







water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

Erosion Survey Study
Muskoka River Watershed

District Municipality of Muskoka

September 21, 2022

September 21, 2022
WE: 22009

Mr. Glenn Cunnington
Manager, Watershed Programs
District Municipality of Muskoka
70 Pine Street
Bracebridge, ON
P1L 1N3

Dear Mr. Cunnington:

RE: Erosion Survey Study
Muskoka River Watershed
District Municipality of Muskoka

1.0 INTRODUCTION

Water's Edge was authorized by The District Municipality of Muskoka (DMM) to develop a citizen science program focused on educating the public on erosion (types, causes, impacts, etc.), how to identify erosion, and the ecological impacts of erosion within the Muskoka River Watershed. This project is part of an Integrated Watershed Management (IWM) initiative to identify the existing conditions within the Muskoka River Watershed. The DMM has developed a digital reporting system linked to Geographic Information System (GIS) mapping that allows for locations of shoreline erosion throughout the watershed to be submitted to the DMM by the public. In this report Water's Edge is providing a final report with different erosion scenarios and their best erosion control practices. For this purpose, we used Ontario Flow Assessment Tools III (OFAT III) (from MNRF) to find the watershed characteristics. The watershed is located north of Lake Simcoe and east of Georgian Bay (Figure 1).

The following data was acquired using the OFAT III. The landcover percentages are found for the entire watershed. The Muskoka River Watershed has a total drainage area roughly 5,000 km^2, with 834 km^2 of lakes. The Muskoka River flows 244 km though a series of connecting lakes from its headwaters in Algonquin Provincial Park to Georgian Bay. The watershed has a high percentage of open water (18%) due to the abundance of lakes. The rest of the watershed is covered with forest (77%), followed by agriculture (2.7%), and infrastructure (1.6%) (OFAT III, 2019).

As of 2020, the watershed has a total number of 61,200 permanent residents which reside in 13 area municipalities including the DMM and County of Haliburton. The watershed has a high seasonal population of 82,300. There are three major towns located in the watershed; Bracebridge, Gravenhurst, and Huntsville (Witzel et al.,2020).

2.0 BACKGROUND

Erosion in rivers is the process of movements of sediment downstream as a result of gravity force and shear stress along the channel. Sediment transport is a complicated process that depends on the slope of channel and sediment grain size. It can happen in both rivers and lakes. In rivers, sediments move due to the force that weight of water applies to the channel banks. When there is more water in the river, the force increases, and hence, it can move higher number of particles and larger particles at the bottom of the river. Therefore, a high amount of rainfall can lead to extreme erosion at the channel bottom at several locations in the river.

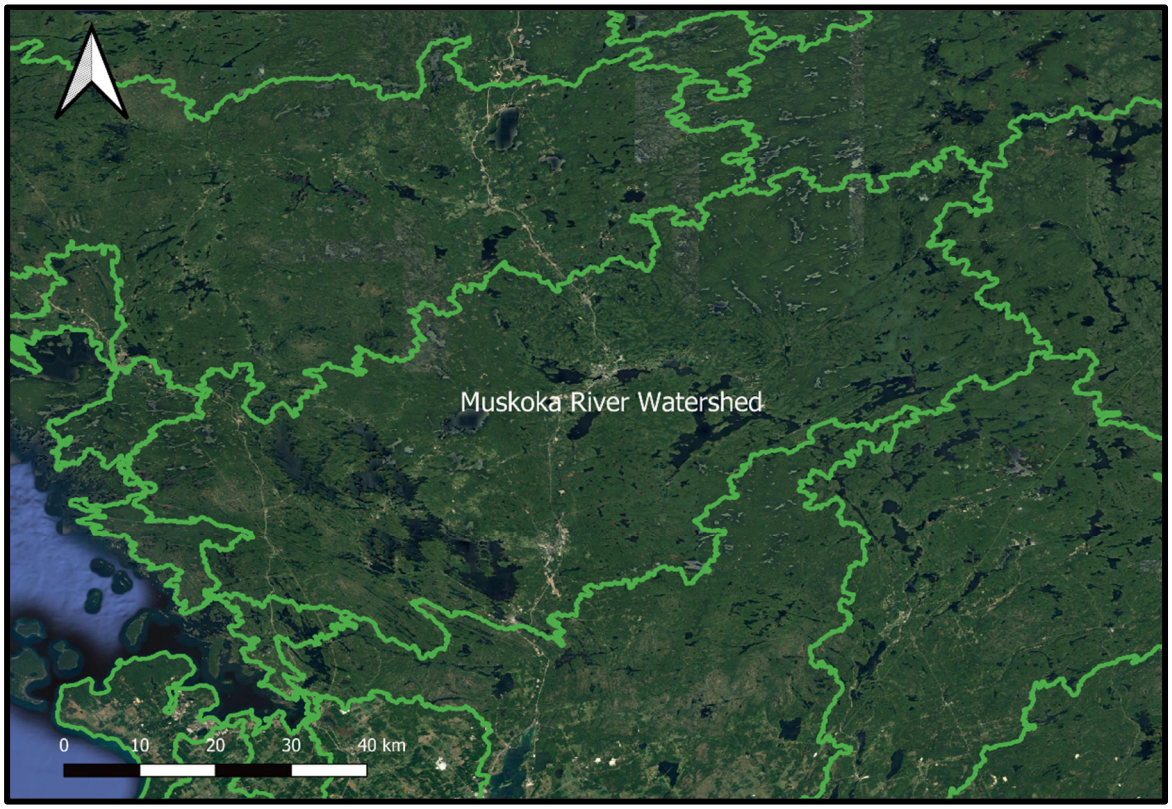


Figure 1: Muskoka River Watershed (Ontario Ministry of Natural Resources and Forestry, 2022)

Erosion along lakeshores is a different process. Lake erosion is usually most extreme near the shoreline where breaking waves occur. Larger lakes can have significant erosion along shorelines which occurs from persistent wave action initiated by wind. More open water in the lake can create larger incoming waves, which can break closer to the shore, and it can lead to more toe erosion of the shoreline bluffs. This process can lead into a fall of the entire soil block along shoreline. In this type of erosion, defining areas of recently exposed structure foundations are critical. Smaller lakes such as those within the Muskoka River Watershed have a different type of lakeshore erosion in the form of wave action from watercraft. As boaters travel across a lake, their wake spreads out and impacts the shoreline. Where the shoreline is unprotected due to alterations by residents, such as removing vegetation, these impacts can be severe. Large wakes can also damage established vegetation, creating the potential for future erosion.

Reviewing the surficial materials of the Muskoka River Watershed is important to evaluate the most likely regions where erosion will occur. As well, stream channel form and sediment supply are controlled by the region's physiography and underlying surficial geology. The Muskoka River Watershed is found in the Canadian Shield, crossing three physiographic units. These units are the Algonquin Highlands, the Number 11 Strip, and the Georgian Bay Fringe. It is also found in clay and sand plains. Sediments in this region are of organic deposits, coarse textured glaciolacustrine deposits, bedrock drift complex, and ice-contact stratified deposits. As well, there are pockets of kame moraine, and peat and muck (Chapman & Putnam, 1984). This means that rivers can carry both suspended and bedload sediments into the lakes during erosion. Which leads into depositing larger particles (sand and gravel) at the lake margin and smaller sediments (silt and clay) all over the lakebed.

2.1 Ecological Impacts

Erosion can also affect ecological changes in the watershed. Erosion occurs when large number of sediments move in a watercourse. Toxic chemicals can become attached or absorbed to sediment particles and transported to and deposited in other areas. This can lead into an increase in pollution in streams and lakes. Erosion can also clog the waterways, which can cause fish habitat destruction as well as declines in number of fish and other species.

3.0 SCOPE AND METHODOLOGY

The project's focus is on developing a Citizen Science Program to educate the public on erosion (types, causes, impacts), the ecological impacts of erosion within the Muskoka River Watershed, and the development of a digital reporting system in order to help the DMM improve said reporting system. The reporting system will consist of the user-friendly application that can be run on a laptop, desktop, or phone entitled Muskoka E-Rode.

The draft reporting system (E-Rode) was developed in conjunction with Muskoka staff and presented to the Community Round Table (CRT) on June 22, 2022. During the session, the CRT was presented with a discussion on the Muskoka River Watershed, a discussion on erosion including the various types of riverine and shoreline erosion, a set of draft questions that are included in the draft E-Rode application, and a demonstration of the beta version of the application. The presentation slides are presented in **Appendix C**.

Subsequently, the Study Team met again with the Steering Committee on July 4, 2022. The CRT meeting comments, as well as staff comments, were discussed. Based on constructive feedback received during the CRT meeting, the reporting system questions were modified to address the comments.

The intent of the overall program is to introduce the E-Rode application to the public on August 3rd, 2022. The application and the results will be reviewed, and any necessary adjustments will be made to ensure that the process is user-friendly and that any results will be beneficial to Muskoka staff in assessing erosion issues within the watershed.

3.1 Member Municipality Data

Although there are more municipalities in the watershed (13 lower and 2 upper tier) than just those within the District Municipality of Muskoka, Water's Edge staff interviewed these member municipalities to acquire erosion data specific to each member municipality. Where possible, this data was entered into the beta version of the application.

The following table (**Table 1**) summarizes the results of the interviews and data collection process.

Table 1: Data Collected from Municipalities*

Municipality	Information Provided By Municipality
District Municipality of Muskoka	Bracebridge – Muskoka Rd 15, 16 Port Sydney – Muskoka Rd 10, 44
District of Parry Sound	No Information Available
County of Haliburton	No Information Received
Township of Muskoka Lakes	Not aware of any significant erosion issues. Flooding event 2019 – roads were regraded – no concern
Town of Bracebridge	Muskoka River Siltation Project | Engage Bracebridge Sedimentation at the outlet into Lake Muskoka
Town of Gravenhurst	Little impact is seen in Gravenhurst -primary concern w/other watersheds. No reports from community. Flooding event 2019
Town of Huntsville	Erosion along Hunters Bay Narrows and along Muskoka River through the town of Huntsville, D/S of Fairy Lake. -erosion is common excuse for shoreline alterations -5 Church St. & 821 Muskoka Rd 10. -high evidence of erosion
Township of Georgian Bay	No Information Received
Township of Lake of Bays	10 Mile Creek ~1276 Seabreeze Rd. – delta creation, impact private property – upstream development
Town of Kearney	No Information Received
Township of Algonquin Highlands	Erosion Records are not kept and therefore unavailable.
Township of Dysart et al.	No known/notable erosion issues
Town of McMurrich/Montein	No Information Received
Township of Perry	No notable erosion issues in Township of Perry
Township of Seguin	No Information Received
Township of the Archipelago	No significant known erosion. 2016, washout of Healey Lake Rd near (45.17722663995013, -79.84984993923473)

*Contacted department of municipality varied by municipality. Departments contacted were Engineering and Transportation, Public Works, Operations, Infrastructure Services, Planning, or Environmental Services.

3.2 Final E-Rode Application Questions

Various questions were selected to describe and locate active erosion within the watershed. The questions had to be sufficiently specific to identify the type of erosion but not overly technical so that they may be understood by the general public.

Because the type of erosion is different for lakes and rivers, the questions were divided into two categories. There are less questions for lake erosion, because there are less signs to identify erosion in lakes. Identifying erosion in rivers is more complicated; therefore, we needed more questions.

Final questions, as amended by constructive comments from the CRT, are listed below.

1) Is the erosion site on a lake or river?
    a. Lake, River

Lake Questions

1) How much vegetation is left on the eroding bank?
    a. None, Some, Half covered, Most, All, Not sure
2) Are there large blocks of soil falling in? (indicating active erosion with accumulation at the bottom of the slope)
    a. Yes, No, Not sure
3) Is there any development in the area? (such as a house, bridge, dock, road, or buried pipes/cables)
    a. Yes, No, Not sure
4) If yes, is the development currently being impacted?
    a. Yes, No, Not sure, There is no nearby infrastructure
5) What is the approximate length of erosion along the shoreline at this location?
    a. <2m,2-10m,10-50m,>50 metres
6) What is the approximate height of erosion along the shoreline at this location?
    a. <1,1-2,2-5,>5 metres
7) Is there any additional information you can provide? (up to X characters)
    a. (open-ended question)

River Questions

1) What is the dominant type of vegetation on the banks?
    a. Trees, Shrubs, Tall grasses, Lawn, Not sure, Other
2) Are the banks failing? (for example, blocks of soil are falling in, bank is exposed, active erosion, etc.)
   Yes, No, Not sure
3) Approximately how wide is the river at the erosion site?
    a. Less than 0.5m, 0.5m – 2m, 2m – 10m, Greater than 10m, Not sure
4) Approximately how deep is the river at the erosion site?
    a. Less than 30cm (12”), 30cm – 50cm (12” – 20”), 50cm – 1m (20” – approx. 3’), over 1 m (3’), Not sure
    b. Yes, No, Not sure
5) Are there any fallen/leaning trees or fence posts?
    a. Yes, No, Not sure
6) Are there any exposed tree roots?
    a. Yes, No, Not sure
7) Are there any cut-off channels/oxbow lakes? (i.e. stagnant water beside the river, evidence of river/creek rerouting)
    a. Yes, No, Not sure
8) Do you see clumps of grass floating or deposited on the banks?
    a. Yes, No, Not sure
9) What colour is the water?
    a. Clear or tea-coloured, Cloudy (like chocolate milk), Not sure
10) Is there any development in the area? (house, bridge, road, buried cables, culvert or other water conveyance)
    Yes, No, Not sure
11) If yes, is the development currently being impacted?
    a. Yes, No, Not sure, There is no nearby infrastructure
12) What is the approximate length of erosion along the shoreline at this location?
    a. <2,2-10,10-50,>50 metres
13) What is the approximate height of erosion along the shoreline at this location?

a. <1,1-2,2-5,>5 metres

14) Is there any additional information you can provide? (up to X characters)
    a. (open-ended question)

Upload Date, Photo & Location

- This should be available in both the lake and river surveys

5.0 DISCUSSION

This summary report is prepared by Water's Edge to assist the DMM in the development of a Citizen Science Program. Based on the background information, we can see that the watershed remains mostly natural with a high percentage of forested areas and only 1.6% of the watershed has been developed. While this may suggest that very little of the watershed is prone to erosion or the impacts of erosion, these areas may still have underlying issues that may cause erosion and further development may cause major erosion. By understanding the location, nature and extent of erosion within the watershed through the E-Rode application, the Citizen Science Program can help municipal staff make effective decisions in the future by providing critical information about erosion sites.

To assist in understanding what needs to be done in the future to address and mitigate erosion sites, there are a range of possible solutions that can be implemented. We note that in general, erosion mitigation solutions can range the continuum from minor slope grading with plantings (least complex with minimal cost) to complete channel realignment using Natural Channel Design principles on riverine systems (intensive and costly) to minor slope grading with plantings to shoreline revetments using large armourstone blocks on lake systems.

However, the best practice to reduce the effects of flooding and erosion is to increase rainfall infiltration and minimize surficial runoff. High intensity rainfalls can cause severe flooding around the watershed similar to the floods that occurred in 2008, 2013, and 2019. Providing areas where water can infiltrate into the ground is critical to reduce flooding. Since this watershed has low percentage of impervious surfaces, the watershed is not affected with serious flash flooding, however for any future development in the watershed, developers should be encouraged to include surfaces that allow water to infiltrate into the ground. Increased flashiness in a river from urbanization also contributes to erosion along watercourses.

The most important practice for reducing erosion along rivers and lakes is to establish or maintain the riparian buffer. Many cottagers and homeowners prefer to manicure their properties right up to the edge of the water however this should be discouraged. These sections of river or lakeshore with manicured lawns and sections of banks without trees and shrubs are prone to erosion due to the reduced rooting depth. Property owners should be made aware of this issue and be encouraged to take part in reestablishing the riparian buffer on their property.

Where existing riverine or lake erosion is occurring and potentially impacting private property and/or municipal infrastructure, the erosion must be assessed and mitigated. As such, the most common erosion control mitigation practices are discussed as follows (see also Figures in **Appendix B**).

1. Eroding Riverbanks and Shorelines

Riverbanks and shorelines are prone to erode when they are not vegetated and protected. An example of riverbank erosion in the Muskoka River Watershed is provided in **Appendix A**. In this location the bank is highly eroded. The stability of a slope is related to its steepness and soil type. If the banks are highly eroded, grading must take place. Stabilizing the bank can happen by grading banks and keeping vegetation on them. Grading is a robust solution to highly eroded areas (such as the example below). A maximum slope of 3:1 is required with planting vegetation on the graded banks.

A bankfull bench should also be added at the bankfull elevation, which helps to slow high velocity flows during over bank flows. Closer to the bank toe, vegetated riverstone can be used as shown in **Appendix A**. Vegetated riverstone can also be seen in **Appendix B-1**. In this method the plant plugs are installed between lifts of stone. As shown in this figure, topsoil is used to hold the plants between stones.

Establishing a riparian buffer can also help protect the bank from further erosion. Riparian buffer strips are areas with vegetation near water bodies. Buffers can have trees, shrubs, grasses or wildflowers, in any combination. As their name suggests, they protect waterbodies from the impacts of neighbouring land uses and erosion. Buffers are also critical to help water quality and protect our drinking water supply.

Another erosion control method for this option can be toe wood with sod mat. This structure provides protection to the banks of newly constructed stream channels. In this method the bank is protected by live branches of wood mixed with sod mat as shown in **Appendix B-2**. This method of protection is great for banks with highly eroded areas.

2. Banks with Minor Erosion

Eroded banks with less slope, can be treated differently. Bank grading with vegetation on the graded banks can be a solution (**Appendix B-3**). Vegetation has a major impact on bank erosion. For the most part, riverbanks with vegetation erode slower than those without vegetation. This is because the roots of the vegetation generally increase the soil's strength around the riverbank, which makes the bank less prone to mass failure. Additionally, plants can act as shock absorbers during heavy rainfall, which also slows the rate of erosion.

Another solution for this type of erosion is using coir fabric. Coir Mats and Logs are used for slope and channel stabilization and stream and riverbank stabilization. They have high tensile strength and durability, which makes it suitable for the most severe erosion control problems. They also have the ability to absorb water and act as a mulch on the surface as well as a wick in the soil mantle.

3. Eroding Shorelines

The solution for eroded lakeshore can be stone and plantings with buffer. This option is very similar to the explained options above. The toe can be protected by stones and the top can be protected by vegetation. Planting of riparian vegetation along the shoreline with stone/rock placed on the lower banks is another method for bank protection. The stones are large enough to stay stable during floods. Vegetation can protect higher elevations by keeping the soil in place where roots exist. This method is great for protecting both the toe and upper bank zones.

A more recent approach is the Dynamic Living Shoreline. A living shoreline uses natural materials to stabilize shorelines and prevent them from eroding. They create resilient shorelines that can better withstand waves and storms without endangering the coastal ecosystem. They use advanced principles of science and ecosystem restoration expertise to restore vegetation and stabilize coastal slopes.

The Dynamic Living Shoreline management approach uses living plants and biomass to protect coastlines and to improve the health of our coastlines by helping to stabilize coastal ecosystems and creating habitat for native species. This approach can also be used in combination with rock walls and other engineering structures.

An example of these methods is shown in **Appendix B-4** as fascine. Fascines are bundles of live woody stems that, when planted in trenches, grow into clumps of erosion-fighting vegetation.

4. Culvert or Bridge Transition Erosion

In this case erosion occurs upstream or downstream of culverts or bridges. The severity of erosion ranges from minor to severe, where the severity is generally based on the impact or potential impact of the erosion. Where minor is either not affecting nor will affect any infrastructure and severe is when there is the potential for imminent loss of infrastructure.

Culverts are particularly vulnerable to erosion on the downstream side as typically culvert openings are smaller than the creek width. This creates increase channel velocities that can scour the bed of the channel leading to a perched culvert. It can also lead to rotational eddies that scour out the banks of the channel often resulting in loss of vegetation or impact to adjacent infrastructure. For bridges, erosion can occur the same way as culverts where the opening is too narrow, or the channel has not been provided enough space to migrate laterally below the bridge. Bridges and culverts are affected by upstream erosion as watercourses naturally migrate laterally through their floodplain. Since bridges and culverts are fixed structures, they are left behind in this channel migration. This is why it becomes important to protect the inlet and outlet areas of bridges and culverts to ensure the watercourse can be funneled towards these structures for their entire lifespan.

To accomplish long-term erosion protection at these locations it is important to understand any current and future changes that could occur near the crossing. It is also important to protect these key infrastructures with the most robust material feasible while also attempting to blend this protection into the natural environment. Riverstone or boulder stone that that is placed along the bank and vegetated with shrubs has excellent short-term and long-term protection against the strongest channel velocities. This should be implemented in areas where the highest scour is expected. Areas of lower scour such as in inside bend of a watercourse can often be simply graded, covered with coir fabric, and planted with shrubs.

5. Shoreline or Riverbank Erosion Near Infrastructure

Shoreline or riverbank erosion that occurs near infrastructure requires the use of robust protection measures. Large boulder or rip rap can be used depending on the size of the watercourse and velocities within it. Gaps in the large boulder stone can be filled with soils and planted with shrubs for additional protection. However, one of the most robust forms of 'natural' bank protection comes in the form of armourstone. Armourstone can be stacked along the bank of a river or shoreline and provide long-term stability and protection. The blocks are typically held in place by their sheer weight and size and are resistant to plucking. Armourstone has also been used to protect infrastructure and property where the watercourse has been confined to a narrow corridor with no ability to meander. Armourstone is also used for erosion protection from heavy wave action along shorelines. The details are shown in **Appendix B-5**.

6. Severe Riverbank Erosion

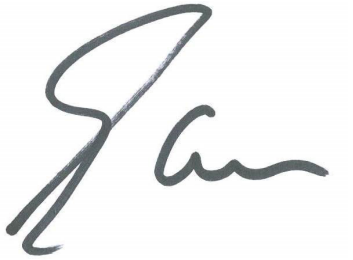
Severe riverbank erosion typically is either imminently going to or has the potential to cause the failure of infrastructure. In these cases, the channel has moved outside of its historical alignment and requires a channel realignment. In some instances where erosion is near infrastructure but there is still room in the floodplain, the existing channel may be relocated and realigned to a new location with full Natural Channel Design (NCD) practices. These NCD practices involve both soft and hard approaches to protecting and aligning the channel so that it can continue to develop naturally and not impact anything outside of its defined corridor. **Appendix B-6** shows all the details of NCD.

Each erosion site will be unique and will require a specific study to determine the correct approach to erosion mitigation. This will typically include a topographic survey, field assessments and analyses (biological, hydrological, hydraulic, fluvial geomorphology, and civil, etc.), the preparation of appropriate reports and plans, and the submission of these plans to review agencies and the acquisition of approvals and permits.

6.0 CONCLUDING COMMENTS

This report summarizes the development of a Citizen Science Program for erosion sites within the Muskoka River Watershed. The application, appropriately named “E-Rode”, has been developed to describe and locate erosion sites. The results will provide DMM staff with information to make decisions about erosion mitigation within the watershed. We encourage this to be a living, adaptable approach so that the goal of improving water quality and fisheries may be achieved.

Respectfully submitted,





Ed Gazendam, Ph.D., P.Eng.,
President, Sr. Geomorphologist

Asal Montakhab, M.A.Sc.,
Water Resources Specialist



Nik Gazendam, C.Tech. CAN-CISEC
Project Manager and Senior Technician

References

Chapman, L. J. and D. F. Putnam. 1984. The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2, Ontario Ministry of Natural Resources, Toronto.

Ontario Flow Assessment Tool III (2019). Digital data from Ministry of Natural Resources and Forestry.

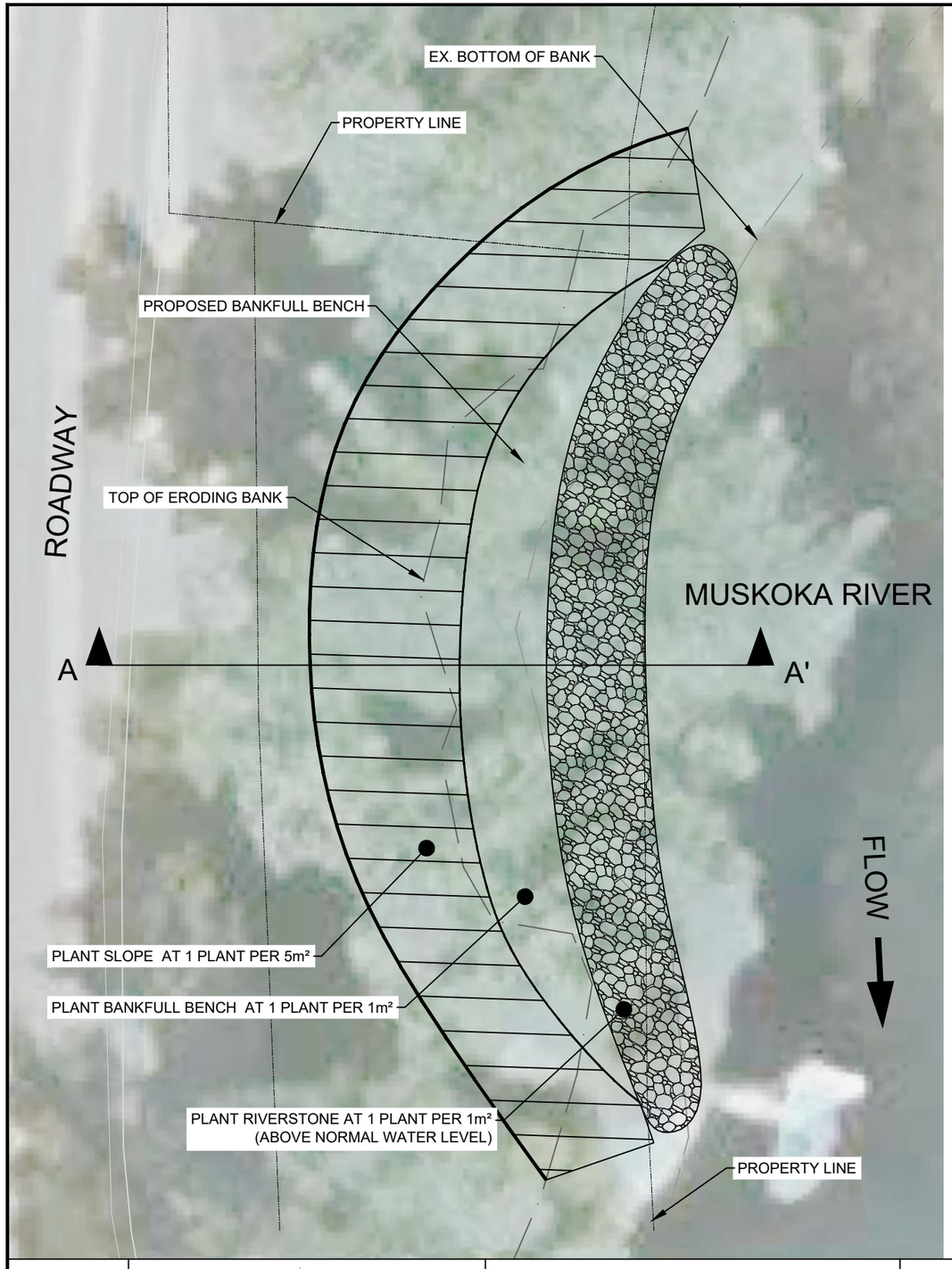
Ontario Ministry of Natural Resources and Forestry (2022). Ontario Watershed Boundaries

Witzel, M., Smith, D., Arney, O., Beaucage, J., Cayley, J., Cragg, C., … Norman Yan. (2020). Interim Advice and Recommendations to Address Priority Environmental Is-sues in the Muskoka River Watershed.

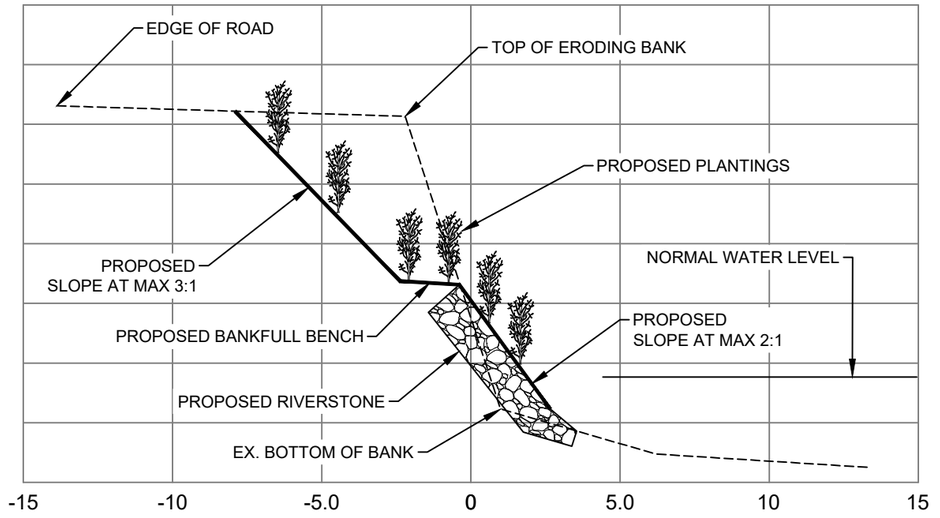


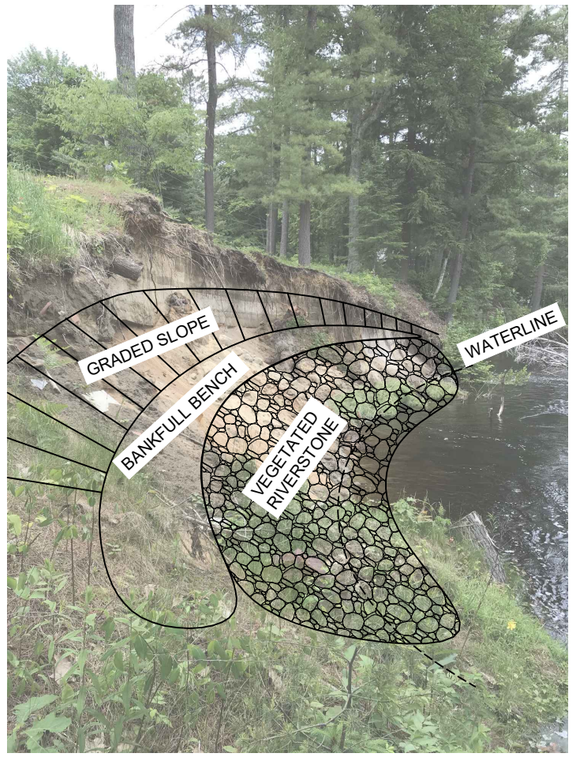
APPENDIX A:

Case Study



CROSS SECTION A-A'





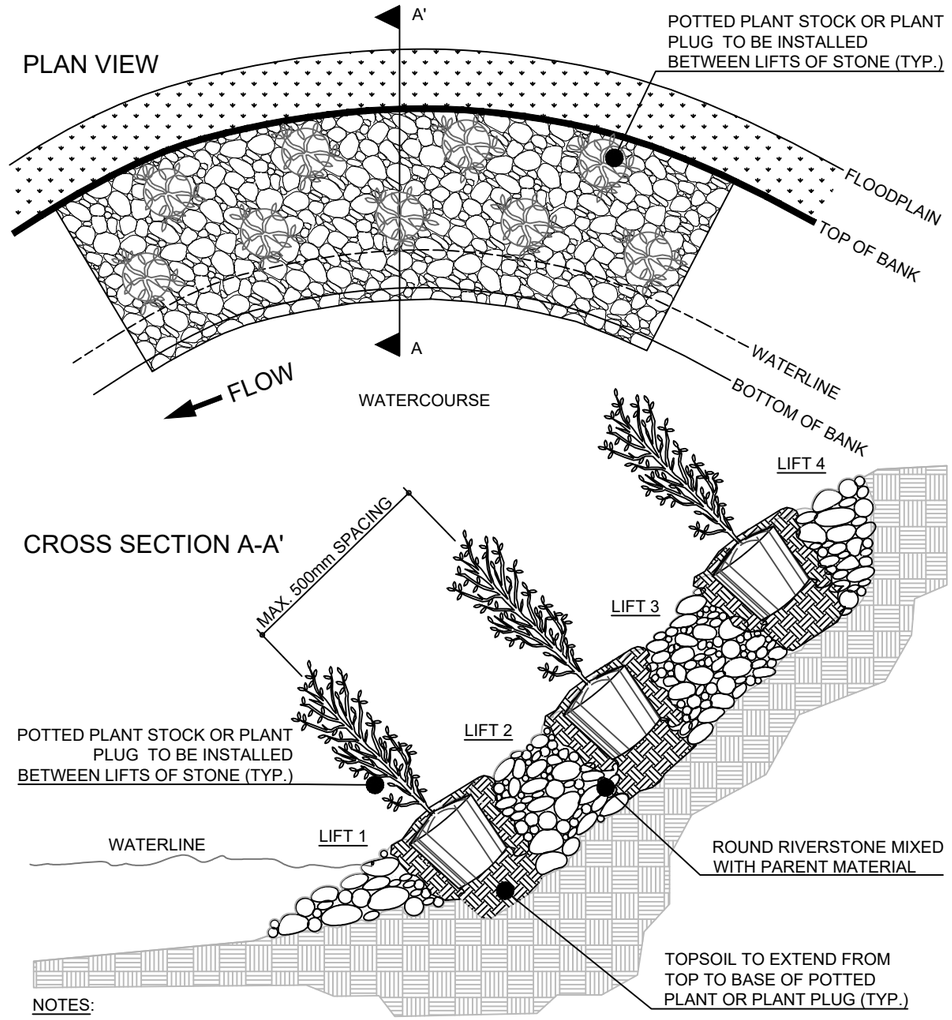
NOTE:
SEE GRADING AND VEGETATED
RIVERSTONE TYPICAL DETAILS

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.	MUSKOKA E-RODE	THE DISTRICT MUNICIPALITY OF MUSKOKA	RIVERBANK EROSION EXAMPLE	DATE September 20, 2022	DESIGN EEG	PROJECT No. 22009
				SCALE N.T.S.	CHECKED EG	SHEET No. 1



APPENDIX B:

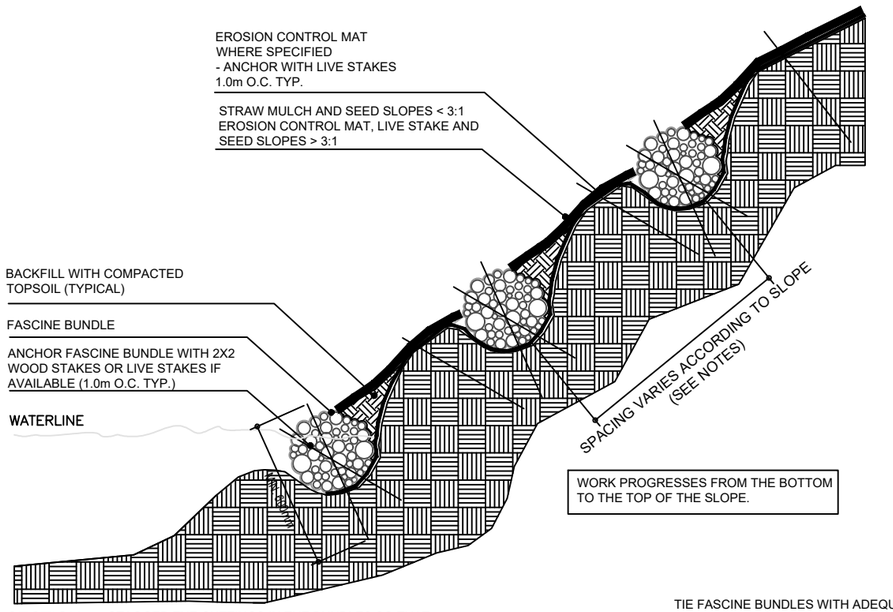
Erosion Mitigation Practices



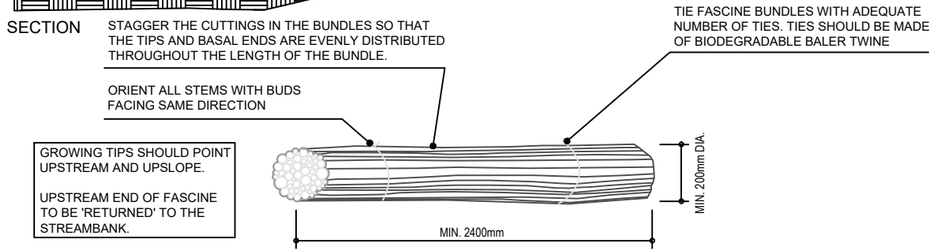
VEGETATED RIVERSTONE DETAIL

N.T.S.

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.	MUSKOKA E-RODE	THE DISTRICT MUNICIPALITY OF MUSKOKA	VEGETATED RIVERSTONE	DATE September 20, 2022	DESIGN EEG	PROJECT No. 22009
				SCALE N.T.S.	CHECKED EG	SHEET No. 1



SECTION



ELEVATION

NOTES:

1. FASCINE BUNDLES TO BE PRODUCED FROM LIVE, DORMANT CUTTINGS OF VARIABLE DIAMETER AND LENGTH. WILLOW AND DOGWOOD SPECIES PREFERRED.

2. FOR OPTIMUM SUCCESS, INSTALL THE UNITS ON THE SAME DAY THEY ARE HARVESTED AND PREPARED. FASCINES NOT BE USED IMMEDIATELY MUST BE STORED IN THE SHADE OR IN WATER. BUNDLES MAY BE SOAKED OVER NIGHT TO IMPROVE SUCCESS.

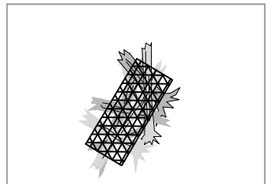
3. RECOMMENDED FASCINE SPACING ACCORDING TO SLOPE;
   - 1.0m O.C. FOR 1:1 SLOPES
   - 1.5m O.C. FOR 2:1 SLOPES
   - 2.0m O.C. FOR 3:1 SLOPES
   - 3.0m O.C. FOR 4:1 SLOPES

4. FOR SEED, MULCH AND ADDITIONAL EROSION CONTROL MEASURES REFER TO PLAN.

FASCINE (TYPICAL)

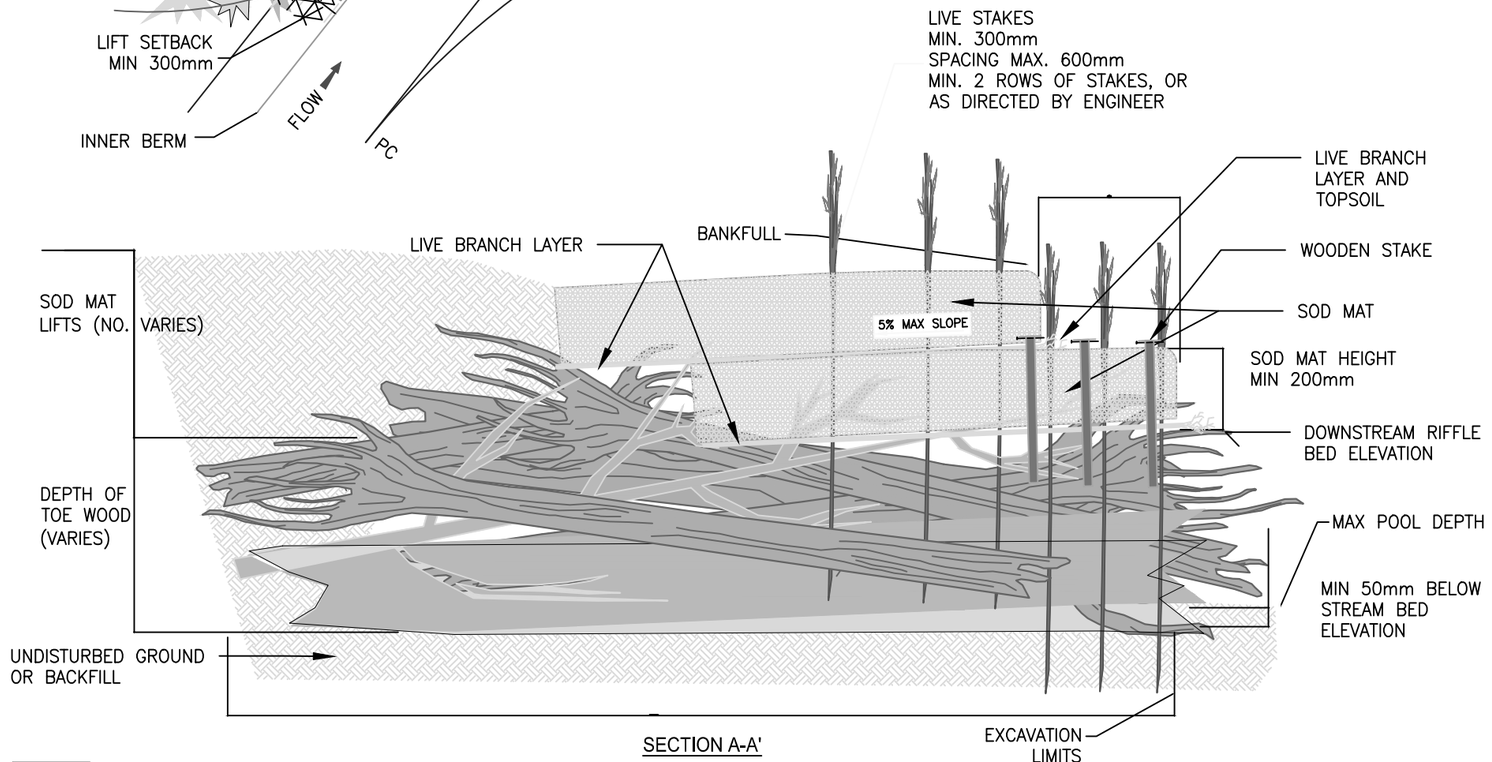
N.T.S.

	water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.	MUSKOKA E-RODE	THE DISTRICT MUNICIPALITY OF MUSKOKA	FASCINE	DATE: September 20, 2022	DESIGN: EEG	PROJECT No.: 22009
					SCALE: N.T.S.	CHECKED: EG	SHEET No.: 2



PLAN SYMBOL

PLANVIEW



SECTION A-A'

D1 TOE WOOD WITH SOD MAT

N.T.S.

NOTES:

1. THIS STRUCTURE PROVIDES PROTECTION TO THE BANKS OF NEWLY CONSTRUCTED STREAM CHANNELS. WOODY DEBRIS OF ALL SIZES CAN BE USED IN THE CONSTRUCTION OF THIS STRUCTURE. THE STABILITY OF THE LOWER PORTION OF THE STREAMBANK IS CRITICAL TO THE SUCCESS OF THE PROJECT.
2. COARSE/LARGE WOODY DEBRIS CONSISTS OF LOGS, ROOTWADS, AND LARGE BRANCHES WHICH ARE NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.
3. A TRENCH SHALL BE EXCAVATED ALONG THE OUTER BANK OF THE POOL. THE BOTTOM ELEVATION OF THE TRENCH SHALL BE AT OR BELOW MAX. POOL DEPTH.
4. COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED IN THE TRENCH WITH THE LARGEST MATERIAL PLACED FIRST. THE LOGS OR WOOD MATERIAL SHALL BE PLACED PERPENDICULAR TO THE FLOW OF WATER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG/BRANCH IS ANCHORED BY ANOTHER LOG/BRANCH. THE COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED TO A HEIGHT OF $\frac{3}{4}$ OF THE FINISHED HEIGHT OF THE WOODY DEBRIS WITH THE FINE/SMALL WOODY DEBRIS MAKING UP THE REMAINING $\frac{1}{4}$ OF THE TOTAL HEIGHT.
5. FINE/SMALL WOODY DEBRIS CONSISTS OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR SMALL LOGS. INVASIVE SPECIES SHALL NOT BE USED. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.
6. FINE/SMALL WOODY DEBRIS SHALL BE PLACED ON TOP OF THE COARSE/LARGE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST. THE FINE WOODY DEBRIS SHALL BE INSTALLED TO AN ELEVATION EQUAL TO THE INVERT OF THE DOWNTREAM RIFFLE.
7. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER AND TO KEEP FUTURE SETTLING TO A MIN.
8. SELECT BACKFILL/TOPSOIL SHALL BE INSTALLED ON TOP OF WOODY DEBRIS TO CREATE A LEVEL SUBSTRATE FOR THE SOD MATS.
9. A THIN LAYER OF LIVE BRANCHES (900–1500mm IN LENGTH) AND TOPSOIL SHALL BE PLACED ON TOP OF THE BALES. THE LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER AND SHALL EXCLUDE INVASIVE SPECIES.
10. NATIVE SOD MATS SHALL BE HARVESTED ONSITE. THEY SHALL BE WEED FREE AND APPROXIMATELY 1000mm X 1000mm WITH A MINIMUM OF 200mm OF INTACT SOIL AND ROOTMASS ATTACHED. THE SOD MATS ARE TO BE INSTALLED ON TOP OF THE LIVE BRANCH LAYER.
11. REPEAT NUMBERS 9 AND 10 UNTIL THE FINISHED ELEVATION EQUALS THE ELEVATION OF BANKFULL.
12. THE TOP OF THE SOD MAT SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.
13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS–SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN +/– 25mm OF THE GRADES AND ELEVATIONS INDICATED ON THE PLANS OR APPROVED BY THE ENGINEER.
14. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF BANK STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
15. LIVE STAKES SHALL BE OF SPECIES APPROVED BY THE ENGINEER. LIVE STAKES SHALL BE 600–900mm LONG AND A MIN. OF 25mm IN DIAMETER AND INSTALLED WITH 2/3 OF THE LENGTH BELOW GROUND WITH A MINIMUM OF 2 BUD SCARS BELOW THE GROUND AND 2 ABOVE GROUND. SEE LIVE STAKE DETAIL.
16. LIVE STAKES SHALL BE PLACED ON THE SLOPE FROM THE INNER BERM TO HALF BANK FULL HEIGHT.
17. WOODEN STAKES SHALL BE 1 X 2" AND A MIN. OF 18" LONG. WOODEN STAKES SHALL BE INSTALLED FROM THE INNER BERM TO BANKFULL ON 450–600mm CENTRES PER THE ENGINEER'S INSTRUCTIONS.

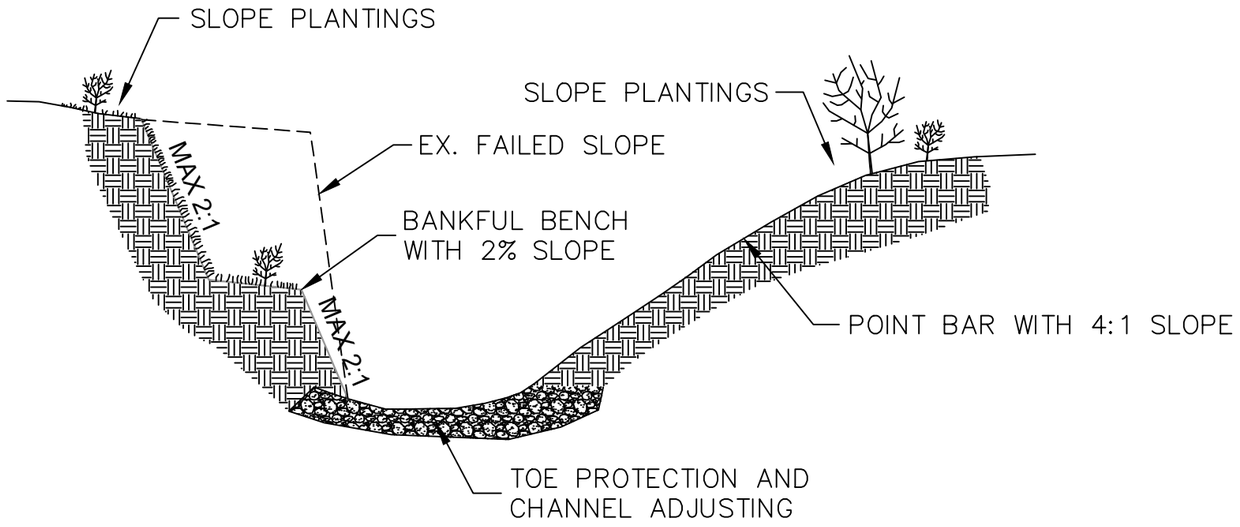
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

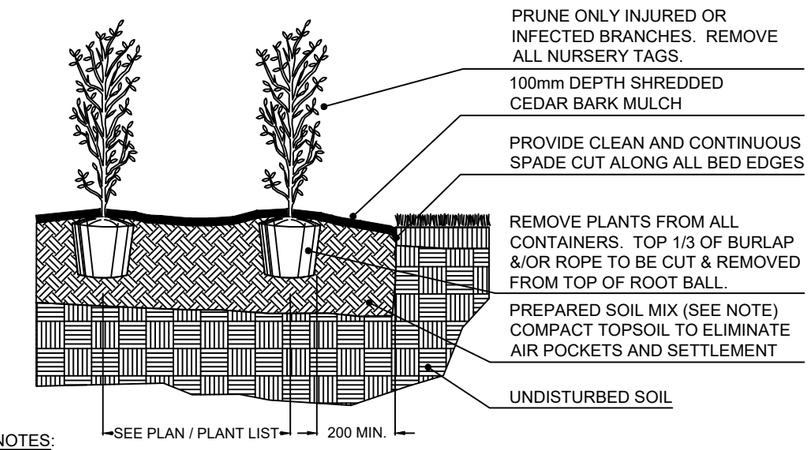
MUSKOKA E-RODE

THE DISTRICT MUNICIPALITY OF MUSKOKA

TOE WOOD WITH SOD MAT

DATE	DESIGN	PROJECT No.
September 20, 2022	EEG	22009
SCALE	CHECKED	SHEET No.
N.T.S.	EG	3



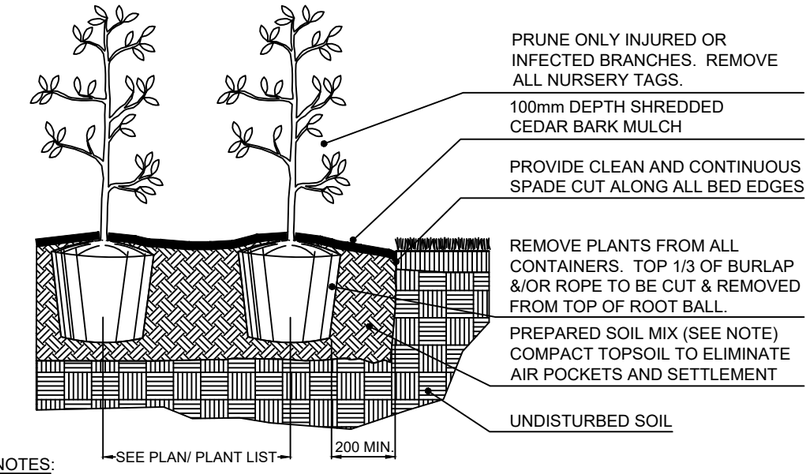


NOTES:

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.

POTTED SHRUB (TYPICAL)

N.T.S.



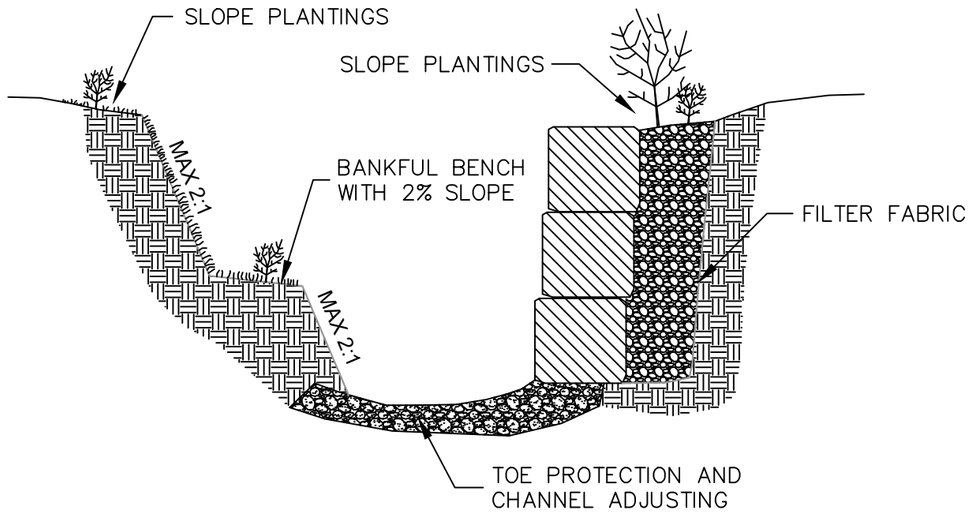
NOTES:

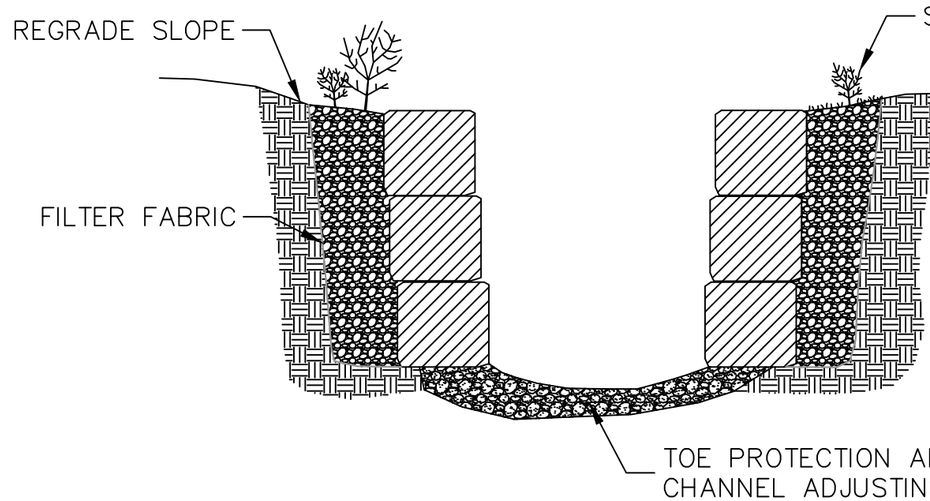
1. SOIL MIXTURE: FOUR (4) PARTS NATIVE SOIL, ONE (1) PART WELL ROTTED COMPOST.
2. SAUCER SHALL BE SOAKED WITH WATER AND MULCHED IMMEDIATELY FOLLOWING PLANTING.
3. ALL DIMENSIONS ARE IN mm.
4. IN POORLY DRAINED SOILS PLANT SHRUB SLIGHTLY HIGHER THAN ADJACENT GRADE.
5. ALL PLANTS TO BE STRAIGHT AND PLANTED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

POTTED TREE (TYPICAL)

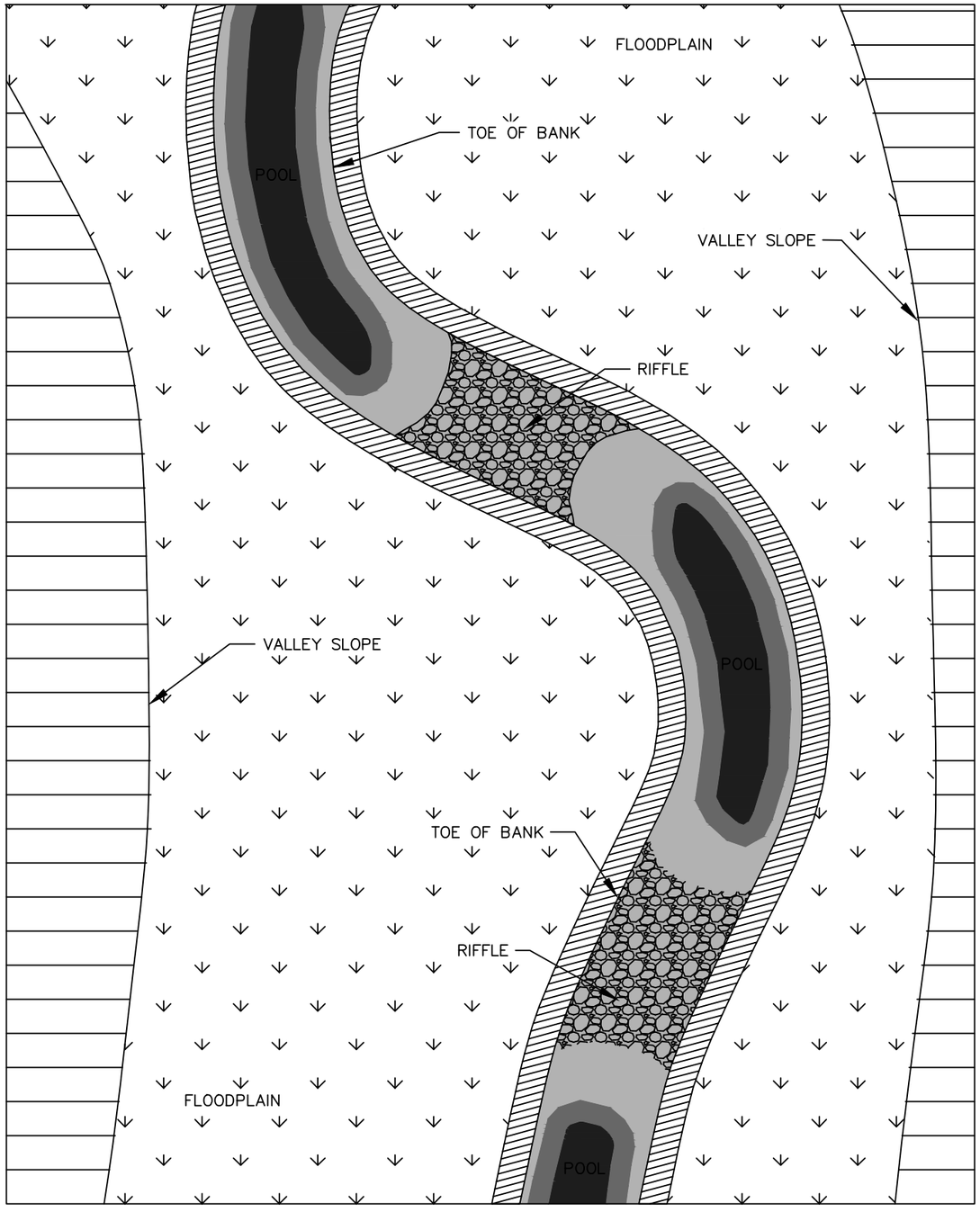
N.T.S.

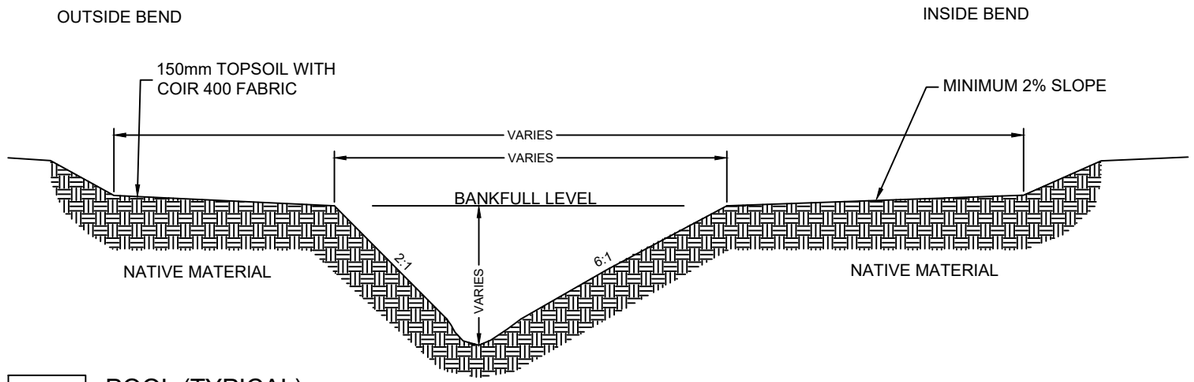
	water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.	MUSKOKA E-RODE	THE DISTRICT MUNICIPALITY OF MUSKOKA	STABILIZE SLOPE AND PLANT	DATE September 20, 2022	DESIGN EEG	PROJECT No. 22009
					SCALE N.T.S.	CHECKED EG	SHEET No. 4





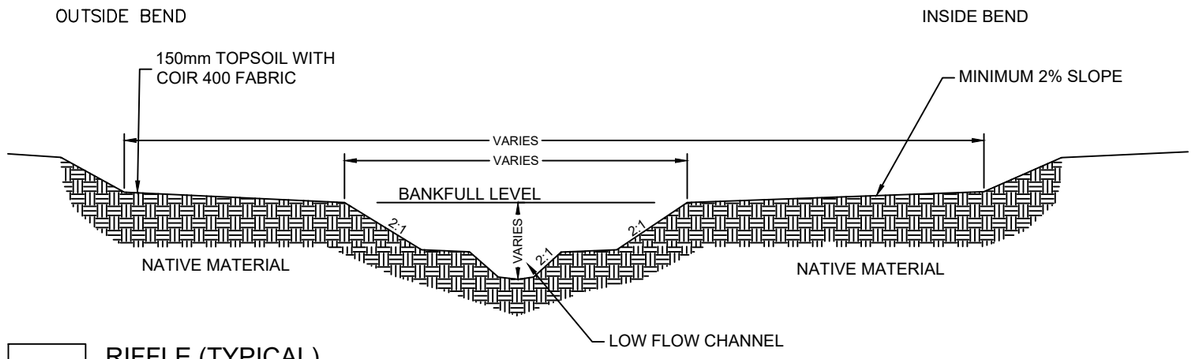
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.	MUSKOKA E-RODE	THE DISTRICT MUNICIPALITY OF MUSKOKA	ARMOURSTONE BANK PROTECTION	DATE September 20, 2022	DESIGN EEG	PROJECT No. 22009
				SCALE N.T.S.	CHECKED EG	SHEET No. 5





POOL (TYPICAL)

N.T.S.



RIFFLE (TYPICAL)

N.T.S.

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

MUSKOKA E-RODE

THE DISTRICT MUNICIPALITY OF MUSKOKA

NATURAL CHANNEL DESIGN

DATE	DESIGN	PROJECT No.
September 20, 2022	EEG	22009
SCALE	CHECKED	SHEET No.
N.T.S.	EG	6



APPENDIX C:

Muskoka E-Rode Presentation



Muskoka E-Rode

Community Round Table Presentation
June 22, 2022

Agenda

1. Introductions
2. Project Scope
3. The Muskoka Watershed
4. Erosion – How it happens and what are the impacts
5. Actual questions
6. Demonstration of the Beta App
7. Q&A session

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

1. Introductions

District of Muskoka:

- Glenn Cunnington, Ph.D., IWM Project Manager
- Alana Perez, IWM Project Coordinator




The Consultant Team:

- Ed Gazendam, Ph.D., – Sr. Engineer/Geomorphologist and Project Manager
- Asal Montakhab, M.Sc., – Fluvial Geomorphologist
- Nik Gazendam – Sr. Technical Specialist / GIS





water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

2. Project Scope

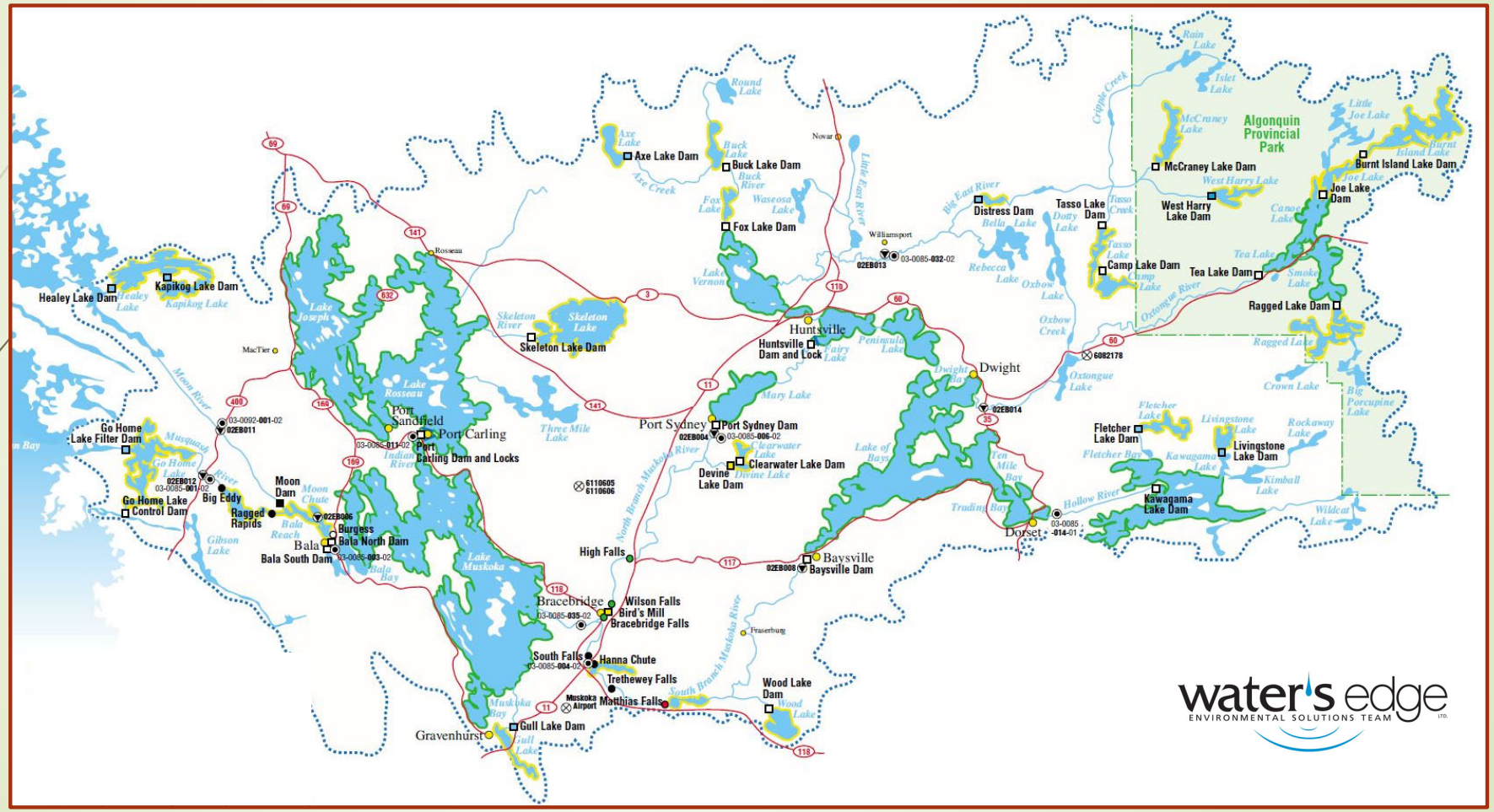
- **OBJECTIVE:** Develop a citizen science program focused on
  - educating the public on erosion (types, causes, impacts, etc.), how to identify erosion and understanding the ecological impacts of erosion within the Muskoka River Watershed
  - Develop an application to enter erosion sites in a District of Muskoka database by citizens

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

2. Project Scope

- Background Review
- Collection of erosion data from 13 member municipalities
- Develop a set of questions for the E-Rode application
- Test data on beta version of E-Rode application (information received to date has limited usefullness)
- Present E-Rode to the CRT
- Reporting (Draft and Final Versions of the report)
- Presentation to Council (tentatively September 19, 2022)

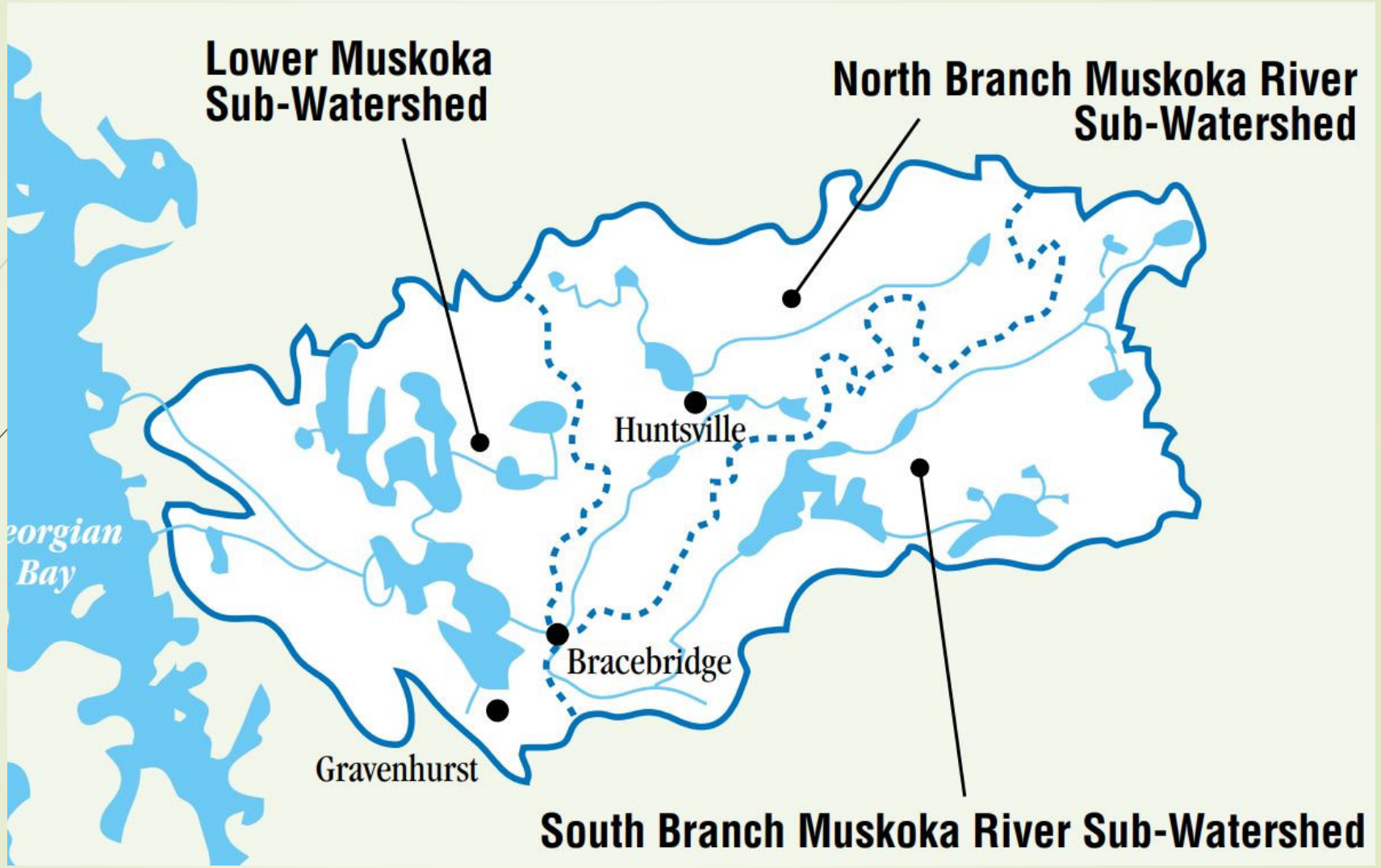
3. The Muskoka Watershed



Some Basic Facts:

- +/- 5,100 km^2 watershed drainage area (510,000 ha)
- Includes about 78,000 ha of lakes (about 15% of the watershed)
- Originates in western portions of Algonquin Park
- Watershed length is about 210 km
- Watershed width is 62 km (at widest point)
- 3 main sub-watersheds – North, South and Lower Muskoka
- 42 water control structures and 3 navigation locks
- Situated on the Canadian Shield
- Mean Annual Flow of 85 m^3/s

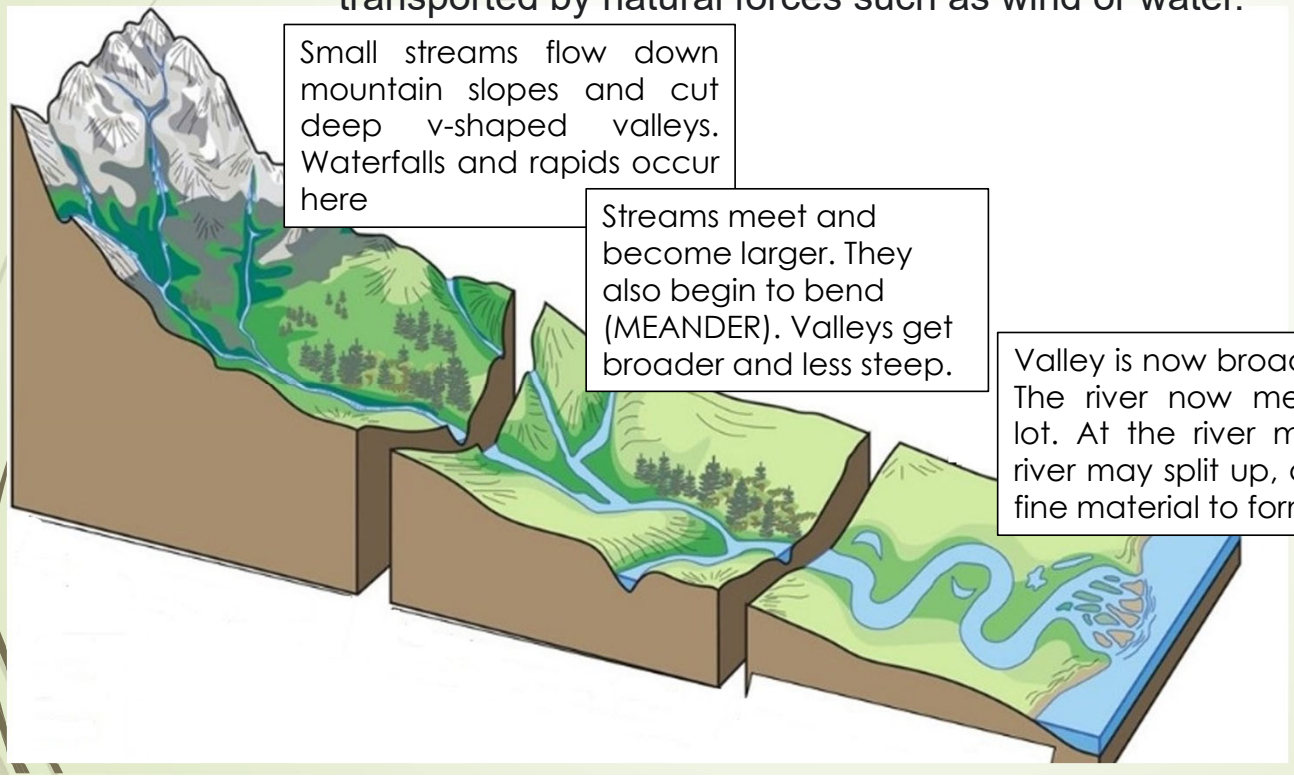
water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.


Lower Muskoka
Sub-Watershed
North Branch Muskoka River
Sub-Watershed
Huntsville
Bracebridge
Gravenhurst
South Branch Muskoka River Sub-Watershed

4. Erosion
How it happens and what are the impacts

What is Erosion:

- Erosion is the geological process in which earthen materials are worn away and transported by natural forces such as wind or water.



water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

4. Erosion
How it happens and what are the impacts

Location of Erosion

- Fields (rills and gullies) – Rivers (bank and bed) – Lakes (shorelines)







water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

4. Erosion
How it happens and what are the impacts

What causes Erosion:

- Soil conditions (bedrock vs sand)
- Anthropogenic influences (bridges, outfalls, power plants, cutting/removal of vegetation, agriculture, cattle access, land development)
- Storms (high flows can cause damage)
- Erosion is a natural process (rivers naturally meander which is a result of erosion)

4. Erosion
How it happens and what are the impacts

Impacts of Erosion:

- Poor water quality and possible impacts to drinking water
- Loss of property
- Impacts to fish habitat and reduced fishing opportunities
- Impacts to navigation / recreational boating
- Impacts to agriculture due to loss of land or topsoil
- Impacts to tourism

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

5. E-Rode Questions

Basic Assumptions:

- Applicable to a wide range of people
- User-friendly
- Useable on the water or at home
- Useful for planning and decision making purposes

5. E-Rode Questions

- Is the erosion site on a lake or river?
  - Lake, River





5. E-Rode Questions

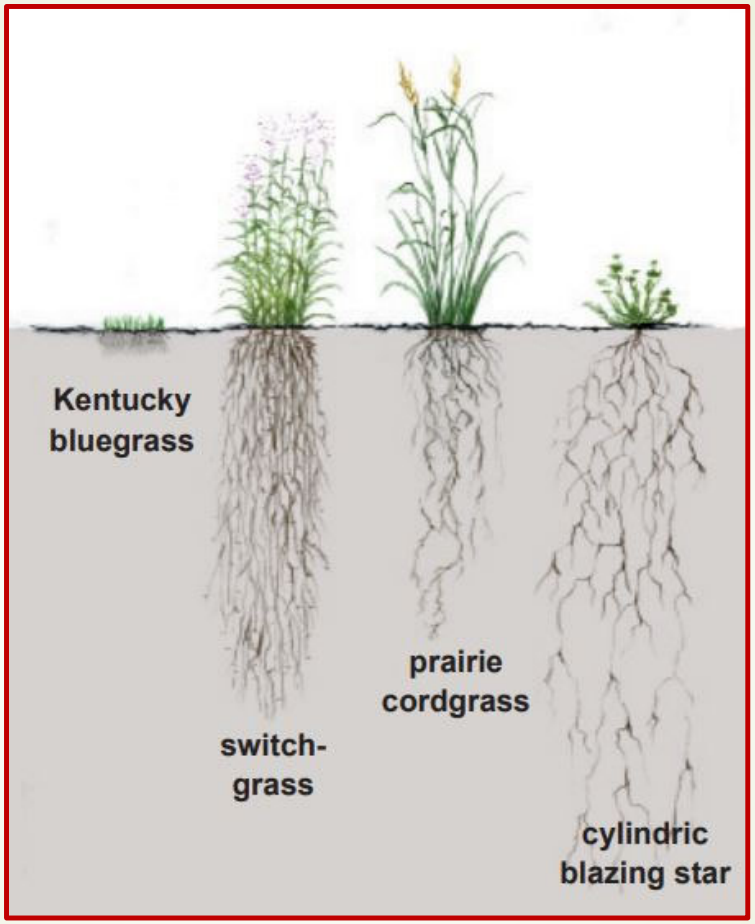
- <u>Lake Questions</u>
- How much vegetation is left on the eroding bank?
  - None, Some, Half, Most, All, Not sure






- Are there large blocks of soil falling in (indicating active erosion with accumulation at the bottom of the slope)?
  - Yes, No, Not sure



Influence of plant root depths on bank stabilization

5. E-Rode Questions

- Are there any exposed bridge footings or building foundations that are not normally exposed?
  - Yes, No, Not sure





- Is a structure (such as a house, bridge, dock, road, or buried pipes/cables) in danger?
  - Yes, No, Not sure





- Is there any additional information you can provide?
  - (open-ended question)

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

5. E-Rode Questions

- River Questions
- Approximately how wide is the river at the erosion site?
  - Less than 0.5m, 0.5m – 2m, 2m – 10m, Over 10m, Not sure



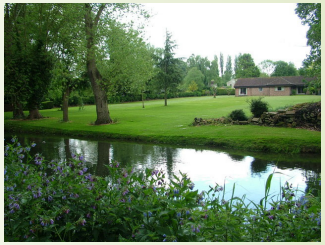


- Approximately how deep is the river at the erosion site?
  - Less than 30cm (12”), 30cm – 50cm (12” – 20”), 50cm – 1m (20” – approx. 3’), over 1 m (3’), Not sure

5. E-Rode Questions

- What kind of vegetation is growing on the banks?
  - Forest, Shrubs, Tall grasses, Lawn, Not sure



- Are the banks failing (for example, blocks of soil are falling in, bank is exposed, active erosion, etc.)?
  - Yes, No, Not sure



5. E-Rode Questions

- Is there a culvert or other water conveyance structure?
  - Yes, No, Not sure





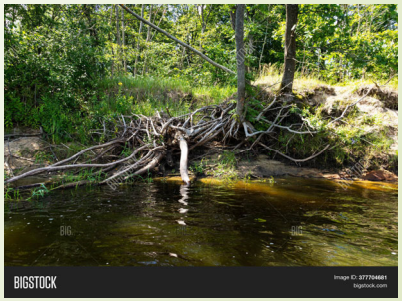
- Are there any fallen/leaning trees or fence posts?
  - Yes, No, Not sure





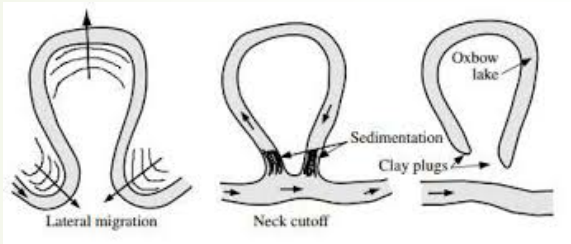
- Are there any exposed tree roots?
  - Yes, No, Not sure

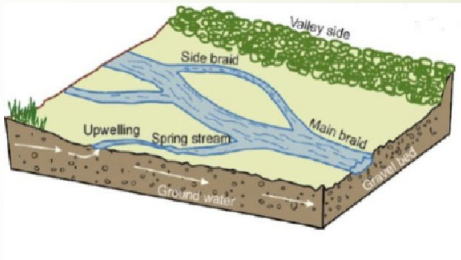




5. E-Rode Questions

- Are there any cutoff channels/oxbow lakes (i.e. stagnant water beside the river, evidence of river/creek rerouting)?
  - Yes, No, Not sure









5. E-Rode Questions

- Do you see clumps of grass floating or deposited on the banks?
  - Yes, No, Not sure





- What colour is the water?
  - Clear or tea-coloured, Cloudy (like chocolate milk), Not sure







water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

5. E-Rode Questions

- Is a structure (such as a house, bridge, dock, road, or buried pipes/cables) in danger?
  - Yes, No, Not sure





- Are there any exposed bridge footings or building foundations that are not normally exposed?
  - Yes, No, Not sure





water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

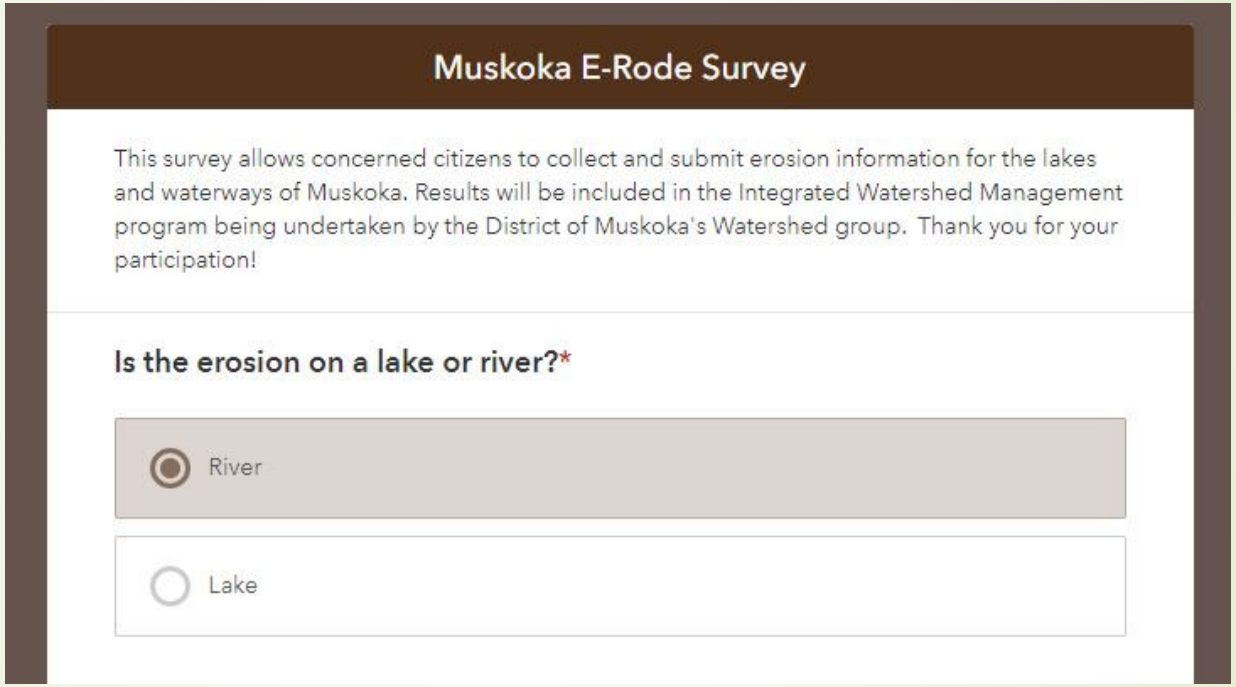
5. E-Rode Questions

- Is there any additional information you can provide?
  - (open-ended question)

- Upload Date, Photo & Location
- Upload Location

(available in both the lake and river surveys)

6. Demonstration of E-Rode Beta App



7. Questions & Answers



water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

7. Questions & Answers

- Can I fill this in while in my canoe?
- If I just take a picture, can I fill the form in when I get home?
- Do I need to have specialized training to fill in the form?
- What if I don't know exactly where I am while filling in the form?
- Can I revise it after I hit send?

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

7. Questions & Answers

- Is there a reward for filling in the most forms?

No, but you do have the personal satisfaction of seeing much of the river AND Glenn will send you a congratulatory email ☺

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.



Muskoka E-Rode

Community Round Table Presentation
June 22, 2022