GP29 – Church Camp Landslide

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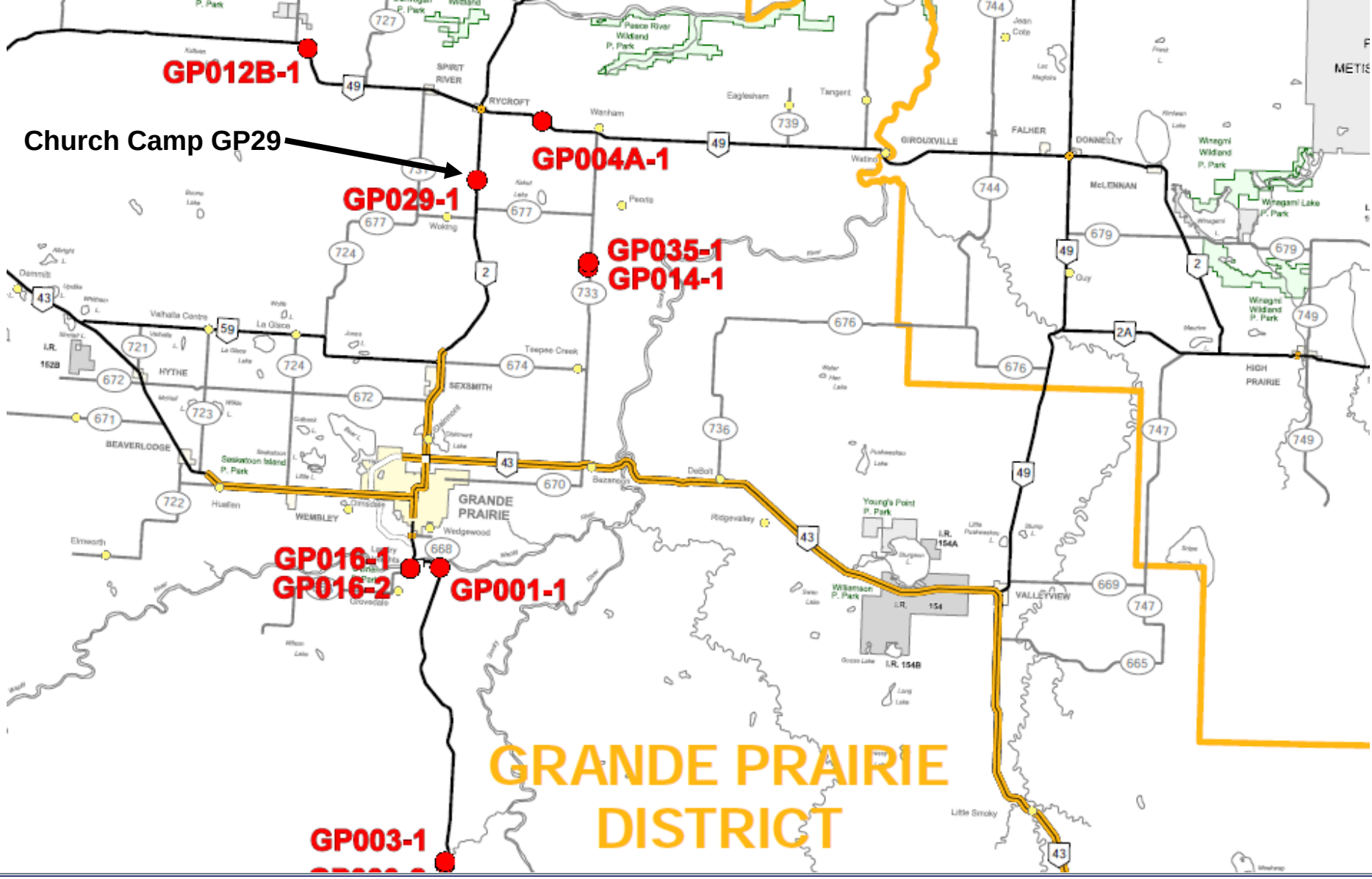

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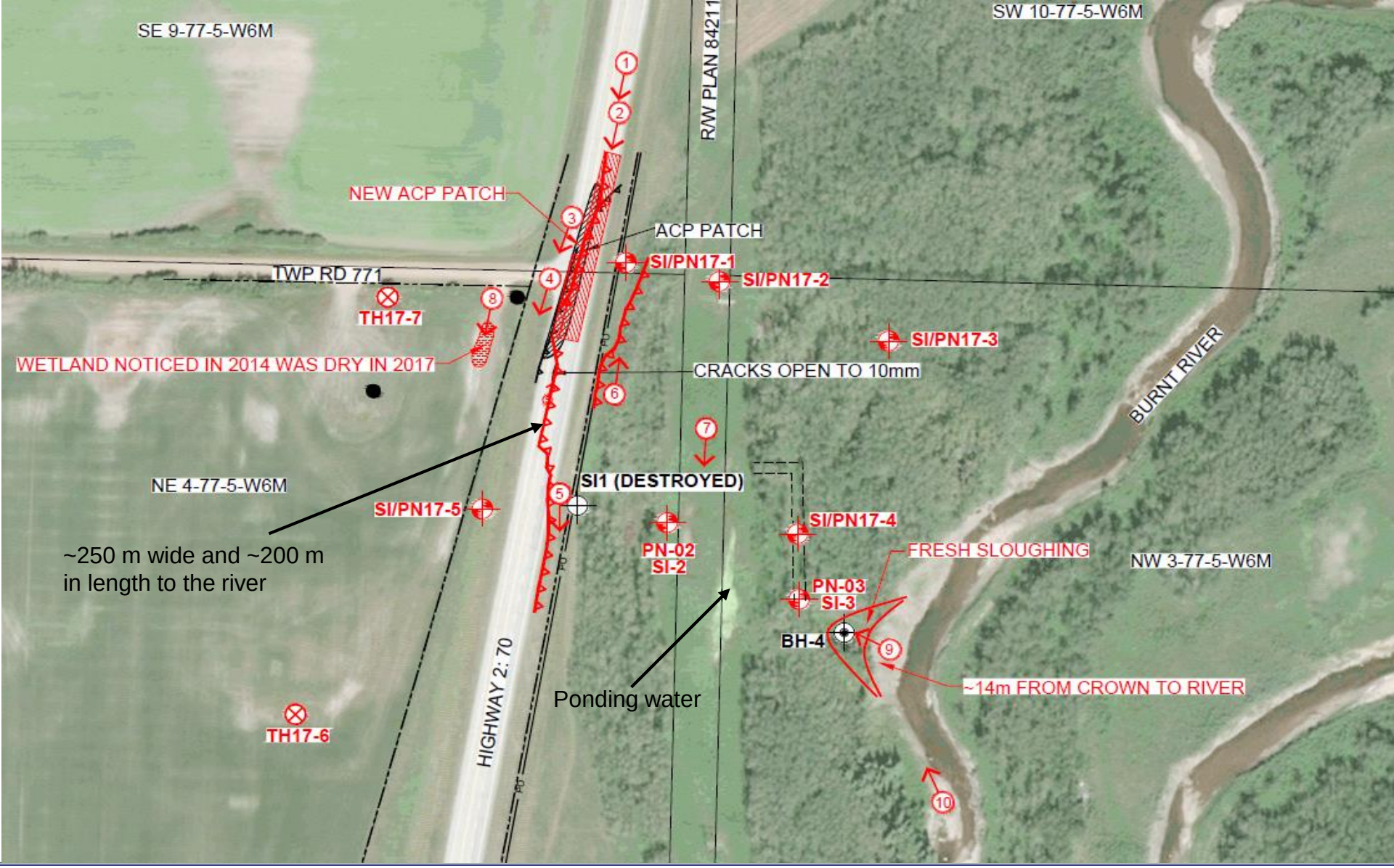

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Background

- The river valley is a pre-glacial valley with drift deposits to about 50m-100m depth.
- It is unknown if the slide predated the highway possibly ancient deep seated landslide.
- Highway was widened in 2013 for a new NBL likely constructed over backscarp.
- Karl Engineering Consultants Ltd. Installed 3 Slope Inclinometers to 36 m and 3 piezometers
- Primary cause due to river erosion at the toe and high ground water regime

Localized Landslides

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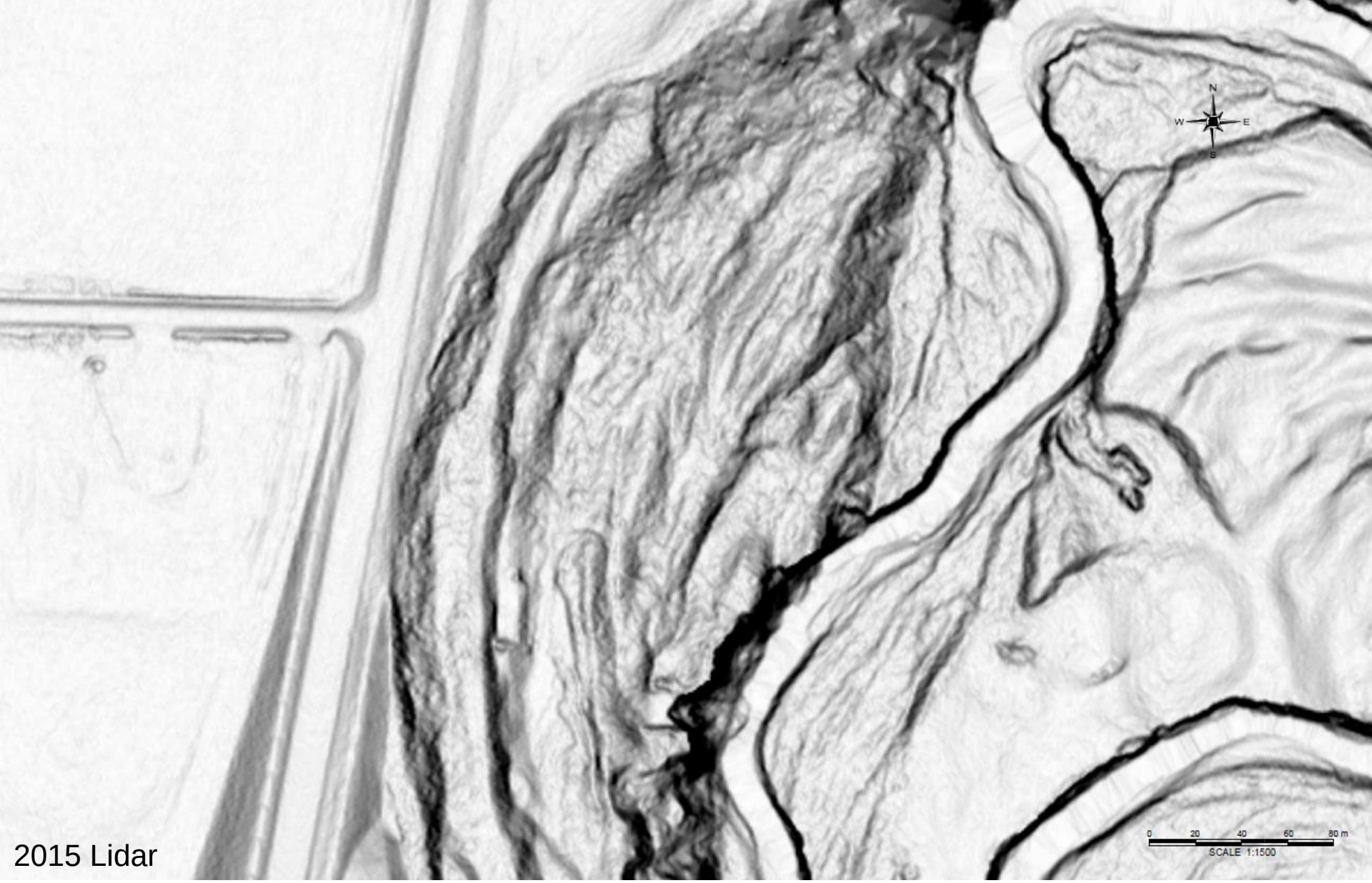

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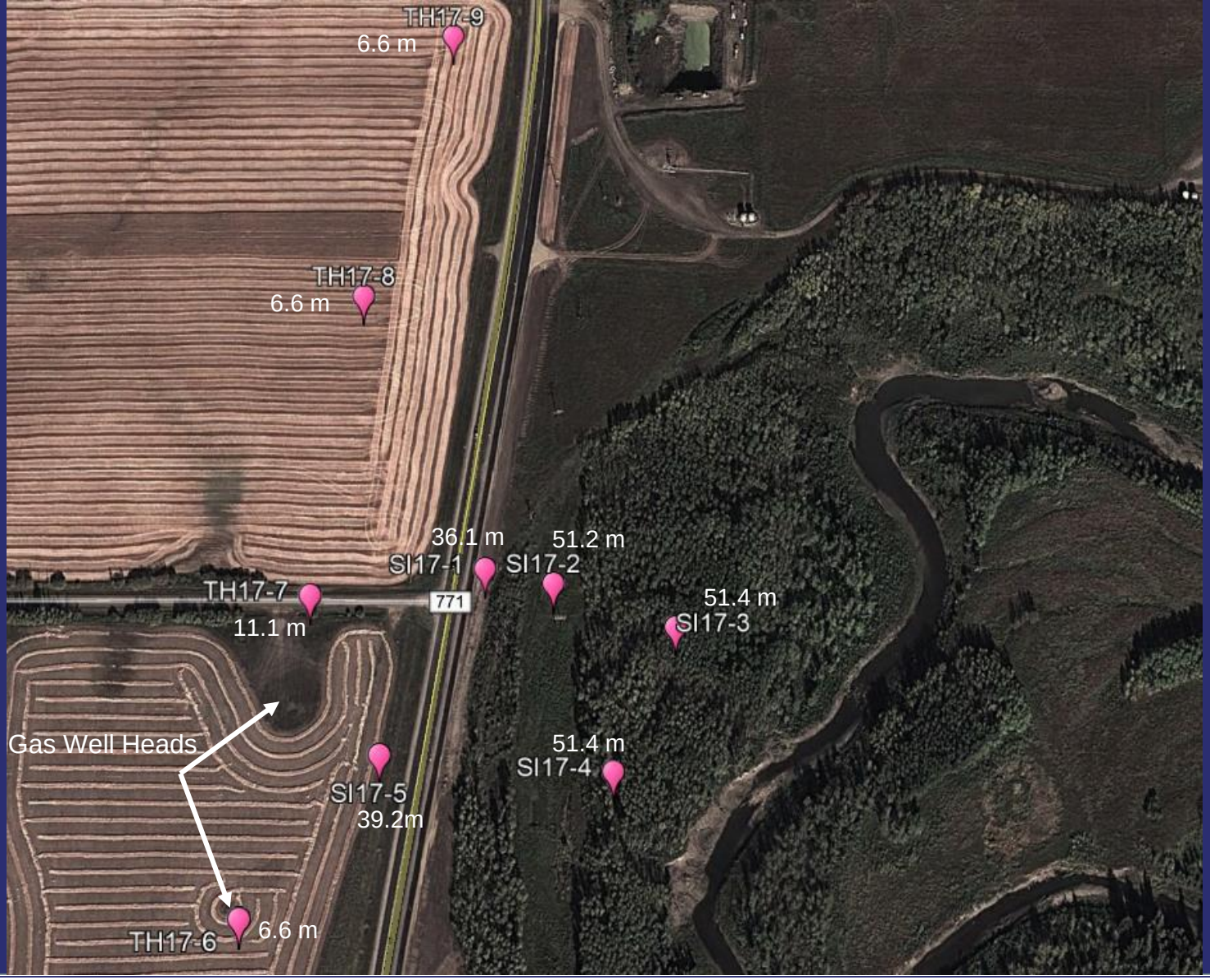
Additional Geotechnical Investigation

- Drilled 9 test holes auger and wet rotary
- Three SIs installed to 51 m with 3 pneumatic piezometers to hopefully catch deep seated movement
- Two SIs installed to 36 and 39 m deep with 2 pneumatic piezometers
- Three tests holes 6.6 m to 11.1 m deep with standpipes for re-alignment information



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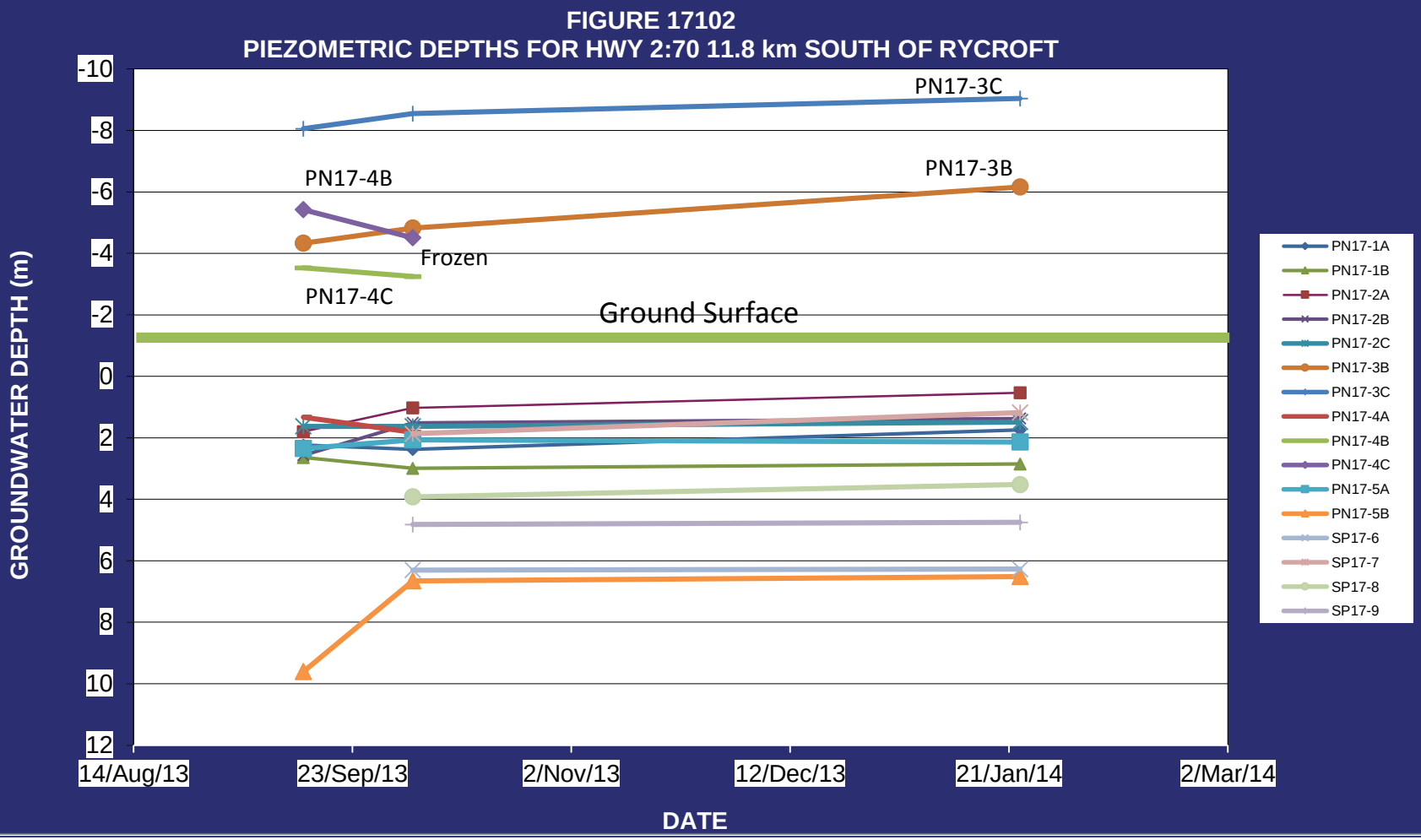
Findings from Investigation



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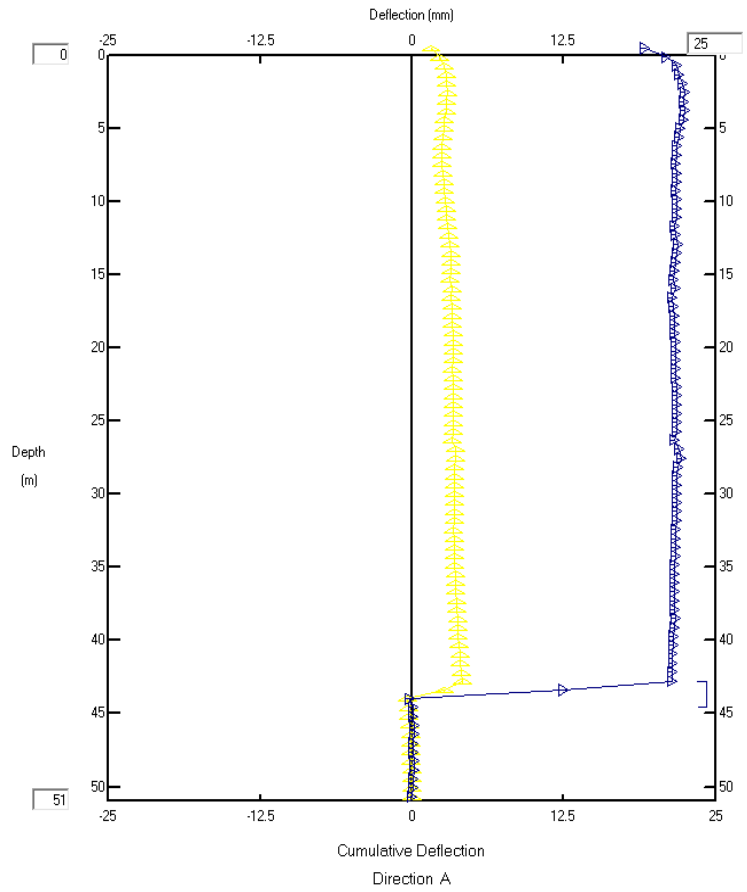
Thurber Engineering



LEGEND

Initial 15 Sep 2017 set 3

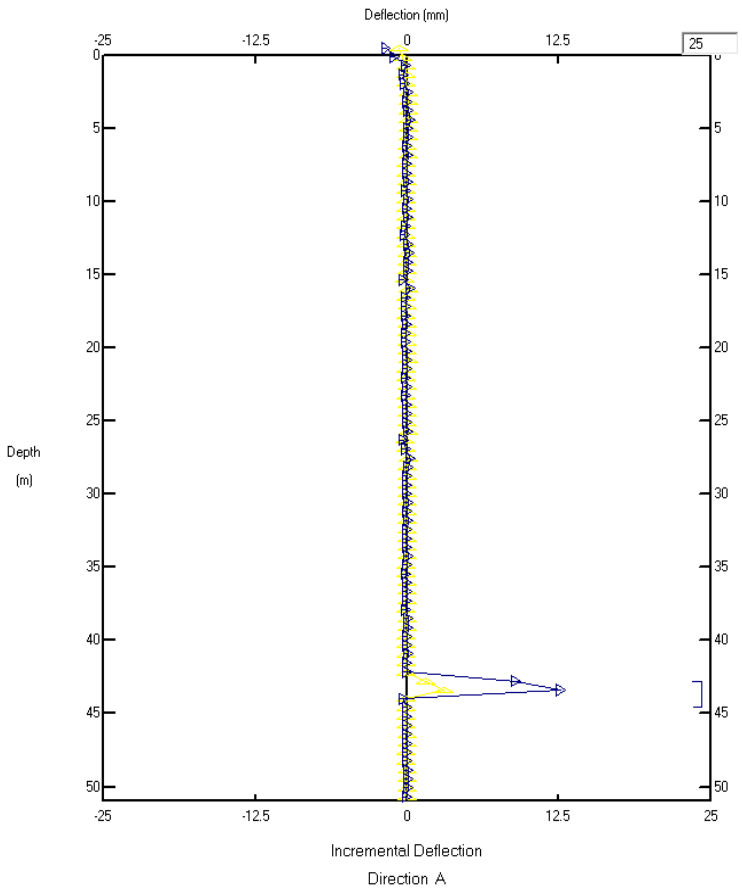
6 Oct 2017* set 5

1 Dec 2019 set 7

SI17-3

43 m (586.4 m elev.)

Ref. Elevation 629.50m



GP029-1 - Church Camp Slide, Inclinometer SI17-3

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Sets marked * include zero shift and/or rotation corrections.

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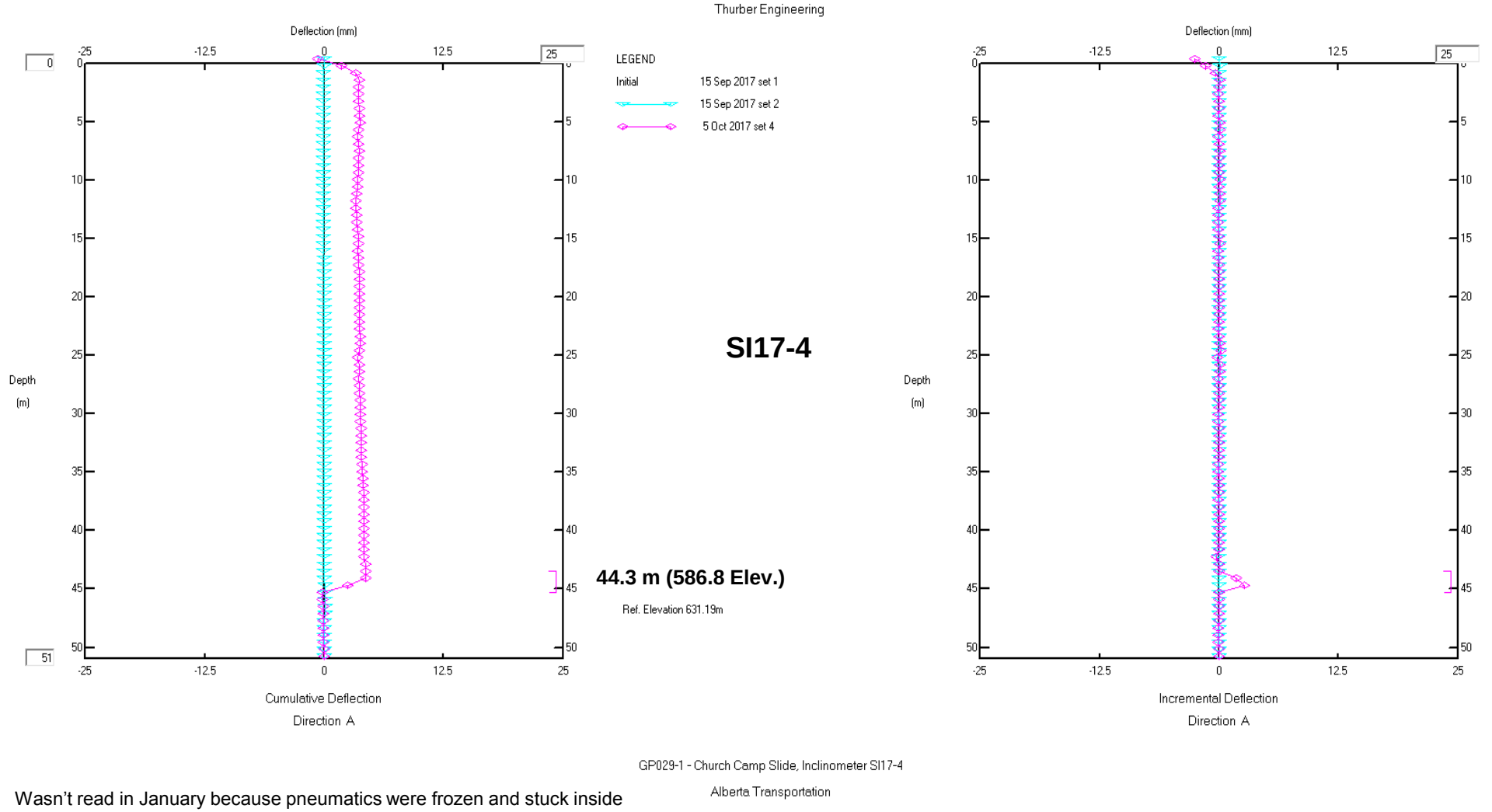

Wasn't read in January because pneumatics were frozen and stuck inside

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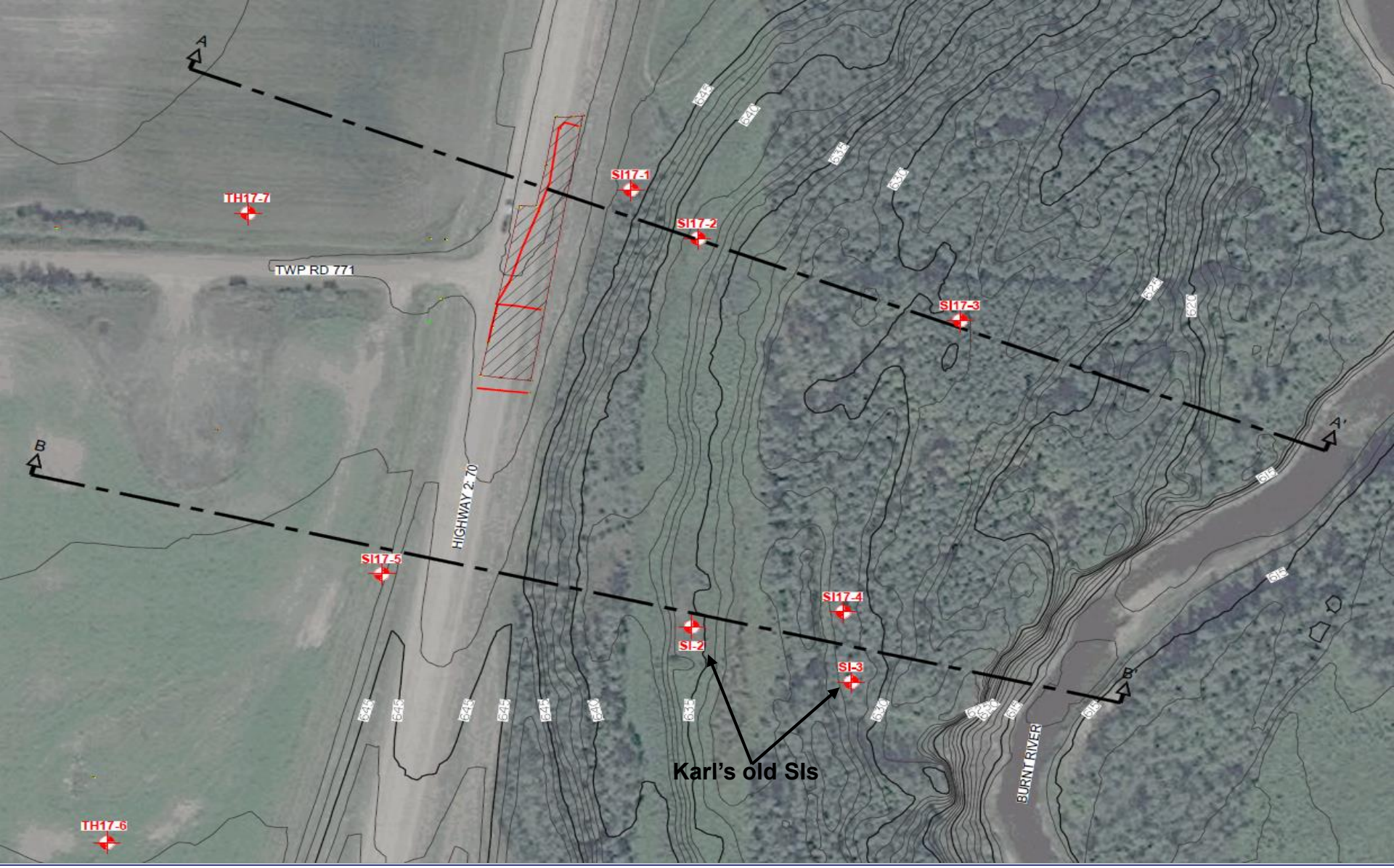

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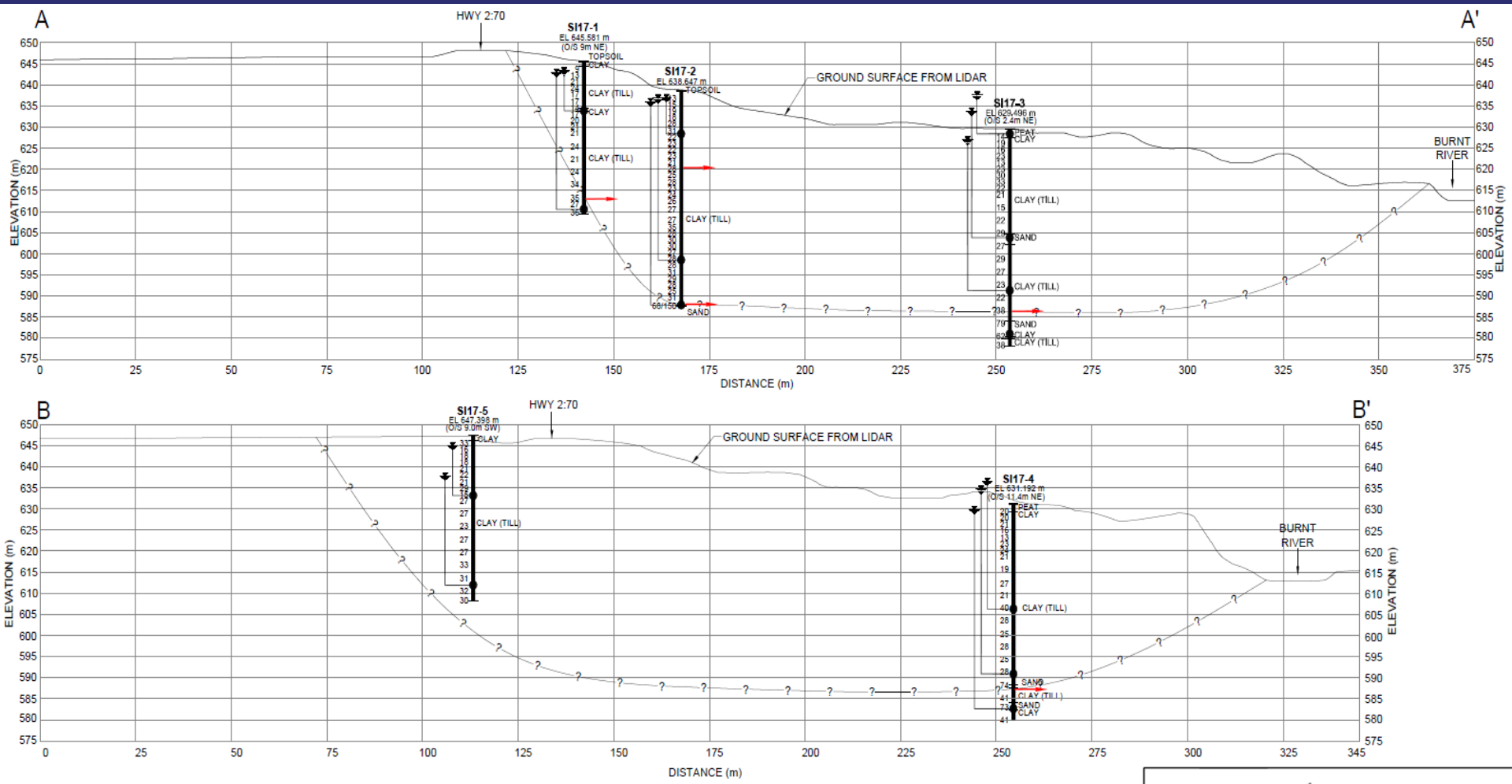

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FOS: 1.065

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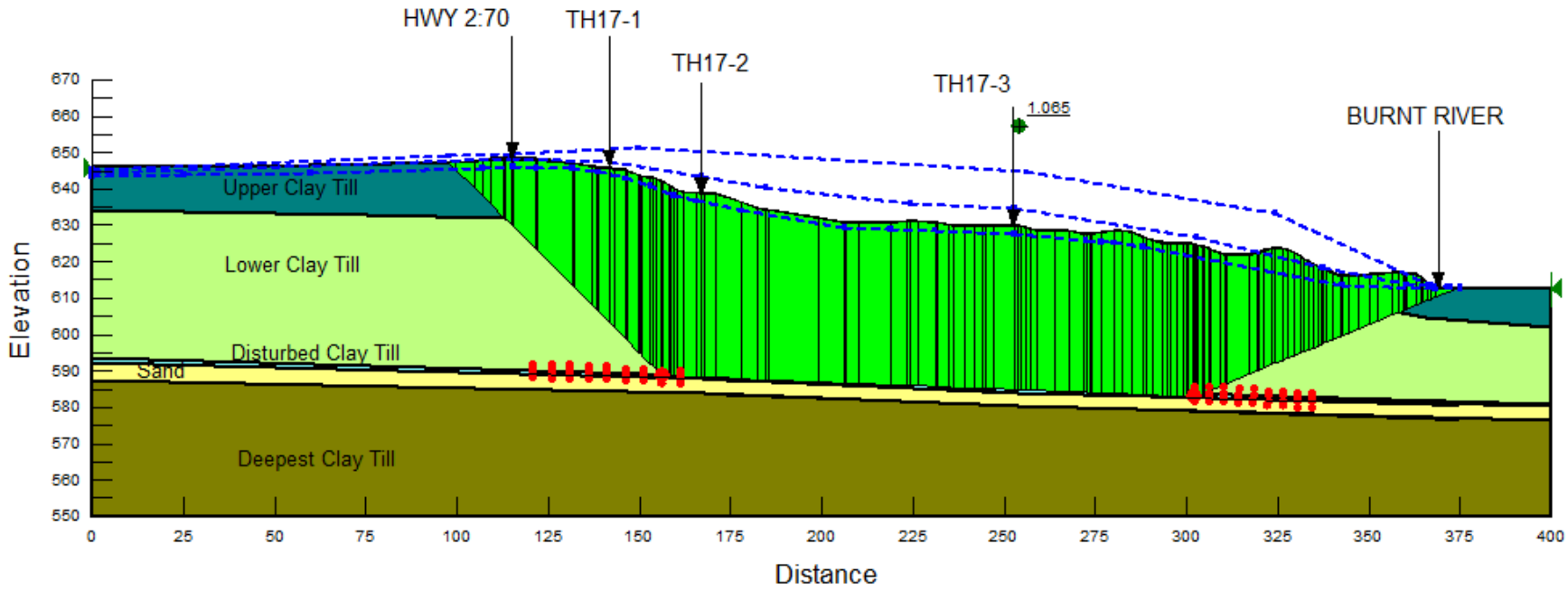
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 1 kPa
Phi: 20 °
Piezometric Line: 3
Name: Lower Clay Till
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 1 kPa
Phi: 21 °
Piezometric Line: 1
Name: Clay Till (Disturbed)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 12 °
Piezometric Line: 2

Name: Sand
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Piezometric Line: 2
Name: Deeper Clay Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 28 °
Piezometric Line: 2



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Phi: 20 °
Piezometric Line: 3
Name: Lower Clay Till
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 1 kPa
Phi: 21 °
Piezometric Line: 1
Name: Clay Till (Disturbed)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 12 °
Piezometric Line: 2

Name: Sand
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
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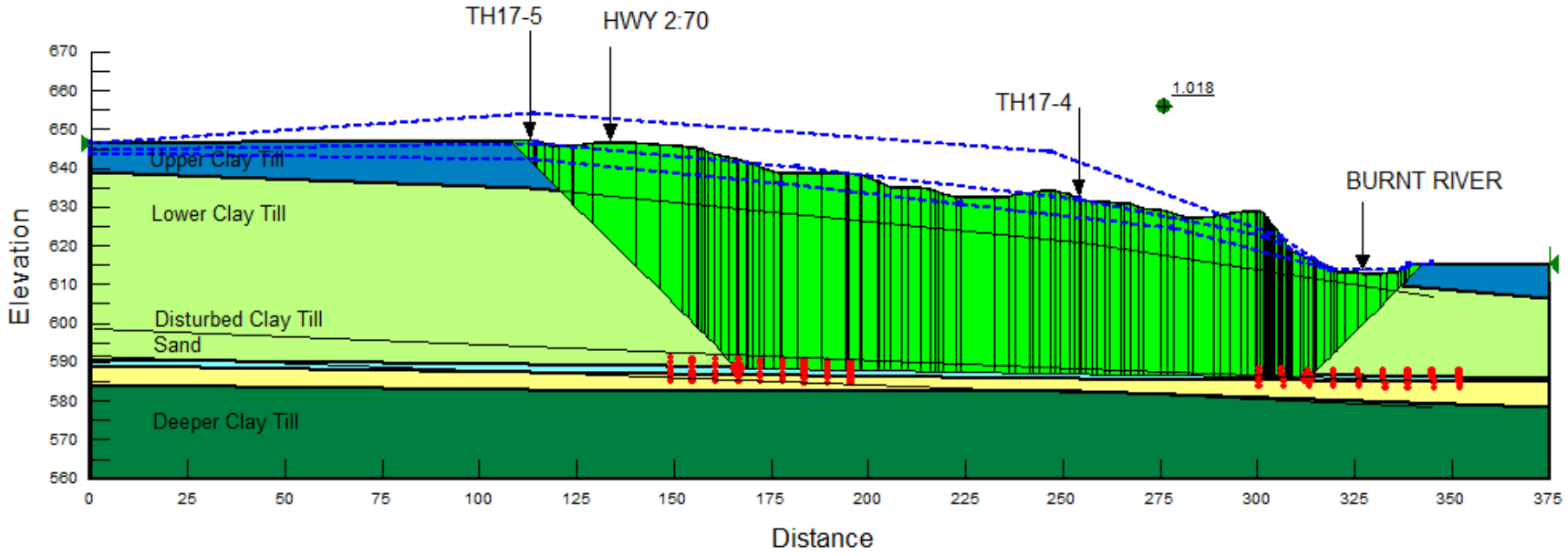
Name: Deeper Clay Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 28 °



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Unit Weight: 18 kN/m³
Cohesion: 1 kPa
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Unit Weight: 19 kN/m³
Cohesion: 1 kPa
Phi: 21 °
Piezometric Line: 1

Name: Clay Till (Disturbed)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 12 °
Piezometric Line: 2

Name: Sand
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 32 °
Piezometric Line: 2

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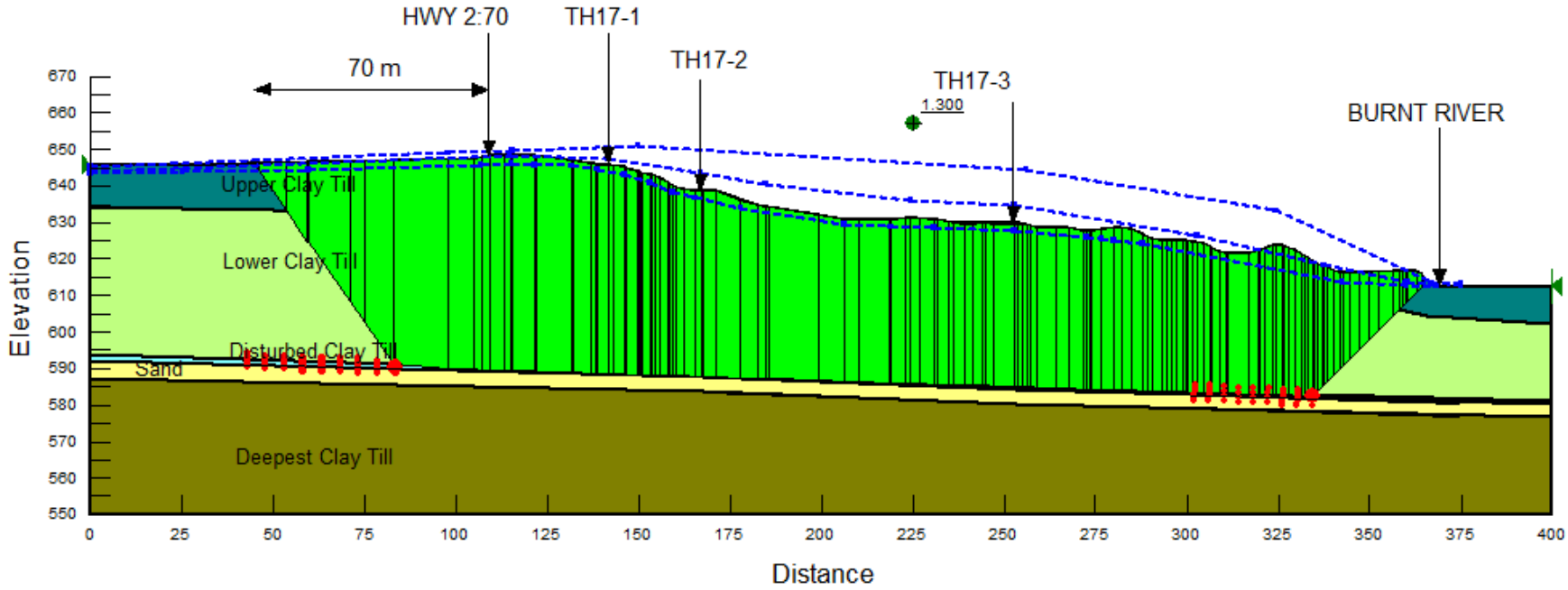
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 28 °
Piezometric Line: 2



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Unit Weight: 18 kN/m³
Cohesion: 1 kPa
Phi: 20 °
Piezometric Line: 3
Name: Lower Clay Till
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 1 kPa
Phi: 21 °
Piezometric Line: 1
Name: Clay Till (Disturbed)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 12 °
Piezometric Line: 2

Name: Sand
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
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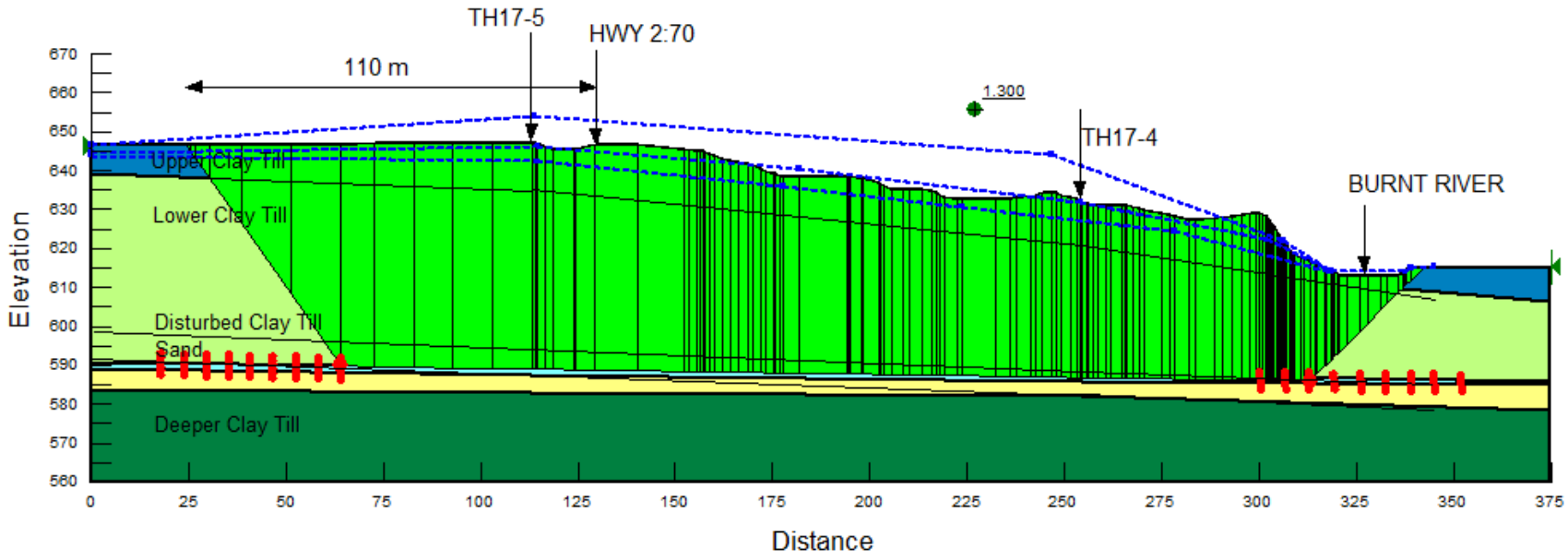
Name: Deeper Clay Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 5 kPa
Phi: 28 °



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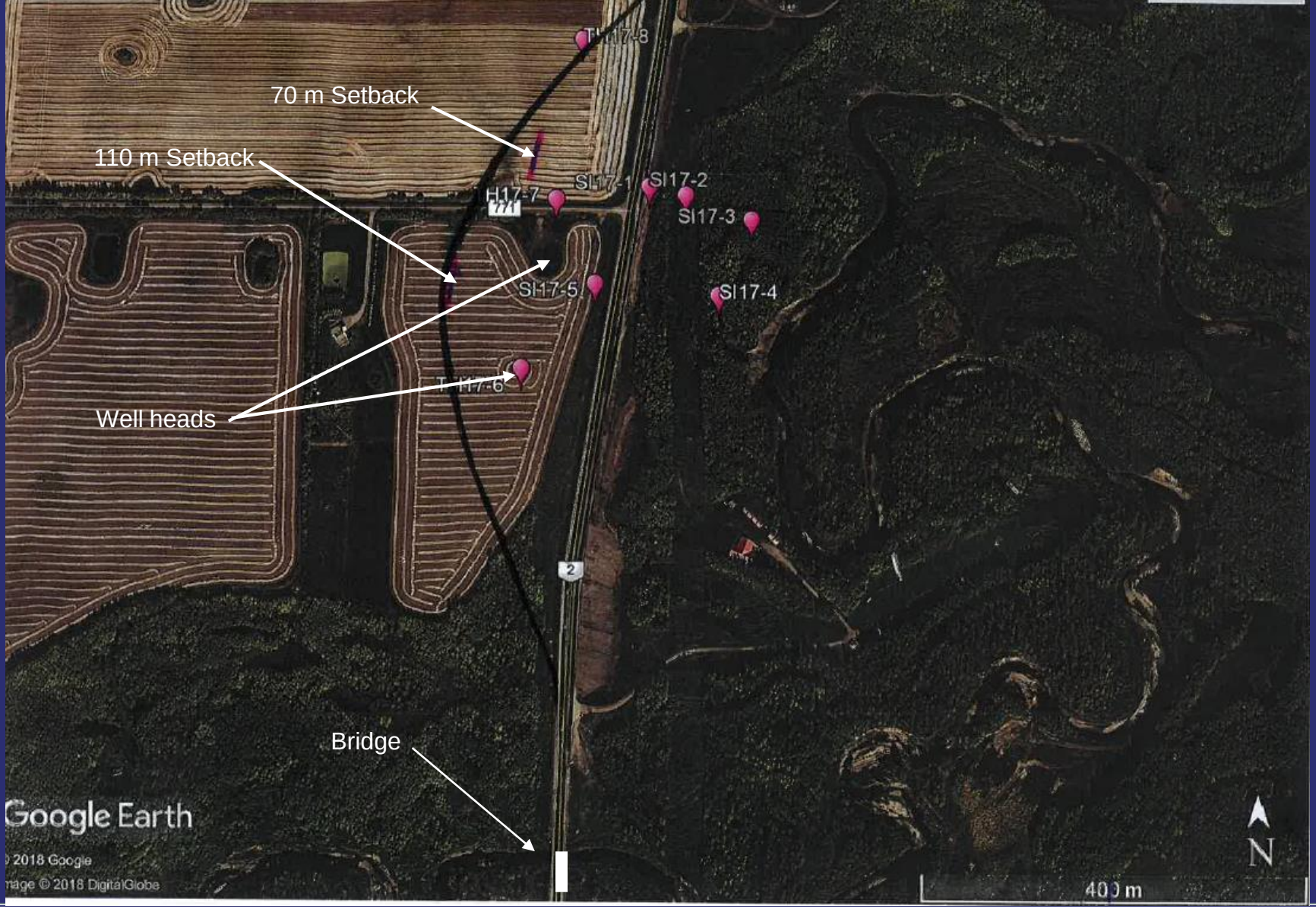
Remedial Measures

- Landslide is too large and deep for pile wall or toe berm
- Re-alignment of the highway is most cost effective option
- Well heads in farmers field will need to be taken into consideration
- WSP will be completing the re-alignment design



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