

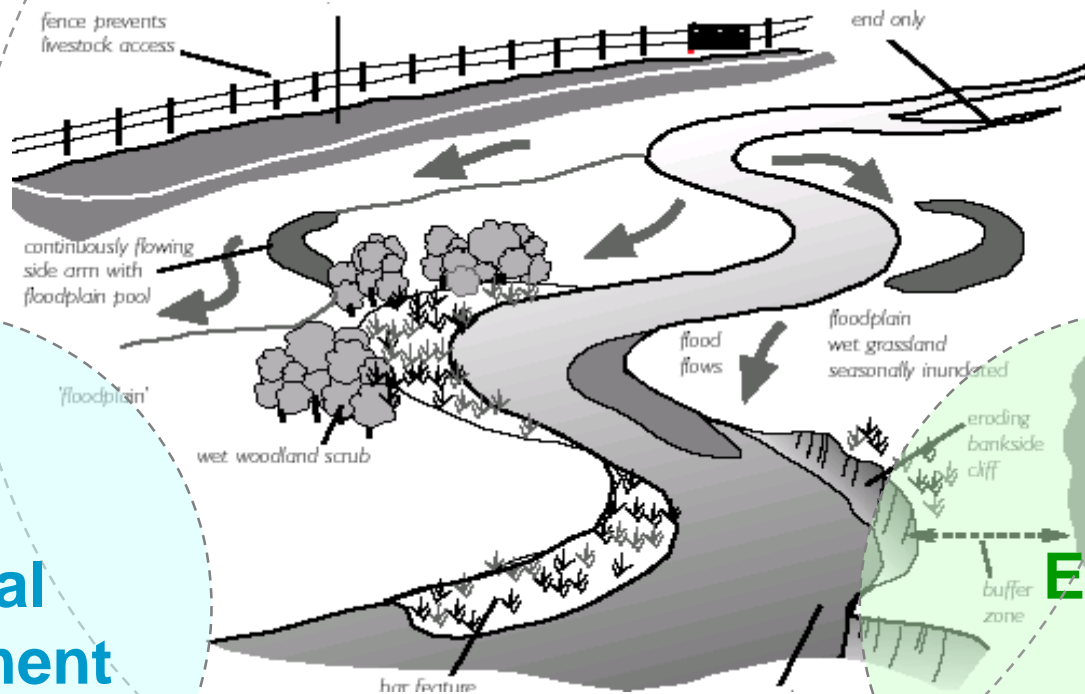
# The Use of Higher-Resolution Satellite Imagery, LiDAR and Drones in River Applications: Meander Belt Width Assessments to Effluent Plume Delineation

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# Fluvial Geomorphology

## *River Form and Evolution*



**Physical Environment**

**Ecology**

# Sustainable River Management



(USFWS, 2014)

# River Management Around the World



Netherlands

Making space for water

Taking forward a new Government strategy for flood management

Working with Natural Processes – the evidence base

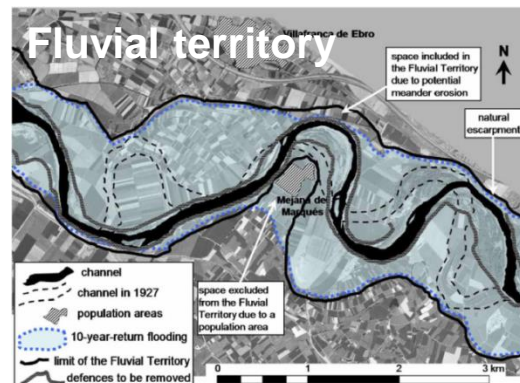
UK

Flooding risk based room...

And more recently erosion...



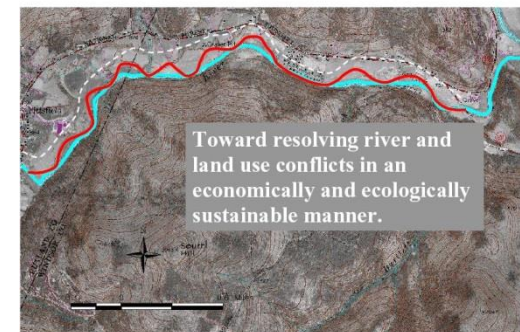
France



Spain

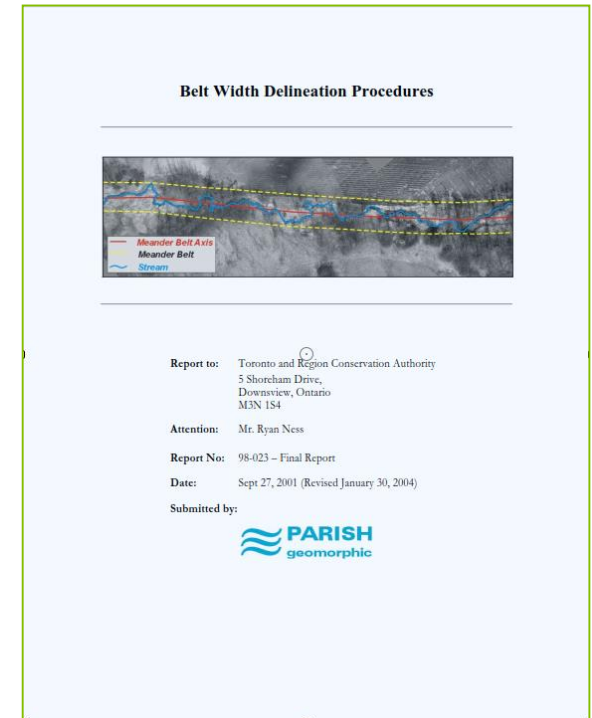
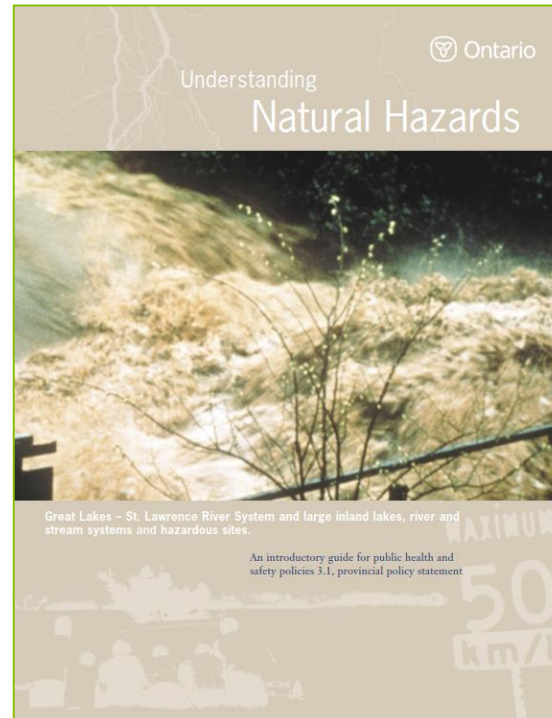
November 20, 2006

Alternatives for River Corridor Management  
Vermont DEC River Management Program



Vermont

# Approach and Protocols in Ontario



## 3.1 NATURAL HAZARDS

### 3.1.1 Development shall generally be directed to areas outside of:

- a) *hazardous lands* adjacent to the shorelines of the *Great Lakes - St. Lawrence River System* and *large inland lakes* which are impacted by *flooding hazards*, *erosion hazards* and/or *dynamic beach hazards*;
- b) *hazardous lands* adjacent to *river, stream and small inland lake systems* which are impacted by *flooding hazards* and/or *erosion hazards*; and
- c) *hazardous sites*.

# Freedom Space (Espace de liberté) in Quebec

COMPLETED PROJECT

FREEDOM SPACE: AN INTEGRATED RIVER MANAGEMENT APPROACH FOR DEALING WITH CLIMATE CHANGE



Photo : Cyril Usnik



Université du Québec à Rimouski



Université du Québec à Montréal

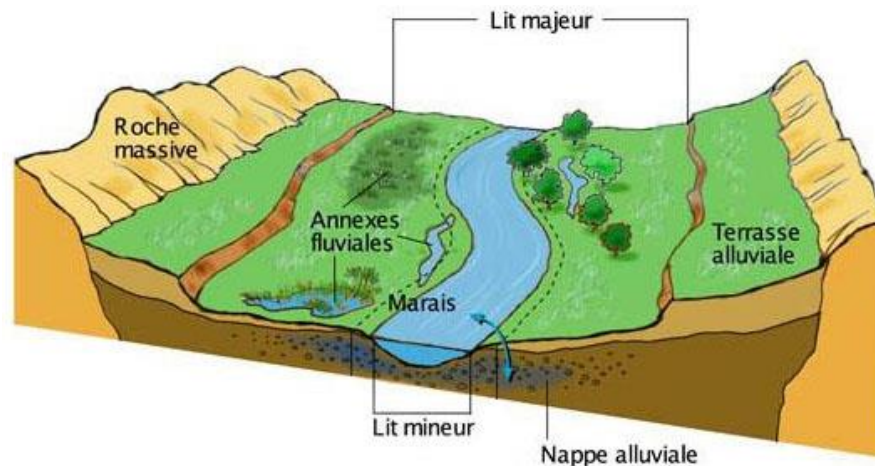
VULNERABILITIES, IMPACTS AND ADAPTATION PROGRAM : WATER RESOURCES

PROJECT START AND END DATES FEBRUARY 2011 • JULY 2013

INFORMATION  
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LEAD SCIENTIST  
Pascale Biron  
Université Concordia

- Flood Risk +
- Erosion Risk +
- Wetlands (groundwater interaction)



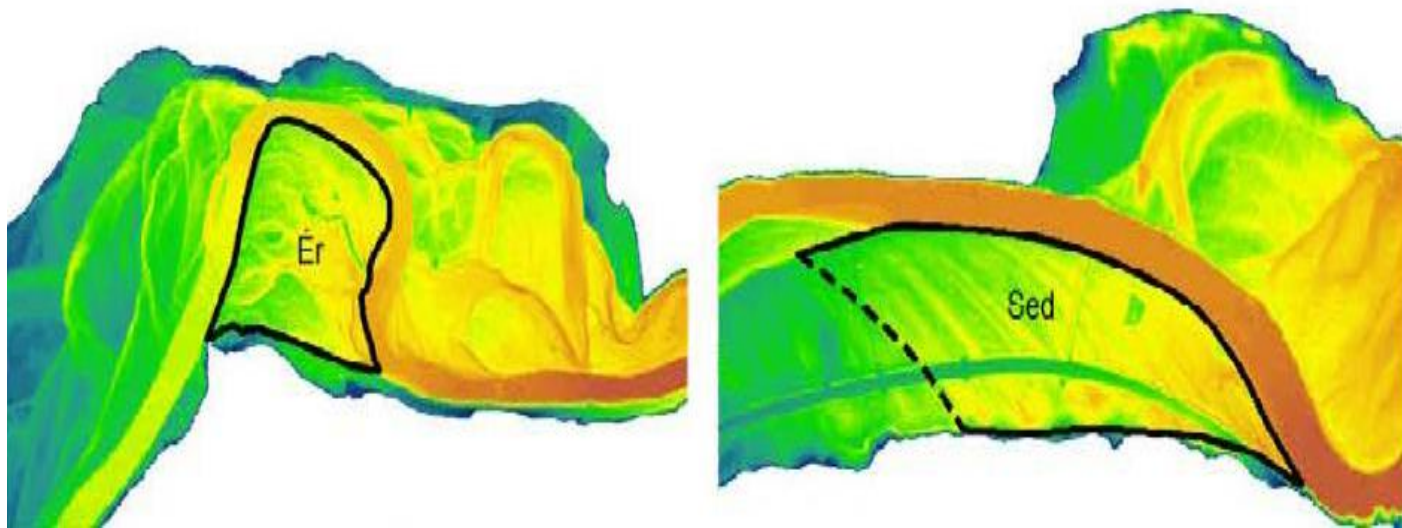
[http://www.eau-loire-bretagne.fr/espace\\_documentaire/documents\\_en\\_ligne/guides\\_milieus\\_aquatiques/Leau\\_LB\\_77.pdf](http://www.eau-loire-bretagne.fr/espace_documentaire/documents_en_ligne/guides_milieus_aquatiques/Leau_LB_77.pdf)

## Freedom Space vs Natural Hazards in Ontario

- Identifies **different levels** of flood and erosion risk within the overall « Freedom Space »
- Involves fluvial geomorphological assessment of flood and erosion mechanisms using **LiDAR data**
- Specifically incorporates **wetlands** as part of the minimal corridor

## Use of LiDAR for Fluvial Geomorphological Analysis

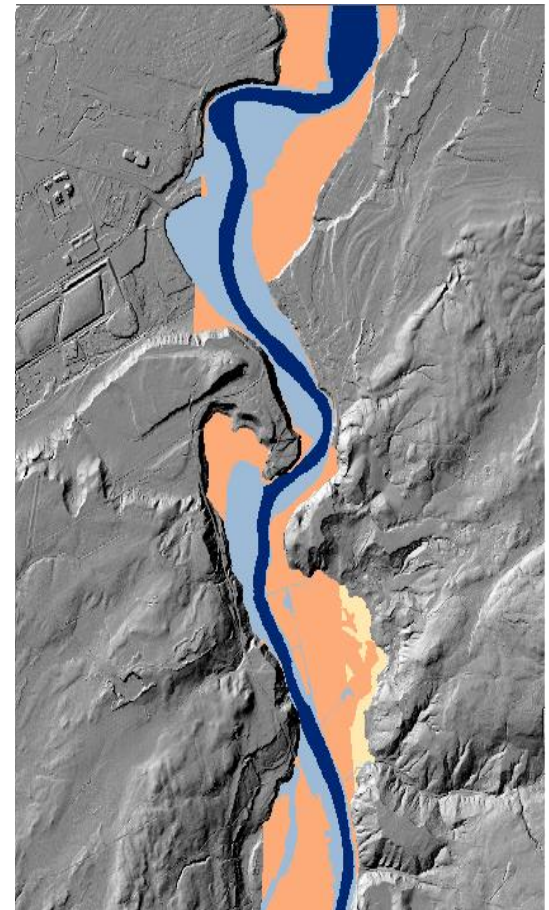
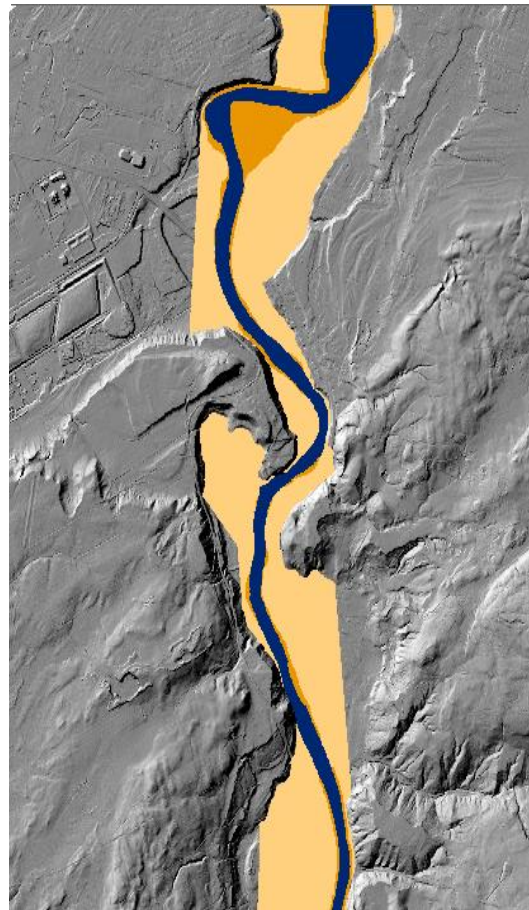
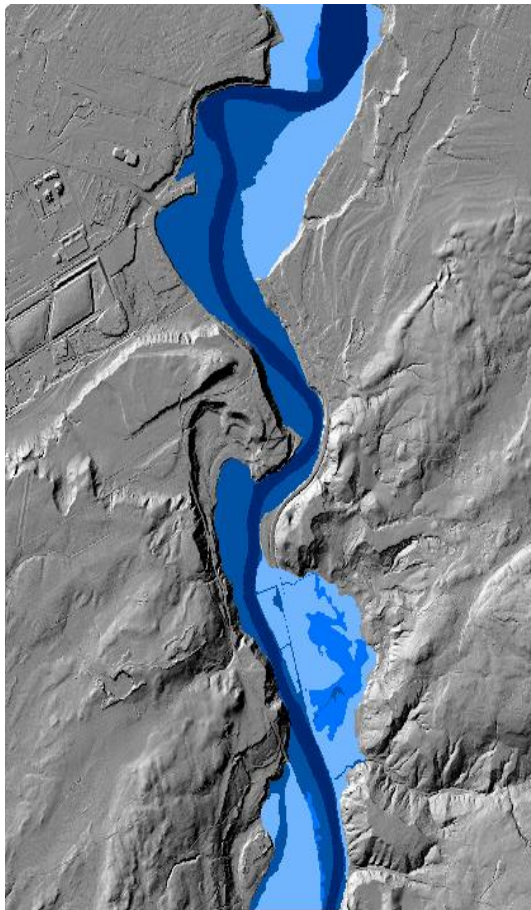
- Flooding mechanisms
- Fluvial geomorphological processes / channel evolution








Identification of erosional (Er) and depositional (Sed) zones of the Matane River using LiDAR  
(from Demers et al. 2014).






# Flooding space + Mobility space = Freedom space



 F<sub>high</sub>  
 F<sub>med</sub>  
 F<sub>low</sub>

 M<sub>50</sub>  
 M<sub>floodplain</sub>

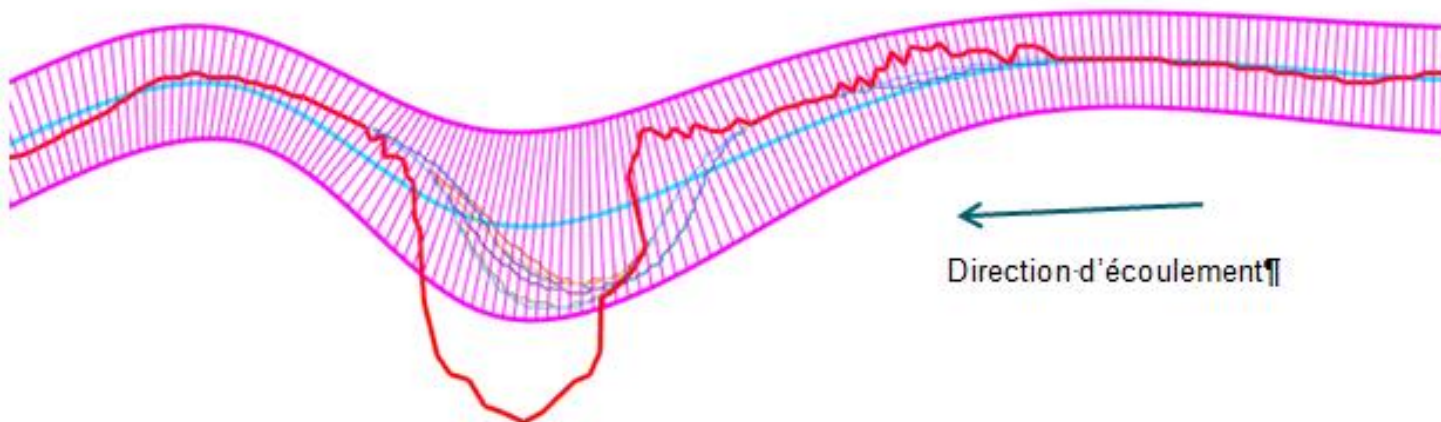
 L<sub>min</sub>  
 L<sub>func</sub>  
 L<sub>rare</sub>

 Matane River, Gaspesie peninsula, Qc, Canada

## Research & Development: Automation

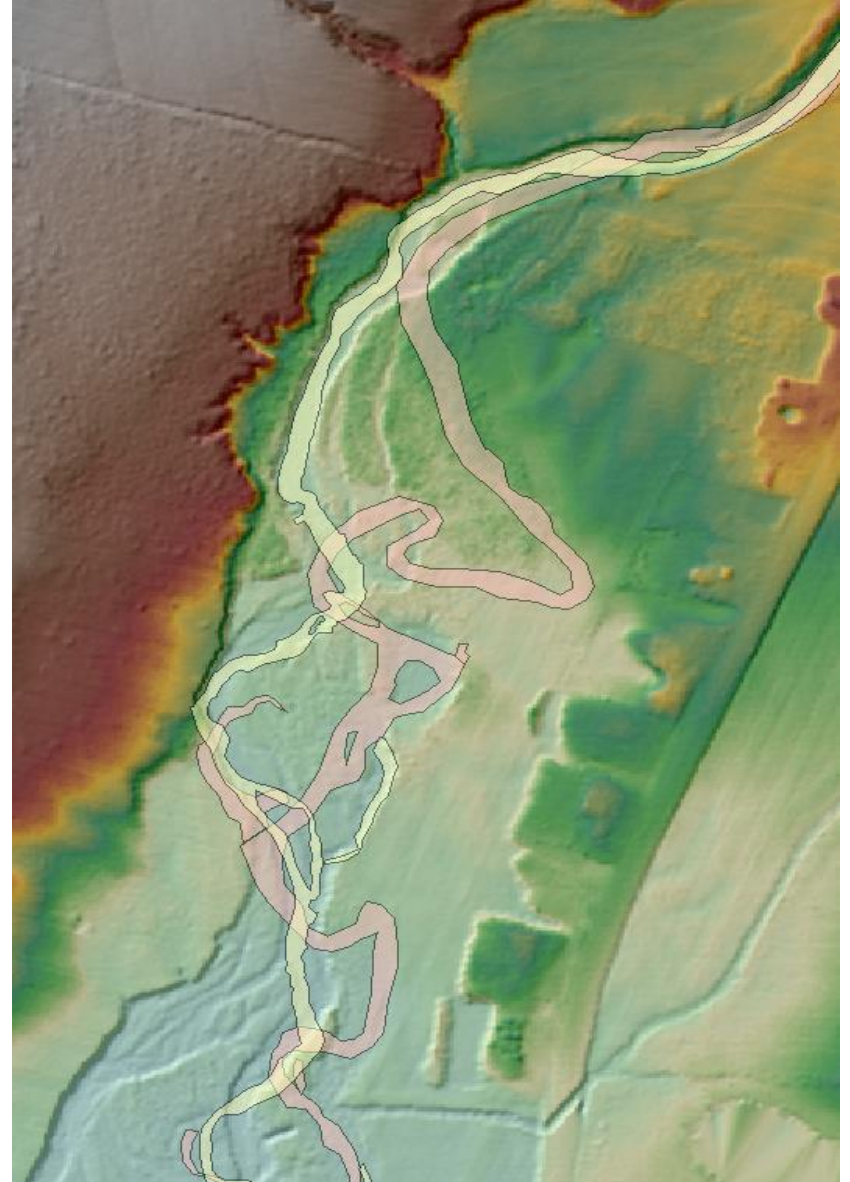


- Predicting channel adjustment over 50 years
- Mapping approach in GIS supported by numeric model (Matlab)
- Erosion rates automatically measured from aerial photography
- Systematically projected to predict future channel position



## Limitations

- Natural channel adjustment record evident from LiDAR may often be modified by human
- May not have LiDAR – Drones may be used



## Drones (Unmanned Aerial Vehicles [UAVs])

Our Ontario Fleet includes:

- Fixed wing – eBee
- Quadcopters – Phantom 4
  - albris

### Special Flight Operation Certificate (SFOC)



**eBee**

(Source: senseFly)



**albris**

(Source: senseFly)



**Phantom 4**

(Source: heliguy.com)

# Drones (Unmanned Aerial Vehicles [UAVs])

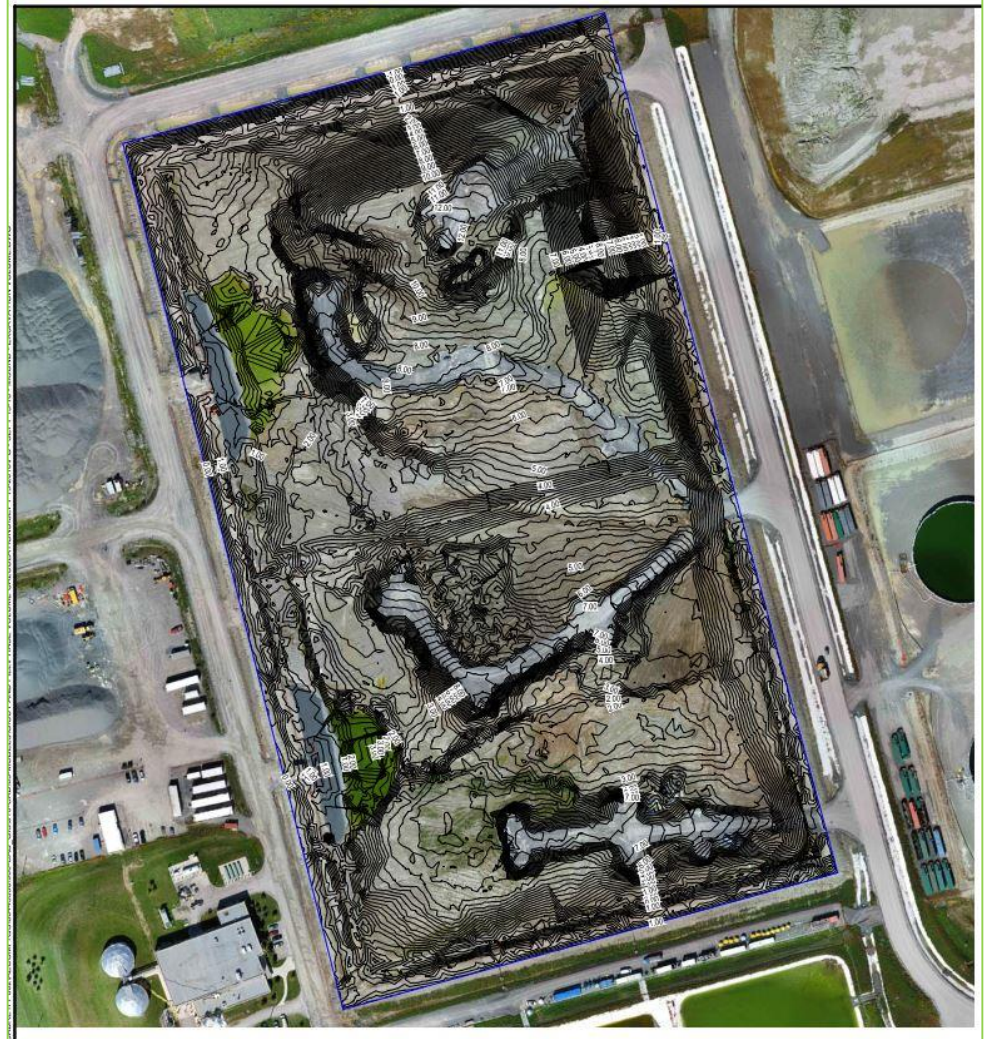
## Applications:

- Detailed surveying, 3D surface rendering (volumetric calculations)
- Inventory – forestry, agriculture, wetland and vegetation community
- Agricultural degradation analysis (infrared camera – crop health)
- Construction site inspection
- Disaster management – damage inspection and assessment
- Stakeholder communication – presentation and promotion
- Hydraulic studies – mixing zone characterization



## Drones (Unmanned Aerial Vehicles [UAVs])

3D surface rendering – landfill with monthly drone surveys



## Mixing Zone Studies

### Regulatory Context:

- *Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy (MOEE, 1994)*
  - ☐ *Policy 5: “Mixing zones should be as small as possible and not interfere with beneficial uses.*
- *Procedure 1-B-5, Deriving Receiving-Water Based, Point Source Effluent Requirements for Ontario Waters (MOEE, 1994)*

The mixing zone must not:

- Be acutely lethal to aquatic life
- Create a barrier to the migration of fish or other aquatic life
- Impinge on existing municipal and other water supply intakes, bathing beaches or important fish spawning areas



## Mixing Zone Studies

### Examples:

- Confirming the size and shape of the mixing zone under different environmental conditions
  - Existing outfall
  - New outfall
- Calibrating and validating a mixing zone model
- Locating an outfall



(Source: Grand Valley State University)



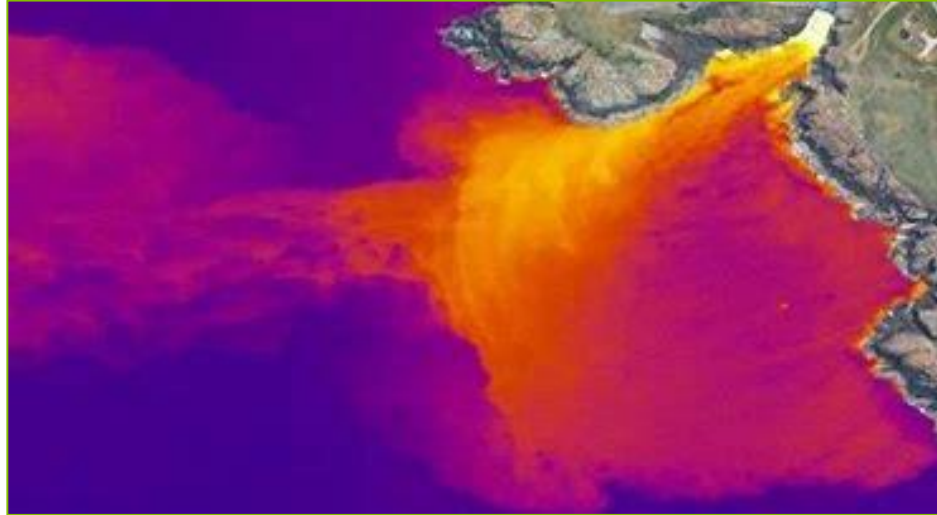
(Source: Scripps Institute of Technology)



## Infrared Photography

Examples:

- Plume delineation
- Applications to aquatic biota
- Locating an outfall
- Locations of groundwater upwellings
- Agriculture (Under or over-watering, bug infestations, overall crop health)
- Pipeline leaks
- Building/roof heat loss



(Source: APEM)

# Questions/Comments?

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