SOURCE TO STREAM 2024 Conference

Canada's Premier Stormwater and Erosion and Sediment Control Conference

Thank you to our sponsors!

EXECUTIVE SPONSORS

ADS Our reason is water.

citygreen URBAN LANDSCAPE SOLUTIONS

CUPOLEX® ENGINEERING SOLUTIONS INC.

ENVIROPOD™

Aquafor Beech Limited

Cleanflo Water Technologies Inc

filtrexx® CANADA SUSTAINABLE TECHNOLOGIES let nature do it®

imbrium®

Matrix Solutions Inc. A Montrose Environmental Company

OAKS LANDSCAPE PRODUCTS

Hydro International®

NEXT STORM

Sustainable Technologies EVALUATION PROGRAM

MEDIA SPONSOR

Environmental Science & Engineering MAGAZINE

HOSTS

Presented by:

Toronto and Region Conservation Authority

In association with:

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature

SOURCE TO STREAM 2024 Conference

Effective Strategies for Addressing Massive Erosion and Slope Instability in Riverine Environments: Insights from Successful Projects in the GTA

Date: March 27th , 2024

Author: Anna Paris, MSc.
Business Development Manager– Hydraulics, Maccaferri North America

MACCAFERRI

Presentation Outline

MACCAFERRI

- Introduction to erosion and slope failure in a changing world
- Mitigation strategies: two successful projects in the GTA
  - ✓Riverhead Drive Slope Stabilization Project (2015)
  - ✓Etobicoke Creek Erosion Control at Rathburn Road East (2008)
- Lessons learnt through the years
- Summary

MACCAFERRI

Erosion is the result of **water and/or wind** getting in contact with soil and **moving** it to a different location

Urban gully in Kinshasa, Democratic Republic of Congo, May 2018. Credit: Matthias Vanmaercke.

Types of Erosion:

BY WATER

- Splash (Rainfall)
- Sheet (Runoff)
- Rill and Gully (Runoff)
- Stream and Channel

BY WIND

- Suspension
- Saltation
- Soil Creep

Soil erosion in Lesotho, 2016. Photo credit: Lschefa

Typical causes:

- **Heavy rainfall** (erosion and/or changes in groundwater level)
- **Earthquakes**
- **Human activities** (e.g. construction or excavation)

Slope failure is a mass movement of rock, soil and debris down a slope.

It happens when the **forces acting** on the slope, such as gravity, **exceed the strength of the materials** that make up the slope causing it to collapse or deform

Photo source: https://crosscut.com/2020/02/landslides-close-roads-washingtons-remote-towns-deal-isolation

EROSION AND SLOPE INSTABILITY HAZARD IN RIVERINE ENVIRONMENT

CAUSES

- Severe weather events (Climate change)*
  - ✓ Increase in frequency and intensity
  - ✓ Rainfall, snowmelt

- Increase in urbanization
  - ✓ Change in land use
  - ✓ Impervious surfaces
  - ✓ Drainage networks

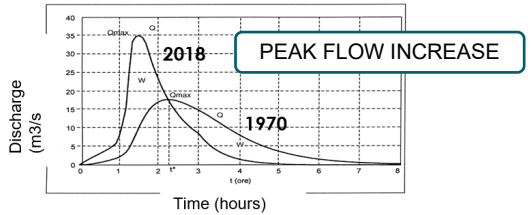
- Modification of watercourse geometry
  - ✓ e.g. alignment, cross-section, grade, bridge crossings

MORE RUNOFF

&

MORE EXTREME FLOOD EVENTS

higher water depth, flow velocity and sediment transport capacity in channels



INCREASE OF EROSION AND SLOPE INSTABILITY HAZARD

* Picture source https://www.canadianunderwriter.ca/features/mother-natures-wrath/

RAVINE AND VALLEY SYSTEMS IN THE GTA

MACCAFERRI

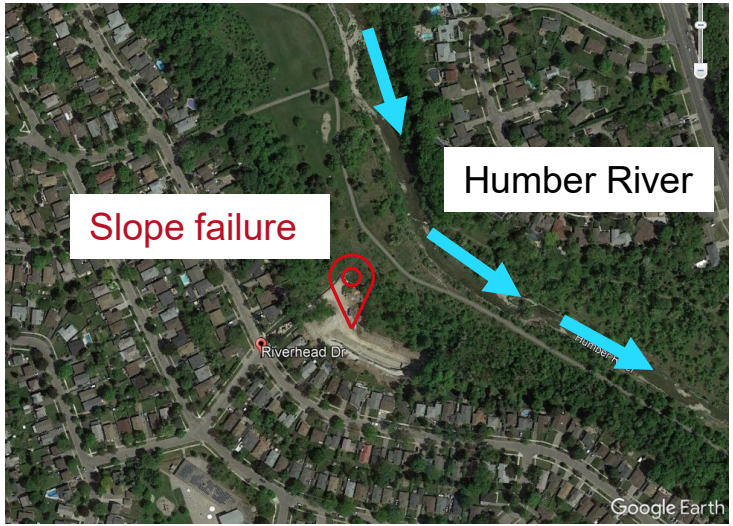
Erosion and slope instability pose a significant threat to **humans** (loss of life), **private properties** (homes), **infrastructure** (roads, pipelines, power lines, etc.) and **Nature** in some locations.

TRCA and other authorities actively plan and implement **mitigation projects**.

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

- July 8th , 2013 storm (138 mm in 10 hours at Martin Grove gauge (east of Toronto Pearson Int. Airport)
- Worst flooding since Hurricane Hazel (1954)
- Location: Humber River watershed, close to Riverhead Drive, Etobicoke
- Slope failure and severe erosion
- Significant property loss with long-term risks to over ten homes



RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

TRCA led the process to mitigate the risk with a Design & Build project

Project main requirements:

- ✓ 12m-high stable slope reconstruction
- ✓ Minimize the encroachment into the floodplain
- ✓ Recreate a natural environment
- ✓ Maximize vegetation re-establishment
- ✓ Integrate with the landscape

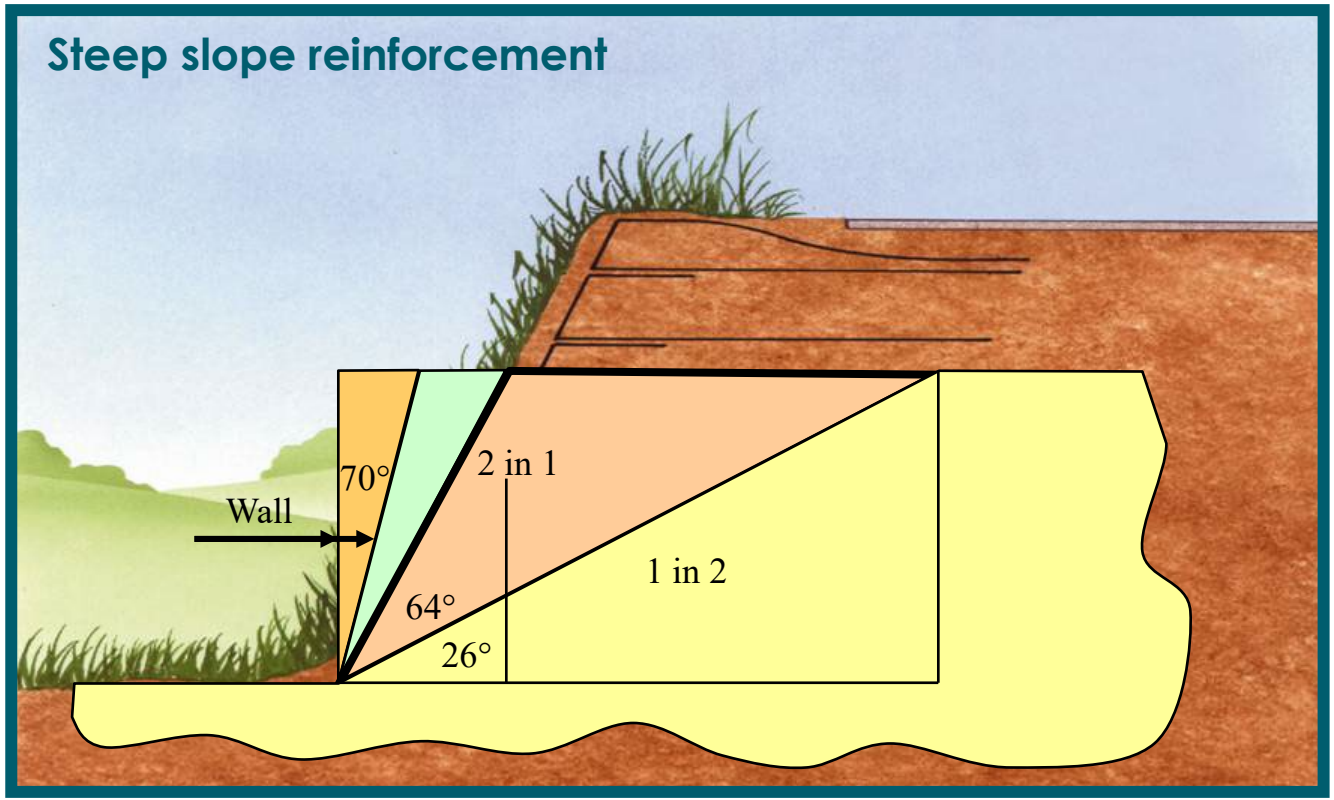
Solution:

- ✓ Terraced slope with MSE walls
- ✓ MSE walls at different elevations and heights
- ✓ Curved alignments
- ✓ Native trees, shrubs planting and Terraseed

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

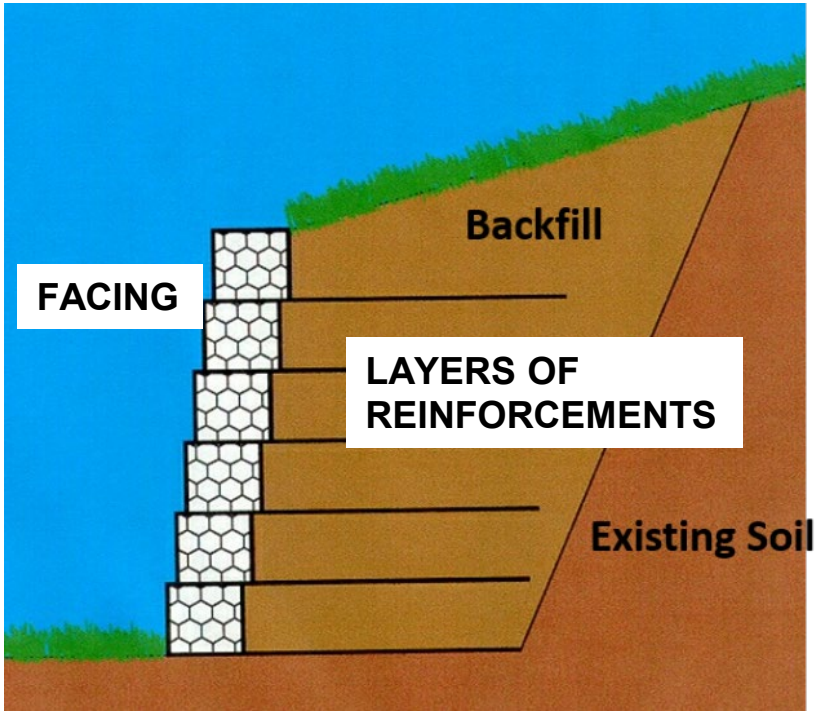
Reinforced Soil Systems



RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

Reinforced Soil Systems



Slope angle > 70°

MECHANICALLY STABILIZED EARTH (MSE) WALLS

Slope angle ≤ 70°

REINFORCED SOIL SLOPES (RSS)

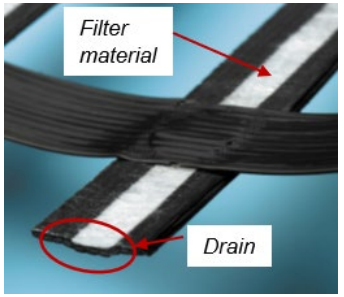
RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

Reinforced Soil Systems

Geogrids:

- A gridlike polymeric material formed by intersecting ribs joined at the junctions
- Function is soil reinforcement
- Typ. uniaxial geogrids
- Can be woven, bonded or extruded
- Length, tensile strength (kN/m) and spacing is part of the design
- Reduction Factors such as installation damage and creep must be considered
- Typ. Backfill needs to be compacted free draining granular material
- Some geogrids can be used with excess soil for RSS



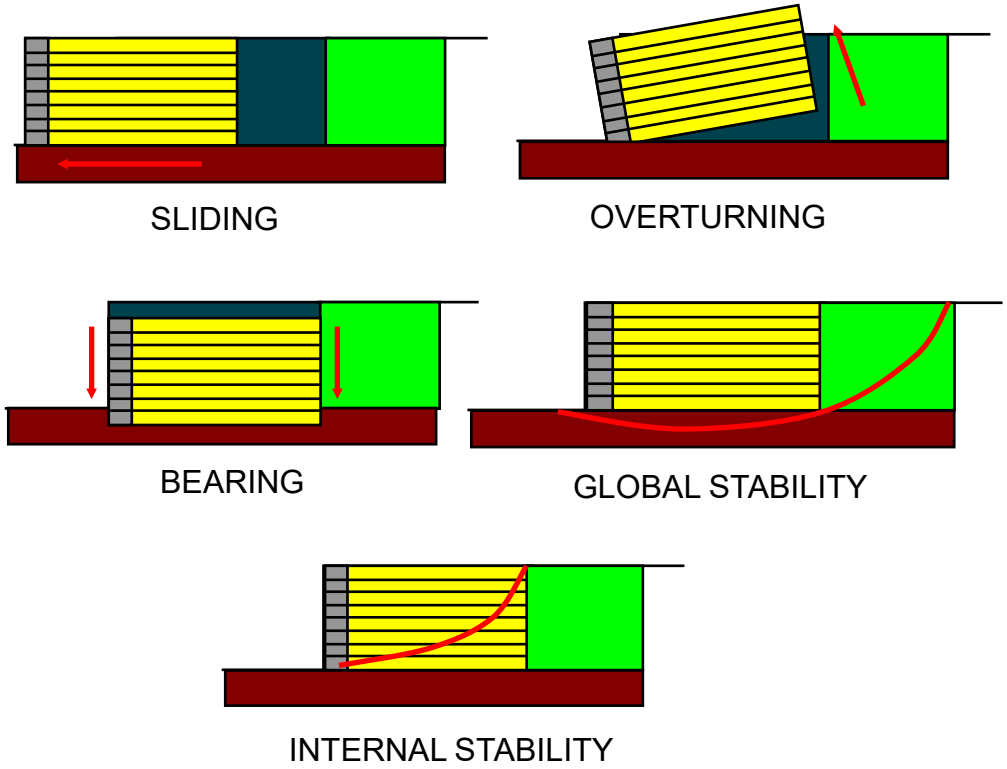
RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

Reinforced Soil Systems

Design, Structural & Geotechnical Stability Analysis

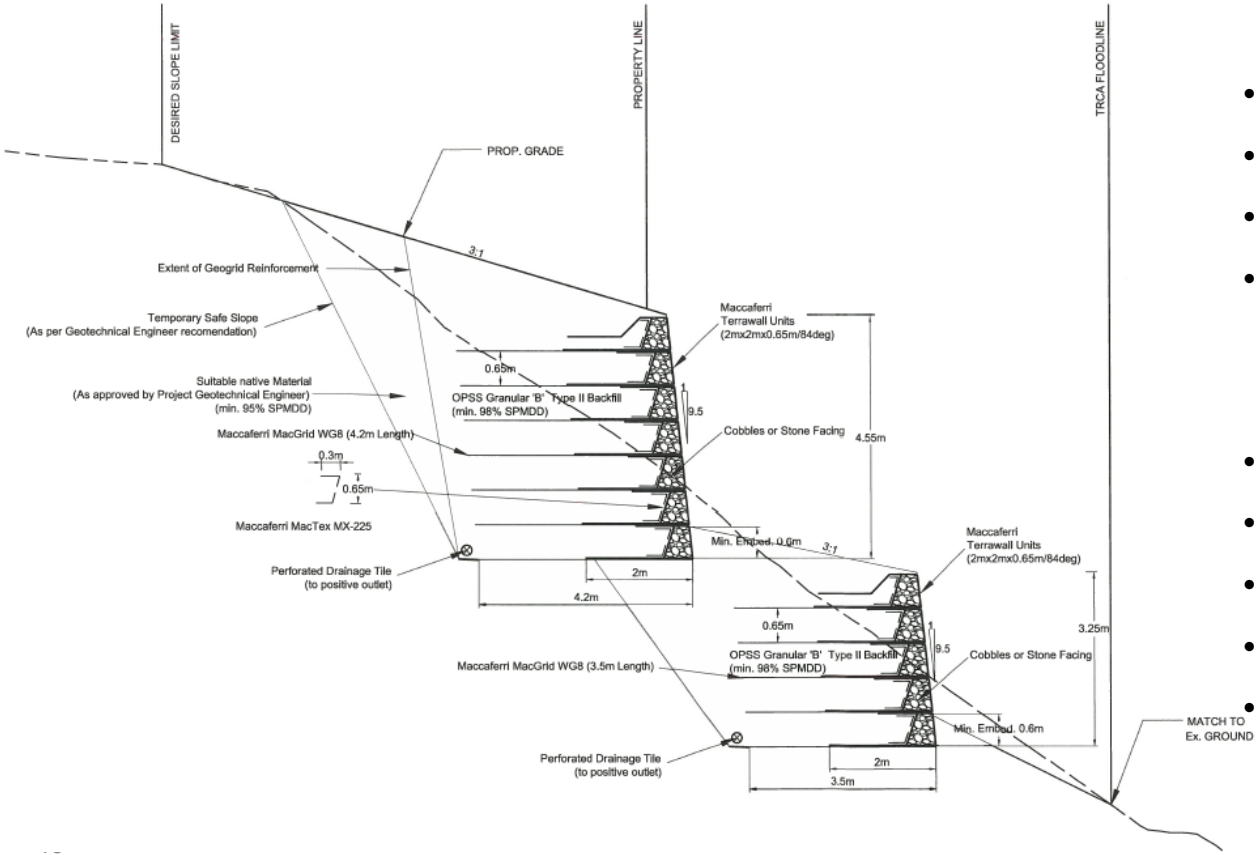
- Existing site topography - natural slopes, excavation limits
- Design configuration – slope height and extension
- External surcharge – e.g. road
- Seismic factors
- Soil types and properties – retained and foundation soil
- Water table
- Stability analysis with software
- Factors of Safety



RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

Typical cross-section



- Tot slope height up to 12 m
- Single MSE wall height up to 8 m
- Sloped bench at 3H:1V
- high-performance uniaxial geogrids made of high tenacity polyester with a polymeric coating
- Geogrid spacing is fixed = 0.65m
- MSE walls facing at 84°
- Pre-assembled facing units
- All the units are connected
- Flexible and monolithic structures

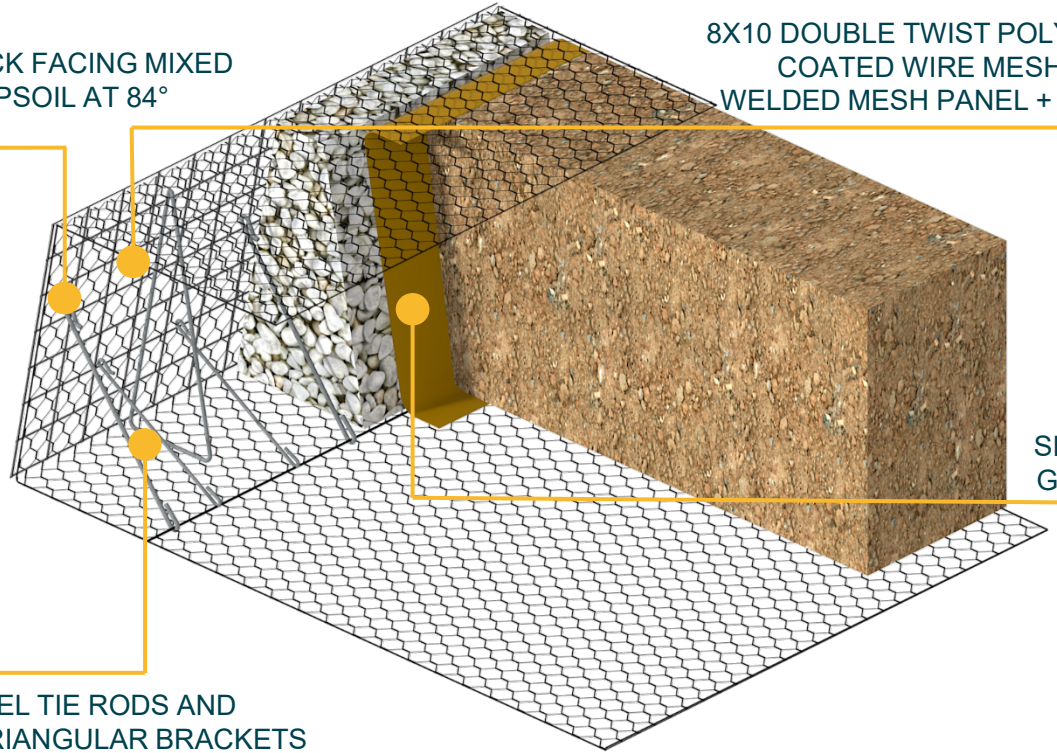
RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

FACING UNIT

SLOPING ROCK FACING MIXED
WITH TOPSOIL AT 84°

8X10 DOUBLE TWIST POLYMER
COATED WIRE MESH
WELDED MESH PANEL + TRM



SEPARATION
GEOTEXTILE

STEEL TIE RODS AND
STEEL TRIANGULAR BRACKETS

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

DURING CONSTRUCTION - SUMMER 2015

Dynex Construction Inc
+
Accardi Schaeffers & Associates Ltd.
+
Maccaferri Canada Ltd.

Photo credit: Dynex Construction Inc

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

DURING CONSTRUCTION - END OF SUMMER 2015

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

MACCAFERRI

END OF CONSTRUCTION - OCTOBER 2015

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

AUGUST 2023

After the Storm - Rebuilding a Neighbourhood from the Ground Up - YouTube

RIVERHEAD DRIVE SLOPE STABILIZATION PROJECT

OCTOBER 2023

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

- Location: Etobicoke Creek watershed, close to Rathburn Rd E, Mississauga
- Severely eroded slope (2008)
- Properties at risk

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

MACCAFERRI

Project main requirements:

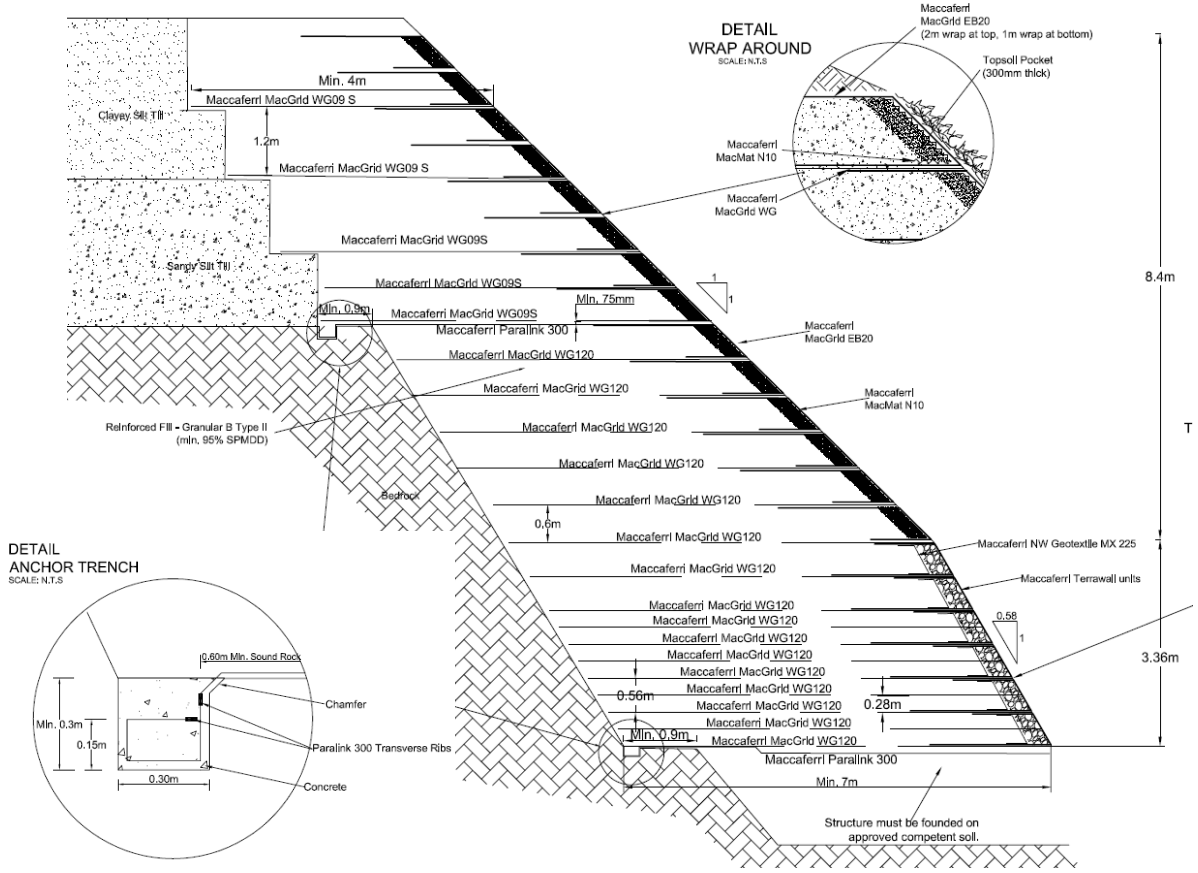
- ✓ 12m-high stable slope reconstruction
- ✓ Minimize the encroachment into the floodplain
- ✓ Recreate a natural environment
- ✓ Maximize vegetation re-establishment
- ✓ Integrate with the landscape

Solution:

- ✓ 12 m-high Reinforced Soil Slope (RSS)
- ✓ Bottom part at 60° to minimize the encroachment with the floodplain and filled with rock for erosion protection during floods
- ✓ Top part at 45°
- ✓ Curved alignment
- ✓ Topsoil and hydroseed

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

Typical Cross-Section

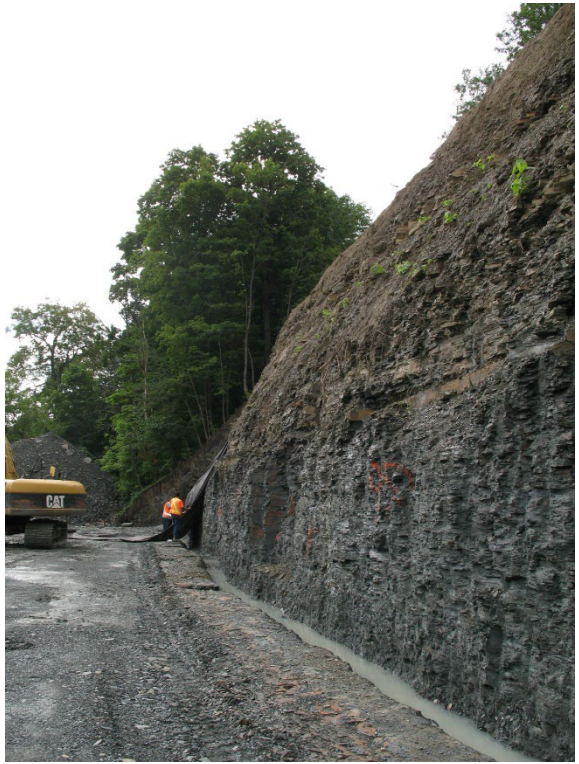


- Tot slope height up to 12 m
- ✓ Pre-assembled double twist polymer coated wire mesh facing units at 60° with rock fill
- Manual geogrid wrap-around at 45° with topsoil pocket
- High-performance uniaxial geogrids made of high tenacity polyester with a polymeric coating
- Geogrid spacing varies from 0.28 m to 1.2 m
- 2 trenches to anchor high-performance 300 kN/m tensile strength geogrids to the bedrock
- Stable, Flexible and monolithic structure

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

MACCAFERRI

DURING CONSTRUCTION – SEPTEMBER 2008



ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

MACCAFERRI

DURING CONSTRUCTION – SEPTEMBER 2008

Pre –assembled units with brackets are easier to install

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

DURING CONSTRUCTION – SEPTEMBER 2008

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

AFTER CONSTRUCTION – MAY 2009

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

JULY 2015

ETOBICOKE CREEK EROSION CONTROL AT RATHBURN ROAD EAST

SEPTEMBER 2023

VEGETATED REINFORCED SOIL SYSTEMS

MACCAFERRI

Structural measures providing mechanical foundations combined with living vegetation*

- Immediate & Long-Term Erosion Control
- Improving Soil Strength and Infiltration
- Reducing Near Bank Velocities
- Providing Resistance to Flooding
- Enhancing Ecosystem Diversity
- Creates and connects wildlife corridors
- Optimizing Aquatic, Riparian, & Terrestrial Life & Habitat Connections
- Noise reduction & energy absorption
- Air, water & soil temperature moderation
- Improving Aesthetic Quality

Top Growth

Root Reinforcement

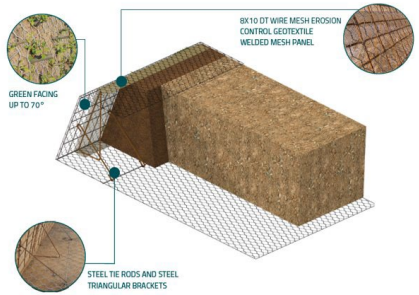
* Source Robbin B. Sotir

LESSONS LEARNT THROUGH THE YEARS

- Installation of pre-assembled facing units is much easier than manually implementing geogrid wrap-around

- Vegetation grows more dense and homogenous through the facing units if they are sloped (typ. up to 70°)
  - ✓ larger growing area
  - ✓ direct rainfall capture and infiltration
  - ✓ moisture retention

- Inspection is always recommended
- Localized re-planting or re-seeding to guarantee long-term vegetation establishment



LESSONS LEARNT THROUGH THE YEARS

Vegetation growth is influenced by environmental factors:

- Climate
- Temperature and available water
- Sunlight, slope exposure
- Nutrients in the soil

Have realistic expectations!

Based on the location and function of the slope…

Choose the right:

- Plant species
- Topsoil quantity and seeds
- Type of backfill, geogrids, erosion control blanket
- Time of installation of vegetation

SUMMARY

- Vegetated reinforced soil structures used to address massive erosion and slope instability
- Long-term protection for the homes at the top of the slopes
- Small footprint – limited interference with floodplain
- Support vegetation growth and allow fast restoration
- Safe and sustainable structures


THANK YOU!
Any questions?
a.paris@maccaferri.com
MACCAFERRI

SOURCE TO STREAM 2024 Conference

Canada's Premier Stormwater and Erosion and Sediment Control Conference

Thank you to our sponsors!

EXECUTIVE SPONSORS

ADS Our reason is water.

citygreen URBAN LANDSCAPE SOLUTIONS

CUPOLEX® ENGINEERING SOLUTIONS INC.

ENVIROPOD™

Aquafor Beech Limited

Cleanflo Water Technologies Inc

filtrexx® CANADA SUSTAINABLE TECHNOLOGIES let nature do it®

imbrium®

Matrix Solutions Inc. A Montrose Environmental Company

OAKS LANDSCAPE PRODUCTS

Hydro International®

NEXT STORM

Sustainable Technologies EVALUATION PROGRAM

MEDIA SPONSOR

Environmental Science & Engineering MAGAZINE

HOSTS

Presented by:

Toronto and Region Conservation Authority

In association with:

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature