Session ID: GEO-6307
Mapping and Monitoring for Suncor’s Oil Sands Tailings Reduction Operation process using GPS surveying and PhotoSat satellite topography.

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Jim Turner, PhotoSat
Stereo satellite photos used to map Suncor Tailings
Where is Suncor Oilsands?

- Alberta, Canada
Where is Suncor Oilsands?

- Athabasca Oilsands, near Fort McMurray
How large is the Suncor Oilsands Operation?

- **Total Mapping Area**
  - About 271 km$^2$ (66,974 acres)

- **Mining**
  - Total - Over 1,000,000 t/day
  - Oilsand - Over 400,000 t/day

- **Extraction**
  - Bitumen – Over 275,000 bbls/day

- **Tailings Ponds**
  - About 31.5 km$^2$ (7,783 acres)
What is TRO?

- **Tailing Reduction Operation**
  - Reducing the need to build more Tailings Ponds
  - Accelerating reclamation
  - Reducing existing MFT inventory (Mature Fine Tailings)
How Large is the Suncor TRO Operation?

- **Designated Drying Areas (DDA)**
  - Total Surface Area 7,550,000 m² (1,866 acres)
  - Tailings Sand Deposit 10,872,000 m³/year
- **697 Tailings Cells**
- **2788 Discharge Locations**

- **System 7 – Field D**
  - 216m x 902m
  - 14 Cells (216m x 64m)
- **Seasonal Operation**
  - April - October
How Large is the Suncor TRO Operation?

- Sand Dump 8 (SD8)
  - Total Surface Area 4,053,693 m² (1,002 acres)
  - Tailings Sand Deposit 39,015,877 m³ / year
- 74 Tailings Cells
- 74 Discharge Locations
- Operates 12 months / year
In 2012

- Survey Department was given the challenge to do monthly topo surveys on all TRO cells.

Trimble R8 GNSS  Trimble VX
In 2012

- Trimble GPS equipment was used on compacted areas of Sand Dump 8.
  - <20% of total area was accessible.
In 2012

- Trimble VX was used to scan DDA Cells.
  - Very slow
  - Multiple set-ups
  - Sparse data
In 2012

- Survey Department was given the challenge to do monthly topo surveys on all TRO cells.
- Trimble GPS equipment was used on compacted areas of Sand Dump 8.
  - < 20% of total area was accessible
- Trimble VX was used to scan DDA Cells.
  - Very slow, multiple set-ups, sparse data
- Aerial LiDAR was used for all TRO Cells.
  - Huge point clouds
  - Slow data delivery
In 2012 - November

- Trimble Dimensions
  - Digital Globe
    - Satellite Remote Sensing for Mining
    - Using Satellite Imagery to produce DEM data

- Digital Globe – PhotoSat
  - PhotoSat was already producing monthly Satellite Orthophotos for Suncor
In 2013

- PhotoSat began collecting monthly Satellite Imagery of Sand Dump 8 and delivering DEM data.
- This project expanded to include all TRO areas.
Many features visible in the Jan 20 satellite topography have been buried by tailings by Feb 23.
50 cm tailings thickness contours
Jan 20 to Feb 23, 2013
Cross-section at Sand Dump 8

- First 5 surfaces from PhotoSat (2013)
  - January 11  - Blue
  - February 23 - Brown
  - March 23    - Green
  - April 15    - Magenta
  - April 24    - Black
Dec 30, 2013

July 29, 2014
July 29, 2014

Thickness Dec 30, 2013 to July 29, 2014
Pond 6 Beach Excavation Survey
GPS and satellite mapping match to ½ inch

- **Pre Excavation Survey**
  - GPS Data - Blue 1’ contours
  - PhotoSat Data - Black 1’ contours

- **Excavation Survey**
  - GPS Data
    - GPS surface – Excavation surface \( 77,982 \text{ yds}^3 \)
    - PhotoSat surface – Excavation surface \( 77,041 \text{ yds}^3 \)
    - Difference (1.2%) \( 941 \text{ yds}^3 \)

  \[ \frac{941 \text{ yds}^3}{70,134 \text{ yds}^2} = 0.0134 \text{ yds} = ½ \text{ inch} \]

  - On average, the PhotoSat data was lower than the GPS data by ½ inch.
Millennium Pit
Trimble VX and GPS vs. PhotoSat Data

- Cross Sections
  - North Pit Wall
  - Overburden Top Cut
Millennium Pit – Cross Sections

- Blue Line - PhotoSat Data
- Red Line – Trimble VX Scan Data
Millennium Pit – Cross Sections

- **Overburden Top Cut**
  - Red Line – GPS Survey Data – March 9
  - Blue Line – PhotoSat Data – March 7
  - Black Line – PhotoSat Data – April 3
  - PhotoSat captured sloughing which is unsafe to survey with GPS.
PhotoSat Customized Data

- Convert DEM data and Orthophotos to Suncor’s Local Mine Grid Coordinates
- Filter DEM data
  - Reduce density of point cloud in flat areas.
- Create Break Lines (Crests and Toes)
  - Used for visual reference on maps with and without contours.
PhotoSat Challenges

- Limitations of satellite mapping
  - Shadows
  - Black Surfaces
    - Petroleum Coke Stockpile
    - Active Oilsands Pits
  - Tree Cover
  - Snow Cover
    - October – March
  - Cloud cover
## Suncor stereo satellite topographic mapping dates 2013-2014

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<td>1. January 11</td>
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<td>3. February 23</td>
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<td>5. March 24</td>
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<td>15. November 18</td>
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<td>16. December 30</td>
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In 2014

- Suncor Survey Department continues to use Trimble GPS equipment for weekly surveys of accessible areas in
  - Mine Pit Advance
  - Overburden Dykes and Dumps
  - Tailings Construction
    - Tailings Reduction Option
    - Tailings Dykes
- For survey areas that not accessible…
In 2014

- Suncor has been using PhotoSat data for surface updates twice per month in
  - Tailings Reduction Operations (TRO)
    - Sand Dump 8
    - DDA Systems
  - Tailings Pond Beaches
- Suncor has been using PhotoSat data for surface updates once per month in
  - Mine Pit Advance
  - Overburden Dumps
PhotoSat Technology  Background
Four key technical components enabling 15cm accuracy mine tailings mapping from space

Adaptation of seismic processing systems

High resolution stereo satellite photos

Graphics Processing Units (GPUs)

Oil sands surveying and 450+ other projects

Characterize the satellites and optimize the process
High resolution stereo satellites

WorldView-1 50cm greyscale 2008

WorldView-2 50cm colour 2010
Ground elevations are measured from the parallax of the satellite stereo pairs.
“Seismic” processing of stereo satellite photos

Satellite topographic surface displayed in a 3D seismic workstation.
PhotoSat 3D stereo satellite processing and visualization system
Better topographic detail

Conventional Photogrammetric mapping

PhotoSat mapping
Lower topographic noise

Photogrammetric mapping

PhotoSat mapping
Better resolution of steep slopes

Photogrammetric mapping

PhotoSat mapping
In collaboration with Suncor PhotoSat developed a process for automatically mapping the mine site toes and crests.

We have been contracted to provide this service every 2 weeks for the balance of 2014.
Millenium Toes and Crests
Millenium Mine Toes and Crests
In collaboration with Suncor PhotoSat, is developing a process for automatically mapping the thickness of the Mature Fine Tailings dewatering cells between satellite mapping passes in increments of 15cm thickness.
System 1, Isopach June 29 to July 13
System 1, Isopach July 13 to July 27