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Assessing and Mitigating Bedrock Erosion along Realigned Lower Albion Creek

Robin McKillop, P.Geo. & **Brian Greck**, P.Eng.

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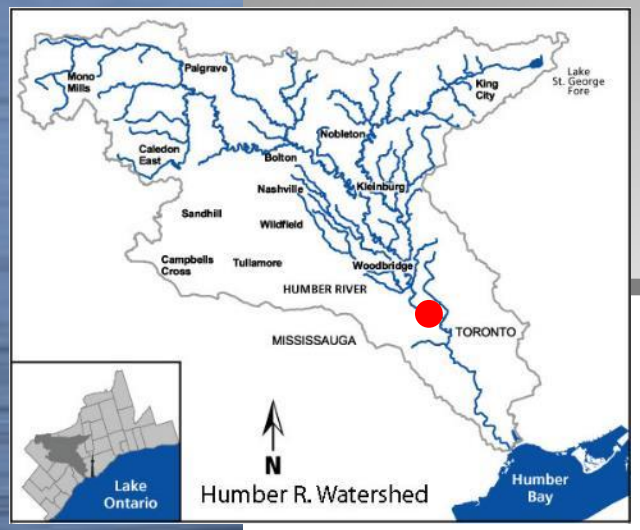
Outline

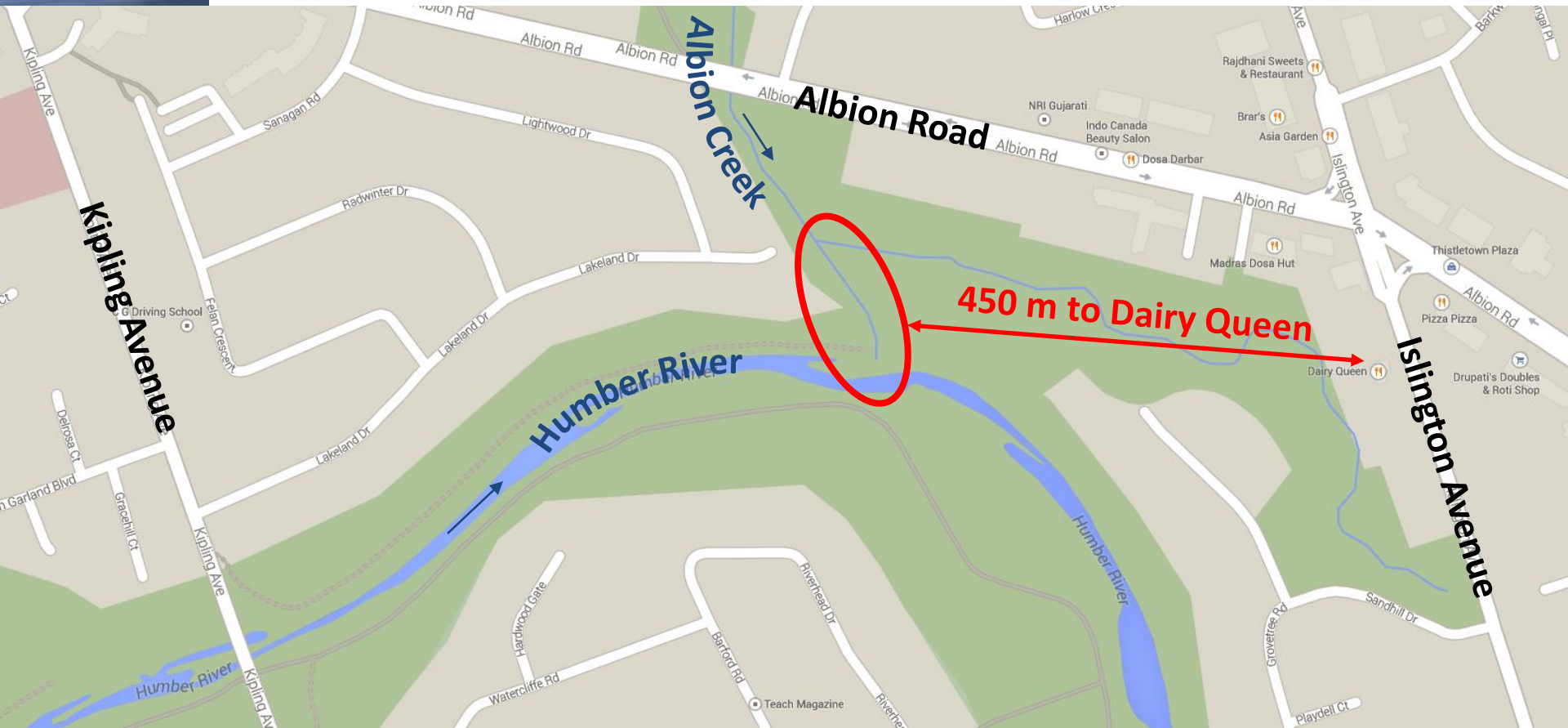
- The Problem
  - Exposed and at-risk sewer infrastructure
- The Assessment
  - Lateral and vertical bedrock erosion
- The Mitigation
  - Protection and monitoring

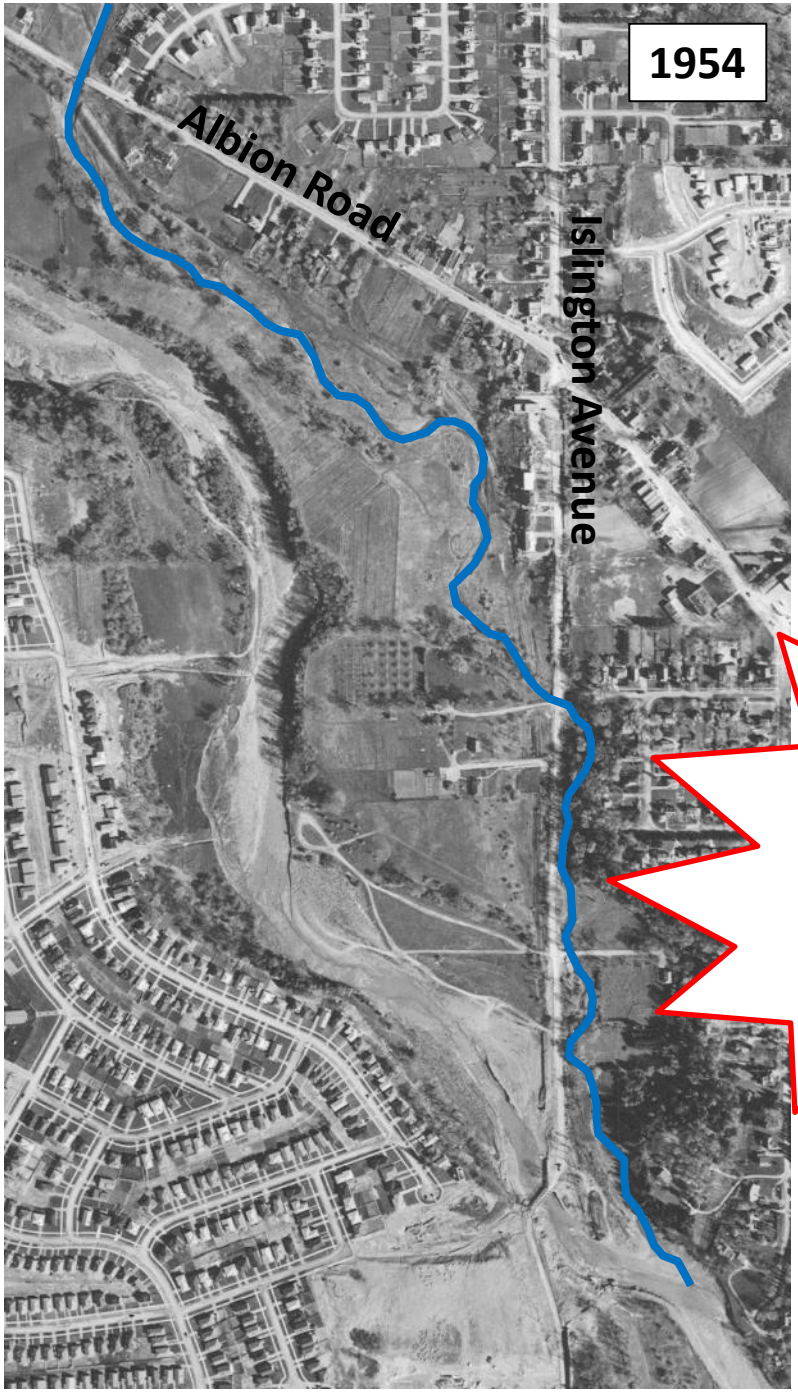
THE PROBLEM

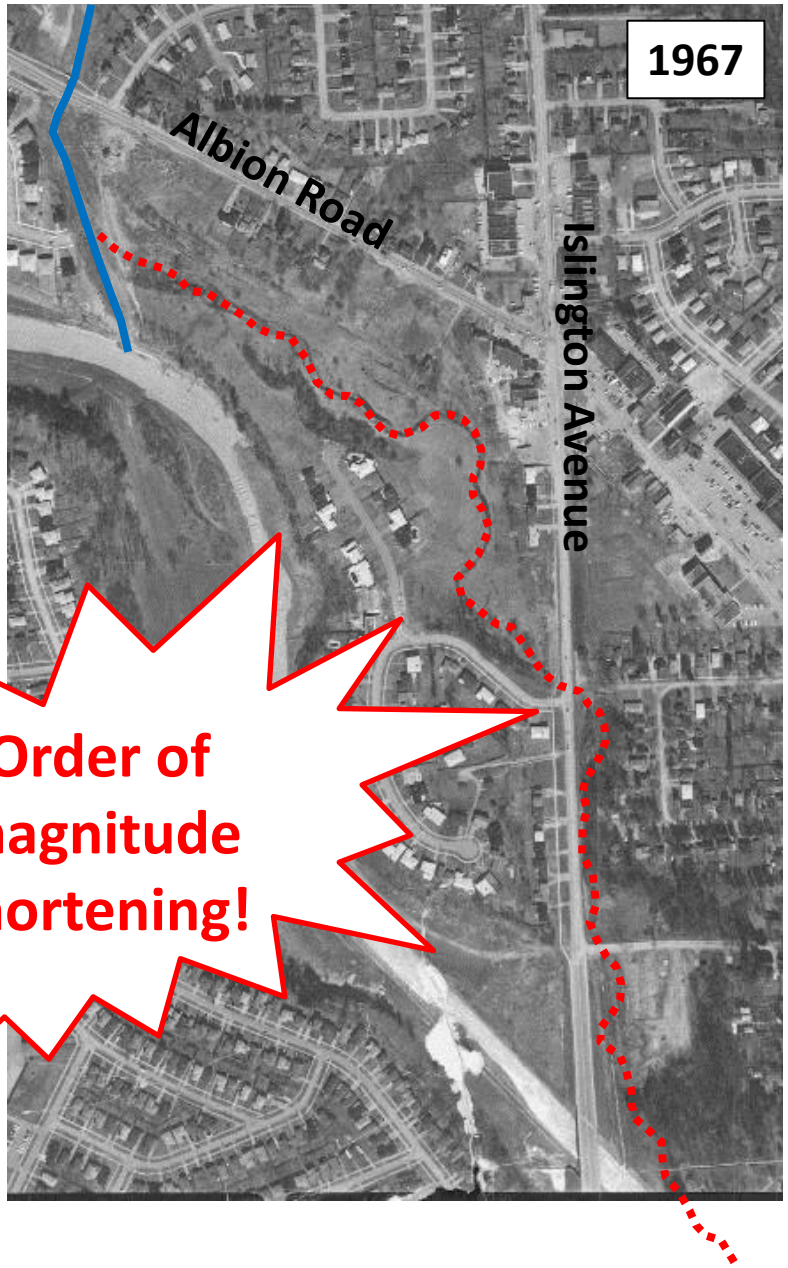
Exposed and at-risk sewer infrastructure

Site Location









Order of magnitude shortening!

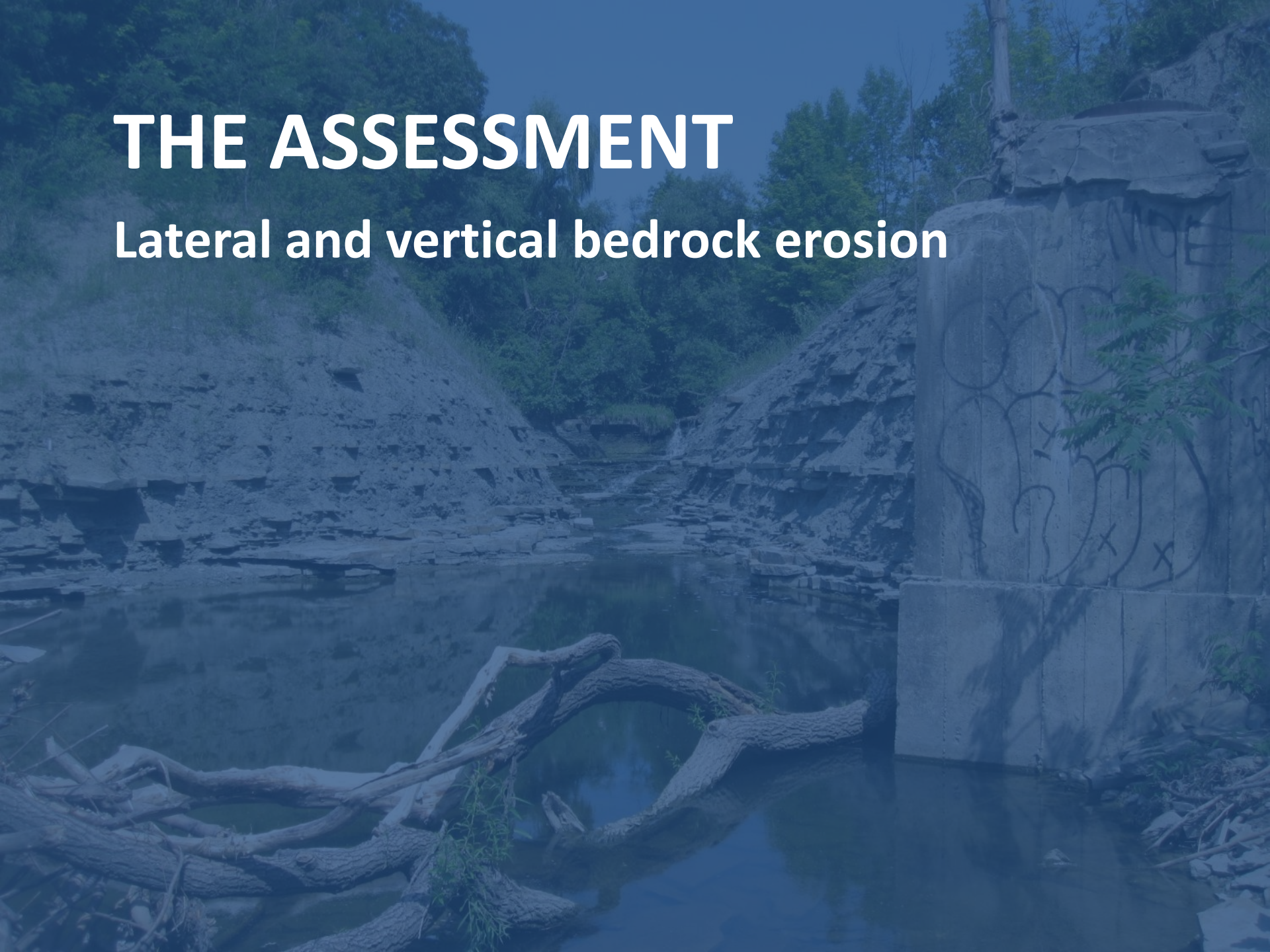

Paul Greck

At-risk sewer infrastructure

Project Objectives

- At-risk sewer infrastructure identified through TRCA monitoring

- Two principal objectives:
  - PHASE 1: Mitigate risk to exposed manhole and undermined sewer
    - Preliminary and detailed design
  - PHASE 2: Assess risk to sewer in banks and at crossings
    a) Lower Albion Creek
    b) Humber River at confluence

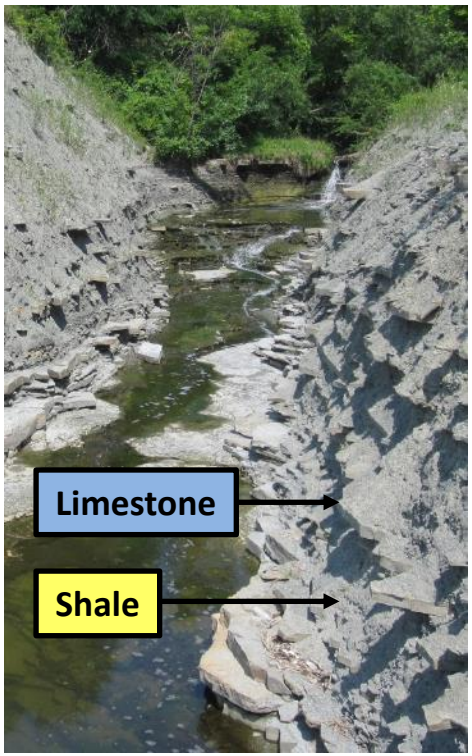


THE ASSESSMENT

Lateral and vertical bedrock erosion

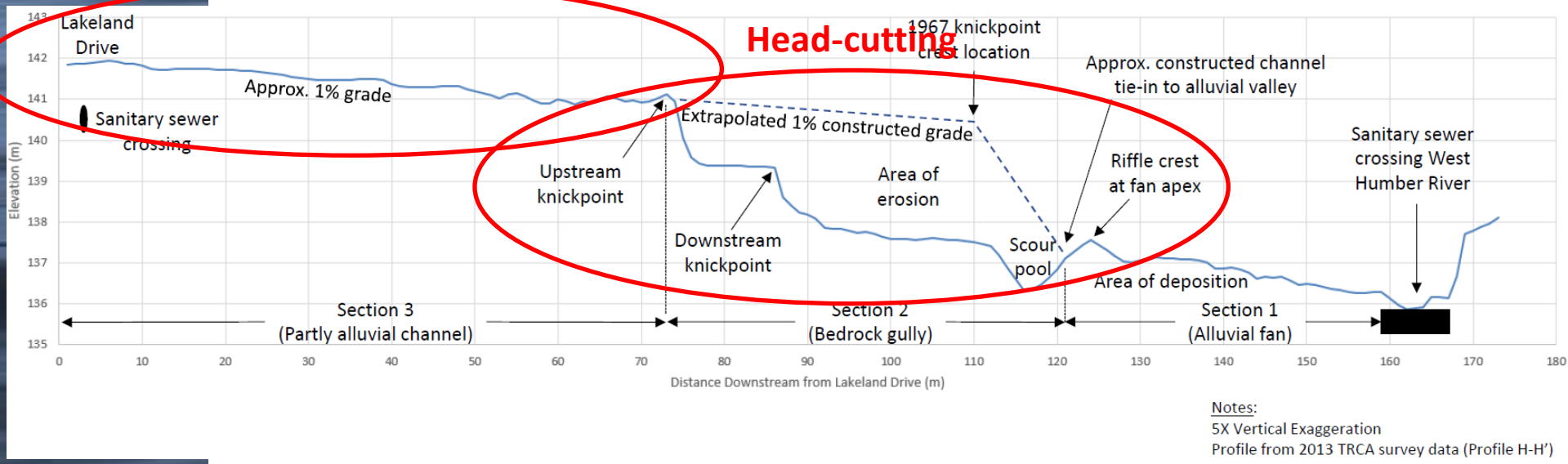
Background

- Conventional erosion threshold analysis inapplicable to bedrock channels
- **Shale** beds within *Georgian Bay Formation* weather rapidly through wetting-drying and freeze-thaw cycles; **limestone** beds more resistant (Tinkler & Parish, 1998)
- Irregular plucking of detached fragments from the bed and banks
- Key is to understand **vertical** and **lateral** erosion processes…



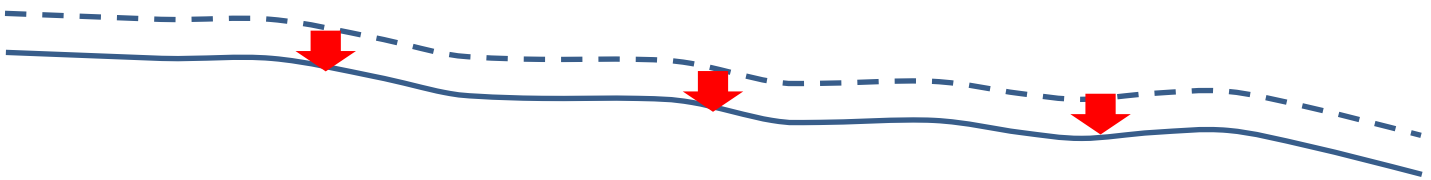
Vertical Erosion

Lower Albion Creek Longitudinal Profile



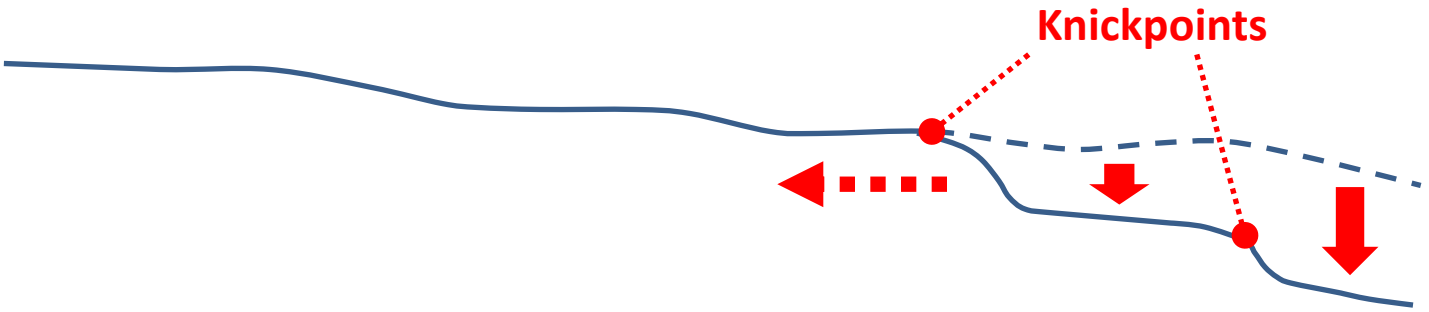
Notes:
5X Vertical Exaggeration
Profile from 2013 TRCA survey data (Profile H-H')

Down-cutting



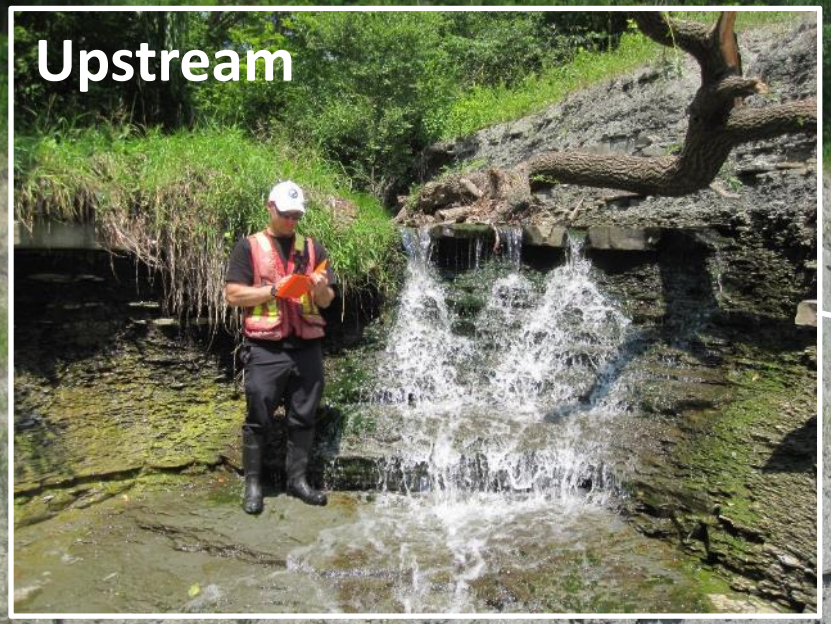
- Bed incision relative to fixed infrastructure
  - 0.0064 m/yr since realignment → 0.45 m cover likely to remain over upstream sewer crossing (Lakeland Dr) after 100 years of continued down-cutting
- Compares well to values reported in literature (e.g., Tinkler & Parish, 1998)

Head-cutting

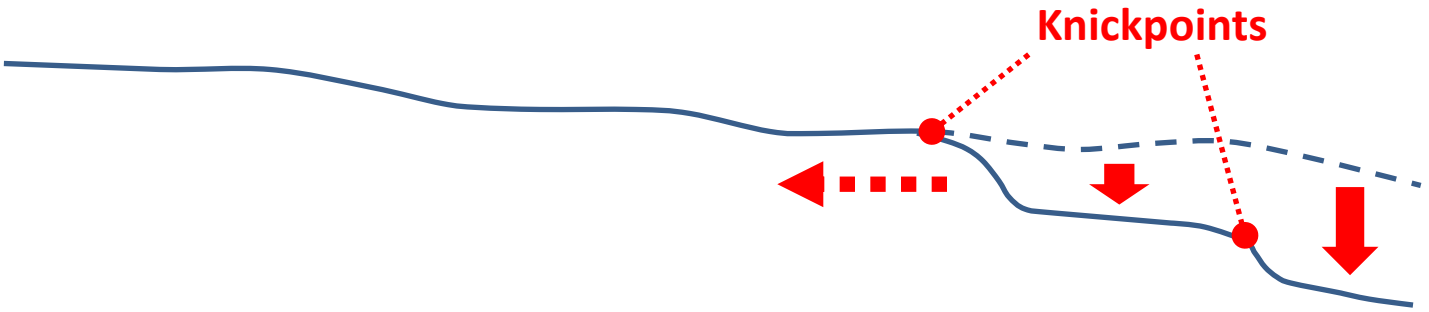


- Channel incising retrogressively from downstream end

Knickpoints



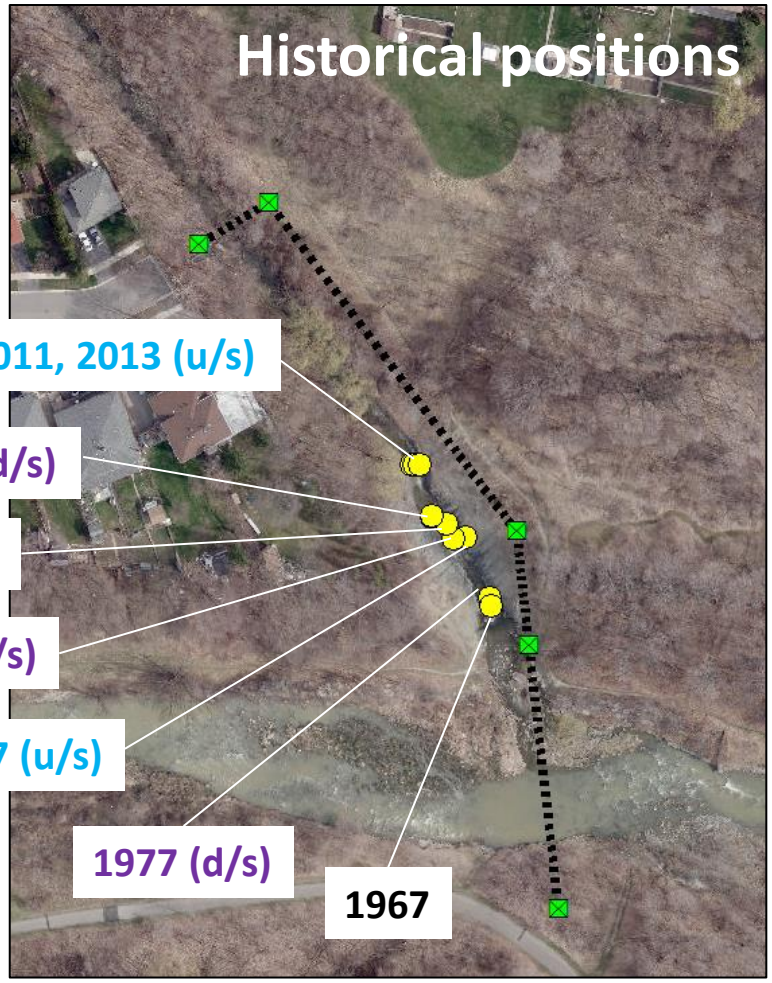
Head-cutting



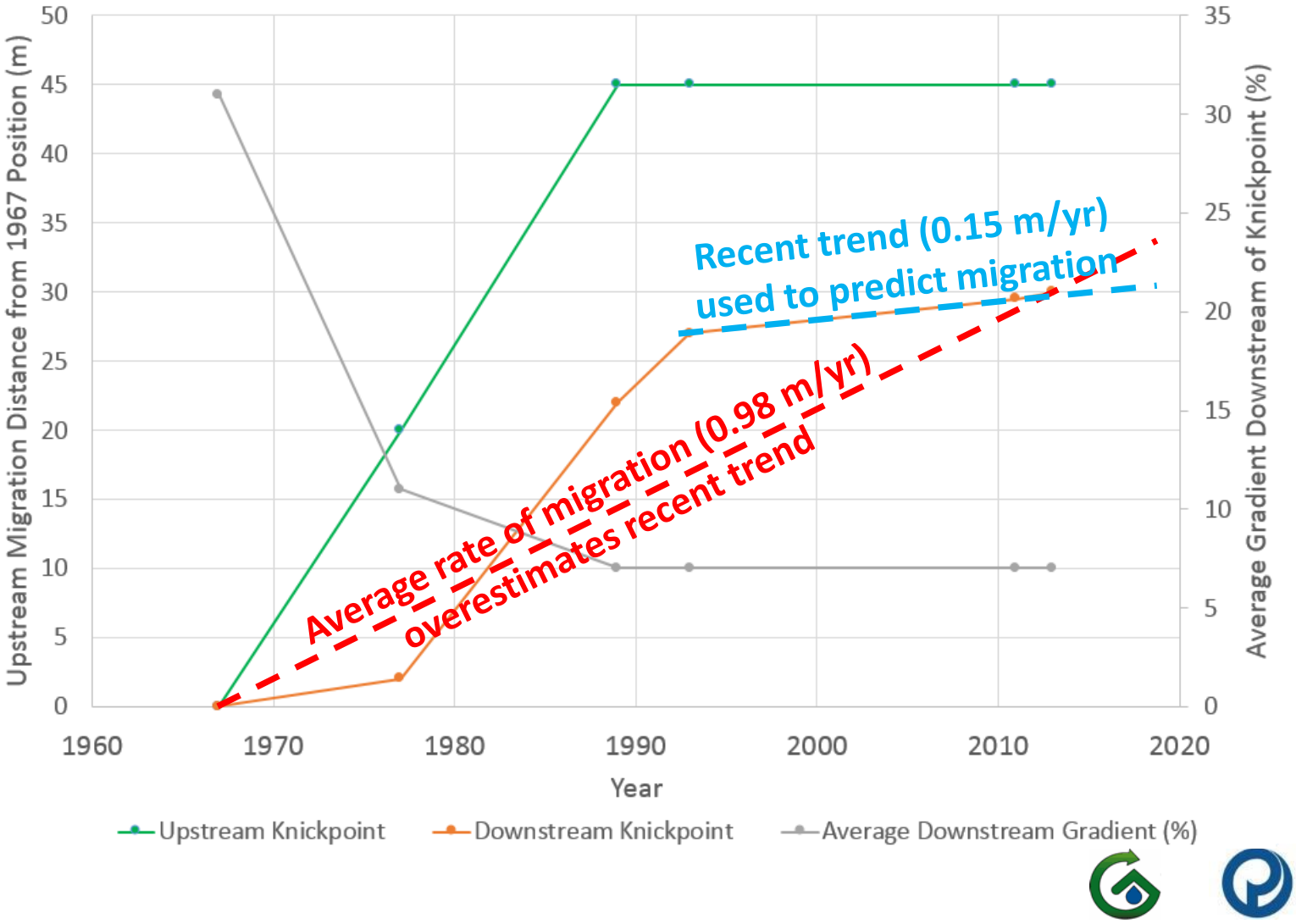
- Channel incising retrogressively from downstream end
- Need to estimate *rate* of upstream knickpoint migration

Knickpoints

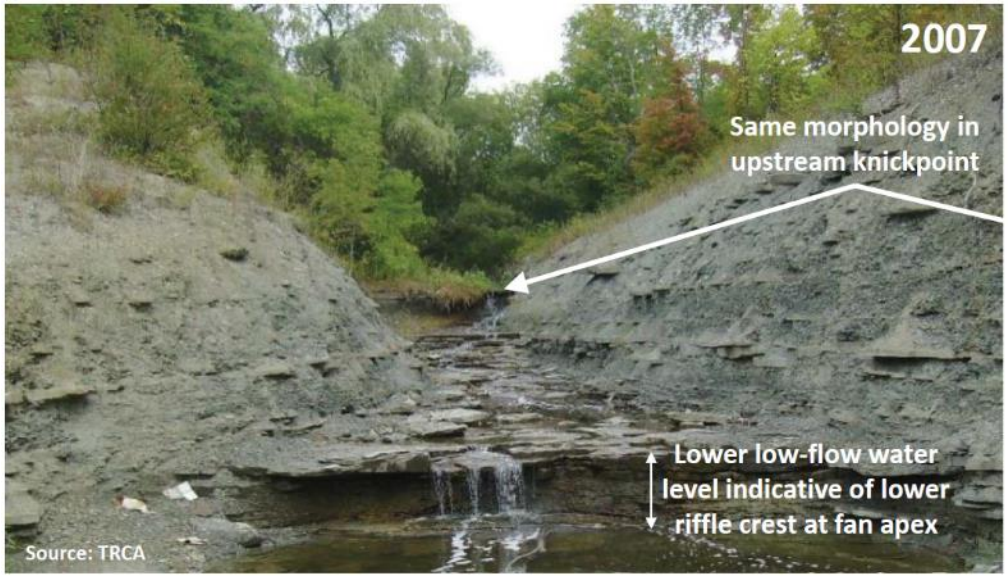
Overlaid Knickpoint Positions



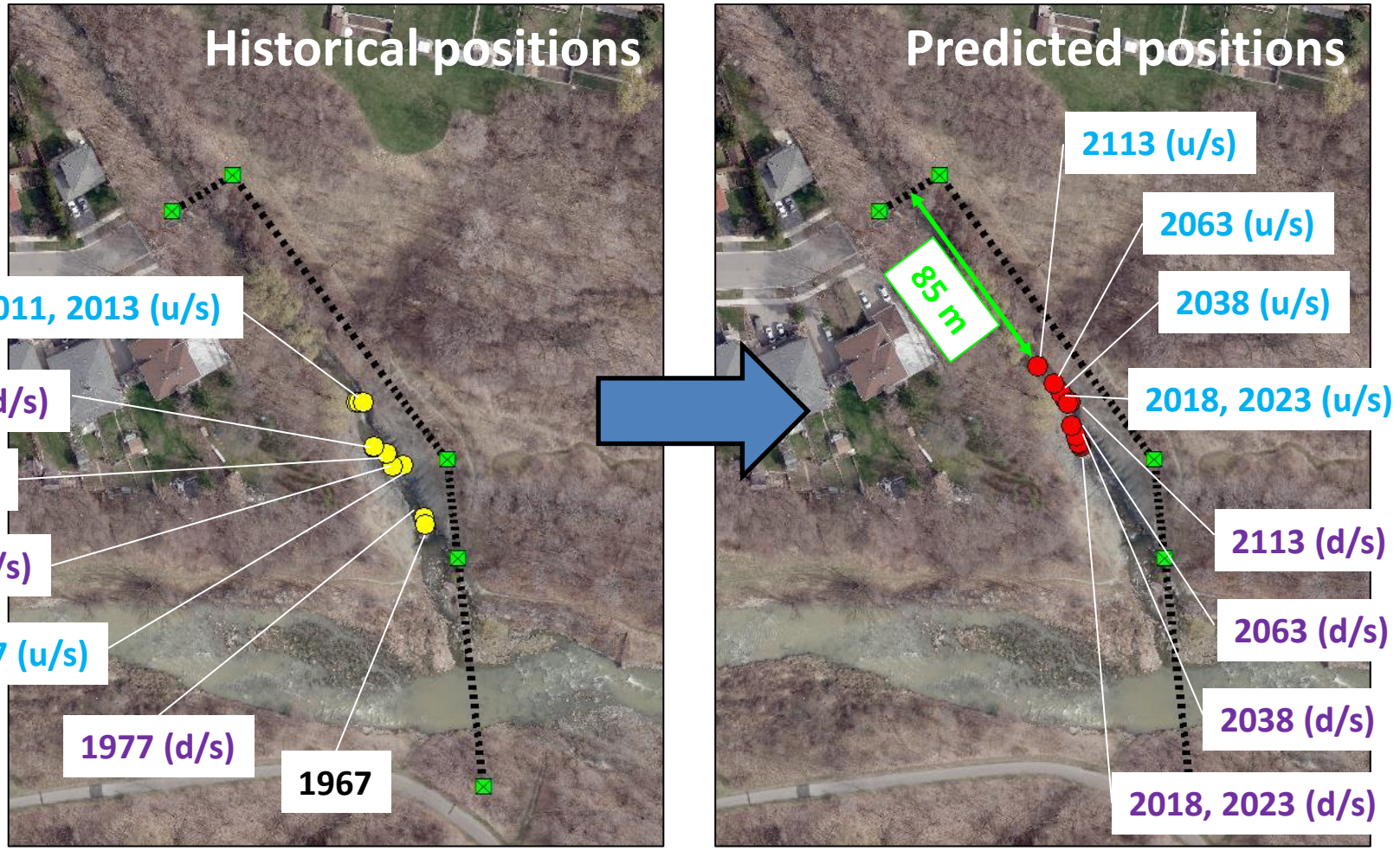
Temporal Trends in Knickpoint Migration



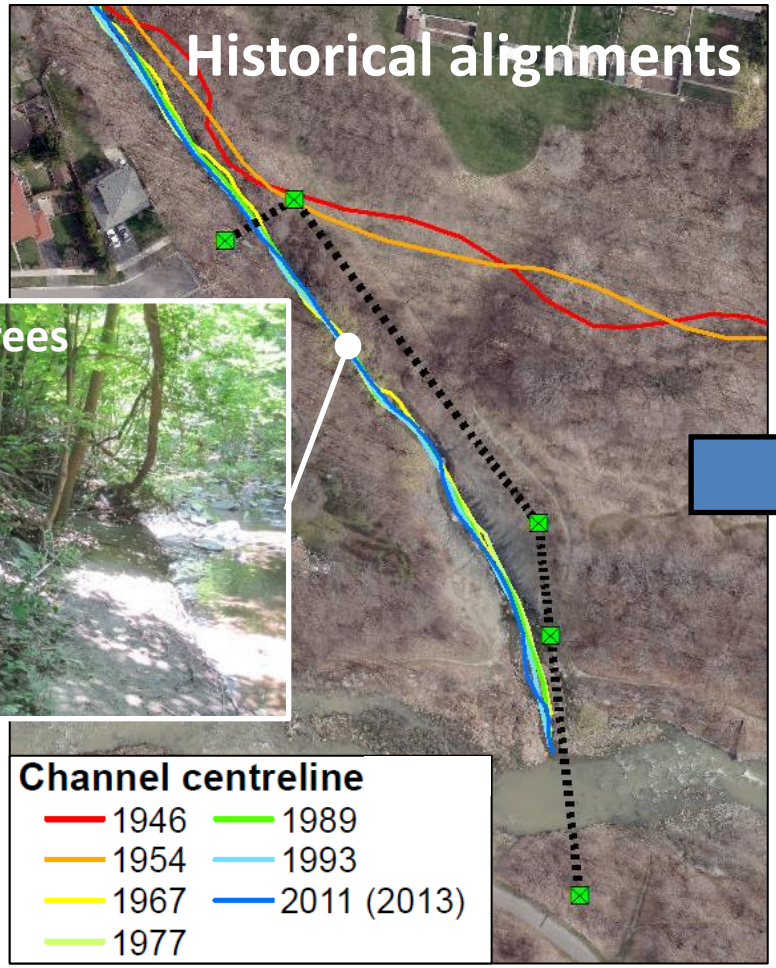
Field 'Check': Morphology of Upstream Knickpoint

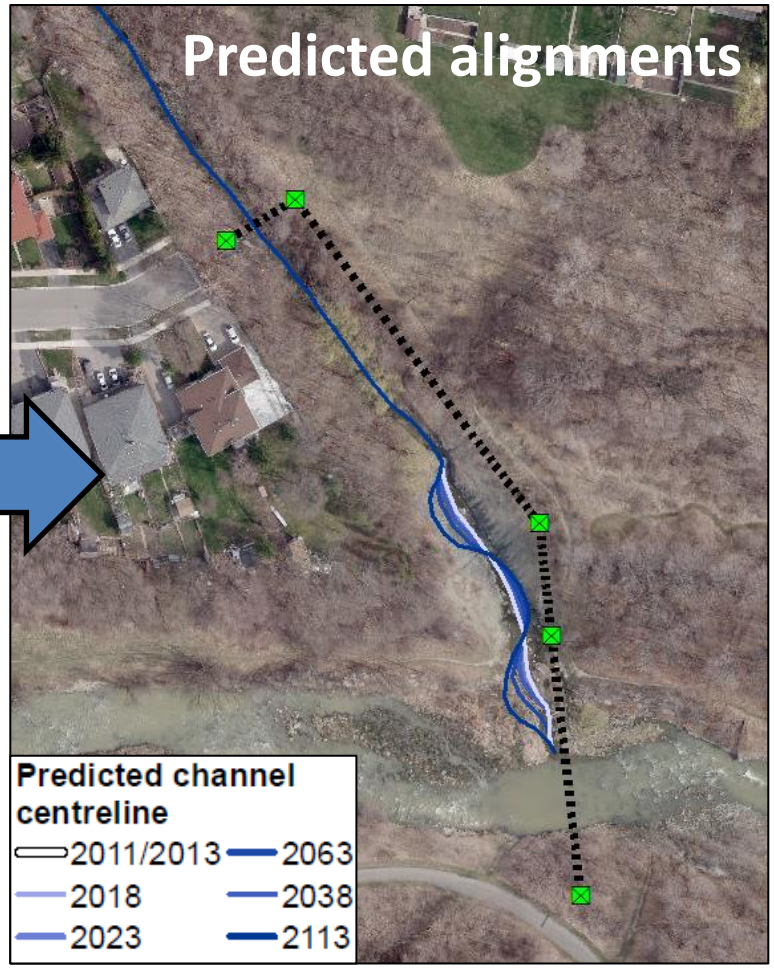


Overlaid Knickpoint Positions

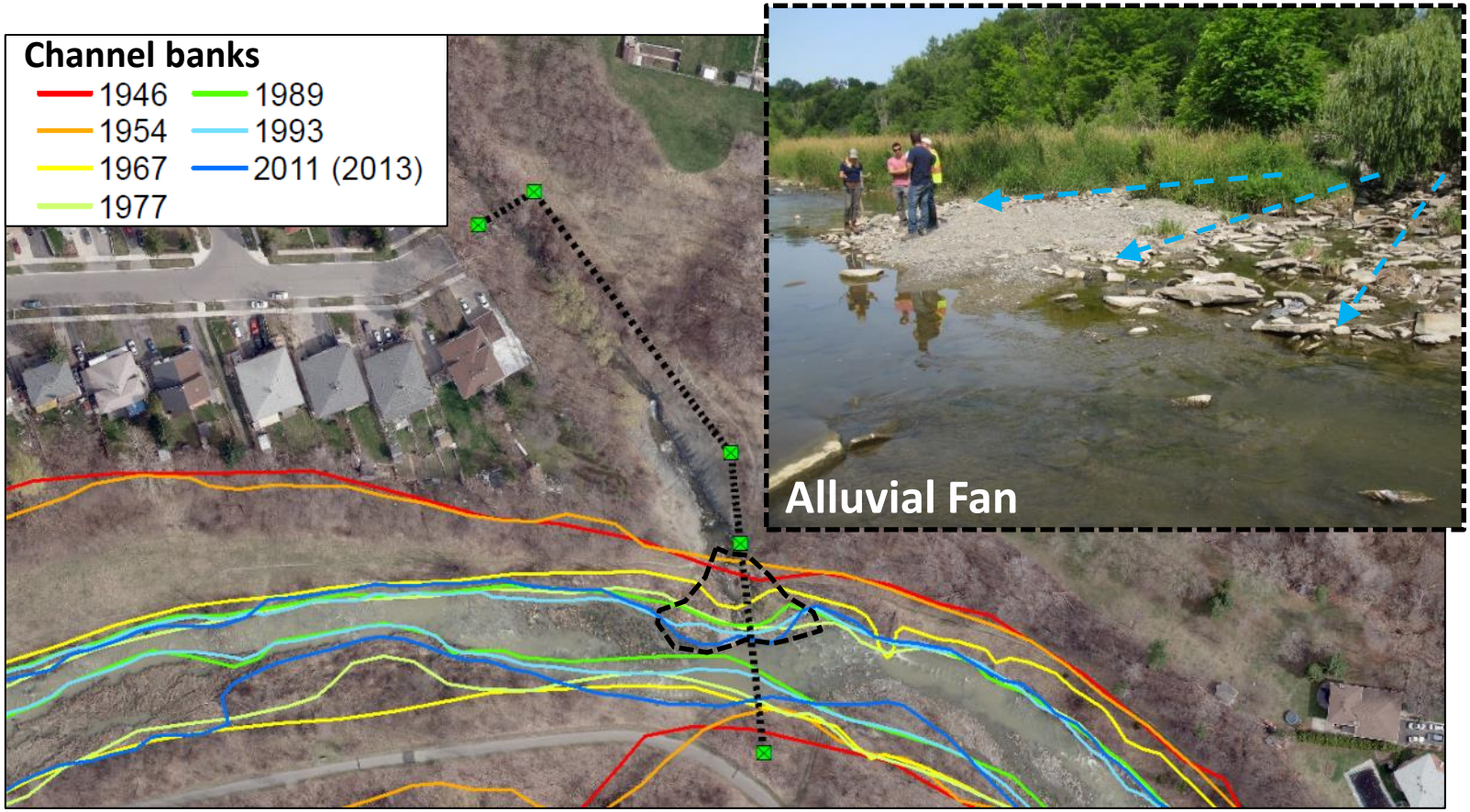


Lateral Erosion



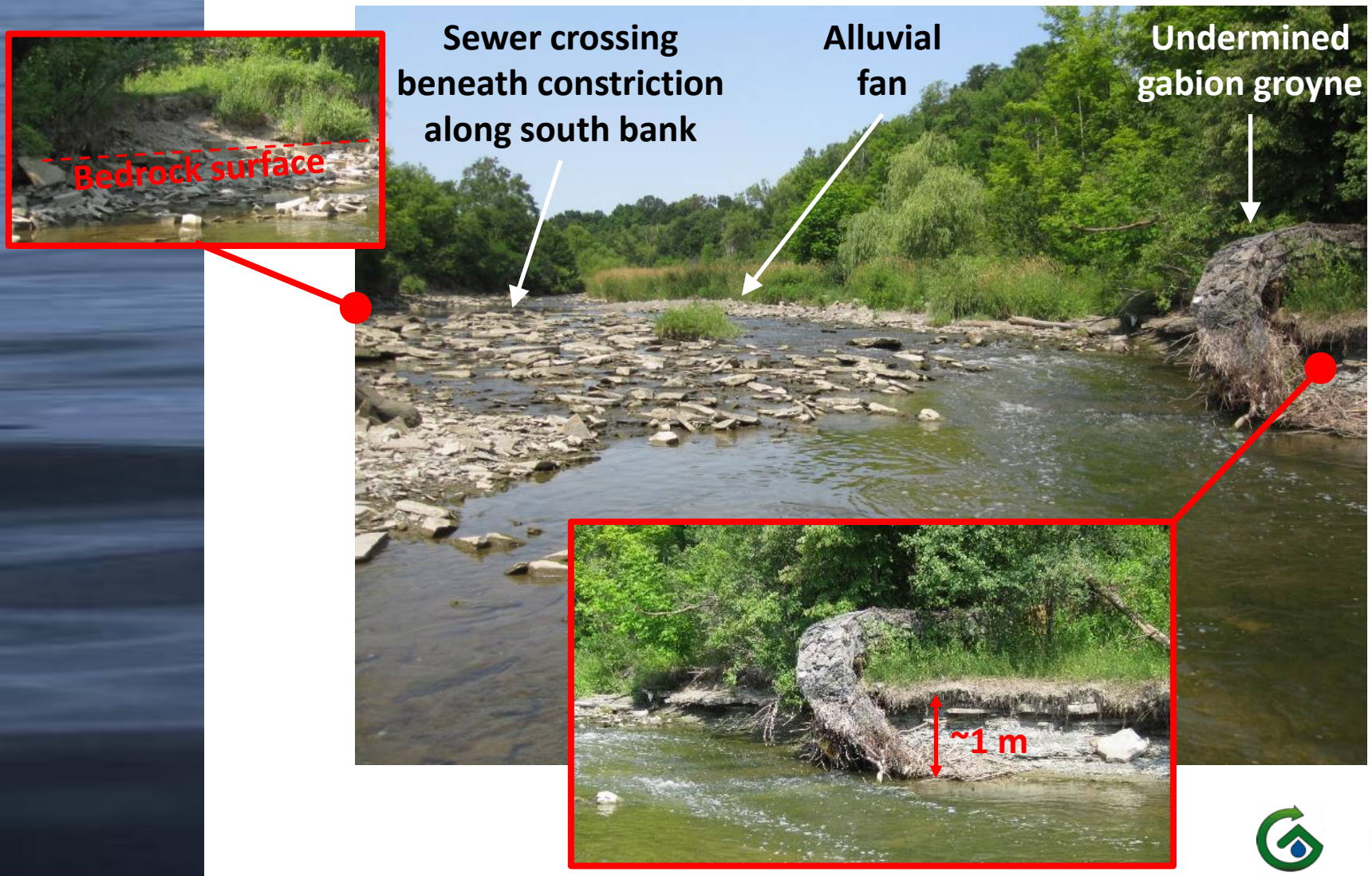


Humber River adjustments

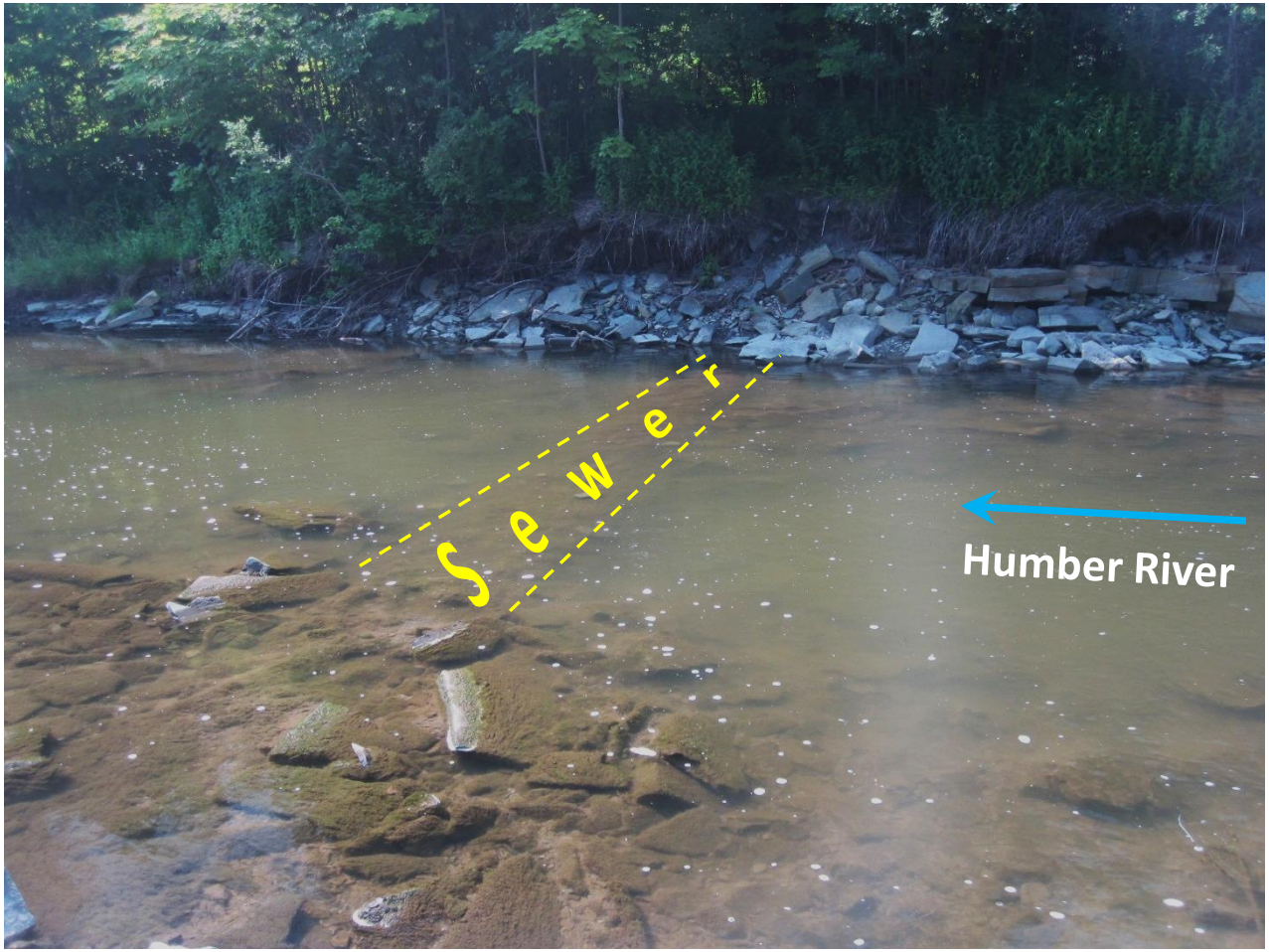


- Fan growth ➔ good and bad

Humber River Down-cutting



Exposed sewer encasement



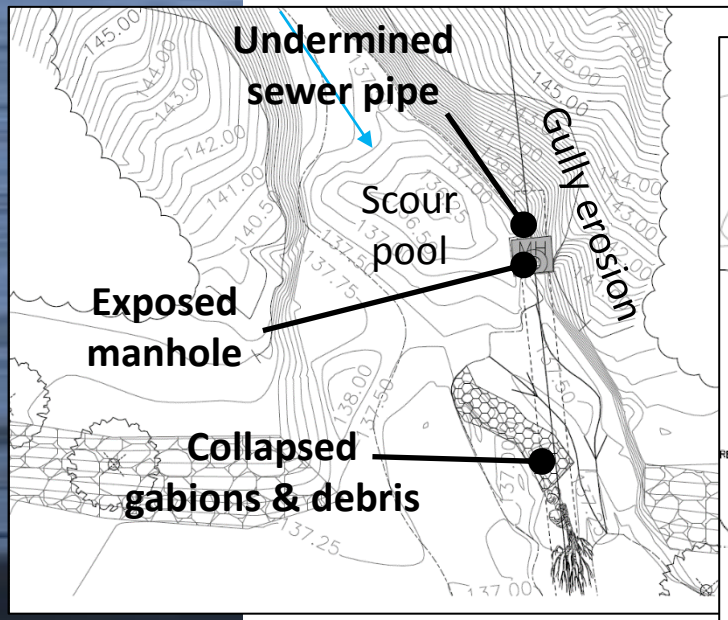
THE MITIGATION

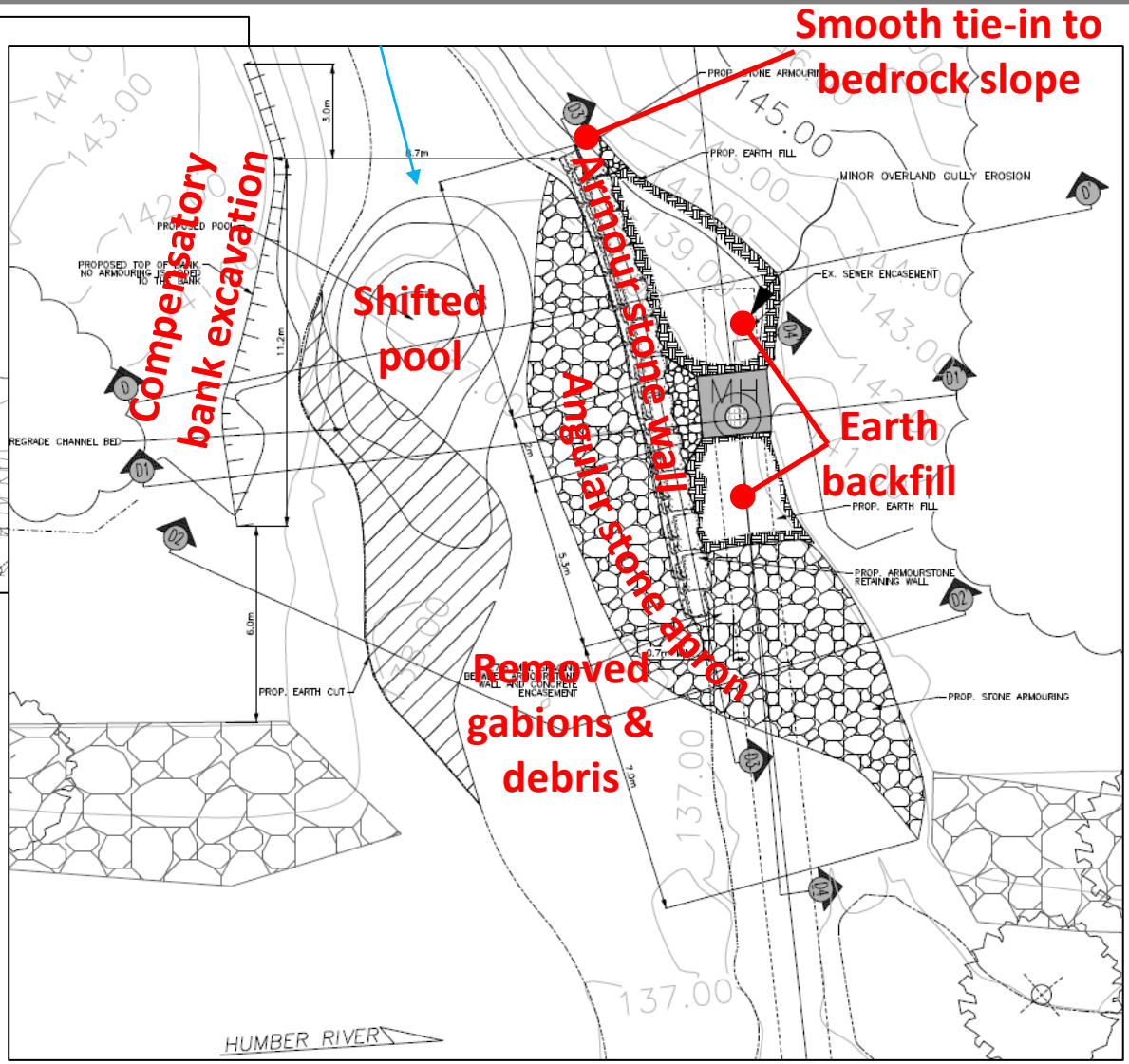
Protection and monitoring

Site-specific solutions based on reach-scale considerations

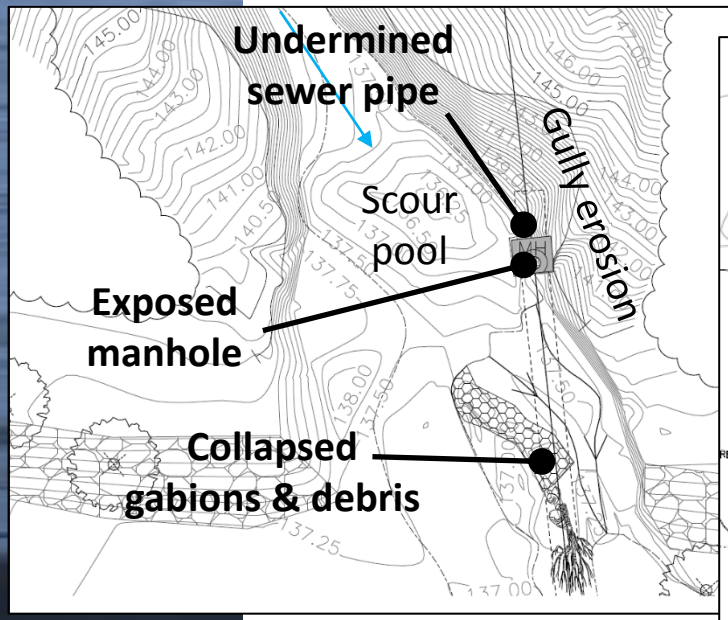
- **PHASE 1**: How to address undermined sewer pipe and exposed manhole along lower Albion Creek?
  - Stabilization, protection & deflection
- **PHASE 2a**: How to address knickpoint migration along lower Albion Creek?
  - Periodic knickpoint monitoring
- **PHASE 2b**: How to address exposed sewer pipe crossing Humber River?
  - Regularly monitor condition of sewer and d/s riffle crest
  - Allow for continued growth of alluvial fan
  - Consider excavating south bank to restore more natural river width before in-stream rock placement

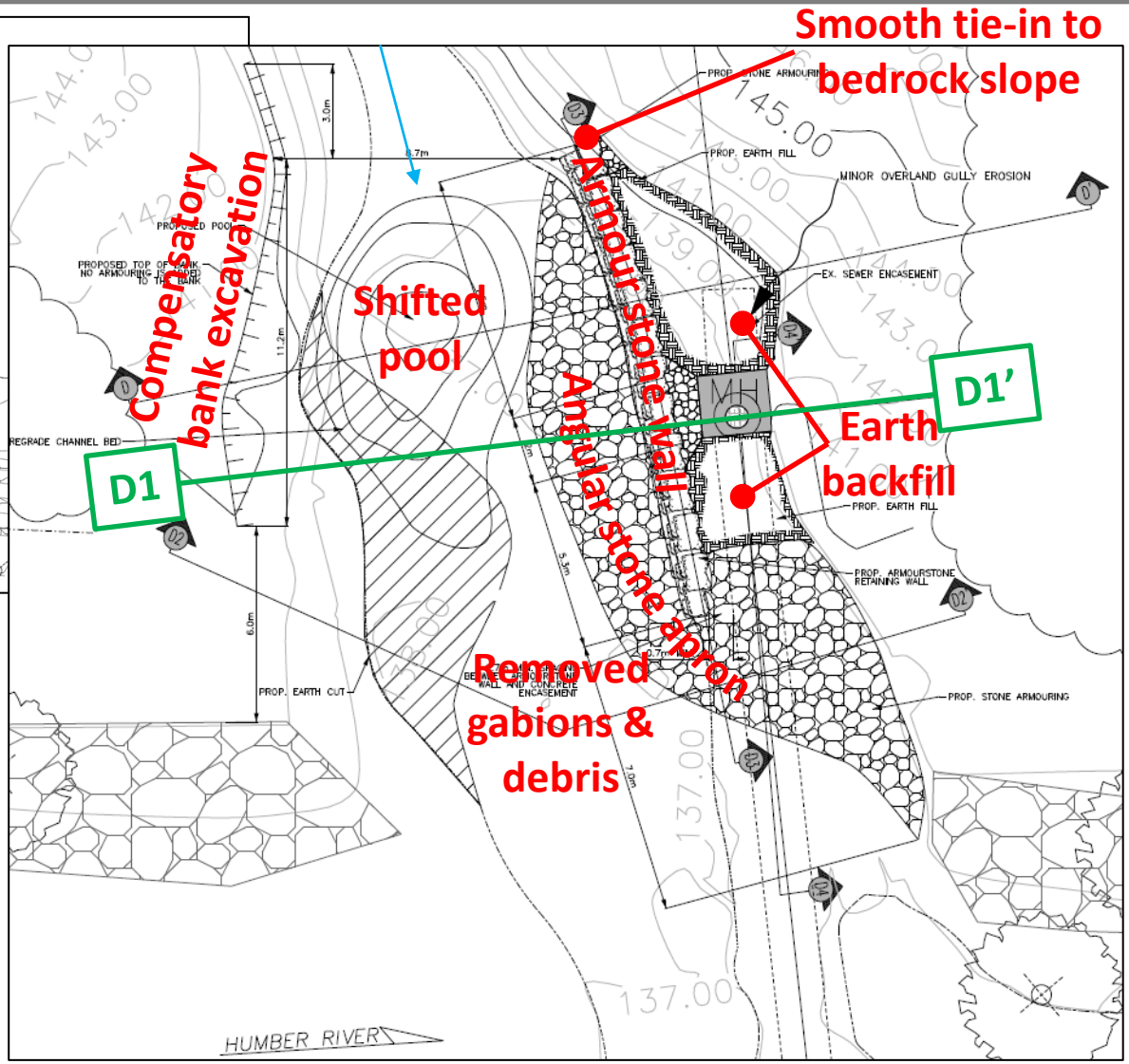
Manhole & sewer protection



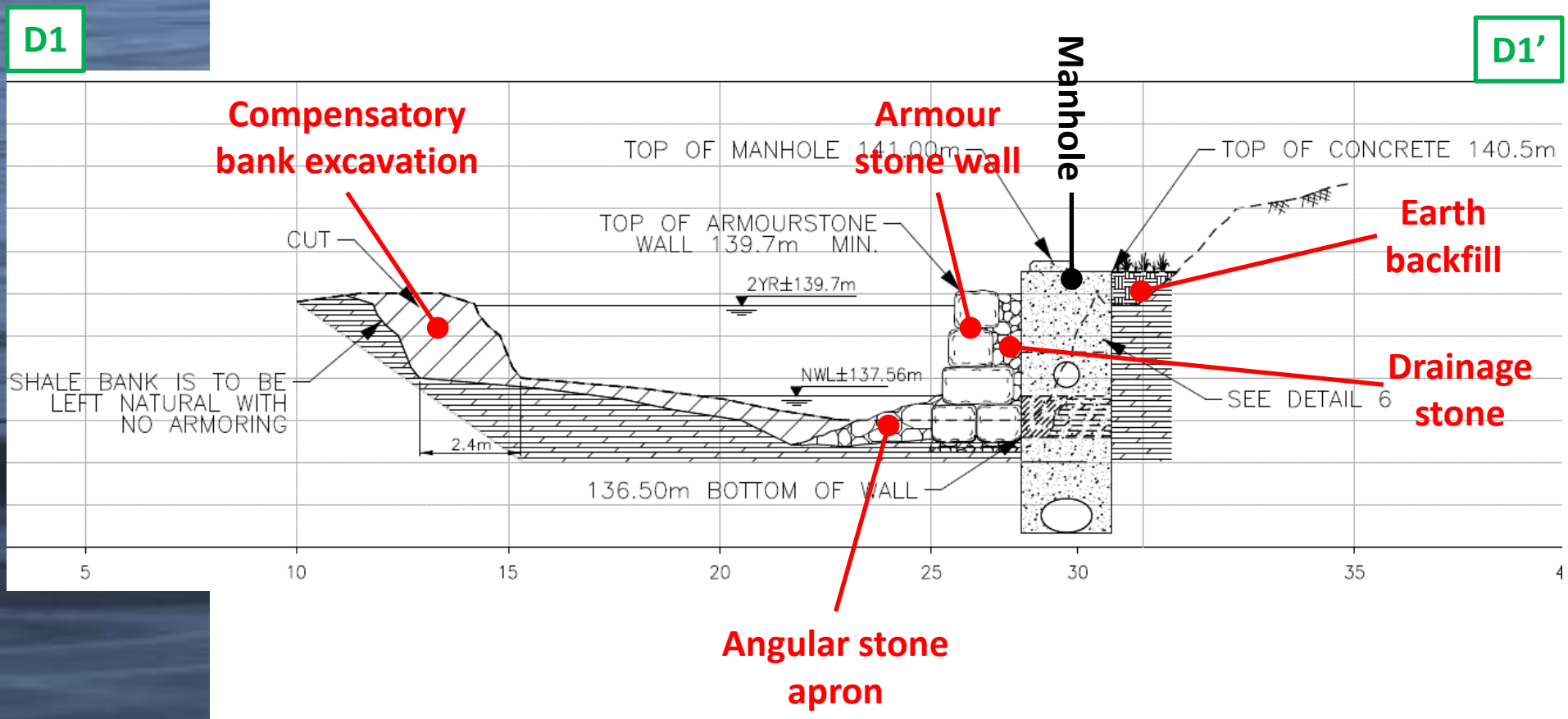


Manhole & sewer protection





Cross-section D1-D1'



Planting Plan

Conclusions

- An order-of-magnitude shortening of lower Albion Creek is responsible for pronounced erosion of its bedrock bed and banks
- Air photo-based knickpoint migration analysis facilitated quantification of trends more important than down-cutting
- Estimates of lateral (bank) erosion rates relied on comparative analysis of historical channels corroborated by field evidence
- Effective protection of exposed sewer infrastructure along lower Albion Creek required an armour stone wall, protected at its base with a rock apron, and compensatory bank excavation

Questions?

robin@pecg.ca
bgreck@greckassociates.ca

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