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Presented by:

Toronto and Region Conservation Authority

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Lake Simcoe Region conservation authority

Credit Valley Conservation – inspired by nature

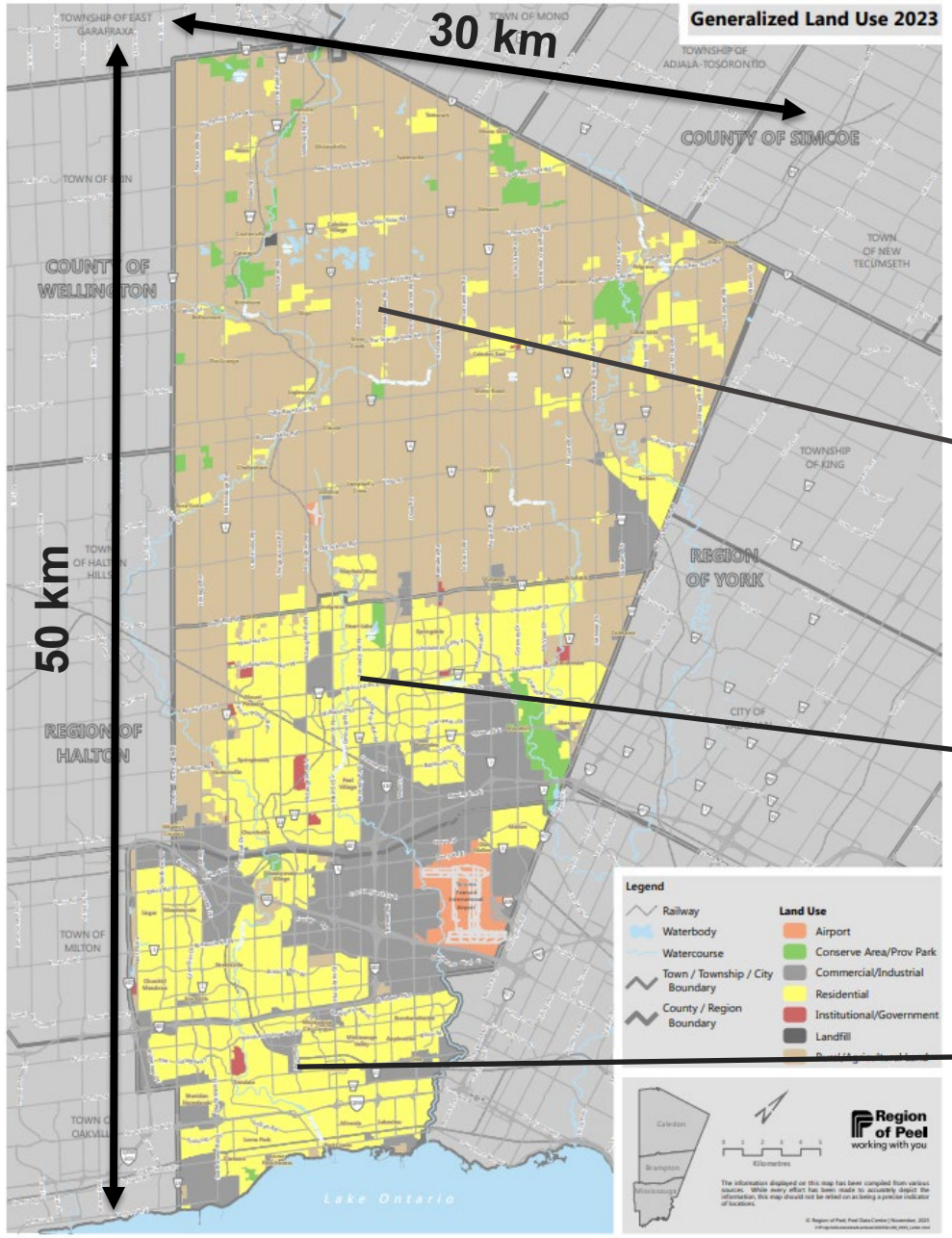
Reading the Reach: A Novel, Systematic, GIS-Based Approach to Erosion Hazard Mapping in Asset Management

March 27, 2024

Max Ornat, EIT
Stantec

Scott Cowan, P.Geo., CTech
KERR WOOD LEIDAL
consulting engineers

REGION OF PEEL



Caledon

Brampton

Mississauga

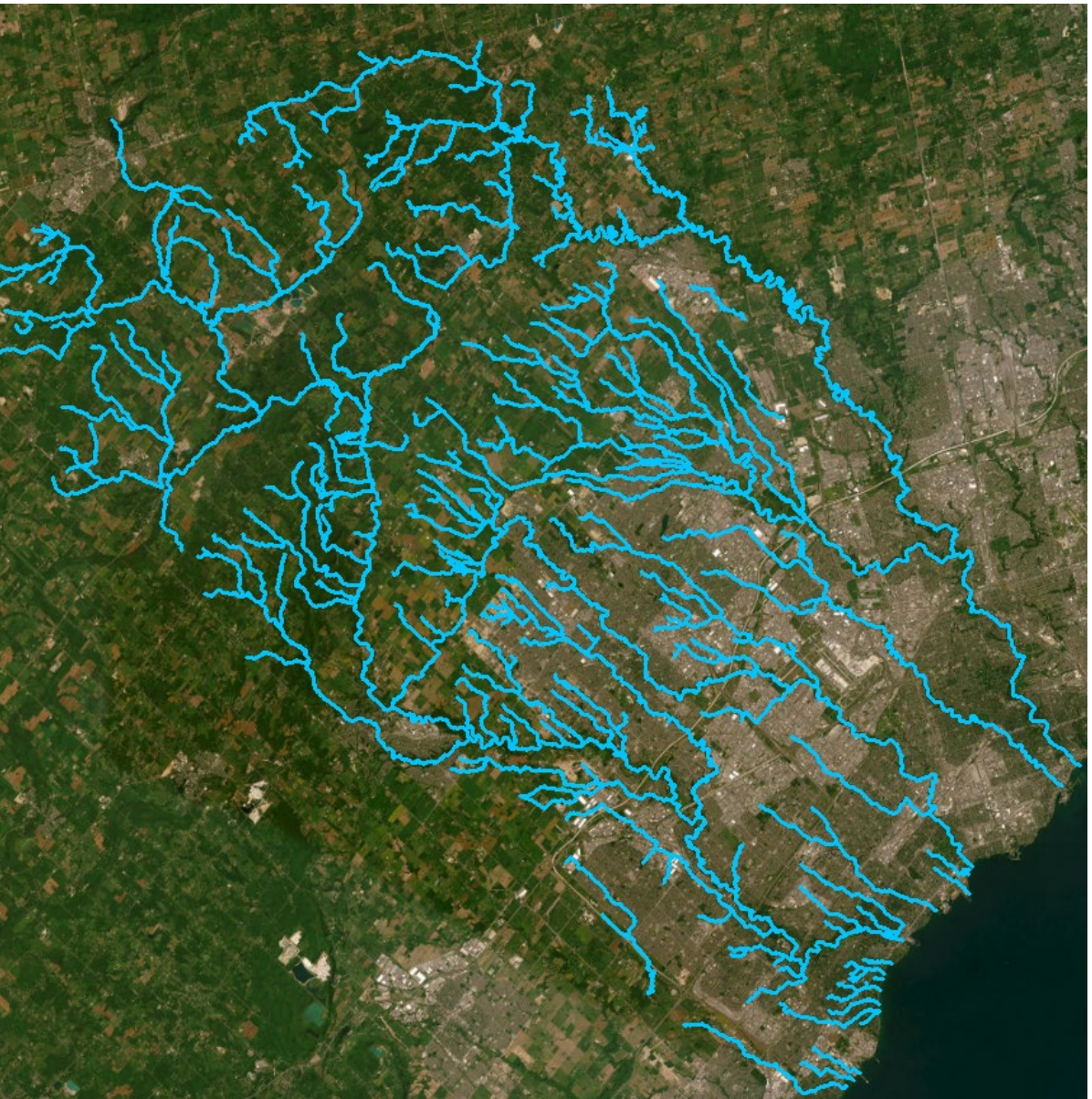
Large – geographically diverse

~ 1.3 million people

Land Use

- Airport
- Conserve Area/Prov Park
- Commercial/Industrial
- Residential
- Institutional/Government
- Landfill
- Rural/Agricultural Land

REGULATED WATERCOURSES

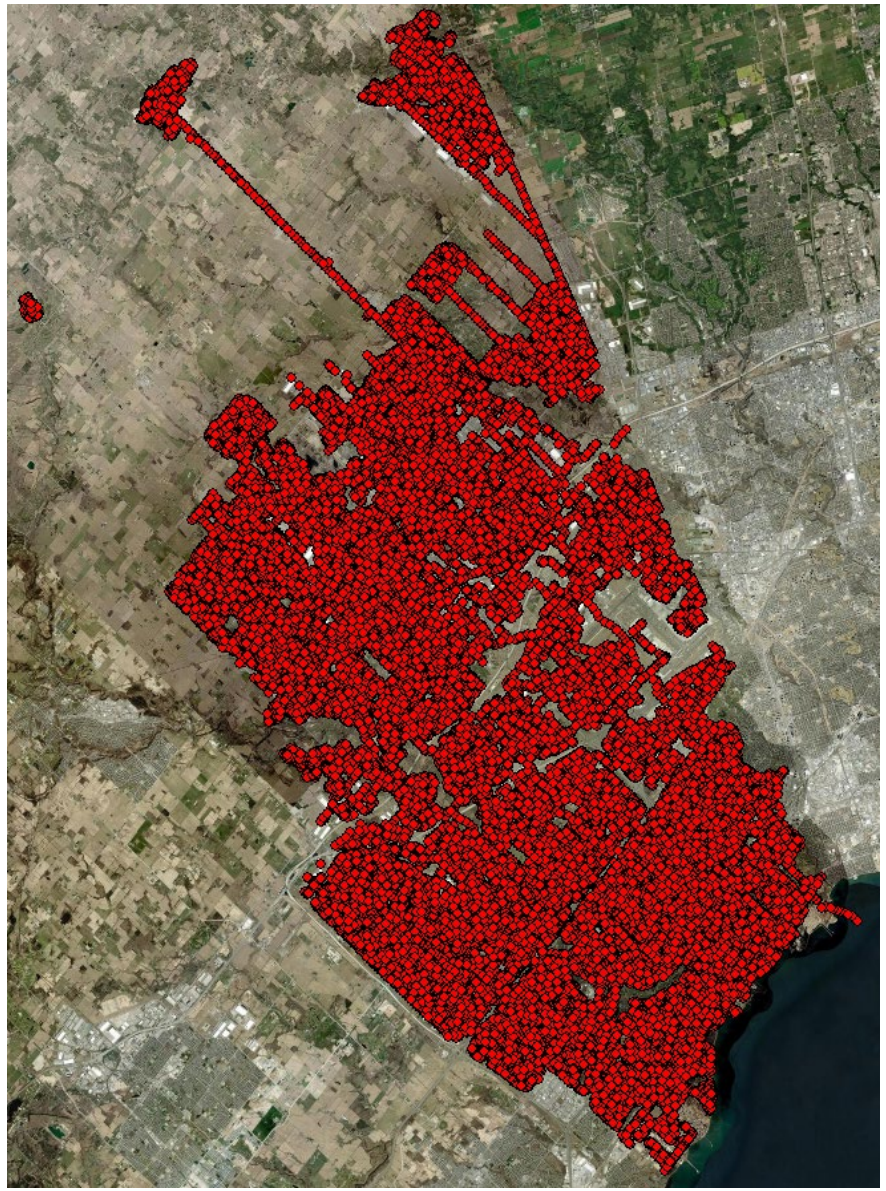


~1.3 million linear meters of regulated watercourse (1,300 KM)

SANITARY MAINTENANCE HOLES

~ 56,000 sanitary maintenance holes

Significant potential for interaction between watercourses and sanitary MH



HISTORICAL APPROACH TO IDENTIFYING EROSION ISSUES

Routine annual site assessments of a portion of MH dataset (100-200 per year)

Annual site assessments – erosion is a concern!

Challenge: earmarking funding for maintenance / mitigation works is difficult

THE PILOT STUDY

Region identified 381 MH at **RISK** of further damage due to bank erosion

Provide relative **RISK** rankings for the 381 to help Region prioritize

RISK TO MH FROM LATERAL EROSION

Risk = **(Likelihood)** and **(Consequence)**

Likelihood = **Lateral Erosion Hazard** and condition

Consequence = Environmental, economic, and social

Approach to Estimate Lateral Erosion Hazard

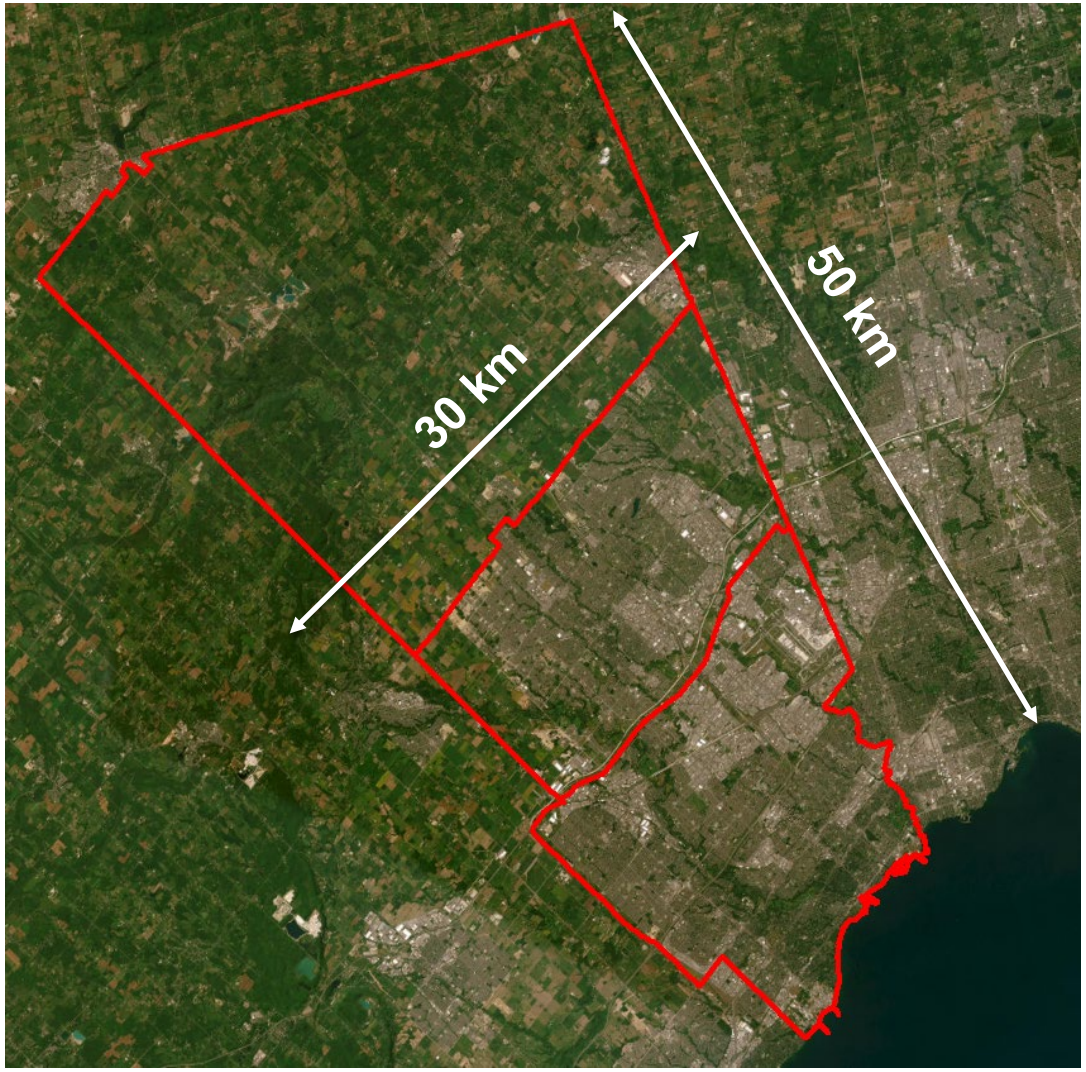
CONSTRAINTS

Data:

- Mapping of regulated watercourses – mostly polyline
- Orthophotographs (2005 and 2021)
- Mapping of MH dataset

Scale:

- The Region is geographically diverse
- Site scale and regional scale would be too fine and coarse, respectively
- **Reach-scale** approach most appropriate for desktop analysis



LIMITATIONS

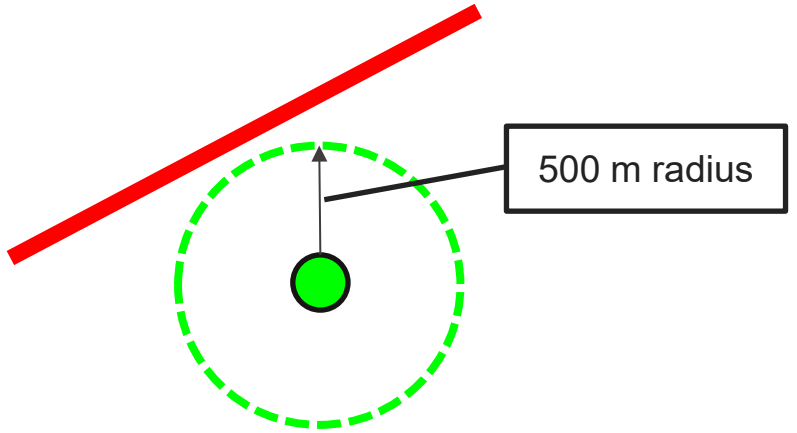
- Vertical scour not considered – available data was limited and spatial scale cost prohibitive
- Maintenance hole infrastructure only (i.e., excludes sanitary sewer)
- Orthophotograph record was limited to 2005 – 2021 (16 years)
- Lateral erosion hazard estimation based on historical observations (i.e., assumes the past will extend into the future)

METHODOLOGY

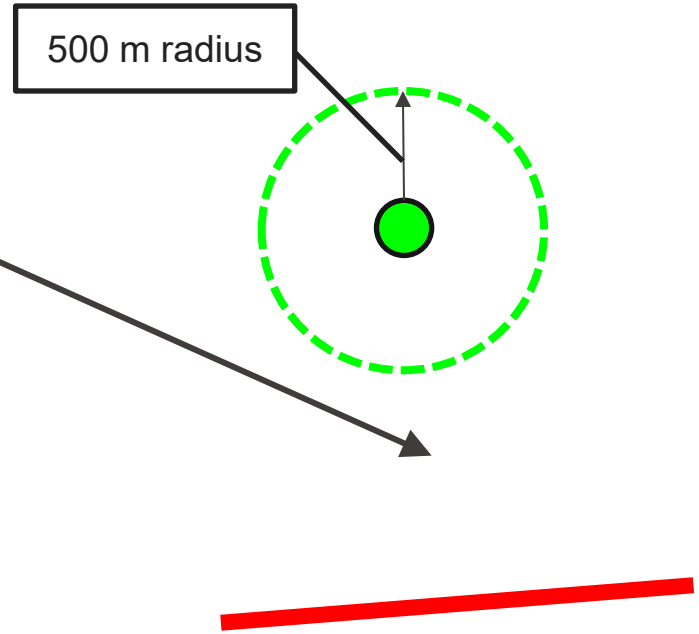
Task No.	Task Name	Task Description
1	**Reach Identification**	Identify reaches adjacent to MH
2	**Analysis**	Reach-scale estimation of average channel width and average annual migration rate
3	**Erosion Hazard Mapping**	Delineate erosion hazard zones for each reach
4	**Erosion Hazard Ranking**	Assign erosion hazard to each MH

TASK 1 – REACH SCREENING

Step 1: Radius of 500 m to identify adjacent watercourse



Step 2: Watercourse extended upstream and downstream to define reach



58 reaches were identified

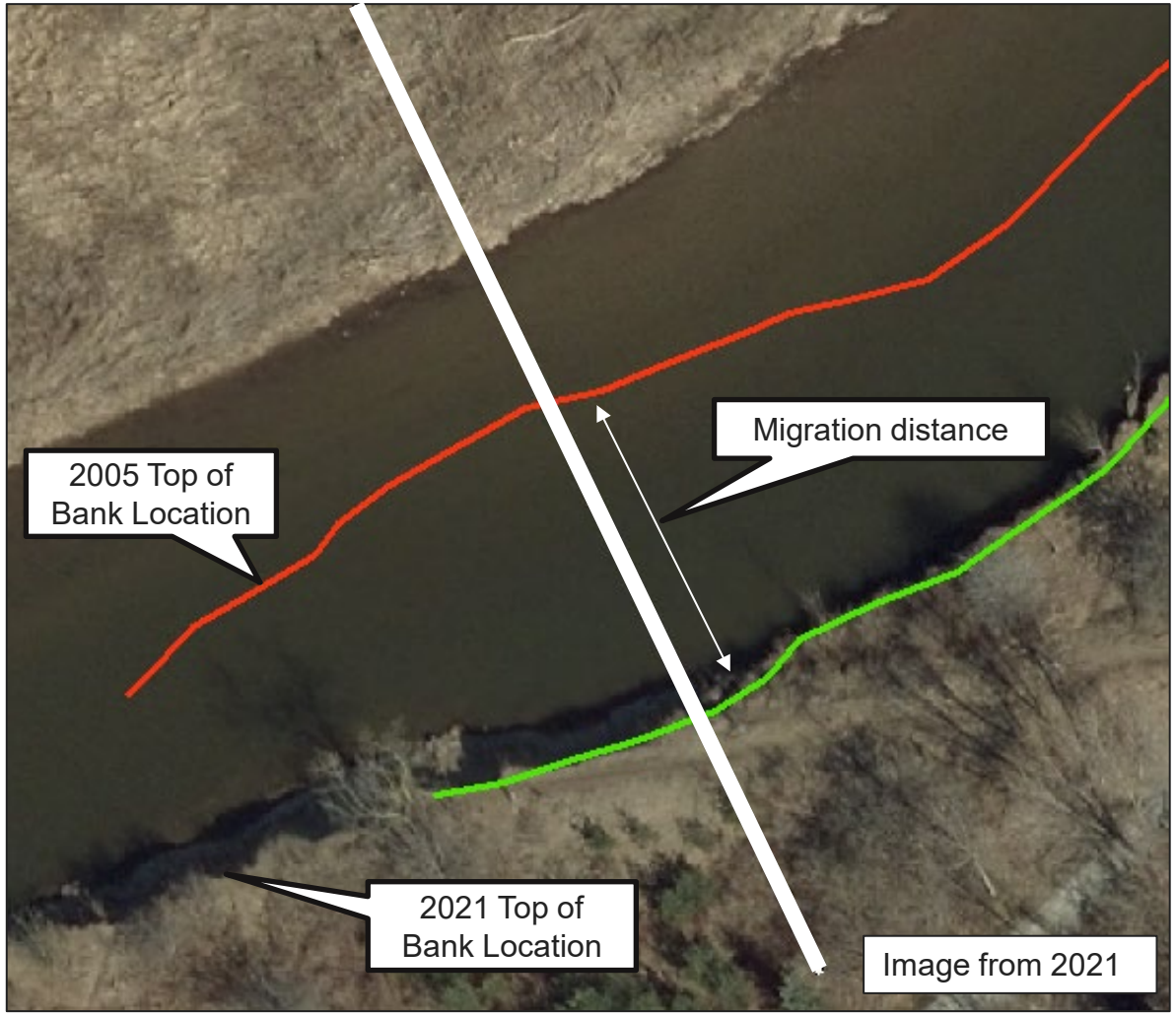
TASK 2 - ANALYSIS

Step 1: Estimate the average annual migration rate at outside bends

Looking for most extreme cases (3 locations)

Estimate average annual migration rate

Applied to entire reach



TASK 2 - ANALYSIS

Step 2: Estimate the top of bank location for the entire reach

Watercourses were provided as polylines

Estimate average reach-scale channel top width (3 locations)

+20% (natural variability in channel form and centerline mapping inconsistencies)

TASK 2 - ANALYSIS

Step 3: Reach description summary

Average annual lateral migration rate extended over selected planning horizon

Planning horizons selected by the Region (0-5, 5-15, 15-30, 30-50, 50+ years)

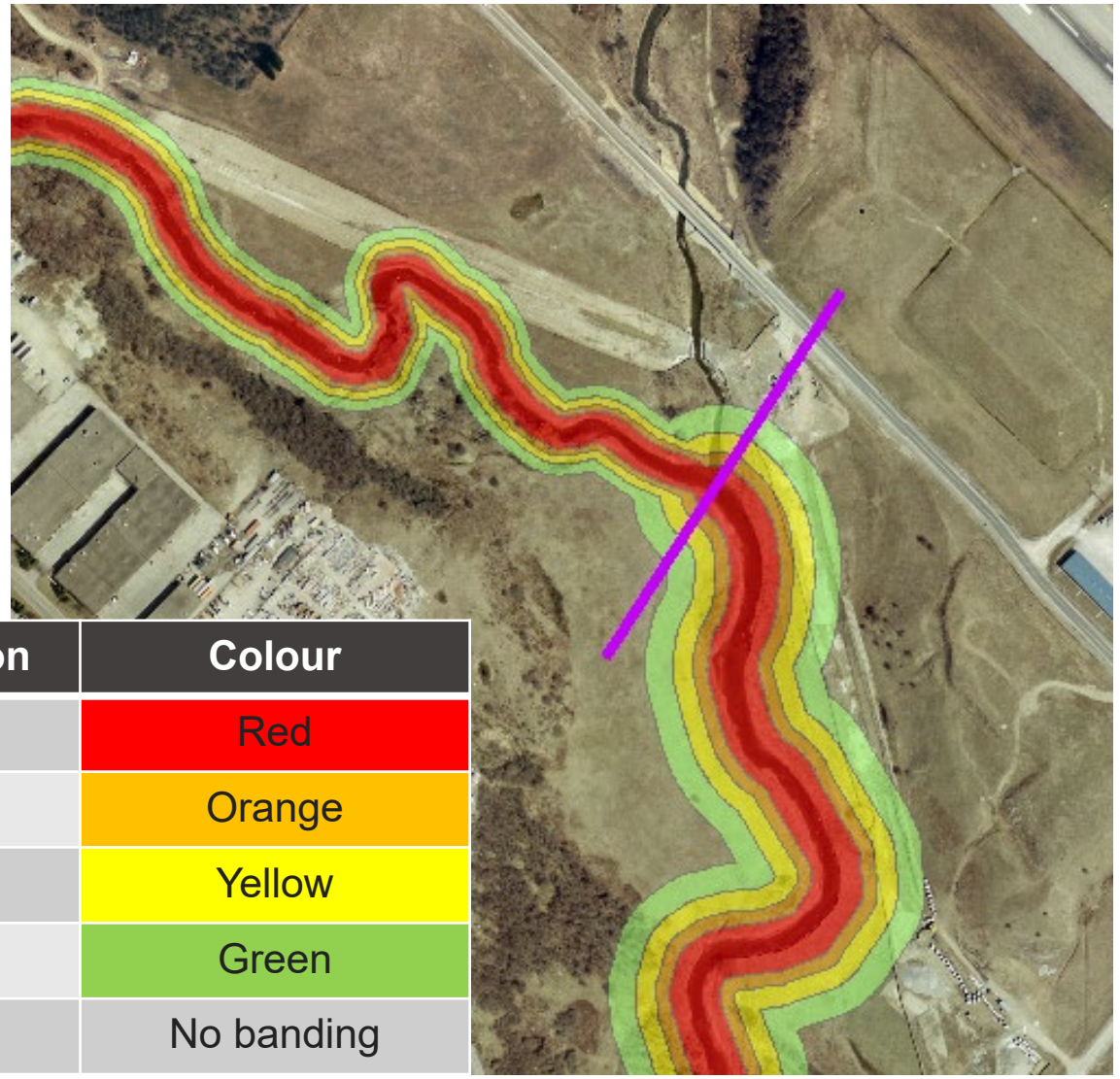
RESULTS OF REACH-BASED DESKTOP GEOMORPHOLOGICAL ASSESSMENT

Reach	Conservation Authority	Municipality	Watercourse Name	Est. Avg. Top Width (m)	Est. Avg. Annual Lateral Migration Rate (m/yr)	Estimated Erosion Hazard Offset (m)			
						5-Year	15-Year	30-Year	50-Year
TA-1	TRCA	Brampton	Tributary A	5.0	0.09	0.5	1.4	2.7	4.5
ECE-1	TRCA	Brampton	Etobicoke Creek East Branch	9.3	0.07	0.4	1.1	2.1	3.5
ECE-5	TRCA	Brampton/Mississauga	Etobicoke East Branch	15.2	0.43	2.2	6.5	12.9	21.5
T3-1	TRCA	Brampton/Mississauga	Tributary 3	5.2	0.11	0.6	1.7	3.3	5.5
SC-1	TRCA	Caledon	Salt Creek	9.2	0.07	0.4	1.1	2.1	3.5
ECW-5	TRCA	Brampton	Etobicoke Creek	16.4	0.28	1.4	4.2	8.4	14.0
ECW-1	TRCA	Brampton	Etobicoke Creek	18.6	0.24	1.2	3.6	7.2	12.0
ECW-6	TRCA	Brampton	Etobicoke Creek	18.2	0.49	2.5	7.4	14.7	24.5
LEC-1	TRCA	Mississauga	Little Etobicoke Creek	9.4	0.07	0.4	1.1	2.1	3.5
LEC-2	TRCA	Mississauga	Little Etobicoke Creek	14.0	0.13	0.7	2.0	3.9	6.5
GRTT-1	TRCA	Brampton	Tributary to Gore Road Tributary	5.1	0.03	0.2	0.5	0.9	1.5

TASK 3 – HAZARD MAPPING

Buffer top of bank by estimated lateral erosion hazard offset

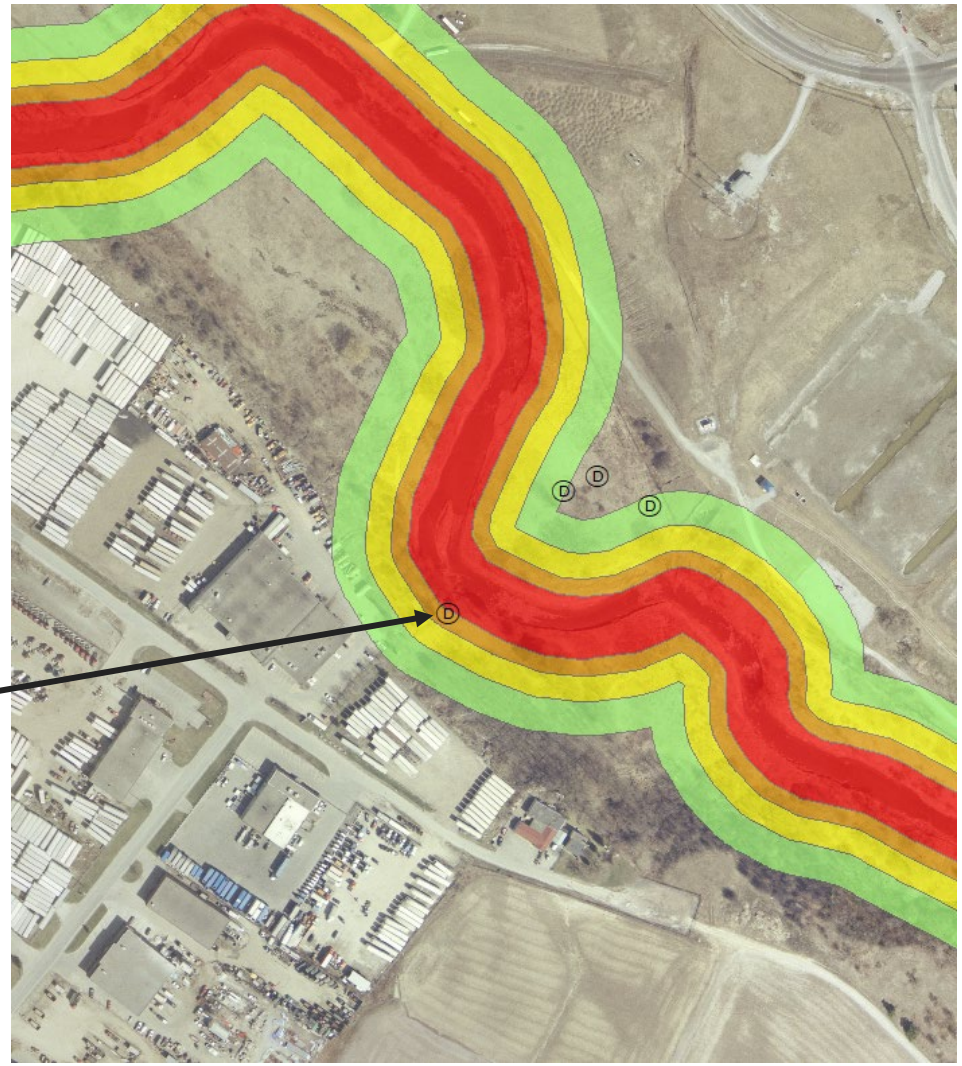
Different reaches have different erosion hazards



Planning Horizon	Colour
0-5	Red
5-15	Orange
15-30	Yellow
30-50	Green
50+	No banding

TASK 4 – ASSIGN HAZARD

Demonstration on how erosion hazard bands are assigned to MH



TYPICAL SITES WITH HIGH EROSION HAZARD

RESULTS

Summary of total number of MHs within each erosion hazard category

- Over half in 50+ bucket
- ~ 20% in 0 – 15 year buckets

Erosion Hazard (Years)	No. of Maintenance Holes	% of Dataset
50+	241	63%
30 – 50	32	8%
15 – 30	36	9%
5 – 15	24	6%
0 – 5	48	13%

Risk Assessment Summary

RESULTS – RISK ASSESSMENT

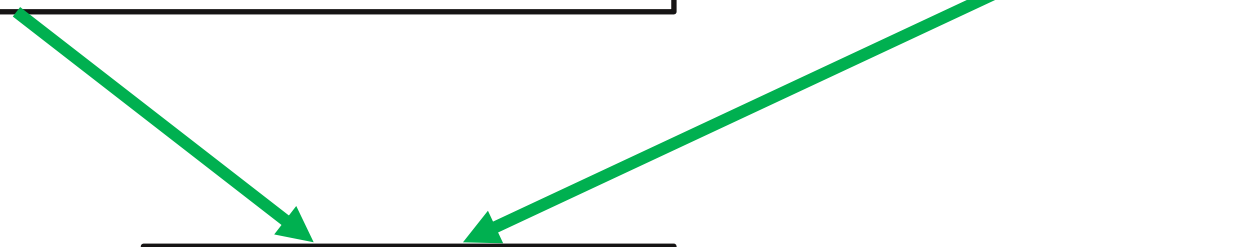
Likelihood

Erosion Hazard (Years)	No. of Maintenance Holes	% of Dataset
50+	241	63%
30 – 50	32	8%
15 – 30	36	9%
5 – 15	24	6%
0 – 5	48	13%

+ MH Condition

Consequence

Environmental, Economic, Social



Risk Assessment

RESULTS – RISK ASSESSMENT

Results can be used to prioritize resources for site investigation and potentially mitigation

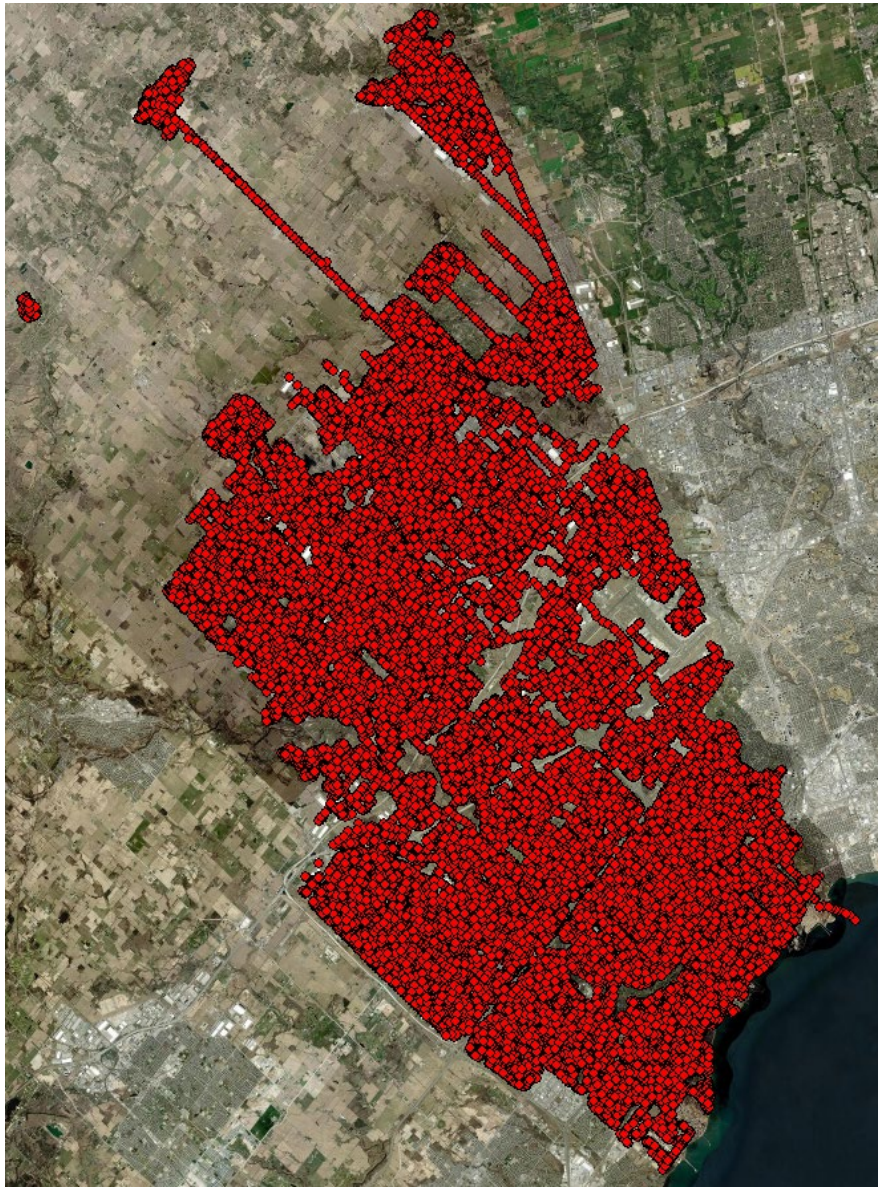
Risk	No. of Maintenance Holes	% of Dataset
Low	138	36%
Medium	177	47%
High	66	17%

Next Steps and Summary

NEXT STEPS

Site assessments to 66 high-risk sites (confirm mitigation approach)

Region expanded erosion hazard review to all MHs (~56,000) within the region



KEY TAKEAWAYS

- Lots of potential for interaction between the built environment and watercourses
- **Understanding geomorphological processes** allows asset managers to **prioritize resources**
- **Reach-scale erosion rate mapping is an effective** tool for **triaging** infrastructure based on relative lateral erosion hazards
- **Geomorphology** can be leveraged **throughout the entire asset management lifecycle** from planning to implementation

Questions?

Scott Cowan
SCowan@kwl.ca

KERR WOOD LEIDAL
consulting engineers

Max Ornat
Maximilian.Ornat@stantec.com

Stantec

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