Updating Ontario's Soil Maps

Measuring Soil Health at Different Landscape Scales Meeting

Ontario Ministry of Agriculture, Food and Rural Affairs

March 8, 2018

Purpose

Provide an update on the status of planned soil mapping activities

- Current activities and data to support mapping
- Soil Mapping Efforts
  - Slope/topography updates
  - New mapping products

Initial Planned Mapping Areas

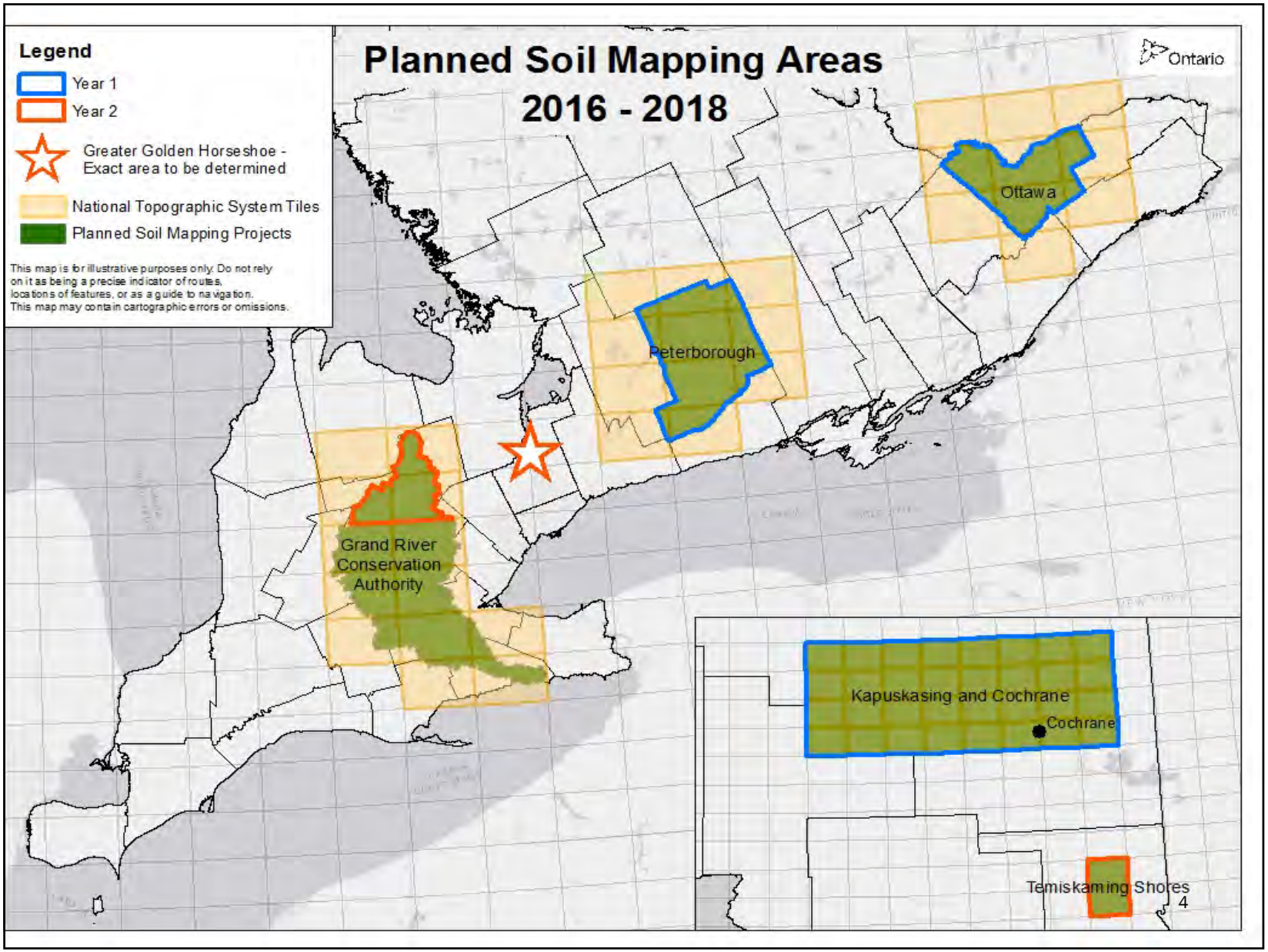
Initial 2 year window of funding support from GF2 and Climate Change Action Plan (CCAP) to initiate work in:

Year 1 – 2016/17

- City of Ottawa area (Ottawa-Carleton)
- County of Peterborough
- Northeastern Ontario: Cochrane – Hearst

Year 2 -2017/18

- City of Ottawa area (Ottawa-Carleton)
- County of Peterborough
- Upper Grand River - TBD


Legend
Year 1
Year 2
Greater Golden Horseshoe - Exact area to be determined
National Topographic System Tiles
Planned Soil Mapping Projects
This map is for illustrative purposes only. Do not rely on it as being a precise indicator of routes, locations of features, or as a guide to navigation. This map may contain cartographic errors or omissions.
Planned Soil Mapping Areas
2016 - 2018
Ontario
Ottawa
Peterborough
Grand River Conservation Authority
Kapuskasing and Cochrane
Cochrane
Temiskaming Shores

Supporting Data

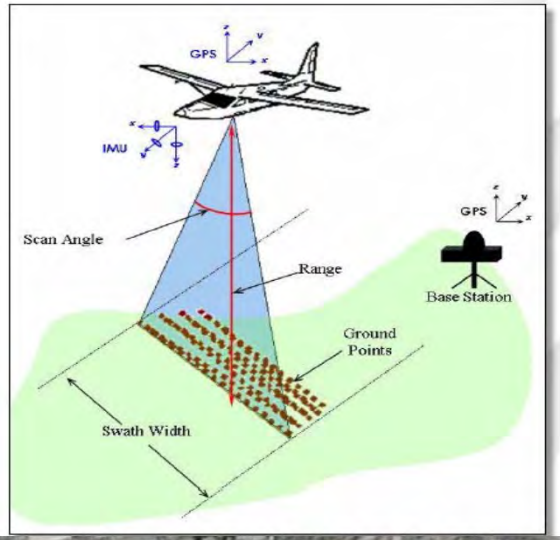
Soil map updates are data intensive:

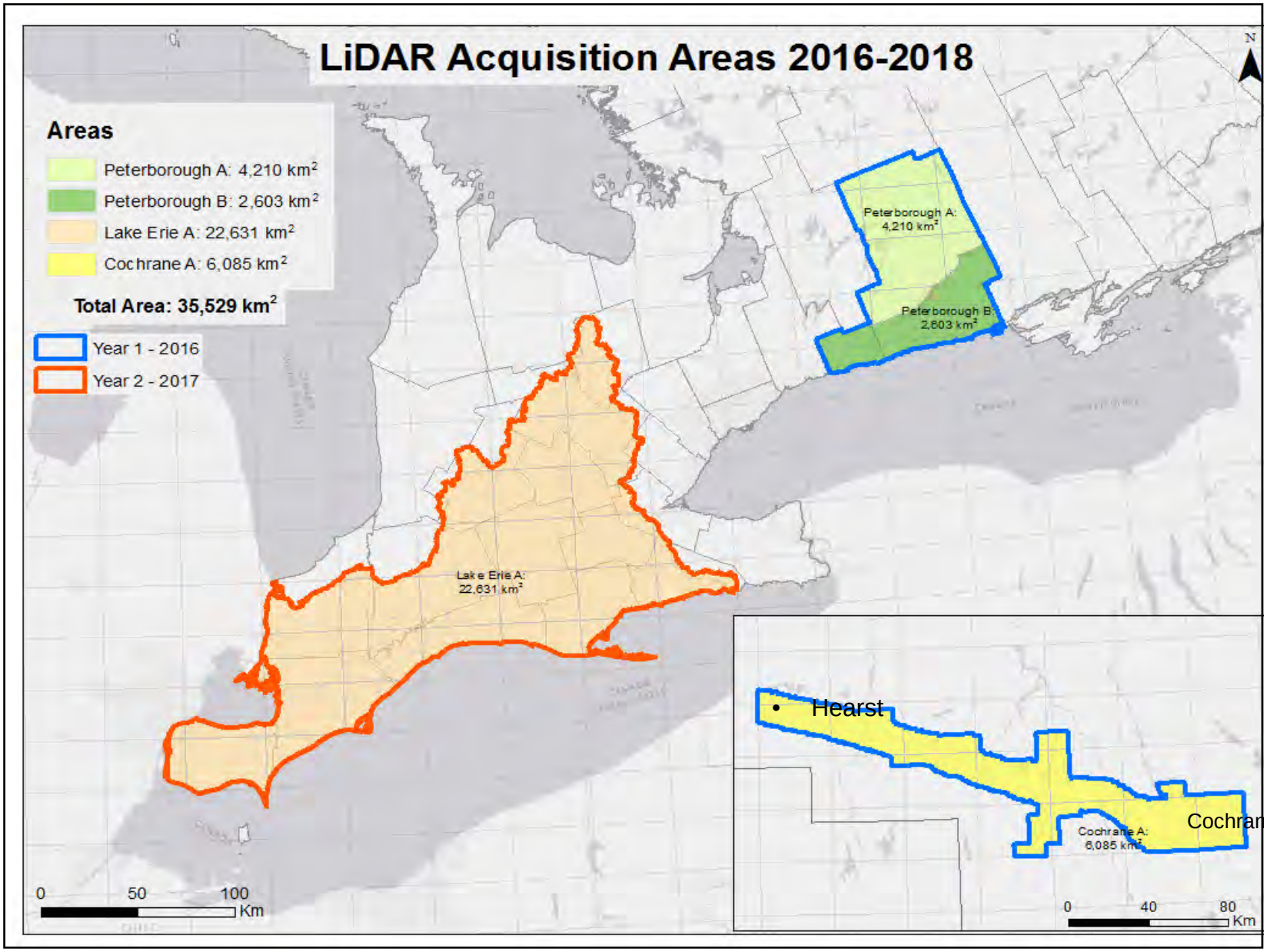
- Detailed elevation data
- Extensive soil pit data and sampling

Data to Support Mapping

LiDAR (Light Detection And Ranging) acquisition

- Initial project covering 3 areas of Ontario reaching its close
- Planned data capture:
  - leaf off conditions (fall or spring)
- Develop detailed surface topography and elevation models.




LiDAR Acquisition Areas 2016-2018
N
Areas
Peterborough A: 4,210 km²
Peterborough B: 2,603 km²
Lake Erie A: 22,631 km²
Cochrane A: 6,085 km²
Total Area: 35,529 km²
Year 1 - 2016
Year 2 - 2017
Peterborough A: 4,210 km²
Peterborough B: 2,603 km²
Lake Erie A: 22,631 km²
Hearst
Cochrane A: 6,085 km²
0 50 100 Km
0 40 80 Km

LiDAR Specifications

- Current project collects 8 elevation points per square meter
- Data being collected is suitable for field-scale surveys, however, can be generalized to local and regional scale as required

LiDAR Data Availability

LiDAR point clouds and DEM can be ordered from Land Information Ontario:

- Limited data currently available
- Full project areas to be released spring and summer 2018

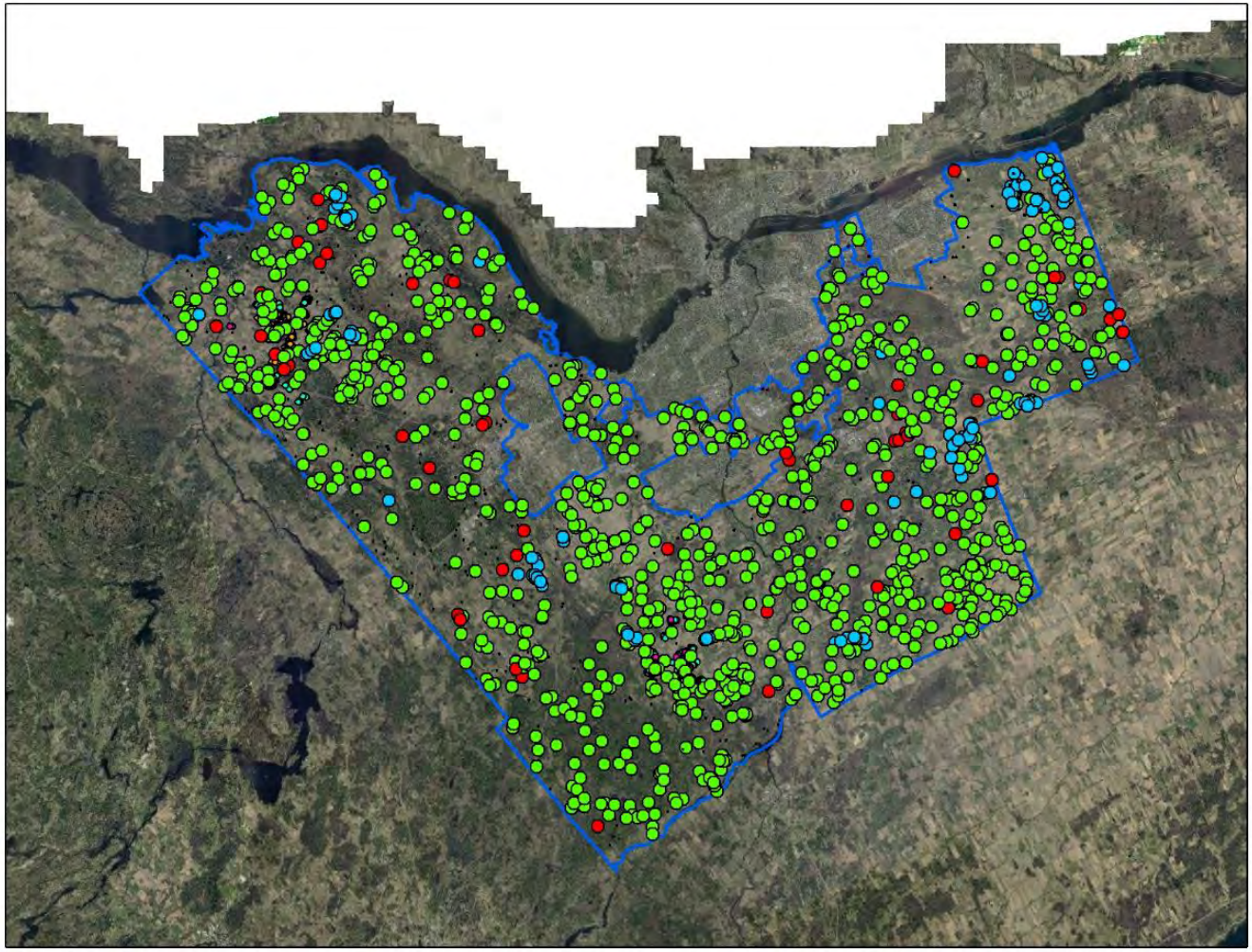
https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home

Data to Support Mapping

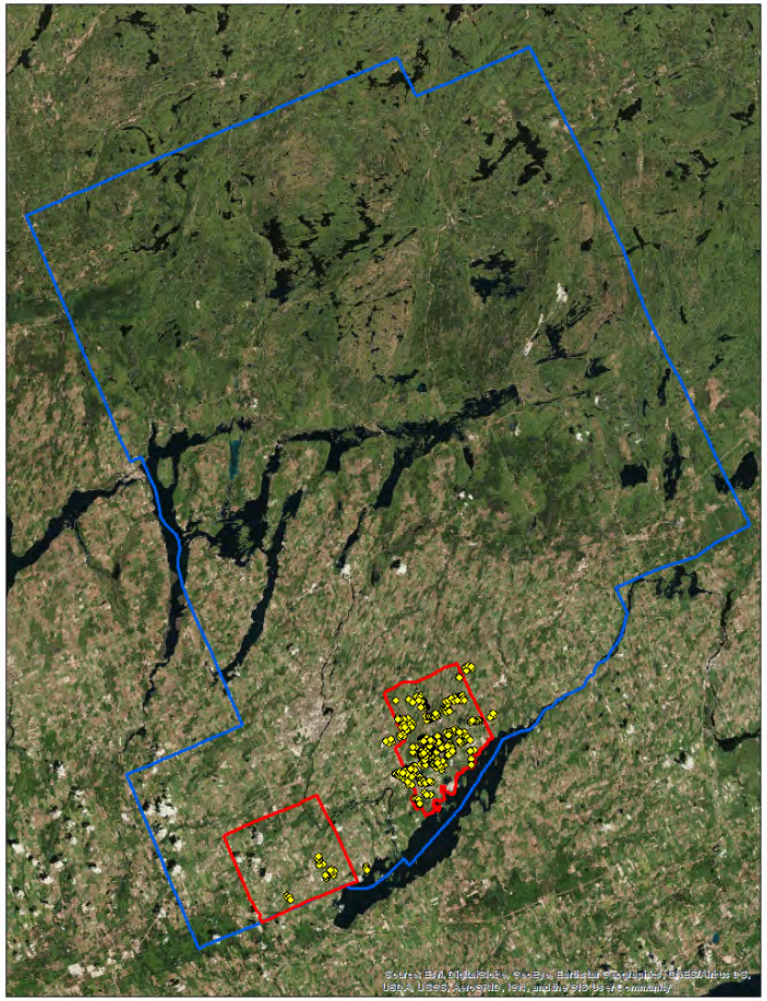
Soil site investigations

- Contractor hired to collect data:
  - 2016 – 1300 sites completed
  - 2017 – 750 sites completed
  - 2018 – 750 sites scheduled

Ottawa Sampling (to date)



Peterborough Sampling (to date)



Digging a Soil Pit

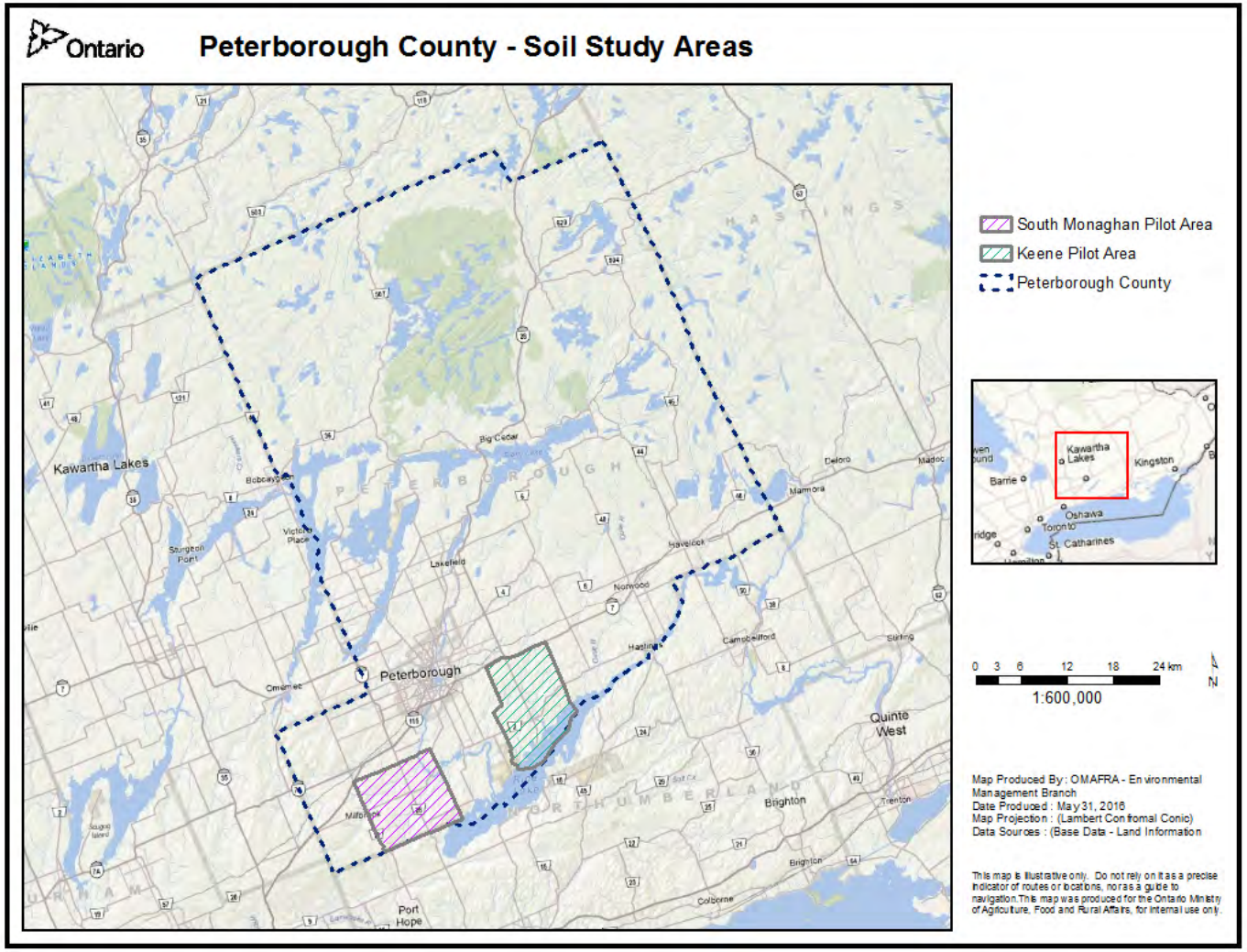
Soil Sampling

- Sampling completed by soil horizon (e.g., Ap, Bm, Ck) to a depth of 1m
- Bulk density determined for upper 2 horizons at each site (typically A and B horizon)
- Samples submitted to the lab for:
  - CEC + cations (Ca, K, Mg, Na), Olsen-P, Total N, Pyrophosphate extractable Al + Fe, Total C, Organic C, Inorganic C, sand, silt, clay, sand fractions, pH
- Full morphology descriptions by horizon as well (colour, structure, consistence, mottles, coarse fragments, etc.)

Peterborough County Pilot Areas

- 2 pilot areas are the initial focus:
  - Keene
  - South Monaghan
- Develop conceptual soil model
  - Soil-landscape relationships
  - Determine inspection density
  - Develop rule sets for predictive soil mapping

Peterborough County Pilot Areas



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Updating Ontario's Soil Maps

Tiered Approach

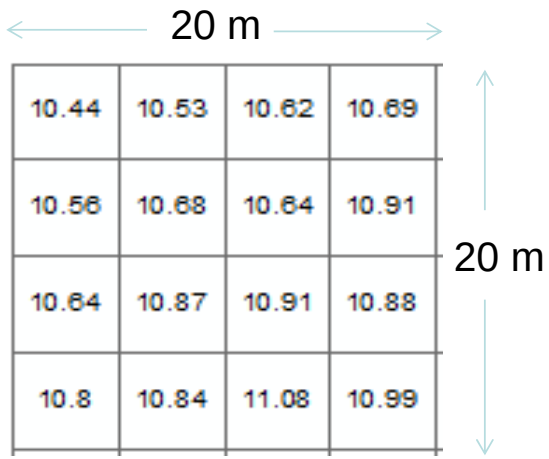
1. Soil Map Upgrades
   a. Slope data
   b. Agricultural capability (CLI) data
2. New survey techniques and products

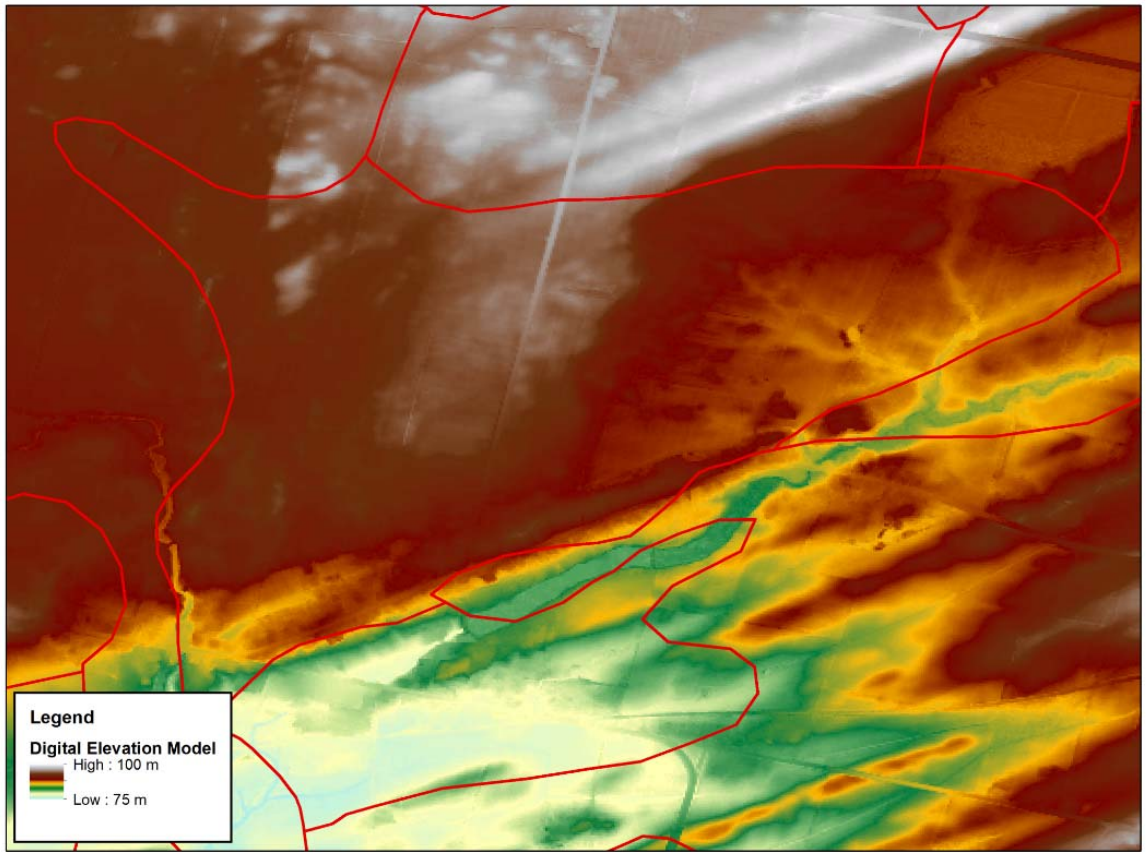
Soil Map Upgrades - Slopes

- How were slopes assigned in original surveys
  - Most limiting?
  - Dominant?
- Advances in technology
  - Digital elevation models (DEM)
  - Light Detection and Ranging (LiDAR)
- These allow us to see the entire landscape, not only from roads or transects

Soil Map Upgrades - Slopes

- What is a DEM?
  - Grid of cells each with a known area and elevation
  - From the difference in elevation between cells we can calculate slope





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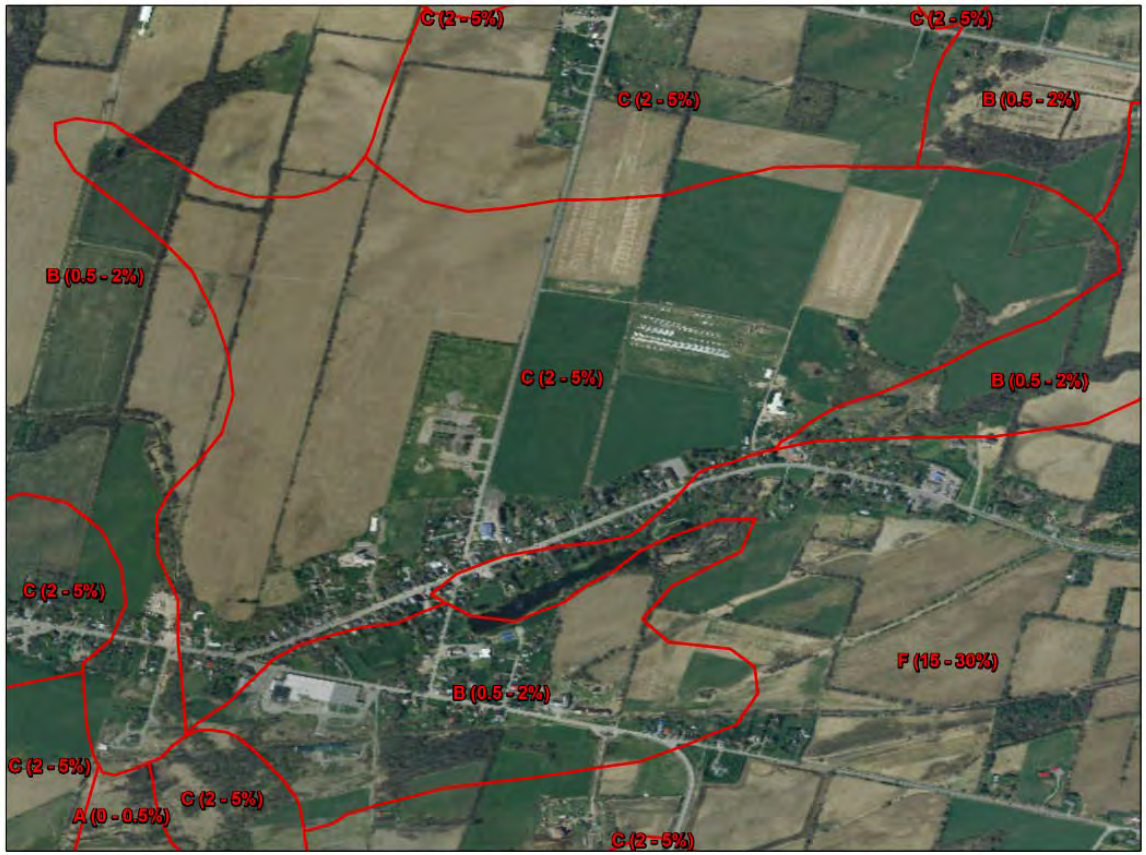
Soil Map Upgrades - Slopes

- Uses the best available DEM
- Slopes generated from DEM
- Slope map generated used to update soil maps
- Let’s look at an example:



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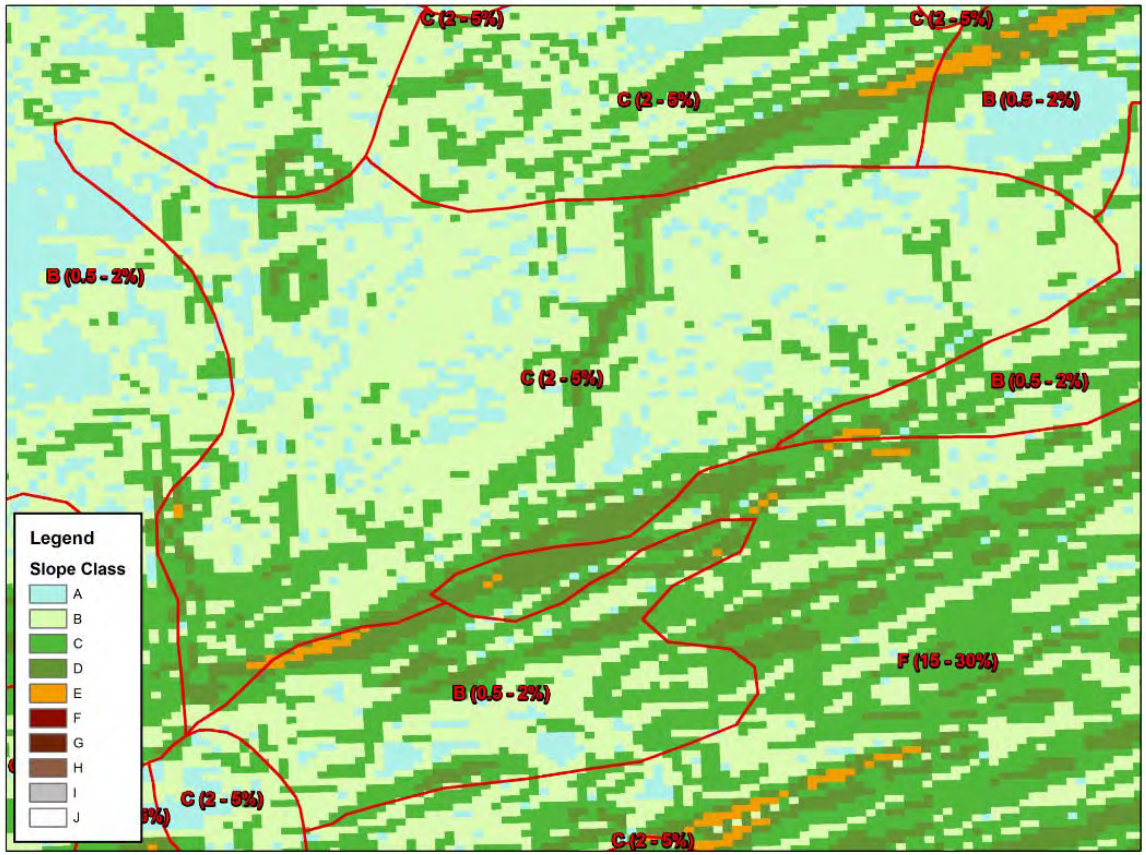
C (2 - 5%)
C (2 - 5%)
C (2 - 5%)
B (0.5 - 2%)
B (0.5 - 2%)
C (2 - 5%)
B (0.5 - 2%)
F (15 - 30%)
B (0.5 - 2%)
C (2 - 5%)
C (2 - 5%)
Legend
Slope Class
A
B
C
D
E
F
G
H
I
J

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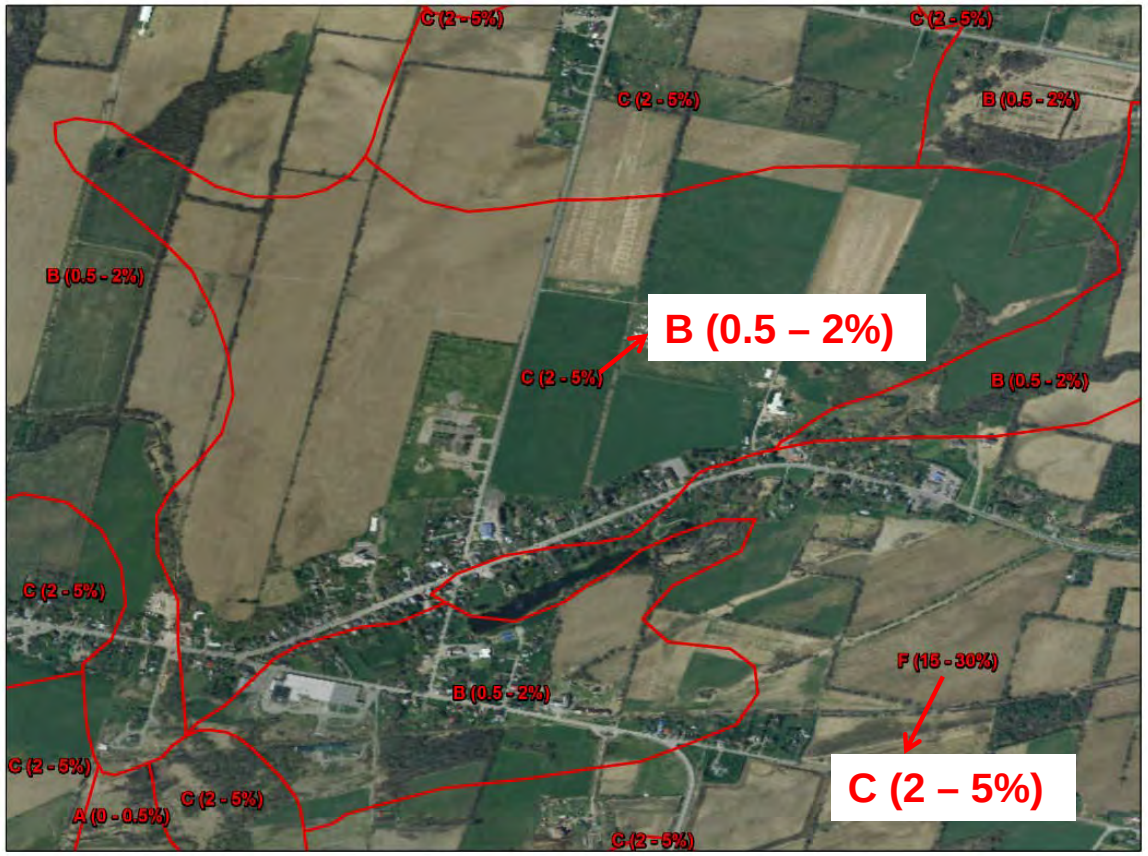
C (2 - 5%)
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B (0.5 – 2%)
C (2 - 5%)
B (0.5 - 2%)
C (2 - 5%)
F (15 - 30%)
B (0.5 - 2%)
C (2 – 5%)
C (2 - 5%)
A (0 - 0.5%)
C (2 - 5%)
C (2 - 5%)

Land Suitability for Agriculture

- Canada Land Inventory Soil Capability Classification for Agriculture (Ontario Version)
  - Climate limitation (C)
  - Soil limitations (S)
  - Topographic limitations (T)

$$\text{CLI} = f(C, S, T)$$

http://www.omafra.gov.on.ca/english/landuse/classify.htm

Implications for Slope Changes

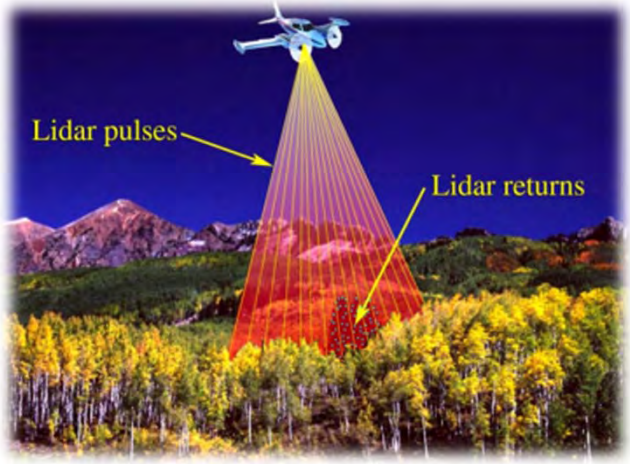
- First area, C slope to B slope could change CLI rating from Class 2 to Class 1
- Second area, F slope to C slope could change CLI rating from Class 5 to Class 2

- Developing a strategy to apply these updates for all survey areas across the province

New Survey Techniques and Products

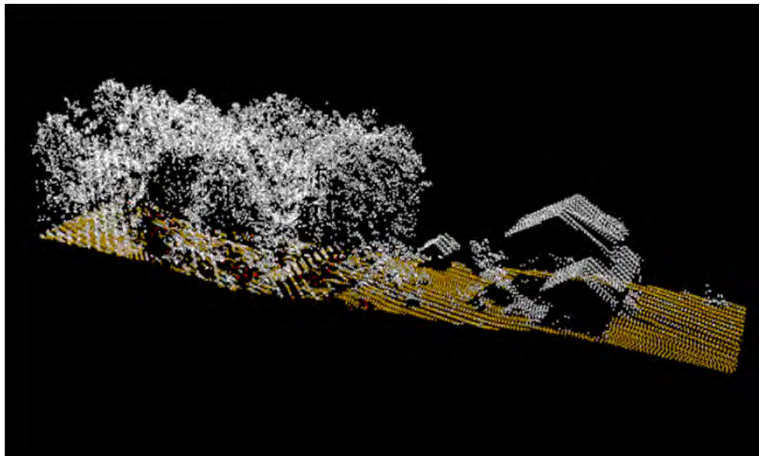
New Survey Techniques

- Driven by Light Detection and Ranging (LiDAR)
- Method that uses light in the form of a pulsed laser to measure distances to the Earth from an aircraft



Example of the Classified Point Cloud

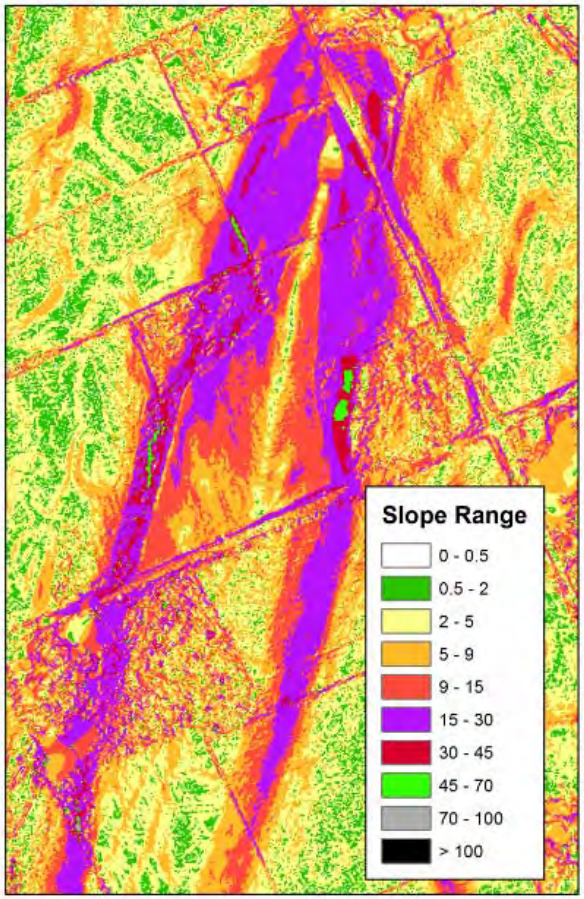
- Elevation points are called a point cloud
- Points classified (e.g. ground vs non-ground)
- DEM generated from the points



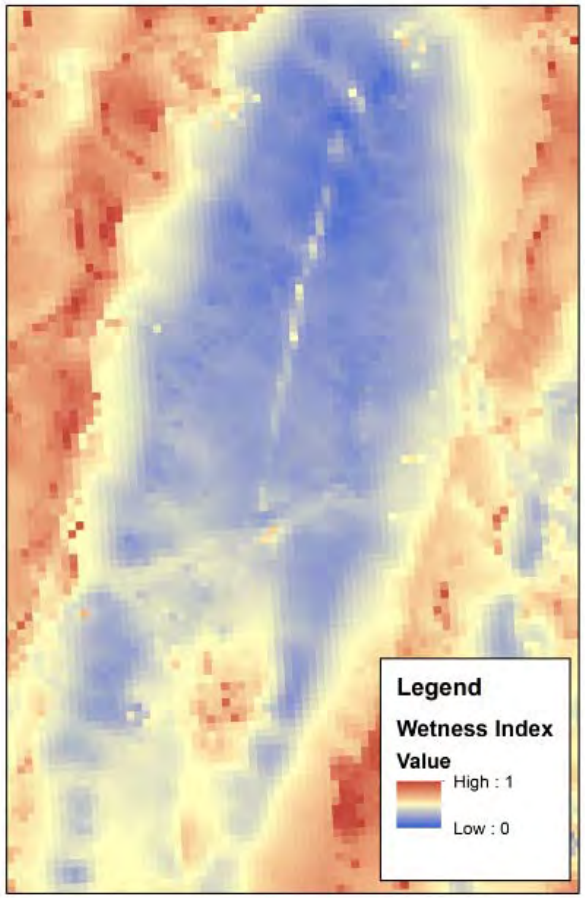
DEM Derivatives

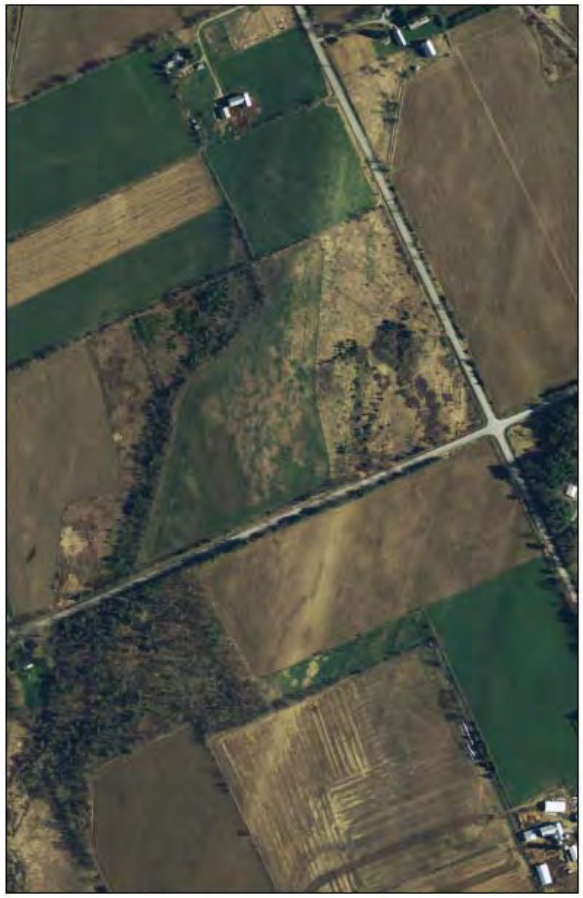
- DEM is first product created from LiDAR data
- Many derived products from the DEM can be created to assist the mapping and are called derivatives
  - Slope map
  - Wetness index map
  - Topographic position index
  - Curvature
  - Relative landscape position
  - Etc.

LiDAR Derivatives - Slope

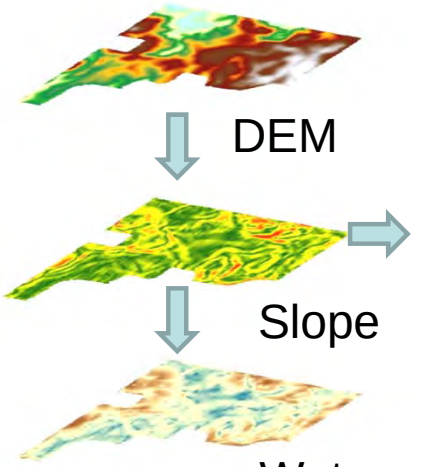


LiDAR Derivative – Wetness Index

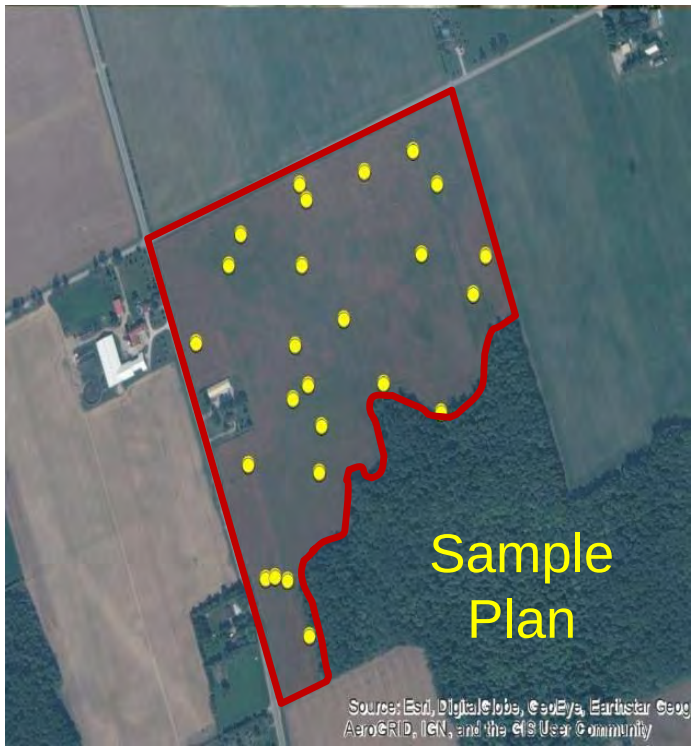




Selecting Sample Sites



- Conditioned Latin Hypercube
- Landscape-based statistical method
- Sample plan capturing most variability



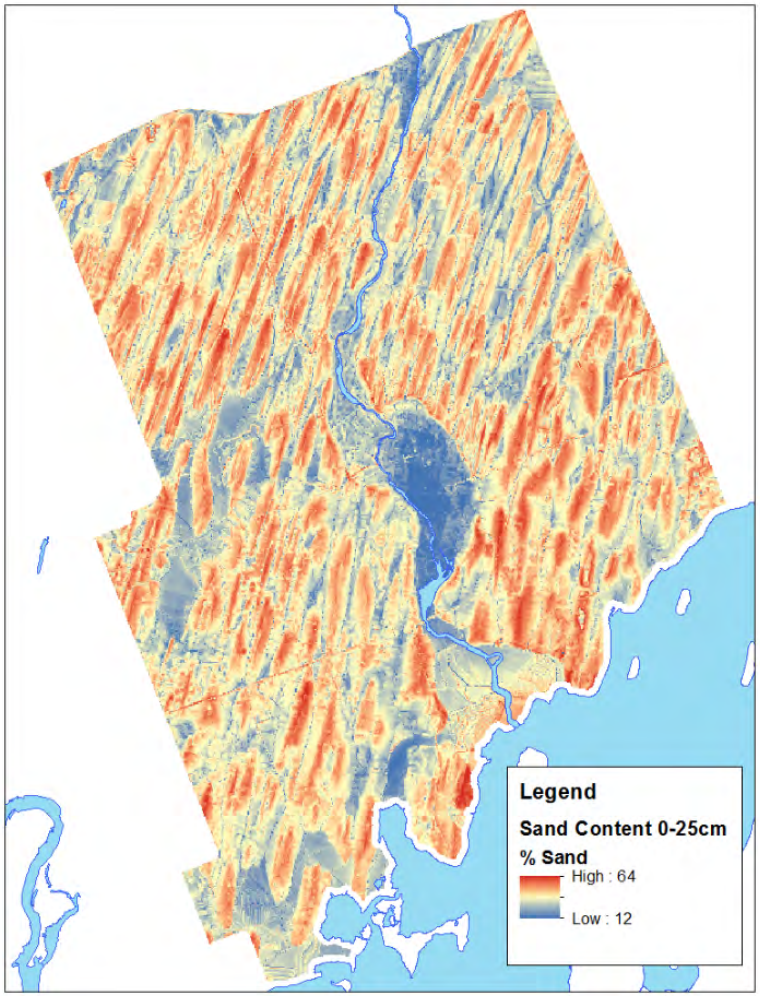
Creating Maps

- Sample data is then correlated with derivatives
- Relationships developed between sample data and derivatives
- Relationships are used to predict soil properties across the study area or field

What is OMAFRA developing?

- LiDAR point cloud
- DEM and derivatives
  - Slope map
  - Wetness index
  - Curvature
- Soil property maps
  - Texture
  - pH
  - OM

Soil Sand Content 0-25cm



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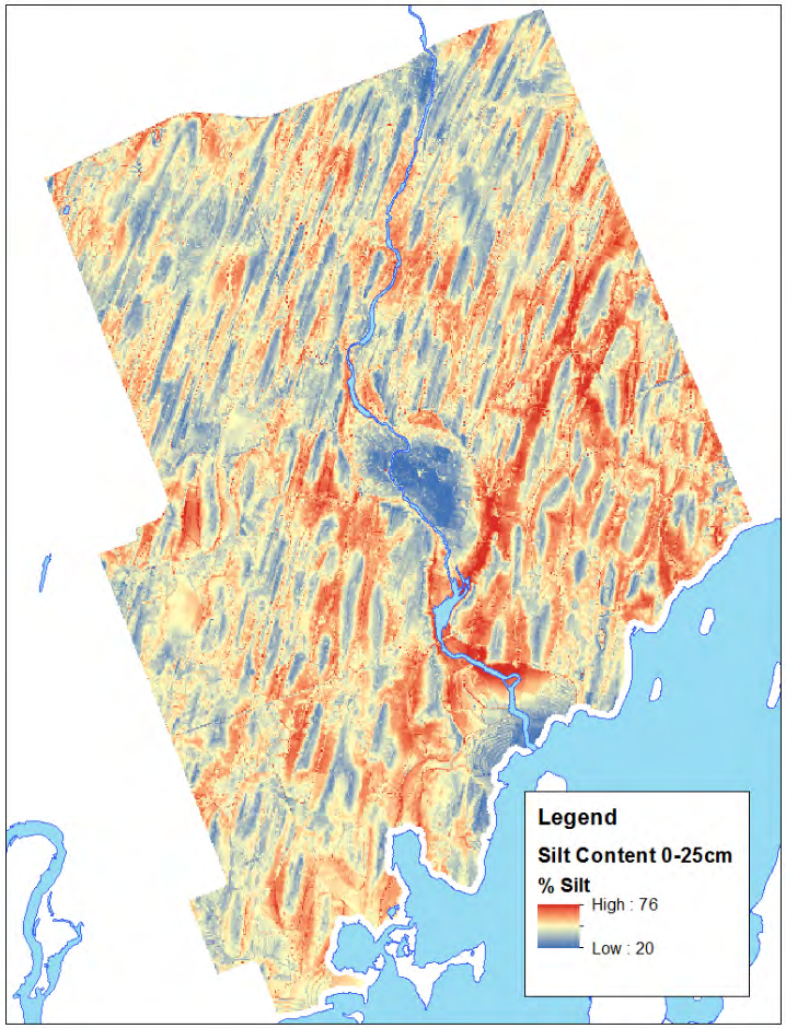
Soil Silt Content 0-25cm



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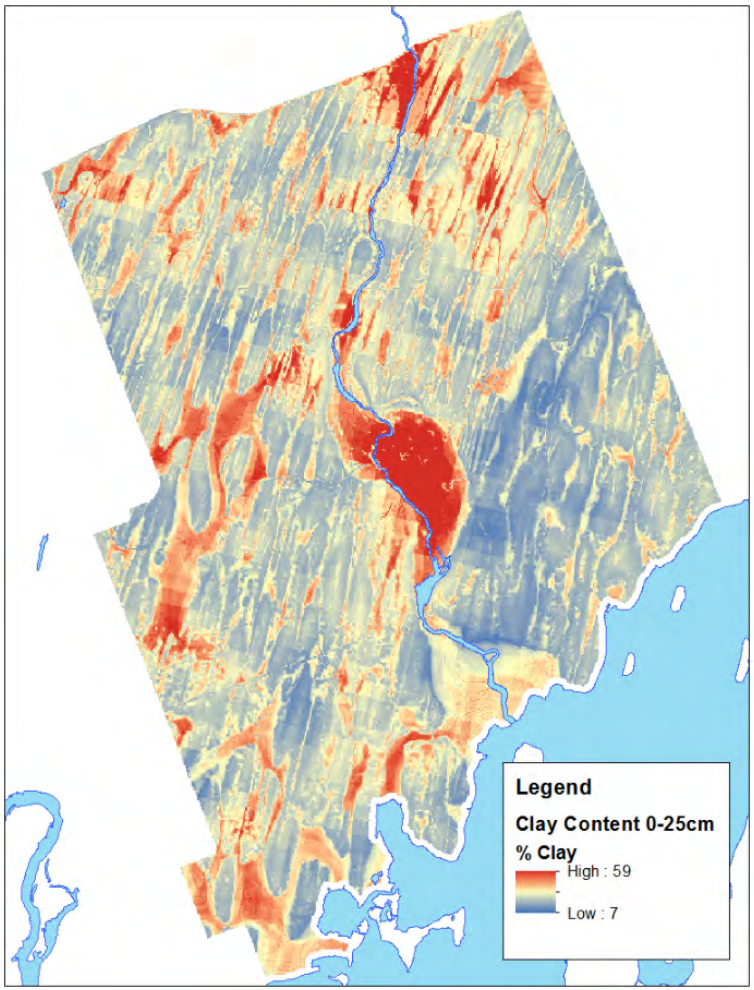
Soil Clay Content 0-25cm



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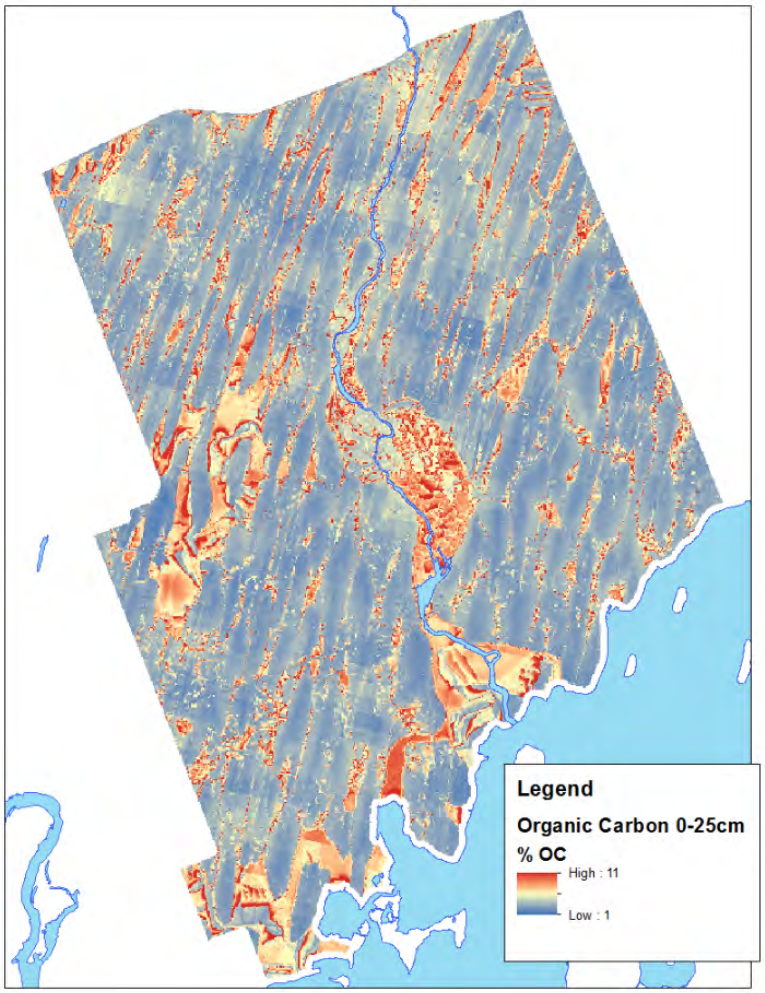
Soil Organic Carbon Content 0-25cm



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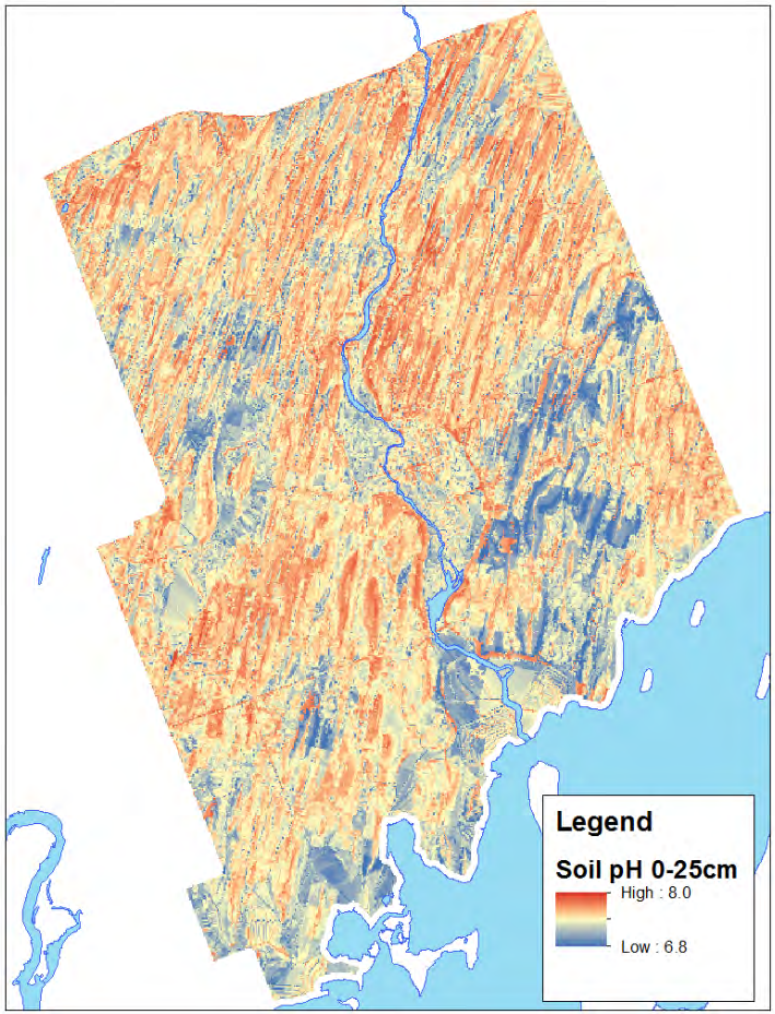
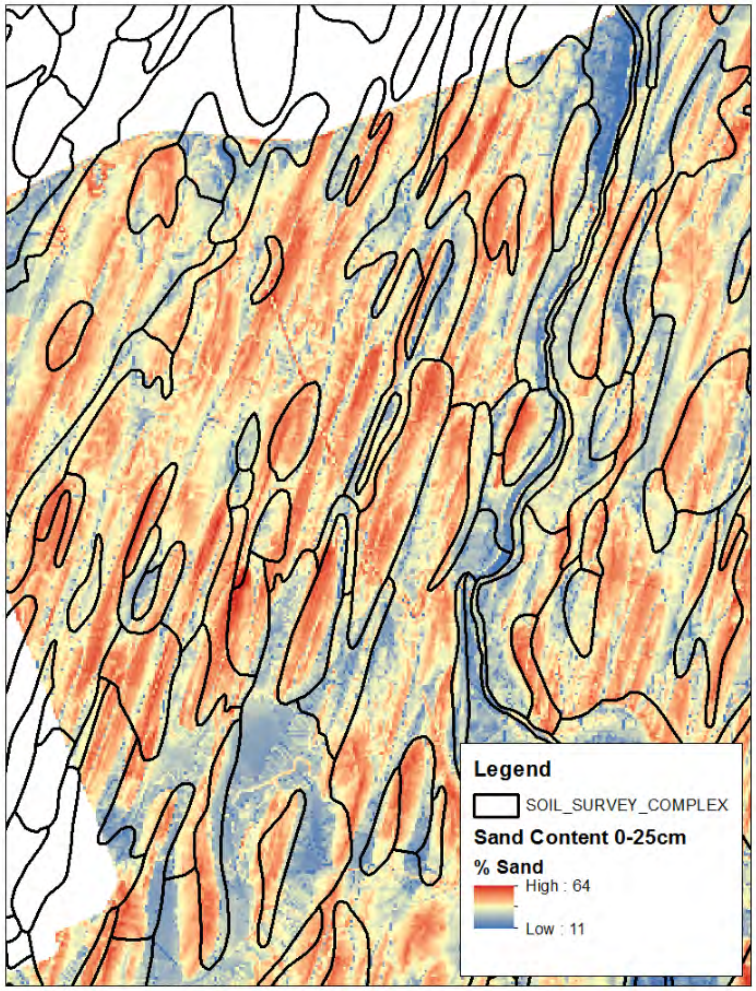
Soil pH 0-25cm



Sand Content and Soil Survey Complex



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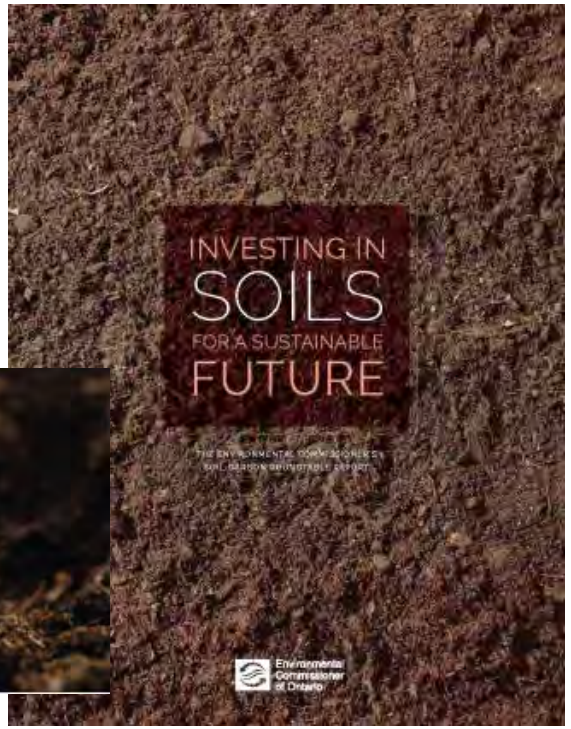
Summary

- There is a lot of work ongoing
  - LiDAR acquisition
  - Soil pits and sampling
  - Soil survey upgrades
  - New soil surveys

Thanks!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