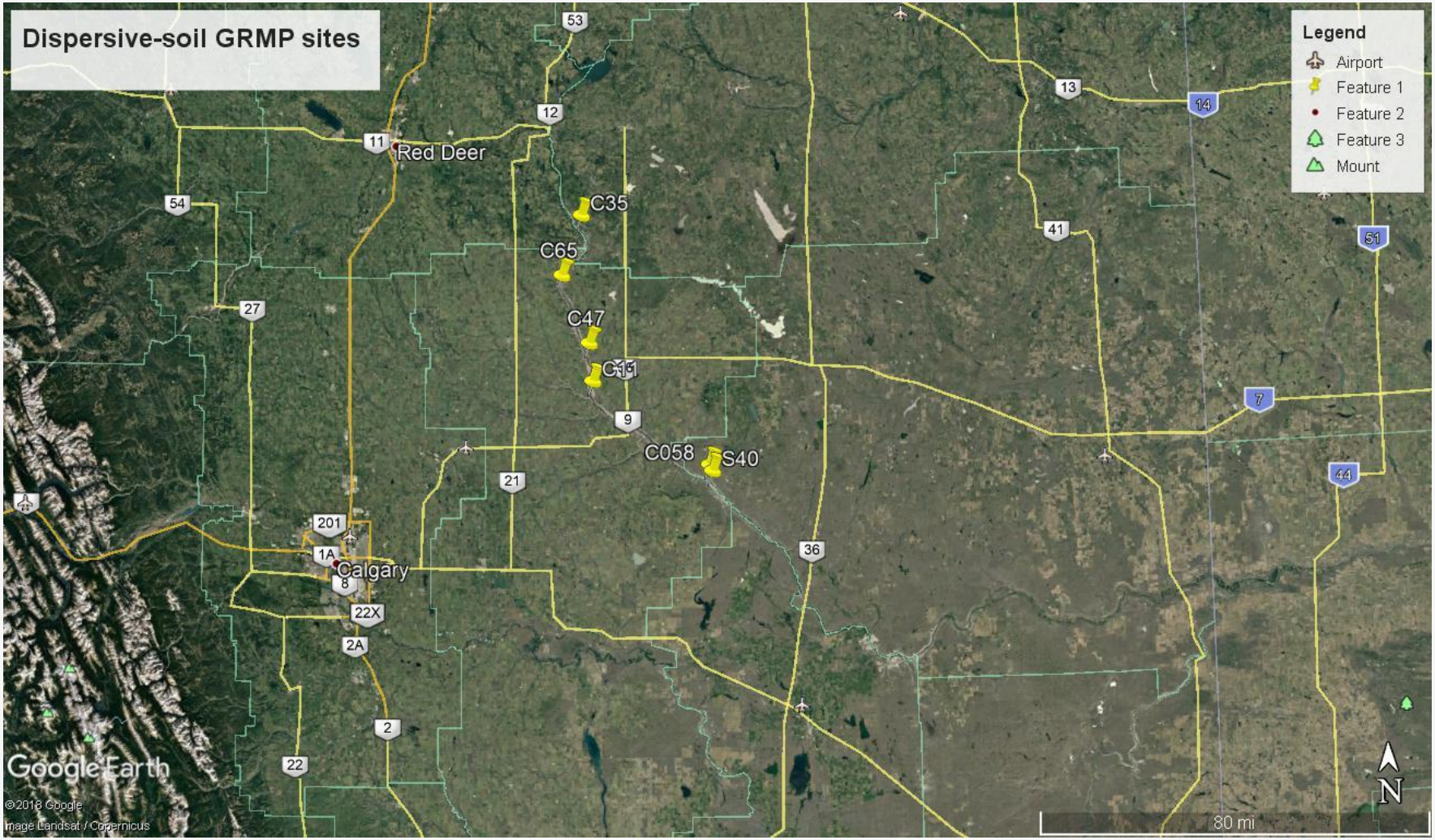
Geohazards Associated with Dispersive-Soil Voids

Chris Grapel, M.Eng., P.Eng. GRMP 2018

Dispersive-Soil GRMP Sites



Klohn Crippen Berger

CANADA'S BEST MANAGED COMPANIES Platinum member

S040 Dorothy Hwy 848:02

S040 Dorothy Hwy 848:02

Dispersive Soils

Dispersive clays are present across the Red Deer River valley in the badlands area and were first identified in 1925 (NRCA 1945).

Dispersive clays erode in the presence of still or flowing water through a process called deflocculation.

Deflocculation occurs when the repulsive forces between individual clay particles exceed the interparticular attractive forces and any other forces that bind the particles together (Ghuman et al 1976, and Sherard et al 1972).

Dissolved-sodium (Na+) cations act to increase the double-diffuse layer of adsorbed molecules, decreasing the attraction between the clay particles, and facilitating separation of the particles from the soil mass into solution (in either flowing or still water)

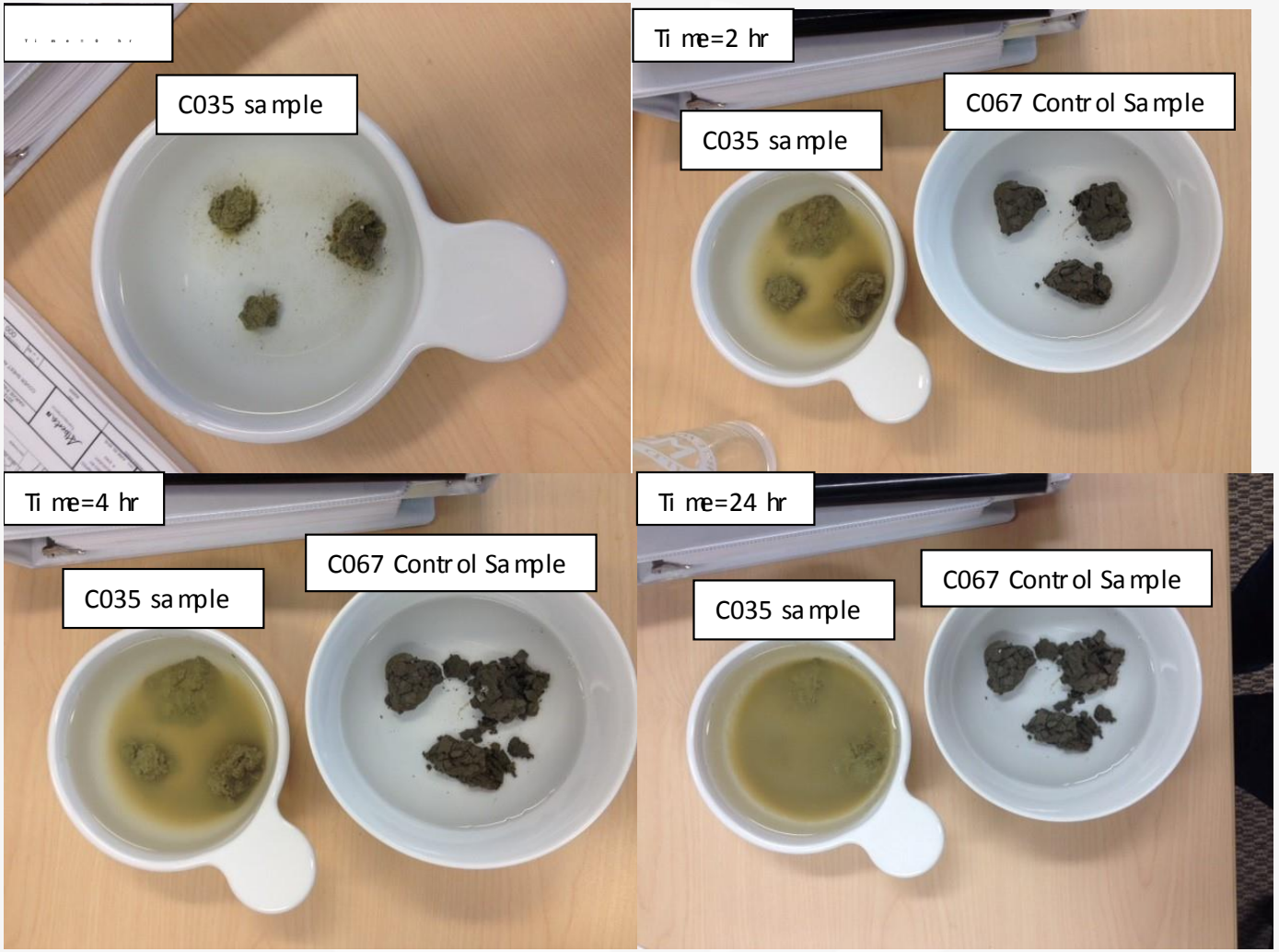
Erosion of Dispersive Soils

The individual clay particles deflocculate into the water column and are suspended in solution.

Chemical analyses such as exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) relate the relative abundance of exchangeable cations to clay-structure stability and dispersion potential.

Dispersive clays are generally classified with a ESP greater than 6, and a SAR greater than 3, though dispersion can occur in soils with ESP below 6 and SAR below 3 (Hardie 2009).

C035 Simplified Crumb Testing (Immersion)



What makes the badlands so bad?

(*According to a Vegetation Ecologist*)

- Exposed marine bedrock;
- Salt-affected topsoil (solonetzic soils);
- Minimal vegetation cover, only salt-tolerant species can thrive; and
- Limited moisture-retention capacity of surface soils exacerbates arid conditions.

Overview of Dispersive Soil GRMP Sites

Geohazards in dispersive soils consist of subsurface voids forming below highway infrastructure, along drainage routes (e.g., ditches, culverts, channels), and erosion of ditches and backslopes

Erosion Geohazards

- C011
- C035

Void geohazards

- C011
- C058
- C065

C011 Ditch Erosion and Sinkholes

Hwy 837:02, km 5.637

AADT 290

PF 12

CF 4

C035 Ditch Erosion

Hwy 590:04, km 20.104

AADT 670

PF 11

CF 4

C035 Hwy 590

C035 Hwy 590

C035 Hwy 590

C035 Hwy 590

C035 Hwy 590

C065-I and -II East of Trochu

Hwy 585:02, km 16.136

AADT 400

PF 13

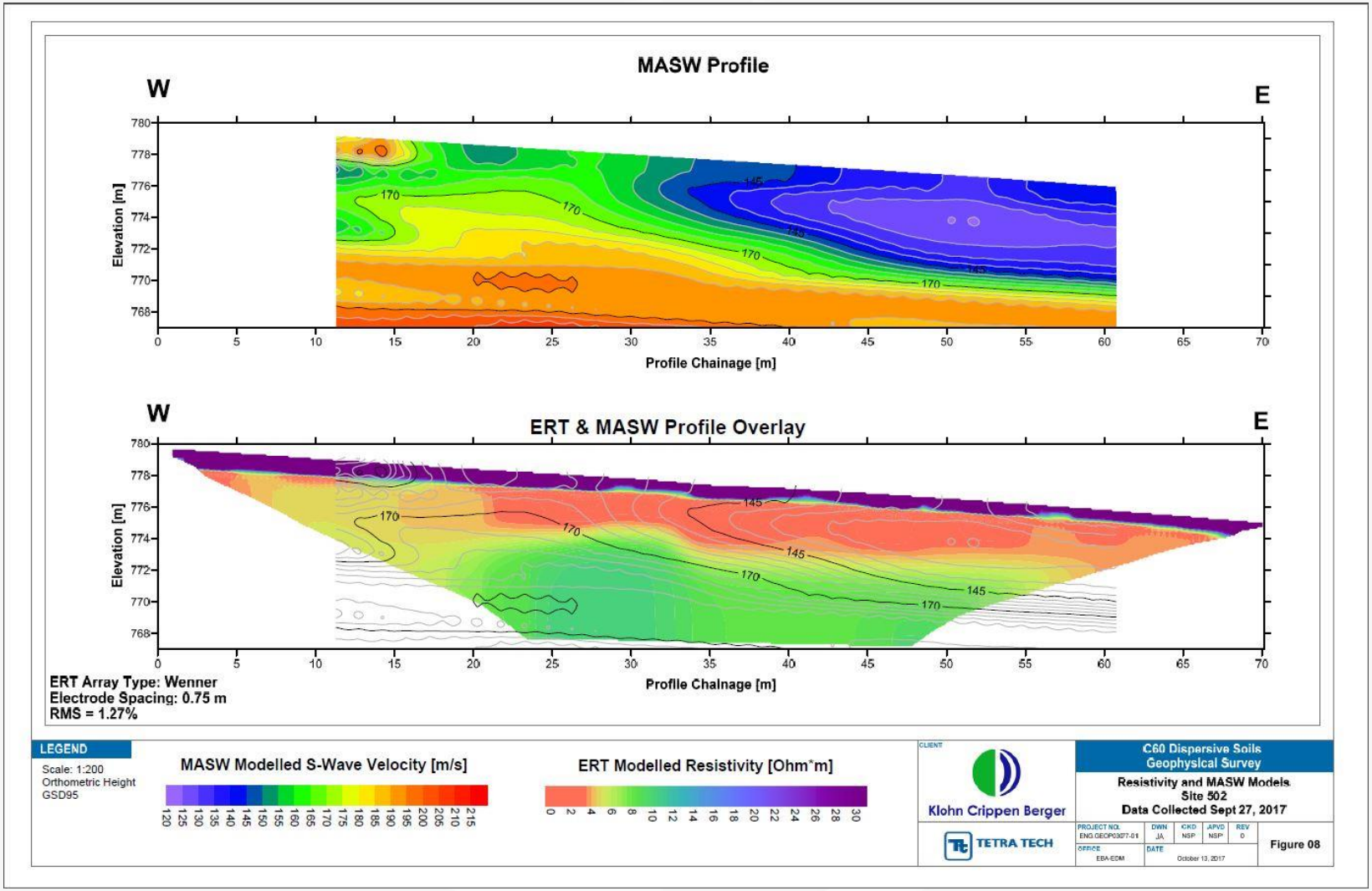
CF 8

C065 Geophysics

TetraTech hired to complete a geophysics survey:

- goal was to assess if voids were present below the two dip areas
- Drilled a borehole at one dip (no void) but soils below highway were quite soft and wet compared to the soils encountered in a borehole drilled on adjacent higher ground
- started at S040 to assess if voids could be detected (success)
- Conducted electrical-resistive tomography (ERT), ohm-mapper, multi-channel analysis of surface waves (MASW), and electro-magnetic (EM) conductivity surveys at C065
- The ERT and MASW gave the best results
- Conclusion – no void detected below highway, but ongoing dissolution at a preferential seepage path could be causing the settlement

C065 Geophysics



Klohn Crippen Berger

CANADA'S BEST MANAGED COMPANIES Platinum member

C058 Sinkholes

Hwy 570:02, km 12.000

AADT 510

PF 5

CF 4

Back to S040 Dorothy

Hwy 848:02, km 11.507

AADT 120

PF 9

CF 4

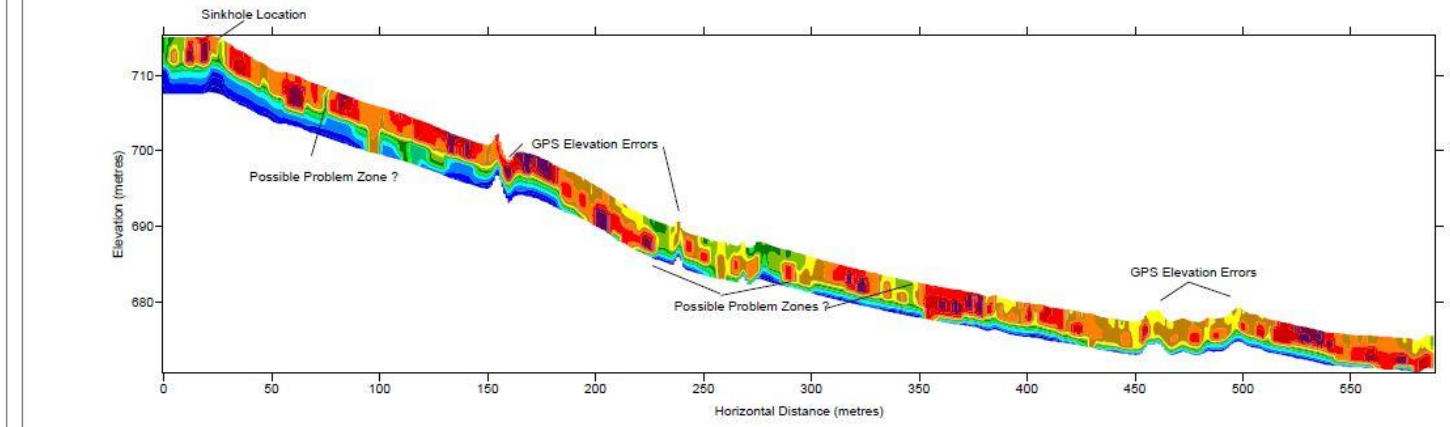
S040 Dorothy Hwy 848:02

S040 Dorothy Hwy 848:02

S040 – Sinkhole near culvert inlet

S040 – Geophysics (EM Conductivity)

S040 – Geophysics (EM Conductivity)



LEGEND

Logarithic Resistivity Scale (Ohmm)

-1 -0.9 -0.6 -0.4 -0.1 0.1 0.4 0.6 0.9 1 1 2 2 2 2 3 3 3

Horizontal Scale 1:1750
Vertical Scale 1:500
UTM z12 Coordinates

CLIENT
Klohn Crippen Berger
TETRA TECH

S040 Dispersive Soils
Geophysical Survey

Dorothy -CCR (OhmMapper)
Resistivity Profile

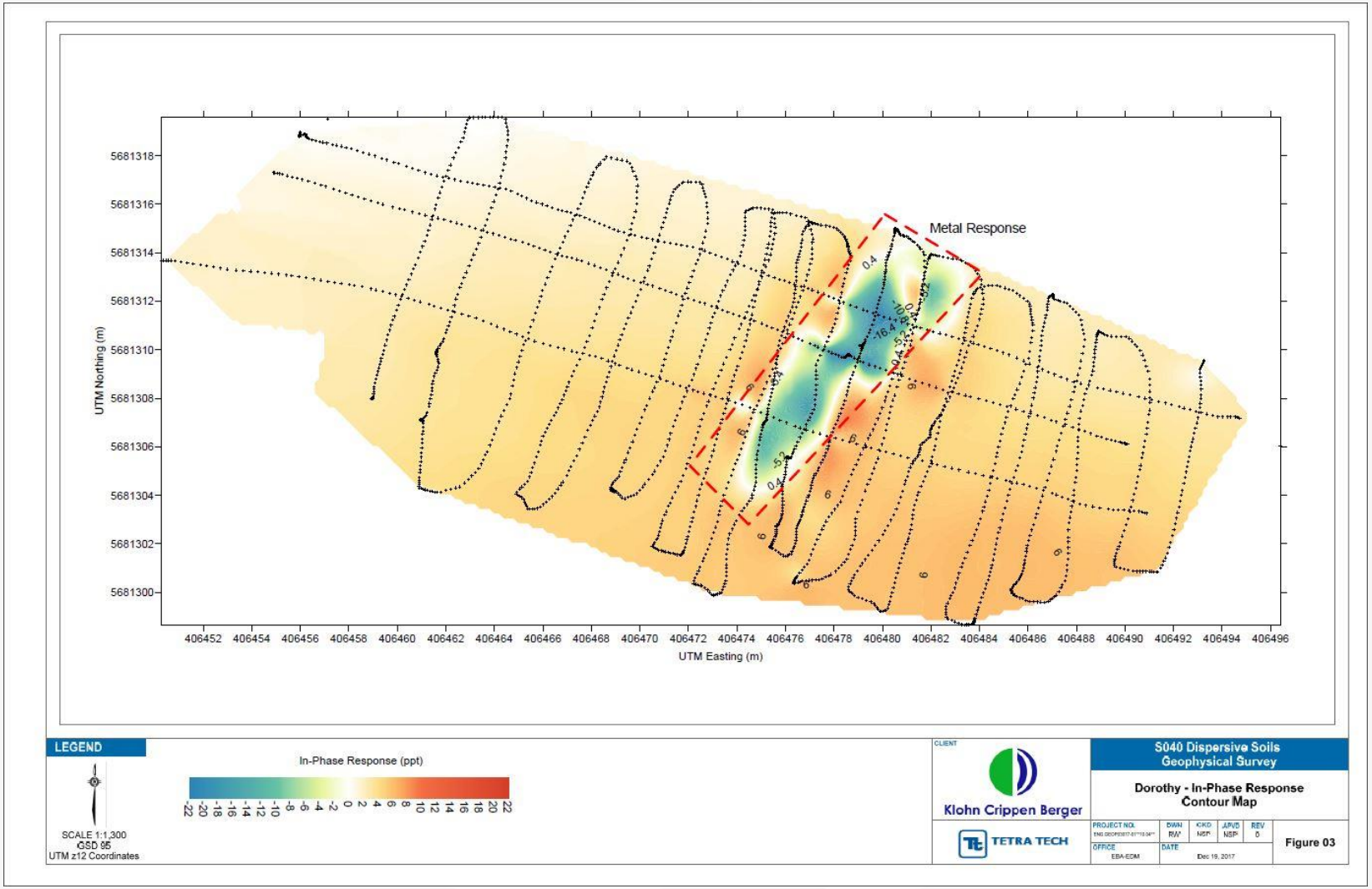
PROJECT NO. | DWN RW | CKD NSP | APVD NSP | REV 0
OFFICE EBA-EDM | DATE Dec 19, 2017

Figure C01

Klohn Crippen Berger

CANADA'S BEST MANAGED COMPANIES
Platinum member

S040 – Geophysics (EM Conductivity)



Klohn Crippen Berger

CANADA'S BEST MANAGED COMPANIES Platinum member

Thank you for your attention

Questions?