Continuous Satellite Surveying for Oil Sands Tailings Management

December 2016
Adrian Mitchell, PhotoSat
Over 650 elevation survey projects worldwide
Background

• In 2008, PhotoSat began development of a new elevation surveying process to meet the needs of clients who struggled to get LiDAR or reliable ground survey crews for international mining and petroleum exploration.

• Because PhotoSat was not a traditional survey company, we re-imagined how elevation data could be extracted from satellite imagery and developed new algorithms adapted from Seismic Processing, optimized for modern hardware.

• Results were better than expected and better than ever previously derived from commercial satellite data.
What is Satellite Surveying?

Ground elevations are surveyed using the parallax between the satellite stereo pairs.

www.photosat.ca
What is Special about PhotoSat Surveying?

- High resolution stereo satellite photos
- Adaptation of seismic processing algorithms
- Graphics Processing Units (GPUs)
- Oil sands surveying and 650+ other projects
- Characterize the satellites and optimize the process
PhotoSat Surveying Advantages

Conventional Processing vs. PhotoSat Surveying

Better resolution of detail and ground features
PhotoSat Surveying Advantages

Conventional Processing | PhotoSat Surveying

Better resolution of Steep Slopes
PhotoSat Surveying Advantages

Conventional Processing vs. PhotoSat Surveying

Improved noise reduction
Application to Tailings Monitoring

- Accuracy and resolution of PhotoSat Surveying has reached the point where it is applicable for continuous monitoring of mines and tailings areas, as well as volumetric calculations of soil (material) changes.

- In 2012, the survey team at Suncor approached us to compare our technology to other elevation survey options available for monitoring their TRO cells.

- PhotoSat Surveying was compared with ground GPS (Trimble GPS), ground spatial scanners (Trimble VX) and airborne LiDAR.
Tailings Monitoring Evaluation 2012

- **Trimble R8 GNSS GPS used on compacted tailings**
  - < 20% of total Sand Dump area was accessible

- **Trimble VX used to scan DDA Cells**
  - Very slow, multiple set-ups, sparse data

- **LiDAR was used for all TRO Cells**
  - Huge point-clouds
  - Slow data delivery
  - Once errors were fixed, good data

- **PhotoSat Surveying**
  - Challenges with clouds
  - Customized to meet client needs (toes & crests, waterbody polygons, thinned data files, data formats, etc.)
Application to Tailings Monitoring

- Since the evaluation was concluded, PhotoSat Surveying has been expanded to include their entire mine site.
- Accuracy has now improved to sub 15cm.

Comparison with 359 surveyed checkpoints
RMSE 12.5cm
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<th>GCP</th>
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Example 1: Beach Excavation

Pre Excavation:
- GPS Survey: Blue 1’ contours
- PhotoSat Survey: Black 1’ contours

Post Excavation:
- GPS surface: $77,982 \text{ yds}^3$
- PhotoSat surface: $77,041 \text{ yds}^3$
- Difference: $941 \text{ yds}^3$ (1.2%)
- On average, the PhotoSat Survey was lower than the GPS data by ½ inch

\[
\frac{941 \text{ yds}^3}{70,134 \text{ yds}^2} = \frac{0.0134 \text{ yds}}{\text{½ inch}}
\]
Example 2: Sand Dump Lift Thickness Beach Profiles

Slide courtesy of client

Jan 20

Feb 23
Example 2:
Sand Dump Lift Thickness Beach Profiles

Difference Contours
• 50 cm tailings thickness contours Jan 20 to Feb 23

Cross-Section
Example 2:
Sand Dump Lift Thickness Beach Profiles

Cross-Section at Sand Dump

Slide courtesy of client
Tailings Monitoring

• Deliverables include:
  – Orthophotos (base data for survey calculations)
  – Survey data (50cm posted grid)
  – Automatically extracted toe & crest contours of all features throughout the mine
  – Automatically calculated waterbody polygons (IR)
  – Thinned version of PhotoSat Survey file

• Tailings surveys delivered 48-72 hours from acquisition, remainder of survey within 5 days of acquisition
Tailings Monitoring

Sand Dump Toes, Crests and Waterbodies over Orthophoto

www.photosat.ca
Products for Tailings Monitoring

Sand Dump Toes, Crests and Waterbodies over Orthophoto
Waterbody Polygons

Satellite orthophoto of main waterbodies with detailed features
PhotoSat Grid Thinning

- Developed to aid client deal with large file sizes and increase handling speed
- Maintains resolution and detail and increases usability
Summary

• PhotoSat Surveying has achieved accuracy levels suitable for tailings monitoring

• Reliable, consistent, regular surveying of large areas has been demonstrated and verified

• The technology continues to improve as more satellites are launched and added to the constellations
Thank You!

Adrian Mitchell  
(604) 681-9770  
adrian@photosat.ca

Please visit our website:  
www.PhotoSat.ca