ISIGHT RPV SERVICES

WHITING

DURAROOT

SolSpec

Infrastructure | People | Environment

North Dakota Goals for Oil & Gas

Industry Vitality + Public Health + Environmental Stewardship

Governor Doug Burgum:

- Innovation instead of Regulation
- UAS BVLOS program for Bakken

Director Lynn Helms:

- Adoption of imaging technologies to increase efficiencies in well site reclamation program

The Problem

- 15,571 active wells that must be reclaimed
- Process can take 3-10 years
- 1,500 wells in reclamation status
- NDIC endeavors to inspect each site annually
- 32 field NDIC field inspectors
- ND Bakken spans 30,000 square miles

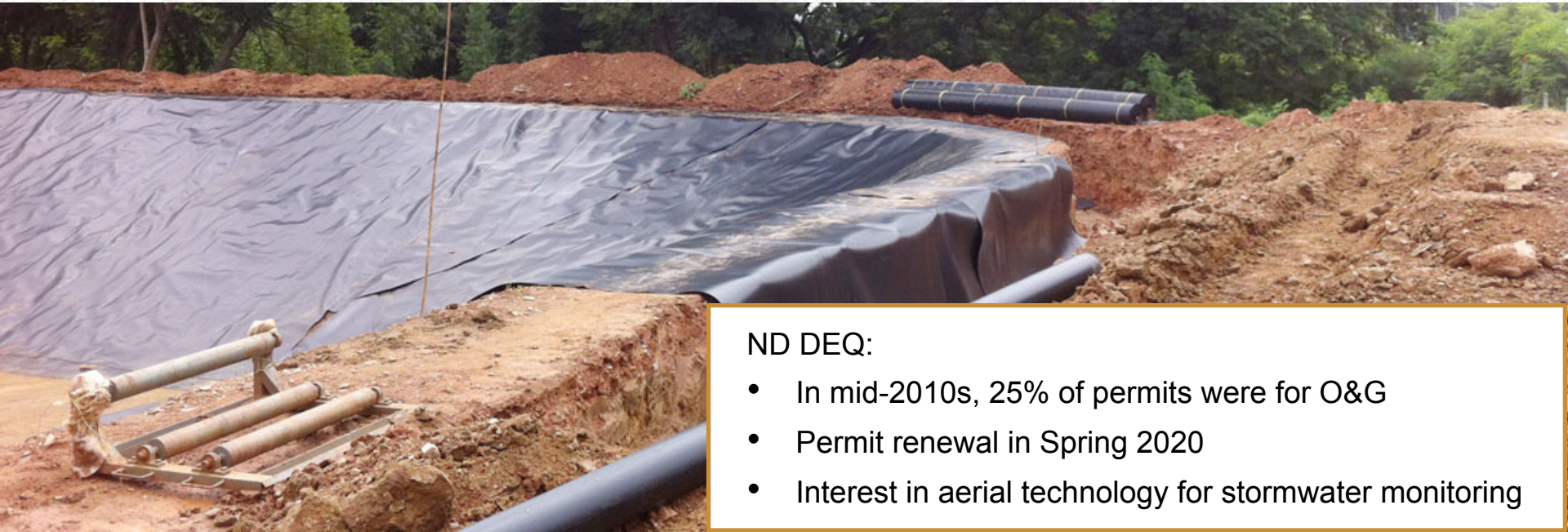
The Problem

- Unknown site conditions
- Backlog site reviews
- Scheduling delays
- Subjective inspection
- Delayed site clearance & bond release

The Problem

North Dakota Construction Stormwater General Permit

- Operator inspection every 14 days & within 24 hrs of storm event
- Site stabilization & 70% of pre-existing cover in 3 years, then 1 inspection/mo



ND DEQ:

- In mid-2010s, 25% of permits were for O&G
- Permit renewal in Spring 2020
- Interest in aerial technology for stormwater monitoring

The Pr…m

Accurate

Cheap

Fast

Similar to OGRP project G-037-73, 2016

Location 1 Aerial Vegetation Survey - Cover Classification

Well Pad: Location 1
Date of Assessment: 9/2/2016
Total Reclaimed Acres: 3.6
Legal Description: Section 16, Township 9N, Range 59W

Legend
Bare Ground
Native
Undesirable
Interim Cover
Baseline Cover

UAV: F550 Hex
Sensor: NIR Red Notch Filter
GSD: 2.5 cm
Altitude: 60 meters

N
0 25 50 100 Feet
1:1,380

Location 1 Vegetative Area					Location 1 Percent Cover			
Evaluation Type	Bare Ground (m^2)	Undesirable (m^2)	Native Cover (m^2)	Total Area (m^2)	Bare Ground (% Cover)	Undesirable (m^2)	Native (% Cover)	Percent of Baseline Native Cover
Baseline	120	16	644	780	15%	2%	83%	83%
Interim Cover	167	4387	9888	14442	1%	30%	68%	

Location 1 - Error Matrix

Classification Data	Class Types	Ground Validation Data (Known Cover Types) Native	Undesirable	Bare Ground	Row Total
	Native	10	0	4	14
	Undesirable	1	7	0	8
	Bare Ground	0	0	0	0
	Column Total	11	7	4	22
	Producer Accuracy	10	7	0	77%

The Problem

OGRP project G-43-01, 2018

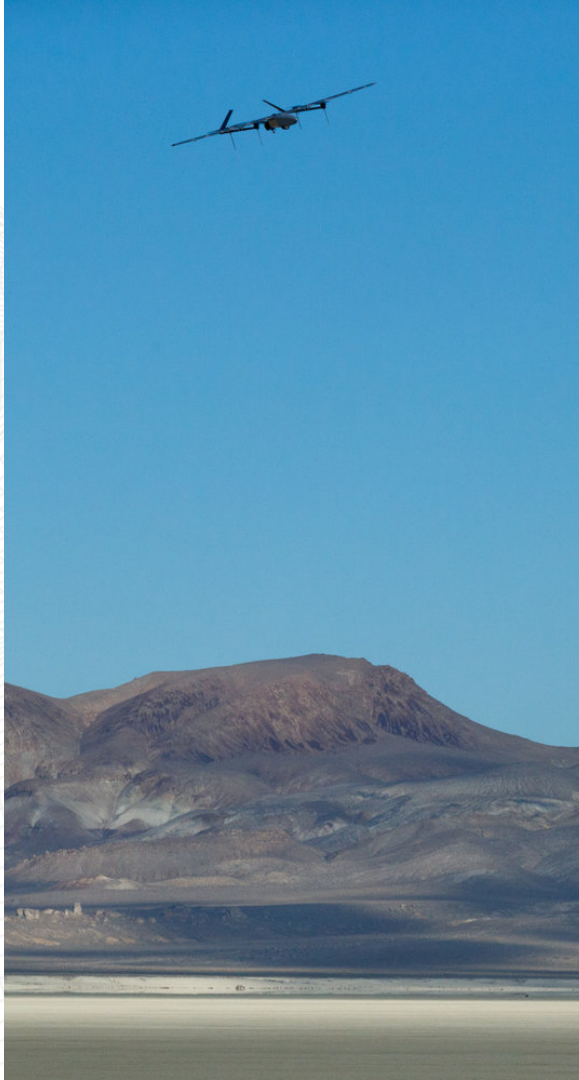
When it comes to aerial imagery…

“Huge amounts of data can be collected

…but those data require appropriate analysis.

To make analysis of large quantities of data economical,

automated data processing and analysis must be employed.”



The Proposal

Automation can resolve issues that inhibit operational performance

The Proposal

GOAL

Develop & validate a suite of **automated analytics** that **bring remote reclamation assessment technology to operational capacity** for industry, agencies, & the interested public of North Dakota.

The Proposal

GOAL

Maximize ROI for North Dakota by addressing **NDIC Research Priorities**:

- Optimum data storage architecture
- Deriving decision support tools from gross data
- Imagery provided to the manager for decision making
- Analysis of cost avoidance against current process
- Imagery tools that enable cost estimates & budgeting to complete reclamation
- Trusted third-party data organization system enabling industry & regulators to access imagery

The Propos

Model Development | Data Acquisition | Model Validation | Model Automation | Cost-Effectiveness Analysis

OBJECTIVES

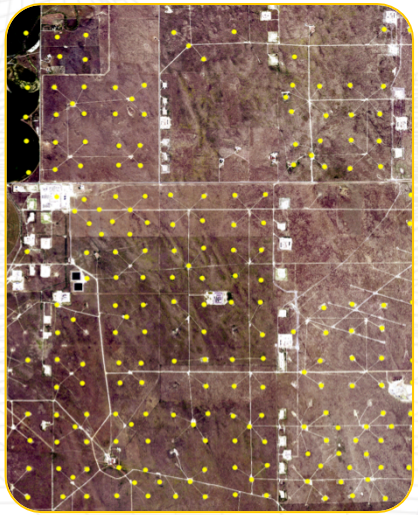
Model Development I: Remote Aerial Inspection Toolkit

- Preliminary Vegetation Cover Comparison
  - USDA National Agricultural Imagery Program (NAIP)

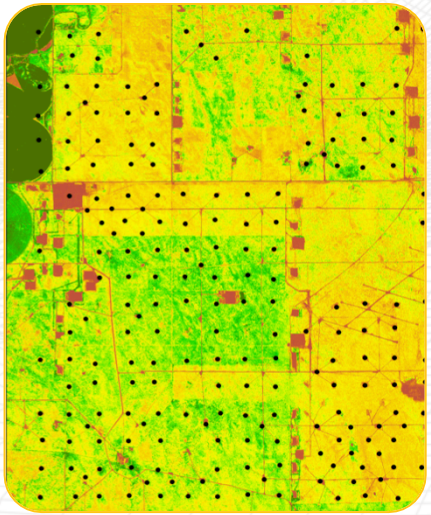
The Proposal

Preliminary Vegetation Cover Comparison

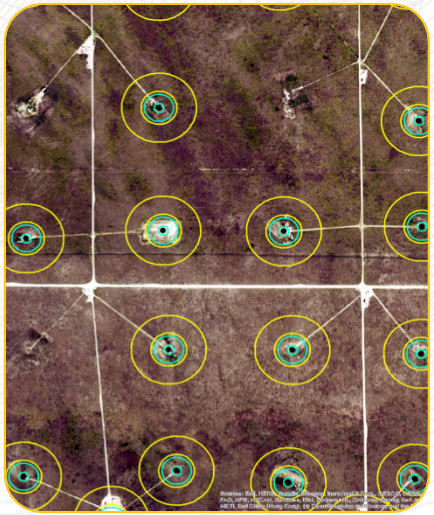
2,219 Whiting well sites



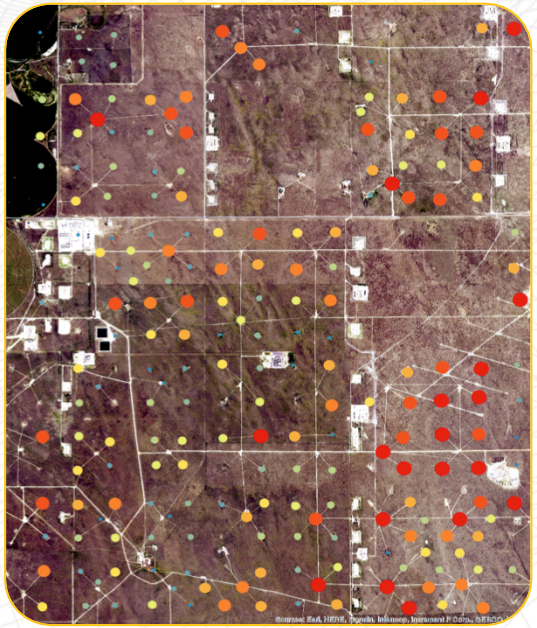
Well Locations



Vegetation Reflectance



Pad Analysis



Site Prioritization

The Proposal

OBJECTIVES

Data Acquisition

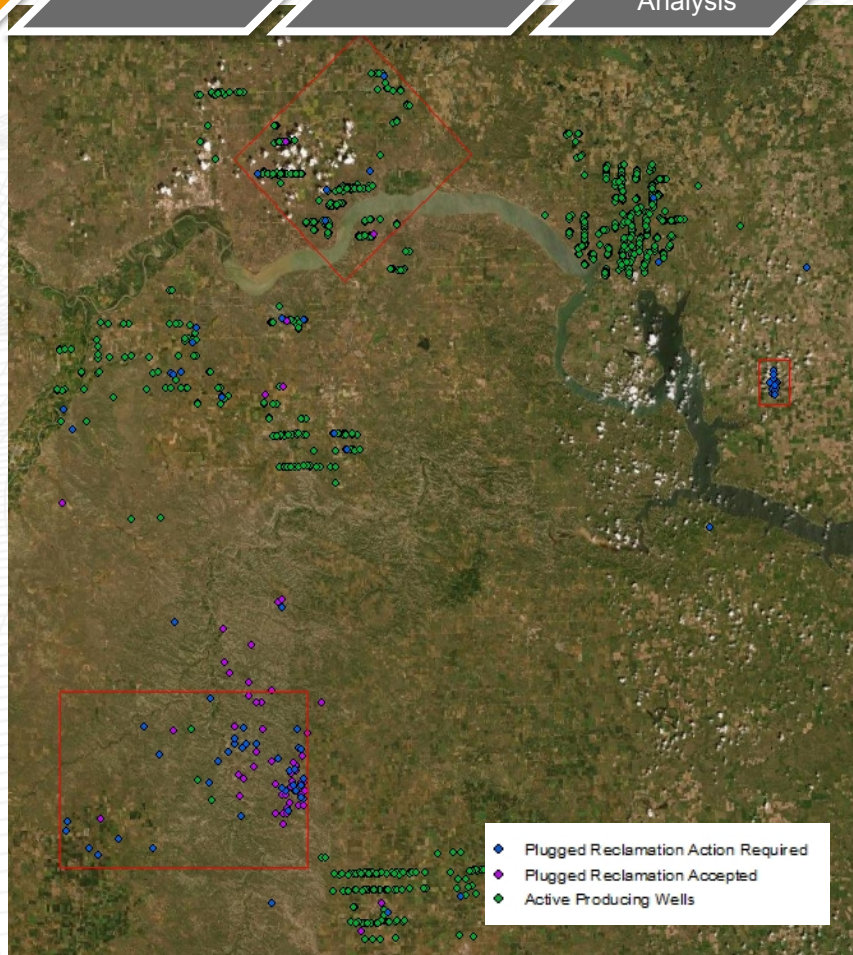
ISIGHT RPV SERVICES

Aerial Data Collection

WHITING

100 Whiting well sites

- 40 partially reclaimed active wells
- 50 plugged well sites in reclamation progress
- 10 fully reclaimed well sites



The Proposal

OBJECTIVES

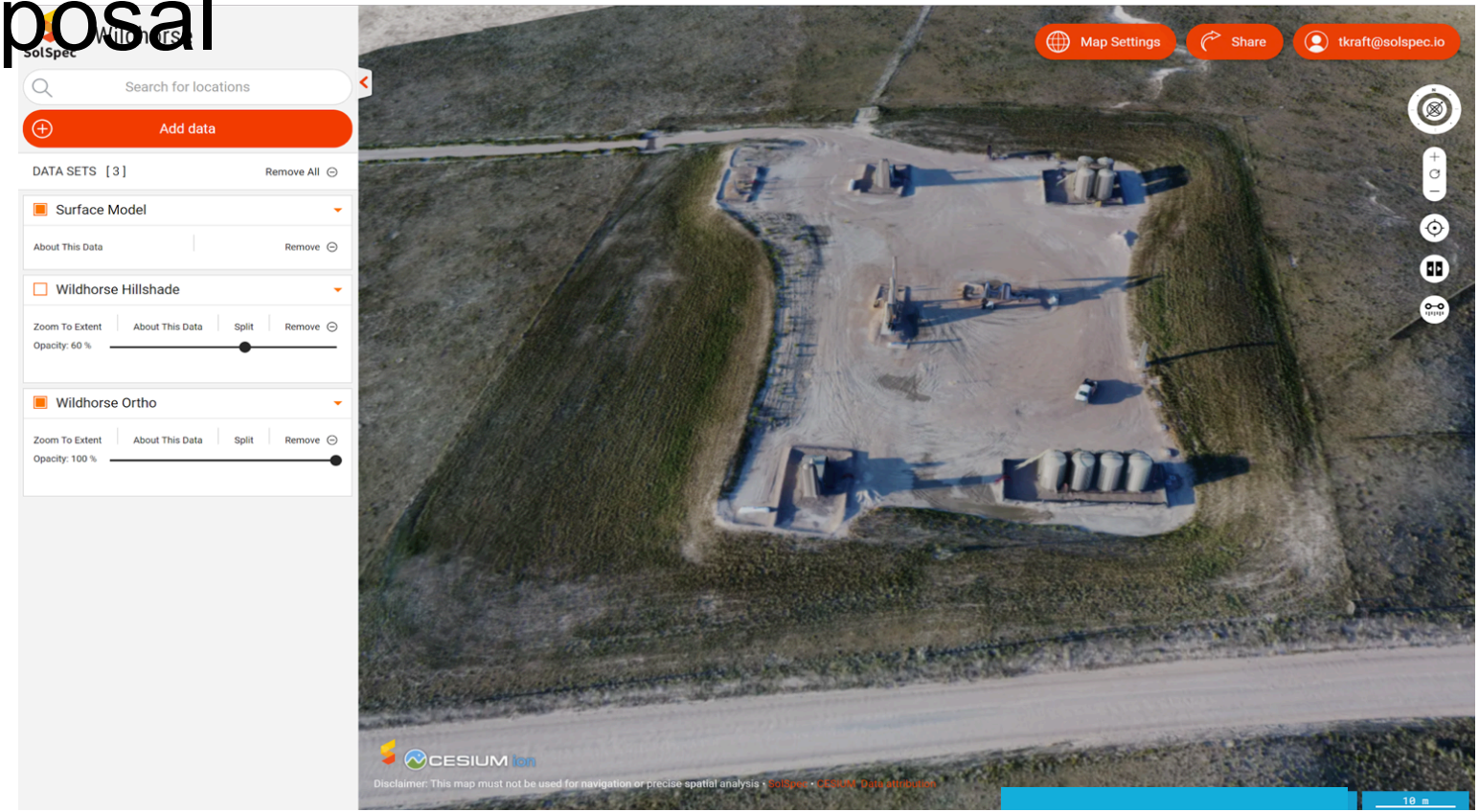
Model Development II: Remote Aerial Inspection Toolkit

- Preliminary Vegetation Cover Comparison
- Aerial Reclamation Inspection Comparison
  - Vegetative Continuity Comparison
  - Infrastructure Identification
  - Problematic Surface Hydrology Identification
  - Topographic Contouring Assessment
  - Volumetric Measurement

The Proposal

Vegetative Continuity Comparison

100 well sites: Ortho + DSM



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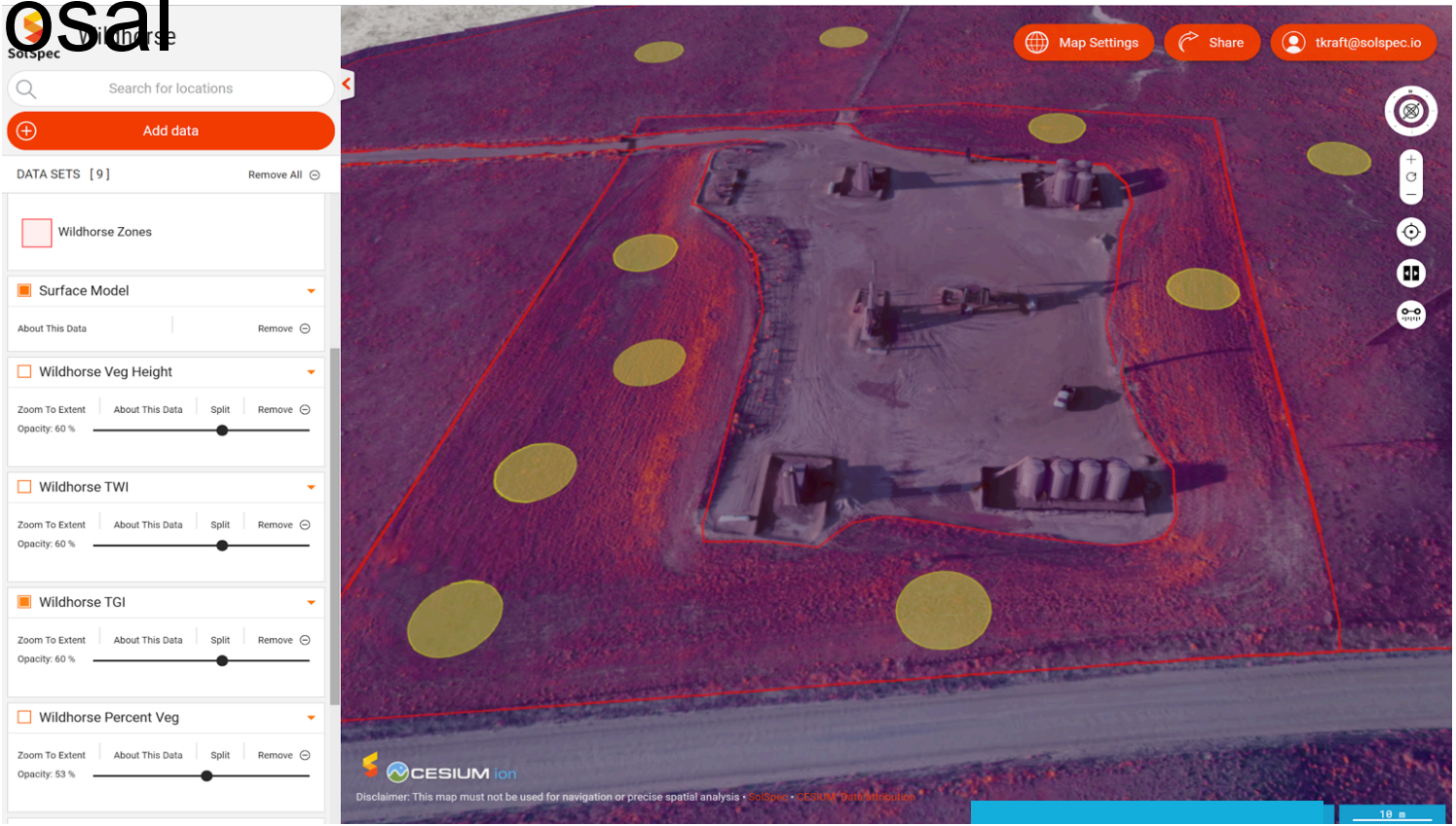
Vegetative Continuity Comparison

100 well sites: Vegetation Spectrum



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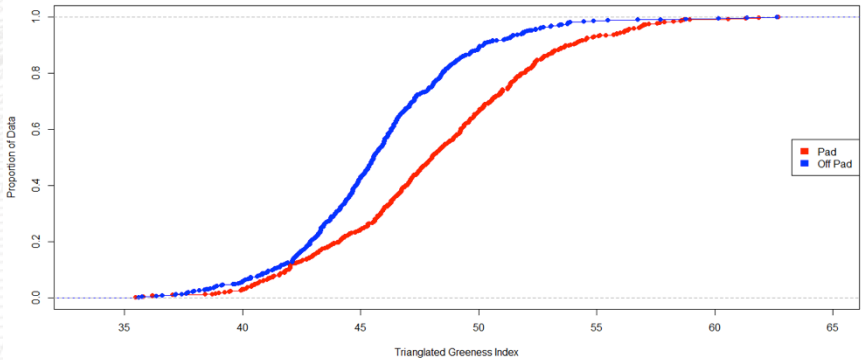
Vegetative Continuity Comparison

100 well sites

Vegetation Spectrum Assessment



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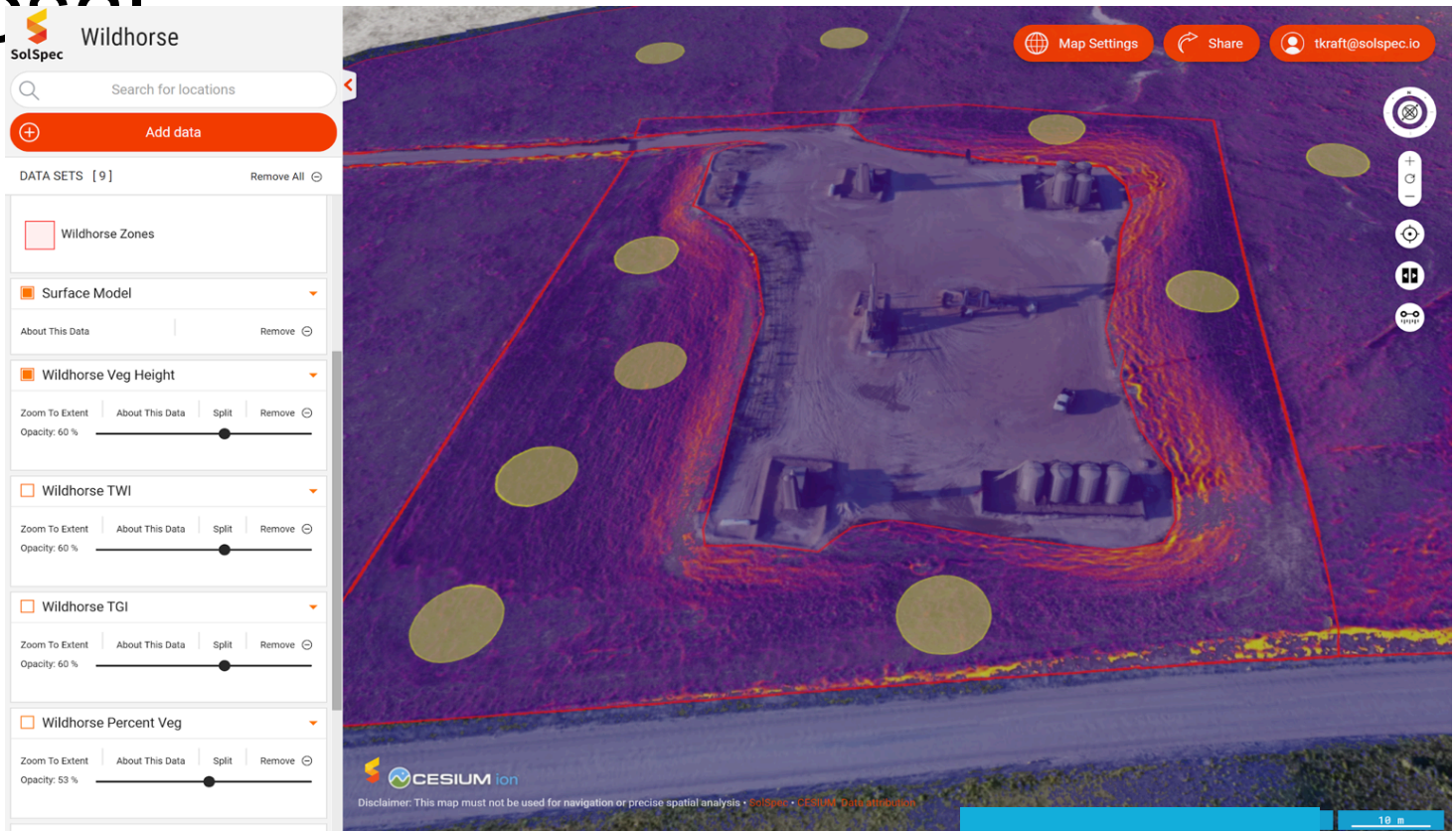
Vegetative Continuity Comparison

100 well sites: Vegetation Structure



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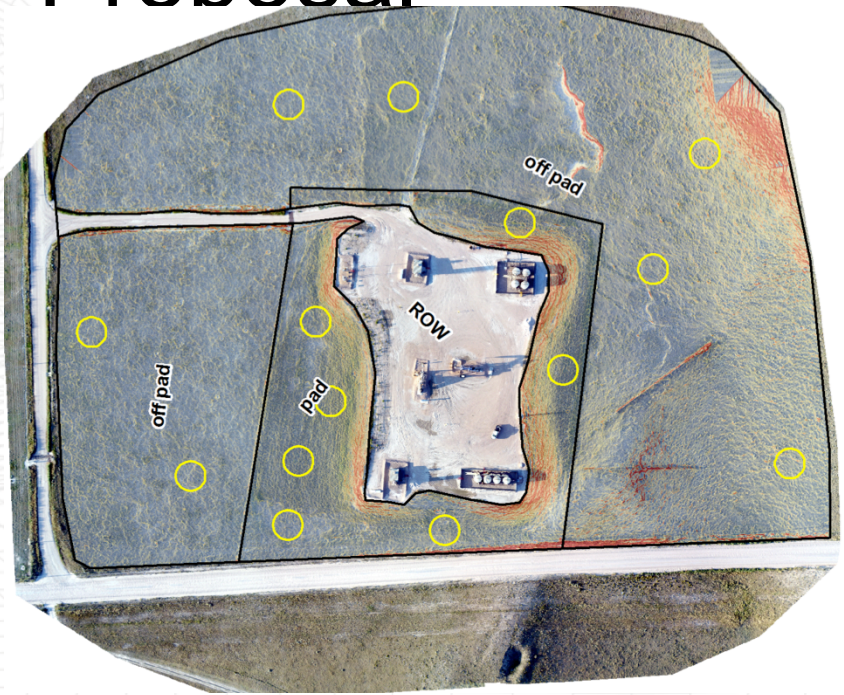
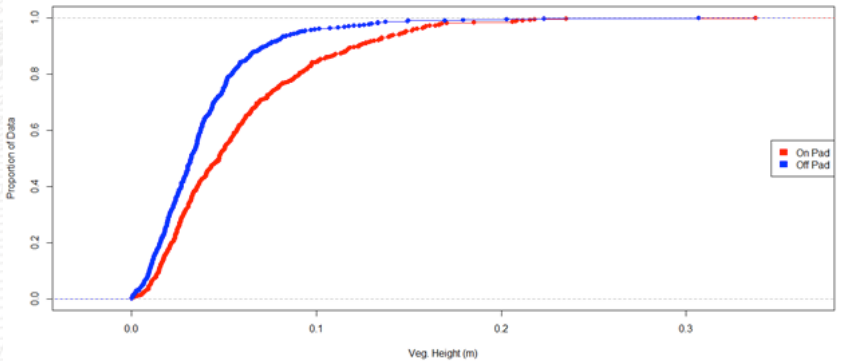
Vegetative Continuity Comparison

100 well sites

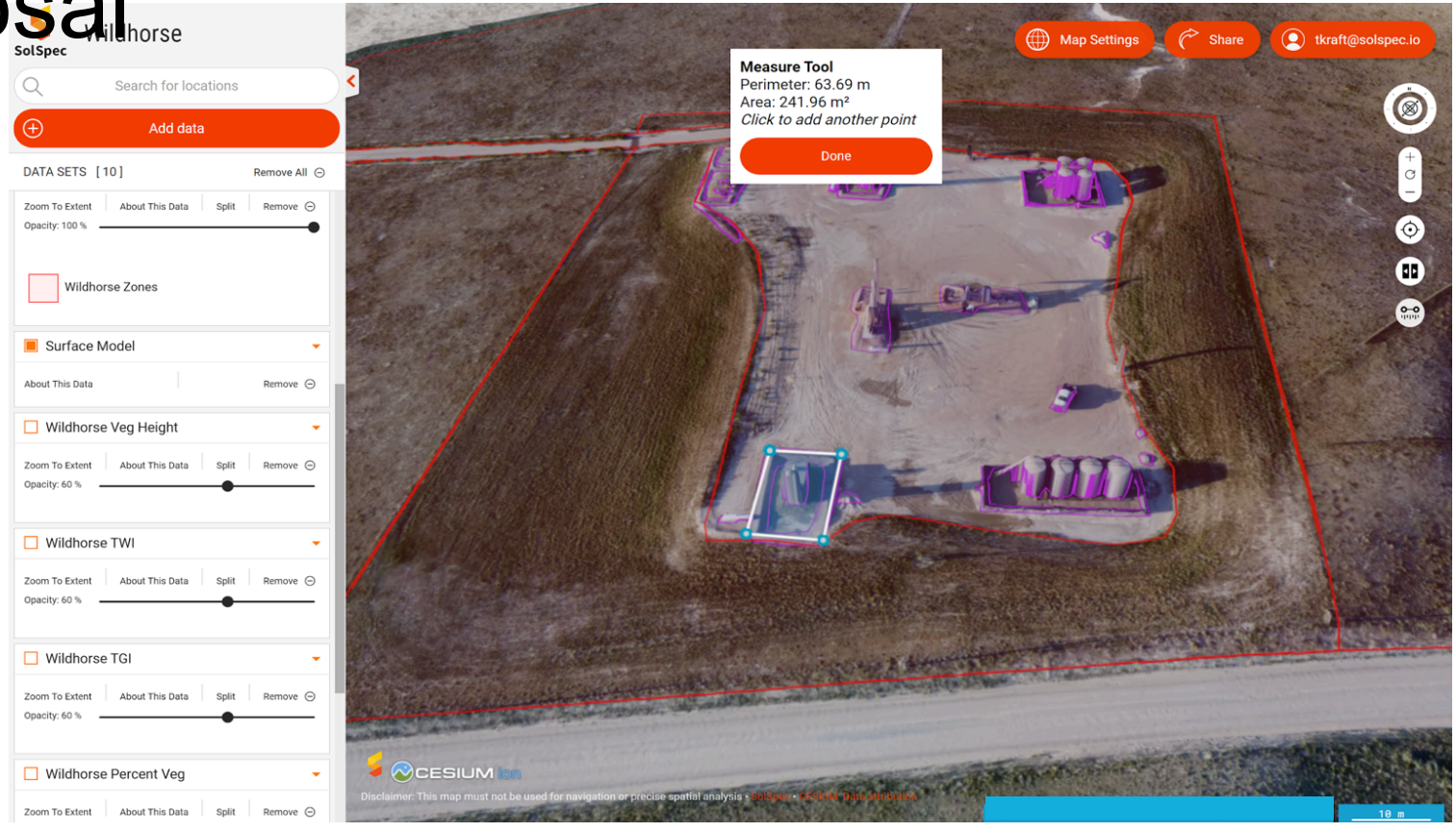


Vegetation Structure Assessment



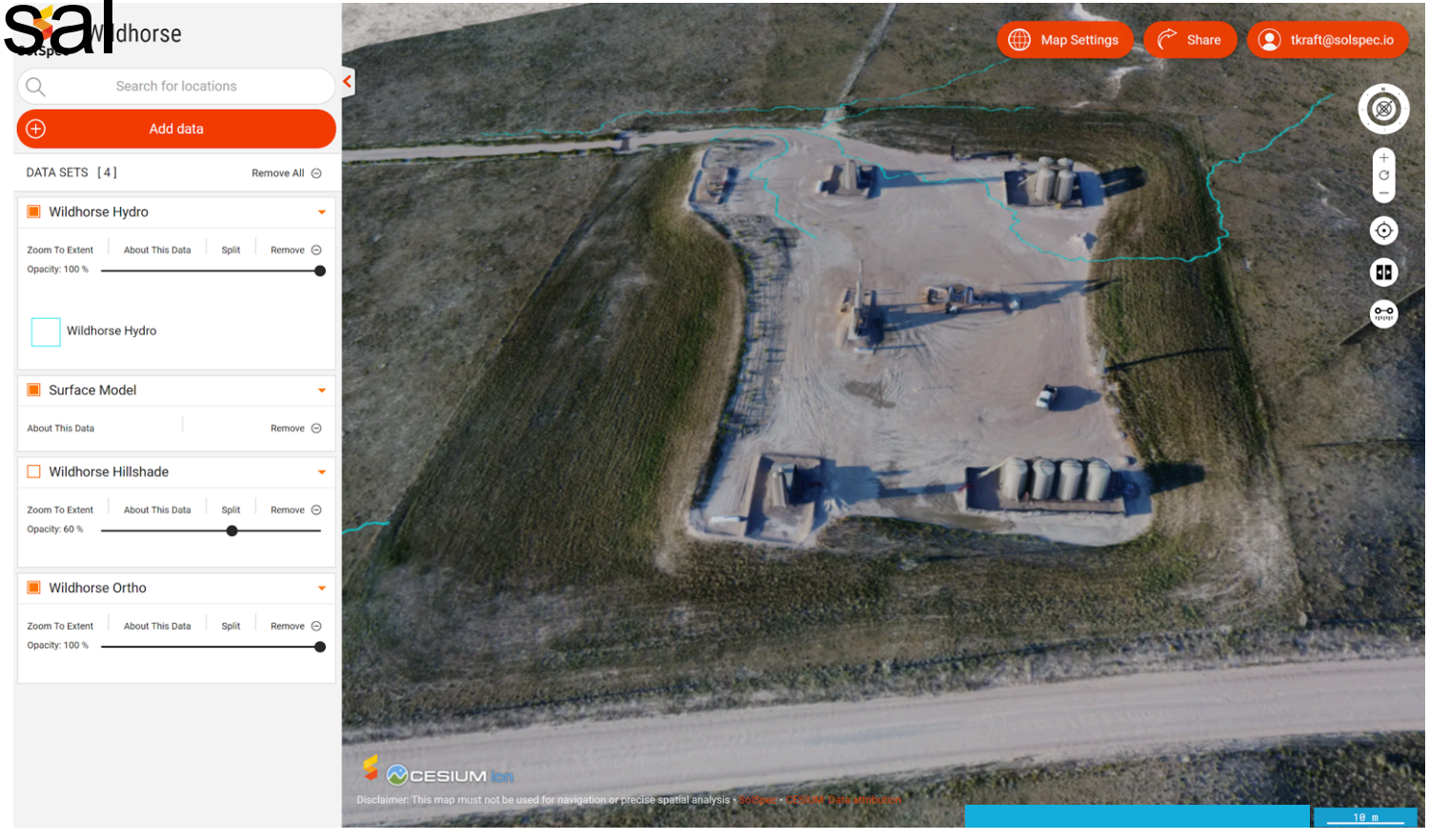
The Proposal

Infrastructure Identification
100 well sites



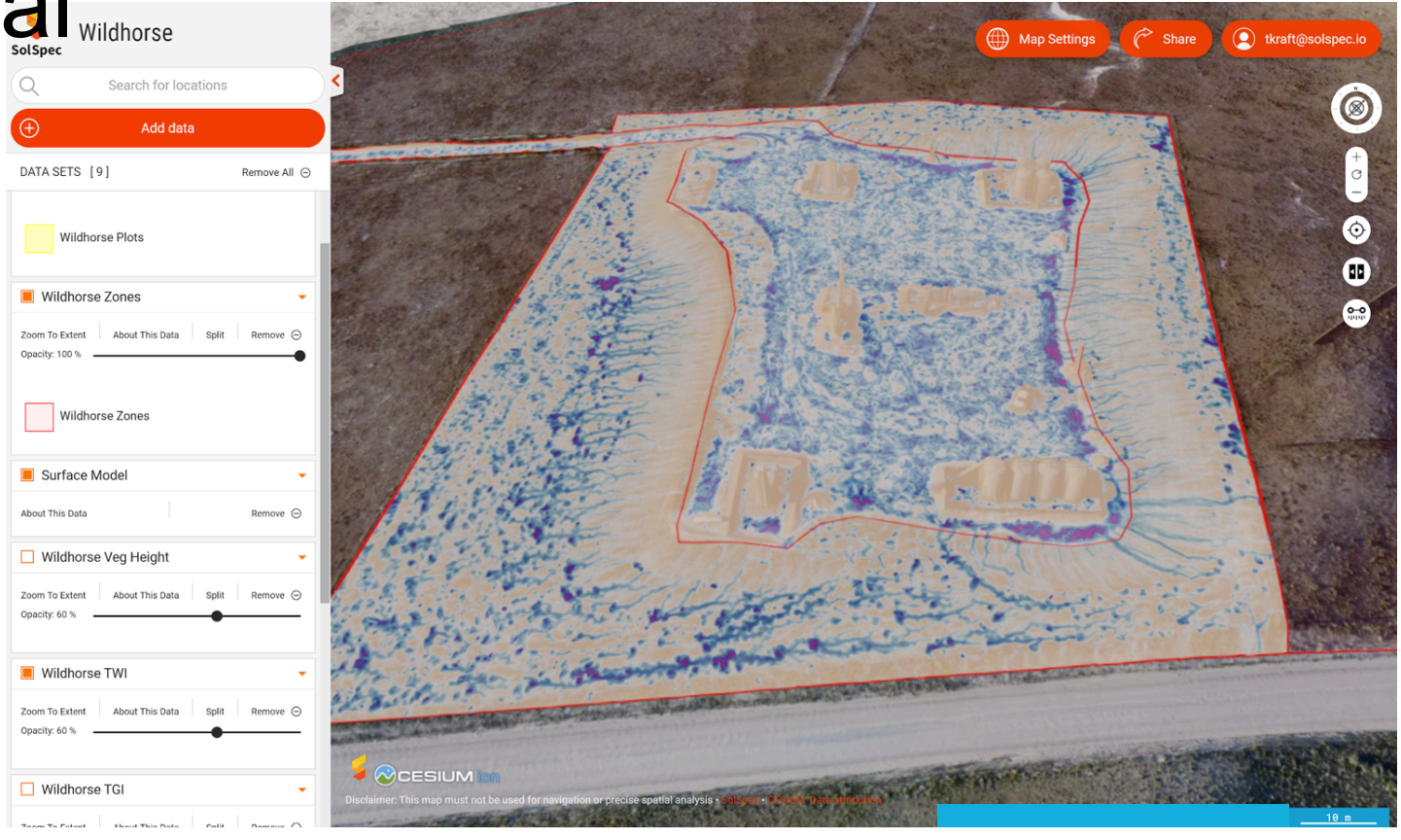
The Proposal

Problematic Surface Hydrology
100 well sites



The Proposal

Topographic Contouring Assessment
100 well sites



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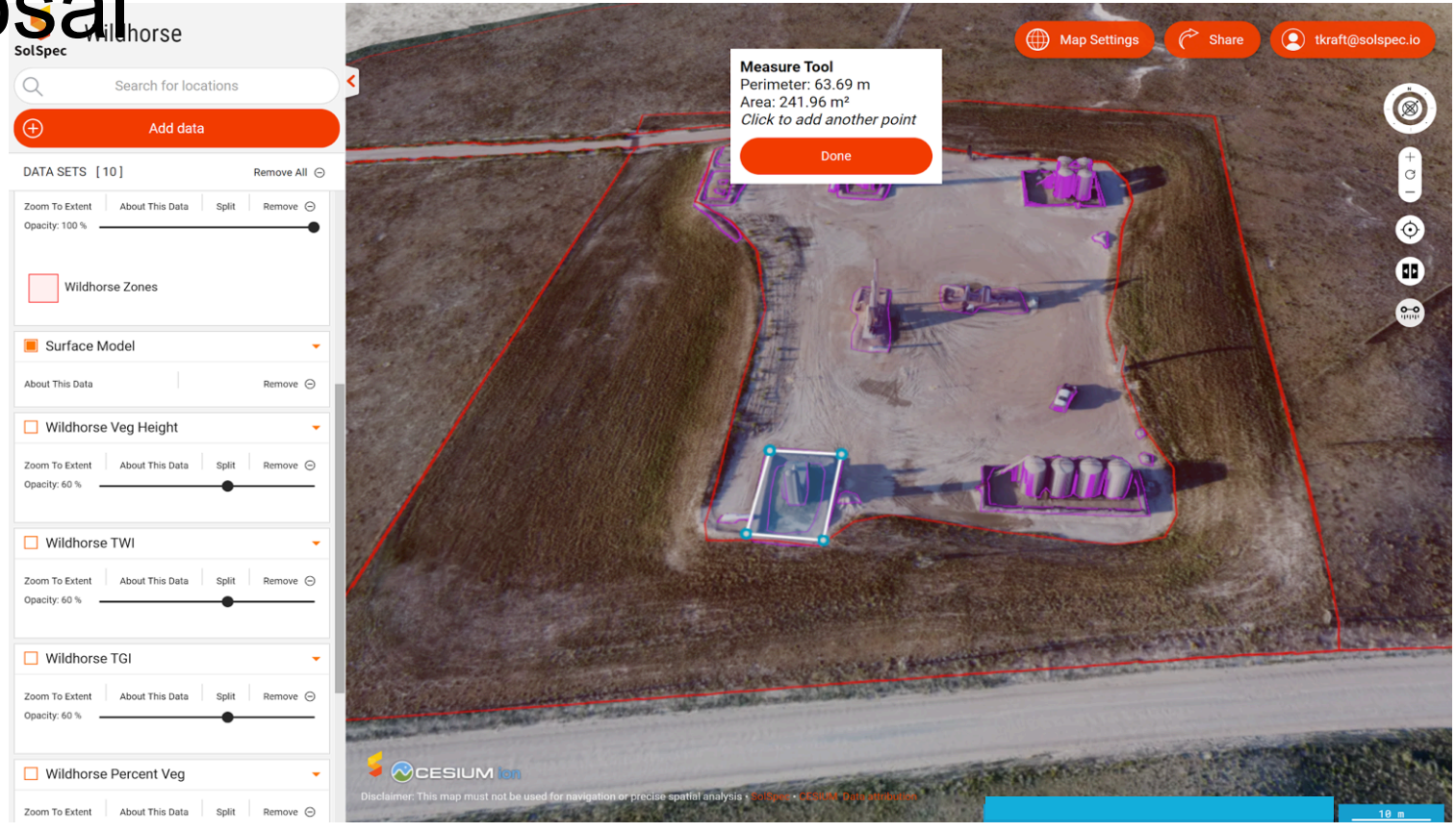
Volumetric Measurement
100 well sites



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OBJECTIVES

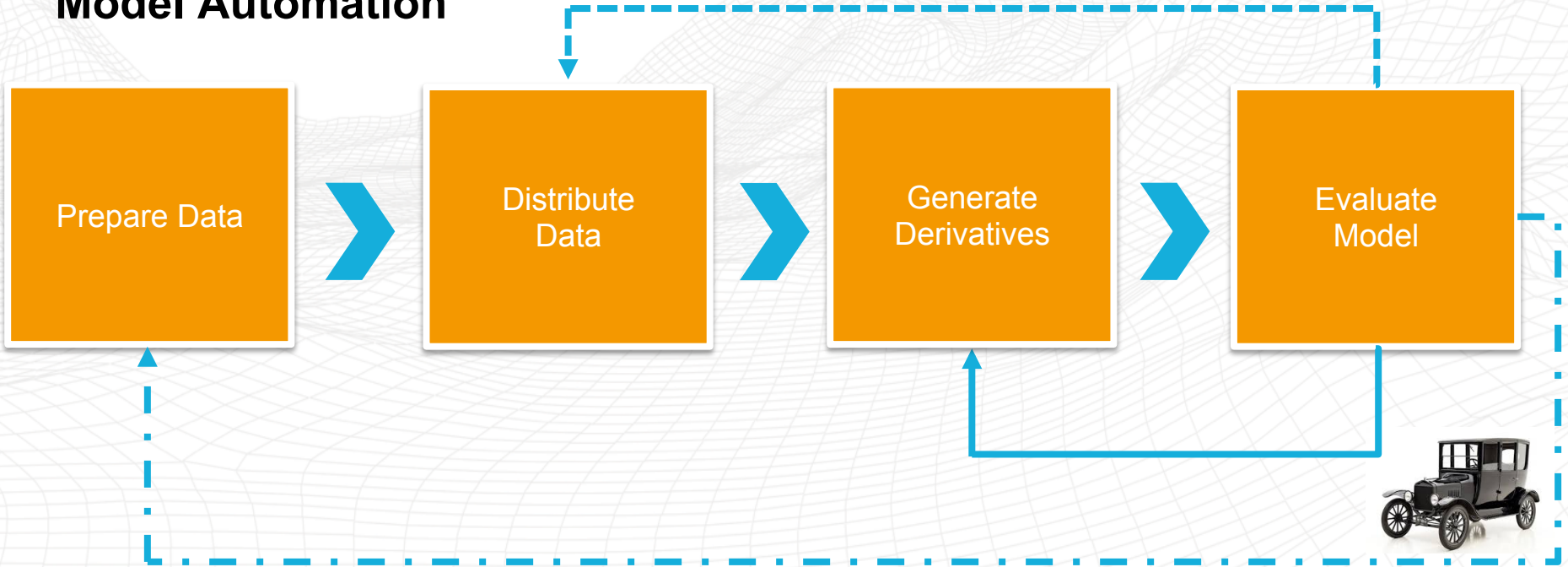
Model Validation: Remote Aerial Inspection Toolkit

- Comparison between preliminary & aerial assessments
- Ground truthing of 30% aerially assessed sites DURAROOT
- NDIC inspection of 20% of aerially inspected sites

Measure effectiveness of toolkit's ability to remotely determine reclamation

The Proposal

Model Automation



The Propos

Model Development | Data Acquisition | Model Validation | Model Automation | **Cost-Effectiveness Analysis**

OBJECTIVES

Cost-Effectiveness Analysis

Evaluate costs & outcomes for Whiting & NDIC against status quo

- Control group: >10 Whiting sites certificated in last 5 years
- Experimental group: 100 Whiting sites, 5 double-sampled w/ BLVOS UAV
  - Inputs: time, equipment, mobilization, information management, etc.
  - Outcomes: Data quality, quantity, consistency, etc.

The Proposal

ANTICIPATED RESULTS & DELIVERABLES

Model Development

- Analytic algorithms capable of efficiently intaking large data volumes & producing operational decision support information for reclamation

Data Acquisition

- Quality aerial imagery for 100 Whiting well sites, 50 on NDIC inspection list

Model Validation

- Statistical measurement of accuracy that provides certainty & confidence in remote reclamation assessment method

The Proposal

ANTICIPATED RESULTS & DELIVERABLES

Model Automation

- Efficient, scalable automated models capable of analyzing large quantities of geospatial data per OGRC Project G-43-01 recommendations

Cost-Effectiveness Analysis

- Evidence substantiating the business case for remote reclamation inspection vs. traditional procedures
- Preliminary analysis of multirotor vs. BVLOS-capable fixed-wing UAV

The Proposal

Model Development → Data Acquisition → Model Validation → Model Automation → **Cost-Effectiveness Analysis**

ANTICIPATED RESULTS & DELIVERABLES

Toolkit of efficient, scalable, statistically robust methods for remotely analyzing reclamation success, including:

- Reestablishment of background vegetation
- Remediation of land contours
- Removal of infrastructure

Bring remote reclamation assessment technology to operational capacity for industry, agencies, & the interested public of North Dakota

The Proposal

BUDGET

Project Activity & Responsible Party	NDIC's Share	Description	Applicant's Share (In-Kind)	Partners' Share (In-Kind)	In-Kind Description
Model Development - SolSpec	$ 22,500	Labor at $80/hour for 281.25 hours	$ 35,000		Labor at $80/hour for 438 hours
Model Automation - SolSpec	$ 19,000	Labor at $100/hour for 190 hours	$ 22,000		Labor at $100/hour for 220 hours
Aerial Data Collection - ISight	$ 70,000	Labor, equipment at $700/ site for 100 sites		$ 34,000	Mobilization at $20k; 5 sites flown with fixed-wing UAV at $700/site; Site discount at $100/ site for 105 sites
Aerial Data Collection - Whiting				$ 32,000	Site manager at $320/site for 100 sites
Ground-Truthing Inspection - Duraroot	$ 26,900	Labor, equipment at $896.66/ site for 30 sites			
Ground-Truthing Inspection - Whiting				$ 9,600	Site manager at $320/site for 30 sites
Model Validation - SolSpec	$ 4,500	Labor at $80/hour for 56.25 hours	$ 10,500		Labor at $80/hour for 131.25 hours
Model Refinement - SolSpec	$ 9,500	Labor at $80/hour for 118.75 hours	$ 12,500		Labor at $80/hour for 156.25 hours
Project Management & Reporting - SolSpec	$ 10,800	Labor at $90/hour for 120 hours	$ 12,000		Labor at $90/hour for 139 hours
		Applicant's & Partners' Subtotal Share:	$ 92,000	$ 75,600	
NDIC's Total Share:	**$ 163,200**	**Applicant's & Partners' Total Share:**	**$ 167,600**	**Total Project Cost:**	**$ 330,800**

The Proposal

TIMELINE

Key Milestones	Responsible Party	Month(s)	Year(s)
Model Development			
Develop: preliminary vegetation cover comparison, vegetative continuity comparison, infrastructure identification, problematic surface hydrology identification, topographic contouring assessment, & volumetric measurement models.	SolSpec	Feb-Aug	2020
Model Automation			
For each model: automate data aggregation, dissemination, derivative generation, analytic process, & internal validation.	SolSpec	Feb-Aug	2020
Aerial Data Collection			
Collect aerial imagery with UAS: 100 sites	ISight	Aug-Sept	2020
Manage access to & supervise site: 100 sites	Whiting	Aug-Sept	2020
Model Validation			
Perform ground-truthing of field inspections: 30 sites	Duraroot	Aug-Sept	2020
Manage access to & supervise site: 30 sites	Whiting	Aug-Sept	2020
Perform agency field inspections: 20 sites	NDIC	Aug-Oct	2020
Test & refine models according to field observations	SolSpec	Nov-April	2020-2021
Reporting			
Quarterly Progress Report 1	SolSpec	March	2020
Quarterly Progress Report 2	SolSpec	June	2020
Quarterly Progress Report 3	SolSpec	Sept	2020
Quarterly Progress Report 4	SolSpec	Dec	2020
Quarterly Progress Report 5	SolSpec	March	2021
Final Report; Delivery of Data, Full Study Results, & Toolkit Availability; Press Release	SolSpec	June	2021
Briefings to NDIC/OGRC	SolSpec	As requested	2020-2021

Thank You.

SolSpec

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WHITING

DURAROOT