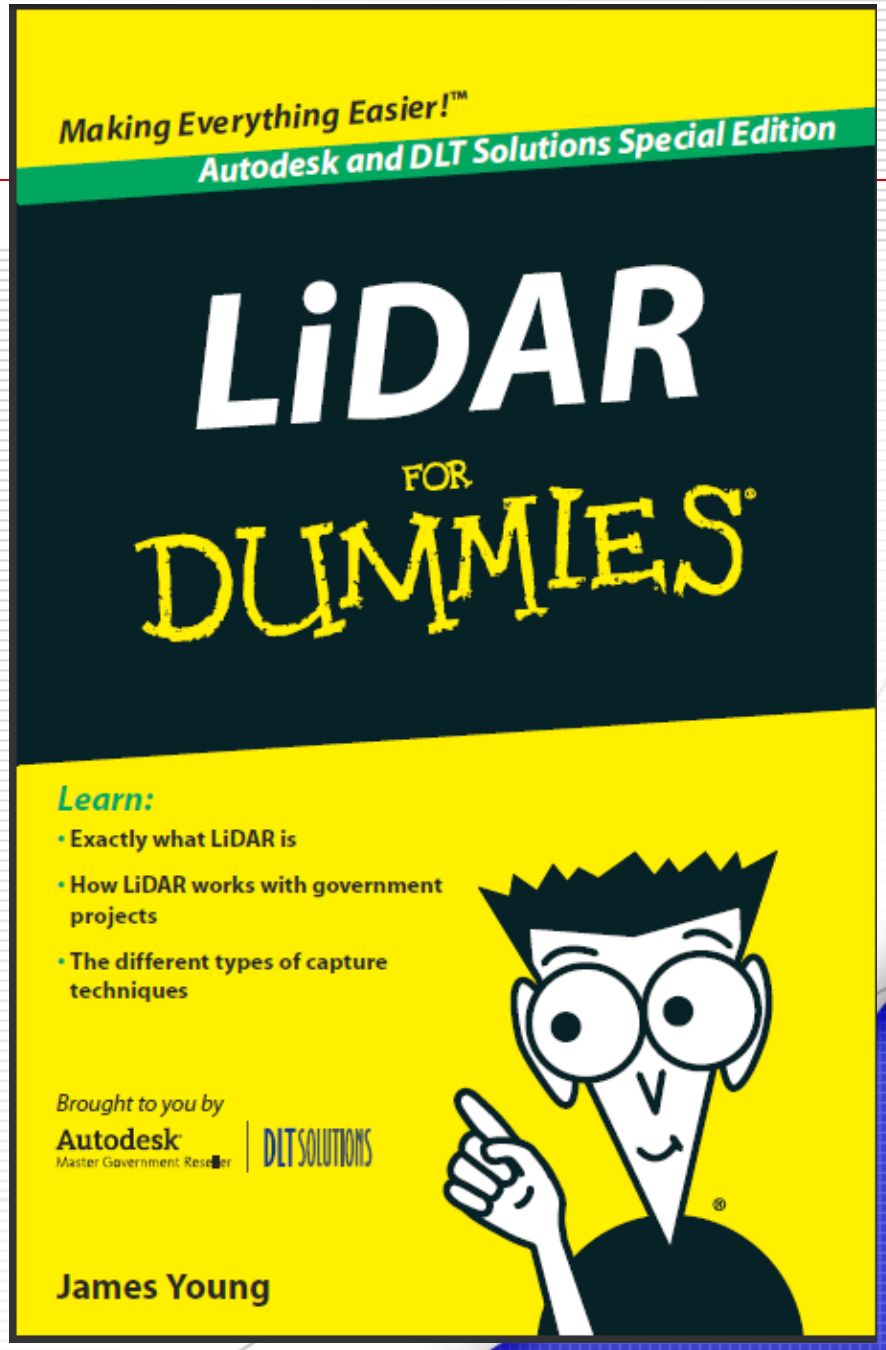

http://www.dlt.com/blog/2011/01/13/lidar-simple/

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What am I doing here?

- **Airborne Imaging**
  - Installed LiDAR scanner
- **What is LiDAR**
- **Flight Parameters**
- **Base Station Network**
- **Flight Mission Calibration**
- **LiDAR specifications to be compared**
  - USGS
  - Ontario
  - Canada
- **Comparison of Collection Parameters**
- **LiDAR Accuracy**
- **Check-points/ Ground Truth**
- **Comparison of Selected Deliverables**
- **Hydro-Flattening**
- **Comparison of Classification**
- **Data Examples**
- **Don’t do this…**

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LiDAR Scanner Installed

Leica ALS-70 HP (MPIA)

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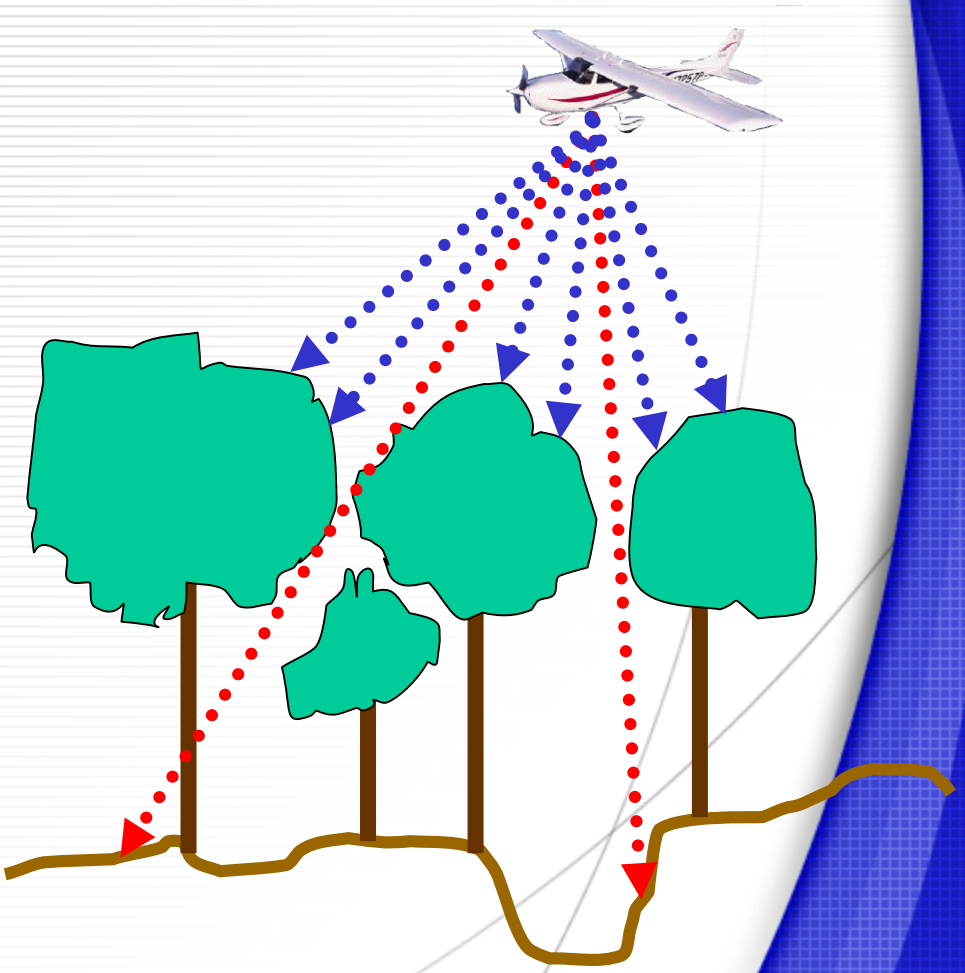
What is LiDAR?

- A method of collecting an extremely accurate topographic surface known as a bare earth model

- Every moving LiDAR system has three main components.

1. GPS locates the aircraft in the world using satellite triangulation with base stations on the ground
2. Inertial Measurement Unit (IMU) records the position of aircraft, by correcting crab, tilt, and tip (like a gyroscope)
3. Laser Sensor supplies the laser pulse which is recorded to create the point cloud data



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Leaf-On vs Leaf Off

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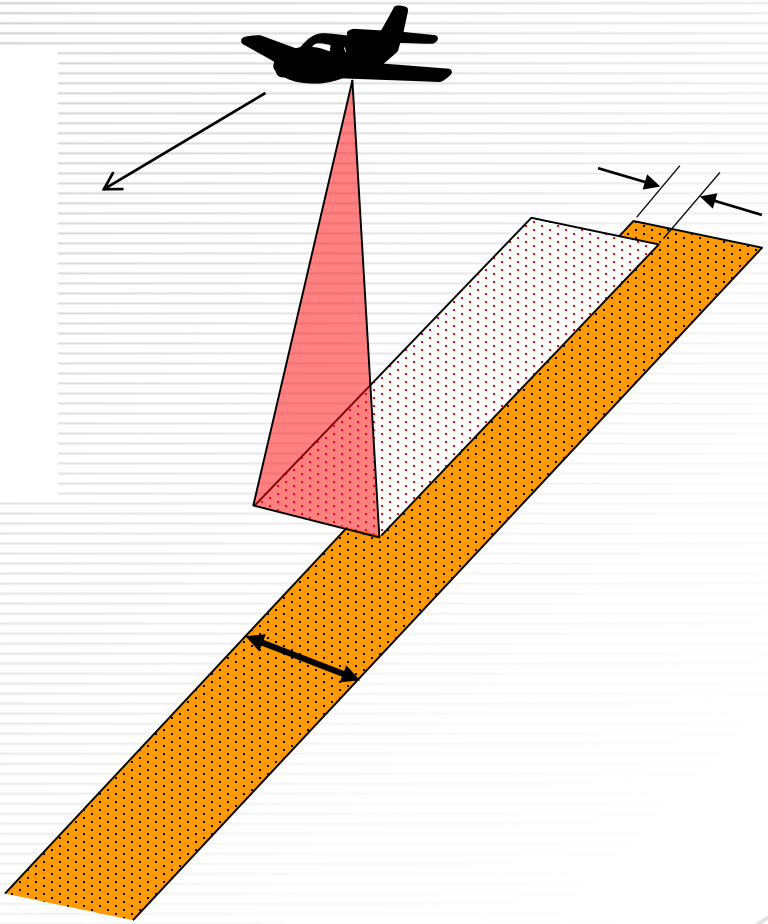
Flight Parameters

- Altitude (AGL)
- Flight Speed (knots)
- Overlap (%)
- Swath width
- Scan Angle (field of view)
- Pulse Rate (kHz – 1000s/sec)
- Point Density (/m^2)



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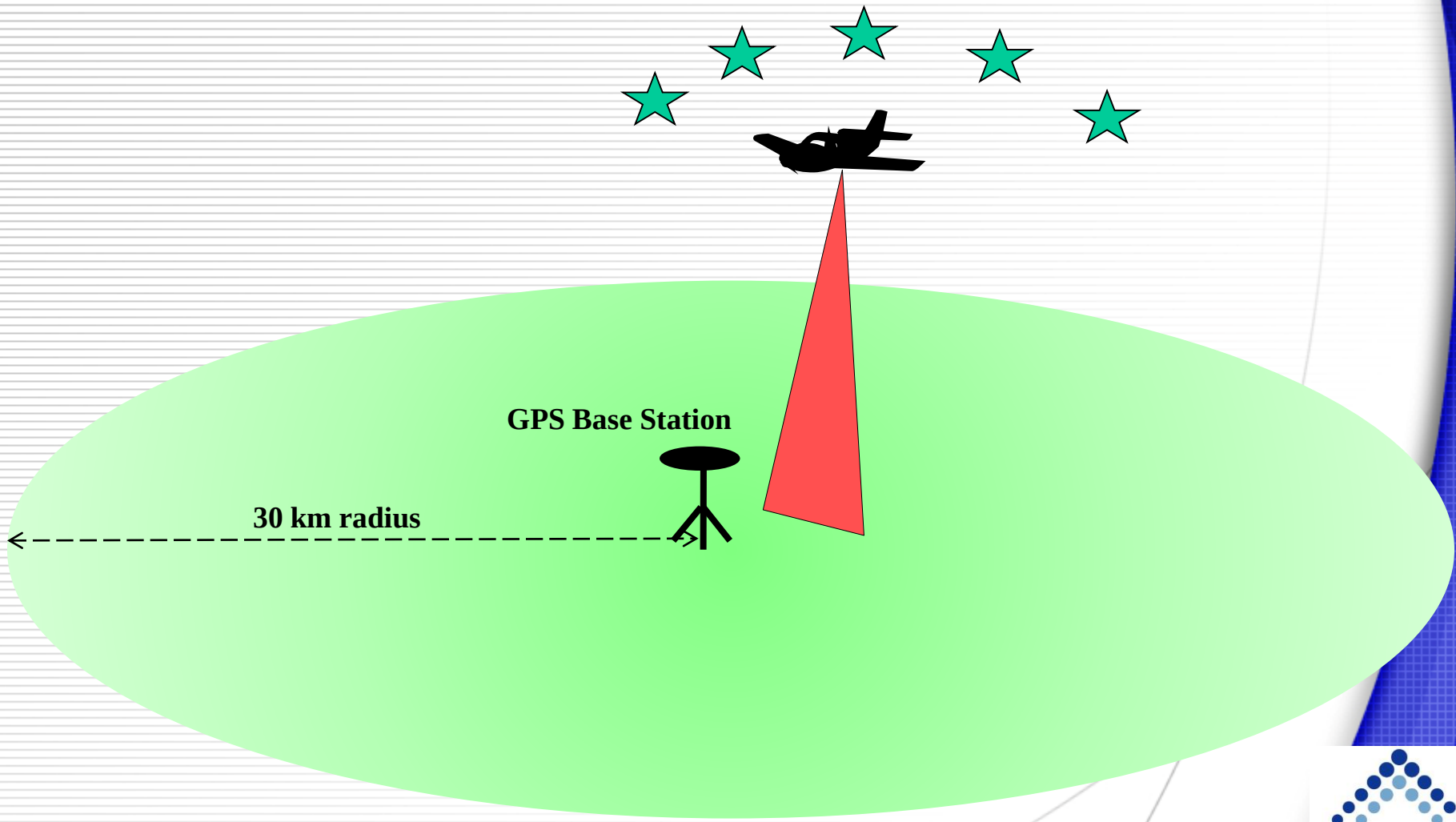
Ground Control Network – Base Stations



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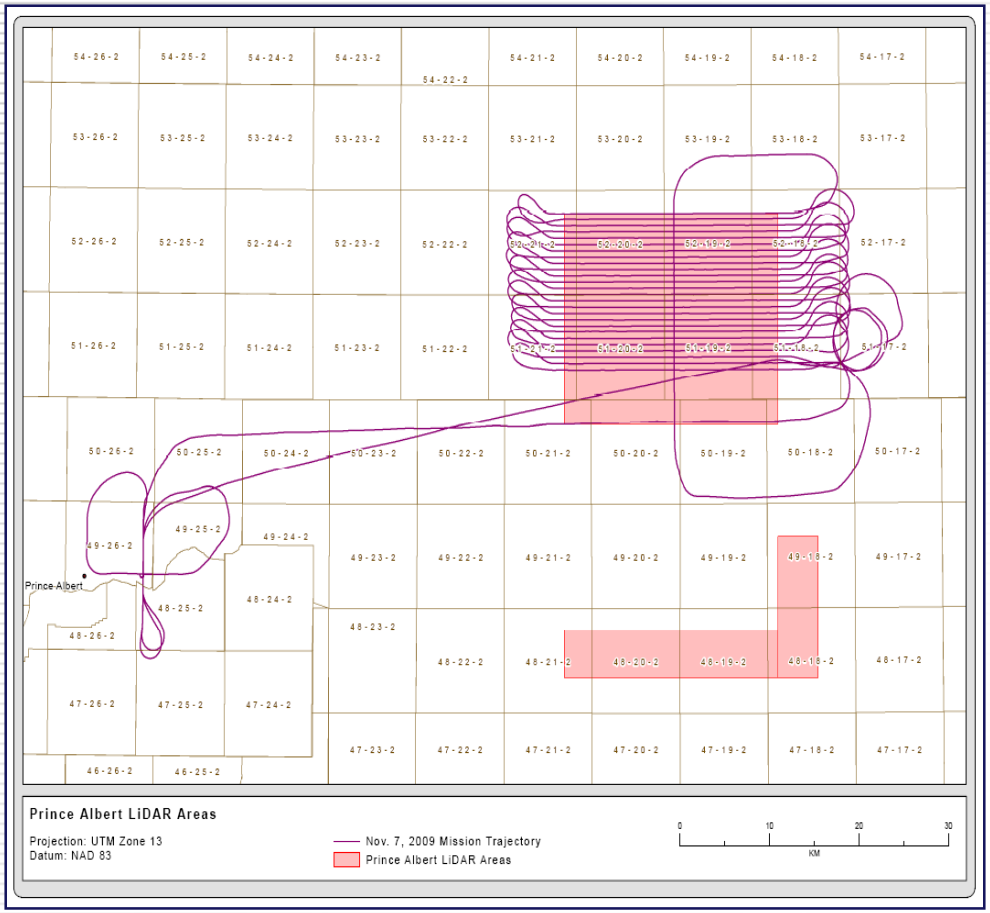
Flight Mission Calibration



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Published LiDAR specifications to be covered

Ontario Specifications for Lidar Acquisition

Federal Floodplain Mapping Guidelines Series

Federal Airborne LiDAR Data Acquisition Guideline

Version 1.0

2017

National Geospatial Program

Lidar Base Specification

CART

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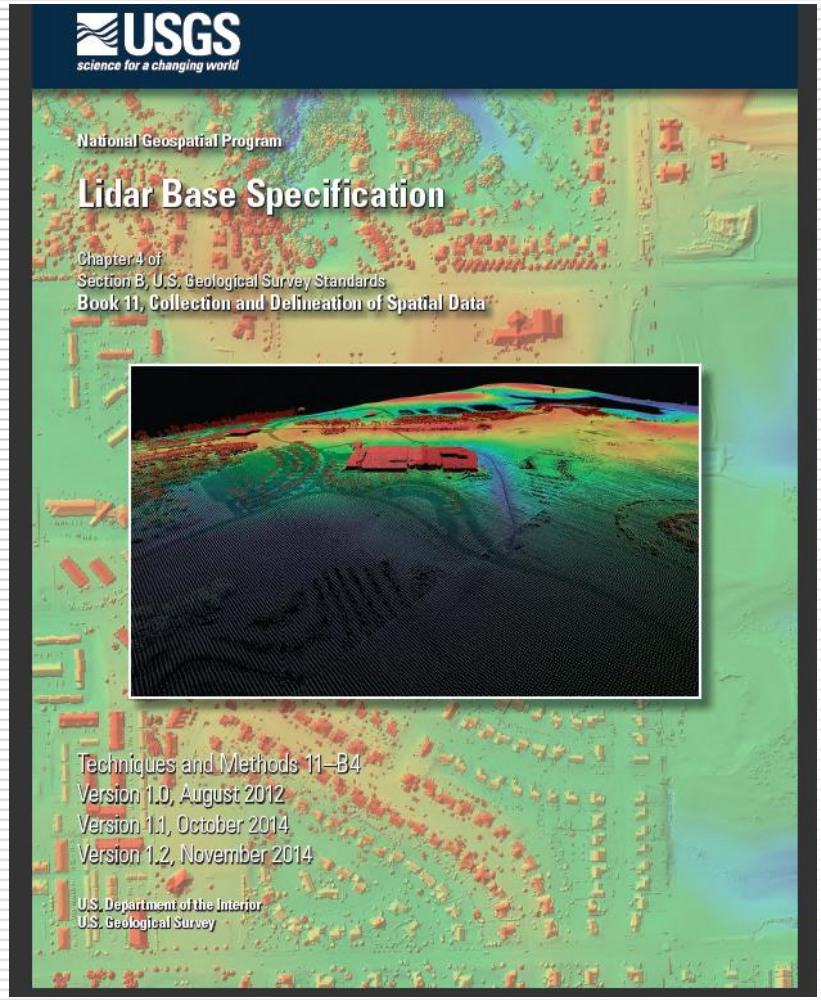
USGS – LiDAR Base Specification



https://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf

More consistent practices in the collection, handling, processing, documentation, and delivery of lidar data will allow the technology and data to become more useful to a broader user base and thereby benefit the Nation as a whole.

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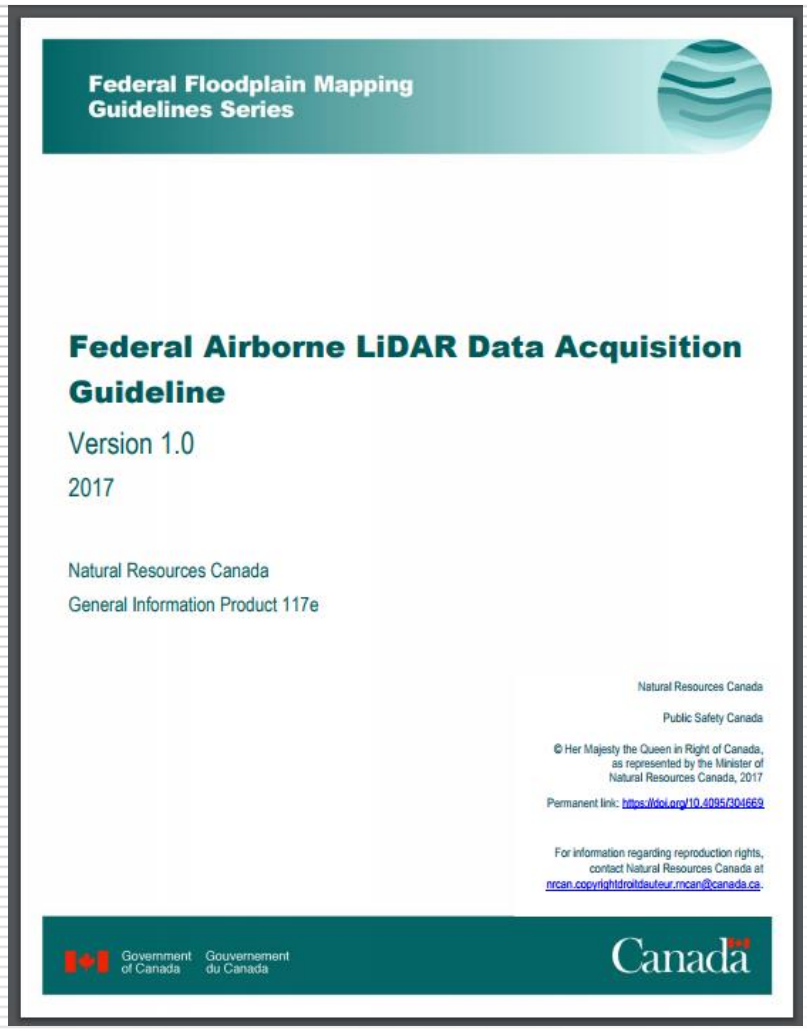
Federal Airborne LiDAR Acquisition Guideline



http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/304/304669/gip_117_v1_0_en.pdf

The intent of this guideline is to set a minimum quality threshold to achieve the federal government needs for unified national elevation data set.

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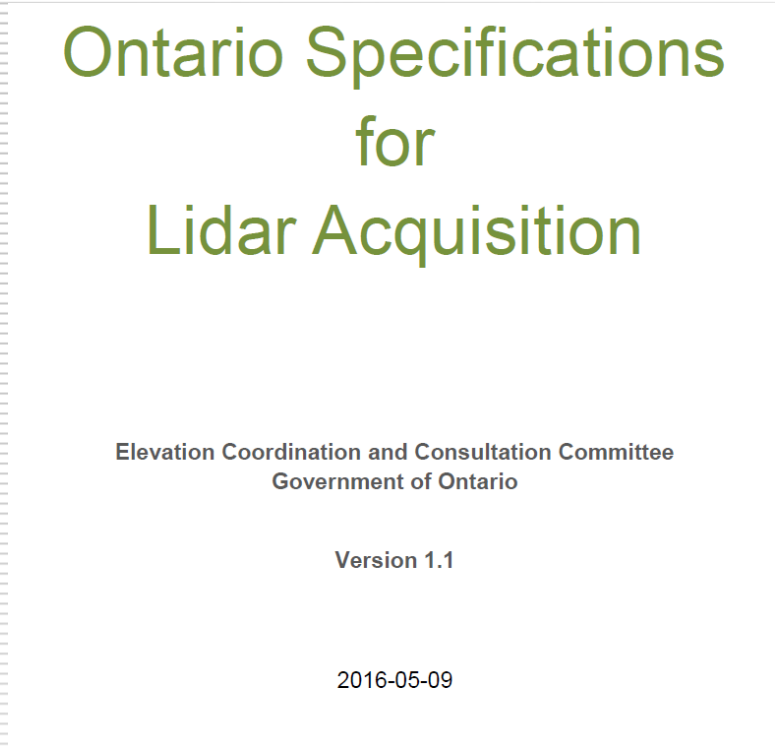
Ontario Specifications for LiDAR Acquisition



https://www.sse.gov.on.ca/sites/MNR-PublicDocs/EN/CMID/OntarioSpecificationsForLidarAcquisition.pdf

The purpose of this specification document is to act as a template for specifications attached to Lidar acquisition projects in Ontario. As a template, multiple options are provided and it is up to the user to select and modify sections of this document as required for their own project.

Not for LiDAR

Imagery and Elevation Collection Guidelines prepared by Mapcon Mapping Ltd

Imagery and Elevation Acquisition Guidelines

Version 1.2
November 9th, 2009

1) Purpose 2
2) Horizontal Reference System (Datum), Map Projection and Vertical Datum 2
3) Data Accuracy 3
4) Ground Control 4
5) Imagery 5
6) Image Orientation Information 8
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8) LiDAR Acquisitions 10
9) Orthophoto 11
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12) Metadata 14
13) Deliverables 15
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15) Appendix A: CMAS and LMAS Calculations 18

Guidelines Prepared For the Government of Ontario
By Mapcon Mapping Ltd, Burnaby, BC
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Comparison of selected collection parameters

Parameter	USGS QL0	USGS QL1	USGS QL2	USGS QL3	Canada CQL1	Ontario 4 Levels
Point Density	<8.0/m^2	<8.0/m^2	<2.0/m^2	<0.5/m^2	>2/m^2	<8.0/m^2
NPS (m)	<0.35	<0.35	<0.71	<1.41	<0.71	<0.35
RMSE (m)	<5.0	<10.0	<10.0	<20.0	<10	<5.0
FVA (m)	<9.8	<19.6	<19.6	<39.2	<19.6	<9.8
VVA (m)	<14.7	<29.4	<29.4	<58.8	<29.4	<14.7
Base Stations					25-35km	
Coordinate System and Datum	UTM NAD83 NAVD88				UTM NAD83 CGVD13	UTM NAD83 CGVD28-1978v

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Accuracy of LiDAR Point Cloud

- RMSE (root mean square error is measured at 1σ or 68%CI
- Fundamental Vertical Accuracy (FVA) which is measured at 2σ or 95%CI – measured on open hard flat surfaces
- If given an RMSE value you can roughly double it to get FVA

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Accuracy of LiDAR Point Cloud

Accuracy requirements help determine the flight parameters of a project

- **Absolute Vertical Accuracy:**
  - (±) 5 cm on Hard flat Surfaces (RMSE)
  - (±) 10 cm on Hard flat surfaces (FVA)
- **Absolute Horizontal Accuracy:**
  - (±) 16cm on Hard flat Surfaces (RMSE)
  - (±) 28cm at 2σ

**in LiDAR vertical and horizontal cannot be the same due to nature of the beam

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Accuracy of LiDAR Point Cloud

Accuracy is affected by:

- Flying height (lower provides higher accuracy)
- Terrain (slope will affect accuracy, hard flat vs vegetated)
- Scan Angle (narrow provides higher accuracy)
- Base Line distance (shorter distance from base stations)
- Satellite constellation

Higher point density does not improve vertical accuracy – it will improve resolution- you can see more detail in a point cloud

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Ground Truth / Check Points

Always complete a hard surface check-point survey to calibrate data and tie it to the ground

Only USGS Specifies the number of check points for

- Non-Vegetated Vertical Accuracy (NVA) Check Points
- Vegetated Vertical Accuracy check points (VVA)

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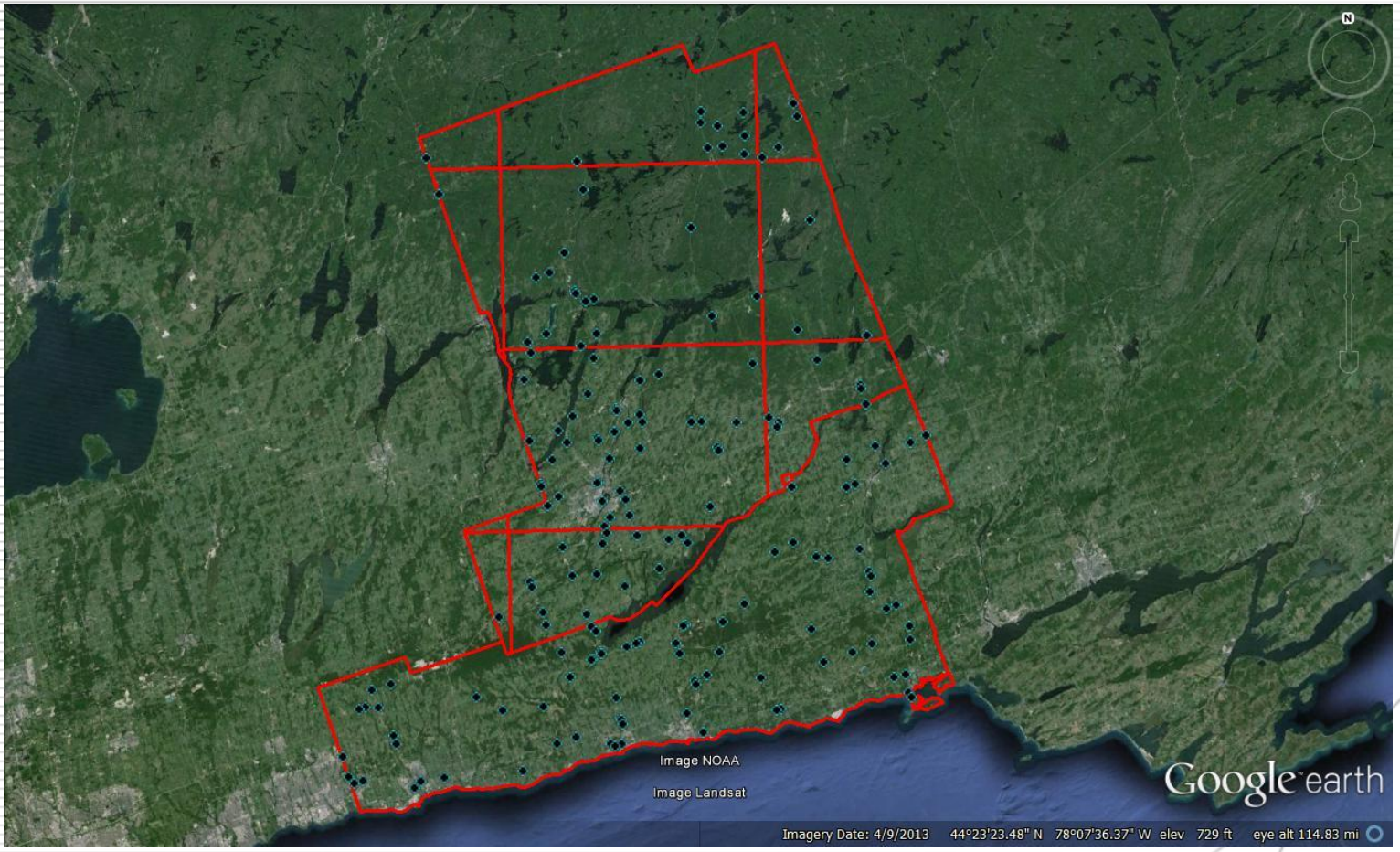
Peterborough Check Points



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Comparison of selected deliverable requirements

Deliverable	USGS	Canada	Ontario
Metadata	FGDC Compliant	ISO 19115:2003	Yes
Intellectual Property	No	No	Yes
Full Waveform	No	No	No
Classification Point Cloud	Yes	yes	Yes
Raw Point Cloud	No	no	Yes
Hydro-Flattened DEM	Yes	No	
Bare-Earth Model	Yes	No	Yes
Raster Digital Surface Model (DSM)	No	No	Yes
Breaklines	Yes	No	Yes

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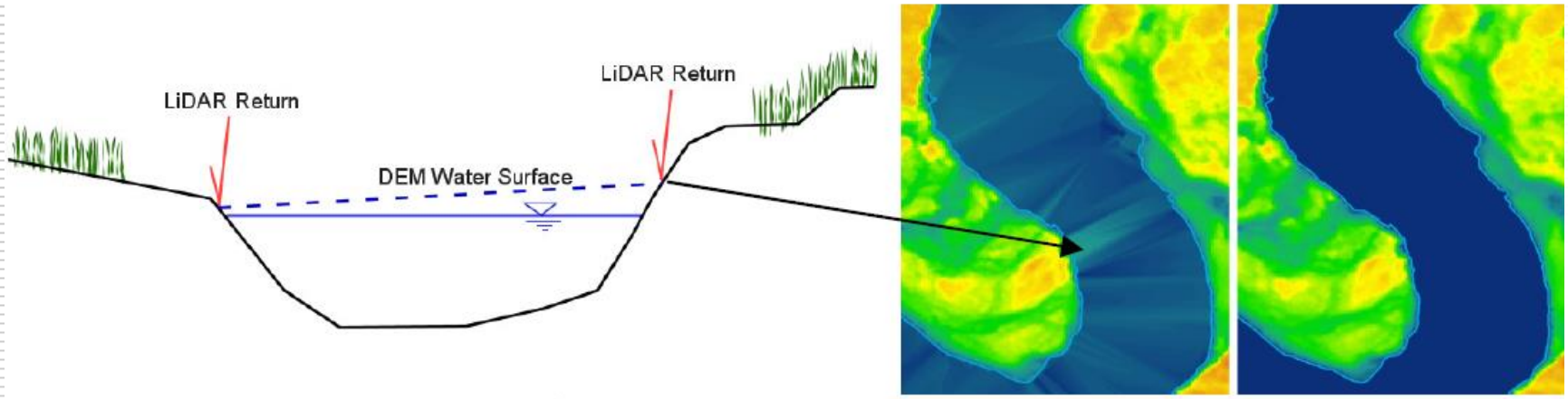
Hydro-Flattened DEM



Courtesy 4DM Inc.

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Comparison of classification Requirements

Table 6. Minimum classified point cloud classification scheme.

Code	Description
1	Processed, but unclassified.
2	Bare earth.
7	Low noise.
9	Water.
10	Ignored ground (near a breakline).
17	Bridge decks.
18	High noise.

Table 2: Point cloud classification scheme

Class Code	Description
0	Unprocessed
1	Processed, but unclassified
2	Bare earth
7	Low noise
9	Water
10	Ignored ground (near a breakline)
17	Bridge decks
18	High noise

Classification	1 – Processed but unclassified 2 – Ground 9 – Water 7 – Low points (noise) 17 – Bridge decks 18 – High noise

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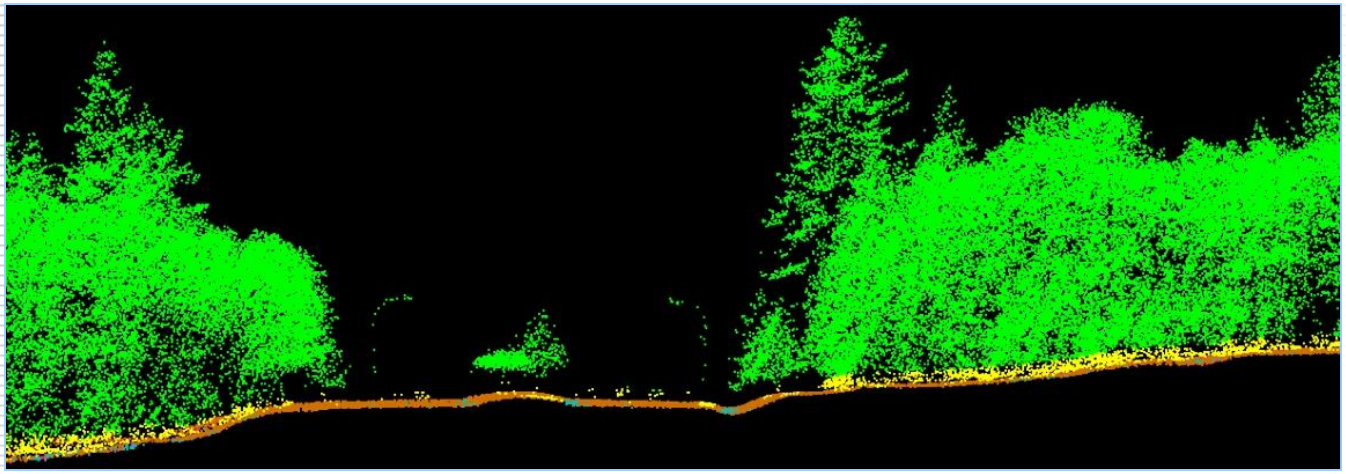
Profile of Point Cloud



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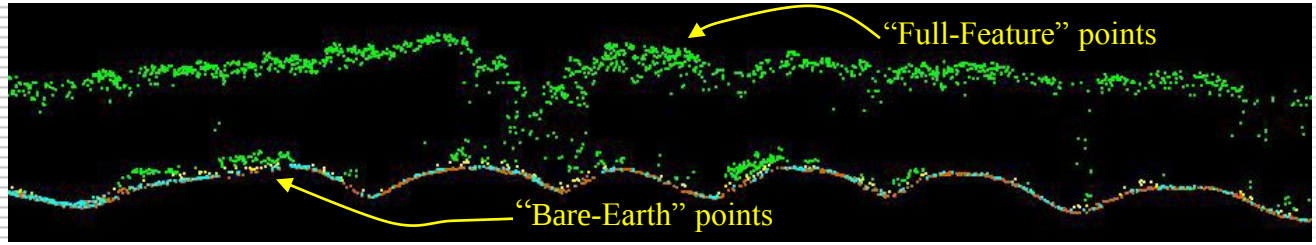
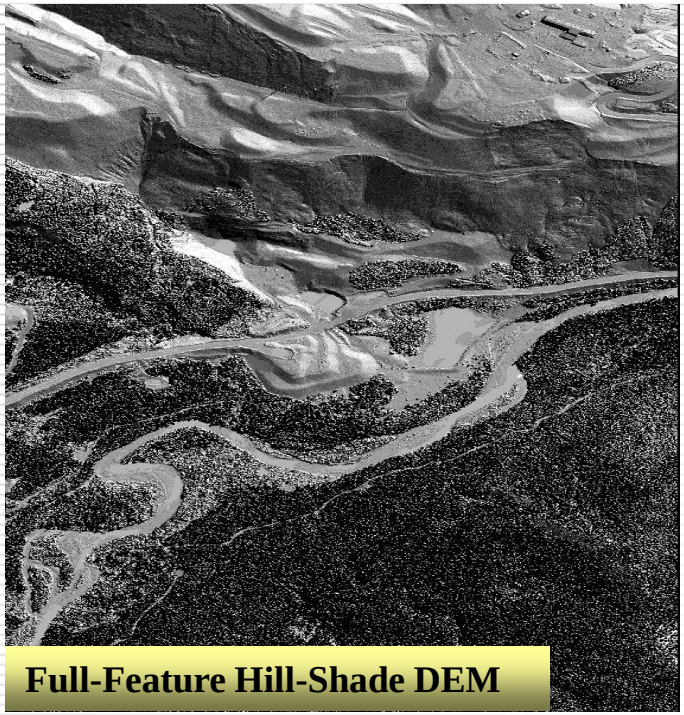
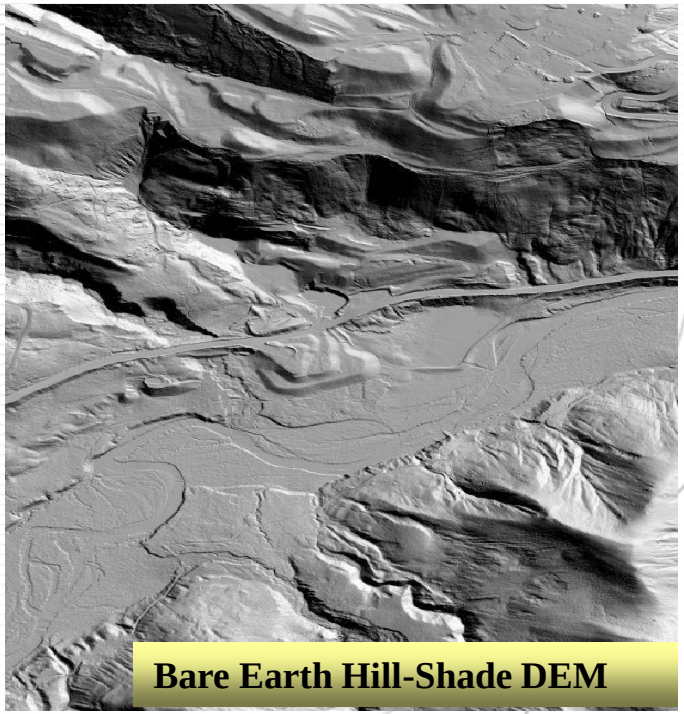
Typical Project Deliverables







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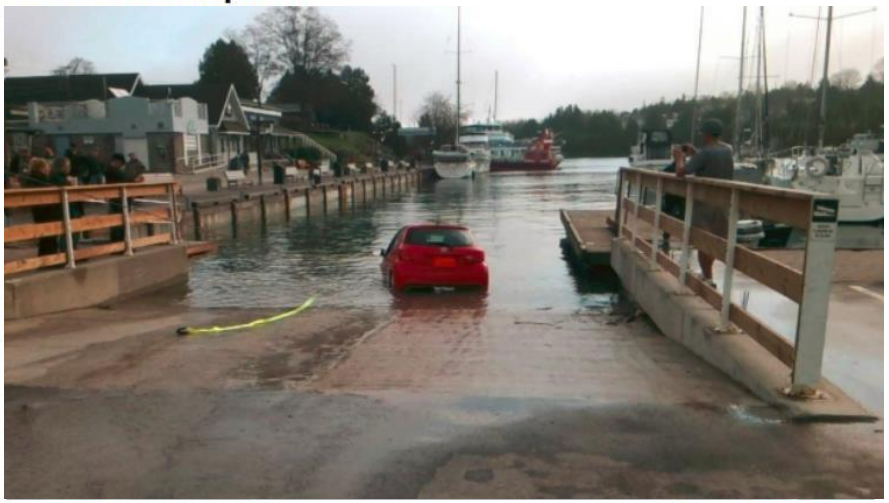
Discussion

Driver following GPS plunges vehicle into Lake Champlain



Guertin says the group started following a GPS device when they got lost and ended up driving on top of the icy lake.

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Airborne Imaging
613-809-1907
susank@airborneimaginginc.com