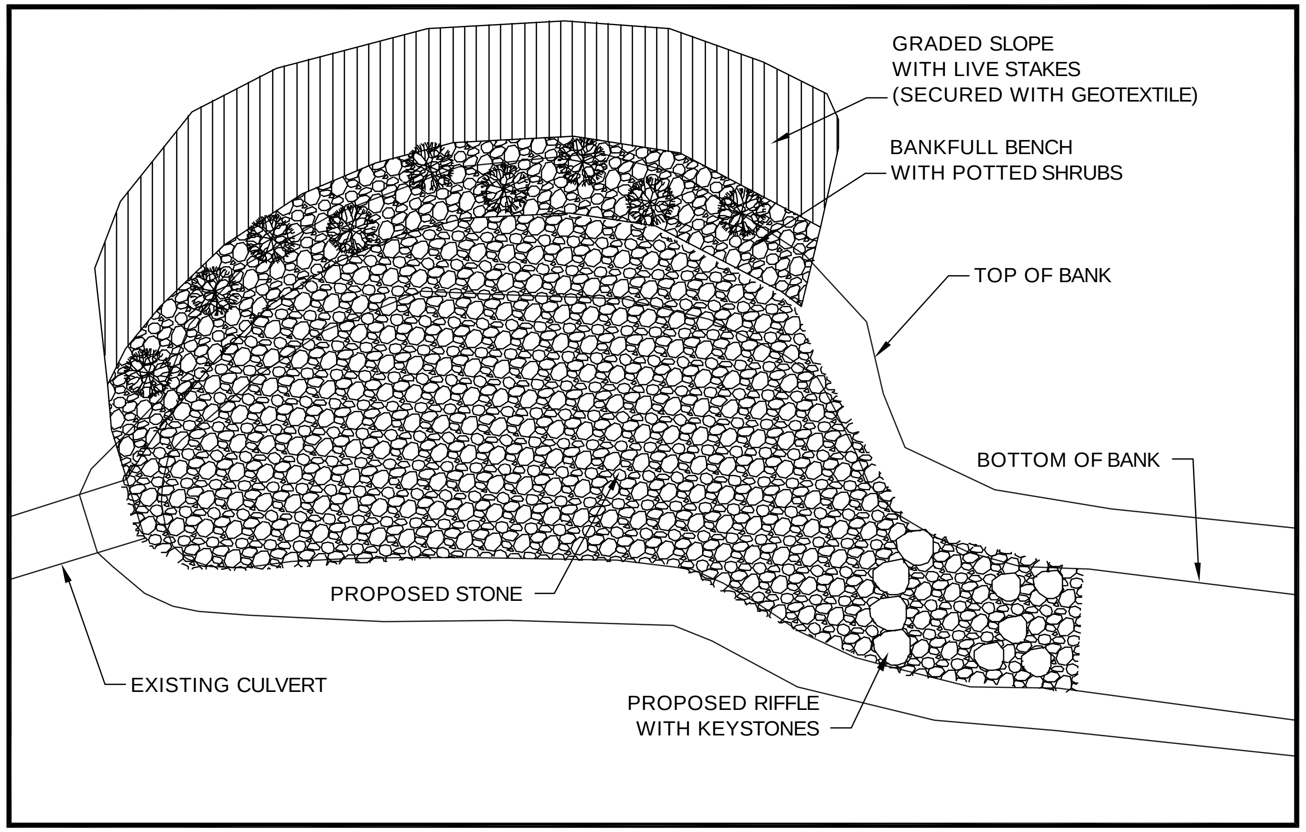
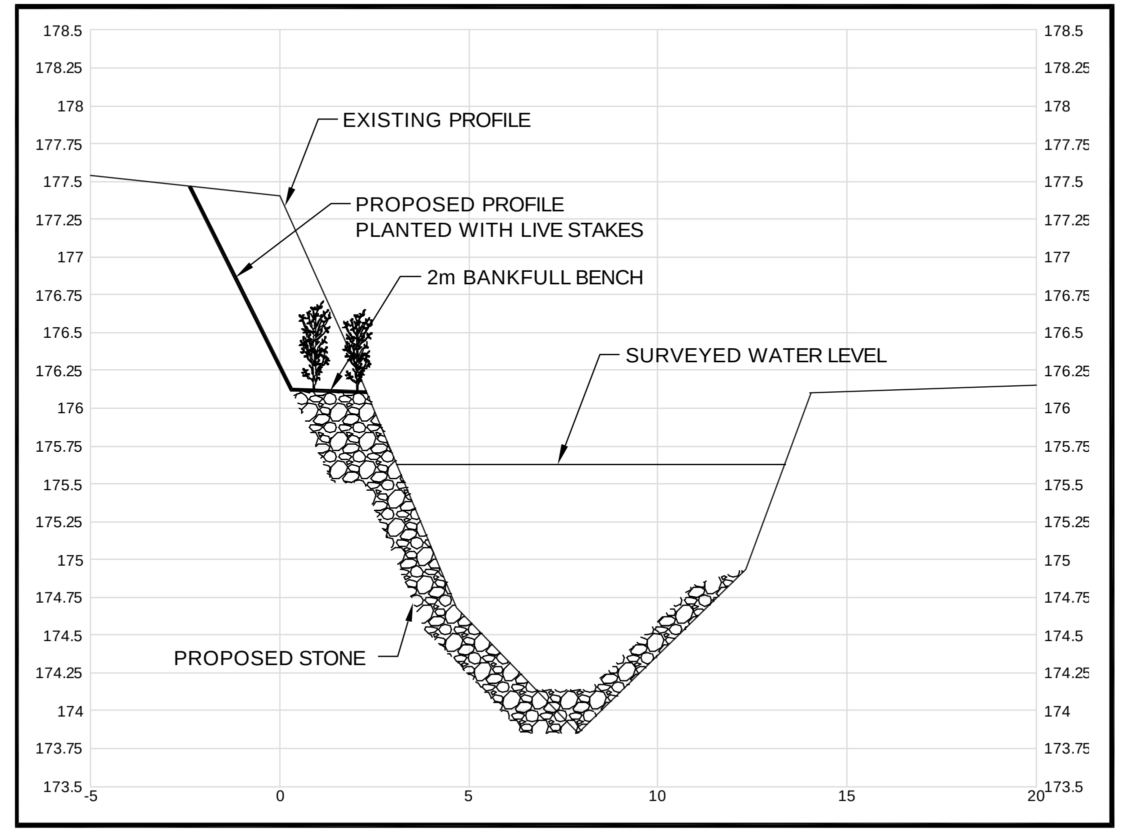
PLAN
SCALE - 1:200



CROSS SECTION
SCALE - 1:200



SITE REVEGETATION:

ALL DISTURBED AREAS, INCLUDING ACCESS ROUTES, STAGING AREAS AND WORK ZONES ARE TO BE CLEARED (PLANT MATERIAL TO BE SALVAGED) PRIOR TO CONSTRUCTION AND REVEGETATED WITH SPECIFIED SEED MIX AND SALVAGED PLANT MATERIAL UNLESS DIRECTED OTHERWISE BY DESIGN DETAILS.

AREA STABILIZATION:

EROSION CONTROL BLANKETS ARE TO BE PLACED TO CONTROL EROSION AFTER SEEDING. ECB TO BE KoirMat 700 OR APPROVED EQUIVALENT AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

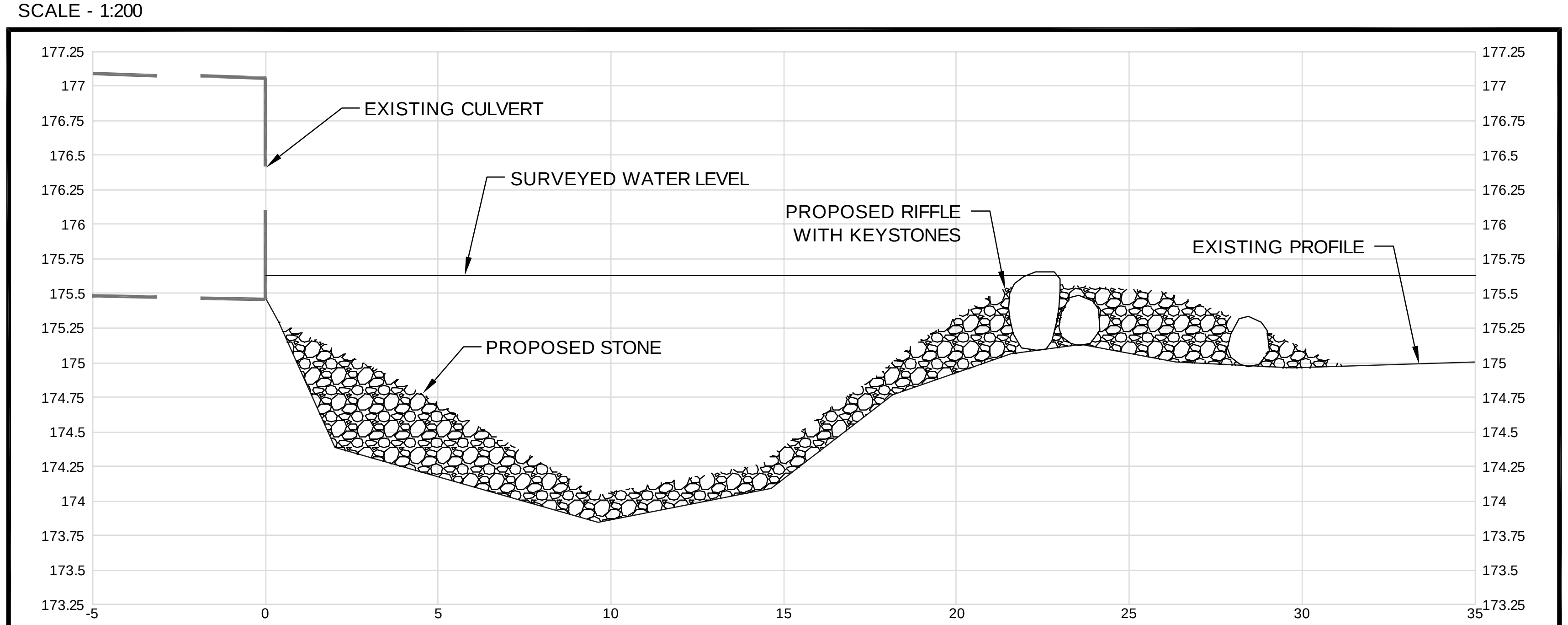
FISHERIES TIMING WINDOW:

THERE SHALL BE NO IN-WATER WORK OR ACTIVITY FROM APRIL 1 TO JUNE 30.

CONSTRUCTION SUPERVISION:

THE PROJECT MANAGER SHALL BE ON SITE OR AVAILABLE DURING ALL PHASES OF CONSTRUCTION AND IN-WATER WORKS.

PROFILE
SCALE - 1:200



SITE 8 CONCEPTUAL PLAN

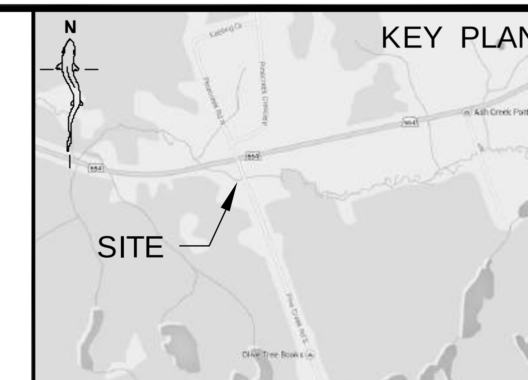
BANK EROSION DOWNSTREAM OF PINECREEK ROAD RESULTS FROM THE UNDERSIZED AND PERCHED CULVERT WITH RESPECT TO EXISTING CHANNEL MORPHOLOGY AND HYDRAULICS. PRIOR TO ANY CREEK WORK OR BANK STABILIZATION, IT IS RECOMMENDED THAT THE DESIGN OF THE PINECREEK ROAD CULVERT IS REVISITED, UPDATED, AND THAT UPGRADES ARE MADE WITH RESPECT TO CROSSING SPAN, SKEW, MATERIAL (CONCRETE BOX/OPEN BOTTOM), AND ELEVATION.

IN THE EVENT THAT FURTHER STUDY AND UPGRADES TO THE CULVERT ARE NOT UNDERTAKEN, THE FOLLOWING DESIGN ***CONCEPTS*** HAVE BEEN DEVELOPED AS AN OPTION TO REDUCE BANK EROSION AT THIS SITE. THESE CONCEPTS REQUIRE FURTHER FIELDWORK AND MODELING TO MOVE INTO THE DETAILED DESIGN PHASE. IT IS POSSIBLE THAT OTHER OPTIONS MAY EXIST SUBSEQUENT TO FURTHER DATA COLLECTION AND ANALYSIS.

INSTRUCTIONS:

1. STABILIZE AND RE-GRADE ERODING BANK TO A MORE STABLE SLOPE WITH A BANKFULL BENCH TO COLLECT MATERIAL SUPPLIED FROM UP SLOPE. SIZE MATERIAL APPROPRIATELY TO WITHSTAND SHEAR FORCES ACTING UPON THE SLOPE.
2. MATCH BED TOPOGRAPHY TO CULVERT OUTLET TO ENHANCE CONNECTIVITY.
3. ARMOUR THE CHANNEL BED AND BANK TOES TO REDUCE THE RISK OF UNDERMINING BANK TREATMENTS.
4. CONSTRUCT A STABLE RIFFLE AT THE DOWNSTREAM END OF THE SCOUR POOL TO CONTROL THE POOL WATER SURFACE ELEVATION AND MAINTAIN THE FUNCTION OF THE POOL TO DISSIPATE ENERGY. RIFFLE MATERIAL SHOULD BE SIZED APPROPRIATELY WITH A RANGE OF DIAMETERS TO REMAIN STABLE, WHILE ALLOWING THE DEPOSITION AND REMOVAL OF SOME SMALLER PARTICLE SIZES.
5. KEYSTONES SHOULD BE PLACED AT THE CREST OF THE RIFFLE TO ENSURE STABILITY AND MAINTAIN THE POOL WATER SURFACE ELEVATION.

KEY PLAN



LEGEND:

SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

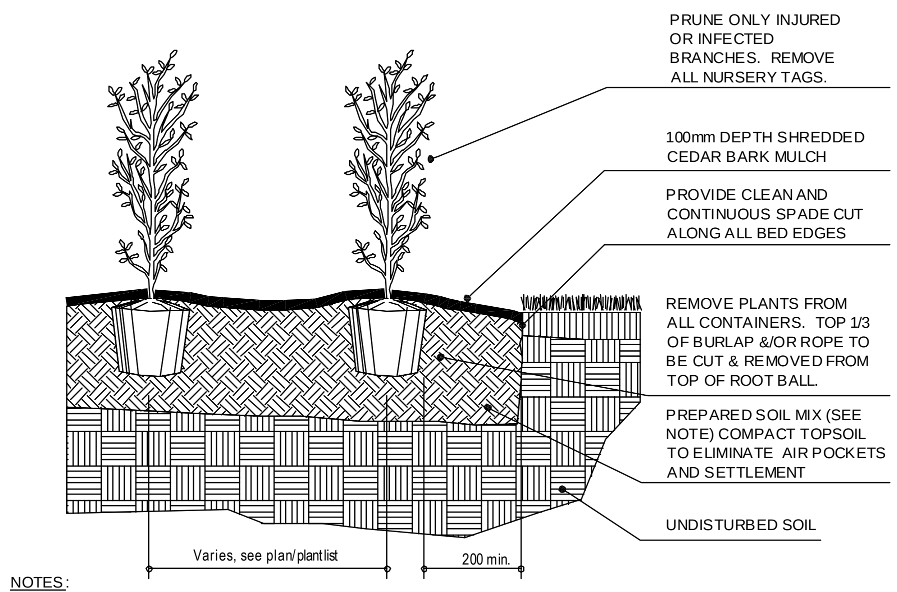
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

SHORELINE RESTORATION

MUNICIPAL DWG NO.	CAD FILENAME
WE 14045-01	PP1
SITE NO.	SHEET #
CA-8	1 OF 2

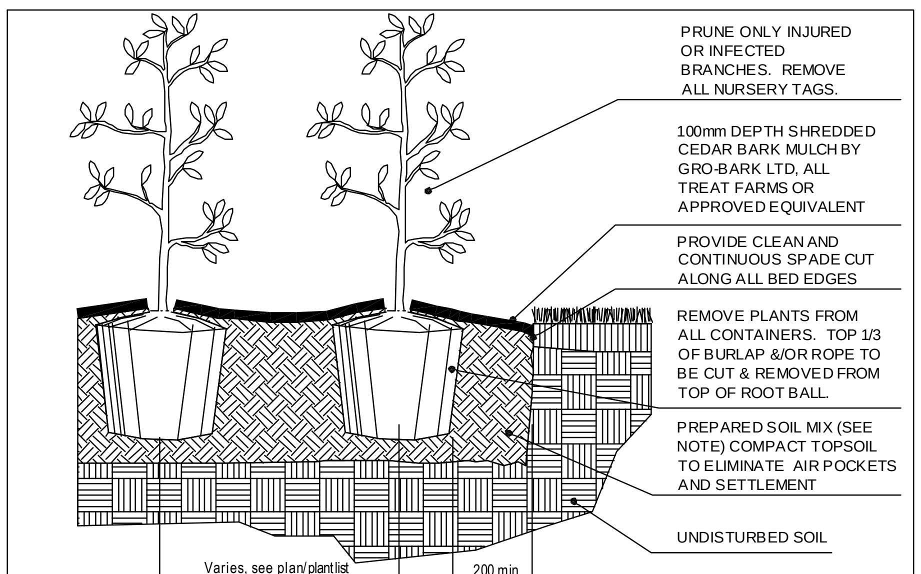


NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D1 POTTED SHRUB (TYPICAL)

N.T.S.



NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D2 POTTED TREE (TYPICAL)

N.T.S.

CONSTRUCTION ACCESS:

1. ACCESS TO THE SITE WILL BE DETERMINED DURING THE START-UP MEETING.
2. ANY CREEK CROSSING TO CONSIST OF BRIDGE SPANNING CREEK FROM TOP OF BANK TO TOP OF BANK. BRIDGE TO BE SUPPLIED BY CONTRACTORS.
3. TREES TO BE TRIMMED OR REMOVED FROM ACCESS AS APPROVED BY PROJECT MANAGER.
4. SAFETY FENCE TO BE ERECTED AS REQUIRED TO LIMIT PUBLIC ACCESS TO TEMPORARY CONSTRUCTION ACCESS ROAD AND CONSTRUCTION SITE.
5. SITE CONSTRUCTION ACTIVITY WILL INCLUDE THE REPAIR OF THE ACCESS AND EGRESS AREAS.
6. UPON COMPLETION OF THE CONSTRUCTION, THE ACCESS WAY IS TO BE REPAIRED TO EXISTING CONDITIONS OR BETTER.
7. CONTRACTOR TO MEET ON SITE WITH PROJECT MANAGER PRIOR TO INITIATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCING AND STAGING NOTES:

1. THE CONTRACTOR SHALL PROVIDE GENERAL ARRANGEMENT DRAWINGS AND A STAGING PLAN WITH THE PROPOSED CONTROL METHODOLOGY AND DEMONSTRATE THAT THE APPROACH CAN ADEQUATELY ADDRESS THE ENVIRONMENTAL AND EXISTING SITE CONDITIONS (VARYING FLOW CONDITIONS, CHANNEL CAPACITIES, WET WEATHER RESPONSE).
2. CONSTRUCTION STAGING MUST HAVE REGARD FOR THE ENVIRONMENTAL ASPECTS OF THE PROPOSED CONSTRUCTION. THIS WILL ENSURE THAT AMPLE TIME IS PROVIDED TO ENSURE THE TIMELY ARRIVAL OF REQUIRED EQUIPMENT AND MATERIALS AND THE APPROPRIATE ALLOCATION OF RESOURCES.
3. INSTALL SILT FENCE AS REQUIRED BY SITE CONDITIONS. FENCE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE THE LIMIT OF CONSTRUCTION ACTIVITY.
4. REMOVE AND STOCKPILE EXISTING VEGETATION FOR POTENTIAL REUSE.
5. GRADE SITE AS REQUIRED.
6. COMPLETE SEEDING AND PLANTING AS PER APPROVED PLAN.
7. STABILIZE ALL SLOPES AS NOTED ON PLAN.
8. REMOVE ANY EXCESS MATERIAL STOCKPILED ON SITE.
9. REMOVE SILT FENCE ONCE ALL VEGETATION HAS BECOME SUFFICIENTLY ESTABLISHED.

EROSION AND SEDIMENT CONTROL STRATEGY :

1. PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT A DETAILED SCHEDULE AND WORK PLAN FOR REVIEW AND APPROVAL OF THE PROJECT MANAGER AND EXTERNAL AGENCIES AS REQUIRED, INDICATING HOW HE WILL IMPLEMENT SEDIMENT AND EROSION CONTROLS, AND HOW HE WILL CONTROL/DIVERT CREEK FLOWS AROUND OR THROUGH THE CONSTRUCTION AREA.
2. SEDIMENT AND EROSION CONTROL MEASURES MUST BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT ENTRY OF SEDIMENT INTO THE WATER OR RE-SUSPENDED SEDIMENT.
3. ANY STOCKPILED MATERIALS SHOULD BE STORED AND STABILIZED AWAY FROM THE WATER. EXCESS MATERIAL SHALL BE REMOVED IMMEDIATELY FROM THE CHANNEL AREA AND TEMPORARILY STOCKPILED IN SUITABLE LOCATIONS IDENTIFIED BY THE DESIGN DRAWINGS AND ON-SITE AREAS APPROVED BY THE PROJECT MANAGER.
4. ONLY CLEAN MATERIAL FREE OF FINE PARTICULATE MATTER SHOULD BE PLACED IN THE WATER.
5. ALL WORK IS TO BE PERFORMED DURING LOW FLOW CONDITIONS AND WORK IS NOT TO BE INITIATED WHEN WEATHER FORECASTS SUGGEST EXTENSIVE RAIN.
6. THE CONSTRUCTION ZONE IS TO BE ISOLATED FROM ADJACENT STREAM FLOWS THROUGH ADEQUATE SILT FENCING, STONE OR ANY OTHER METHOD AS APPROVED BY THE PROJECT MANAGER.
7. ALL WORK IS TO BE COMPLETED AS EXPEDITIOUSLY AS POSSIBLE AND ANY WORK THAT HAS BEEN INITIATED MUST BE COMPLETED WITHIN THE WORKING DAY. IF THIS IS NOT POSSIBLE, THEN THE CONTRACTOR MUST ENSURE, TO THE SATISFACTION OF THE PROJECT MANAGER, THAT THE WORK SITE IS ADEQUATELY STABILIZED.
8. ONCE EACH GRADING COMPONENT OF THE PROJECT HAS BEEN COMPLETED BY THE CONTRACTOR, THE SITE IS TO BE REVEGETATED AS PER THE PLANS AND STABILIZED.
9. ANY EROSION AND SEDIMENT CONTROLS ARE TO BE REMOVED AT THE COMPLETION OF THE PROJECT AFTER A JOINT INSPECTION BY THE CONTRACTOR AND PROJECT MANAGER.
10. ANY DEVIATIONS FROM THE APPROVED STRATEGY MUST BE APPROVED BY THE PROJECT MANAGER.
11. CONTRACTOR EQUIPMENT TO STAY OUT OF THE CHANNEL BED AND AVOID ANY UNNECESSARY DISRUPTION OF THE CHANNEL.
12. SEDIMENT LADEN DEWATERING DISCHARGE SHOULD BE PUMPED TO A SETTLING BASIN OR FILTERING SYSTEM WELL AWAY FROM THE WATERCOURSE AND ALLOWED TO SETTLE AND/OR FILTER THROUGH THE RIPARIAN VEGETATION BEFORE RE-ENTERING THE WATERCOURSE DOWNSTREAM OF THE CONSTRUCTION AREA.

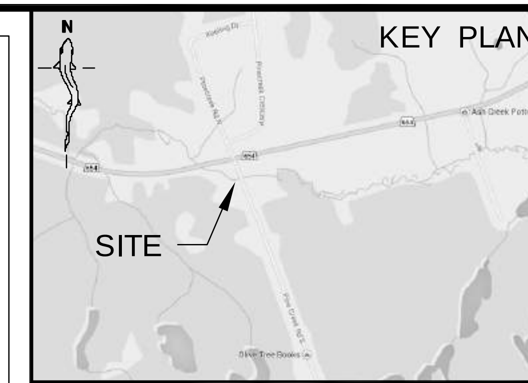
LANDSCAPE NOTES:

1. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH BY-LAWS AND CODES HAVING JURISDICTION OVER SITE LOCATION.
2. COMPLETE ALL WORK TO THE SATISFACTION OF THE PROJECT MANAGER. REPORT ANY CHANGES, DISCREPANCIES OR SUBSTITUTIONS TO THE PROJECT MANAGER FOR REVIEW. OBTAIN APPROVAL FROM THE PROJECT MANAGER BEFORE PROCEEDING.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE EXISTING SERVICE LOCATIONS.
4. EXACT LOCATIONS OF PLANT MATERIAL WILL BE DETERMINED BY PLACEMENT OF SITE SERVICES SUCH AS HYDRO VAULTS, METERS, UTILITIES ROOF RAIN WATER LEADERS, DRIVEWAYS, LIGHT STANDARDS, ETC.
5. ALL PLANT MATERIAL LOCATIONS TO BE STAKED OR MARKED OUT AND APPROVED BY PROJECT MANAGER PRIOR TO INSTALLATION.
6. SUPPLY ALL PLANT MATERIAL IN ACCORDANCE WITH THE CANADIAN STANDARDS FOR NURSERY STOCK (7TH ED.).
7. INSTALL PLANT MATERIAL ACCORDING TO DETAILS SHOWN.
8. DISTURBED SOIL AREAS AROUND TREES AND SHRUBS ARE TO BE COVERED WITH SHREDDED CONIFER BARK MULCH SUCH AS 'CANADA RED' OR 'GRO-BARK' SPM MULCH, OR APPROVED EQUIVALENT. ALTERNATIVE MULCHES MUST BE APPROVED BY THE PROJECT MANAGER.
9. CONTRACTOR TO UTILIZE LAYOUT DIMENSIONS WHERE PROVIDED.
10. PROVIDE PLANTING BED AREA AS NOTED ON THE DRAWING OR TO ACCOMMODATE MATURE SIZE OF PLANT MATERIAL.
11. ALL SUPPORT SYSTEMS MUST BE REMOVED TO THE SATISFACTION OF THE PROJECT MANAGER ONCE THE TREE IS ESTABLISHED.
12. SUPPLY AND PLACE TOPSOIL IN ACCORDANCE WITH OPSS 570 TO A MINIMUM DEPTH OR 100MM UNLESS OTHERWISE SPECIFIED.
13. SUPPLY AND PLACE SOD IN ACCORDANCE WITH OPSS 571 UNLESS OTHERWISE SPECIFIED.
14. SUPPLY AND PLACE SEED IN ACCORDANCE WITH OPSS 572 UNLESS OTHERWISE SPECIFIED.
15. CONTRACTOR TO PROVIDE NECESSARY EROSION CONTROL PROTECTION AS REQUIRED TO ENSURE SOIL STABILIZATION AND PROPER SEED GERMINATION.
16. ALL DIMENSIONS IN MM UNLESS OTHERWISE NOTED.
17. IF DISCREPANCIES ARISE BETWEEN PLANT MATERIAL COUNT SHOWN ON DRAWING AND PLANT LIST THE DRAWING SHALL BE CONSIDERED CORRECT.
18. CONTRACTOR TO PROVIDE MINIMUM 1 YEAR WARRANTY FROM DATE ACCEPTED ON ALL WORK UNLESS OTHERWISE SPECIFIED.
19. ANY SITE PLAN OR GRADING AND SERVICING SHOWN IS FOR INFORMATION ONLY. REFER TO APPROVED DRAWINGS.

ENVIRONMENTAL NOTES:

1. REFUELLING ACTIVITIES SHOULD BE CONDUCTED IN AN ENVIRONMENTALLY RESPONSIBLE MANNER. THIS INCLUDES A KEEPING THE FUELLING OPERATIONS 30 M SETBACK FROM THE WATER'S EDGE, DRAINAGE PATHWAY OR UNLESS OTHERWISE DIRECTED BY THE PROJECT MANAGER. SPILL KITS AND SUFFICIENT AMOUNT OF SORBANT MATERIAL SHOULD BE AVAILABLE ON THE FUEL OR SERVICE VEHICLES.
2. ANY PART OF EQUIPMENT ENTERING THE WATER SHOULD BE FREE OF FLUID LEAKS AND EXTERNALLY CLEANED AND DEGREASED TO PREVENT ANY DELETERIOUS SUBSTANCES FROM ENTERING THE WATER.
3. ANY SPILLS RESULTING FROM REFUELLING OPERATIONS, HYDRAULIC LEAKS, MAINTENANCE ETC. MUST BE REPORTED IMMEDIATELY TO THE PROJECT MANAGER WHO WILL THEN NOTIFY THE SPILLS ACTION CENTRE IF REQUIRED.
4. ALL MATERIALS AND EQUIPMENT USED FOR THE PURPOSE OF SITE PREPARATION AND PROJECT COMPLETION SHOULD BE OPERATED AND STORED IN A MANNER THAT PREVENTS ANY DELETERIOUS SUBSTANCE (E.G. PETROLEUM PRODUCTS, SILT, DEBRIS, ETC) FROM ENTERING THE WATER.
5. THE AREA OF DISTURBANCE WITHIN THE CHANNEL AND ON THE STREAMBANKS MUST BE KEPT TO A MINIMUM. HEAVY EQUIPMENT TRAFFIC WILL BE RESTRICTED TO ESTABLISHED TRAVEL PATHWAYS.
6. STOCKPILE AND STAGING AREAS SHOULD BE WELL REMOVED FROM THE WATERCOURSE AND CONTAINED BY APPROPRIATE SEDIMENT AND EROSION CONTROLS.
7. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE INSTALLED AND MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD. THE INSTALLED MEASURES SHOULD BE ROUTINELY INSPECTED TO ENSURE THAT THEY ARE FUNCTIONING AS INTENDED. DISTURBED SOILS SHOULD BE STABILIZED IMMEDIATELY WITH SUITABLE PLANTINGS/SEED/MAT. MAINTENANCE SHOULD CONTINUE UNTIL SUCH TIME AS THE DISTURBED AREAS ARE SUFFICIENTLY STABILIZED THROUGH VEGETATIVE GROWTH.
8. TRAFFIC MANAGEMENT PLAN OR CROSSING CONSTRAINTS - SPAN STRUCTURE ONLY. SPECIFIC DETAILS TO BE PROVIDED BY CONTRACTOR.
9. WEATHER CONDITIONS SHOULD BE MONITORED TO ADEQUATELY PREPARE THE SITE FOR RAIN EVENTS.
10. AS CONSTRUCTION ACTIVITIES IN AND AROUND WATER IS CHALLENGING, WITH A SIGNIFICANT POTENTIAL FOR ENVIRONMENTAL EFFECT, IT IS RECOMMENDED THAT THE CONTRACTOR ORGANIZE AN IN-WATER CONSTRUCTION TEAM WHICH WILL CONSIST OF AN ENVIRONMENTAL MONITOR, SUPERVISOR, SELECTED MACHINE OPERATORS AND GENERAL LABOURERS. THIS TEAM WILL BE RESPONSIBLE FOR THE CONSTRUCTION ACTIVITIES WITHIN THE CHANNEL INCLUDING THE CONSTRUCTION OF THE CHANNEL AND RE-GRADING OF THE STREAMBANKS AND FLOODPLAINS.

KEY PLAN



SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

SHORELINE RESTORATION

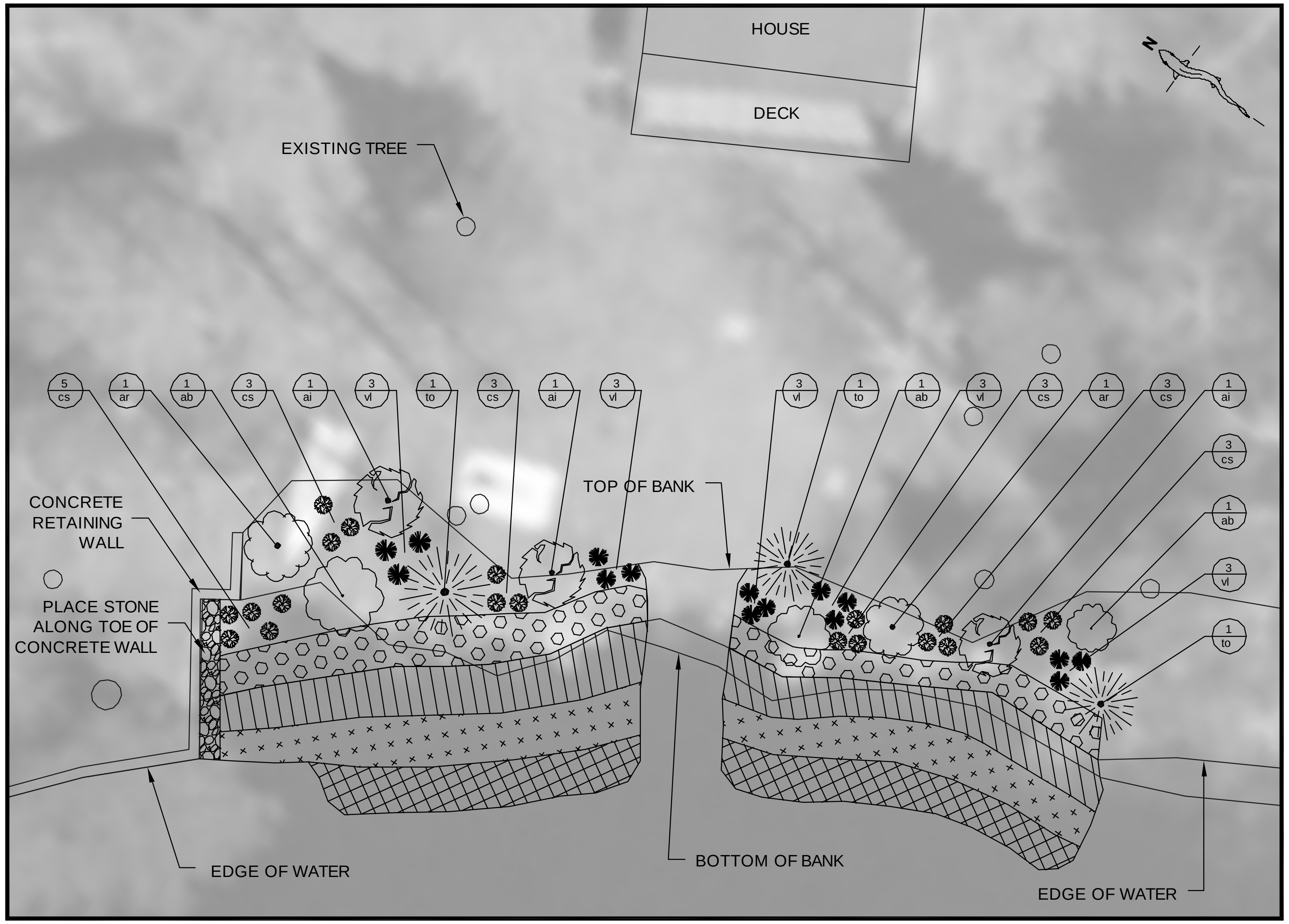
MUNICIPAL DWG NO. WE 14045-01

CAD FILENAME DET

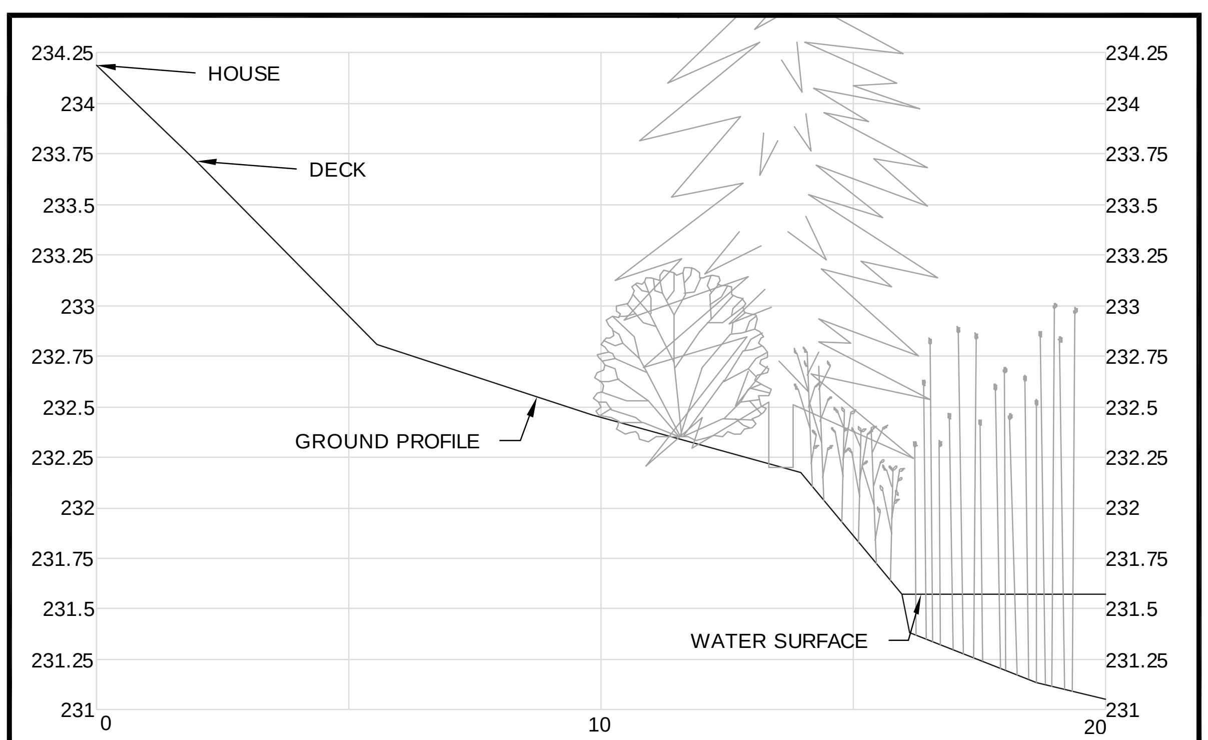
SITE NO. CA-8

SHEET # 2 OF 2

PLAN
SCALE - 1:150



PROFILE
SCALE - 1:150



SITE REVEGETATION:

ALL DISTURBED AREAS, INCLUDING ACCESS ROUTES, STAGING AREAS AND WORK ZONES ARE TO BE CLEARED (PLANT MATERIAL TO BE SALVAGED) PRIOR TO CONSTRUCTION AND REVEGETATED WITH SPECIFIED SEED MIX AND SALVAGED PLANT MATERIAL UNLESS DIRECTED OTHERWISE BY DESIGN DETAILS.

AREA STABILIZATION:

EROSION CONTROL BLANKETS ARE TO BE PLACED TO CONTROL EROSION AFTER SEEDING. ECB TO BE KoirMat 400 OR APPROVED EQUIVALENT AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

CONSTRUCTION SUPERVISION:

THE PROJECT MANAGER SHALL BE ON SITE OR AVAILABLE DURING ALL PHASES OF CONSTRUCTION AND IN-WATER WORKS.

FISHERIES TIMING WINDOW:

THERE SHALL BE NO IN-WATER WORK OR ACTIVITY FROM APRIL 1 TO JUNE 30.

SITE 9 PLANTING PLAN

SITE 9 HAS ALREADY BEGUN TO NOT MOW TO THE WATER'S EDGE AND NEEDS ADVICE ON WHAT TO PLANT TO ENHANCE THE RIPARIAN BUFFER.

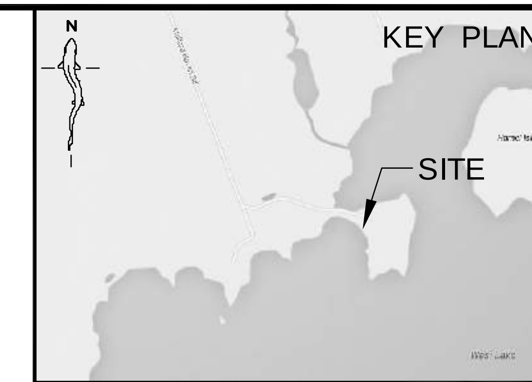
INSTRUCTIONS:

1. NO SCARIFICATION OR TILLING SHOULD BE REQUIRED, THERE IS ALREADY WELL ESTABLISHED GRASS. REMOVING THIS GRASS WILL CAUSE SOIL EROSION. TO AVOID DISTURBING THE EXISTING GRASS, USE A SHOVEL OR GARDEN TOOLS TO PLANT VEGETATION.
2. PLANT LIVE POTTED AND PLUG PLANTS DURING THE SPRING AND EARLY SUMMER (MOST OF THE VEGETATION IN THIS SITE WILL INCLUDE PLUGS AND POTTED PLANTS. THE SEED MIX USED IN THIS PLAN IS GEARED MORE TOWARD GRASSES (SLOW DOWN RUNOFF) TO FILTER RUNOFF FROM PARKING LOT), SEED MIXES SHOULD BE PLANTED IN THE FALL. PLANTING IN THE FALL IS NEEDED TO ALLOW FOR FREEZING TO INITIATE GERMINATION, HOWEVER IF THE SEEDS HAVE ALREADY BEEN PREPARED FOR GERMINATION PLANTING IN THE SPRING CAN BE DONE.
3. IF SCARIFICATION IS NECESSARY AND NEEDS TO BE DONE IN THE SPRING TIME, CANADA WILD RYE SHOULD BE SEEDED TO PREVENT SOIL EROSION. "DUE TO ITS QUICK ESTABLISHMENT IT MAKES AN IDEAL NURSE CROP FOR NATIVE MEADOW PLANTINGS AS IT MATURES IN THE FIRST TO SECOND YEAR, LONG AHEAD OF OTHER LONGER LIVED WARM SEASON NATIVE GRASSES AND EVENTUALLY GIVES WAY IN COMBINED PLANTINGS TO OTHER NATIVE GRASSES" (ONTARIO SEED CO. LTD., 2015A).
4. PLANT THE AQUATIC (BULRUSHES AND PICKEREL WEED) BETWEEN MAY AND THE END OF JULY IN THE WATER CLOSE TO SHORE (LESS THAN 60 CM DEEP).

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	MATURE HEIGHT (m)	MATURE SPREAD (m)	O.C. SPACING (m)	QNTY.
	TREES					
ar	Acer rubrum	Red Maple	20.0	12.0	12.0	2
to	Thuja occidentalis	White Cedar	15.0	4.0	3.0	3
ai	Alnus incana	Speckled Alder	3.0	2.5	2.0	3
ab	Abies balsamea	Balsam Fir	30	6.0	3.0	3
	SHRUBS					
cs	Cornus stolonifera	Red Osier Dogwood	3.0	3.0	2.0	20
vl	Viburnum lentago	Nannyberry	3.0	6.0	3.0	15
	FRINGE					
cv	Carex vulpinoidea	Fox Sedge	1.0		0.3	54
vh	Verbena hastata	Blue Vervain	1.0		0.3	54
mr	Mimulus ringens	Square–Stemmed Monkey	0.9		0.3	54
	EMERGENT					
sc	Schoenoplectus tabernaemontani	Soft Stem Bulrush	3.0		0.3	52
sa	Scirpus atrovirens	Dark Green Bulrush	1.5		0.3	64
pc	Pontederia cordata	Pickerel Weed	1.0		0.3	68

KEY PLAN



LEGEND:

- SOFT STEM BULL RUSH (CLUMPS OF 3/sm)
- DARK GREEN BULL RUSH (CLUMPS OF 3/sm)
- PICKEREL WEED (CLUMPS OF 3/sm)
- FOX SEDGE, BLUE VERVAIN AND SQUARE-STEMMED MONKEY

SCALE: AS NOTED	DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

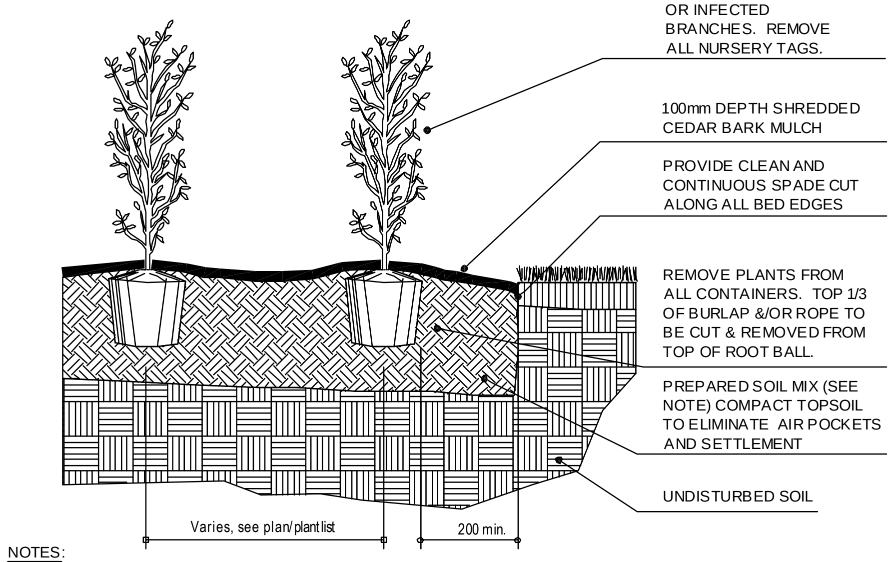
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

SHORELINE RESTORATION

MUNICIPAL DWG NO.	CAD FILENAME
WE 14045-01	PP1
SITE NO. CA-9	SHEET # 1 OF 2

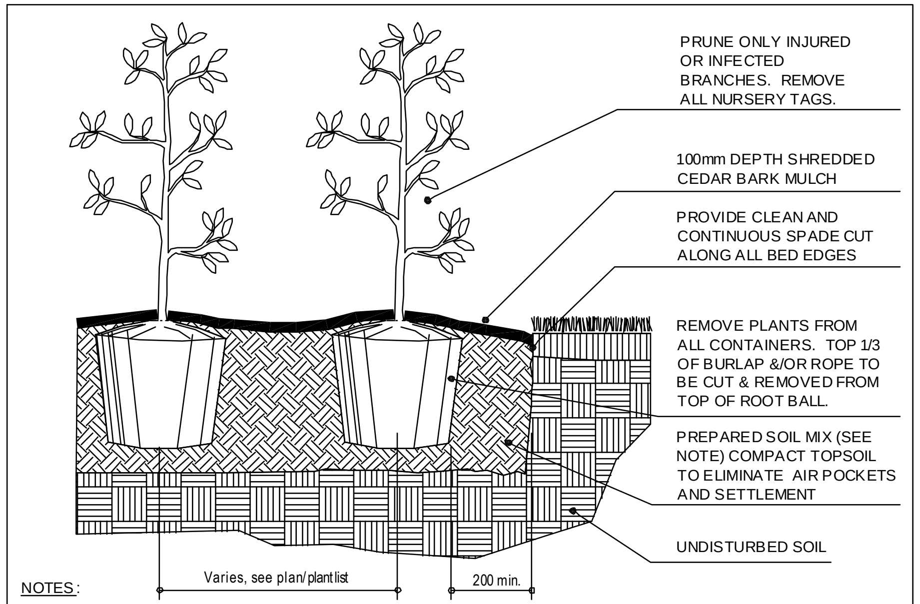


NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D1 — POTTED SHRUB (TYPICAL)

N.T.S.



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2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D2 — POTTED TREE (TYPICAL)

N.T.S.

CONSTRUCTION ACCESS:

1. ACCESS TO THE SITE WILL BE DETERMINED DURING THE START-UP MEETING.

2. ANY CREEK CROSSING TO CONSIST OF BRIDGE SPANNING CREEK FROM TOP OF BANK TO TOP OF BANK. BRIDGE TO BE SUPPLIED BY CONTRACTORS.

3. TREES TO BE TRIMMED OR REMOVED FROM ACCESS AS APPROVED BY PROJECT MANAGER.

4. SAFETY FENCE TO BE ERECTED AS REQUIRED TO LIMIT PUBLIC ACCESS TO TEMPORARY CONSTRUCTION ACCESS ROAD AND CONSTRUCTION SITE.

5. SITE CONSTRUCTION ACTIVITY WILL INCLUDE THE REPAIR OF THE ACCESS AND EGRESS AREAS.

6. UPON COMPLETION OF THE CONSTRUCTION, THE ACCESS WAY IS TO BE REPAIRED TO EXISTING CONDITIONS OR BETTER.

7. CONTRACTOR TO MEET ON SITE WITH PROJECT MANAGER PRIOR TO INITIATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCING AND STAGING NOTES:

1. THE CONTRACTOR SHALL PROVIDE GENERAL ARRANGEMENT DRAWINGS AND A STAGING PLAN WITH THE PROPOSED CONTROL METHODOLOGY AND DEMONSTRATE THAT THE APPROACH CAN ADEQUATELY ADDRESS THE ENVIRONMENTAL AND EXISTING SITE CONDITIONS (VARYING FLOW CONDITIONS, CHANNEL CAPACITIES, WET WEATHER RESPONSE).

2. CONSTRUCTION STAGING MUST HAVE REGARD FOR THE ENVIRONMENTAL ASPECTS OF THE PROPOSED CONSTRUCTION. THIS WILL ENSURE THAT AMPLE TIME IS PROVIDED TO ENSURE THE TIMELY ARRIVAL OF REQUIRED EQUIPMENT AND MATERIALS AND THE APPROPRIATE ALLOCATION OF RESOURCES.

3. INSTALL SILT FENCE AS REQUIRED BY SITE CONDITIONS. FENCE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE THE LIMIT OF CONSTRUCTION ACTIVITY.

4. REMOVE AND STOCKPILE EXISTING VEGETATION FOR POTENTIAL REUSE.

5. GRADE SITE AS REQUIRED.

6. COMPLETE SEEDING AND PLANTING AS PER APPROVED PLAN.

7. STABILIZE ALL SLOPES AS NOTED ON PLAN.

8. REMOVE ANY EXCESS MATERIAL STOCKPILED ON SITE.

9. REMOVE SILT FENCE ONCE ALL VEGETATION HAS BECOME SUFFICIENTLY ESTABLISHED.

EROSION AND SEDIMENT CONTROL STRATEGY :

1. PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT A DETAILED SCHEDULE AND WORK PLAN FOR REVIEW AND APPROVAL OF THE PROJECT MANAGER AND EXTERNAL AGENCIES AS REQUIRED, INDICATING HOW HE WILL IMPLEMENT SEDIMENT AND EROSION CONTROLS, AND HOW HE WILL CONTROL/DIVERT CREEK FLOWS AROUND OR THROUGH THE CONSTRUCTION AREA.

2. SEDIMENT AND EROSION CONTROL MEASURES MUST BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT ENTRY OF SEDIMENT INTO THE WATER OR RE-SUSPENDED SEDIMENT.

3. ANY STOCKPILED MATERIALS SHOULD BE STORED AND STABILIZED AWAY FROM THE WATER. EXCESS MATERIAL SHALL BE REMOVED IMMEDIATELY FROM THE CHANNEL AREA AND TEMPORARILY STOCKPILED IN SUITABLE LOCATIONS IDENTIFIED BY THE DESIGN DRAWINGS AND ON-SITE AREAS APPROVED BY THE PROJECT MANAGER.

4. ONLY CLEAN MATERIAL FREE OF FINE PARTICULATE MATTER SHOULD BE PLACED IN THE WATER.

5. ALL WORK IS TO BE PERFORMED DURING LOW FLOW CONDITIONS AND WORK IS NOT TO BE INITIATED WHEN WEATHER FORECASTS SUGGEST EXTENSIVE RAIN.

6. THE CONSTRUCTION ZONE IS TO BE ISOLATED FROM ADJACENT STREAM FLOWS THROUGH ADEQUATE SILT FENCING, STONE OR ANY OTHER METHOD AS APPROVED BY THE PROJECT MANAGER.

7. ALL WORK IS TO BE COMPLETED AS EXPEDITIOUSLY AS POSSIBLE AND ANY WORK THAT HAS BEEN INITIATED MUST BE COMPLETED WITHIN THE WORKING DAY. IF THIS IS NOT POSSIBLE, THEN THE CONTRACTOR MUST ENSURE, TO THE SATISFACTION OF THE PROJECT MANAGER, THAT THE WORK SITE IS ADEQUATELY STABILIZED.

8. ONCE EACH GRADING COMPONENT OF THE PROJECT HAS BEEN COMPLETED BY THE CONTRACTOR, THE SITE IS TO BE REVEGETATED AS PER THE PLANS AND STABILIZED.

9. ANY EROSION AND SEDIMENT CONTROLS ARE TO BE REMOVED AT THE COMPLETION OF THE PROJECT AFTER A JOINT INSPECTION BY THE CONTRACTOR AND PROJECT MANAGER.

10. ANY DEVIATIONS FROM THE APPROVED STRATEGY MUST BE APPROVED BY THE PROJECT MANAGER.

11. CONTRACTOR EQUIPMENT TO STAY OUT OF THE CHANNEL BED AND AVOID ANY UNNECESSARY DISRUPTION OF THE CHANNEL.

12. SEDIMENT LADEN DEWATERING DISCHARGE SHOULD BE PUMPED TO A SETTLING BASIN OR FILTERING SYSTEM WELL AWAY FROM THE WATERCOURSE AND ALLOWED TO SETTLE AND/OR FILTER THROUGH THE RIPARIAN VEGETATION BEFORE RE-ENTERING THE WATERCOURSE DOWNSTREAM OF THE CONSTRUCTION AREA.

LANDSCAPE NOTES:

1. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH BY-LAWS AND CODES HAVING JURISDICTION OVER SITE LOCATION.

2. COMPLETE ALL WORK TO THE SATISFACTION OF THE PROJECT MANAGER. REPORT ANY CHANGES, DISCREPANCIES OR SUBSTITUTIONS TO THE PROJECT MANAGER FOR REVIEW. OBTAIN APPROVAL FROM THE PROJECT MANAGER BEFORE PROCEEDING.

3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE EXISTING SERVICE LOCATIONS.

4. EXACT LOCATIONS OF PLANT MATERIAL WILL BE DETERMINED BY PLACEMENT OF SITE SERVICES SUCH AS HYDRO VAULTS, METERS, UTILITIES ROOF RAIN WATER LEADERS, DRIVEWAYS, LIGHT STANDARDS, ETC.

5. ALL PLANT MATERIAL LOCATIONS TO BE STAKED OR MARKED OUT AND APPROVED BY PROJECT MANAGER PRIOR TO INSTALLATION.

6. SUPPLY ALL PLANT MATERIAL IN ACCORDANCE WITH THE CANADIAN STANDARDS FOR NURSERY STOCK (7TH ED.).

7. INSTALL PLANT MATERIAL ACCORDING TO DETAILS SHOWN.

8. DISTURBED SOIL AREAS AROUND TREES AND SHRUBS ARE TO BE COVERED WITH SHREDDED CONIFER BARK MULCH SUCH AS 'CANADA RED' OR 'GRO-BARK' SPM MULCH, OR APPROVED EQUIVALENT. ALTERNATIVE MULCHES MUST BE APPROVED BY THE PROJECT MANAGER.

9. CONTRACTOR TO UTILIZE LAYOUT DIMENSIONS WHERE PROVIDED.

10. PROVIDE PLANTING BED AREA AS NOTED ON THE DRAWING OR TO ACCOMMODATE MATURE SIZE OF PLANT MATERIAL.

11. ALL SUPPORT SYSTEMS MUST BE REMOVED TO THE SATISFACTION OF THE PROJECT MANAGER ONCE THE TREE IS ESTABLISHED.

12. SUPPLY AND PLACE TOPSOIL IN ACCORDANCE WITH OPSS 570 TO A MINIMUM DEPTH OR 100MM UNLESS OTHERWISE SPECIFIED.

13. SUPPLY AND PLACE SOD IN ACCORDANCE WITH OPSS 571 UNLESS OTHERWISE SPECIFIED.

14. SUPPLY AND PLACE SEED IN ACCORDANCE WITH OPSS 572 UNLESS OTHERWISE SPECIFIED.

15. CONTRACTOR TO PROVIDE NECESSARY EROSION CONTROL PROTECTION AS REQUIRED TO ENSURE SOIL STABILIZATION AND PROPER SEED GERMINATION.

16. ALL DIMENSIONS IN MM UNLESS OTHERWISE NOTED.

17. IF DISCREPANCIES ARISE BETWEEN PLANT MATERIAL COUNT SHOWN ON DRAWING AND PLANT LIST THE DRAWING SHALL BE CONSIDERED CORRECT.

18. CONTRACTOR TO PROVIDE MINIMUM 1 YEAR WARRANTY FROM DATE ACCEPTED ON ALL WORK UNLESS OTHERWISE SPECIFIED.

19. ANY SITE PLAN OR GRADING AND SERVICING SHOWN IS FOR INFORMATION ONLY. REFER TO APPROVED DRAWINGS.

ENVIRONMENTAL NOTES:

1. REFUELLING ACTIVITIES SHOULD BE CONDUCTED IN AN ENVIRONMENTALLY RESPONSIBLE MANNER. THIS INCLUDES A KEEPING THE FUELLING OPERATIONS 30 M SETBACK FROM THE WATER'S EDGE, DRAINAGE PATHWAY OR UNLESS OTHERWISE DIRECTED BY THE PROJECT MANAGER. SPILL KITS AND SUFFICIENT AMOUNT OF SORBANT MATERIAL SHOULD BE AVAILABLE ON THE FUEL OR SERVICE VEHICLES.

2. ANY PART OF EQUIPMENT ENTERING THE WATER SHOULD BE FREE OF FLUID LEAKS AND EXTERNALLY CLEANED AND DEGREASED TO PREVENT ANY DELETERIOUS SUBSTANCES FROM ENTERING THE WATER.

3. ANY SPILLS RESULTING FROM REFUELLING OPERATIONS, HYDRAULIC LEAKS, MAINTENANCE ETC. MUST BE REPORTED IMMEDIATELY TO THE PROJECT MANAGER WHO WILL THEN NOTIFY THE SPILLS ACTION CENTRE IF REQUIRED.

4. ALL MATERIALS AND EQUIPMENT USED FOR THE PURPOSE OF SITE PREPARATION AND PROJECT COMPLETION SHOULD BE OPERATED AND STORED IN A MANNER THAT PREVENTS ANY DELETERIOUS SUBSTANCE (E.G. PETROLEUM PRODUCTS, SILT, DEBRIS, ETC) FROM ENTERING THE WATER.

5. THE AREA OF DISTURBANCE WITHIN THE CHANNEL AND ON THE STREAMBANKS MUST BE KEPT TO A MINIMUM. HEAVY EQUIPMENT TRAFFIC WILL BE RESTRICTED TO ESTABLISHED TRAVEL PATHWAYS.

6. STOCKPILE AND STAGING AREAS SHOULD BE WELL REMOVED FROM THE WATERCOURSE AND CONTAINED BY APPROPRIATE SEDIMENT AND EROSION CONTROLS.

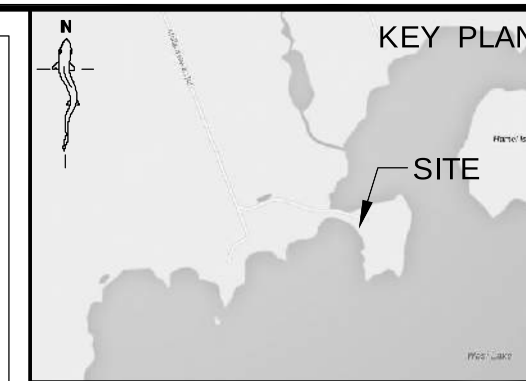
7. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE INSTALLED AND MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD. THE INSTALLED MEASURES SHOULD BE ROUTINELY INSPECTED TO ENSURE THAT THEY ARE FUNCTIONING AS INTENDED. DISTURBED SOILS SHOULD BE STABILIZED IMMEDIATELY WITH SUITABLE PLANTINGS/SEED/MAT. MAINTENANCE SHOULD CONTINUE UNTIL SUCH TIME AS THE DISTURBED AREAS ARE SUFFICIENTLY STABILIZED THROUGH VEGETATIVE GROWTH.

8. TRAFFIC MANAGEMENT PLAN OR CROSSING CONSTRAINTS - SPAN STRUCTURE ONLY. SPECIFIC DETAILS TO BE PROVIDED BY CONTRACTOR.

9. WEATHER CONDITIONS SHOULD BE MONITORED TO ADEQUATELY PREPARE THE SITE FOR RAIN EVENTS.

10. AS CONSTRUCTION ACTIVITIES IN AND AROUND WATER IS CHALLENGING, WITH A SIGNIFICANT POTENTIAL FOR ENVIRONMENTAL EFFECT, IT IS RECOMMENDED THAT THE CONTRACTOR ORGANIZE AN IN-WATER CONSTRUCTION TEAM WHICH WILL CONSIST OF AN ENVIRONMENTAL MONITOR, SUPERVISOR, SELECTED MACHINE OPERATORS AND GENERAL LABOURERS. THIS TEAM WILL BE RESPONSIBLE FOR THE CONSTRUCTION ACTIVITIES WITHIN THE CHANNEL INCLUDING THE CONSTRUCTION OF THE CHANNEL AND RE-GRADING OF THE STREAMBANKS AND FLOODPLAINS.

KEY PLAN



SCALE: AS NOTED

DATE: March 05, 2015

No.	DATE	BY	REVISIONS

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

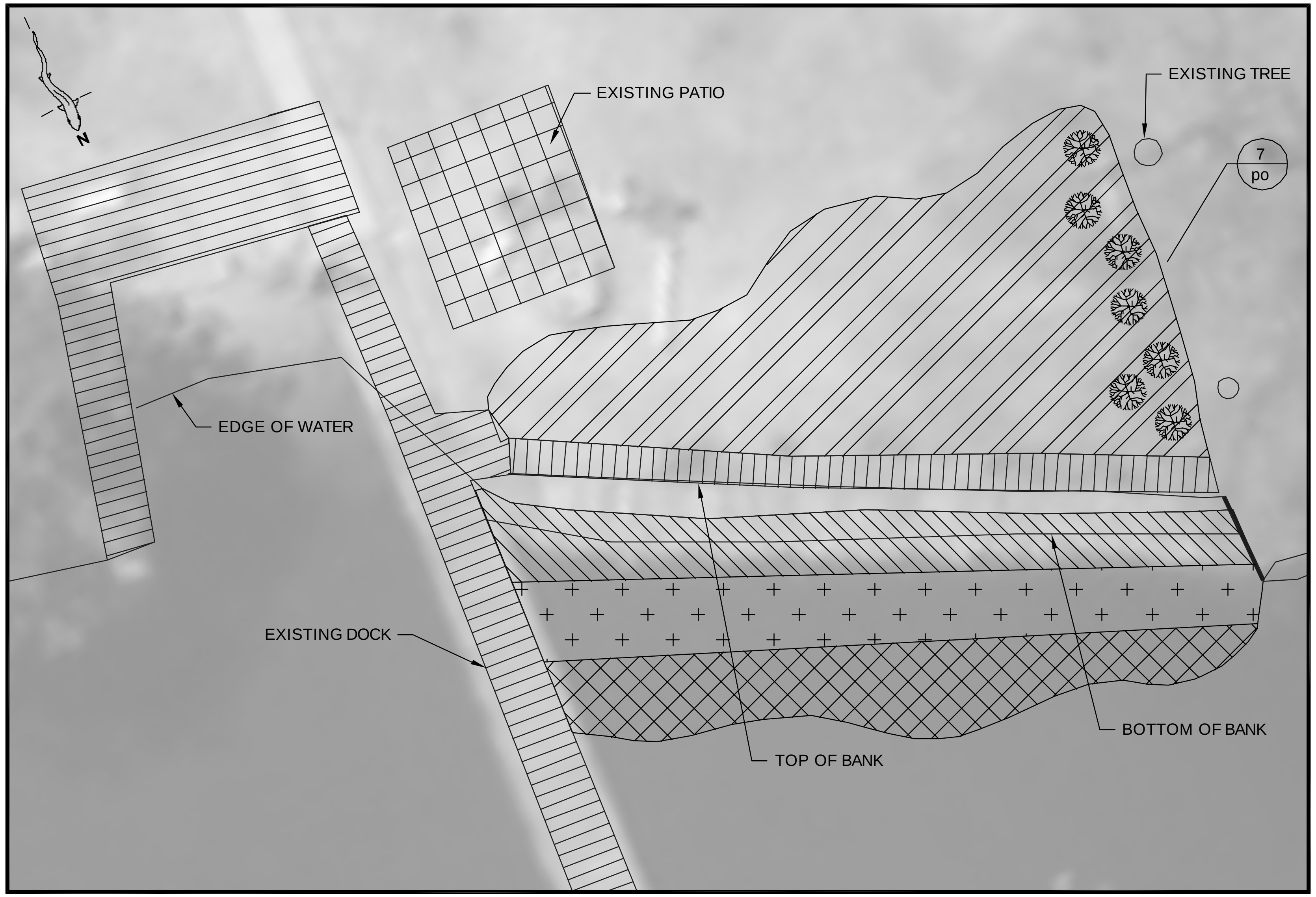
CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

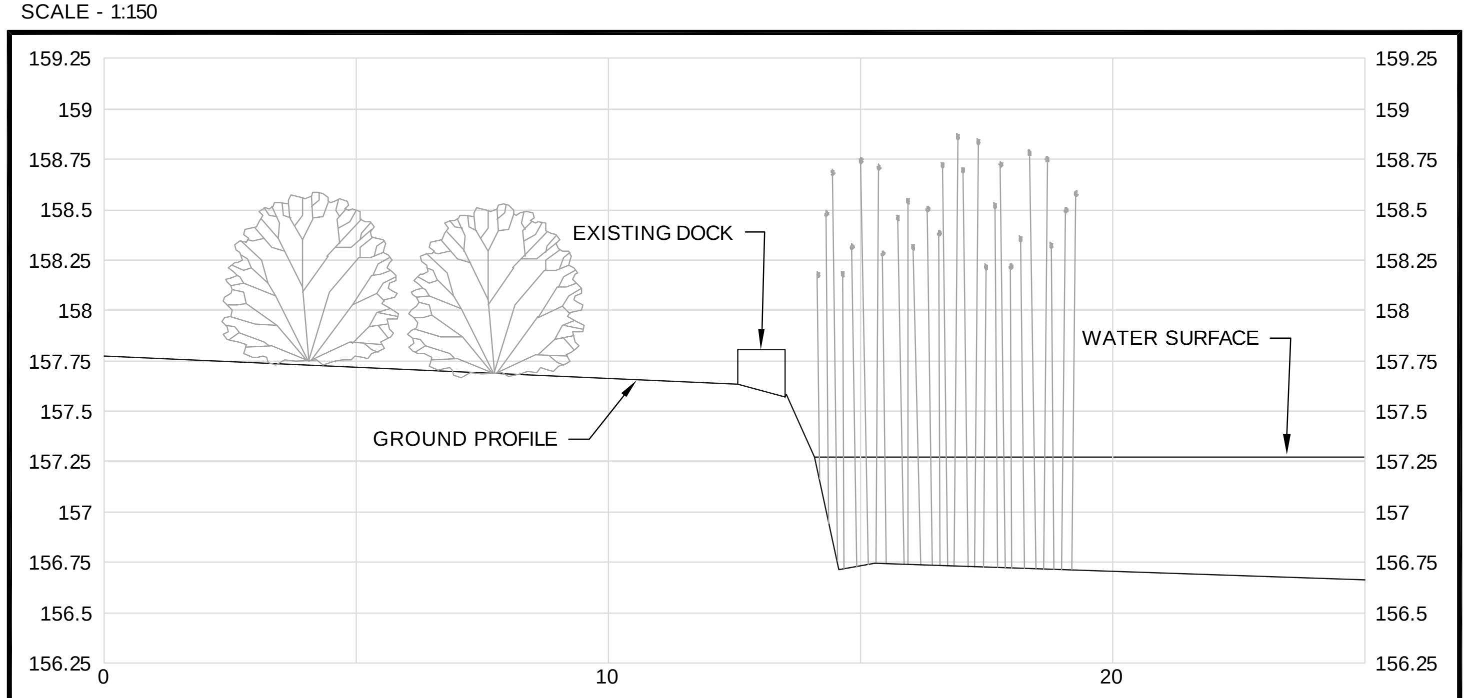
SHORELINE RESTORATION

MUNICIPAL DWG NO.	CAD FILENAME
WE 14045-01	DET
SITE NO.	**SHEET #**
CA-9	2 OF 2

PLAN
SCALE - 1:150



PROFILE
SCALE - 1:150



SITE REVEGETATION:

ALL DISTURBED AREAS, INCLUDING ACCESS ROUTES, STAGING AREAS AND WORK ZONES ARE TO BE CLEARED (PLANT MATERIAL TO BE SALVAGED) PRIOR TO CONSTRUCTION AND REVEGETATED WITH SPECIFIED SEED MIX AND SALVAGED PLANT MATERIAL UNLESS DIRECTED OTHERWISE BY DESIGN DETAILS.

AREA STABILIZATION:

EROSION CONTROL BLANKETS ARE TO BE PLACED TO CONTROL EROSION AFTER SEEDING. ECB TO BE KoirMat 400 OR APPROVED EQUIVALENT AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS.

CONSTRUCTION SUPERVISION:

THE PROJECT MANAGER SHALL BE ON SITE OR AVAILABLE DURING ALL PHASES OF CONSTRUCTION AND IN-WATER WORKS.

FISHERIES TIMING WINDOW:

THERE SHALL BE NO IN-WATER WORK OR ACTIVITY FROM APRIL 1 TO JUNE 30.

SITE 11 PLANTING PLAN

SITE 11 HAS A DOCK PARALLEL TO SHORE AND IS CONCERNED ABOUT SIGHT LINES AND ALLOWING ROOM FOR GRANDCHILDREN TO PLAY. ADDITIONALLY, THIS SITE HAS CANADIAN GEESE ISSUES AND NEED TO BE DETERRED.

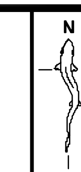
INSTRUCTIONS:

1. NO SCARIFICATION OR TILLING SHOULD BE REQUIRED, THERE IS ALREADY AN ESTABLISHED GRASS. REMOVING THIS GRASS WILL CAUSE SOIL EROSION. THUS WHEN PLANTING THE PLANTS USE A SHOVEL OR GARDEN TOOLS TO PLANT VEGETATION.
2. PLANT LIVE POTTED AND PLUG PLANTS DURING THE SPRING AND EARLY SUMMER. THE SEED MIX USED IN THIS PLAN IS GEARED MORE TOWARD GRASSES (TO KEEP LINE OF SIGHT), SEED MIXES SHOULD BE PLANTED IN THE FALL. PLANTING IN THE FALL IS NEEDED TO ALLOW FOR FREEZING TO INITIATE GERMINATION, HOWEVER IF THE SEEDS HAVE ALREADY BEEN PREPARED FOR GERMINATION PLANTING IN THE SPRING CAN BE DONE.
3. IF SCARIFICATION NEEDS TO BE DONE IN THE SPRING TIME, CANADA WILD RYE SHOULD BE SEEDED TO PREVENT SOIL EROSION. "DUE TO ITS QUICK ESTABLISHMENT IT MAKES AN IDEAL NURSE CROP FOR NATIVE MEADOW PLANTINGS AS IT MATURES IN THE FIRST TO SECOND YEAR, LONG AHEAD OF OTHER LONGER LIVED WARM SEASON NATIVE GRASSES AND EVENTUALLY GIVES WAY IN COMBINED PLANTINGS TO OTHER NATIVE GRASSES" (ONTARIO SEED CO. LTD., 2015A).
4. PLANT THE AQUATIC (BULRUSHES AND PICKEREL WEED) BETWEEN MAY AND THE END OF JULY IN THE WATER CLOSE TO SHORE (LESS THAN 60 CM DEEP).

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	MATURE HEIGHT (m)	MATURE SPREAD (m)	O.C. SPACING (m)	QNTY.
	SHRUBS					
po	Physocarpus opulifolius	Ninebark	3.0	6.0	2.0	7

KEY PLAN



SITE

LEGEND:

- WET MEADOW MIX & PLUGS OF HERBACEOUS PLANTS
- SOFT STEM BULL RUSH (CLUMPS OF 3/sm)
- DARK GREEN BULL RUSH (CLUMPS OF 3/sm)
- PICKEREL WEED (CLUMPS OF 3/sm)

SCALE: AS NOTED	DATE: March 05, 2015

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NORTH BAY-MATTAWA CONSERVATION AUTHORITY

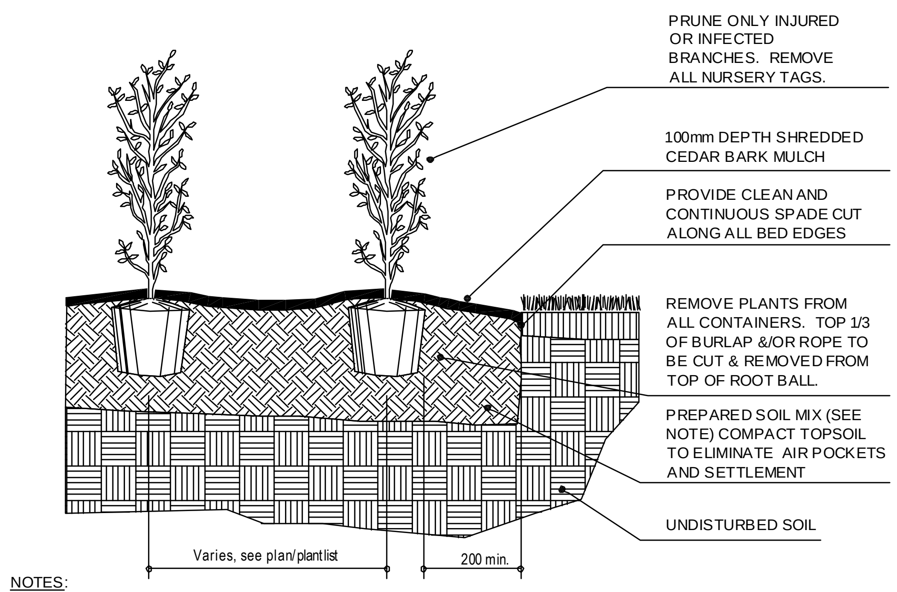
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

CONSULTANT

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

SHORELINE RESTORATION

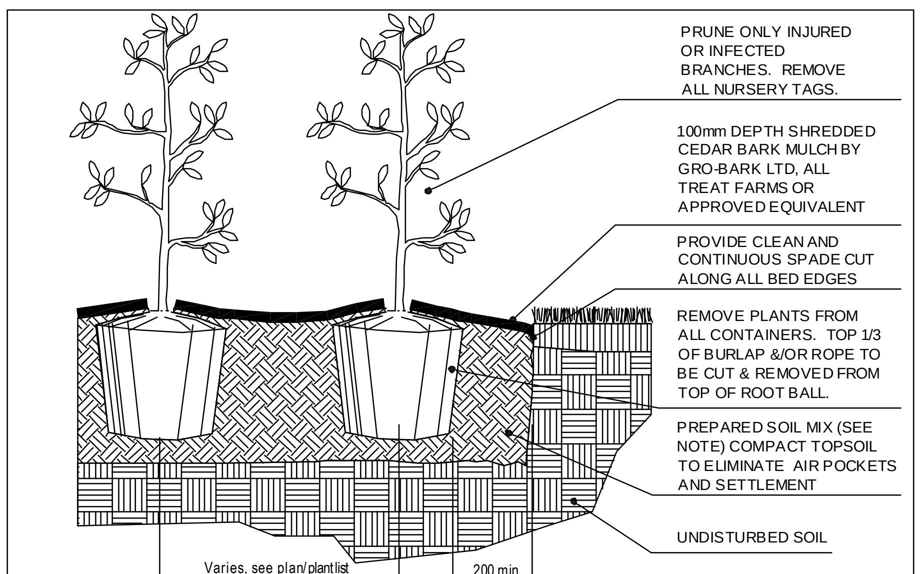
MUNICIPAL DWG NO.	CAD FILENAME
WE 14045-01	PP1
SITE NO.	SHEET #
CA-11	1 OF 2



NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D1 POTTED SHRUB (TYPICAL)
N.T.S.



NOTES:

1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED VERTICALLY REGARDLESS OF SLOPE.

D2 POTTED TREE (TYPICAL)
N.T.S.

CONSTRUCTION ACCESS:

1. ACCESS TO THE SITE WILL BE DETERMINED DURING THE START-UP MEETING.
2. ANY CREEK CROSSING TO CONSIST OF BRIDGE SPANNING CREEK FROM TOP OF BANK TO TOP OF BANK. BRIDGE TO BE SUPPLIED BY CONTRACTORS.
3. TREES TO BE TRIMMED OR REMOVED FROM ACCESS AS APPROVED BY PROJECT MANAGER.
4. SAFETY FENCE TO BE ERECTED AS REQUIRED TO LIMIT PUBLIC ACCESS TO TEMPORARY CONSTRUCTION ACCESS ROAD AND CONSTRUCTION SITE.
5. SITE CONSTRUCTION ACTIVITY WILL INCLUDE THE REPAIR OF THE ACCESS AND EGRESS AREAS.
6. UPON COMPLETION OF THE CONSTRUCTION, THE ACCESS WAY IS TO BE REPAIRED TO EXISTING CONDITIONS OR BETTER.
7. CONTRACTOR TO MEET ON SITE WITH PROJECT MANAGER PRIOR TO INITIATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCING AND STAGING NOTES:

1. THE CONTRACTOR SHALL PROVIDE GENERAL ARRANGEMENT DRAWINGS AND A STAGING PLAN WITH THE PROPOSED CONTROL METHODOLOGY AND DEMONSTRATE THAT THE APPROACH CAN ADEQUATELY ADDRESS THE ENVIRONMENTAL AND EXISTING SITE CONDITIONS (VARYING FLOW CONDITIONS, CHANNEL CAPACITIES, WET WEATHER RESPONSE).
2. CONSTRUCTION STAGING MUST HAVE REGARD FOR THE ENVIRONMENTAL ASPECTS OF THE PROPOSED CONSTRUCTION. THIS WILL ENSURE THAT AMPLE TIME IS PROVIDED TO ENSURE THE TIMELY ARRIVAL OF REQUIRED EQUIPMENT AND MATERIALS AND THE APPROPRIATE ALLOCATION OF RESOURCES.
3. INSTALL SILT FENCE AS REQUIRED BY SITE CONDITIONS. FENCE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE THE LIMIT OF CONSTRUCTION ACTIVITY.
4. REMOVE AND STOCKPILE EXISTING VEGETATION FOR POTENTIAL REUSE.
5. GRADE SITE AS REQUIRED.
6. COMPLETE SEEDING AND PLANTING AS PER APPROVED PLAN.
7. STABILIZE ALL SLOPES AS NOTED ON PLAN.
8. REMOVE ANY EXCESS MATERIAL STOCKPILED ON SITE.
9. REMOVE SILT FENCE ONCE ALL VEGETATION HAS BECOME SUFFICIENTLY ESTABLISHED.

EROSION AND SEDIMENT CONTROL STRATEGY :

1. PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL SUBMIT A DETAILED SCHEDULE AND WORK PLAN FOR REVIEW AND APPROVAL OF THE PROJECT MANAGER AND EXTERNAL AGENCIES AS REQUIRED, INDICATING HOW HE WILL IMPLEMENT SEDIMENT AND EROSION CONTROLS, AND HOW HE WILL CONTROL/DIVERT CREEK FLOWS AROUND OR THROUGH THE CONSTRUCTION AREA.
2. SEDIMENT AND EROSION CONTROL MEASURES MUST BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT ENTRY OF SEDIMENT INTO THE WATER OR RE-SUSPENDED SEDIMENT.
3. ANY STOCKPILED MATERIALS SHOULD BE STORED AND STABILIZED AWAY FROM THE WATER. EXCESS MATERIAL SHALL BE REMOVED IMMEDIATELY FROM THE CHANNEL AREA AND TEMPORARILY STOCKPILED IN SUITABLE LOCATIONS IDENTIFIED BY THE DESIGN DRAWINGS AND ON-SITE AREAS APPROVED BY THE PROJECT MANAGER.
4. ONLY CLEAN MATERIAL FREE OF FINE PARTICULATE MATTER SHOULD BE PLACED IN THE WATER.
5. ALL WORK IS TO BE PERFORMED DURING LOW FLOW CONDITIONS AND WORK IS NOT TO BE INITIATED WHEN WEATHER FORECASTS SUGGEST EXTENSIVE RAIN.
6. THE CONSTRUCTION ZONE IS TO BE ISOLATED FROM ADJACENT STREAM FLOWS THROUGH ADEQUATE SILT FENCING, STONE OR ANY OTHER METHOD AS APPROVED BY THE PROJECT MANAGER.
7. ALL WORK IS TO BE COMPLETED AS EXPEDITIOUSLY AS POSSIBLE AND ANY WORK THAT HAS BEEN INITIATED MUST BE COMPLETED WITHIN THE WORKING DAY. IF THIS IS NOT POSSIBLE, THEN THE CONTRACTOR MUST ENSURE, TO THE SATISFACTION OF THE PROJECT MANAGER, THAT THE WORK SITE IS ADEQUATELY STABILIZED.
8. ONCE EACH GRADING COMPONENT OF THE PROJECT HAS BEEN COMPLETED BY THE CONTRACTOR, THE SITE IS TO BE REVEGETATED AS PER THE PLANS AND STABILIZED.
9. ANY EROSION AND SEDIMENT CONTROLS ARE TO BE REMOVED AT THE COMPLETION OF THE PROJECT AFTER A JOINT INSPECTION BY THE CONTRACTOR AND PROJECT MANAGER.
10. ANY DEVIATIONS FROM THE APPROVED STRATEGY MUST BE APPROVED BY THE PROJECT MANAGER.
11. CONTRACTOR EQUIPMENT TO STAY OUT OF THE CHANNEL BED AND AVOID ANY UNNECESSARY DISRUPTION OF THE CHANNEL.
12. SEDIMENT LADEN DEWATERING DISCHARGE SHOULD BE PUMPED TO A SETTLING BASIN OR FILTERING SYSTEM WELL AWAY FROM THE WATERCOURSE AND ALLOWED TO SETTLE AND/OR FILTER THROUGH THE RIPARIAN VEGETATION BEFORE RE-ENTERING THE WATERCOURSE DOWNSTREAM OF THE CONSTRUCTION AREA.

LANDSCAPE NOTES:

1. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH BY-LAWS AND CODES HAVING JURISDICTION OVER SITE LOCATION.
2. COMPLETE ALL WORK TO THE SATISFACTION OF THE PROJECT MANAGER. REPORT ANY CHANGES, DISCREPANCIES OR SUBSTITUTIONS TO THE PROJECT MANAGER FOR REVIEW. OBTAIN APPROVAL FROM THE PROJECT MANAGER BEFORE PROCEEDING.
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4. EXACT LOCATIONS OF PLANT MATERIAL WILL BE DETERMINED BY PLACEMENT OF SITE SERVICES SUCH AS HYDRO VAULTS, METERS, UTILITIES ROOF RAIN WATER LEADERS, DRIVEWAYS, LIGHT STANDARDS, ETC.
5. ALL PLANT MATERIAL LOCATIONS TO BE STAKED OR MARKED OUT AND APPROVED BY PROJECT MANAGER PRIOR TO INSTALLATION.
6. SUPPLY ALL PLANT MATERIAL IN ACCORDANCE WITH THE CANADIAN STANDARDS FOR NURSERY STOCK (7TH ED.).
7. INSTALL PLANT MATERIAL ACCORDING TO DETAILS SHOWN.
8. DISTURBED SOIL AREAS AROUND TREES AND SHRUBS ARE TO BE COVERED WITH SHREDDED CONIFER BARK MULCH SUCH AS 'CANADA RED' OR 'GRO-BARK' SPM MULCH, OR APPROVED EQUIVALENT. ALTERNATIVE MULCHES MUST BE APPROVED BY THE PROJECT MANAGER.
9. CONTRACTOR TO UTILIZE LAYOUT DIMENSIONS WHERE PROVIDED.
10. PROVIDE PLANTING BED AREA AS NOTED ON THE DRAWING OR TO ACCOMMODATE MATURE SIZE OF PLANT MATERIAL.
11. ALL SUPPORT SYSTEMS MUST BE REMOVED TO THE SATISFACTION OF THE PROJECT MANAGER ONCE THE TREE IS ESTABLISHED.
12. SUPPLY AND PLACE TOPSOIL IN ACCORDANCE WITH OPSS 570 TO A MINIMUM DEPTH OR 100MM UNLESS OTHERWISE SPECIFIED.
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14. SUPPLY AND PLACE SEED IN ACCORDANCE WITH OPSS 572 UNLESS OTHERWISE SPECIFIED.
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17. IF DISCREPANCIES ARISE BETWEEN PLANT MATERIAL COUNT SHOWN ON DRAWING AND PLANT LIST THE DRAWING SHALL BE CONSIDERED CORRECT.
18. CONTRACTOR TO PROVIDE MINIMUM 1 YEAR WARRANTY FROM DATE ACCEPTED ON ALL WORK UNLESS OTHERWISE SPECIFIED.
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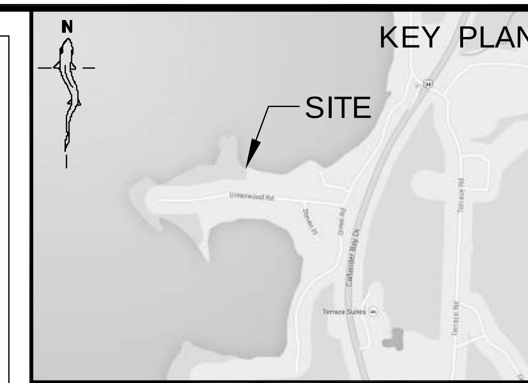
10. AS CONSTRUCTION ACTIVITIES IN AND AROUND WATER IS CHALLENGING, WITH A SIGNIFICANT POTENTIAL FOR ENVIRONMENTAL EFFECT, IT IS RECOMMENDED THAT THE CONTRACTOR ORGANIZE AN IN-WATER CONSTRUCTION TEAM WHICH WILL CONSIST OF AN ENVIRONMENTAL MONITOR, SUPERVISOR, SELECTED MACHINE OPERATORS AND GENERAL LABOURERS. THIS TEAM WILL BE RESPONSIBLE FOR THE CONSTRUCTION ACTIVITIES WITHIN THE CHANNEL INCLUDING THE CONSTRUCTION OF THE CHANNEL AND RE-GRADING OF THE STREAMBANKS AND FLOODPLAINS.

KEY PLAN



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