Evaluating Technology-based Assessments for Use in Reclamation Certification of Footprint

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Background

- Companies responsible for ***industrial sites*** are required to complete ***reclamation certification*** to demonstrate that sites are ***self sustaining*** and meet ***equivalent land capabilities***
- Reclamation certification requires ***time***, ***cost,*** and ***labor intensive in-field assessments***
- ***In-field*** data collection based on “spot checks” and results may ***not be fully reproducible*** (human bias)
- Remote sensing technologies could ***augment*** the reclamation certification process ensuring ***repeatability*** of data collection for the entire footprint
- ***Time series*** of a site spanning decades can be created using remote sensing
- ***Remote sensing outcomes*** can also be ***variable*** (timing of image acquisitions)

How can we quantify the risk of not achieving the intended outcomes when applying remote sensing technology, compared to in-field data collection?

Time, Financial and Safety Considerations

- Total cost until a reclamation certificate is issued around ***$25,000*** for ***single wellsites*** and ***up to $100,000*** for ***larger OSE programs***
- ***172,354*** abandoned and inactive wells still require reclamation (Well Status | Alberta Energy Regulator (aer.ca))
- Using remote sensing technologies, the ***cost per site assessment*** can be ***reduced by up to 75%*** (based on contractor budgeting for this project)
- Remote sensing has the ***potential to accelerate site assessments*** with ***considerable time savings***
- Maximizing ***safety*** of field assessment crews especially in remote locations

http://blog.abmi.ca/2014/02/26/we-have-a-reclamation-certificate-but-is-it-good-enough/ -

https://www.cbc.ca/news/canada/calgary/bakx-owa-seqouia-pwc-alberta-orphan-wells-1.7336635 -

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Project Objectives

- Evaluate ***remote sensing-based approaches*** relative to ***field-based approaches*** for landscape, soil, and vegetation parameters used in site assessments
- ***Identify risk*** and ***benefits*** of field vs. technology-based assessments for reclamation certification and ***evaluate trade-offs***
- Develop a ***guidance document*** for practitioners and regulators on the use of remote-sensing technologies in reclamation certification
- Report on opportunities to use remote-sensing technologies to ***evaluate wildlife habitat***

Credit: Hatfield Consultants LLP

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What is Remote Sensing

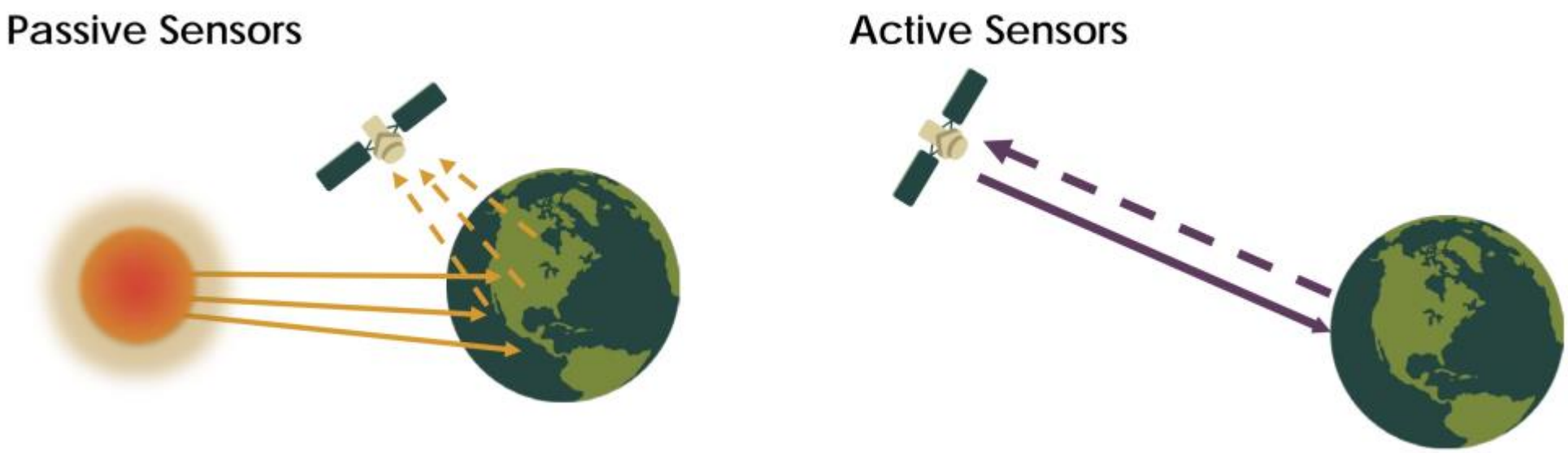

***Diagram of a passive sensor versus an active sensor**. Credit: NASA Applied Sciences Remote Sensing Training Program.*

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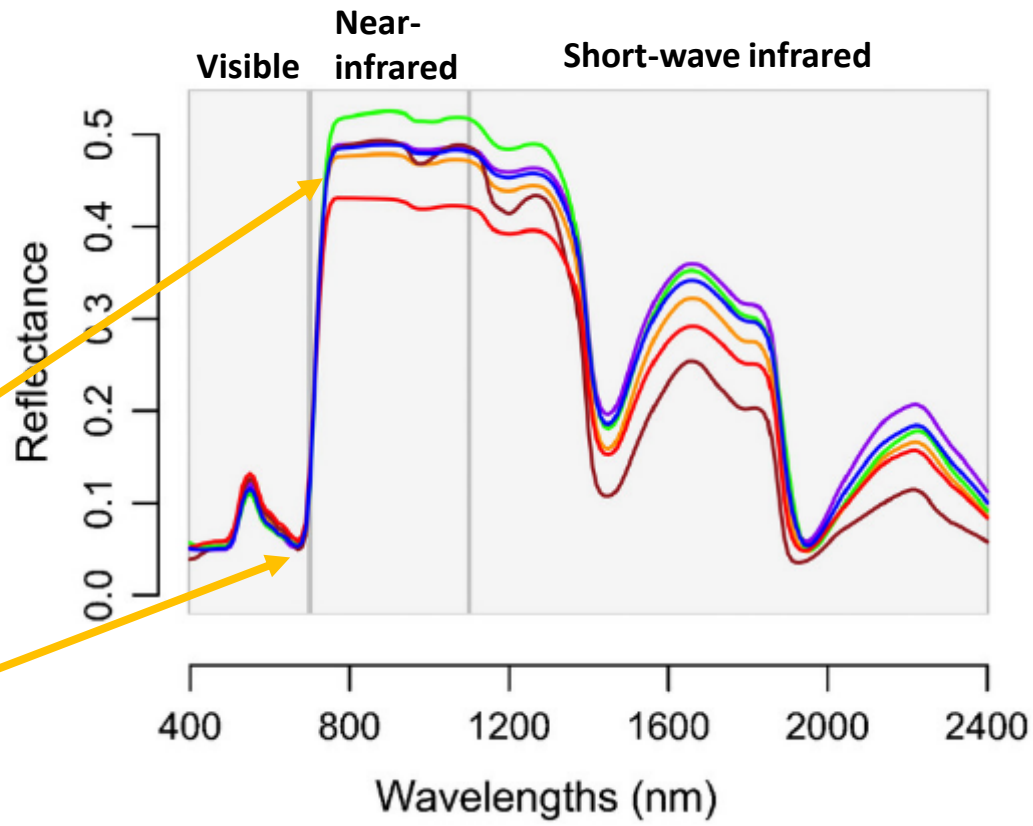
What is Remote Sensing – Passive Sensors

- ***Passive sensors*** capture reflected solar radiation
- Sensors differ in ***spectral*** and ***spatial resolution***
- Typical multispectral sensors cover parts of the ***visible***, ***near-infrared*** spectrum, and ***short-wave infrared***
- Reflectance ***varies*** among objects and seasons
- A typical index to differentiate vegetated from unvegetated areas is the ***Normalized Difference Vegetation Index*** (NDVI)

$$NDVI = \frac{NIR - red}{NIR + red}$$



Meireles et al. (2020), Leaf reflectance spectra capture the evolutionary history of seed plants. New Phytol, 228: 485-493. https://doi.org/10.1111/nph.16771

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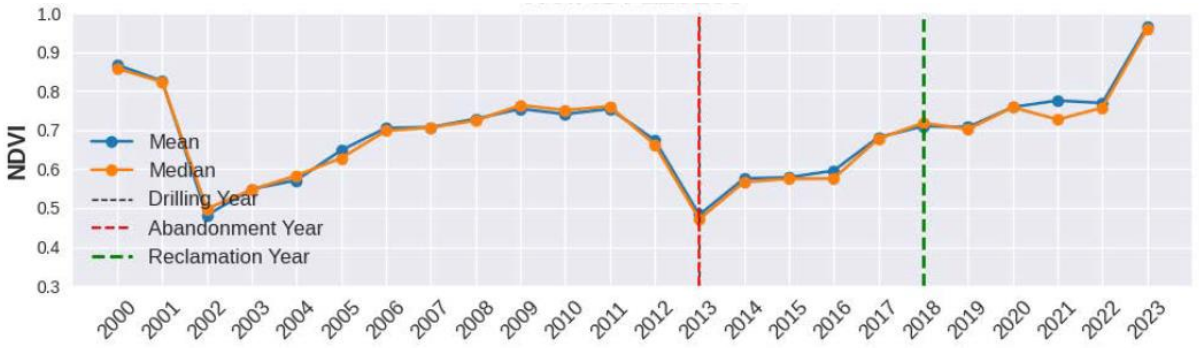
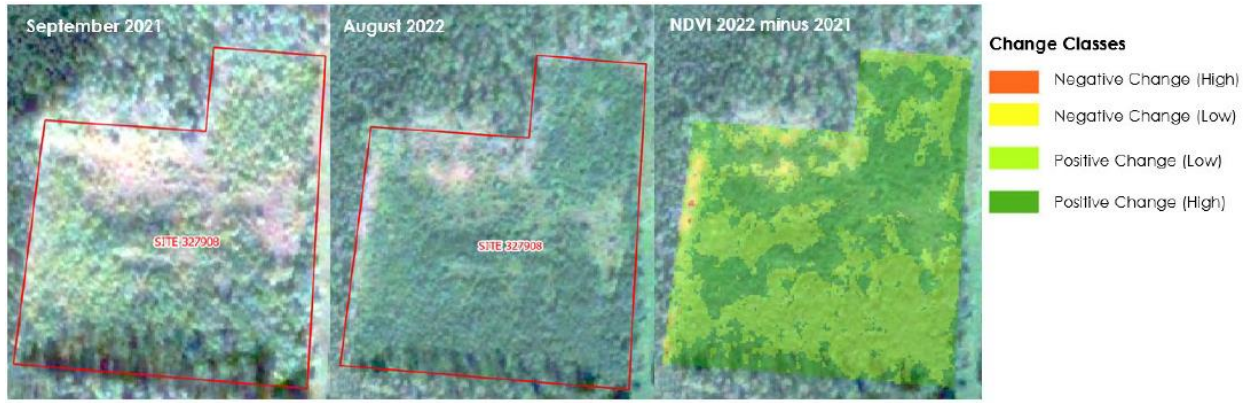
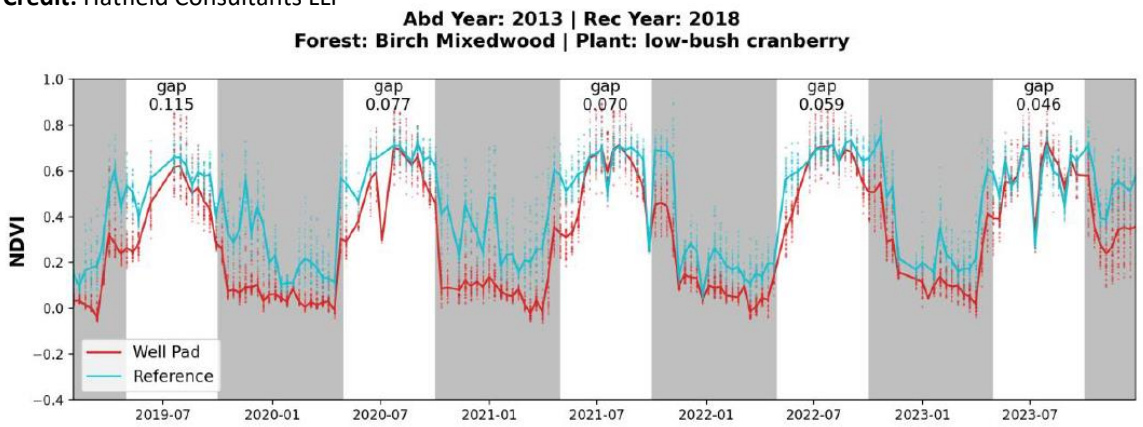
What is Remote Sensing – NDVI examples



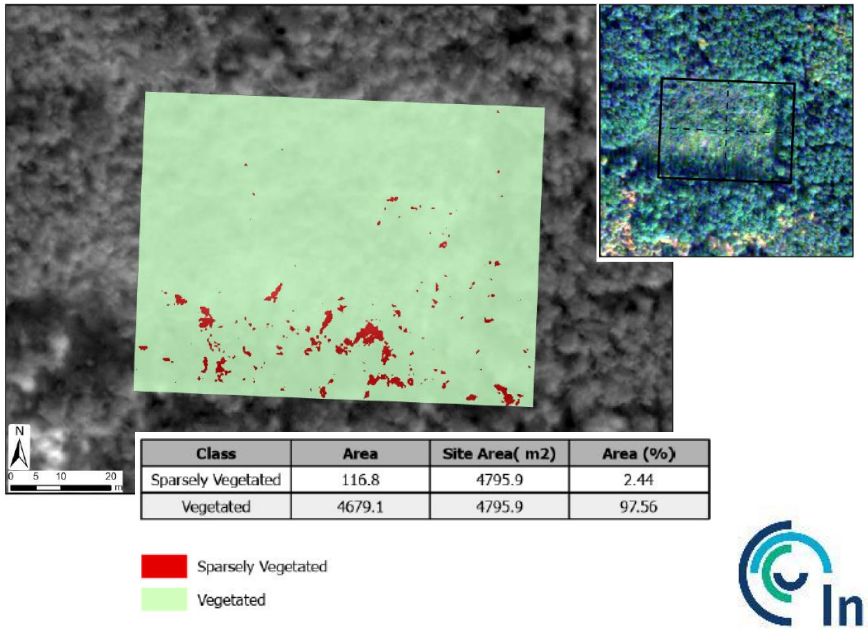
Credit: Hatfield Consultants LLP



Credit: Pleiades Neo Image provided by SkyWatch overlaid with derivates calculated by Stantec



Credit: Hatfield Consultants LLP



Class	Area	Site Area(m2)	Area (%)
Sparsely Vegetated	116.8	4795.9	2.44
Vegetated	4679.1	4795.9	97.56

Credit: Vertex Resource Group Ltd.

- Values approaching +1 indicates dense and healthy vegetation
- 0 suggests barren areas or sparse vegetation
- Values approaching -1 indicate water bodies (lack of dry land)

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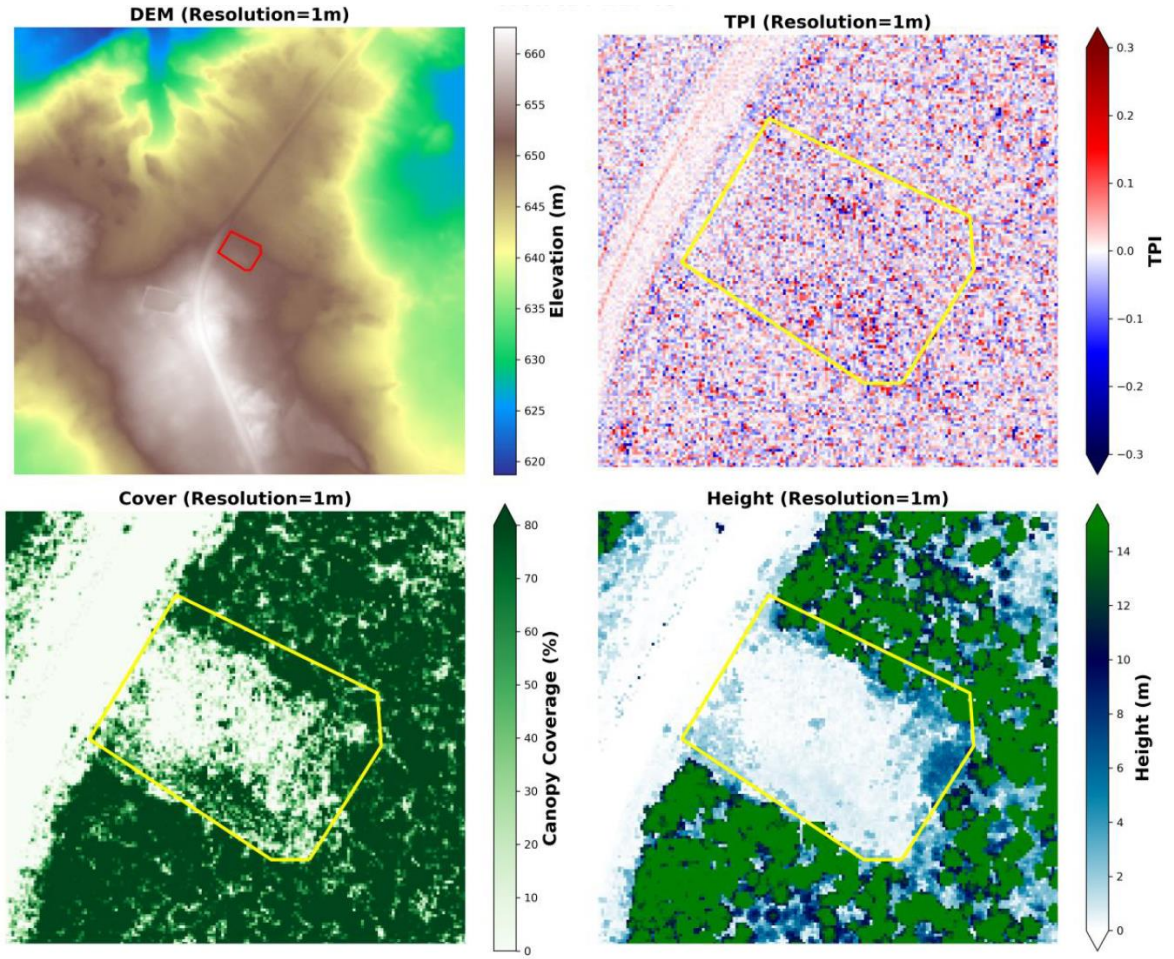
What is Remote Sensing – Active Sensors

- ***Active sensors*** such as LiDAR (Light detection and ranging) emit laser pulses to measure distances to Earth's surface or other objects
- Calculates the ***distance*** between objects and the sensor by measuring the ***time delay*** between ***emission*** and ***detection*** of the laser pulses
- Combines millions of distance measurements and aggregates them into ***point clouds*** used for various outcomes (e.g., elevation, terrain classification, heights)



Credit: Hatfield Consultants LLP

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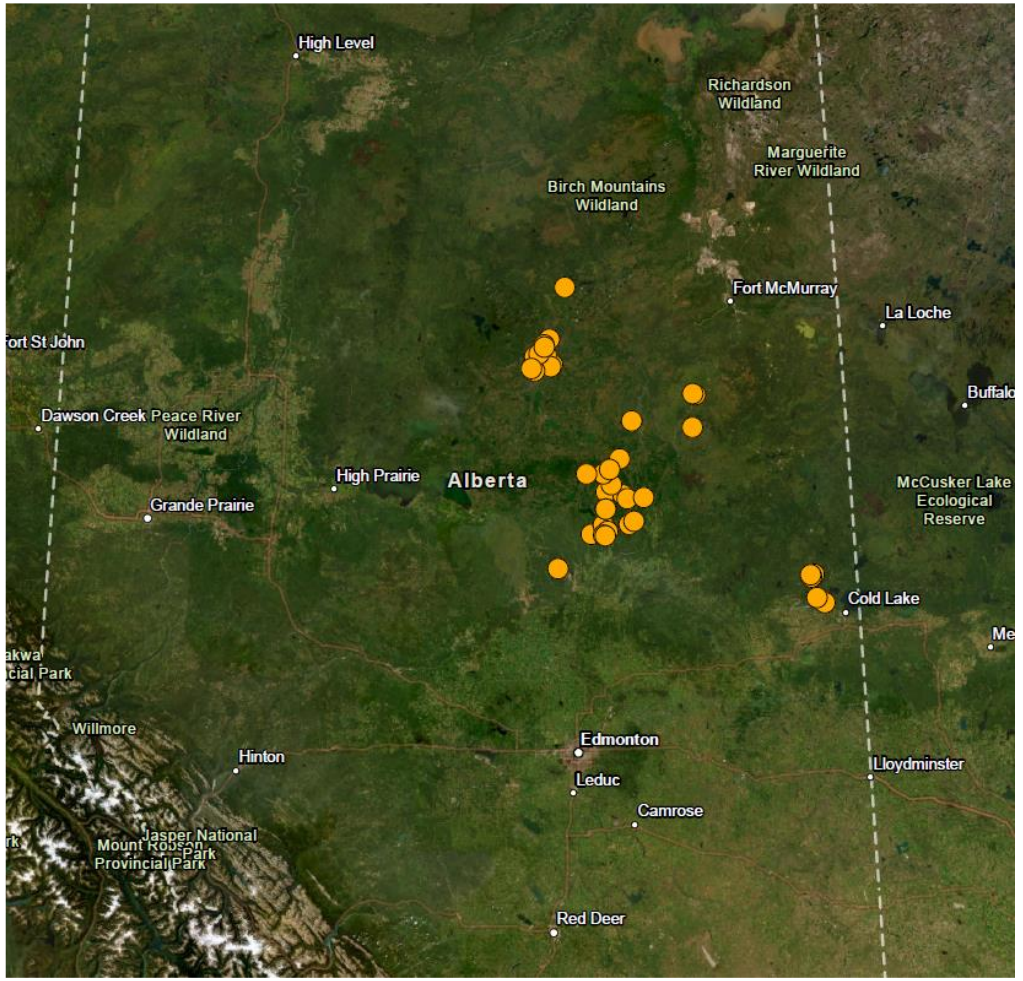
Methodology

- Identified ***30 wellsites*** <u>with</u> issued reclamation certificates
- Stantec, Vertex and Hatfield to run ***20 remote sensing-based site assessments*** per consultant on the set of 30 sites
- Consultants were ***free to choose how to conduct the site assessment*** but following directly or indirectly the "*2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands*"
- InnoTech provided consultants with remote sensing data products (LiDAR, multispectral and VHR imagery) but were allowed to leverage any other ***freely available*** data products for their assessments



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First results

- Clear differences among consultants
- Cons. 1 introduces a new “uncertain” category
- Cons. 2 would recommend a “no pass” on 40% of the assessed sites
- Cons. 3 in full agreement with the outcomes based on the in-field DSAs
- Cons. 1+2 recommend a “no pass”

What about the “uncertain” category? Could this be useful?

Recommendation
- no pass
- pass
- uncertain

Two independent RS assessments **fail** a site **with** a reclamation certificate. What could this mean?

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First results

-
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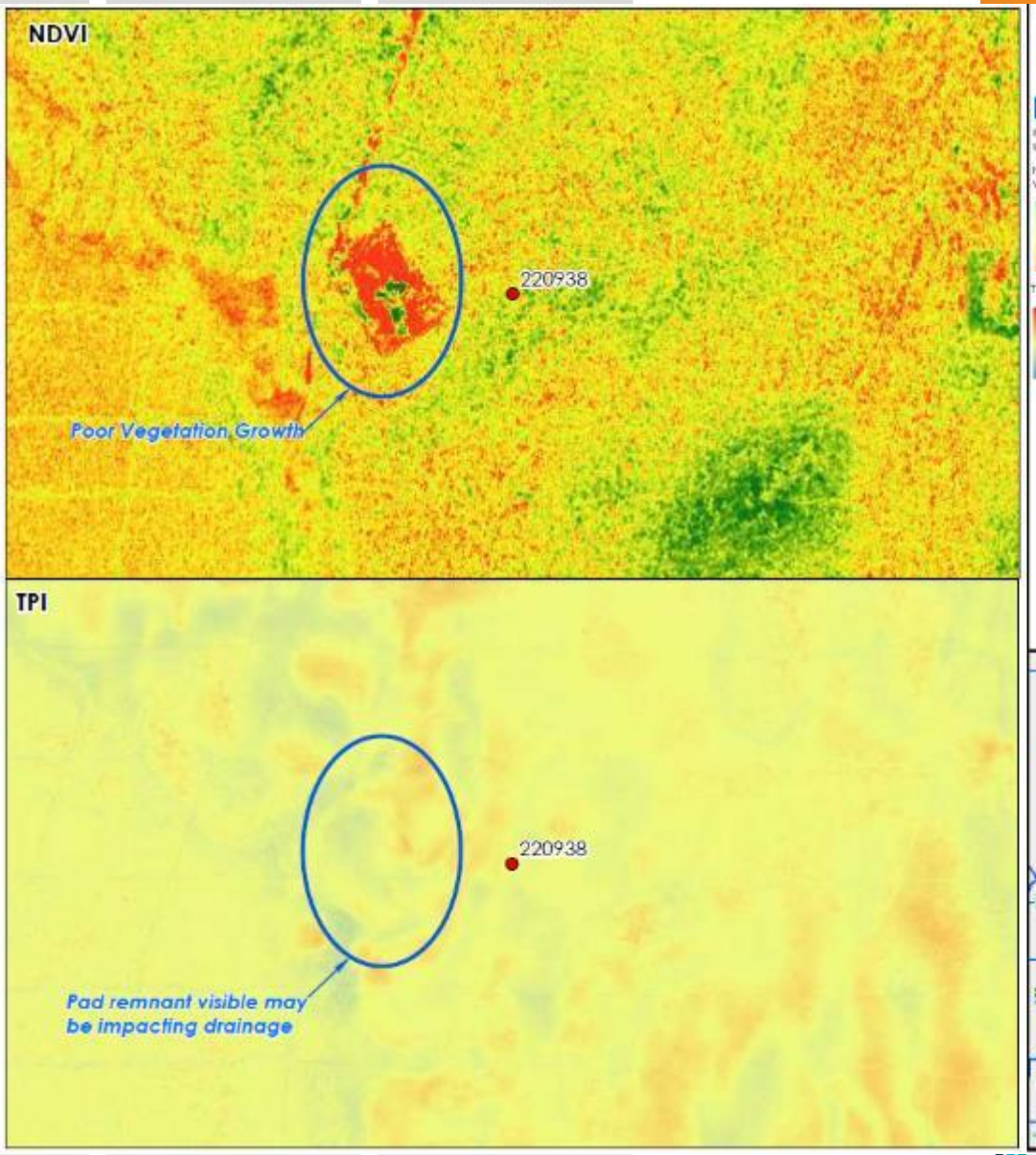
Consultant 1 | Consultant 2 | Consultant 3



cons: 3

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194296 -

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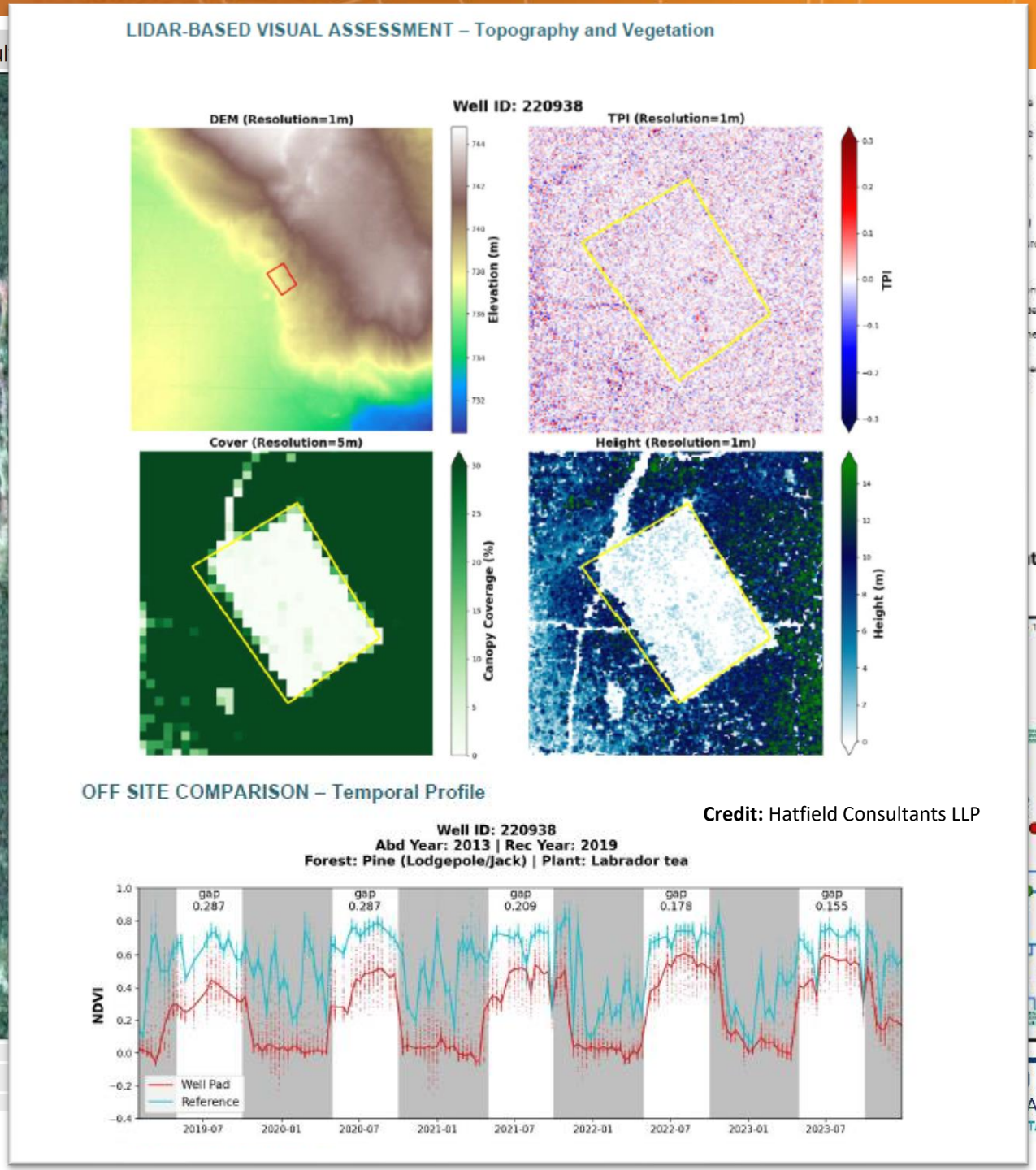
First results



Credit: Hatfield Consultants LLP

cons: 3

194542 -
194296 -

Assessment Overview

Technology-based Assessment Results – Consultant 1		
Decision Tree	Pass	Probability score of pass = 93.5%
Spectral Recovery	Pass	Vegetation indices did not fully recover on the recorded reclamation year (2019), but basically reach the pre-disturbance level in years after
Comparison with Off-Site Location	Pass	Vegetation indices of well pad show similar pattern with reference off-site area after reclamation year and no obvious gaps observed during summer
Visual Assessment (VHR)	Uncertain	High-resolution imagery was obtained in early spring. While vegetation is visible in some portions of the well pads, extensive areas may not yet exhibit full growth of shrubs and grass.
Visual Assessment (LiDAR)	NA	
Final Status	**PASS**	

Assessment Overview

Technology-based Assessment Results – Consultant 2		
Sign of surface staining and contamination	No	No contamination or spill recorded at site ground from near Infrared or ultraviolet bands shows no anomalous reflectance (Baoyang Liu, 2024)
Presence of industry artifacts	No	New growth is visible and evenly distributed across the old facility clearing
Canopy re-vegetation consistent with ecological unit	Yes	Site is in the DEP layer Labrador tea - mesic - Pj-Sb c1 feature. New Growth is visible and slow growing, but more ground data would be required to confirm the ecological unit outside of the c1 Pine leading land cover type the team assigned.
NDVI indicates healthy spectral response	Yes	Appears to have a very healthy NDVI spectral Response. See Map 7 Annotations
Topography consistent with adjacent units to enable site drainage	Yes	According to TPI the site is laying in level and somewhat lower position from its surroundings but no unnatural scaring or drainage concerns due to past industrial activity.
Presence of other active sites upstream within 1km	No	None
Has spill be recorded at site	No	No reports from AER or Abadata
Site has ground water well within 1km	No	Reviewed Alberta Water Well Information Database (AWWID)
Additional Comments		Site has healthy and good growth of Aspen similar to adjacent stands

Assessment Overview

Technology-based Assessment Results – Consultant 3	
Pass/Fail	Pass
Vegetation Cover	No issues
Density/Cover Class	Grid 2 lower, but actual densities on ground would be greater than what LiDAR can detect
Disturbance Intensity	Minimal
Ecosite Limitations	None
Optical Imagery	Displays forest development better than LiDAR
Landscape/Soils	No issues
Professional Judgement Required	Yes
Comments	Grid 2 lower tree/shrub cover and density due to naturally high native graminoid cover found in low areas with higher water tables.

Next steps

- Deep dive into the actual analyses and ***identification*** of the ***uncertainties/risks*** associated with each approach
- ***Quantify uncertainties*** and opportunities using remote sensing and in-field assessment to manage risk and resources to ***ensure best outcomes***
- Prepare a ***guidance document*** for practitioners and regulators on the use of remote sensing technologies in reclamation certification
- **PTAC member is providing *additional sites with DSAs completed in 2024* (not submitted for review, hence outcome is unknown) *+ sites not ready for DSAs (fail)***
- **All three consultants agreed to apply their approaches to 10 new sites (every consultant assesses the same 10 sites)**
- Additional opportunity to test outcomes on ***fully blind outcomes (pass/fail)*** to further understand differences and commonalities in assessment processes across consultants

Questions?

Please feel to reach out:

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