TRACE ASSOCIATES

SUSTAINTECH 2026

Tier 3 Guideline Calculations and Risk-based Detailed Site Assessment of Salinity Yielding a Zero Remediation Outcome in Southern Saskatchewan

Presented by: K. Eric Van Gaalen, M.Sc., P.Ag. and Connor M. Frizzley, B.A.Sc., P.Ag.

Date: March 19, 2026

File: 0300-011 Tier 3 Calculations SustainTech 2026

Outline

1. Introduction to the Site – Site History, General Challenges, and High-level Options
2. Salinity Guidelines
3. Risk Assessment
4. Sustainability and Benefits

Site History

- Southwest Saskatchewan
- Drilled in 1969
- Produced 10,311,100 m^3 of gas from 1972 to 1976
- Surface casing vent – brine spill in 1994
- Abandoned in 1997
- Cultivated/Agricultural land use
- Known historical infrastructure include a wellhead, flare pit, and third-party pipeline

Historical Reporting – Prior to Trace Site Management

- 1994 brine spill remediation – unknown volume
- 2001 Reclamation Program – paratill granular calcium nitrate
- 2014 Phase 1 environmental site assessment (ESA) – multiple areas of potential environmental concern (APECs) including flare pit and drilling waste disposal area (DWDA)
- 2015 Phase 2 ESA – electromagnetic (EM) survey identified elevated conductivity northeast of well centre

Photograph from historical client documents

Challenges with the Site

- Trace has consulted since 2022
- Initial review: volume salinity affected soil (~35,000 m³)
- Limited assets in the area, resulting in minimal cost savings and synergy benefits
- Limited lateral delineation from initial Phase 2 ESA
- Landowner historically concerned about vegetation
- Long reclaimed access road
- Nearest Class 2 Landfill ~200 km away

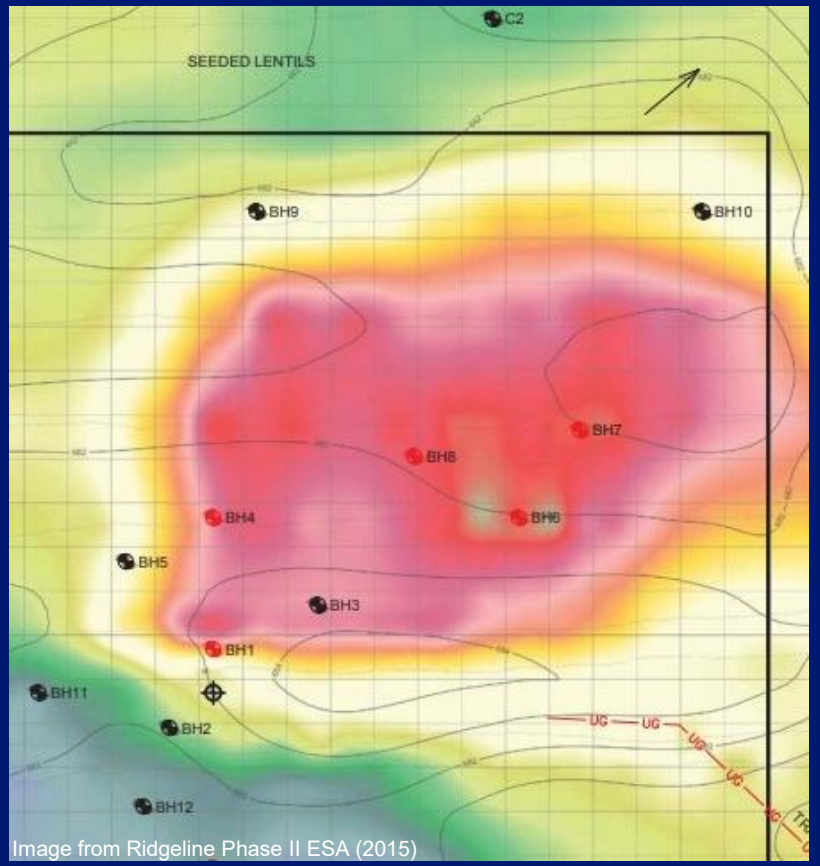


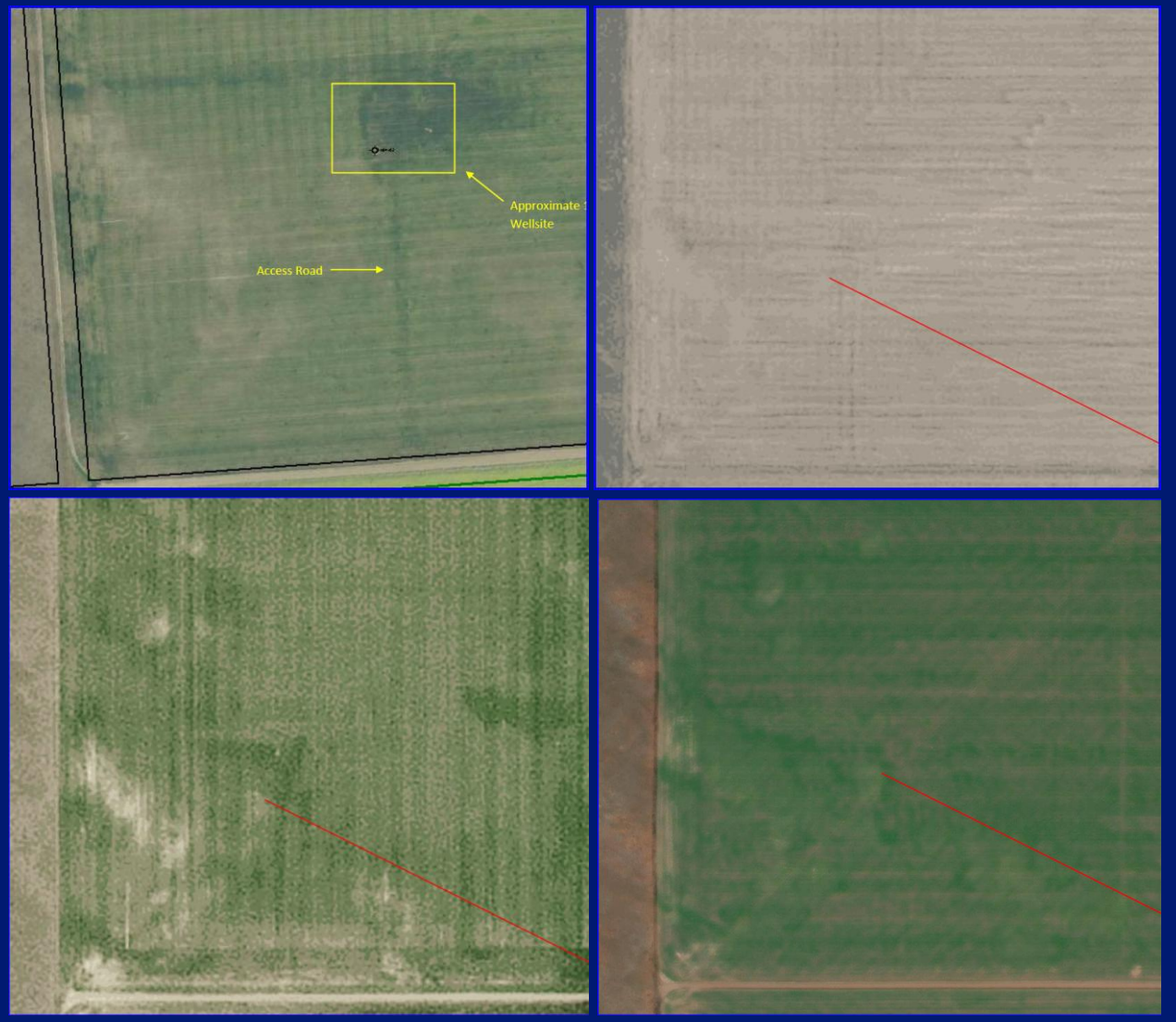
Image from Ridgeline Phase II ESA (2015)

High Level Options

- **Options 1a, 1b, 1c:** Delineate and remediate to Tier 1 guidelines – Potentially >$1,000,000
- **Options 2a, 2b, 2c:** Delineate / data gap fill to calculate Tier 3 guidelines
- Options analysis: guideline options/costs, remedial options, draft scenarios of Tier 3 guidelines, data gaps analysis
- Option 2 Indicated high potential for net benefit

High-level Considerations

- General impression of risk
- Substances of potential concern, receptors (groundwater? vegetation?), complaints?
- Historical reports, interviews, current status
- Imagery lineage, recovery?



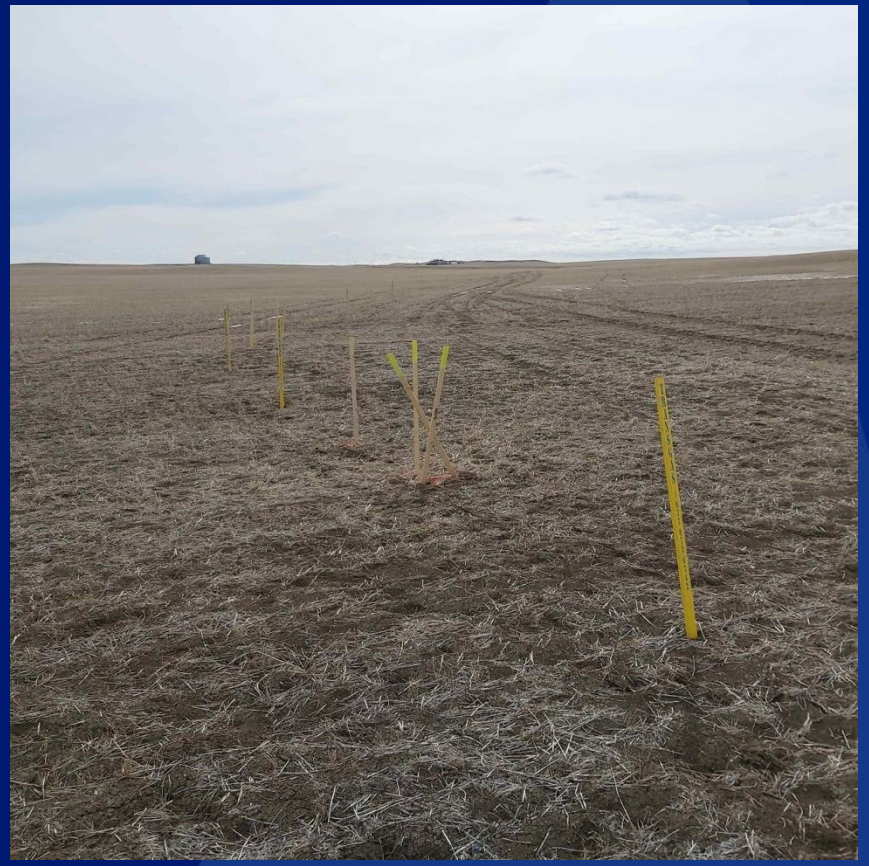
Upper left – 2011 Image Phase I ESA (Ridgeline, 2014)
Upper right – 2014 Image (AbaData – Planet)
Lower left – 2018 Image (AbaData – Planet)
Lower right – 2024 Image (AbaData – Esri)

Salinity Guidelines

- PNG033 Phase 2 and Tier 1 Site-specific electrical conductivity (EC) and sodium adsorption ratio (SAR)
- PNG045 - Acknowledgment of Reclamation for Sodium Chloride-Impacted Sites
  - Tier 1 Acceptable Solutions
  - Tier 2 Acceptable or Alternative
  - Tier 3 Endpoints (Alternative Solutions)
    - Subsoil Salinity Tool Guidelines
    - Root zone risk assessment

Risk Assessment Process – Supplemental Phase 2

- Delineate soil EC, SAR, chloride, and sodium. Background soil sulphate ~2,500 mg/kg, background sodium ~750 mg/kg. EC (Tier 1 = 5 dS/m) and SAR (Tier 1 = 8).
- Soil chloride on site 2,300 mg/kg.
- Soil sodium on site 1,100 mg/kg, mostly in top 1.5 m below ground surface (mbgs) driving EC >10 dS/m.
- History of some risk to vegetation pathway. Selective removal? Groundwater pathways at potential risk?
- Successful Phase 2 without need for further supplementals – pre-planning was key.



Tier 3 Site-specific Salinity Guidelines

- Conceptual site model and Subsoil Salinity Tool (SST)
- Plume 175 m long, 0 to 4 mbgs
- WT ~9 mbgs
- SST = low-risk groundwater receptors
- Potential risk to vegetation via the root zone pathway
- Post SST - potential surface soil remedial volume of ~7,900 m³

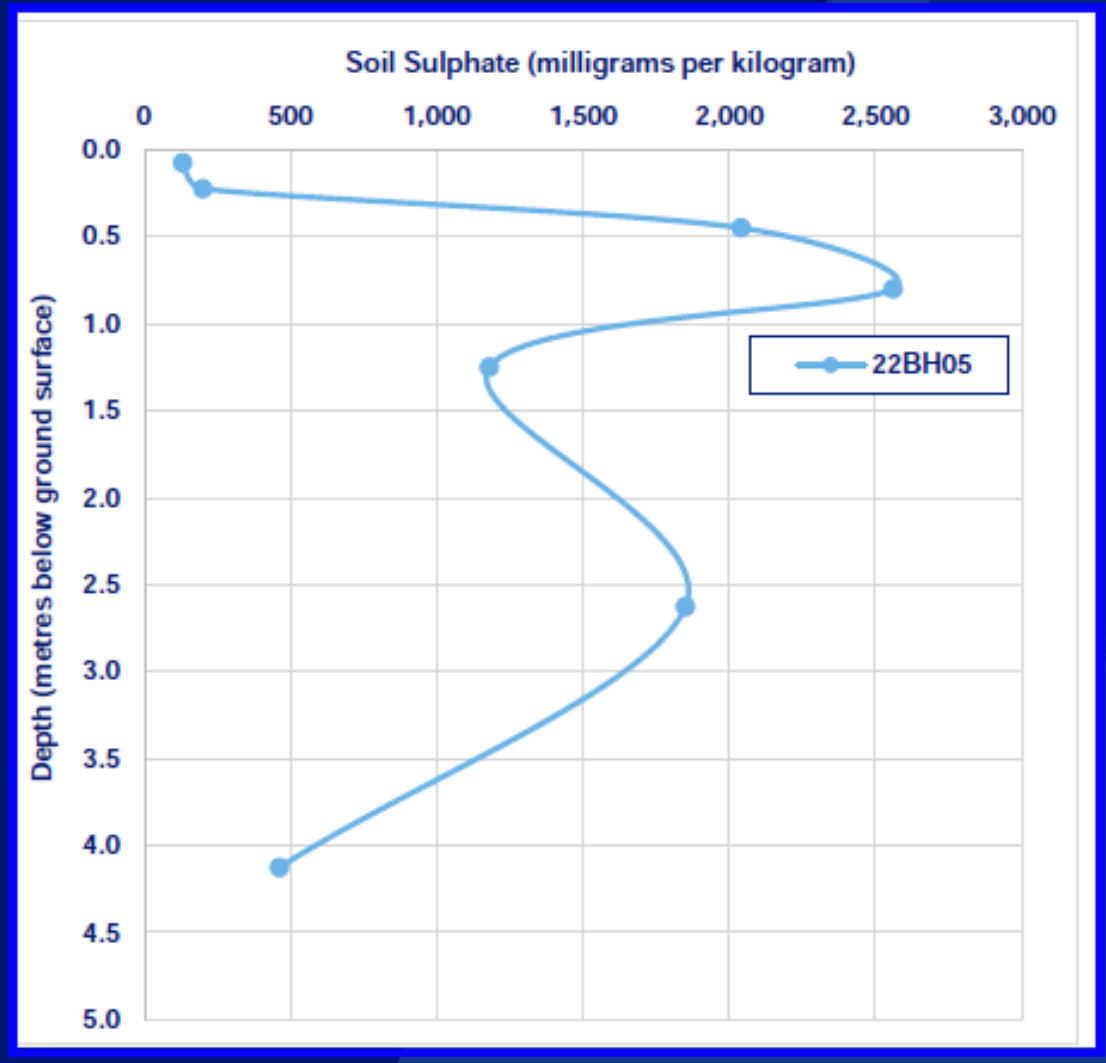
Pathway	SubArea 1		SubArea 2	
	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)
Root Zone	800	~ 70	1800	~ 70
Livestock Watering	NA WT >6 m	NA	NA WT >6 m	NA
Irrigation Watering	NA WT >6 m	NA	NA WT >6 m	NA
Aquatic Life	5300	~ 1000	2400	~ 1000
DUA	7000	~ 1000	2900	~ 1000
Minimum Chloride Guideline (mg/kg)	800		1800	

Screen capture of SST output screen

Root Zone Pathway Risk Assessment

Primary considerations:

1. Salinity migrating downward over time? Or risk of net upward movement / capillary action and accumulation at surface
2. Groundwater variables, soil texture, topography, local indicators, background sulphate profiles (example image)
3. Vegetation condition? Improving? Declining? Constant?



What is a Risk-based Detailed Site Assessment (DSA)?

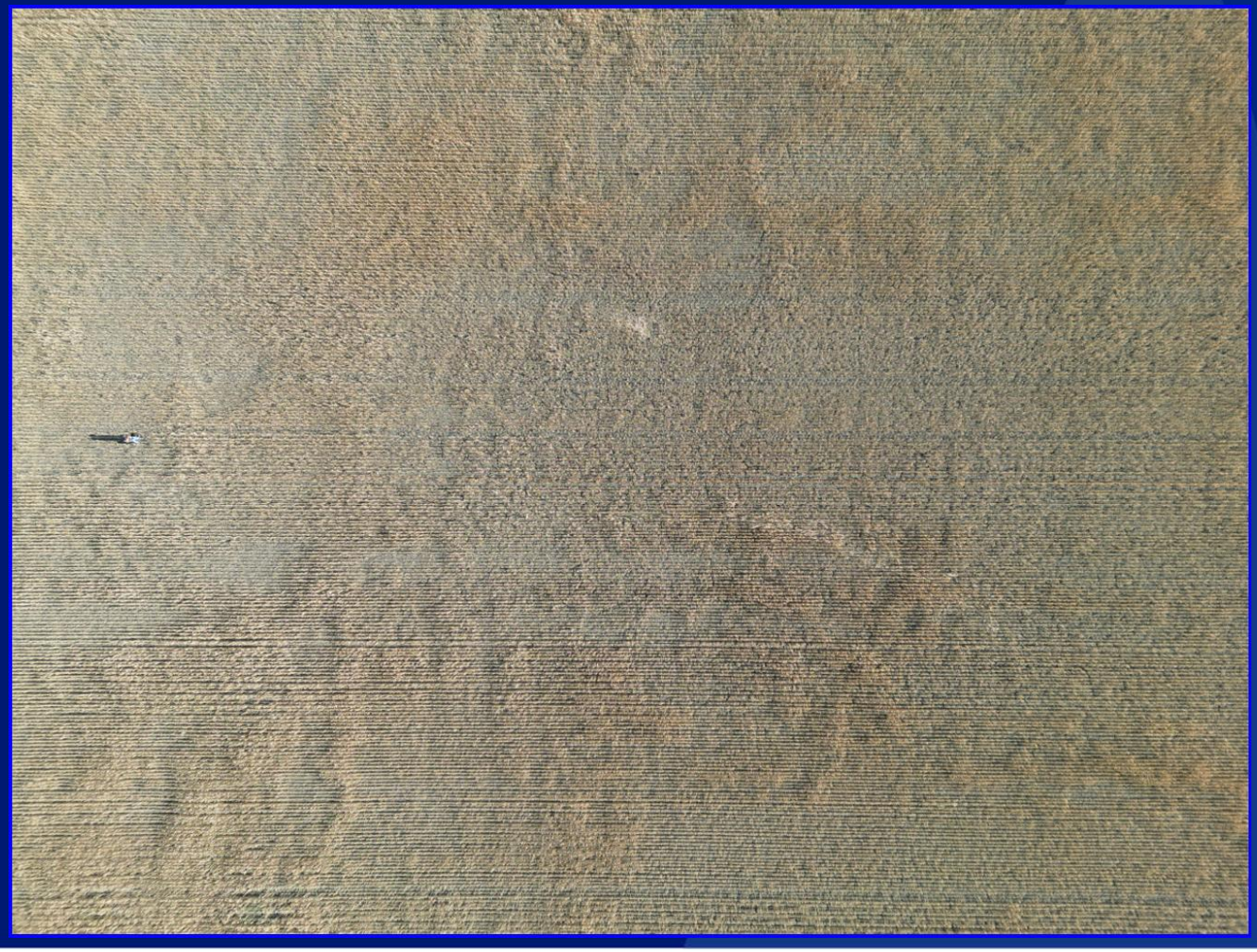
- Conventional pass/fail assessment, plus:
  - Quantify magnitude and extent of potential concerns. E.g., Map variable areas on site and background – compare parameters.
  - Diagnose cause. Site history, five factors of soil formation, third party.
  - Prescribe next steps, rem or rec or precise justification follow-up assessment?

Two-year Risk-based Detailed Site Assessment

- 2023 – wheat – late prime
- 2024 – canola – early prime

Two-year Risk-based Detailed Site Assessment

- 2023 – wheat, wavy crop, droughty – opportune time to see stress areas from altered soil variables
- Nadir images during mid-late prime stage

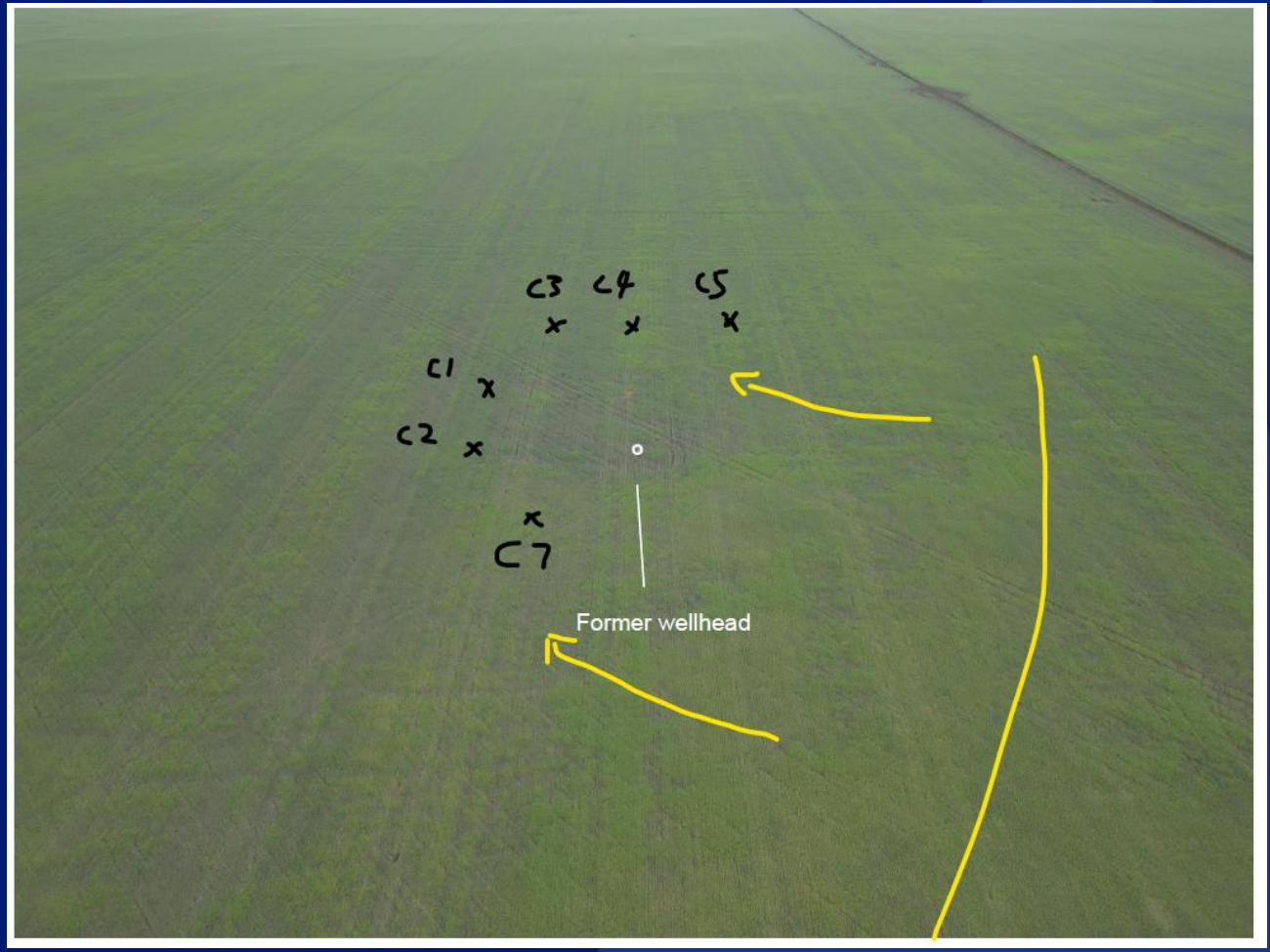


Two-year Risk-based Detailed Site Assessment

- 2024 – canola
- Early prime (still slightly green)
- Nadir – yes, added oblique imaging (e.g., looking south)
- Topographic variability, soil formation = stratify
- Background and on-site variability

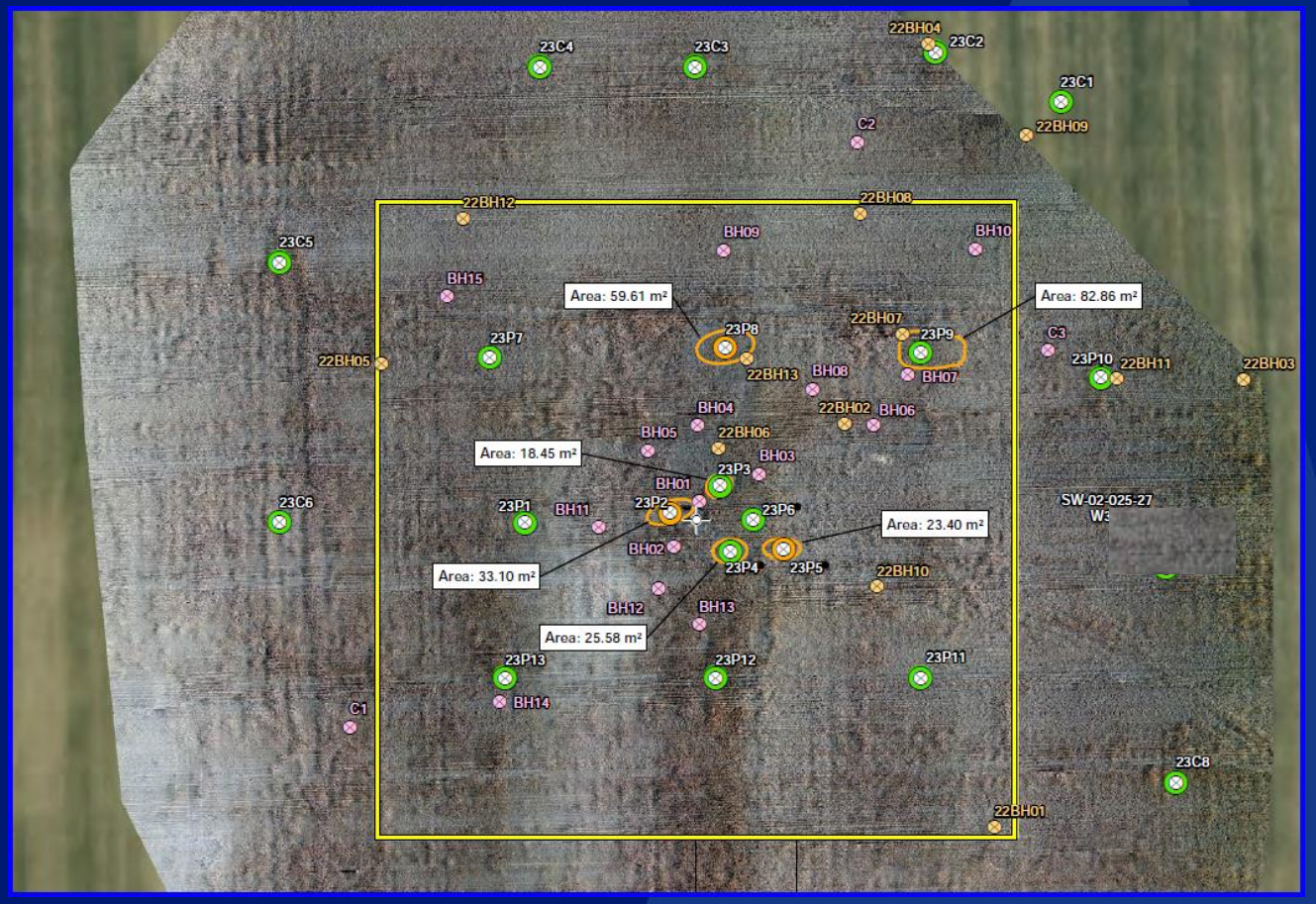
Two-year Risk-based Detailed Site Assessment

- 2024 - canola
- Oblique image (e.g., looking east)
- Topographic variability, soil formation
- Stratify
- Background and on-site variability



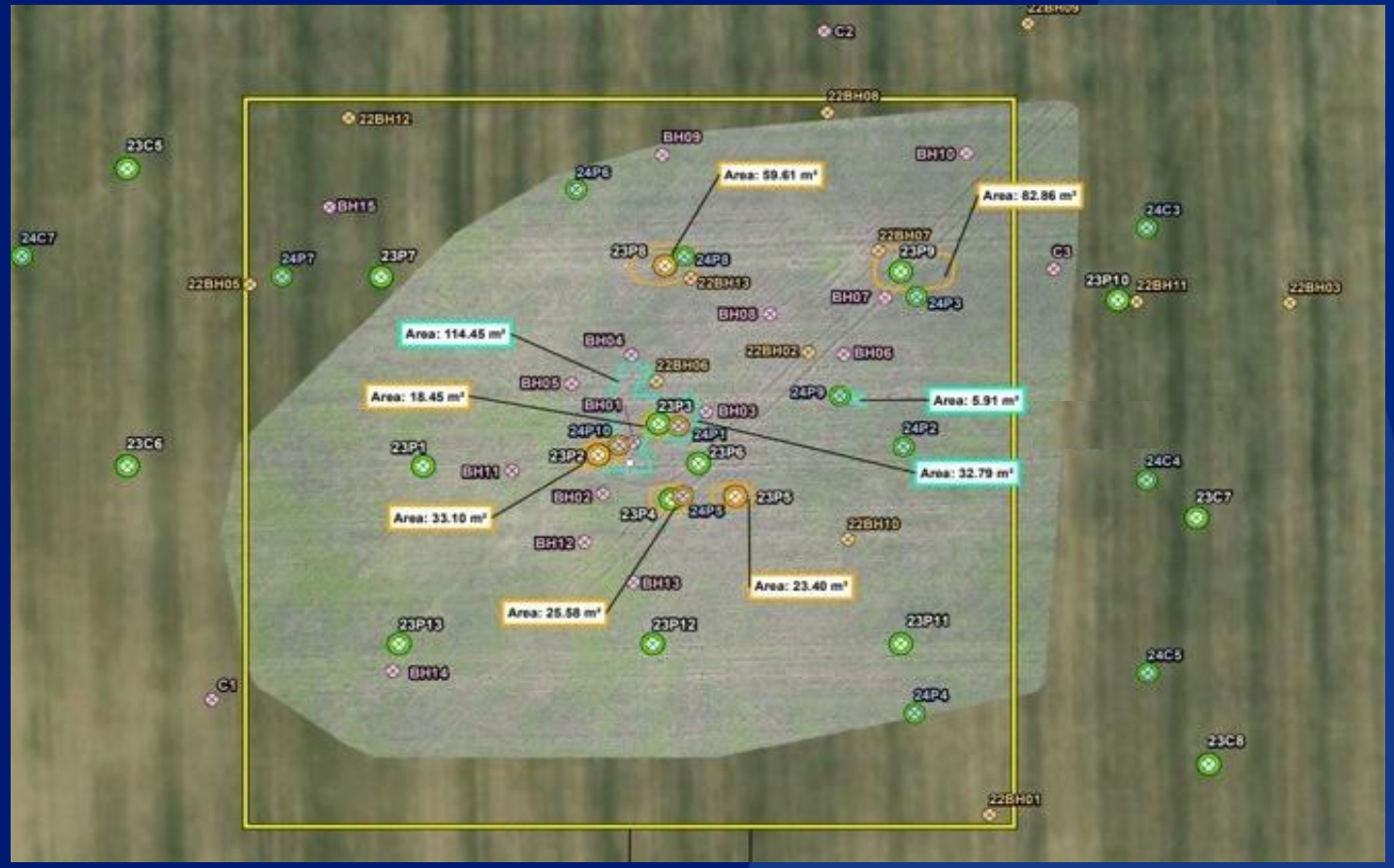
Risk-based DSA Parameters – Vegetation – 2023

- Height, head length, head weight, density, health metrics, weeds, bare areas assessed at worst-case locations
- Accurate mapping with Submeter GPS
- All parameters met thresholds except ~1% of total site area with height of 40 cm (at three points) relative to 42-cm threshold. One point with density of 46 plants per metre relative to 47 threshold.



Risk-based DSA Parameters – Vegetation – 2024

- Height, raceme length, pod density, plant density, maturity, health metrics.
- All parameters met thresholds except 1% of total site area with height of 70 cm relative to 76 cm.
- Cause? Salinity/SAR? Inspect soils in detail.



Risk-based Detailed Site Assessment – Soils

- Lab salinity, field EC and chloride
- Field colour, moisture, texture, structure, consistence (aggregate strength) inclusions, tilth, root depth / root restrictions, admixture (10% HCl), PNG018 + Canadian System of Soil Classification
- Low vegetation areas had better soil consistency ratings
- Moderate to very high clay contents (left to right) = increased vegetation performance
- Cause: clay-content, structure, consistence influencing moisture retention/release

Two-year Risk-based Detailed Site Assessment

- Sceptre soils (Grumic Brown soils), clay to heavy clay, high moisture retention.
- Time: vegetation issues resolving to equivalent land capability. Gradual downward migration of salts from topsoil, re-establishment of tilth.
- No landowner concerns by 2025.
- Regulator engagement.
- Rem/Rec would be disruptive.

Sustainability and Benefits

- Cost savings (~$4 million)
- Volume of soil avoiding landfill (~35,000 m³ relative to Tier 1 and ~7,900 m³ relative to SST without risk-based DSA
- Limited disruption to land and soil
- Reclaimed access did not require disturbance
- Reduced traffic on rural municipality and provincial roads
- Reduced pollutants from equipment and trucks

Project Management – Highlights

- Communication with client and technical team – early and often
- Fiduciary responsibilities of consultant and client to public and environment
- Close contamination in responsible, timely, cost-effective manner
- Ensure all parties have the information they need when needed and concur with the process

QUESTIONS?

We're Here to Help.

ERIC VAN GAALEN, M.Sc., P.Ag.
Principal Scientist
evangaalen@traceassociates.ca

CONNOR FRIZZLEY, B.A.Sc., P.Ag.
Environmental Scientist
cfrizzley@traceassociates.ca

TRACE
ASSOCIATES

We exist to help you have a great life.