REPORT

Foundation Investigation and Design
Improvements to County Road 3 Approaches
Highway 417, Site No. 27-212
United Counties of Prescott and Russell, Ontario

GWP 4050-18-00

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the improvements to the eastbound and westbound approaches of the existing Highway 417 / County Road 3 overpasses (Site No. 27-212), which is located in the United Counties of Prescott and Russell, Ontario (GWP 4050-18-00), as part of the Mega 10 Project (Purchase Order No. 4017-E-0019).

This report presents the results of the foundation investigation carried out for the existing County Road 3 overpasses. The purpose of this foundation investigation was to assess the subsurface conditions in the area of the existing approaches, to evaluate causes of the settlement at the existing sleeper slabs on all four quadrants, and to provide geotechnical input for selection of a technically preferred alternative for design of the approach slab in order to address the existing deficiencies at the approaches. The foundation investigation included drilling boreholes, installing vibratory wire piezometers (VWP's), carrying out piezocone penetration tests, and subsequent laboratory testing on selected soil samples.

The terms of reference for the original scope of work are outlined in MTO's Work Item Order Form for Assignment 6, dated October 17, 2018. Golder's scope of work for foundation engineering services associated with the County Road 3 overpasses is contained in Appendix 2B: Work Item Quote Form of Dillon's Technical Proposal for this assignment.

The work was carried out in accordance with Golder's Project Specific Supplementary Quality Control Plan dated April 2018.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 General

The two existing County Road 3 overpasses (Site 27-212.1/2), each of which carries two lanes of Highway 417 over County Road 3, are located about 4 km west of the village of Casselman in the United Counties of Prescott and Russell, Ontario (see Key Plan in Drawings 1 and 2).

The overpasses were constructed in 1973 and consist of six-span pre-stressed precast AASHTO girder concrete structures. The overpass bridges are about 115.8 m long, 12.4 m wide, and aligned in a north-south direction. As shown on the original construction drawings (drawings nos. D-6830-1 and D-6823-1 dated September 1970), each superstructure is supported on five piers (each with two columns) founded on steel HP310 x 110 piles (12 HP 74) and semi-integral abutments founded on steel HP310 x 79 piles (12 HP 53) driven to refusal.

The existing bridge embankments are approximately 3 to 4 m in height above the natural ground level (i.e., the top of the abutments is at about elevation 69 m). The embankment side slopes are generally oriented at about 3 horizontal to 1 vertical (3H:1V) but as steep as 2H:1V.

An investigation was carried out in 1970 for the design of the original/existing bridges by the Ontario Department of Highways. The results of that investigation are contained in the following report:

- Foundation Investigation Report for "Proposed Crossing at Hwy. 417, Eastbound and Westbound Lanes and County Road No. 3, *Twp. Of Cambridge – Co. of Russell, District No. 9 (Ottawa), W.J. 70-F-2, W.P. 35-66-14 (Geocres 31G00-45)*", by Foundation Section, dated February 10, 1970.

The available information and foundation records indicate the subsurface conditions at the site generally consist of surficial fill, topsoil and/or native sandy and silty soils, overlying an extensive deposit of firm to stiff clay to silty clay, up to about 20 m in thickness, followed by loose to very dense glacial till, over limestone bedrock at about 18 to 26 m depths.

The existing embankment loading over the thick sensitive and compressible clay deposit has resulted in large settlement of the embankments since the original construction in 1973. Significant settlement of the clayey deposit, in the order of 0.8 m, was predicted for the embankment fill height of 3 m (as indicated in the previous report available from Geocres, numbered 31G00-45), with about 0.3 m anticipated within the first 1 to 2 years.

Due to the anticipated settlement, it was initially recommended that the approach fills (including about 1 m of surcharge above the profile grade) be placed two years prior to the construction of the bridges to allow some of the settlement to take place. However, it appears from the foundation records (Geocres 31G00-45) that the bridges were constructed within 6 months (and likely as little as 4 months) after placement of the approach fills and surcharge, with the pile driving commencing in February 1973. No historical settlement monitoring record is available for this site.

The structure was rehabilitated in 2005 and that rehabilitation included removal and replacement of the existing approach slabs, as well as construction of sleeper slabs. Subsequent to the rehabilitation, additional settlement/depression was identified at the ends of all the approach slabs.

2.2 Regional Geological Conditions

As delineated in *The Physiography of Southern Ontario*[1], this section of Highway 417 lies within the major physiographic region known as the Russell and Prescott Sand Plains.

The Russell and Prescott Sand Plains region is characterized by estuarine and river channel deposits of medium to fine grained sand, locally reworked into dunes. These soils are underlain by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.

The regional bedrock is composed of sedimentary rocks of the Lindsay formation, consisting of thinly to medium bedded crystalline limestones and calcareous shales. These Ordovician sedimentary rocks are, in turn, underlain at depth by igneous and metamorphic bedrock of the Precambrian Shield.

The site falls within the Western Québec Seismic Zone (WQSZ) according to the Geological Survey of Canada. The WQSZ constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and Cornwall. Within the WQSZ, recent seismic activity has been concentrated in two subzones; one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes in the WQSZ includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2, and the 1944 Cornwall-Massena event which had a magnitude of 5.6. The most recent significant earthquake in the Ottawa area, on May 17, 2013, had a magnitude of 5.2 and was centered about 18 km north-east of Shawville, Québec.

[1] Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.

3.0 INVESTIGATION PROCEDURES

The subsurface investigation at the existing approaches was carried out between December 4, 2018 and January 11, 2019. During that time, four boreholes (numbered 18-601 to 18-604) and four piezocone penetration tests (numbered CPT 18-605 to 18-608) were advanced at the locations shown on Drawings 1 and 2.

The boreholes were advanced using 108 mm inside diameter (200 mm outside diameter) continuous-flight hollow-stem augers on a truck mounted drill rig, supplied and operated by Marathon Underground Constructors Corp. of Greely, Ontario.

- Boreholes 18-601 and 18-603 were advanced just west and east of the sleeper slabs, at the ends of the approach slabs, at the County Road 3 bridge structures on the westbound and eastbound lanes of Highway 417, respectively. These boreholes were cored through the asphaltic concrete and advanced until practical refusal to augering was encountered at depths of about 26.3 and 27.3 m below the existing ground surface.
- Boreholes 18-602 and 18-604 were advanced within the approach slabs of the County Road 3 bridge structures, on the westbound and eastbound lanes of Highway 417, respectively. These boreholes were cored through the asphaltic concrete and approach slab and advanced until practical refusal to augering was encountered at depths of about 25.4 and 29.7 m below the existing ground surface.

Samples of overburden in the boreholes were obtained at vertical intervals of about 0.60 and 0.76 m within the non-cohesive soil layers, using 35 mm inside diameter (50 mm outer diameter) split-spoon samplers. In-situ vane testing was carried out within the cohesive deposits, using an MTO ‘N’-size vane, with the reaction (torque) measured by a pair of calibrated scales, to measure the undrained shear strength of the cohesive soils. After determining the undrained shear strength, remoulded shear strengths were also measured at selected intervals.

Relatively undisturbed clayey samples were retrieved throughout the clayey deposit using a fixed piston sampler with 73 mm diameter thin-walled Shelby tubes. Eleven (11) Shelby tube samples were retrieved from Borehole 18-601, ten (10) Shelby tube samples were retrieved from Borehole 18-602, eleven (11) Shelby tube samples were retrieved from Borehole 18-603, and thirteen (13) Shelby tube samples were retrieved from Borehole 18-604.

The testing and sampling intervals were carried out within the overburden in accordance with the procedures outlined in the MTO Work Item Order Form for this assignment.

Upon completion of drilling, a model PWS vibrating wire piezometer (VWP) from RocTest Ltd. was installed in each borehole at various depths. The piezometer was secured to the outside of a length of PVC pipe, inserted to the desired depth, and each borehole (including the PVC pipe) was backfilled with a grout mix of Portland Type I cement and bentonite, complete with flushmount cover. The site conditions were restored following completion of work. The VWP’s were connected to a datalogger to allow subsequent measurement of the pore water pressures and measurements were taken on January 5, January 11, February 1, and February 19, 2019.

The field investigation program also included piezocone penetration tests. A total of four Cone Penetration Tests (CPT’s) (numbered CPT 18-605 to CPT 18-608) were carried out, adjacent to each of the four borehole locations.

- CPT 18-605 and CPT 18-606 were advanced though the west and east approaches, just beyond the sleeper slab, on the westbound lanes of Highway 417, adjacent to Boreholes 18-601 and 18-602, respectively

- CPT 18-607 and CPT 18-608 were advanced though the east and west approaches, just beyond the sleeper slab, on the eastbound lanes of Highway 417, adjacent to Boreholes 18-603 and 18-604, respectively.

The CPT's were carried out using a 25 ton truck (C-3) mounted drill rig supplied and operated by ConeTec Investigations Ltd. of Richmond Hill, Ontario. The penetration tests used a 15 cm^2 tip base area probe, with an equal end area friction sleeve, and tip and sleeve capacities of 1,500 bar and 15 bar, respectively.

In each CPT hole, the existing asphaltic concrete was cored and the surficial fill was drilled through. The piezocone was pushed starting from approximately 1.8 to 2.4 m in depths. The tip resistance, shaft friction, and pore water pressures were measured at approximately 0.025 m depth intervals. The CPT holes were advanced until encountering practical refusal to piezocone advancement at depths ranging from about 25.6 to 26.7 m below the existing ground surface.

A total of 4 dissipation tests were completed in the CPT holes; i.e. one dissipation test in each completed testhole. The groundwater levels at the CPT locations were inferred based on the pore water pressure measurements taken during advancement.

The CPT holes were backfilled with bentonite pellets mixed with native soils in the overburden. The site conditions were restored following completion of work.

The field work was supervised by members of Golder's technical and engineering staff, who located the boreholes and CPT holes, supervised the drilling, sampling and in-situ testing operations, logged the boreholes, and examined and cared for the soil samples. Traffic control was provided for the entire duration of the field work in accordance with the Ontario Traffic Manual, Book 7, Temporary Conditions.

The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratories in Ottawa and Mississauga for further examination and laboratory testing.

- Index and classification tests, consisting of grain size distribution, Atterberg limits, and water content determination, were carried out on selected soil samples at the Golder's Ottawa and Mississauga laboratories.
- Two consolidated direct shear tests were carried out, one on samples from the embankment fill and one on the native granular soils.
- Two consolidated drained (CID) triaxial tests, with unload-reload cycles, were carried out on samples from the embankment fill and native granular soils.
- Ten oedometer consolidation tests, which included four incremental loaded (IL) consolidation tests and two long-term (LT) consolidation tests, were performed on selected Shelby tube samples from each of the boreholes. Four Shelby tube samples, one from each borehole, were submitted to the University of Western Ontario's (UWO) laboratory for one-dimensional consolidation testing using constant rate of strain (CRS).

All of the laboratory tests were carried out in accordance to MTO and/or ASTM standards as appropriate.

Following the field work, the borehole and CPT hole locations were surveyed by Golder personnel using a Trimble R8 GPS unit. The borehole and CPT hole locations, including MTM NAD 83 CRS CBNv6-2010.0 (CRS) northing and easting coordinates, and ground surface elevations referenced to Geodetic datum, are summarized in the following table and are shown on Drawings 1 and 2.

Borehole Number	Borehole Location	MTM NAD83 CSRS Zone 9 Northing (m)	MTM NAD83 CSRS Zone 9 Easting (m)	Ground Surface Elevation (m)	Borehole/CPT Depth (m)
18-601	WBL - West of Bridge, Beyond Sleeper Slab	5019901.4	410466.5	68.8	26.3
18-602	WBL - East of Bridge, Within Approach Slab	5019806.4	410555.1	69.0	25.4
18-603	EBL - East of Bridge, Beyond Sleeper Slab	5019765.8	410531.1	68.7	27.3
18-604	EBL - West of Bridge, Within Approach Slab	5019865.0	410438.3	68.8	29.7
CPT 18-605	WBL - West of Bridge, Beyond Sleeper Slab	5019898.5	410458.4	68.8	25.6
CPT 18-606	WBL - East of Bridge, Beyond Sleeper Slab	5019799.6	410551.0	68.9	25.6
CPT 18-607	EBL - East of Bridge, Beyond Sleeper Slab	5019772.6	410535.4	68.7	26.2
CPT 18-608	EBL - West of Bridge, Beyond Sleeper Slab	5019871.0	410443.3	68.8	26.7

4.0 SITE STRATIGRAPHY

4.1 General

The subsurface conditions encountered in the boreholes advanced during the current investigation are shown on the Record of Boreholes in Appendix A. The results of the water content determination, Atterberg limit testing, and grain size distribution are indicated on the Record of Borehole sheets. The results of the geotechnical laboratory testing carried out as part of the current investigation are presented in Appendix B.

The Record of Borehole sheets and laboratory testing results from the previous investigation at the site are provided in Appendix C. The results of piezocone penetration tests, which include the results of pore pressure dissipation tests, are presented in Appendix D. Selected site photographs taken by Golder personnel showing the existing structure and surrounding area are included in Appendix E.

The borehole and CPT hole locations from the previous and current investigations at the site are shown on Drawings 1 and 2. An interpreted soil stratigraphy section projected along the centreline of the existing embankment is also shown on Drawings 1 and 2. Note that the stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic section are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the site consist of pavement structure and embankment fill, overlying a layer of native sandy silt to sand and silt, underlain by compressible clayey deposit. The clayey deposit is in turn underlain by relatively thin deposits of glacial till, over limestone bedrock.

A more detailed description of the major soil strata and groundwater conditions encountered in the testholes is provided in the following sub-sections. In the following discussion, emphasis is placed on the subsurface conditions encountered in the boreholes advanced during the current investigation, which are in general agreement with the Geocres information. The Geocres information is referenced herein only regarding the clay parameters in Section 4.4 and the bedrock surface elevation in Section 4.6.

4.2 Pavement Structure and Fill

4.2.1 Pavement Structure

All four boreholes were advanced through the existing Highway 417 approaches. Boreholes 18-601 and 18-603 were advanced through the roadway embankment, just beyond the sleeper slab, on the westbound and eastbound lanes of Highway 417, respectively. Boreholes 18-602 and 18-604 were advanced within the approach slab, on the westbound and eastbound lanes of Highway 417, respectively.

At Boreholes 18-601 and 18-603, the pavement structure consists of about 200 mm of asphaltic concrete, overlying approximately 1.5 m and 1.0 m of sand and gravel to sandy gravel base/subbase. At Boreholes 18-602 and 18-604, the pavement structure consists of about 100 mm of asphaltic concrete, overlying approximately 240 and 280 mm of Portland cement concrete slab, above approximately 2.1 m and 2.0 m of sand and gravel base/subbase.

The thickness of the existing pavement structure component encountered at the boreholes are summarized in the following table:

Pavement Structure Component	Thickness (mm) (Average)	
	Approach Embankment (Beyond Sleeper Slab)	Approach Embankment (within Approach Slab)
Asphaltic Concrete	200	100
Portland Cement Concrete	-	240 – 280 (260)
Granular Base/Subbase[(1)]	1,000 – 1,500 (1,250)	2,020 – 2,060 (2,040)
Total Pavement Structure	1,200 – 1,700 (1,450)	2,400

Notes: [(1)] Granular base/subbase was difficult to distinguish at time of drilling.

SPT ‘N’ values obtained within the sand and gravel to sandy gravel base/subbase range from 19 to 79 blows per 0.3 m of penetration, indicating a compact to very dense condition.

Grain size distribution testing was carried out on four samples of the granular base/subbase materials, the results of which are shown on the Record of Boreholes and are provided on Figure B1 in Appendix B. It should be noted that the samples were retrieved using a 35 mm inside diameter sampler and therefore the results do not reflect the larger particle content of the fill.

The measured water contents of four samples of the sand and gravel to sandy gravel base/subbase ranged from approximately 1 to 3 percent.

4.2.2 Silty Sand to Sand and Silt Fill

The pavement structure is underlain by embankment fill consisting of silty sand to sand and silt. The embankment fill extends to depths between about 3.4 and 3.7 m below existing ground surface (Elevations 65.1 and 65.7 m) in Boreholes 18-601 and 18-602 advanced through the westbound lanes, to about 4.4 and 4.6 m below existing ground surface (Elevations 64.1 and 64.4 m) in Boreholes 18-603 and 18-604 advanced through the eastbound lanes.

SPT 'N' values obtained within the silty sand to sand and silt fill range from 2 to 60 blows per 0.3 m of penetration, indicating a very loose to very dense condition.

Grain size distribution testing was carried out on three samples of the embankment fill, the results of which are shown on the Record of Boreholes and provided on Figure B2 in Appendix B. It should be noted that the samples were retrieved using a 35 mm inside diameter sampler and therefore the results do not reflect the larger particle content of the fill.

The measured water contents of two samples of the silty and sandy fill layer were both approximately 13 percent.

One consolidated drained direct shear test was carried out on two combined samples of the sand and silt fill layer from Borehole 18-603. The results of this testing are provided on Figure B3 in Appendix B.

In addition, one consolidated drained (CID) triaxial test, with unload-reload cycles, was carried out on samples of the embankment fill. The results of this testing are provided on Figure B4 in Appendix B.

4.3 Sandy Silt to Sand and Silt

A layer of native sandy silt to sand and silt is present beneath the embankment fill in all four boreholes.

At Boreholes 18-601 and 18-602 (on westbound lanes), the sandy and silty layer was encountered at depths of about 3.4 to 3.7 m below existing ground surface (Elevations 65.1 to 65.7 m) and is about 2.2 to 2.6 m thick. At Boreholes 18-603 and 18-604 (on eastbound lanes), the sandy and silty layer was encountered at about 4.4 to 4.6 m below existing ground surface (Elevations 64.1 to 64.4 m) and is about 1.5 to 1.6 m thick.

The thickness of the native sandy and silty layer on the westbound lanes is about the same as what was encountered in the previous boreholes advanced in the area. However, the native sandy and silty soils were found to be thinner (by about 1 m) on the eastbound lanes in comparison to the previous boreholes advanced in this area. It is possible that portions of the native sandy and silty soils along the eastbound lanes were sub-excavated and backfilled with embankment fill during bridge construction.

Standard penetration tests carried out within the native sandy and silty soils measured 'N' values ranging from 2 to 21 blows per 0.3 m of penetration, indicating a very loose to compact condition.

The results of grain size distribution testing carried out on two samples of the sandy silt to sand and silt are shown on the Records of Boreholes and provided on Figure B5 in Appendix B. The measured water contents of two samples of the sandy and silty soils were approximately 25 and 27 percent.

One consolidated drained direct shear test was carried out on one sample of the sandy silt deposit. The results of this testing are provided on Figure B6 in Appendix B.

In addition, one consolidated drained (CID) triaxial test, with unload-reload cycles, was carried out on samples from the native sandy and silty soils. The results of this testing are provided on Figure B7 in Appendix B.

4.4 Clay, Silty Clay to Clayey Silt

The pavement structure, fill, and sandy and silty soils are underlain by a thick deposit of compressible clay to silty clay to clayey silt. The clayey deposit was fully penetrated in all boreholes, and extends to depths of about 24.4 to 26.7 m below existing ground surface (Elevations 42.1 to 44.6 m), with thicknesses varying from about 18.2 to 20.8 m. In the previous boreholes, the clayey deposit was recorded to extend to about Elevations 42.7 to 44.0 m.

Standard penetration tests carried out within the clayey deposit measured 'N' values generally ranging from 'Weight of Rods' to 'Hydraulic Pressure', with the exception of one test in Borehole 18-603, which recorded a blow count of 3 per 0.3 m of penetration. In-situ shear vane testing carried out within this deposit measured undrained shear strengths varying from about 12 to 49 kPa from the top of the deposit to about Elevations 49 to 50 m, indicating a soft to firm consistency. Below these elevations, the undrained shear strength ranged from about 41 to 72 kPa, generally increasing with depth, indicating a firm to stiff consistency. The measured in-situ remoulded strengths in the clayey deposit ranged from about 1 to 17 kPa, with sensitivity varying from about 3 to 48, but more generally from 3 to 10, indicating a soil of low sensitivity to extra sensitive (CFEM, 2006).

Atterberg limit testing carried out on 14 samples of the clay, silty clay to clayey silt measured plasticity index values ranging from 14 to 41 percent and liquid limit values ranging from about 32 to 64 percent, mainly reflecting a soil of medium to high plasticity (with the exception of one low plasticity result). The results of Atterberg limit testing are shown on the record of boreholes and on Figure B8 in Appendix B. The measured natural water contents of samples of the clay, silty clay to clayey silt ranged from approximately 36 to 84 percent.

The results of the measured natural water content, liquid limit, plastic limit and the corresponding liquidity index of each clayey sample are summarized in the table below. The calculated liquidity indices vary from 0.7 to 2.4, but more generally between 1.0 and 1.5, indicating the measured natural water content of the selected samples is generally the same or slightly greater than their liquid limit values.

Borehole/ Sample Number	Sample Depth/ Elevation (m)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Liquidity Index
18-601 / 11	59.4	43	42	19	1.1
18-601 / 17	50.2	54	50	23	1.1
18-602 / 11	59.6	49	43	18	1.3
18-602 / 13	56.6	60	59	20	1.0
18-602 / 14	55.0	47	49	20	0.9
18-602 / 18	47.3	58	38	18	2.0
18-603 / 10	60.9	84	64	23	1.5
18-603 / 16	51.7	36	32	18	1.3
18-603 / 20	45.6	62	41	25	2.4
18-604 / 10	60.9	45	55	21	0.7
18-604 / 12	57.8	74	60	22	1.3
18-604 / 17	50.2	44	41	20	1.1
18-604 / 19	47.2	66	55	26	1.4
18-604 / 20	45.7	63	46	25	1.8

The results of grain size distribution testing carried out on samples of the clayey deposit are shown on the Record of Boreholes and are provided on Figures B9 and B10 in Appendix B.

Laboratory oedometer consolidation testing was carried out on eight samples of the clayey deposit. The preconsolidation pressures, where possible, were estimated from the Void Ratio versus Logarithmic Pressures plot using the Casagrande and work methods. The results of the testing are provided on Figures B11 to B20 in Appendix B and are summarized in the table below.

Borehole/ Sample Number/ Lab	Type of Test	Sample Depth/ Elevation (m)	Unit Weight (kN/m^3)	σ_P' (kPa)	σ_{vo}' (kPa)	$\sigma_P' - \sigma_{vo}'$ (kPa)	C_c	C_r	e_o	OCR
18-601 / 11	IL	9.7 / 59.1	17.5	130	170	-40	0.67	0.012	1.19	0.8
18-602 / 14	IL	14.2 / 54.8	17.1	180	180	-	0.95	0.010	1.29	1.0
18-603 / 16	IL	17.3 / 51.4	18.4	300	250	50	0.28	0.005	0.98	1.2
18-604 / 20	IL	23.5 / 45.3	16.0	220	270	-50	0.77	0.022	1.78	0.8
18-602 / 18	LT	21.6 / 47.4	17.8	-	270	-	-	-	0.96	-
18-604 / 10	LT	7.9 / 60.9	16.7	-	155	-	-	-	1.55	-
18-601 / 15	CRS	15.5 / 53.3	-	220	220	-	1.67	0.018	1.70	1.0
18-602 / 17	CRS	18.6 / 50.4	-	290	205	85	1.73	0.012	1.61	1.4
18-603 / 12	CRS	11.0 / 57.7	-	45	190	-145	0.34	0.013	1.19	0.2
18-604 / 14	CRS	14.0 / 54.8	-	180	200	-20	0.18	0.008	0.98	0.9

Notes:
σ_P' Apparent preconsolidation pressure
σ_{VO}' Computed existing vertical effective stress
C_c Compression index
C_r Recompression index
e_o Initial void ratio
OCR Overconsolidation ratio
IL Incremental loading oedometer consolidation test
LT Long-term oedometer consolidation test
CRS Constant rate of strain consolidation test

As a comparison, the primary consolidation parameters obtained from the previous oedometer consolidation testing on two samples of clayey deposit from the original investigation (i.e., prior to the bridge construction) by MTO are summarized below:

- Overconsolidation ratio, OCR = 1.1 and 1.0;
- Compression Index, C_c = 1.40 and 1.35; and
- Initial void ratio, e_o = 1.86 and 2.05.

Based on the results of the past Geocres investigation, the clayey deposit was normally consolidated to slightly overconsolidated, with OCR ranging between about 1.0 and 1.1, prior to the bridge construction and embankment loading. The initial void ratio, e_o, of the two samples, prior to construction of the embankments, was greater than those measured from the current investigation. The compression indices, C_c, of the two samples tested from the previous investigation were also generally greater than the values obtained from the current investigation. These changes in primary consolidation parameters are likely the result of the embankment loading.

Based on the results of the IL and CRS oedometer consolidation testing on four of the samples from the current investigation, the clayey soil is normally consolidated to slightly overconsolidated, with OCR ranging from about 1.0 to 1.4.

The results of the IL and consolidation testing on the four remaining samples from the current investigation indicates OCR ranging from about 0.2 to 0.9. The ratio from the one CRS test of 0.2 (from borehole 18-603) does not seem to be representative or reasonable and, discounting that test, the OCR range from about 0.8 to 0.9. Based on the sample quality designation system (Lacasse et al., 1985), the calculated strain required to reach the existing effective stress is shown to be greater than 4 percent for these samples, which indicates the samples could have been disturbed or, could be the result of ongoing consolidation. The sample quality designation system developed by Lacasse et al was based on testing of overconsolidated clays (with OCR ranging from 1.4 to 5.0) and may not be valid for samples where primary consolidation is still ongoing (i.e., that are partially consolidated).

OCR close to but less than 1.0 could therefore indicate that the clayey deposits (or portions of) are not fully consolidated under the current embankment loading (i.e., primary consolidation is not completed), which could be the case given the ongoing, excessive settlement observed at this site. However, given the inherent uncertainties associated with the sampling and testing, the degree of ongoing consolidation is difficult to assess.

The results of the LT oedometer consolidation testing on two samples of the clayey deposit from the current investigation are summarized below:

- Secondary compression index, C_α = 0.004 and 0.006; and,
- Ratio of secondary compression index and compression index, C_α / C_c = 0.02

A summary of engineering properties for the clayey deposit is provided on Figure B22, which includes the parameters calculated/measured within the deposit during both the current and past Geocres investigations.

4.4.1 CPT Results

The undrained shear strength profile of the clay has been evaluated based on the results of the piezocone testing program, using the following equation:

$$Su = (q_t - \sigma_{VO}) / N_K$$

Where:

- Su = Calculated undrained shear strength (kPa);
- q_t = Measured net tip resistance (kPa);
- σ_{VO} = Calculated total vertical stress (kPa); and,
- N_K = Correlation factor, selected by ConeTec.

The undrained shear strength profiles for the clayey deposit determined from the results of the piezocone testing, as described above, are summarized in Appendix D.

Based on the estimates from the CPT results, the undrained shear strength of the clayey deposit increases steadily with depth from about 15 to 30 kPa at the top of the deposit, generally reaching about 60 to 75 kPa at the bottom of the layer before encountering the glacial till.

The CPT results have also been interpreted and calibrated against the laboratory consolidation test results to provide a profile of the preconsolidation pressure with elevation, as shown on Figure B22 in Appendix B. The method used to process the data is suggested by Demers and Leroueil (2002) for Champlain Sea clay, with:

$\sigma_P' = (q_t - \sigma_{VO}) / N_{\sigma t}$ Where: σ_P' = Calculated preconsolidation pressure (kPa);

q_t = Measured net tip resistance (kPa);

σ_{VO} = Calculated total vertical stress (kPa); and,

$N_{\sigma t}$ = Correlation factor, selected as 3.0 based on Bjerrum (1975) correlation.

As can be seen on Figure B22, similar preconsolidation pressures were recorded from the four CPT carried out at the north and south approach embankments. The results from the CPT indicate that the preconsolidation pressure of the clayey deposit consistently increases with the existing overburden effective stress from the top to the bottom of the deposit before reaching practical refusal, suggesting that the clay is effectively normally consolidated over its entire thickness due to the existing embankment loading (which generally exceeded the preconsolidation pressure prior to construction of the embankments).

4.5 Gravelly Sandy Silt to Gravelly Silty Sand (Till)

A deposit of glacial till was encountered directly beneath the clayey soils in all four boreholes. The glacial till deposit generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt to silty sand. The till was not fully penetrated but was proven to depths of at least about 25.4 to 29.7 m (Elevations 39.1 to 43.7 m).

Standard penetration test ‘N’ values of 10 to greater than 50 blows per 0.3 m of penetration were measured in the glacial till, indicating a loose to very dense condition, generally increasing with depth. The higher ‘N’ values could reflect the presence of cobbles and boulders, rather than the actual condition of the soil matrix. More generally, the till was found to be compact to dense.

Grain size distribution testing was carried out on three samples of the till, the results of which are shown on the Record of Boreholes and are provided on Figure B21. It should be noted the samples were retrieved using a 35 mm inside diameter sampler and therefore the results do not reflect the larger particle content of the deposit.

The results of Atterberg limit testing on one sample of the glacial till was found to be non-plastic. The measured water contents of three samples of till ranged between about 8 and 12 percent.

4.6 Refusal or Bedrock

Practical refusal to augering and CPT advancement was encountered in all current boreholes and CPT holes at depths ranging from about 25.4 to 29.7 m below existing ground surface (Elevations 39.1 to 43.7 m), at which depths the testholes were terminated. The auger or CPT advancement refusal may represent the surface of bedrock but could also indicate the presence of cobbles and/or boulders within the glacial till deposit.

Bedrock was encountered and proven beneath the glacial till deposit in all previous boreholes at about Elevations 39.0 to 41.5 m. The bedrock was cored to depths of at least 1.5 m below bedrock surface using an AXT-sized core.

The following table summarizes the bedrock surface or refusal depths and elevations as encountered at the borehole locations during the current and previous Geocres investigation at the site.

Borehole Number	Borehole Location	Existing Ground Surface Elevation (m)	Depth to Auger Refusal / Bedrock Surface (m)	Auger Refusal / Bedrock Surface Elevation (m)
18-601	WBL - West of Bridge, Beyond Sleeper Slab	68.8	26.3 [R]	42.5[R]
18-602	WBL - East of Bridge, Within Approach Slab	69.0	25.4 [R]	43.6 [R]
18-603	EBL - East of Bridge, Beyond Sleeper Slab	68.7	27.3 [R]	41.4 [R]
18-604	EBL - West of Bridge, Within Approach Slab	68.8	29.7 [R]	39.1 [R]
CPT 18-605	WBL - West of Bridge, Beyond Sleeper Slab	68.8	25.6 [R]	43.2 [R]
CPT 18-606	WBL - East of Bridge, Beyond Sleeper Slab	68.9	25.6 [R]	43.3 [R]
CPT 18-607	EBL - East of Bridge, Beyond Sleeper Slab	68.7	26.2 [R]	42.5 [R]
CPT 18-608	EBL - West of Bridge, Beyond Sleeper Slab	68.8	26.7 [R]	42.1 [R]
1	EBL - Between North Abutment and Pier 1	65.4	26.2	39.2
2	EBL - Between Pier 2 and Pier 3	62.4	22.2	40.2
3	EBL - Pier 3	62.3	21.8	40.5
5	EBL - Between Pier 5 and South Abutment	65.4	23.9	41.5
6	WBL - Pier 1	65.3	26.2	39.1
7	WBL - Pier 2	57.5	18.2	39.3
8	WBL - Pier 3	62.1	22.6	39.5
9	WBL - Between Pier 4 and Pier 5	62.1	21.8	40.3

Note: [R] = Depth to auger refusal in borehole or tip refusal in CPT hole

The bedrock encountered in the previous investigation was described as consisting of fossiliferous, crystalline, fine grained limestone with occasional thin shale seams. The Total Core Recovery (TCR) was generally in excess of 90 percent; however, the Rock Quality Designation (RQD) values were not measured on recovered bedrock core samples during the previous investigation.

4.7 Groundwater Conditions

Four VWP's were installed, one at each borehole, at various depths. The VWP's were connected to a datalogger to allow subsequent measurement of the pore water pressures and the measurements were taken on January 5, January 11, February 1 and February 19, 2019. The interpreted groundwater levels based on the results of the VWP readings are summarized in the table below.

Borehole	Ground Surface Elevation (m)	VWP Depth (m)	VWP Elevation (m)	Date of Measurement	Groundwater Depth (m)	Groundwater Elevation (m)
18-601	68.8	22.8	46.0	Jan 5, 2019	15.2	53.6
				Feb 1, 2019	15.8	53.0
				Feb 19, 2019	15.9	52.9
18-602	69.0	8.4	60.6	Jan 5, 2019	5.3	63.7
				Feb 1, 2019	5.6	63.4
				Feb 19, 2019	5.6	63.4
18-603	68.7	18.3	50.5	Jan 5, 2019	9.5	59.3
				Jan 11, 2019	9.7	59.1
				Feb 1, 2019	9.8	59.0
				Feb 19, 2019	9.7	59.1
18-604	68.8	12.3	56.5	Feb 1, 2019	8.4	60.4
				Feb 19, 2019	8.2	60.6

The results of the VWP readings indicate that the stabilized groundwater levels at this site vary from about Elevations 52.9 to 63.4 m.

It should be noted that groundwater levels are anticipated to fluctuate seasonally, and higher groundwater levels are expected during wet / precipitation periods of the year.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Christine Ko, P.Eng., and reviewed by Mr. Bill Cavers, P.Eng., a Senior Geotechnical Engineer and Associate with Golder. Mr. Fin Heffernan, P.Eng., the MTO Foundations Designated Contact for this assignment, conducted an independent quality review of this report.

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PART B

Foundation Design
Improvements to County Road 3 Approaches
Highway 417, Site No. 27-212
United Counties of Prescott and Russell, Ontario
GWP 4050-18-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides foundation design recommendations for the proposed improvements/ rehabilitation to the existing County Road 3 overpasses, Site No. 27-212 (GWP 4050-18-00) in the United Counties of Prescott and Russell, Ontario. The recommendations provided herein are based on interpretation of the factual data obtained from the boreholes and piezocone tests advanced during the current and previous subsurface investigations, and are provided in accordance with the current Canadian Highway Bridge Design Code CAN/CSA-S6-14 (CHBDC).

The foundation investigation report, discussion, and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided, as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

The two existing County Road 3 overpasses (Site 27-212), each of which carries two lanes of Highway 417 over County Road 3 (Route 500W), are located about 4 km west of the village of Casselman in the United Counties of Prescott and Russell, Ontario.

The overpasses consist of six-span pre-stressed precast AASHTO girder concrete structures. The overpass bridges are about 115.8 m long, 12.4 m wide, and aligned in a north-south direction. As shown on the original construction drawings (drawings nos. D-6830-1 and D-6823-1 dated September 1970), each superstructure is supported on five piers (each with two columns) founded on steel HP310 x 110 piles (12 HP 74) and semi-integral abutments founded on HP310 x 79 piles (12 HP 53) driven to refusal.

The embankment side slopes of the existing structures are generally oriented at about 3 horizontal to 1 vertical (3H:1V) but as steep as 2H:1V.

6.2 Approach Embankment

Based on the results of the current investigation, the existing bridge embankments vary from about 3.4 to 3.7 m in height along the westbound lanes and approximately 4.4 to 4.6 m in height along the eastbound lanes above the natural ground level, with the top of the abutments is at about elevation 69 m.

The embankment subgrade soils generally consist of native sandy and silty soils, overlying a soft to stiff compressible clayey deposit, which is in turn underlain by glacial till, over limestone bedrock.

6.2.1 Geocres Review of Existing Embankments

It is understood that the original bridge was constructed in 1973. Significant settlement of the clayey deposit, in the order of 0.8 m, was predicted for the proposed 3 m of fill height during the original investigation (as indicated in the previous report available from Geocres, numbered 31G00-45), with about 0.3 m of settlement anticipated to occur within the first 1 to 2 years.

Due to the anticipated settlement, it was initially recommended that the approach fills (including about 1 m of surcharge above the profile grade) be placed two years prior to the construction of the bridges to allow some of the settlement to take place. However, it appears from the foundation records (Geocres 31G00-45) that the

bridges were constructed within 6 months (and likely as little as 4 months) after placement of the approach fills and surcharge.

Based on discussions with Golder personnel (a former MTO Chief Foundation Engineer) familiar with the original bridge construction, due to schedule constraint, the time for preloading and surcharging was reduced. Based on field observation, it was considered at the time that the rate of consolidation settlement of the underlying clayey deposit might be higher than initially estimated (i.e., the clayey soils were consolidating at a faster rate than anticipated), and therefore the surcharge was allowed to be removed sooner than initially recommended.

6.2.2 Approach Embankment Settlement

Significant settlement of the approach embankments has occurred since the original construction (i.e., since the completion of surcharge and preloading and subsequent paving). In 1988, the original approach slabs were removed and replaced and the approaches were repaved. A major structure rehabilitation was carried out in 2005 and that rehabilitation included removal and replacement of the existing approach slabs, as well as construction of sleeper slabs. Subsequent to the 2005 rehabilitation, additional settlement/depression was identified at the ends of all the approach slabs.

A survey was carried out by J.D. Barnes (JDB) in November 2018 for this site. Based on the design profile grade from the 2005 rehabilitation and the surveying results by JDB, settlement up to about 150 mm (on the westbound lanes) and up to about 170 mm (on the eastbound lanes) is indicated to has occurred at the approaches during that period. No other settlement records are available for this site to verify the magnitudes of settlement that has occurred since the start of construction. The 2005 design profile grade and 2018 surveying results are presented on Drawings 3 and 4.

The bridges themselves are not anticipated to have settled as the structures were founded on deep foundations supported on bedrock. The settlement of the approach embankment could possibly be a result of the following:

- Compression of the embankment fill material itself (which is about 3.4 to 4.6 m thick).
- Elastic settlement of the native sandy and silty soils (which are about 1.5 to 2.6 m thick).
- Consolidation of the underlying native clayey soils (which are up to about 20 m thick).
- Elastic settlement of the glacial till deposit at depth.

Based on the results of the current investigation, the embankment consists of pavement structure overlying conventional earth fill consisting of silty sand to sand and silt. Provided that the materials were properly placed and compacted, the post-construction settlement due to compression of the embankment fill itself should be less than about 15 to 30 mm, and the majority of the settlement from the fill compression should have occurred during construction.

The embankment fill is underlain by the native sandy and silty subgrade. Provided that the subgrade soils were not disturbed, the elastic settlement of these soils should be less than about 25 mm and would also occur likely entirely during embankment construction. No significant *post-construction* settlement of the sandy and silty soils is therefore expected. Similarly, the post-construction settlement of the glacial till deposit is also expected to be negligible.

The magnitude of the settlement due to consolidation of the clayey deposit underlying the approach embankments is expected to be much more significant than the compression of the embankment fill and native

sandy/silty soils. Consolidation settlement of the clayey deposit has likely occurred over time since the original construction and appears to be ongoing (i.e., the clayey deposit may not have fully consolidated), as discussed further below.

6.2.3 Settlement Analyses

Settlement analyses were carried out using Rocscience's Settle3D 4.0 software to estimate the magnitude of settlement of the clayey deposit since the original construction and predict the future settlement.

These analyses were carried out taking into account the existing embankment geometry and construction sequence. The input to the analyses (including the stress levels, preconsolidation pressure profile and consolidation parameters) were estimated based on the primary consolidation characteristics of the deposit from the previous investigation (i.e., prior to the bridge construction), and supplemented with secondary and time-dependent consolidation parameters (that were not measured during the previous investigation) obtained from the current investigation, as presented on the Summary of Engineering Properties, Figure B22.

A summary of the consolidation parameters and assumptions adopted for the initial analyses is provided below.

- **Primary Consolidation Parameters:** OCR = 1.0, Cc = 1.35, Cr = 0.0675 and e_o = 2.0. These parameters were estimated based on the average values from the results of the original investigation (i.e., prior to the bridge construction) carried out by MTO, since the purpose of the settlement analyses was to estimate the magnitude of settlement of the clayey deposit since the original construction. These parameters were also compared with the results of the current investigation by Golder. Some of the primary consolidation parameters (e.g. e_o = 1.0 to 1.8) from the current investigation are different from those obtained from the previous investigation but are considered reasonable to have changed as a result of the embankment loading, which would have altered the consolidation characteristics of the deposit.
- **Secondary Consolidation Parameters:** C_α ranges from 0.004 to 0.006 and C_α / C_c is about 0.02. These parameters (which were not available from the original investigation) were estimated based on the results of the LT oedometer consolidation testing during the current investigation and are considered reasonable comparing with past experiences on similar sites and published values.
- **Time-dependent Consolidation Parameters:** C_{vr} = 3 x 10^{-3} cm^2/s and C_v = 6 x 10^{-4} to 6 x 10^{-5} cm^2/s (which was later refined to C_v = 4 x 10^{-4} cm^2/s, as described further below). These parameters (which were not available from the original investigation) were estimated based on the IL oedometer consolidation testing during the current investigation by Golder. These parameters are difficult to estimate with high accuracy while at the same time the settlement analysis results are highly sensitive to the selected values.
- **Groundwater Levels:** The groundwater levels were estimated based on the results of the VWP readings from the current investigation, since the previous investigation water levels were based on open hole readings (which are assumed to not be representative of the stabilized water levels) and there are no reasons to assume that the groundwater conditions have changed significantly since the original construction. The groundwater measurements from the VWP's indicate that there is a downward hydraulic gradient within the clayey deposit, which has an effect on the final effective stress of the deposit. The clayey deposit was therefore modelled as a composite of four soil layers within that stratum, each with its own static water level, in order to approximate that hydraulic gradient. The final effective stress of the clayey deposit was computed using the Boussinesq distribution method and based on the hydraulic gradient input in the model.

- **Construction Sequence:** Based on the foundation records and discussions with Golder personnel (a former MTO Chief Foundation Engineer) familiar with the original bridge construction, it was assumed that the approach fills were preloaded with 1 m of surcharge for a period of 4 months before the commencement of the bridge construction.

As previously noted, a survey was carried out by JDB in November 2018 for this site. Based on the design profile grade from the 2005 rehabilitation (assuming the pavements were constructed to the design grades) and the surveying results by JDB, settlements of up to about 150 mm (on the westbound lanes) and up to about 170 mm (on the eastbound lanes) are indicated to have occurred at the approaches during that period. However, no other settlement records are available for this site to verify the magnitudes of settlement that has actually occurred since the start of construction. A sensitivity analysis was therefore carried out using the range of time-dependent consolidation parameters as noted above (C_v = 6 x 10^{-4} to 6 x 10^{-5} cm^2/s) and the results were compared to the field observations.

Based on the results of the sensitivity analysis, assuming C_v = 4 x 10^{-4} cm^2/s and C_{vr} = 3 x 10^{-3} cm^2/s, the estimated settlement on the centreline of the approach embankment during the period from 2005 to 2019 range from about 110 to 150 mm on the westbound and eastbound lanes, respectively, which are similar in magnitudes to the settlements indicated by the survey (by JDB) and 2005 rehabilitation carried out during that period, suggesting a reasonable model calibration with the field observations. Using the above consolidation parameters, the initial analysis results also indicated that the clayey deposit is currently at about 65 to 70 percent of consolidation and predict an additional primary consolidation settlement in the order of 120 to 160 mm on the westbound and eastbound lanes for the next 20 years (a typical rehabilitation cycle when the profile could be corrected), as represented by graphs (in green) on Figures F1 and F2 in Appendix F.

However, there are several limitations to the settlement analysis that has been carried out:

- There is very limited settlement monitoring data for this site. The only quantifiable data is based on the design profile grade from the 2005 rehabilitation (assuming the pavements were built to design grades) and the survey by JDB in November 2018. No other settlement records are available to verify the actual magnitudes of settlement.
- There is no information on the original pavement design and the previous rehabilitations prior to 2005. The previous rehabilitations (e.g., pad and overlay the roadway periodically to reinstate the roadway profile) would have added some minor additional loading, potentially leading to increased settlement of the normally consolidated clayey soils. However, the magnitudes of the additional loading and any resulting settlement are unknown.
- The consolidation parameters (e.g. C_r, C_c, e_o, etc.) of the clayey deposit are not constant but have changed (or are changing) over time as a result of the embankment loading. However, the rate of change is not known and is not easily modelled.

Based on the above limitations, the results of the initial settlement analysis may not be representative of the actual ground behaviour and the estimates are possibly conservative. Therefore, consideration was given to the following two scenarios, which assume that the primary consolidation of the clayey deposit may have been completed or nearly completed (achieved by adjusting the magnitude of C_v and/or C_{vr} within the model). The results of the updated analyses are summarized below.

- Assuming C_v and C_{vr} = 3.6 x 10^{-3} cm^2/s, other parameters remain constant and that the primary consolidation has been completed (i.e., the site is currently at 100 percent of consolidation in 2019), the estimated settlements on the westbound and eastbound lanes are in the range of 30 to 60 mm between 2005 and 2019 (which is less than half of the magnitude based on the field observations during the same period and therefore likely not realistic), as represented by the graphs (in red) on Figures F1 and F2 in Appendix F.
- Assuming C_v = 1.35 x 10^{-3} cm^2/s, C_{vr} = 3 x 10^{-3} cm^2/s, other parameters being constant and that primary consolidation is almost completed at this site (i.e., the site is currently at 90 to 95 percent of consolidation in 2019) and some degree of secondary compression is occurring, the estimated settlements on the westbound and eastbound lanes are in the range of about 90 to 150 mm between 2005 and 2019 (which is similar in magnitude to the field observations during the same period), as represented by the graphs (in blue) on Figures F1 and F2 in Appendix F.

Based on previous discussion with MTO and past experiences with similar project sites, it is Golder's opinion that the scenario where the primary consolidation is almost completed (i.e., the site currently at **90 to 95 percent** consolidation) may be the most likely scenario for this site, while the other two cases are considered as the worst case (65 to 70 percent consolidation completed) and best case (100 percent consolidation completed) scenarios, respectively.

The soil parameters used in the settlement analyses are summarized in the following table:

Material	Bulk Unit Weight (kN/m^3)	C_c	C_r	e_o	OCR	C_v (cm^2/s)	C_{vr} (cm^2/s)	$C\alpha/ C_c$
Pavement Structure	22.5	-	-	-	-	-	-	-
Silty Sand to Sand and Silt (Fill)	20.0	-	-	-	-	-	-	-
Sandy Silt to Sand and Silt	20.0	-	-	-	-	-	-	-
Silty Clay to Clay	16.0	1.35	0.0675	2.0	1.0	Varies[1]	Varies[1]	0.02
Glacial Till	20.0	-	-	-	-	-	-	-

Notes:
C_c Compression index
C_r Recompression index
e_o Initial void ratio
OCR Overconsolidation ratio
C_v Coefficient of consolidation at compression
C_{vr} Coefficient of consolidation at recompression
C_α Secondary compression index
[1] The values of C_v and C_{vr} were adjusted to represent the degree of primary consolidation.
C_v = 4 x 10^{-4} cm^2/s and C_{vr} = 3 x 10^{-3} cm^2/s for 65 to 70 percent primary consolidation.
C_v = 1.35 x 10^{-3} cm^2/s and C_{vr} = 3 x 10^{-3} cm^2/s for 90 to 95 percent primary consolidation.
C_v = 3.6 x 10^{-3} cm^2/s and C_{vr} = 3.6 x 10^{-3} cm^2/s for 100 percent primary consolidation.

As previously noted, the clayey deposit at this site was normally consolidated over its entire thickness prior to the bridge construction (i.e., the initial effective stress was effectively the same as the preconsolidation pressure of the deposit at any depth) and any additional load would result in overstressing of the clay and significant settlement. The embankment loading exceeded the deposit's initial preconsolidation pressure and therefore the consolidation settlement had occurred in the 'virgin' compression range and was significant in magnitude.

Based on the existing embankment height, the assessed effective stress level, and the interpreted preconsolidation pressure profile within the clayey deposit, the measured groundwater levels, as well as the varying consolidation parameters (as described above), the estimated total settlement for a period of 20 years (the typical rehabilitation cycle for bridge approaches) and 30 years (the end of the existing bridge life span) for each of the above scenarios are provided in the following table. The results of the settlement analyses are also graphically presented in Appendix F.

Time Period[1]	Best Case Scenario (100% Consolidation Completed)	Most Likely Scenario (90 - 95% Consolidation Completed)	Worst Case Scenario (65- 70% Consolidation Completed)
20 years	12 – 30	70 – 110	120 – 160
30 years	15 – 35	90 – 150	160 – 240

Notes:

1. Assume pavement rehabilitation commences in 2020 and no additional load applied to the underlying clayey deposit.
2. The ranges of estimated settlements are due to variable subsurface conditions on eastbound and westbound lanes.

The settlement would be entirely differential relative to the structures (which are supported on deep foundations on bedrock). These settlement values have, in general, exceeded the usual values accepted by MTO for freeway approaches to bridges, as shown in the following table:

Distance from Abutment (m)	Tolerable Settlement (mm)
0 to 20	<25
20 to 50	<50
50 to 75	<75
>75	<100

Source: “Embankment Settlement Criteria for Design” by MTO, dated July 2, 2010.

6.2.4 Deformation Survey

It should be noted that no historical settlement monitoring record is available at this site and therefore the total amount of settlement that has occurred since the start of construction could not be verified.

There is a recent deformation survey carried out by MTO between Fall 2017 and Spring 2019, with the baseline readings taken on October 17, 2017 and the subsequent readings taken on November 23, 2017, December 20, 2017, March 23, 2018 and May 15, 2019.

The deformation survey showed movements in the range of 1 to 10 mm (with maximum up to about 12 mm) during the surveyed period. However, that survey was only carried out within a short period of time and, taking into account of the survey accuracy, the available data is not sufficient to predict the trend of movement. Additional settlement monitoring should be carried out to help further calibrate the geotechnical model and more accurately predict the future settlement.

6.3 Mitigation Measures

6.3.1 Finite Element Soil-Structure Interaction

Finite element soil-structure interaction modelling was carried out using Rocscience's RS2 software to evaluate various approach slab alternatives. The purpose of the finite element modelling is to develop a project specific approach slab detail for the approach improvements, which might potentially accommodate the significant ongoing consolidation of the underlying clayey deposit, as well as reduce the strain (cracking) of pavement as a result of the settlement/deflection of the slab and permit future maintenance.

Based on a literature review of approach slab design from other jurisdictions, as well as in collaboration with Dillon and MTO, the following conceptual approach slab alternatives were considered:

- Alternative 1 – Approach slab with sleeper slab and expansion joint (similar to current site conditions)
- Alternative 2 – Approach slab with sleeper slab (no end dam/expansion joint)
- Alternative 3 – Roof slab with grade beam and approach slab without sleeper slab
- Alternative 4 – Approach slab without sleeper slab
- Alternative 5 – Approach slab with drain trough
- Alternative 6 – Buried approach slab

The various approach slab design alternatives are graphically shown in Appendix G.

For each alternative listed above, various scenarios (where applicable) were assessed, which included no and rough soil-concrete interface, varying approach slab depths/angles/lengths, and horizontal movements (i.e., expansion and contraction of the asphaltic concrete and approach slab due to temperature changes and traffic loading).

The preliminary results of the finite element modelling were presented in a modelling workshop with MTO on April 8 and 9, 2019 and summarized in the following draft modelling and analysis report.

- Finite Element Modelling Report by Golder Associates Ltd. for "*Finite Element Analysis of Bridge Approach Slab, Soil-structure Interaction, Highway 417, Site No. 27-212, United Counties of Prescott and Russell, Ontario*" G*WP 4050-18-00*, dated June 2019.

The results of the finite element modelling show that the behaviour of the approach slab is governed by the estimated consolidation settlement of the underlying clayey deposit (in the order 160 mm over the next 20 years), which made it very challenging to identify the preferred alternative.

Alternatives 3 and 4 were carried forward, with the understanding that these alternatives do not provide allowance for thermal expansion and contraction, resulting in strains in the asphaltic concrete pavement. However, as illustrated in the FEM modelling, the strains due to the significant consolidation settlement are much greater than the strains due to thermal effects. Considering the large anticipated settlements, the strains (i.e., vertical and horizontal movement due to temperature and traffic loading) are minimal for Alternatives 3 and 4 in comparison. Alternative 1 was also carried forward but it was recognized that settlement would have to be addressed for this alternative to be feasible, since the sleeper slab and expansion joint do not allow for future profile corrections.

Once the preferred rehabilitation option has been selected, additional modelling will be carried out to include soil and/or asphalt reinforcement, if considered necessary.

6.3.2 Embankment Rehabilitation Options

Based on the discussion during the modelling workshop with Dillon and MTO and the results of the FE modelling, it was considered that Alternatives 2, 5 and 6 were not preferred for this site and therefore were not considered further. In addition, intrusive ground improvement techniques such as preloading/surcharging, installation of vertical wick drains, rigid stone columns or deep soil mixing were also not considered feasible or cost effective for this site due to the existing approach embankment fill, the thickness of compressible clay deposit and the remaining life span of the bridge (estimated to be about 25 to 30 years).

The following embankment rehabilitation options were identified during the modelling workshop for further evaluation:

- Option 1 – Reconstruct the full embankment with expanded polystyrene (EPS) to reduce the settlement magnitude sufficiently to meet the MTO paving criteria and reconstruct the approach slab using Alternative 1
- Option 2 – Partially reconstruct the approach embankment with 1 m of EPS to reduce/delay future settlement, monitor the settlement magnitude to assess when pavement rehabilitation would be required and reconstruct with an inclined approach slab using Alternative 3
- Option 3 – Re-grade the approach using granulars and asphalt padding (without EPS), monitor the settlement magnitude to assess when pavement rehabilitation would be required and reconstruct with an inclined approach slab using Alternative 3
- Option 4 – Partially reconstruct the approach embankment with 1 m of EPS to reduce/delay future settlement, monitor the settlement magnitude to assess when pavement rehabilitation would be required and reconstruct with an inclined approach slab using Alternative 4
- Option 5 – Re-grade approach using granulars and asphalt padding (without EPS), monitor the settlement magnitude to assess when pavement rehabilitation would be required and reconstruct with an inclined approach slab using Alternative 4

More details on the potential rehabilitation options are provided below and summarized in Table 1.

6.3.2.1 Option 1

In order to address the ongoing settlement and to meet the usual settlement values accepted by MTO for freeway approaches to bridges, the existing embankment fill would need to be sub-excavated and replaced with ultra-lightweight fill such as expanded polystyrene (EPS) to reduce the stresses imposed on the underlying compressible clay layers to less than the deposit's current preconsolidation pressures.

Based on the results of the current investigation, the height of the existing embankment fill varies from about 3.4 to 3.7 m on the westbound lanes and about 4.4 to 4.6 m on the eastbound lanes. Given the required thickness of material needed for the pavement structure and the protective/approach concrete slab over the EPS (about 1 m in total), and a granular working/levelling pad (about 0.3 m) for placement of the EPS, it is considered that the remaining thickness (i.e., up to about 2.4 m on the westbound lanes and up to about 3.3 m on the eastbound lanes) within 20 m of the abutments (which is the critical area) would need to consist of EPS, to limit the settlement at the abutments to within the allowable limits.

Beyond the 20 m limit from the abutments, EPS thickness may be reduced over a distance, although there is a reasonable risk that the settlement will exceed the tolerable allowances (as per the MTO pavement criteria). EPS fill is available in any thickness (after custom cutting) but is most commonly available in 0.3 m increments. If this approach is considered acceptable, the EPS should be stepped down in 0.3 m thickness increments to transition over a distance of about 30 m, starting at about 20 m from the abutments (i.e., the EPS would extend to about 50 m from the abutments in total).

The EPS will need to be covered with a concrete slab to protect it from being overstressed by the traffic loads; overstressing of the EPS could lead to rutting of the pavement surface. A concrete slab thickness of 125 mm with reinforcing is typical for the protective slab. The approach slab may act as the protective slab.

A suitable lightweight fill type would be EPS22 in accordance with ASTM D6817-11, or equivalent.

The EPS is potentially soluble in hydrocarbons. To guard against dissolution of the EPS in the case of an accidental release and infiltration of fuel (such as could occur in the case of a collision), it is general practice to cover the outside surface of the EPS with 10 mil polyethylene sheeting.

The blocks beneath the side slopes can step up to match the 2H:1V side slope and, once covered with the polyethylene sheeting, can then be covered with soil.

An NSSP providing additional information on the EPS material and its placement as well as the concrete protective slab should be included in the contract documents, if this option is selected.

Lightweight Cellular Concrete (LCC) is not considered a feasible alternative to EPS, since LCC is essentially free flowing and will require confinement during placement of the concrete, which could be difficult to achieve due to the existing embankment geometry. In addition, LCC typically has a unit weight of 5 kN/m^3, which is higher than that of EPS. Therefore, if LCC is considered, additional subexcavation of the embankment subgrade soils and backfilling with LCC would be required to compensate the difference in weights between LCC and EPS.

6.3.2.2 Option 2

This option does not include sleeper slabs, as the expansion joints between the approach and sleeper slabs will not permit future profile corrections. The existing embankment fill would be subexcavated to a depth of about 2 m depth below the existing ground surface and backfilled with 1 m of EPS, and in turn covered by the approximately 1 m thick pavement structure. More details on EPS is provided in Section 6.3.2.1 above.

A roof slab would be constructed over the new embankment backfill and supported by a grade beam. The grade beam is typically founded on piles driven to refusal to mitigate settlement. A flat or inclined approach slab (without sleeper slab) is then connected to the grade beam.

This option would allow the roadway to continue to settle, but at a lesser magnitude and slower rate, and accept the short- and long-term potential impacts of the expected settlement on the roadway performance. It would be planned to pad and overlay the roadway periodically to reinstate the roadway profile; a 7- or 10-year rehabilitation cycle is anticipated based on the maintenance history of the existing embankment approaches, which is more frequent than the usual 20-year cycle. It should be noted the weight of the overlay would add some minor additional loading and settlement of the normally consolidated clayey soils.

In addition, this option would require frequent monitoring and maintenance of the roadway. The incremental costs of this option including ongoing maintenance, highway traffic and commercial affects need to be considered in the long-term costs. Further, there are potential moderate to high risks associated with settlement occurring over time, which will affect the rideability and could potentially cause an accident to occur and/or the highway to be blocked for a more extended period of time, if profile correction is not carried out in a timely way.

Based on the results of the settlement analysis, if 1 m of EPS is used, the magnitudes of estimated total settlement within a 7- and 10-year rehabilitation cycle for each scenario are provided in the table below and graphically shown on Figures F3 and F4 in Appendix F. Based on discussions with MTO and Dillon, the estimated total settlement for a period of 20 years (the typical rehabilitation cycle for bridge approaches) and 30 years (the end of the existing bridge life span) are also provided in the table below for comparison purposes.

Time Period	Estimated Total Settlement (mm), with 1 m EPS		
	Best Case Scenario (100% Consolidation Completed)	Most Likely Scenario (90 - 95% Consolidation Completed)	Worst Case Scenario (65- 70% Consolidation Completed)
7 years	0	0 – 40	30 – 50
10 years	0	0 – 40	50 – 70
20 years	0	0 – 40	90 – 100
30 years	0	0 – 40	110 – 130

Note: The ranges of settlement values are a result of varying subsurface conditions at the WBL and EBL approaches.

6.3.2.3 Option 3

Similar to Option 2, this option does not include sleeper slabs; however no subexcavation of the existing embankment fill would be carried out. The roof slab would be constructed directly over the existing embankment fill and supported by a grade beam. An inclined approach slab (without sleeper slab) is then connected to the grade beam.

This option would not address the magnitude and current rate of settlement, allowing the roadway to continue to settle as well as accepting the short- and long-term potential impacts of the expected settlement on the roadway performance. Also similar to Option 2, more frequent profile correction (i.e., a 7- or 10-year rehabilitation cycle) than the usual 20-year cycle is anticipated.

This option would also require frequent monitoring and maintenance of the roadway, which should be considered in the long-term costs. Further, there are potential moderate to high risks associated with larger, more extensive settlement (likely greater in magnitude than for Option 2 which includes 1 m of EPS) occurring over time, which will affect rideability and could potentially cause an accident to occur and/or the highway to be blocked for a more extended period of time, if profile correction is not carried out in a timely way.

Based on the results of the settlement analysis, if no EPS is used, the magnitudes of estimated total settlement within a 7- and 10-year rehabilitation cycle for each scenario are provided in the table below and graphically shown in Figures F3 and F4 in Appendix F. Based on discussions with MTO and Dillon, the estimated settlement for 20 years (the typical rehabilitation cycle for bridge approaches) and 30 years (the likely end of the existing bridge life span) are also provided in the table below for comparison purposes.

Time Period	Estimated Total Settlement (mm), with no EPS		
	Best Case Scenario (100% Consolidation Completed)	Most Likely Scenario (90 - 95% Consolidation Completed)	Worst Case Scenario (65- 70% Consolidation Completed)
7 years	10 – 20	30 – 50	50 – 60
10 years	10 – 25	40 – 70	60 – 90
20 years	12 – 30	70 – 110	120 – 160
30 years	15 – 35	90 – 150	160 –240

Note: The ranges of settlement values are a result of varying subsurface conditions at the WBL and EBL approaches.

6.3.2.4 Option 4

This option is similar to Option 2, with the exception that there would be no roof slab. The approach slab would connect directly to the bridge deck. From an approach slab-ground interaction viewpoint, this option is no different from Option 2, except the approach slab settlement (‘bump’) issue would occur closer to the bridge deck.

The magnitudes of estimated total settlement are the same as those presented in the table in Section 6.3.2.2 above.

6.3.2.5 Option 5

This option is similar to Option 3, with the exception that there would be no roof slab. The approach slab would connect directly to the bridge deck. From an approach slab-ground interaction viewpoint, this option is no different from Option 3, except the approach slab settlement (‘bump’) issue would occur closer to the bridge deck.

The magnitudes of estimated total settlement are the same as those presented in the table in Section 6.3.2.3 above.

6.3.3 Conclusion

From a foundation prospective, Option 1 would limit the post-construction settlement and has the lowest risk of rideability and safety concerns in the future. However, according to Dillon, it is understood that this is likely the most expensive option and would have a significant impact to the construction schedule and on public use of the highway, as it requires full reconstruction of the existing embankment (which would necessitate extensive shoring or cross-overs). The full embankment reconstruction is also considered to be not cost-effective and would result in throwaway costs, recognizing the remaining life span of the existing bridge is estimated to be about 25 to 30 years. Therefore, this is not considered a preferred option.

Option 5 is likely the most cost-effective option, recognizing frequent monitoring and maintenance would be required in order to assess rideability and determine when profile corrections are required. The period between padding to restore the pavement may vary depending on the actual degree of consolidation, as previously discussed (although likely still within the 7- to 10-year range). It is recommended that long time settlement monitoring be implemented to help further calibrate the settlement analysis model as well as more accurately predict the magnitude and the rate of the future settlement, which could assist with the design of the future structure replacements.

7.0 ADDITIONAL CONSIDERATIONS

It is understood that the proposed rehabilitation of the approaches of the existing County Road 3 overpasses will require temporary widening of the highway, which involves placement of fill within the widened section. Considering the short duration of the widening (expected to be within 45 days), the additional load due to the fill placement and paving would be transient in nature and should not result in additional settlement of the permanent roadway due to consolidation of the underlying clayey deposit.

In addition, the existing embankment side slopes of the existing structures are generally oriented at about 3H:1V but as steep as 2H:1V. The rehabilitation of the approaches will include re-grading of the existing embankment slopes and, in areas where the existing embankments are steeper than 3H:1V, additional fill will be required to re-grade the slopes. The additional fill will be up to about 1.5 m high, but generally much less, will be along short sections and will be mostly at the toe or the lower portions of the existing embankment slopes (i.e., the height of additional fill at or adjacent to the shoulders will be minimal). Based on the limited additional loading at the roadway shoulders, it is considered that the additional fill for the re-grading will not result in excessive (i.e., intolerable) settlements of the underlying clay and roadway surface.

8.0 CLOSURE

This Foundation Design Report was prepared by Ms. Christine Ko, P.Eng., and reviewed by Mr. Bill Cavers, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Fin Heffernan, P.Eng., the Designated MTO Foundations Contact for this assignment, conducted an independent quality review of this report.

Golder Associates Ltd.

Christine Ko, P.Eng.
Geotechnical Engineer

William Cavers, P.Eng.
Associate, Senior Foundations Engineer

Fin Heffernan, P.Eng.
Designated MTO Foundations Contact

RK/CK/WC/FJH/hdw
https://golderassociates.sharepoint.com/sites/25312g/deliverables/6000 - hwy 417 cr3/001-fidr/05-final/1899802-6000-001-r-rev0-hwy 417 cr3 fidr-sept2019.docx

Table 1: Comparison of Embankment Settlement Mitigation Alternatives

Embankment Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Option 1 Reconstruct full embankment with EPS and reconstruct approach slab using Alternative 1	■ Limits post-construction maintenance	■ Require subexcavation of entire existing embankment fill and replacement with EPS to meet MTO requirement ■ Significant impact on schedule and disruption to highway use during construction	■ Likely most expensive option	■ Low risk option
Option 2 Partially reconstruct approach embankment with 1 m of EPS and reconstruct approach slab using Alternative 3	■ Minimal impact on construction schedule	■ Require removal of existing sleeper slabs and subexcavation of existing embankment fill and replacement with 1 m of EPS ■ Require frequent monitoring and maintenance ■ Possible interim safety issue, between overlays, due to settlement	■ Relatively low costs, but must consider post-construction monitoring and maintenance costs	■ Lesser but still excessive roadway settlement in short- and long-term
Option 3 Regrade approach using granulars and asphalt padding (without EPS), and reconstruct approach slab using Alternative 3	■ Minimal impact on construction schedule	■ Require removal of existing sleeper slabs to allow padding and overlay to take place ■ Require frequent monitoring and maintenance ■ Possible interim safety issue, between overlays, due to settlement	■ Relatively low costs, but must consider post-construction monitoring and maintenance costs	■ Excessive roadway settlement in short- and long-term

Embankment Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Option 4 Partially reconstruct approach embankment with 1 m of EPS and reconstruct approach slab using Alternative 4	■ Minimal impact on construction schedule	■ Require removal of existing sleeper slabs and subexcavation of existing embankment fill and replacement with 1 m of EPS ■ Require frequent monitoring and maintenance ■ Possible interim safety issue, between overlays, due to settlement	■ Relatively low costs, but must consider post-construction monitoring and maintenance costs	■ Lesser but still excessive roadway settlement in short- and long-term
Option 5 Regrade approach using granulars and asphalt padding (without EPS) and reconstruct approach slab using Alternative 4	■ Minimal impact on construction schedule	■ Require removal of existing sleeper slabs to allow padding and overlay to take place ■ Require frequent monitoring and maintenance ■ Possible interim safety issue, between overlays, due to settlement	■ Likely the cheapest option, but must consider post-construction monitoring and maintenance costs	■ Excessive roadway settlement in short- and long-term

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

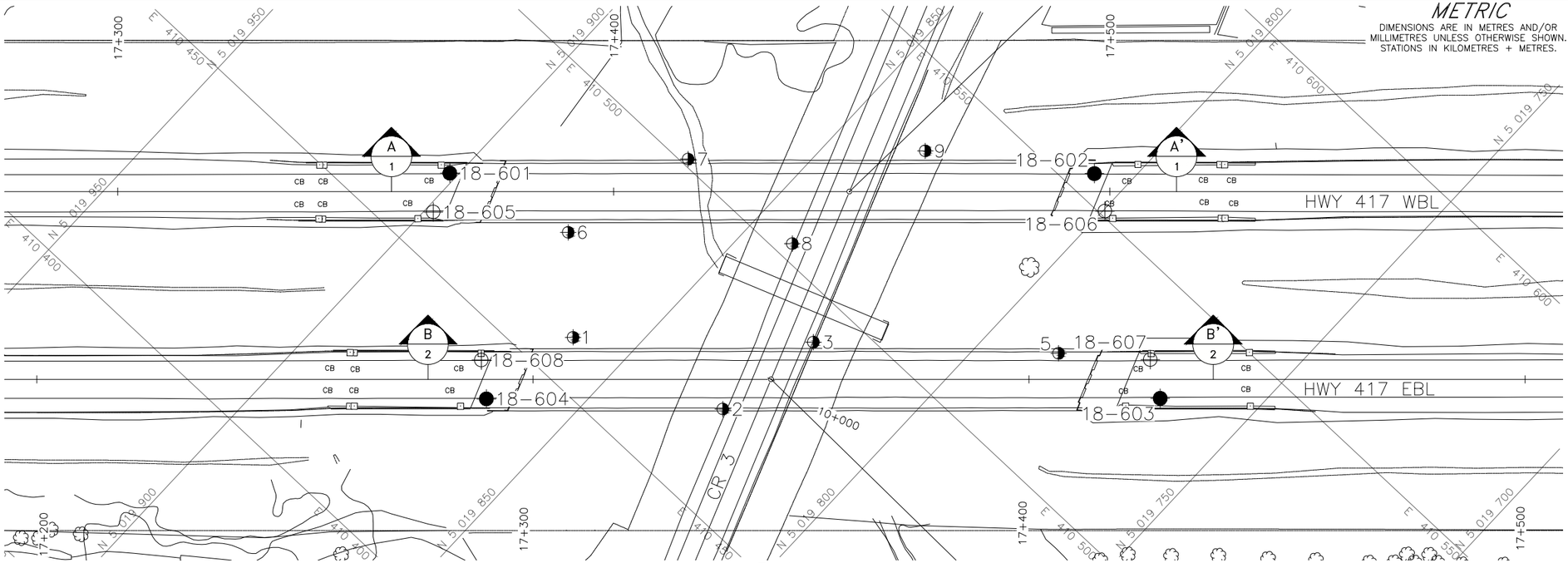
CONT No.
GWP No. 4050-18-00

SHEET

HWY 417/CR 3 OVERPASS (WBL)

BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.310501 LONG. -75.151995

GOLDER



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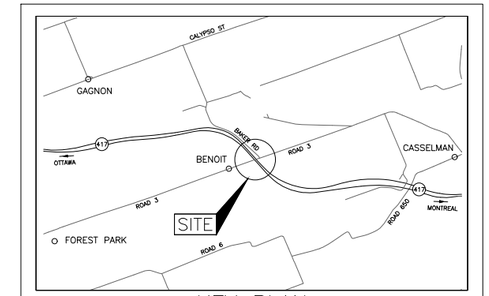
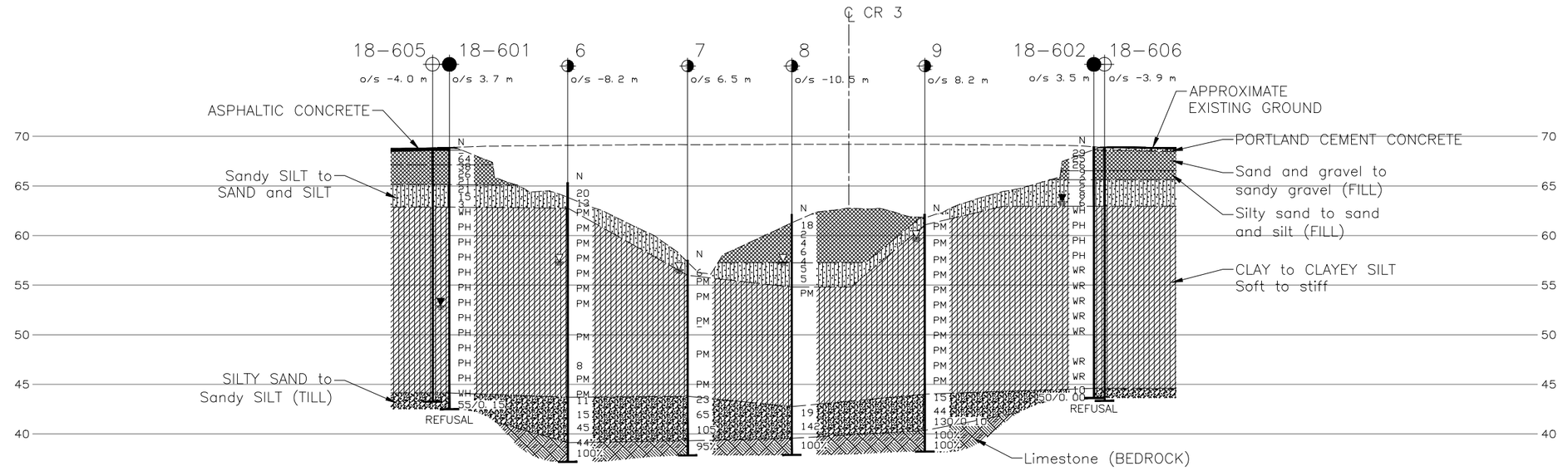


KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- Cone Penetration Test – Current Investigation
- Borehole – Previous Investigation Geocres No. 31G00-045
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Total Core Recovery (TCR)
- WL in VWP, measured on February 19, 2019
- WL upon completion of drilling



PROFILE A-A' – HWY 417 WBL
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BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
18-601	68.8	5019901.4	410466.5
18-602	69.0	5019806.4	410555.1
18-603	68.7	5019765.8	410531.0
18-604	68.8	5019865.0	410438.3
18-605	68.8	5019898.5	410458.4
18-606	68.9	5019799.6	410551.0
18-607	68.7	5019772.6	410535.4
18-608	68.8	5019871.0	410443.3
1	65.5	5019860.7	410459.2
2	62.5	5019828.7	410469.3
3	62.3	5019824.6	410491.6
5	65.5	5019786.9	410523.7
6	65.4	5019875.8	410474.0
7	57.5	5019868.2	410501.3
8	62.1	5019841.3	410503.2
9	62.2	5019834.4	410535.2

NOTES

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REFERENCE

Base plans provided in digital format by Dillon, drawing file no. 327-417-18-1.dwg, received February 14, 2019.

LICENSED PROFESSIONAL ENGINEER P.F.C. KO 100103970 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER W. CAVERS 100077934 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31G-276

HWY. 417		PROJECT NO. 1899802	DIST. EASTERN
SUBM'D. KP	CHKD. CK	DATE: 2/21/2019	SITE: 27-212
DRAWN: JM	CHKD. WC	APPD. FJH	DWG. 1

PLOT DATE: September 26, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

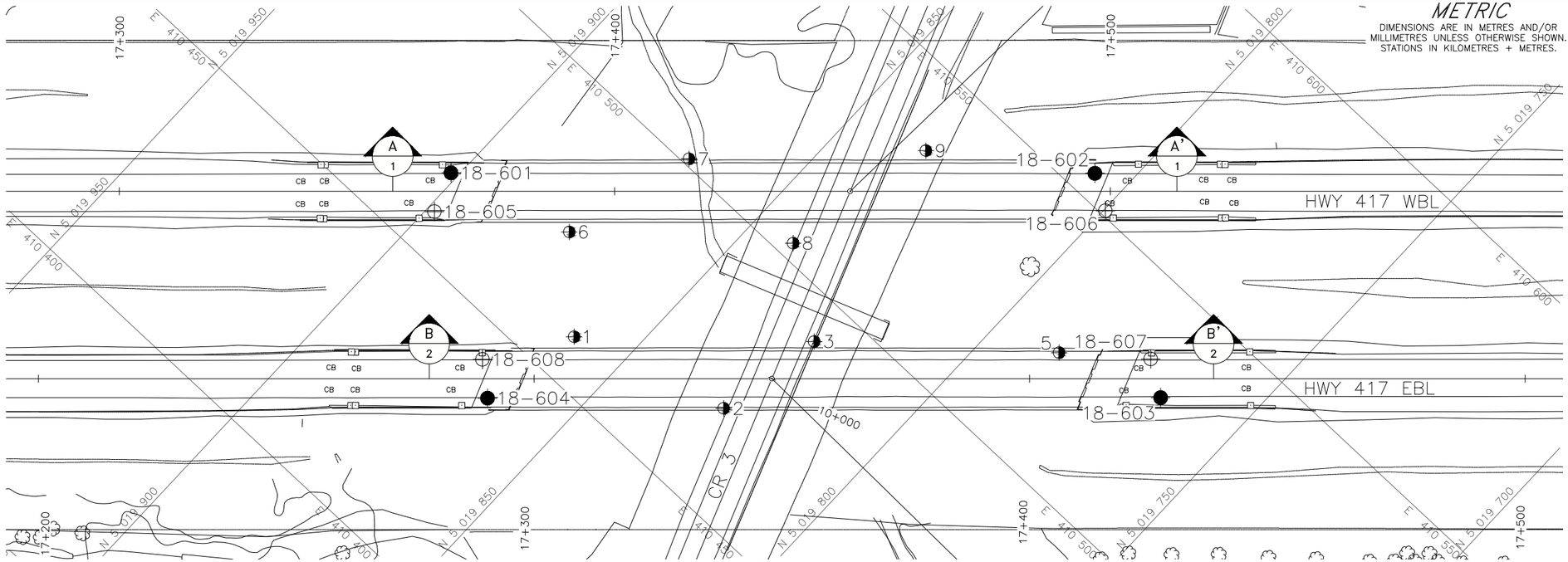
CONT No.
GWP No. 4050-18-00

SHEET

HWY 417/CR 3 OVERPASS (EBL)

BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.310501 LONG. -75.151995

GOLDER



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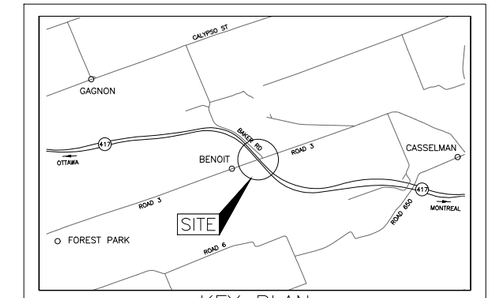

KEY PLAN
SCALE
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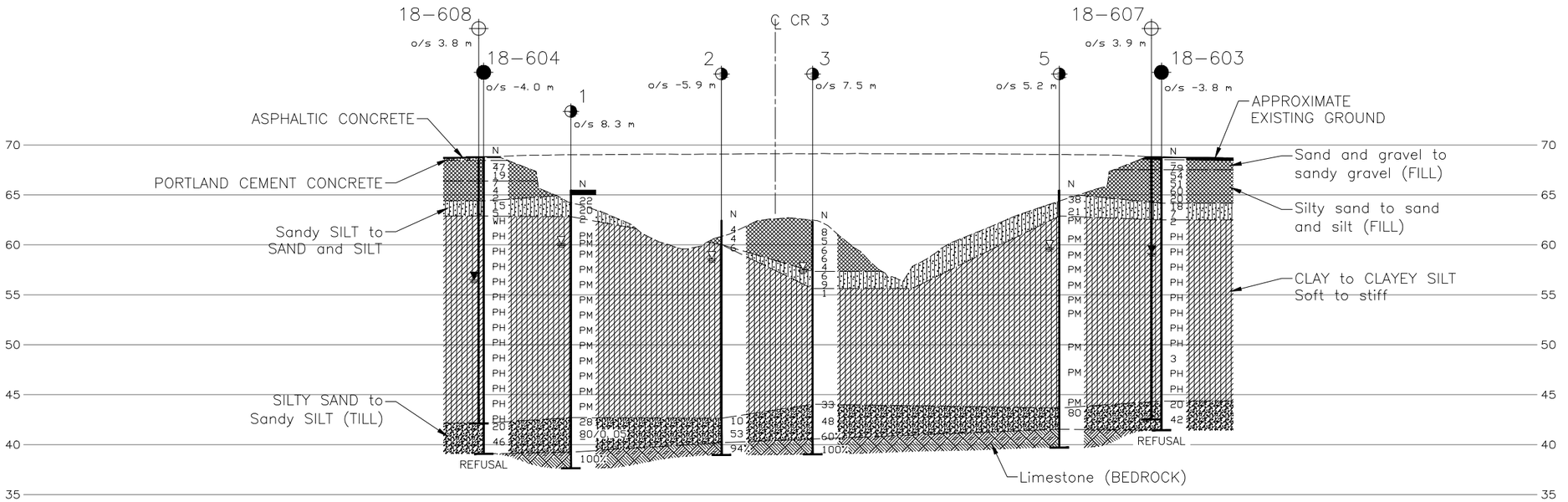
LEGEND

- Borehole – Current Investigation
- Cone Penetration Test – Current Investigation
- Borehole – Previous Investigation Geocres No. 31G00-045
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Total Core Recovery (TCR)
- WL in VWP, measured on February 19, 2019
- WL upon completion of drilling



PROFILE B-B' – HWY 417 EBL
SCALE
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5 0 5 10 m

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
18-601	68.8	5019901.4	410466.5
18-602	69.0	5019806.4	410555.1
18-603	68.7	5019765.8	410531.0
18-604	68.8	5019865.0	410438.3
18-605	68.8	5019898.5	410458.4
18-606	68.9	5019799.6	410551.0
18-607	68.7	5019772.6	410535.4
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6	65.4	5019875.8	410474.0
7	57.5	5019868.2	410501.3
8	62.1	5019841.3	410503.2
9	62.2	5019834.4	410535.2

NOTES

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REFERENCE

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LICENSED PROFESSIONAL ENGINEER P.F.C. KO 100103970 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER W. CAVERS 100077934 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.
.	.	.	.

Geocres No. 31G-276

HWY. 417		PROJECT NO. 1899802	DIST. EASTERN
SUBM'D. KP	CHKD. CK	DATE: 2/21/2019	SITE: 27-212
DRAWN: JM	CHKD. WC	APPD. FJH	DWG. 2

PLOT DATE: September 26, 2019
FILENAME: N:\Active\Spatial_MV\MTO\Hwy417Bridges\99_PROJ\1899802_Dillon_Foundations\40_PROD\0001_Foundations\1899802-0001-BB-0001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

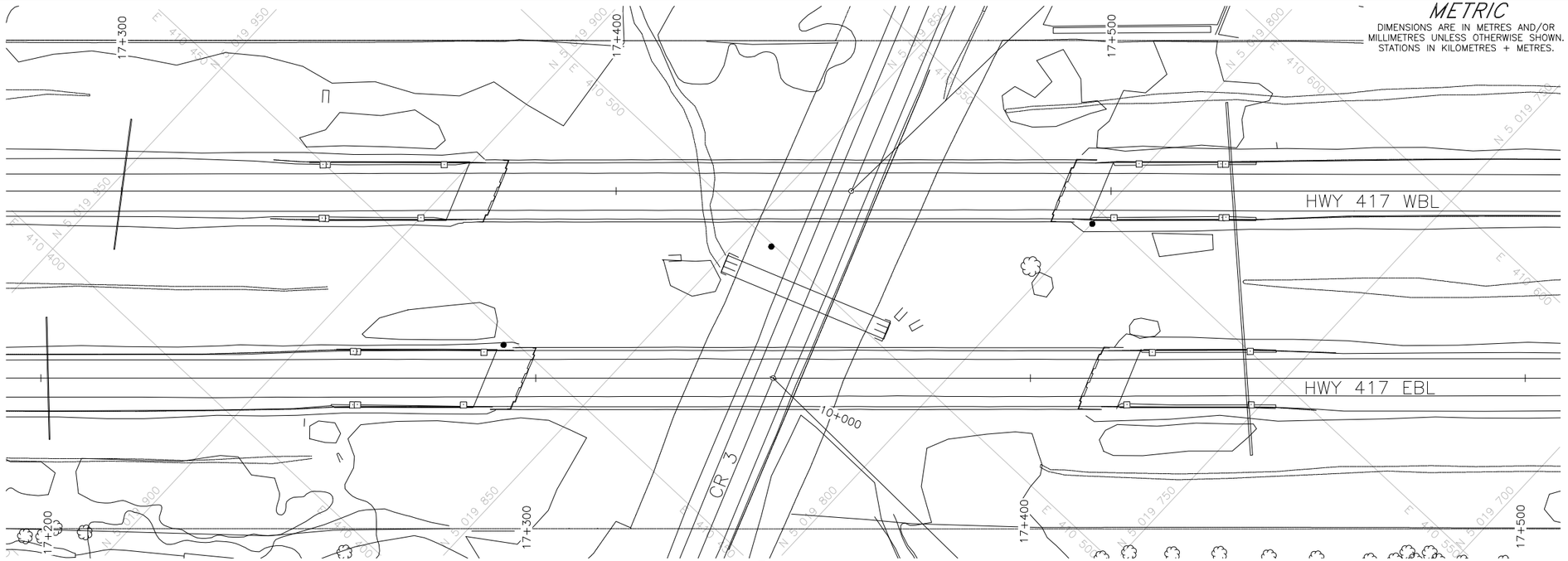
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4050-18-00

HWY 417/CR 3 OVERPASS (WBL)
DESIGN PROFILE VS SURVEY RESULTS

SHEET

GOLDER



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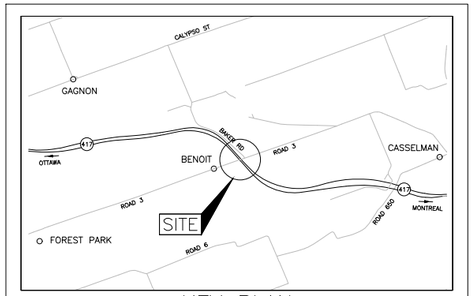

KEY PLAN
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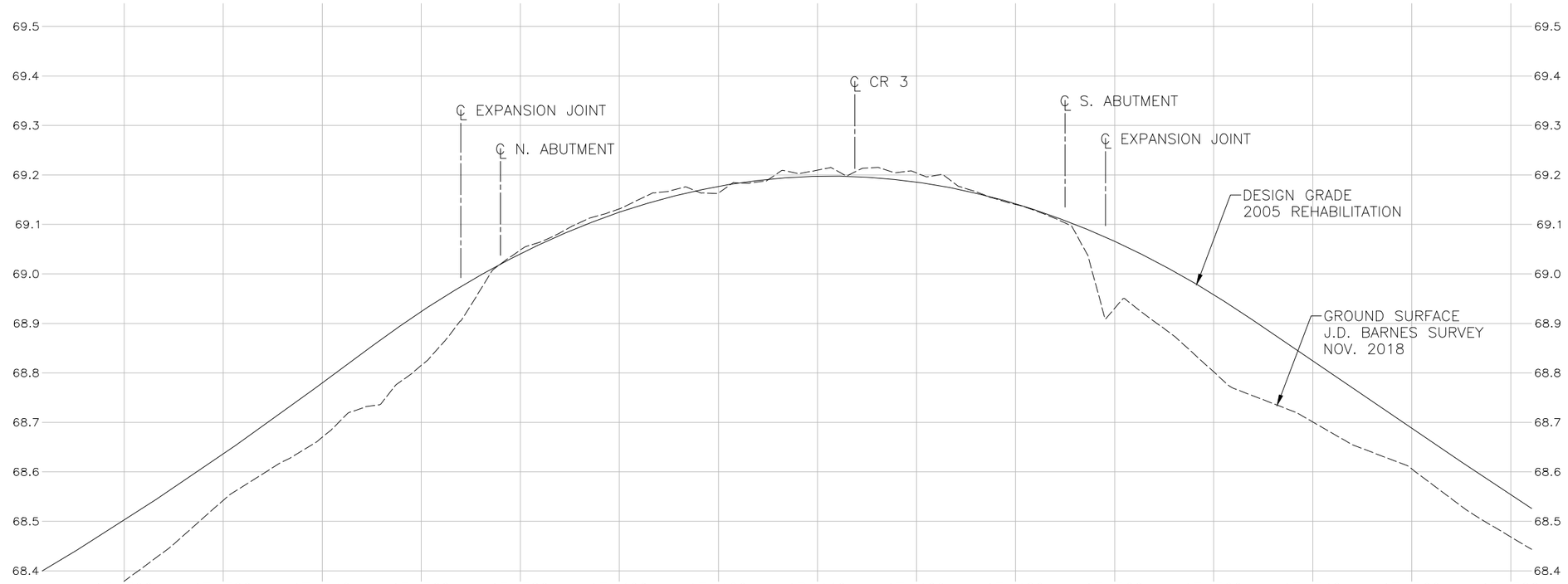

PROFILE ALONG HWY 417 WBL
SCALE
10 0 10 20 m
0.1 0 0.1 0.2 m

LEGEND

—— Design Grade – 2005 Rehabilitation

– – – Existing Ground Surface – Surveyed by J.D. Barnes November 2018

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100103370
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
W. CAVERS
100077934
PROVINCE OF ONTARIO

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REFERENCE

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NO.	DATE	BY	REVISION
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Geocres No. 31G-276

HWY. 417	PROJECT NO. 1899802 (6000)		DIST. EASTERN
SUBM'D. CK	CHKD. CK	DATE: 9/26/2019	SITE: 27-212
DRAWN: JM	CHKD. WC	APPD. FJH	DWG. 3

PLOT DATE: September 26, 2019
FILENAME: N:\Active\Spatial_MVTO\Hwy417Bridges\09_PROJ\1899802_Dillon_Foundations\10_PROD\0002_Foundations\1899802-0002-BD-0001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

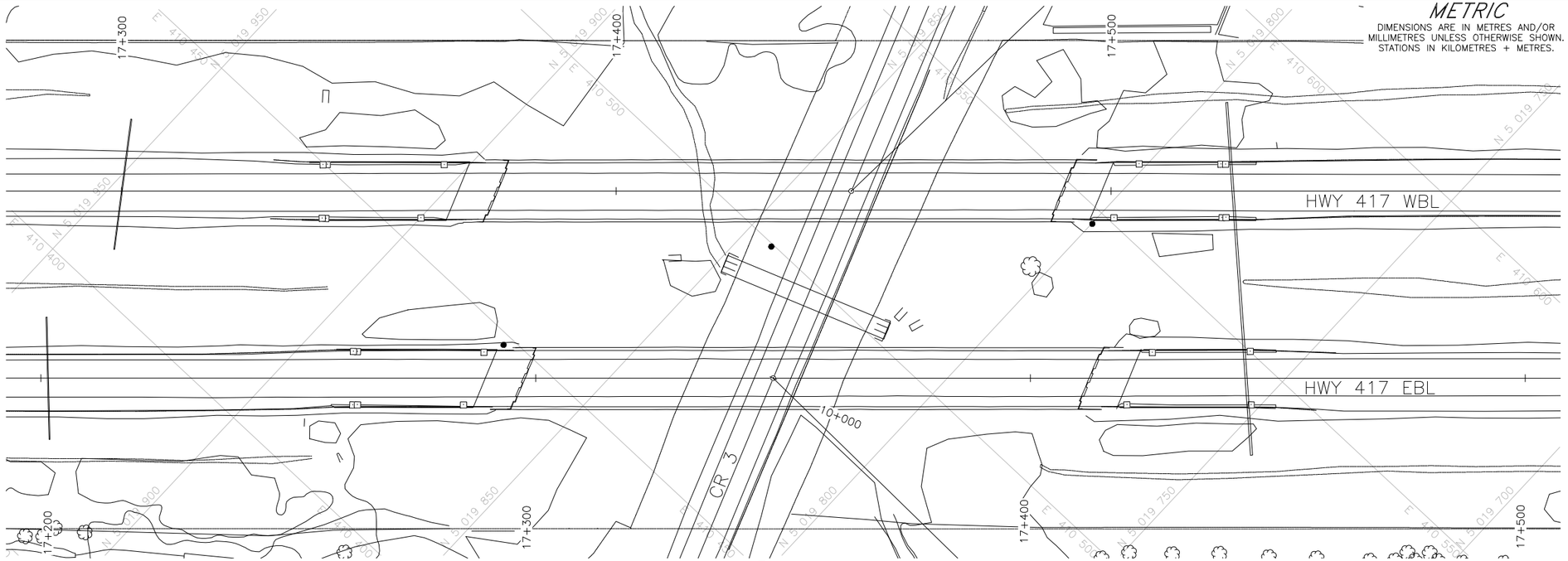
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4050-18-00

HWY 417/CR 3 OCERPASS (EBL)
DESIGN PROFILE VS SURVEY RESULTS

SHEET

GOLDER



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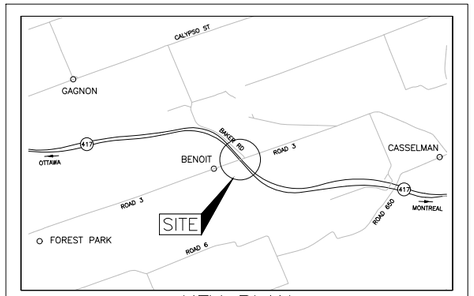

KEY PLAN
SCALE
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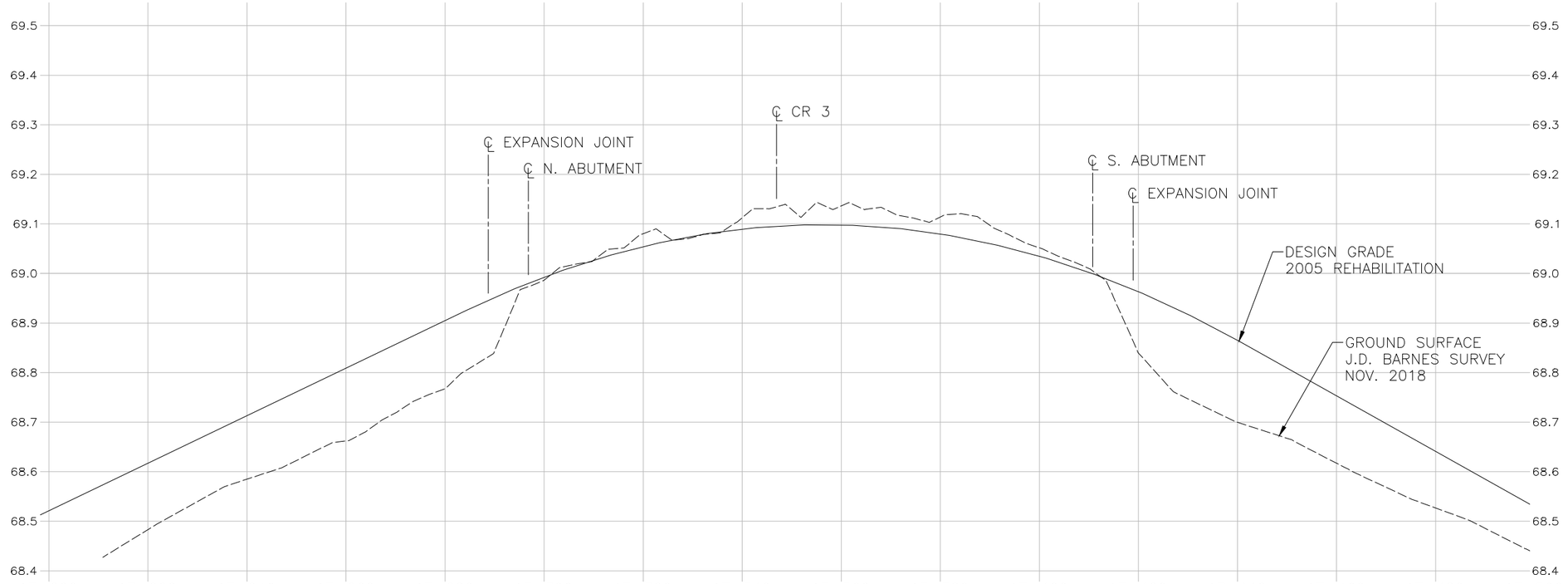

PROFILE ALONG HWY 417 EBL
SCALE
10 0 10 20 m
0.1 0 0.1 0.2 m

LEGEND

——— Design Grade – 2005 Rehabilitation

– – – Existing Ground Surface – Surveyed by J.D. Barnes, November 2018

LICENSED PROFESSIONAL ENGINEER
P.F.C. KO
100103370
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
W. CAVERS
100077934
PROVINCE OF ONTARIO

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NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31G-276

HWY. 417	PROJECT NO. 1899802 (6000)		DIST. EASTERN
SUBM'D. CK	CHKD. CK	DATE: 9/26/2019	SITE: 27-212
DRAWN: ZS	CHKD. WC	APPD. FJH	DWG. 4

PLOT DATE: September 26, 2019
FILENAME: N:\Active\Spatial_Jul\MTO\Hwy417Bridges\09_PROJ\1899802_Dillon_Foundations\10_PROD\0002_Foundations\1899802-0002-BD-0001.dwg

APPENDIX A

Record of Boreholes - Current Investigation

List of Abbreviations and Symbols
Record of Boreholes 18-601 to 18-604

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:
The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)
A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness Condition	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 10	Trace	Trace sand
10 to 20	Some	Some sand
20 to 35	(ey) or (y)	Sandy
over 35	And	Sand and Gravel

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90º angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

GOLDER

PROJECT 1899802-6000

RECORD OF BOREHOLE No 18-601

SHEET 1 OF 3

METRIC

G.W.P. 4050-18-00 LOCATION N 5019901.4; E 410466.5 NAD 83 MTM ZONE 9 (LAT. 45.311110; LONG. -75.152400) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY JEM

DATUM Geodetic DATE December 17 - 18, 2018 CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.8	GROUND SURFACE										
0.0 / 68.6	ASPHALTIC CONCRETE										
0.2	(SW/GW) Sand and gravel, some silt (FILL) Very dense Grey Dry		1	AS	-						
			2	SS	64		68		○		38 46 (16)
67.1											
1.7	(SM/ML) Sand and silt, trace gravel (FILL) Dense to compact Brown Dry to moist		3	SS	38		67				
			4	SS	26		66				
			5	SS	21						
65.1							65				
3.7	(ML) Sandy SILT Compact to very loose Brown to grey Wet		6	SS	21						
			7	SS	15		64		○		
			8	SS	3						0 22 72 6
62.9							63				
5.9	(CH) CLAY, contains silt layers Firm to soft Grey with red mottling Wet		9	SS	WH						
							62	× + × +			
			10	TP	PH		61				
								× +			
59.7							60	× +			
9.1	(CI/CH) SILTY CLAY to CLAY, contains silt layers Soft to firm Grey Wet		11	TP	PH				○		0 0 55 45
							59				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1899802-6000

RECORD OF BOREHOLE No 18-601

SHEET 2 OF 3

METRIC

G.W.P. 4050-18-00 LOCATION N 5019901.4; E 410466.5 NAD 83 MTM ZONE 9 (LAT. 45.311110; LONG. -75.152400) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY JEM

DATUM Geodetic DATE December 17 - 18, 2018 CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	25 50 75		
	(CI/CH) SILTY CLAY to CLAY, contains silt layers Soft to firm Grey Wet										
			12	TP	PH		58				
							57				
			13	TP	PH						
							56				
			14	TP	PH		55				
							54				
			15	TP	PH	▼					
							53				
			16	TP	PH		52				
							51				
			17	TP	PH						0 0 20 80
49.0							50				
19.8							49				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1899802-6000

RECORD OF BOREHOLE No 18-601

SHEET 3 OF 3

METRIC

G.W.P. 4050-18-00 LOCATION N 5019901.4; E 410466.5 NAD 83 MTM ZONE 9 (LAT. 45.311110; LONG. -75.152400) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY JEM

DATUM Geodetic DATE December 17 - 18, 2018 CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(CI/CH) SILTY CLAY to CLAY, contains silt layers Stiff Grey Wet		18	TP	PH		48				
			19	TP	PH		47				
			20	TP	PH		46				
							45				
44.1											
24.7	(SM) Silty SAND, some gravel, trace to some clay, contains cobbles and boulders (TILL) Very loose to very dense Wet		21	SS	WH		44				18 38 34 10
			22	SS	55/0.15		43				
42.5											
26.3	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK NOTES: 1. VWP was installed at 22.9 m depth (Elev. 46.0 m). 2. Water level was measured in VWP at 15.9 m depth below ground surface (Elev. 52.9 m) on February 19, 2019.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-602

SHEET 1 OF 3

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019806.4; E 410555.1 NAD 83 MTM ZONE 9 (LAT. 45.310240; LONG. -75.151290)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JEM

DATUM Geodetic

DATE December 18 - 20, 2018

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
69.0	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
68.7	PORTLAND CEMENT CONCRETE										
0.3	(SW/GW) Sand and gravel (FILL) Compact Grey Moist		1	SS	29		68				
			2	SS	25						
			3	SS	26		67				
66.6											
2.4	(SM/ML) Sand and silt, trace clay (FILL) Loose to very loose Brown Moist		4	SS	9				○		0 62 35 3
65.7			5	SS	2		66				
3.4	(ML) Sandy SILT Very loose to loose Grey Wet		6	SS	2		65				
			7	SS	8		64				
			8	SS	6	▼					
63.0							63				
6.0	(CH) CLAY, contains silt seams Firm to soft Grey to red brown Wet		9	SS	WH			× +			
			10	TP	PH		62	+			
								× +			
59.9							61	+			
9.1	(CI/CH) SILTY CLAY to CLAY Firm Grey Wet		11	TP	PH			×	○		0 0 50 50
							60	+			

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-602

SHEET 2 OF 3

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019806.4; E 410555.1 NAD 83 MTM ZONE 9 (LAT. 45.310240; LONG. -75.151290)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JEM

DATUM Geodetic

DATE December 18 - 20, 2018

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(CI/CH) SILTY CLAY to CLAY Firm Grey Wet										
			12	TP	PH		58				
							57				
			13	TP	WR						0 0 28 72
							56				
			14	TP	WR		55				0 0 38 62
							54				
			15	TP	WR						
							53				
			16	TP	WR		52				
							51				
			17	TP	WR						
49.0							50				

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-602

SHEET 3 OF 3

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019806.4; E 410555.1 NAD 83 MTM ZONE 9 (LAT. 45.310240; LONG. -75.151290)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JEM

DATUM Geodetic

DATE December 18 - 20, 2018

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	25 50 75		
20.0	(CI) SILTY CLAY Stiff Grey Wet						48				
			18	TP	WR				○		0 0 43 57
							47	× +			
								+			
			19	TP	WR		46				
44.6								× +			
24.4	(ML) Gravelly sandy SILT, trace to some clay (TILL) Loose to compact Grey Moist						45	+			
			20	SS	10				○		25 28 39 8
43.7							44				
			21	SS	50/0.00						
25.4	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK NOTES: 1. VWP was installed at 8.4 m depth (Elev. 60.6 m). 2. Water level was measured in VWP at 5.6 m depth below ground surface (Elev. 63.4 m) on February 19, 2019.										

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-603

SHEET 1 OF 3

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019765.8; E 410531.1 NAD 83 MTM ZONE 9 (LAT. 45.309880; LONG. -75.151610)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JEM

DATUM Geodetic

DATE December 4 - 7, 2018

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.7	GROUND SURFACE										
0.0 / 68.5	ASPHALTIC CONCRETE										
0.2	(GW/SW) Sandy gravel to sand and gravel, some silt (FILL) Very dense Grey Dry		1	AS	-				○		70 21 (9)
67.5			2	SS	79		68		○		36 48 (16)
1.2	(SM/ML) Sand and silt, trace clay (FILL) Very dense to compact Brown Moist		3	SS	54		67				
			4	SS	51		66				
			5	SS	60		65				0 63 34 3
64.1			6	SS	20						
4.6	(ML/SM) SILT and SAND Compact to loose Grey brown Wet		7	SS	18		64		○		0 38 (62)
62.5			8	SS	7		63				
6.2	(CH) CLAY, contains silt layers Firm Grey brown Wet		9	SS	2		62	× + × +			
			10	TP	PH		61		○		0 0 12 88
59.6							60	× +			
9.1	(CI/CL) SILTY CLAY to CLAYEY SILT Soft to firm Grey Wet		11	TP	PH	▼	59	× +	○		

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1899802-6000

RECORD OF BOREHOLE No 18-603

SHEET 2 OF 3

METRIC

G.W.P. 4050-18-00 LOCATION N 5019765.8; E 410531.1 NAD 83 MTM ZONE 9 (LAT. 45.309880; LONG. -75.151610) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY JEM

DATUM Geodetic DATE December 4 - 7, 2018 CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(Cl/CL) SILTY CLAY to CLAYEY SILT Soft to firm Grey Wet										
			12	TP	PH		58				
							57				
			13	TP	PH						
							56				
			14	TP	PH		55				
							54				
			15	TP	PH		53				
			16	TP	PH		52				0 0 53 47
							51				
			17	TP	PH		50				
49.2 19.5	(Cl) SILTY CLAY Stiff Grey Wet						49				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-603

SHEET 3 OF 3

METRIC

PROJECT 1899802-6000
G.W.P. 4050-18-00
DIST Eastern HWY 417
DATUM Geodetic

LOCATION N 5019765.8; E 410531.1 NAD 83 MTM ZONE 9 (LAT. 45.309880; LONG. -75.151610)
BORHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)
DATE December 4 - 7, 2018

ORIGINATED BY DG
COMPILED BY JEM
CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(CI) SILTY CLAY Stiff Grey Wet		18	SS	3						
			19	TP	PH						
			20	TP	PH						0 1 19 80
44.3											
24.4	(ML) Sandy SILT, some gravel, trace clay (TILL) Compact to dense Grey Wet		21	SS	20				N.P.		14 31 48 7
			22	SS	42						
41.4											
27.3	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK										

NOTES:

1. VWP was installed at 18.3 m depth (Elev. 50.4 m).
2. Water level was measured in VWP at 9.6 m depth below ground surface (Elev. 59.1 m) on February 19, 2019.
3. N.P. = non-plastic

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-604

SHEET 1 OF 4

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019865.0; E 410438.3 NAD 83 MTM ZONE 9 (LAT. 45.310790; LONG. -75.152770)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE January 5 - 11, 2019

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.8	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.1 / 68.4	PORTLAND CEMENT CONCRETE										
0.4	(GW/SW) Gravel and sand, trace to some silt (FILL) Dense to compact Grey Moist		1	GS	-		68				
			2	SS	47				○		51 38 (11)
			3	SS	19		67				
66.4											
2.4	(SM) Silty sand, trace gravel (FILL) Loose to very loose Brown Moist		4	SS	7		66				
			5	SS	4				○		1 67 (32)
			6	SS	2		65				
64.4											
4.4	(SM/ML) SAND and SILT Compact to loose Brown Wet		7	SS	15		64				
			8	SS	5						
62.9							63				
5.9	(CH) CLAY, contains silt seams Firm Grey with red mottling Wet		9	SS	WH			× + × +			
			10	TP	PH	▼	61		○		0 0 38 62
							60	× + × +			
			11	TP	PH						
							59				

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-604

SHEET 2 OF 4

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019865.0; E 410438.3 NAD 83 MTM ZONE 9 (LAT. 45.310790; LONG. -75.152770)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE January 5 - 11, 2019

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(CH) CLAY, contains silt seams Firm Grey with red mottling Wet										
			12	TP	PH		58				
							57				
			13	TP	PH						
							56				
			14	TP	PH		55				
							54				
			15	TP	PH						
							53				
			16	TP	PH		52				
							51				
50.5											
18.3	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Wet		17	TP	PH		50				0 0 40 60
							49				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-604

SHEET 3 OF 4

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019865.0; E 410438.3 NAD 83 MTM ZONE 9 (LAT. 45.310790; LONG. -75.152770)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE January 5 - 11, 2019

CHECKED BY CK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Wet		18	TP	PH						
			19	TP	PH		48				0 0 17 83
							47				
			20	TP	PH		46				0 2 38 60
							45				
			21	TP	PH		44				
			22	TP	PH		43				
42.1											
26.7	(SM/ML) Gravelly SAND and SILT, some clay (TILL) Compact to dense Grey brown Wet		23	SS	20		42				
			24	SS	46		41				
							40				
39.1											
29.7											

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 18-604

SHEET 4 OF 4

METRIC

PROJECT 1899802-6000

G.W.P. 4050-18-00

LOCATION N 5019865.0; E 410438.3 NAD 83 MTM ZONE 9 (LAT. 45.310790; LONG. -75.152770)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE January 5 - 11, 2019

CHECKED BY CK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%) 25 50 75		
	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK										

NOTES:

1. VWP was installed at 12.3 m depth (Elev. 56.5 m).

2. Water level was measured in VWP at 8.2 m depth below ground surface (Elev. 60.6 m) on February 19, 2019.

$+^3, \times^3$: Numbers refer to Sensitivity

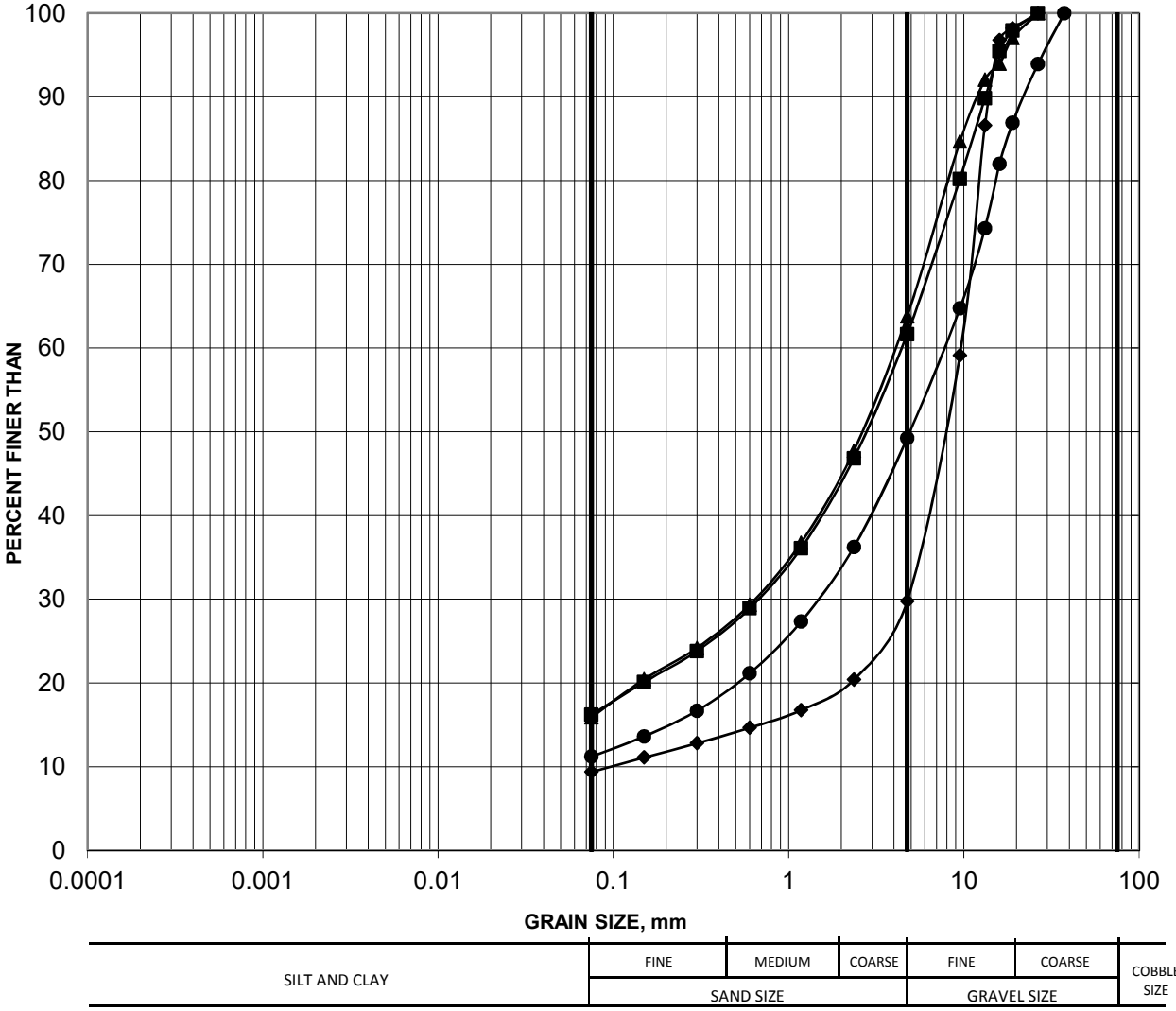
$\circ^{3\%}$ STRAIN AT FAILURE

APPENDIX B

Laboratory Test Results - Current Investigation

GRAIN SIZE DISTRIBUTION	FIGURE B1

SAND AND GRAVEL TO SANDY GRAVEL (FILL)



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
18-601	2	0.76-1.37	38	46	16
18-603	1	0.20-0.76	70	21	9
18-603	2A	0.76-1.22	36	48	16
18-604	2	0.76-1.37	51	38	11

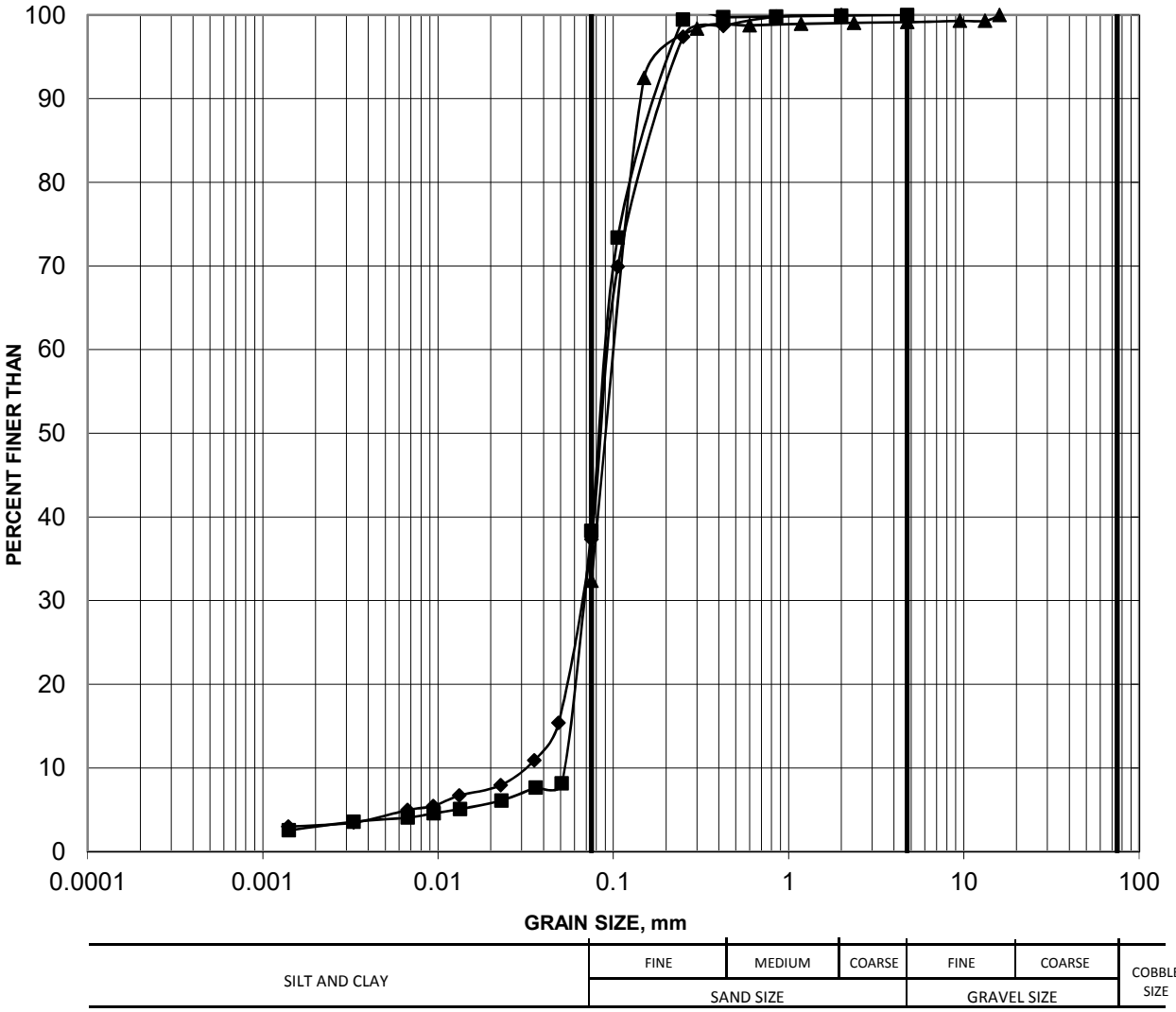
Project: 1899802/6000

Golder Associates

Created by: MI
Checked by: CW

GRAIN SIZE DISTRIBUTION	FIGURE B2

SILTY SAND TO SAND AND SILT (FILL)



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-602	4B	2.44-2.90	0	62	35	3
18-603	5	3.05-3.66	0	63	34	3
18-604	5	3.05-3.66	1	67	32	

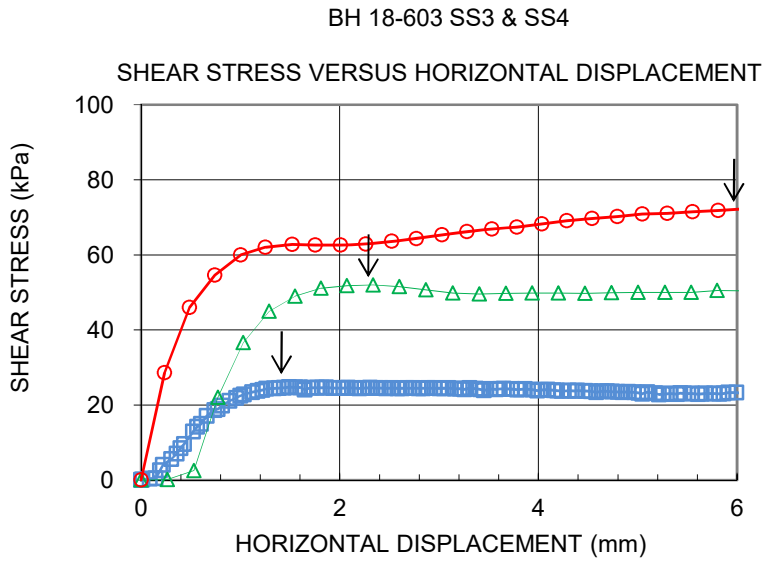
Project: 1899802/6000

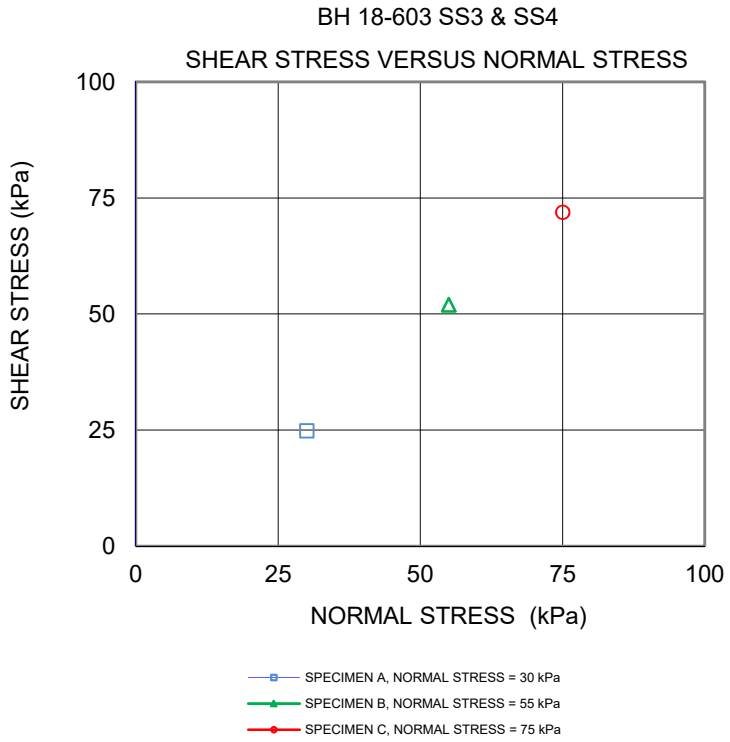
Golder Associates

Created by: MI
Checked by: CW

CONSOLIDATED DRAINED DIRECT SHEAR TEST
ASTM D3080

FIGURE B3A





Date: 02/19/2019
Project No. 1899802/6000

Golder Associates

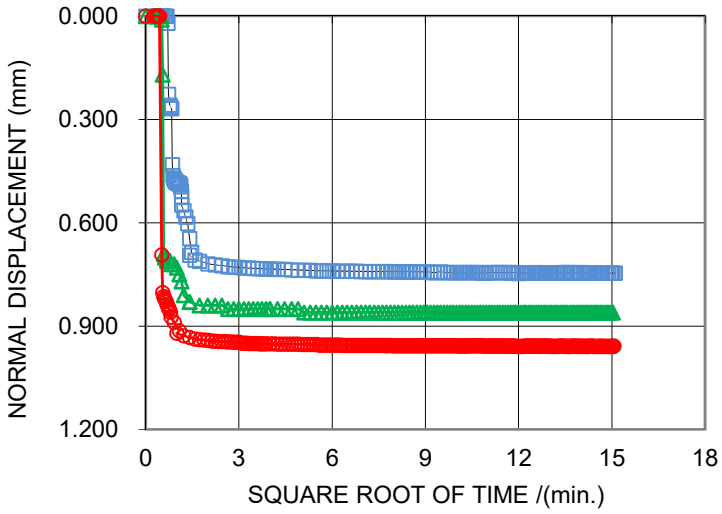
Prepared By: MI
Checked By: CW

CONSOLIDATED DRAINED DIRECT SHEAR TEST
ASTM D3080

FIGURE B3B

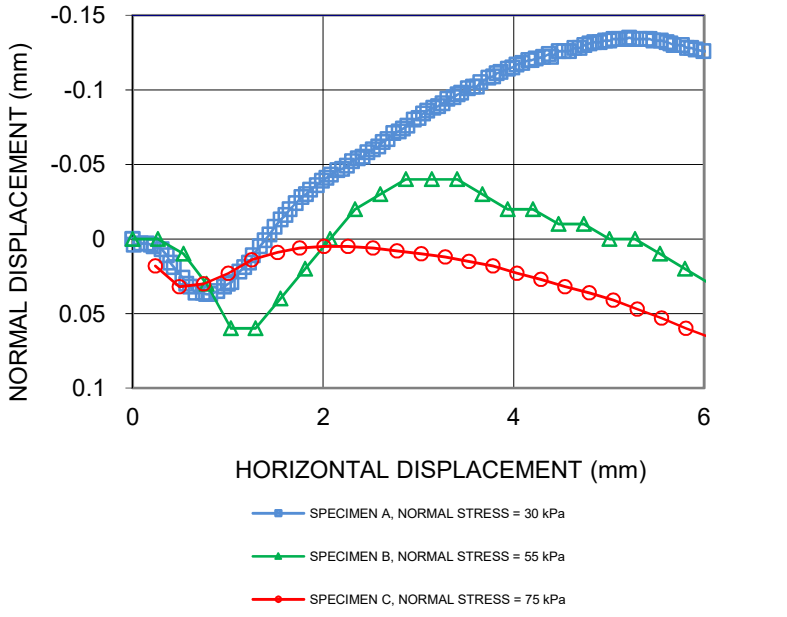
BH 18-603 SS3 & SS4

NORMAL DISPLACEMENT VERSUS SQUARE ROOT OF TIME



BH 18-603 SS3 & SS4

NORMAL DISPLACEMENT VERSUS HORIZONTAL DISPLACEMENT



Date: 02/19/2019
Project No. 1899802/6000

Golder Associates

Prepared By: MI
Checked By: CW

CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 1 OF 4			FIGURE B4A
TEST STAGE	A	B	C
BOREHOLE NUMBER	18-601 & 18-602		
SAMPLE NUMBER	4 & 5		
DEPTH, ft	-		
SPECIMEN DIAMETER, cm	5.10	5.18	5.07
SPECIMEN HEIGHT, cm	10.16	10.13	10.19
NATURAL WATER CONTENT, %	13.5	13.7	11.5
DRY DENSITY, Mg/m^3	1.51	1.48	1.56
WATER CONTENT BEFORE CONSOLIDATION, %	24.1	26.6	26.2
CELL PRESSURE, σ_3, kPa	440.0	470.0	530.0
BACK PRESSURE, kPa	410.0	410.0	410.0
PORE PRESSURE PARAMETER "B"	0.90	0.90	0.90
CONSOLIDATION PRESSURE, σc, kPa	30.0	60.0	120.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	0.5	0.4	0.9
WATER CONTENT AFTER CONSOLIDATION, %	23.8	26.0	25.6
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, HOURS	3	7	9
WATER CONTENT AFTER TEST, %	27.5	26.3	24.7
MAX. DEVIATOR STRESS, $(\sigma_1-\sigma_3)$, kPa	119.3	204.9	429.7
AXIAL STRAIN AT $(\sigma_1-\sigma_3)$ MAXIMUM, %	1.3	3.5	4.3
MAX PRINCIPAL STRESS RATIO, (σ'_1/σ'_3) maximum	4.9	4.4	4.6
FILTER DRAINS USED, y/n	y	y	

TEST NOTES:

Specimens compacted to a target density 1.76 g/cm^3 at 11% moisture content; achieved 97%, 95% and 99% compaction respectively.

FAILURE PLANE NUMBER	-	-	1.0
ANGLE OF FAILURE, DEGREES	-	-	40.0

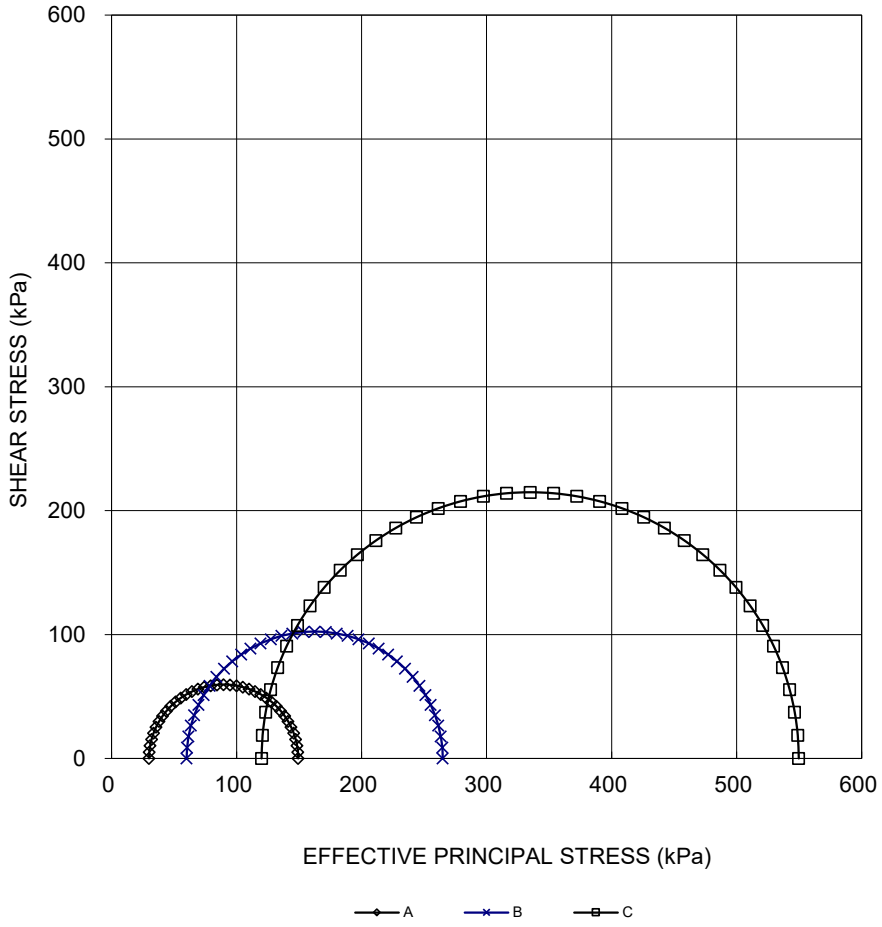
Date: 4/01/2019 Prepared By: LH

Project No. 1899802(6000) **Golder Associates** Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 2 OF 4

FIGURE B4B

BH 18-601 SA 4 & 5 BH18-602 SA5



Date: 4/01/2019
Project No. 1899802(6000)

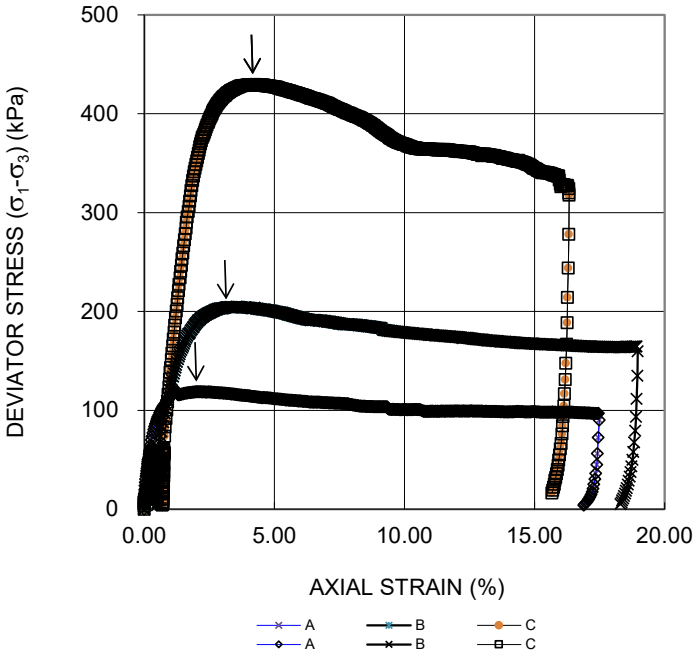
Golder Associates

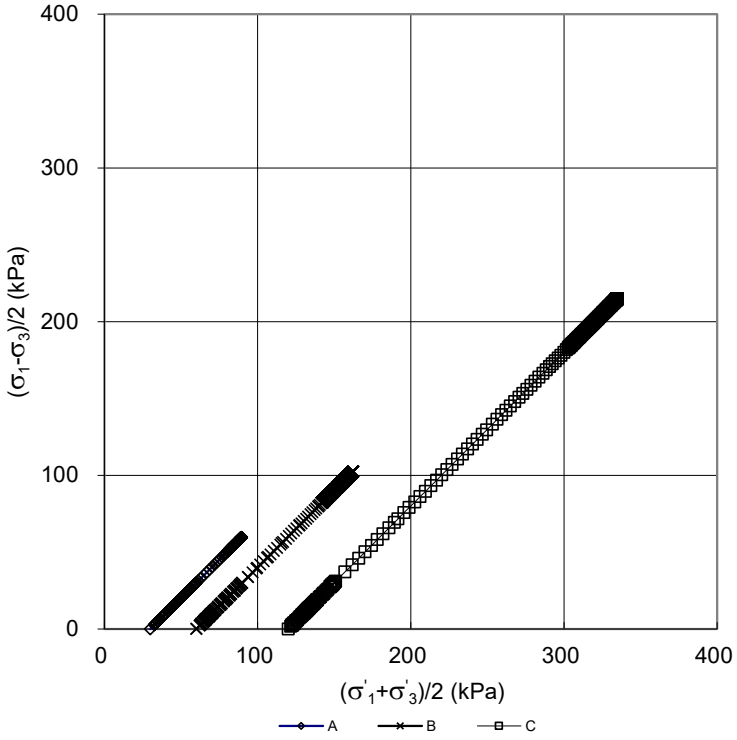
Prepared By: LH
Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 3 OF 4

FIGURE B4C

BH 18-601 SA 4 & 5 BH18-602 SA5





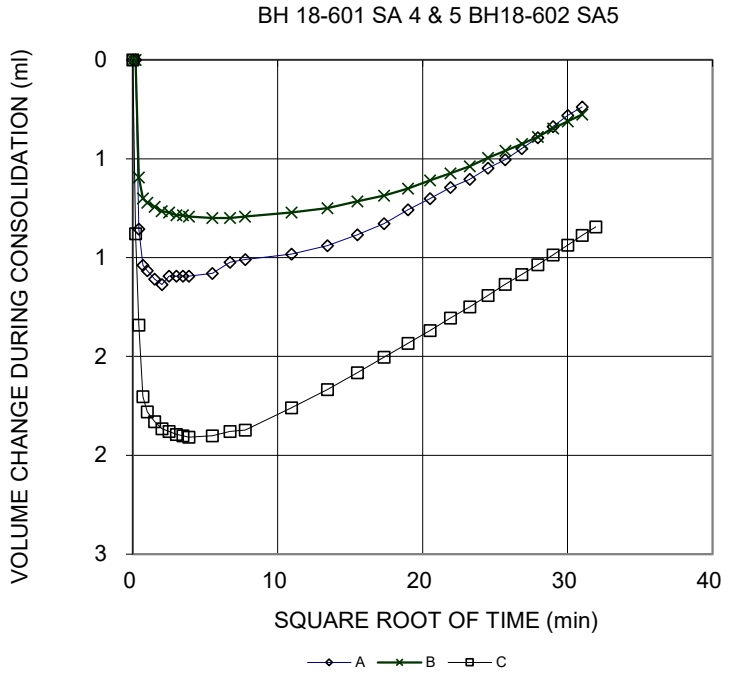
Date: 4/01/2019
Project No. 1899802(6000)

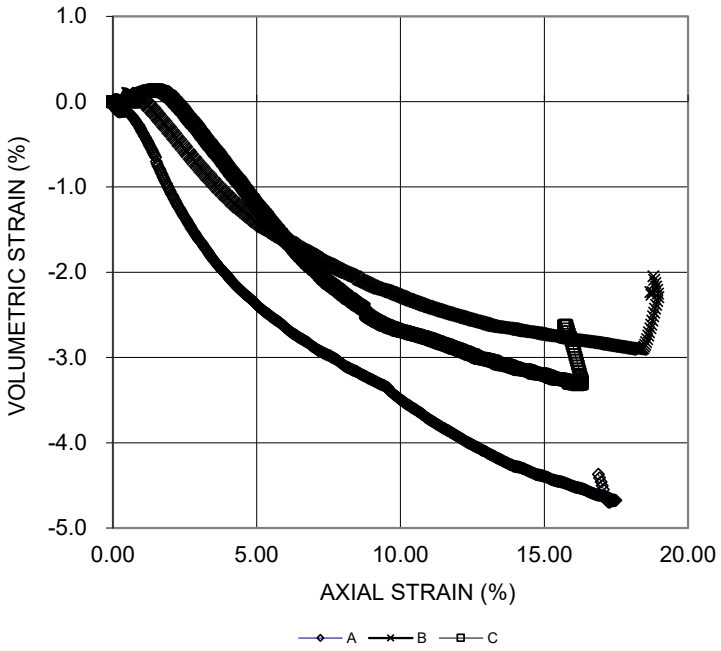
Golder Associates

Prepared By: LH
Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 4 OF 4

FIGURE B4B





NOTES: POSITIVE (+) VOLUMETRIC STRAIN = SAMPLE VOLUME DECREASING
NEGATIVE(-) VOLUMETRIC STRAIN = SAMPLE VOLUME INCREASING

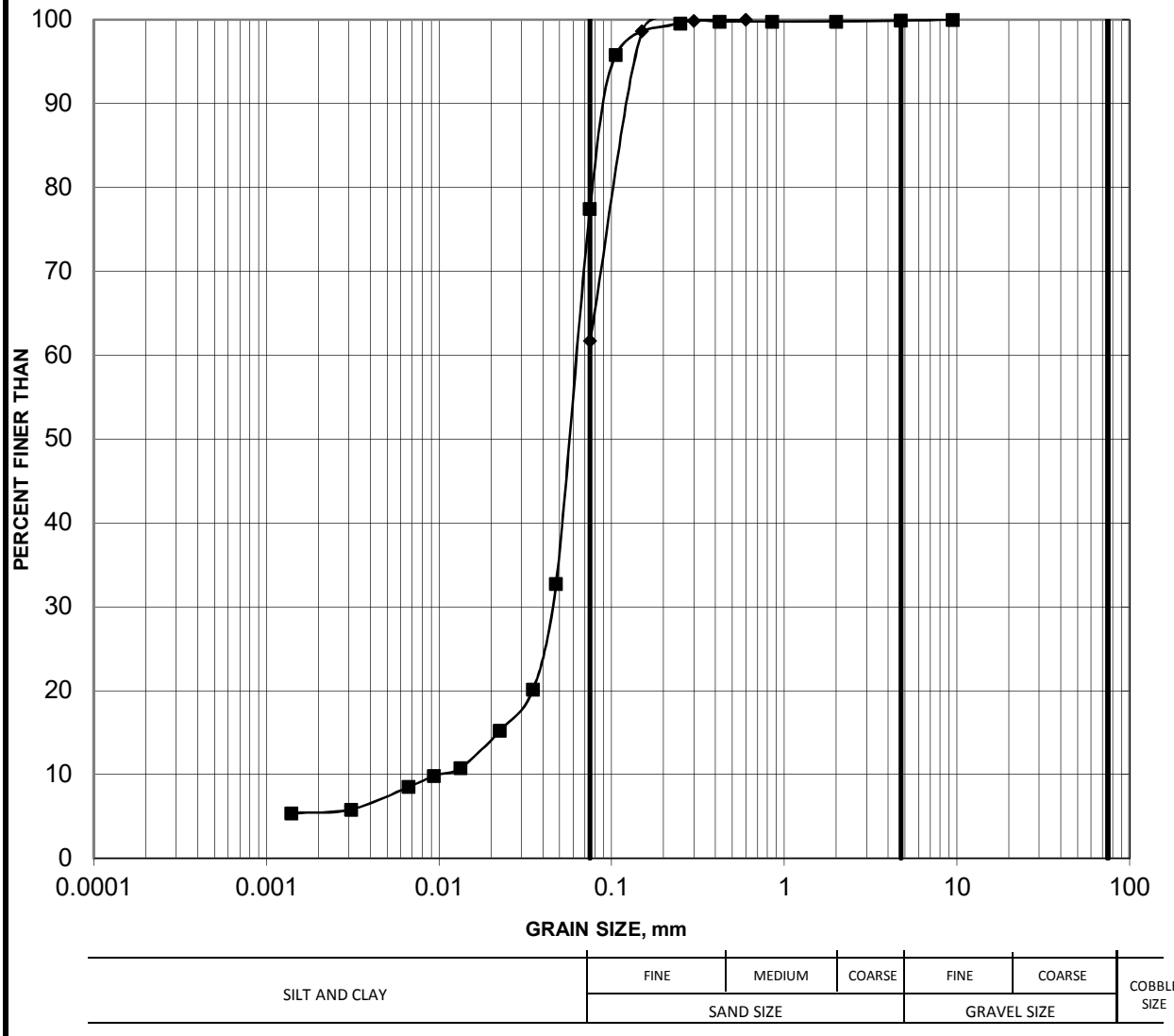
Date: 4/01/2019 Prepared By: LH

Project No. 1899802(6000) **Golder Associates** Checked By:

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND AND SILT TO SANDY SILT



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-601	8	5.33-5.94	0	22	72	6
18-603	7	4.57-5.18	0	38	62	

Project: 1899802/6000

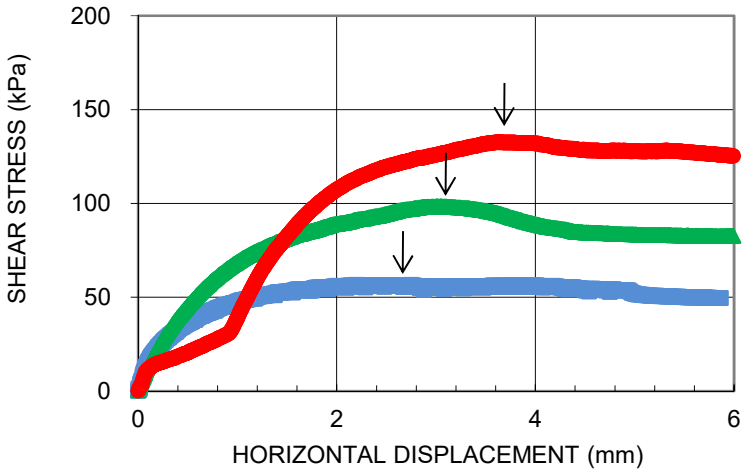
Golder Associates

Created by: MI
Checked by: CW

CONSOLIDATED DRAINED DIRECT SHEAR TEST ASTM D3080	FIGURE B6A

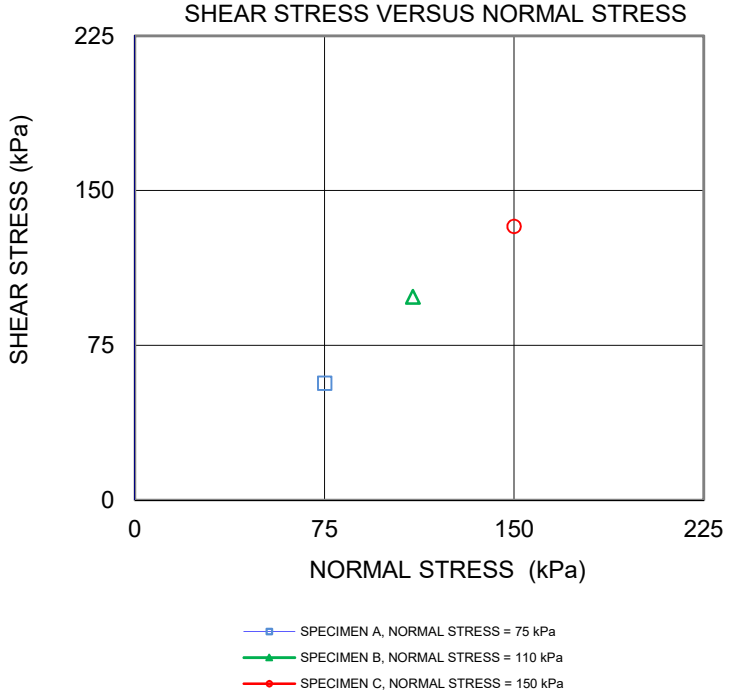
BH 18-601 SS7

SHEAR STRESS VERSUS HORIZONTAL DISPLACEMENT



BH 18-601 SS7

SHEAR STRESS VERSUS NORMAL STRESS



Date: 02/19/2019

Project No. 1899802/6000

Golder Associates

Prepared By: MI

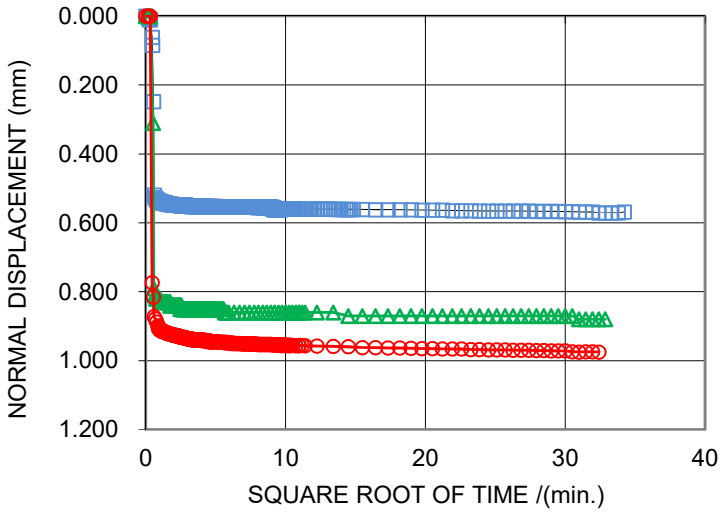
Checked By: CW

CONSOLIDATED DRAINED DIRECT SHEAR TEST
ASTM D3080

FIGURE B6B

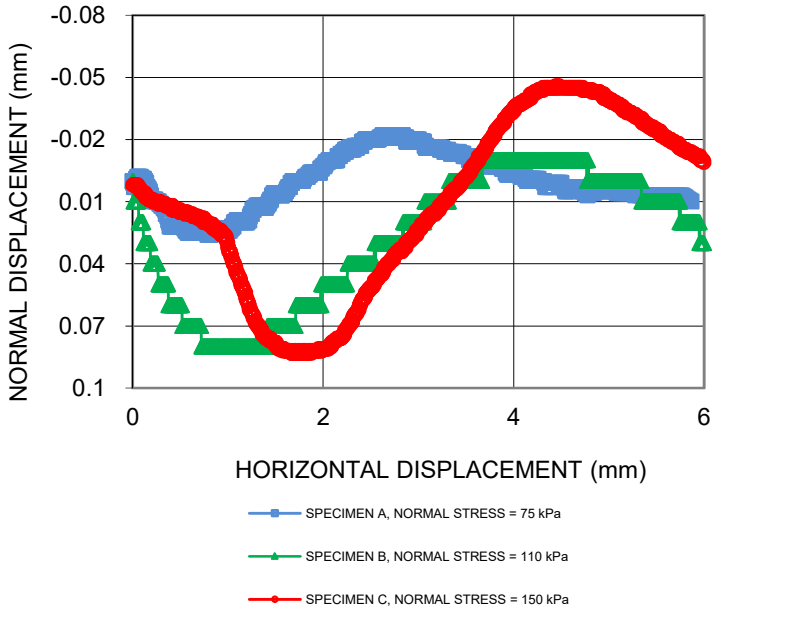
BH 18-601 SS7

NORMAL DISPLACEMENT VERSUS SQUARE ROOT OF TIME



BH 18-601 SS7

NORMAL DISPLACEMENT VERSUS HORIZONTAL DISPLACEMENT



Date: 02/19/2019

Project No. 1899802/6000

Golder Associates

Prepared By: MI

Checked By: CW

CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 1 OF 4			FIGURE B7A
TEST STAGE	A	B	C
BOREHOLE NUMBER		18-604	
SAMPLE NUMBER		7 & 8	
DEPTH, ft		-	
SPECIMEN DIAMETER, cm	5.06	5.06	5.05
SPECIMEN HEIGHT, cm	10.07	10.08	10.07
NATURAL WATER CONTENT, %	22.1	20.7	20.4
DRY DENSITY, Mg/m^3	1.46	1.47	1.49
WATER CONTENT BEFORE CONSOLIDATION, %	24.9	25.5	25.4
CELL PRESSURE, σ_3, kPa	530.0	510.0	610.0
BACK PRESSURE, kPa	480.0	410.0	410.0
PORE PRESSURE PARAMETER "B"	0.90	0.90	0.90
CONSOLIDATION PRESSURE, σc, kPa	50.0	100.0	200.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.2	2.3	3.3
WATER CONTENT AFTER CONSOLIDATION, %	24.1	23.9	23.2
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, HOURS	28	38	29
WATER CONTENT AFTER TEST, %	24.5	23.3	23.2
MAX. DEVIATOR STRESS, $(\sigma_1-\sigma_3)$, kPa	143.7	287.7	525.5
AXIAL STRAIN AT $(\sigma_1-\sigma_3)$ MAXIMUM, %	14.0	18.8	14.7
MAX PRINCIPAL STRESS RATIO, (σ'_1/σ'_3) maximum	3.9	3.9	3.6
FILTER DRAINS USED, y/n	y	y	y

TEST NOTES:

Specimens compacted to a target density 1.79 g/cm^3 at 20% moisture content; achieved 99%, 99% and 100% compaction respectively.

FAILURE PLANE NUMBER	-	-	-
ANGLE OF FAILURE, DEGREES	Bulged	Bulged	Bulged

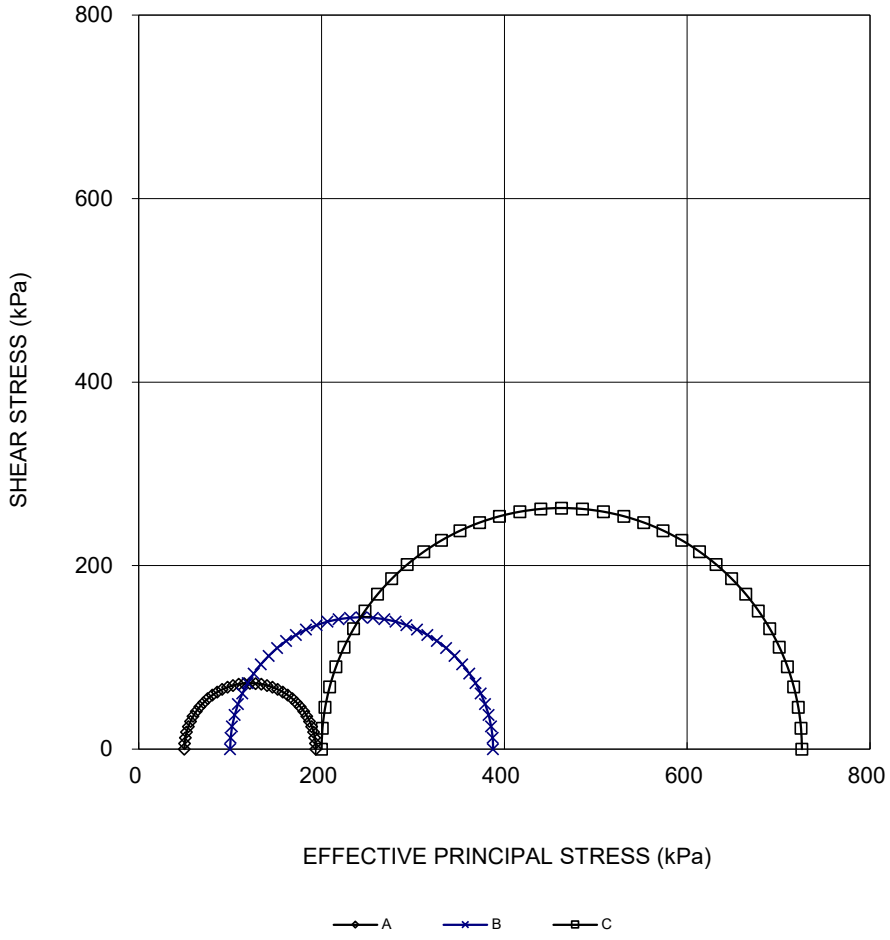
Date: 3/29/2019 Prepared By: LH

Project No. 1899802(6000) **Golder Associates** Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 2 OF 4

FIGURE B7B

BH 18-604 SA 7 & 8



Date: 3/29/2019
Project No. 1899802(6000)

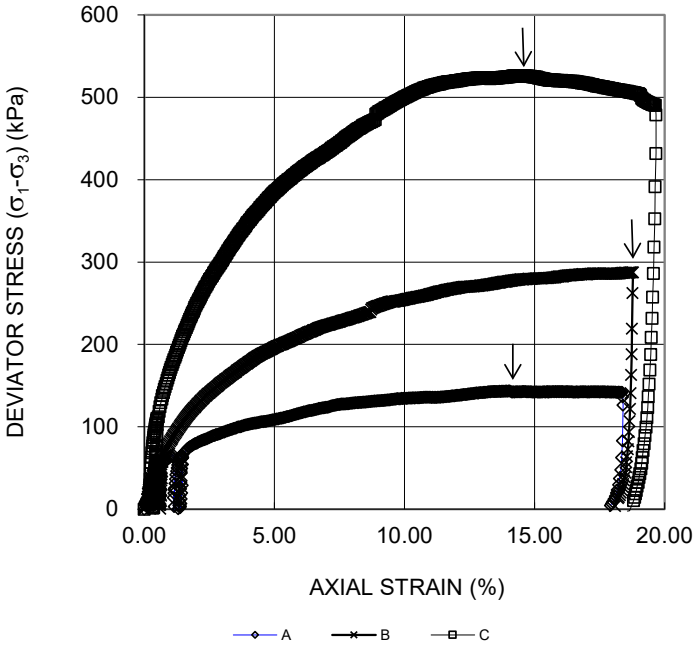
Golder Associates

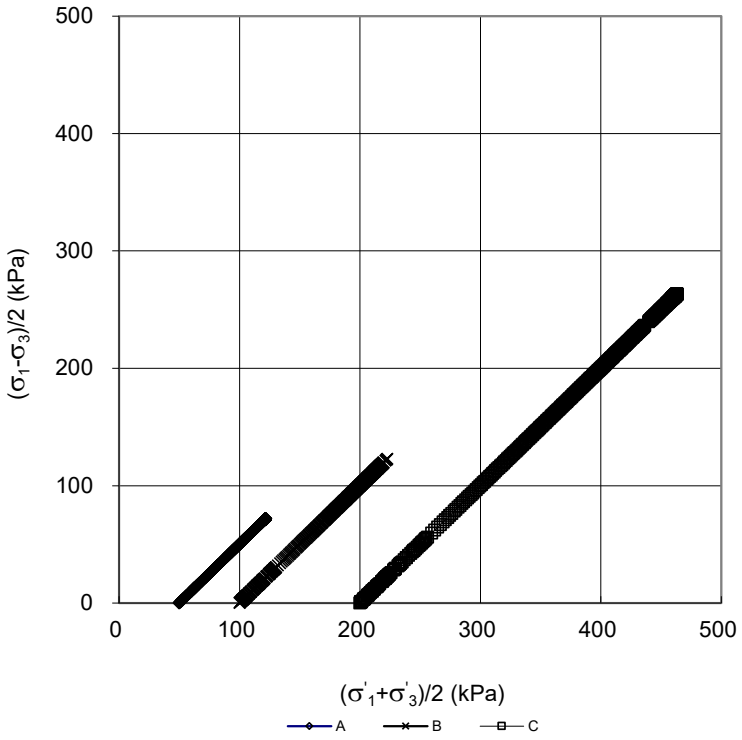
Prepared By: LH
Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 3 OF 4

FIGURE B7C

BH 18-604 SA 7 & 8





Date: 3/29/2019
Project No. 1899802(6000)

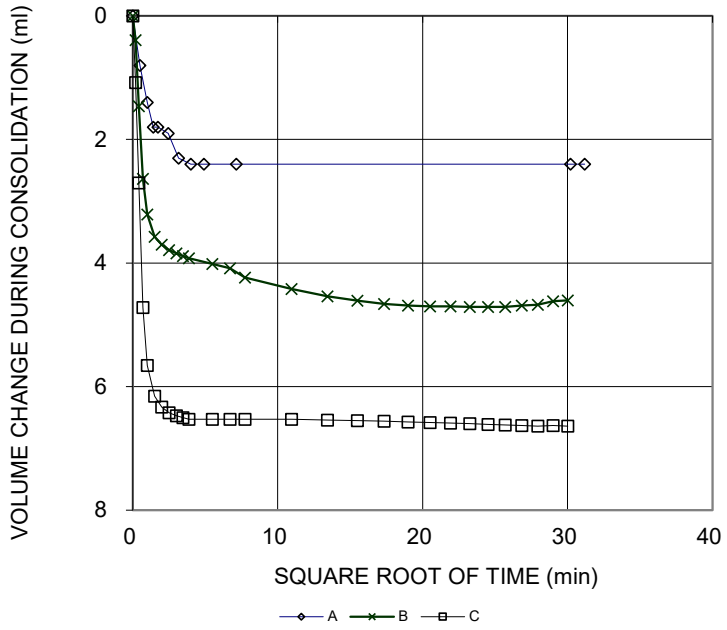
Golder Associates

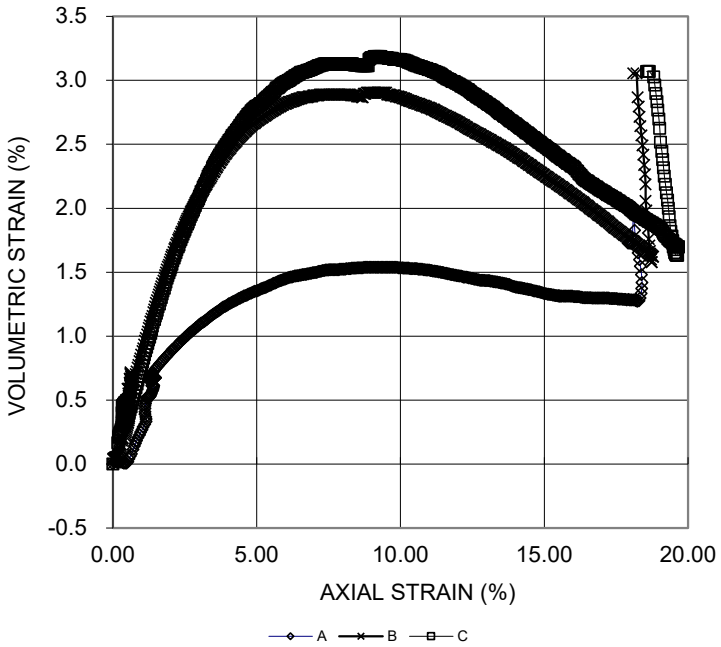
Prepared By: LH
Checked By:

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 4 OF 4

FIGURE B7D

BH 18-604 SA 7 & 8



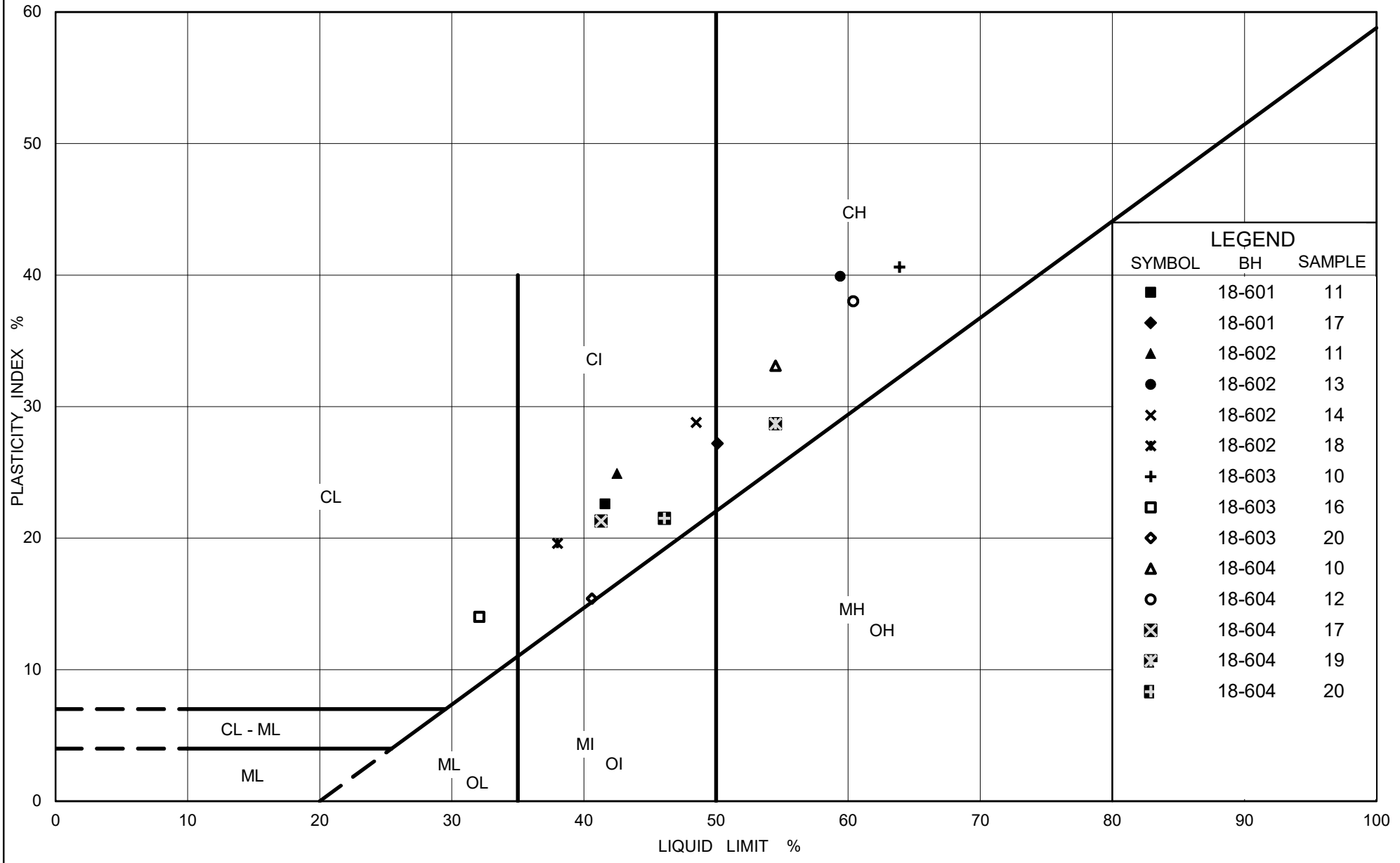


NOTES: POSITIVE (+) VOLUMETRIC STRAIN = SAMPLE VOLUME DECREASING
NEGATIVE(-) VOLUMETRIC STRAIN = SAMPLE VOLUME INCREASING

Date: 3/29/2019 Prepared By: LH

Project No. 1899802(6000) **Golder Associates** Checked By:

Oct 75, FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART
CLAY TO CLAYEY SILT

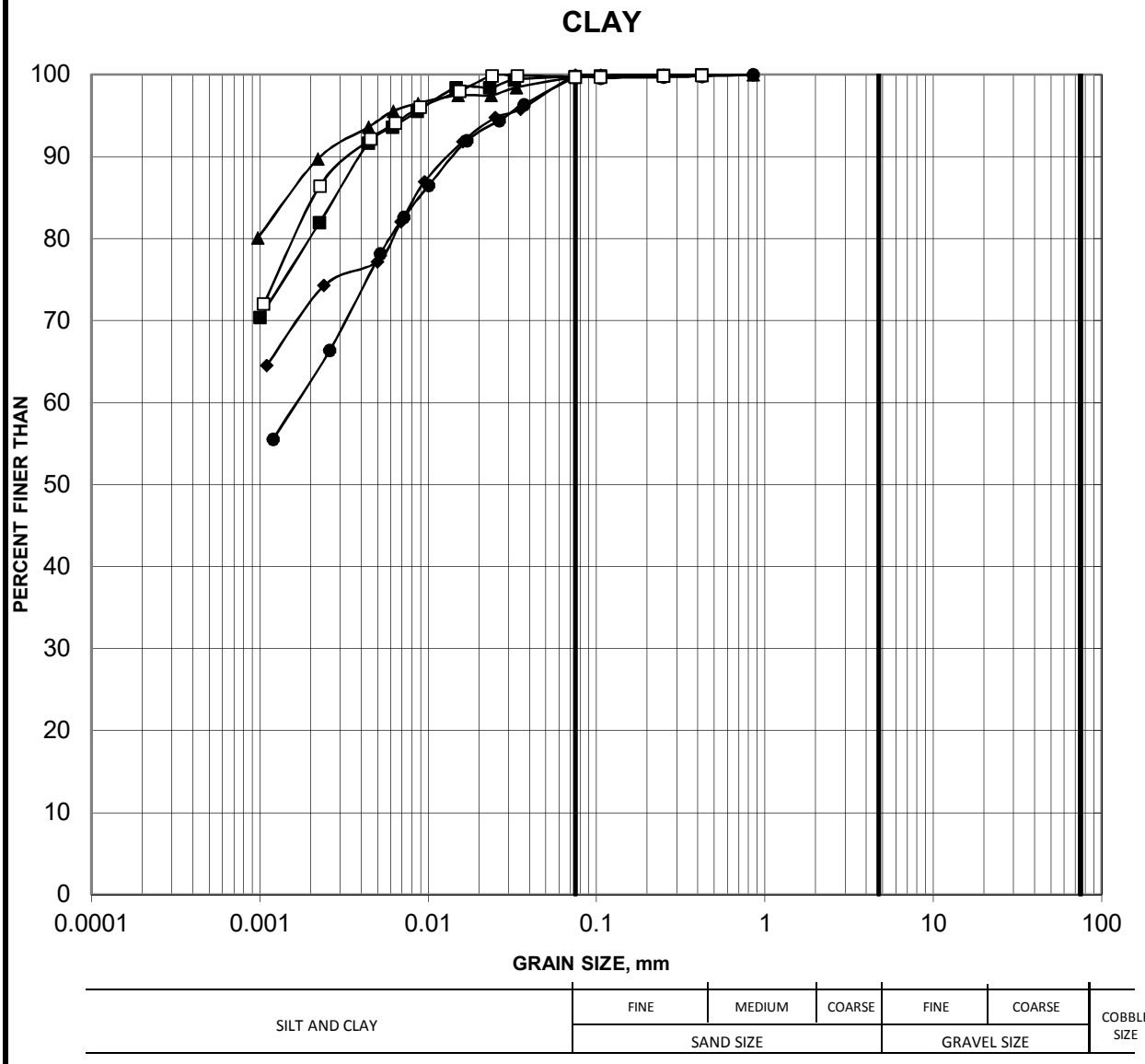
FIG No. B8

Project No. 1899802/6000

Compiled By : MI Checked By : CW

GRAIN SIZE DISTRIBUTION

FIGURE B9



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-601	17	18.29-18.90	0	0	20	80
18-602	13	12.19-12.65	0	0	28	72
18-603	10	7.62-8.13	0	0	12	88
18-604	10	7.62-8.23	0	0	38	62
18-604	19	21.34-21.95	0	0	17	83

Project: 1899802/6000

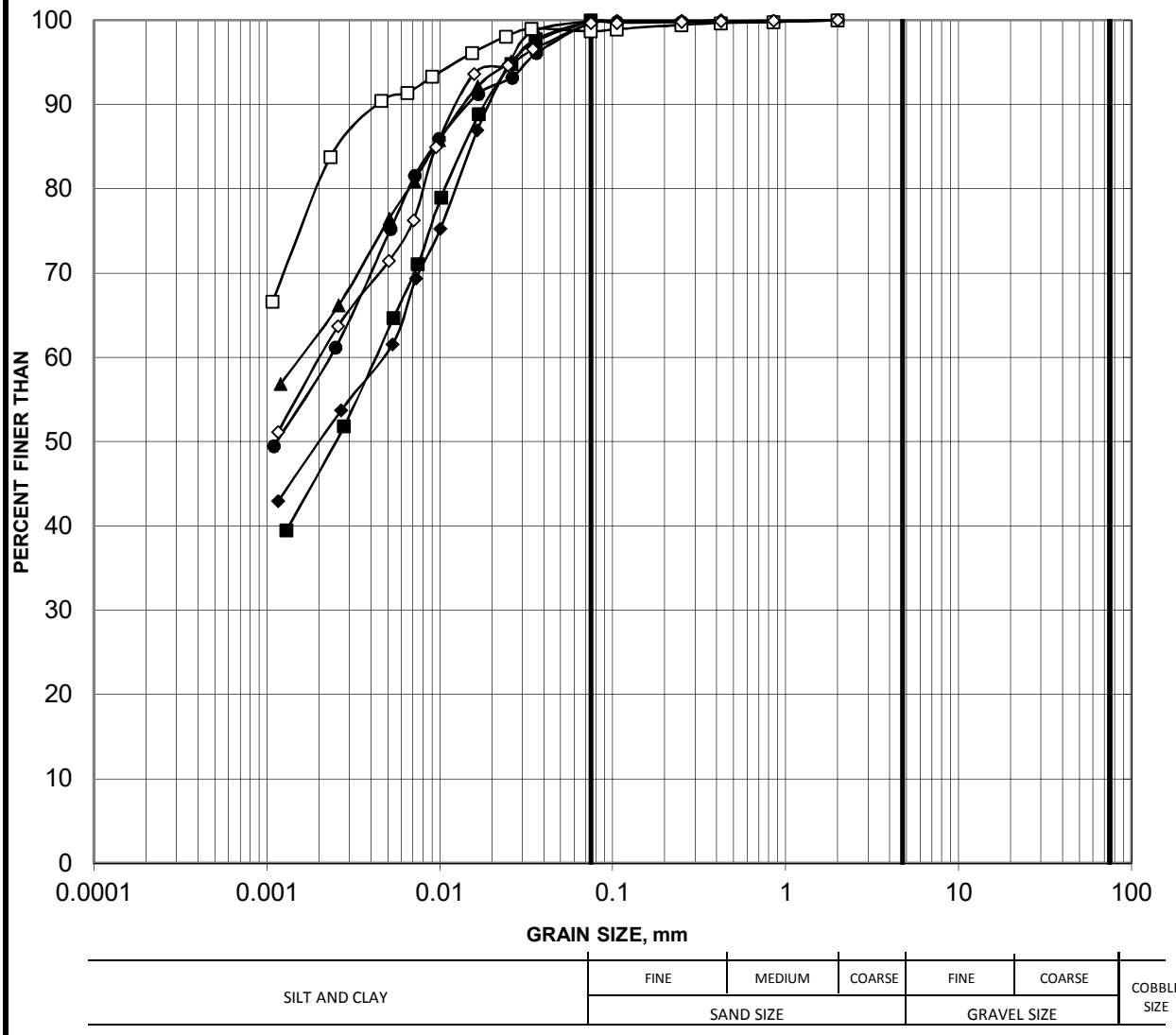
Golder Associates

Created by: MI
Checked by: CW

GRAIN SIZE DISTRIBUTION

FIGURE B10A

SILTY CLAY TO CLAYEY SILT



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-601	11	9.14-9.75	0	0	55	45
18-602	11	9.14-9.68	0	0	50	50
18-602	14	13.72-14.23	0	0	38	62
18-602	18	21.34-21.95	0	0	43	57
18-603	20	22.86-23.47	0	1	19	80
18-604	17	18.29-18.90	0	0	40	60

Project: 1899802/6000

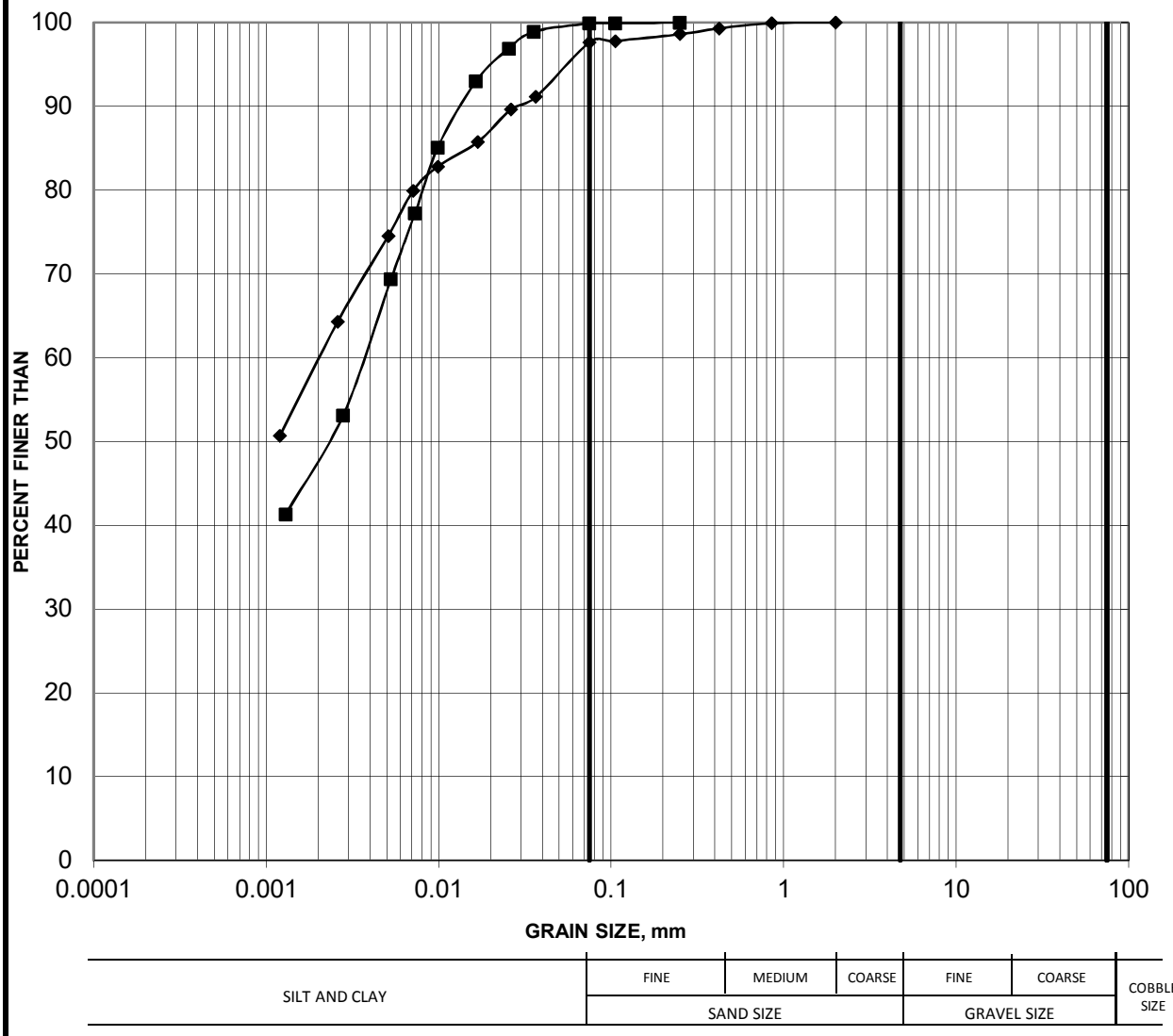
Golder Associates

Created by: MI
Checked by: CW

GRAIN SIZE DISTRIBUTION

FIGURE B10B

SILTY CLAY TO CLAYEY SILT

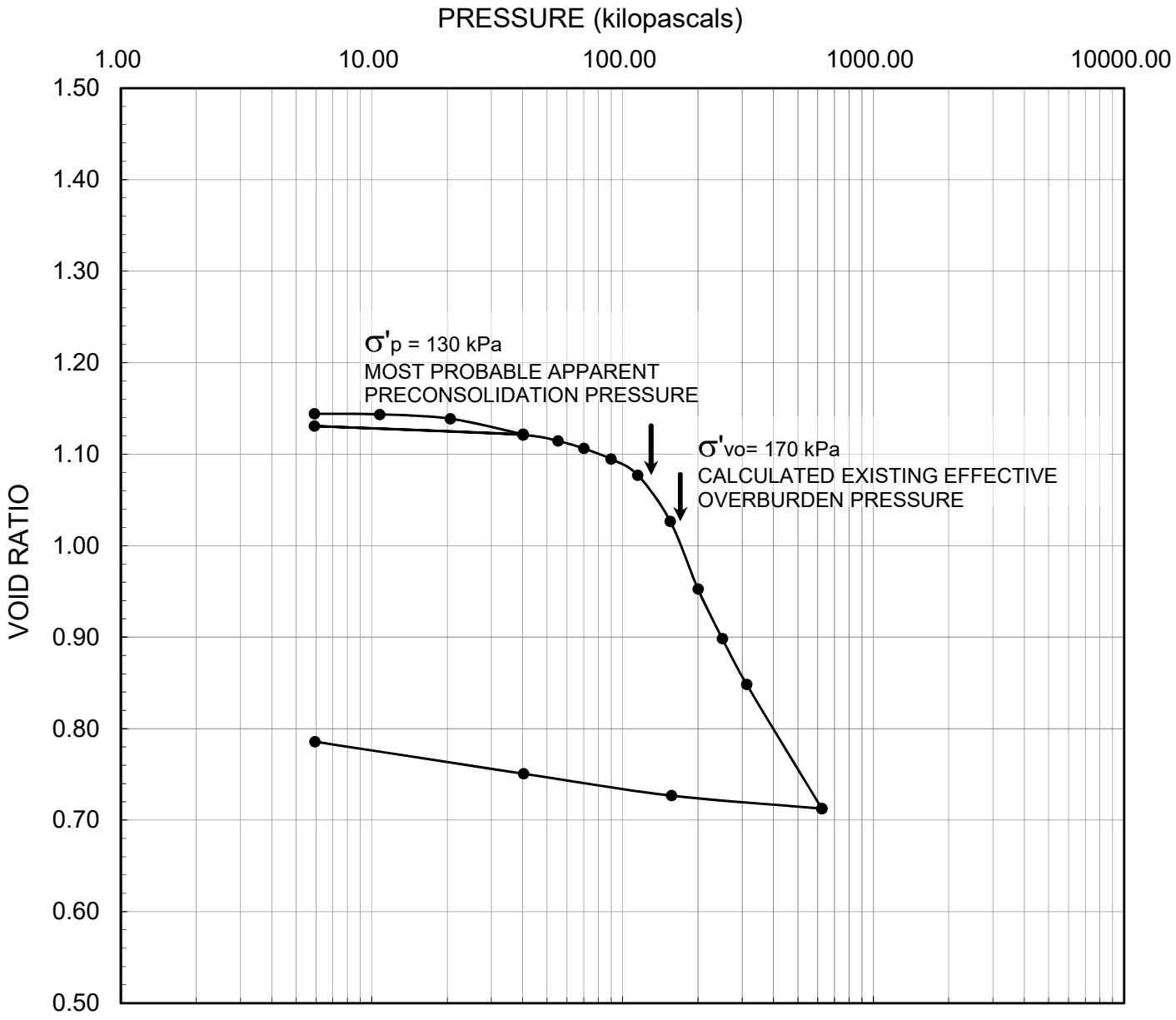


Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-603	16	16.76-17.37	0	0	53	47
18-604	20	22.86-23.47	0	2	38	60

Project: 1899802/6000

Golder Associates

Created by: MI
Checked by: CW



LEGEND

Borehole:	18-601	w_i = 43%	S_o = 99%	γ = 17.5 kN/m³
Sample:	11	w_f = 31%	e_o = 1.19	G_s = 2.73
Depth (m):	9.7	w_l = 42%	C_c = 0.67	
Elevation (m):	59.1	w_p = 19%	C_r = 0.012	

GOLDER

SCALE	AS SHOWN
DATE	03/27/19
CADD	N/A
ENTERED	MI
CHECK	CW
REVIEW	CK

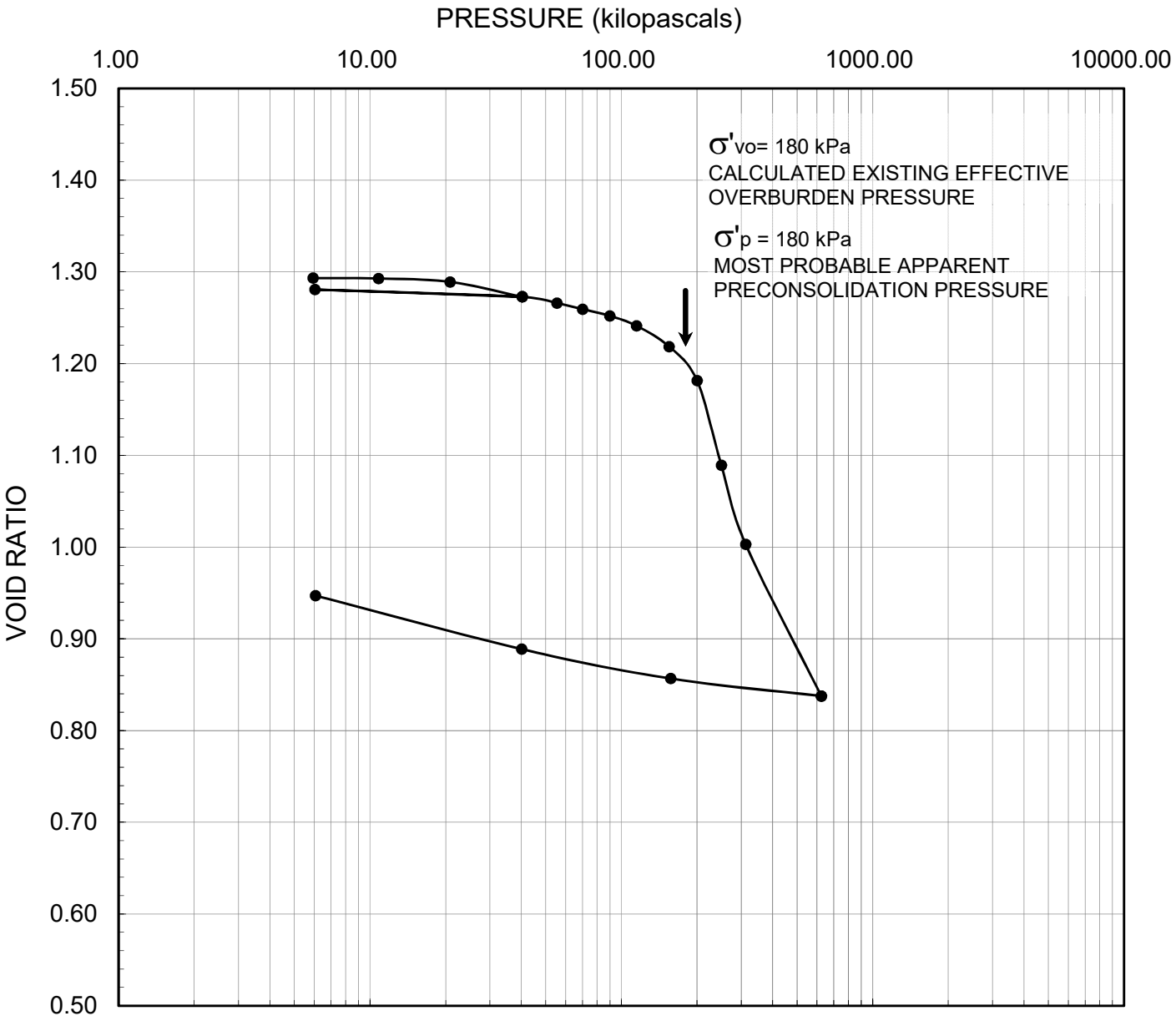
FILE No. Consolidation summary

PROJECT No. 1899802/6000 REV. 0

TITLE

CONSOLIDATION TEST RESULTS

FIGURE **B11**



LEGEND

Borehole:	18-602	w_i = 47%	S_o = 99%	γ = 17.1 kN/m³
Sample:	14	w_f = 35%	e_o = 1.29	G_s = 2.73
Depth (m):	14.2	w_l = 49%	C_c = 0.95	
Elevation (m):	54.8	w_p = 20%	C_r = 0.010	

GOLDER

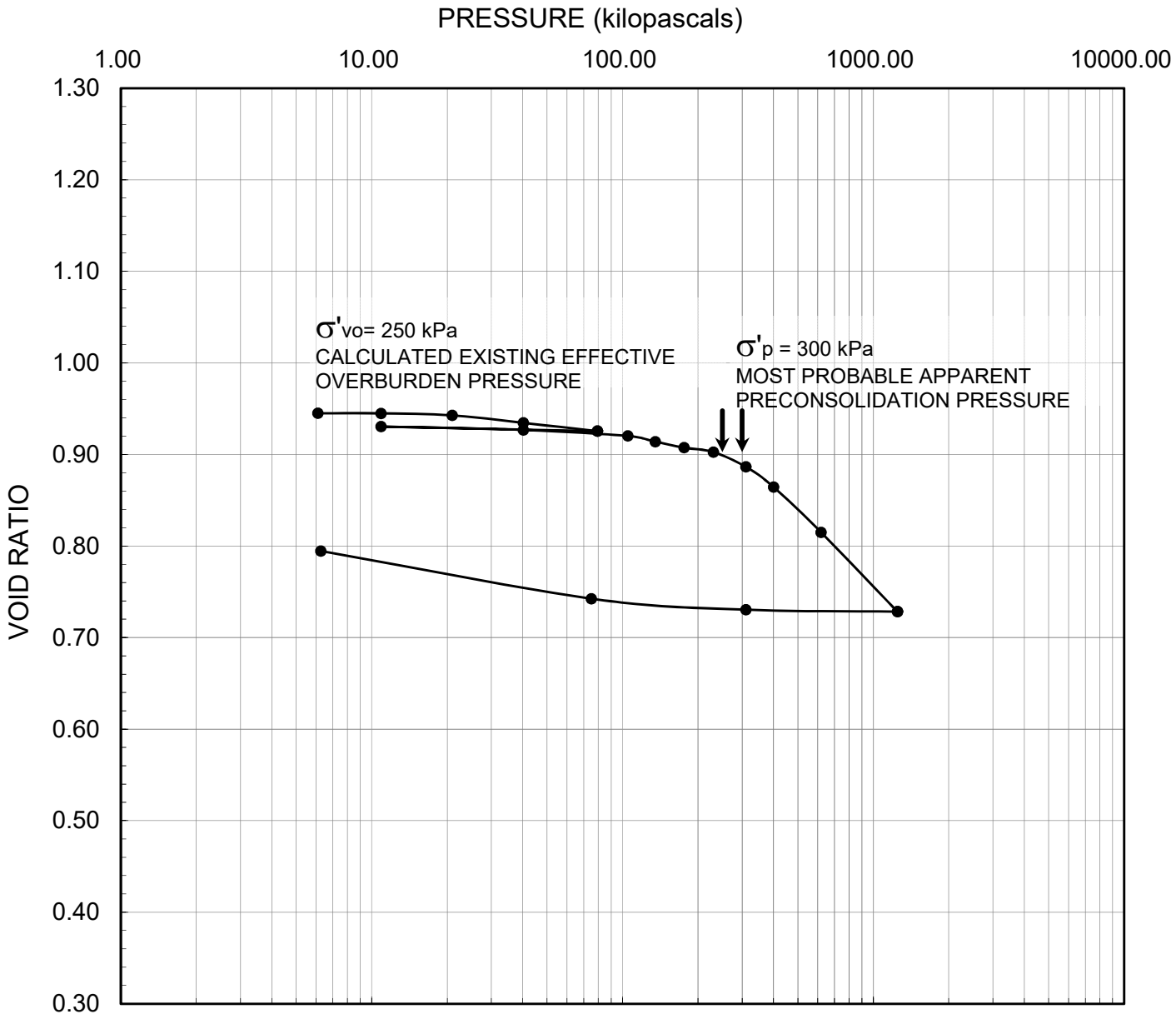
SCALE	AS SHOWN
DATE	04/01/19
CADD	N/A
ENTERED	MI
CHECK	CW
REVIEW	CK

TITLE

CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary		
PROJECT No.	1899802/6000	REV.	0

FIGURE **B12**



LEGEND

Borehole:	18-603	w_i = 36%	S_o = 100%	γ = 18.4 kN/m³
Sample:	16	w_f = 30%	e_o = 0.98	G_s = 2.73
Depth (m):	17.3	w_l = 32%	C_c = 0.28	
Elevation (m):	51.4	w_p = 18%	C_r = 0.005	

GOLDER

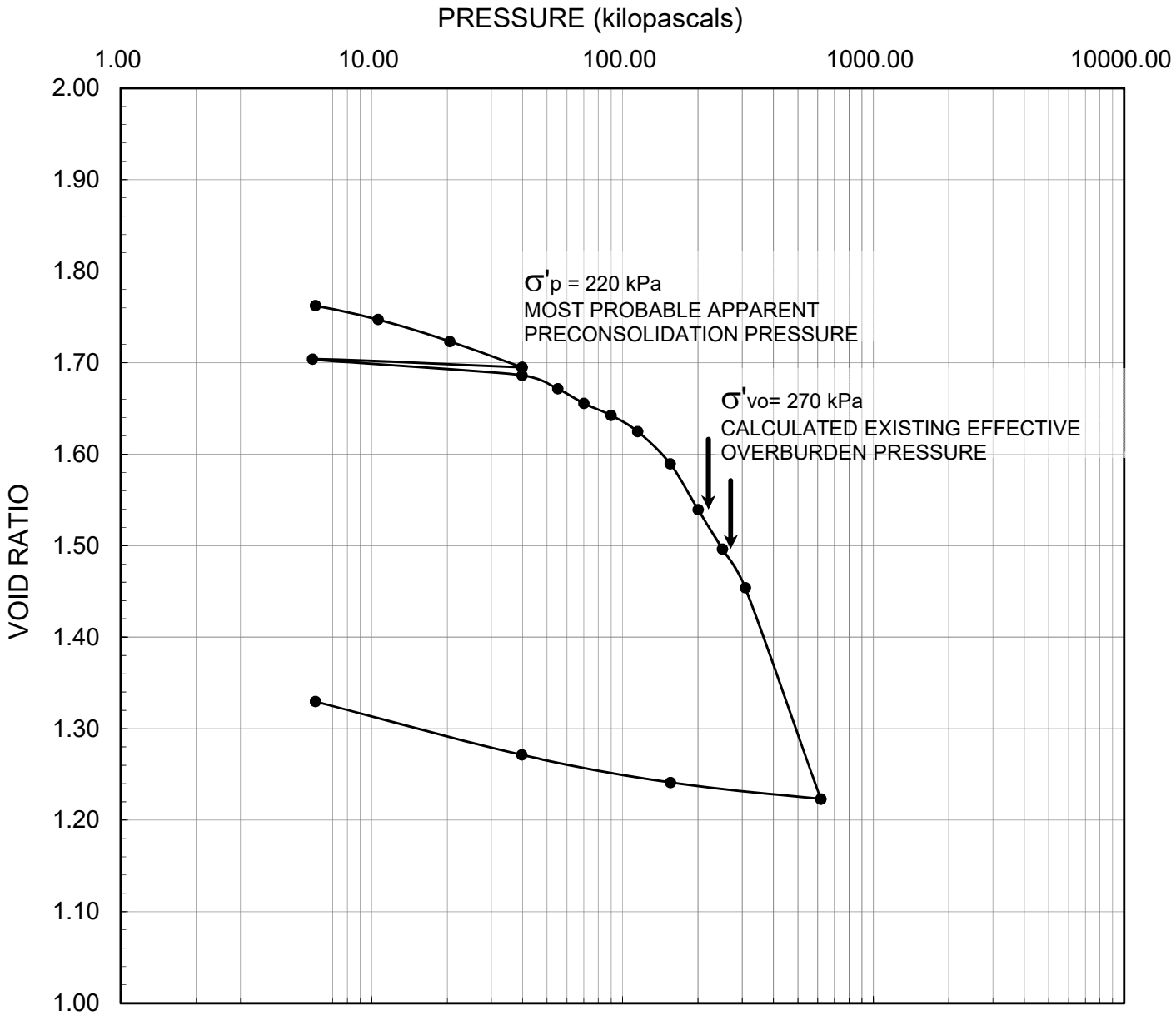
SCALE	AS SHOWN
DATE	03/27/19
CADD	N/A
ENTERED	MI
CHECK	CW
REVIEW	CK

TITLE

CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary		
PROJECT No.	1899802/6000	REV.	0

FIGURE **B13**



LEGEND

Borehole:	18-604	w_i = 63%	S_o = 98%	γ = 16 kN/m³
Sample:	20	w_f = 48%	e_o = 1.78	G_s = 2.78
Depth (m):	23.5	w_l = 46%	C_c = 0.77	
Elevation (m):	45.3	w_p = 25%	C_r = 0.022	

GOLDER

SCALE	AS SHOWN
DATE	03/27/19
CADD	N/A
ENTERED	MI
CHECK	CW
REVIEW	CK

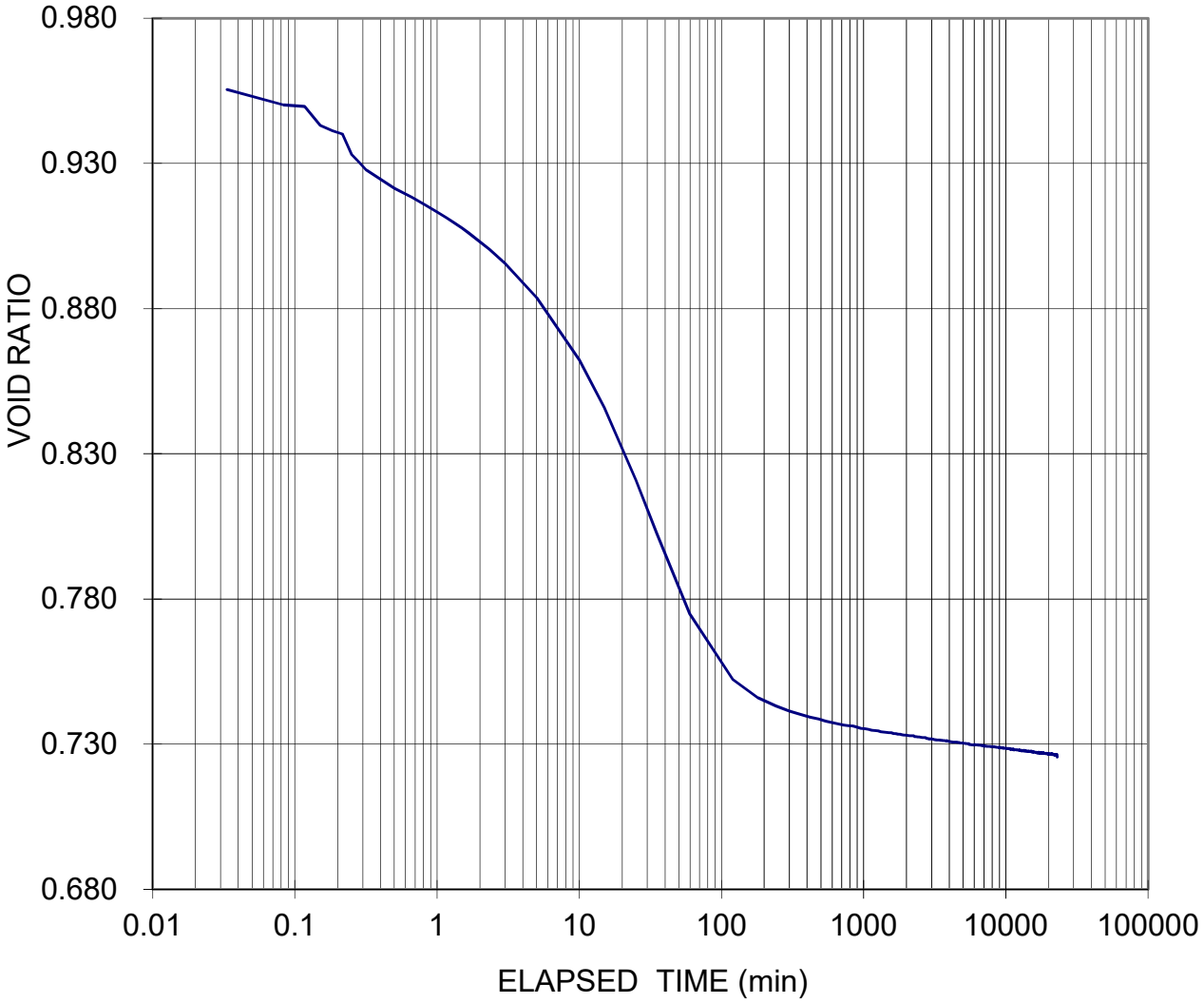
TITLE

CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary		
PROJECT No.	1899802/6000	REV.	0

FIGURE **B14**

PRESSURE = 200 kPa



LEGEND

Borehole:	18-602	w_i = 46%	S_o = 100%
Sample:	18	w_f = 37%	C_α = 0.0096
Depth (m):	21.6	w_l = 38%	
Elevation (m):	47.4	w_p = 18%	

GOLDER

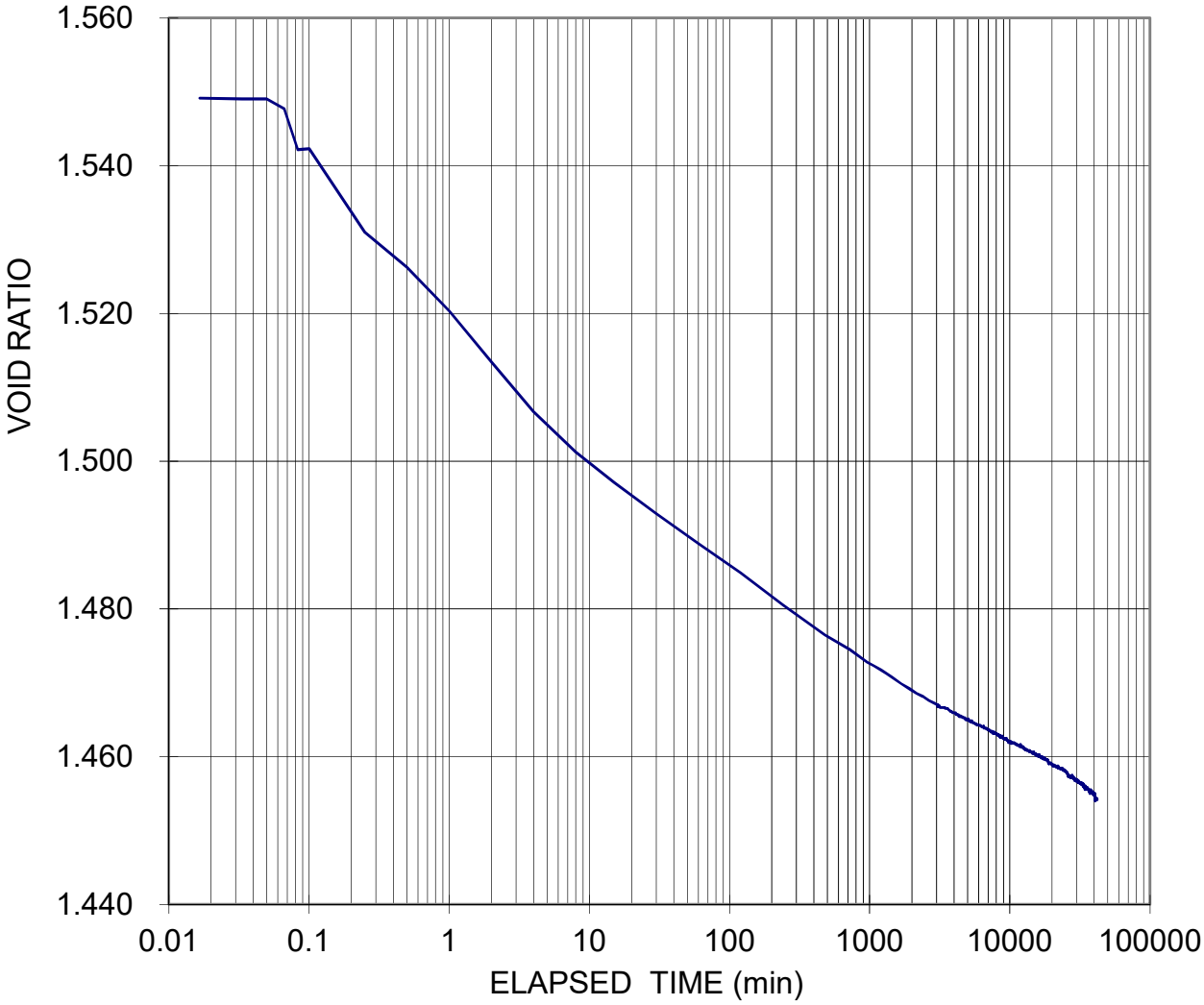
SCALE	AS SHOWN
DATE	1-Apr-19
DESIGN	MI
CHECK	CW
REVIEW	CK

TITLE

SUMMARY OF SECONDARY COMPRESSION TEST

PROJECT No. 1899802/6000 | REV. 0 | FIGURE B15

PRESSURE = 117.28 kPa



LEGEND

Borehole:	18-604	w_i = 54%	S_o = 100%
Sample:	10	w_f = 54%	C_α = 0.0096
Depth (m):	7.9	w_l = 55%	
Elevation (m):	60.9	w_p = 21%	

GOLDER

SCALE	AS SHOWN
DATE	1-Apr-19
DESIGN	MI
CHECK	CW
REVIEW	CK

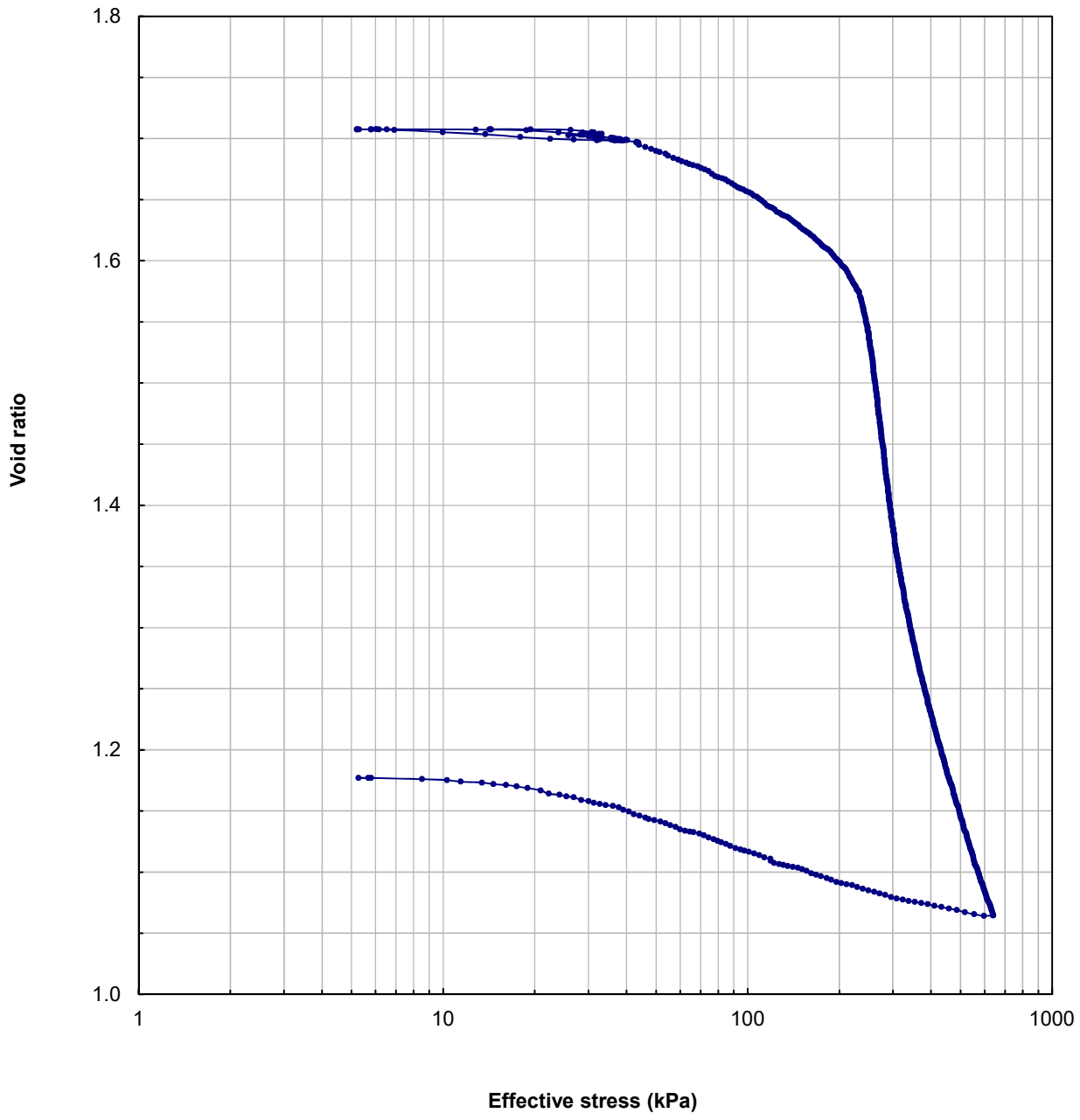
TITLE

SUMMARY OF SECONDARY COMPRESSION TEST

PROJECT No. 1899802/6000 | REV. 0 | FIGURE B16

CRS TEST RESULTS
BOREHOLE 18-601 SAMPLE 15

FIGURE B17

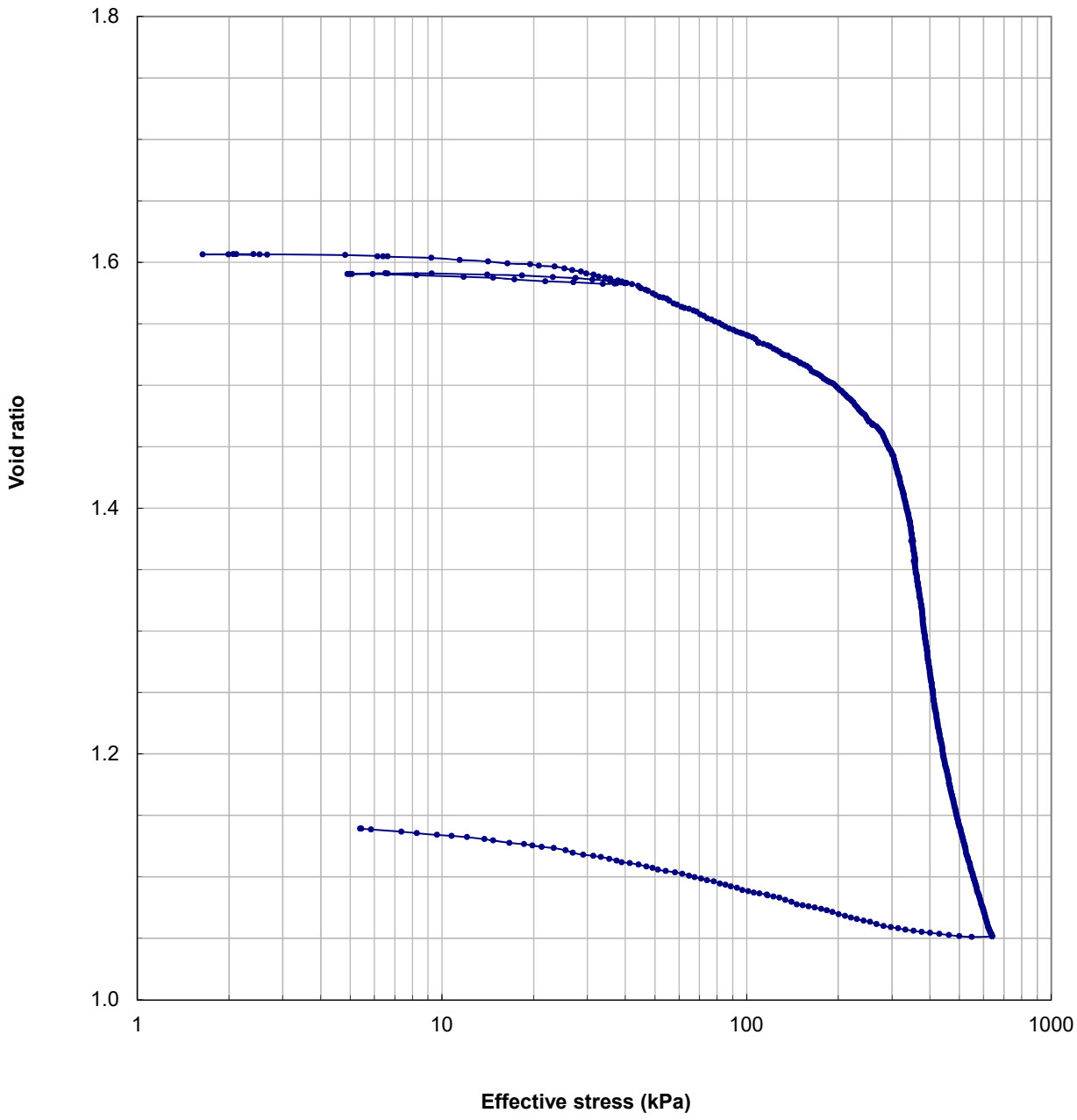


Western Engineering

Civil & Environmental Engineering

CRS TEST RESULTS
BOREHOLE 18-602 SAMPLE 17

FIGURE B18

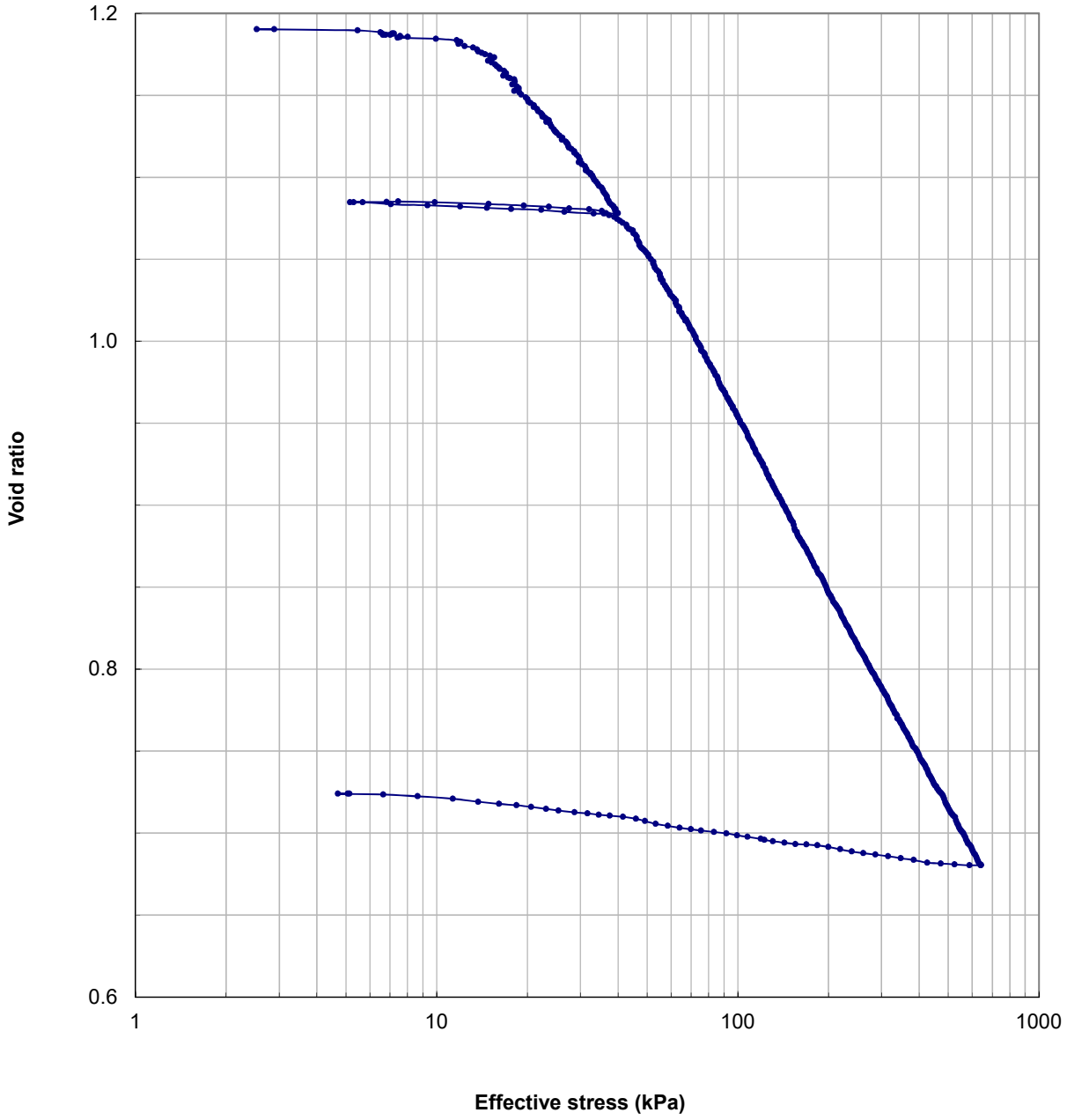


Western Engineering

Civil & Environmental Engineering

CRS TEST RESULTS
BOREHOLE 18-603 SAMPLE 12

FIGURE B19

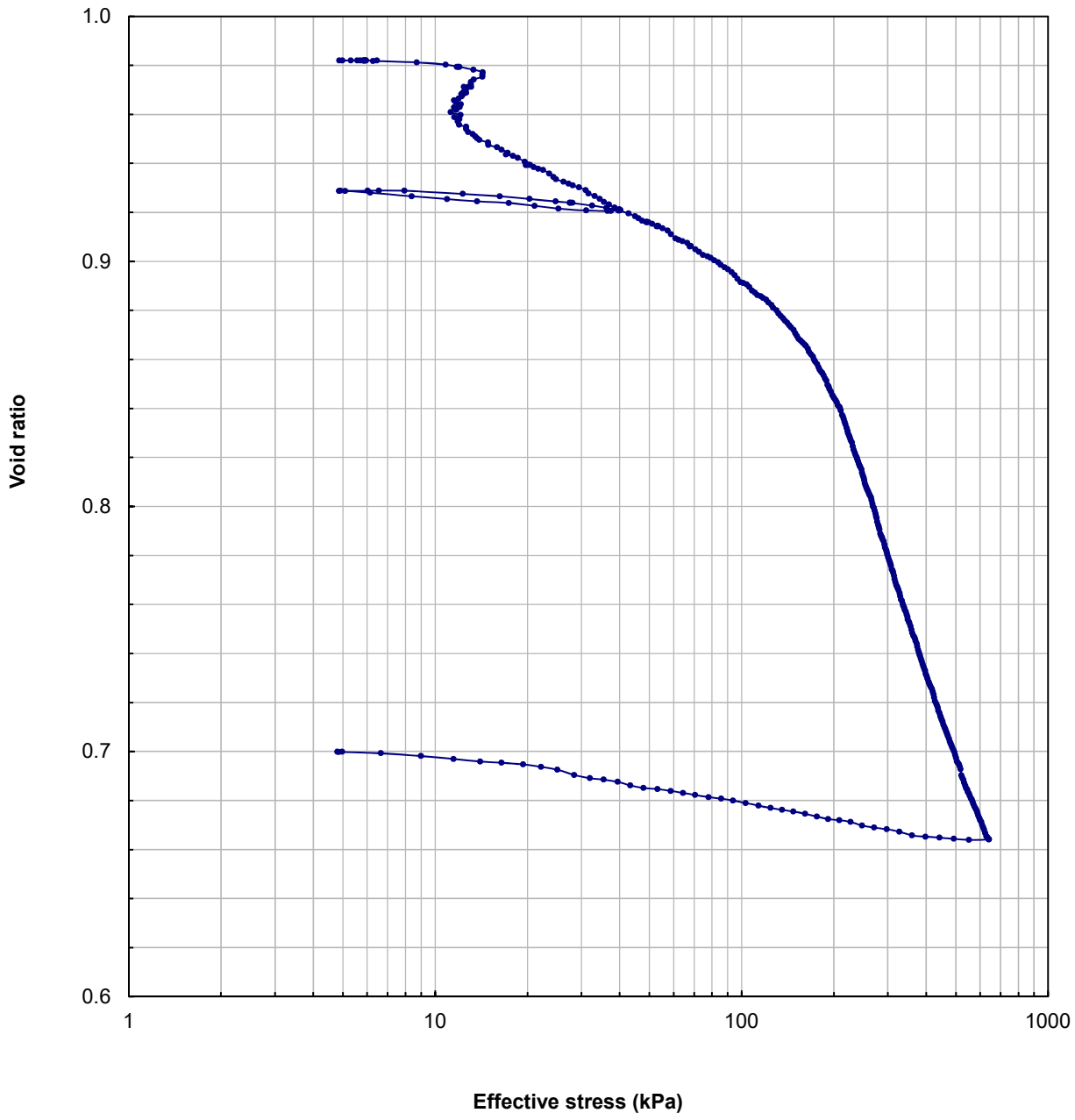


Western Engineering

Civil & Environmental Engineering

CRS TEST RESULTS
BOREHOLE 18-604 SAMPLE 14

FIGURE B20



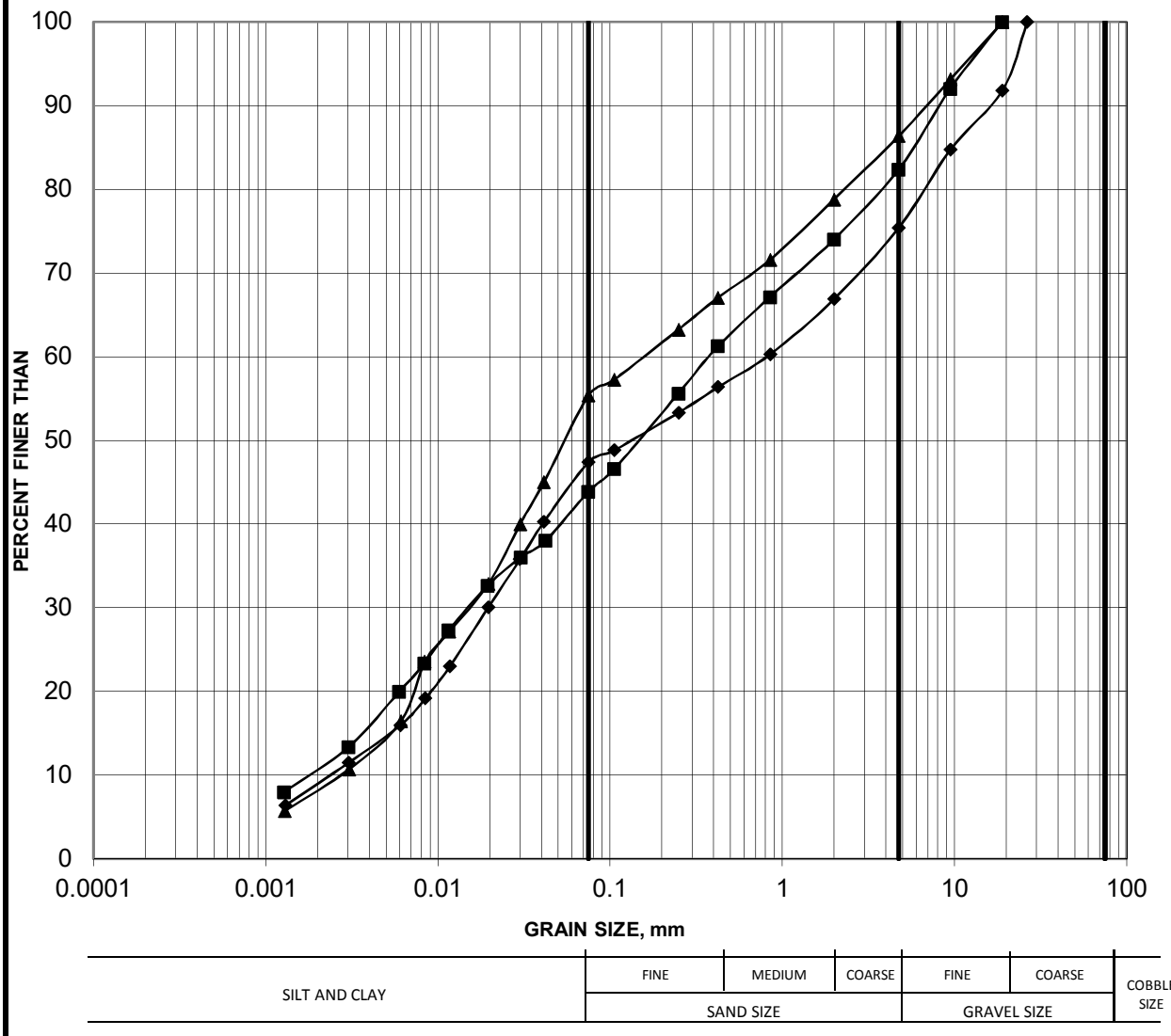
Western Engineering

Civil & Environmental Engineering

GRAIN SIZE DISTRIBUTION

FIGURE B21

GRAVELLY SANDY SILT TO GRAVELLY SILTY SAND (TILL)

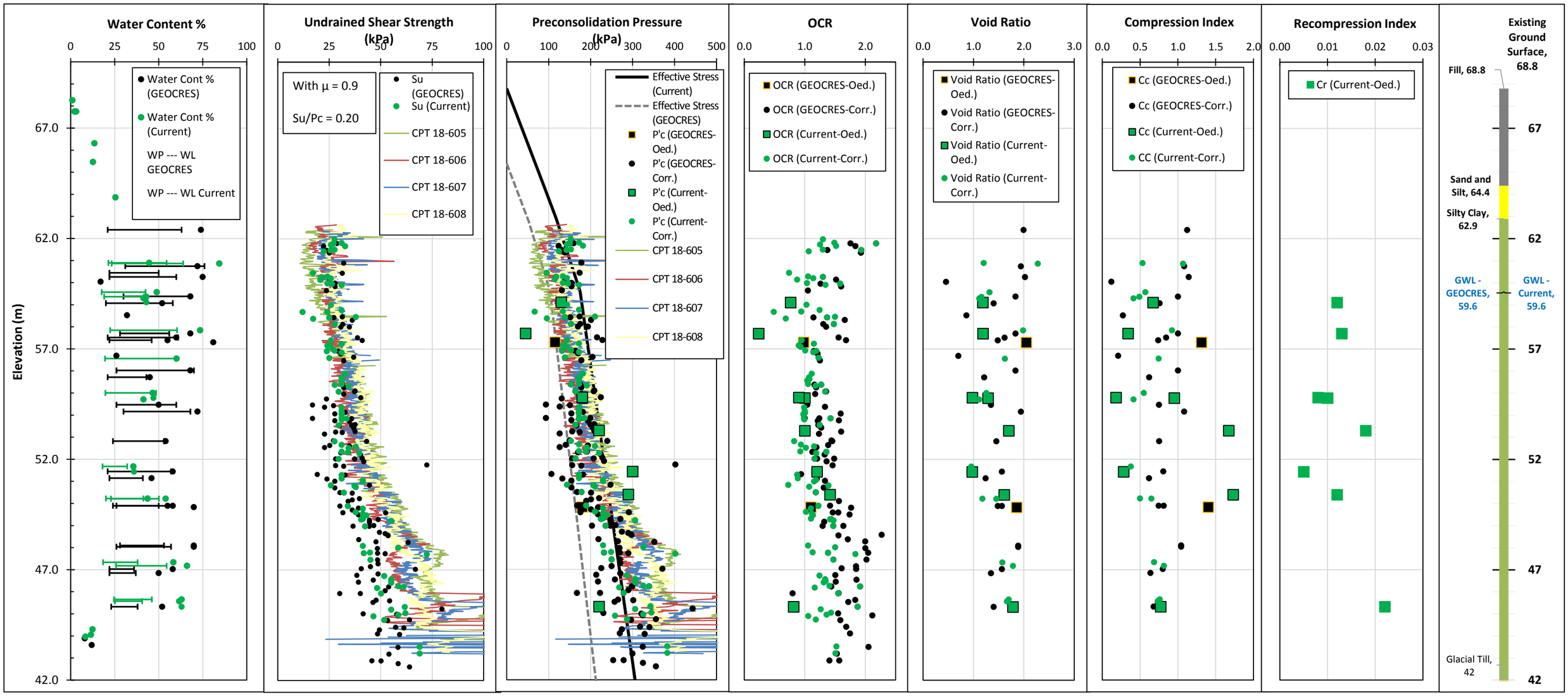


Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
18-601	21B	24.69-24.99	18	38	34	10
18-602	20	24.38-24.99	25	28	39	8
18-603	21	24.38-24.99	14	31	48	7

Project: 1899802/6000

Golder Associates

Created by: MI
Checked by: CW



GOLDER

Foundation Investigation and Design

Improvements to County Road 3 Approaches, Highway 417
United Counties of Presectt and Russell, Ontario

Summary of Engineering Properties

Project No.:	1899802
Date:	March-14-19
Drawn:	RK
Review:	CK

FIGURE B22

APPENDIX C

Borehole Records and Laboratory Test Results – Previous Investigation

(Geocres No. 31G00-045)

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 239 + 80 ℄ EBL Hwy. 417 o/s 25' Lt. ORIGINATED BY HRS
W.P. 35-66-14 BORING DATE January 13, 14 & 22, 1970 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
214.7	Ground Level					
0.0	Topsoil					
1.5	Silty fine sand Compact Brown		1	SS	22	
			2	SS	20	
206.0			3	SS	2	
8.7	Laminated clay (Grey Brown) and silty clay (Grey) with random silt seams (½ - 1" thick) throughout Firm to stiff		4	TW	PM	
			5	TW	PM	
			6	TW	PM	
			7	TW	PM	
			8	TW	PM	
			9	TW	PM	
			10	TW	PM	
			11	TW	PM	
			12	TW	PM	
160±			13	TW	PM	
55±	Stiff Dark Grey with org. mottling. occ. silt layers up to 12" thick		14	TW	PM	
			15	TW	PM	
			16	TW	PM	
140.0						
74.7	Het.mix of silt, sand & gravel with trace of clay (Glacial Till)		17	SS	28	
			18	SS	80/2"	
			19	WS	-	
128.7	Compact - V. Dense					
86.0	Limestone Bedrock Sound		20	AXT	100%	
123.4						
91.3	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS	GR. SA. SI. CL.
	0 58 (42)
Lost TW#4 ▼ 197.0	
	103
lost sample	
no recovery drill with bicone bit	

% STRAIN AT FAILURE

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 240 + 80 ℄ EBL Hwy. 417 o/s 20' Rt. ORIGINATED BY CM
W.P. 35-66-14 BORING DATE January 12 - 13, 1970 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing; Cone CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
204.8	Ground Level					
0.0	Fill Material Silty fine sand with trace of organics.		1	SS	4	200
196.8	Loose. Brown		2	SS	4	
8.0			3	SS	6	
	Laminated clay to silty clay					190
						180
						170
						160
						150
139.8						140
65.0	Het.mix.of silt,sand & gravel with trace to some clay (Glacial Till)		4	SS	10	
131.8	Loose - Very dense		5	SS	53	
73.0	Limestone Bedrock					130
127.8	Sound		6	AXT	94%	
77.0	End of Borehole					120

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

0 74 (26)

▼ 192.0

Washed ahea through clay stratum

44 39 (17)

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 241 + 40 ℄ EBL Hwy. 417 o/s 25' Lt. ORIGINATED BY HS

W.P. 35-66-14 BORING DATE January 13 - 15 & 20 - 21, 1970 COMPILED BY CM

DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT
204.4	Ground Level				
0.0	Fill Material				
	Silty fine sand with trace of gravel		1	SS	8
			2	SS	5
	Loose		3	SS	6
	Brown		4	SS	6
188.0			5	SS	4
16.4	Silty fine sand with trace of clay & org. matter.		6	SS	6
182.4	Loose. Grey		7	SS	9
22.0			8	SS	1
	Laminated clay to silty clay				
	Firm to stiff				
144.4			9	SS	33
60.0	Het.mix. of silt, sand & gravel with trace of clay (Glacial Till)		10	SS	48
	Dense to very dense				
133.0	Grey		11	AXT	60%
71.4	Limestone Bedrock				
128.0	Sound		13	AXT	100%
76.4	End of Borehole				

ELEV. SCALE: 200, 190, 180, 170, 160, 150, 140, 130, 120

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS GR. SA. SI. CL.

2 54 (44)

▼ 188.4

0 61 (39)

24 43 28 5

20
15 ◇ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 243 + 00 ℄ EBL Hwy. 417 o/s 20' Lt. ORIGINATED BY HRS
W.P. 35-66-14 BORING DATE January 9, 12, 13 & 27, 1970 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
214.7	Ground Level				
0.0	Topsoil				
1.0	Silty fine sand Compact to dense Brown		1	SS	38
206.2			2	SS	21
8.5	Laminated clay (grey brown) and silty clay (grey) with random silt seams (½ - 2" thick) throughout. Firm to stiff		3	TW	PM
			4	TW	PM
			5	TW	PM
			6	TW	PM
			7	TW	PM
			8	TW	PM
			9	TW	PM
			10	TW	PM
160±					
55±	Dark grey with organic mottling. Occ. silt layers up to 12" thick.		11	TW	PM
143.2			12	TW	PM
			13	SS	80
71.5	Het. mix. of silt, sand & gravel with some clay (Glacial Till) Very dense. Grey				
136.2					
78.5	Limestone Bedrock Sound				
130.2					
84.5	End of Borehole				

ELEV. SCALE: 210, 200, 190, 180, 170, 160, 150, 140, 130

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F. — ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE — 400 800 1200 1600 2000

LIQUID LIMIT w_L — PLASTIC LIMIT w_p — WATER CONTENT w — WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.: 98; 102; 106

REMARKS: GR. SA. SI. CL.

▼ 195.7

Lost TW sample
18 59 22 10

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 242 + 50 ℄ WBL Hwy. 417 O/S 30' Rt. ORIGINATED BY CM
W.P. 35-66-14 BORING DATE January 7 - 13, 1970 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing; Cone CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
214.3	Ground Level					
0.0	Topsoil					
1.0	Silty fine sand to fine sandy silt Compact. Brown		1	SS	20	
205.8			2	SS	13	
8.5	Laminated clay (grey-brown) and silty clay (grey) with random silt seams (½-1" thick) throughout. Firm to stiff		3	TW	PM	
			4	TW	PM	
			5	TW	PM	
			6	TW	PM	
			7	TW	PM	
			8	TW	PM	
			9	TW	PM	
			10	TW	PM	
160±						
54±	Stiff Dark grey with organic mottling. occ. silt & fine sand layers 6-12" thick		11	SS	8	
			12	TW	PM	
143.3			13	TW	PM	
71.0	Het.mix.of silt,sand & gravel with trace of clay (Glacial Till) Compact to dense		14	SS	11	
			15	SS	15	
			16	SS	45	
128.3			17	AXT	44%	
86.0	Limestone Bedrock Sound		18	AXT	100%	
121.9						
92.4	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000
LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
	0 36 (64)
99	
102	▼188.0
101	
	lost TW sample
	9 27 20 4

20
15 ÷ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 243 + 30 WBL Hwy. 417 o/s 20' Lt. ORIGINATED BY HS

W.P. 35-66-14 BORING DATE January 16, 19 -20, 1970 COMPILED BY GM

DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing; Cone CHECKED BY JK

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
188.6	Ground Level				
0.0	With some sand & trace of organics mottled brown-grey		1	SS	6
183.6			2	TW	PM
5.0	Laminated clay (Grey brown) and silty clay (grey) with random silt seams (½-1" thick) throughout		3	TW	PM
			4	TW	PM
			4A	SS	-
	Firm to stiff				
160±					
29±	Dark grey with org. mottling; occ. silt layers 6-12" thick		5	TW	PM
			6	TW	PM
143.6	Stiff				
45.0	Het.mix. of silt, sand & gravel with trace to some clay		7	SS	23
			8	SS	65
	Compact to very dense Grey		9	SS	105
128.9					
59.7	Limestone Bedrock		10	AXT	95%
124.1	Sound				
64.5	End of Borehole				

ELEV. SCALE: 180, 170, 160, 150, 140, 130, 120

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F. — ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE — 400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w

WATER CONTENT % — 20 40 60

BULK DENSITY γ P.C.F.: 98

REMARKS: ▼185.3

GR. SA. SI. CL.

20
13 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 24+00 ℄ WBL Hwy. 417 o/s 35' Rt. ORIGINATED BY HRS
W.P. 35-66-14 BORING DATE January 15 - 20, 1970 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring-NX & BX Casing; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
203.7	Ground Level				
0.0	Fill Material				
	Fine sand with trace of silt and gravel		1	SS	18
			2	SS	2
			3	SS	4
	Very loose to compact		4	SS	6
187.7			5	SS	4
16.0	Silty fine sand with some clay & organic matter.		6	SS	5
			7	SS	5
179.7	Loose. Grey				
24.0	Clay to silty clay		8	TW	PM
	Firm to stiff				
	Grey brown to grey				
140.2					
63.5	Het.mix.of silt,sand & gravel with trace to some clay.		9	SS	19
			10	SS	142
	Compact to very dense				
129.7	Grey				
74.0	Limestone Bedrock		11	AXT	100%
124.2	Sound				
79.5	End of Borehole				

ELEV. SCALE: 200, 190, 180, 170, 160, 150, 140, 130

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P — w — w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

▼ 188.0

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 70-F-2 LOCATION Sta. 24+87 ℄ WBL Hwy. 417 o/s 28' Lt. ORIGINATED BY HRS
W.P. 35-66-14 BORING DATE January 6 - 8, 1970 COMPILED BY GM
DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing; Cone CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
203.8	Ground Level					
0.0	Silty fine sand					
200.3	Brown		1	TW	PM	200
3.5	Laminated clay (Grey-Brown) and silty clay (Brown) with random silt seams (½-1" thick throughout)		2	TW	PM	
			3	TW	PM	190
			4	TW	PM	
	Firm to stiff		5	TW	PM	180
			6	TW	PM	
			7	TW	PM	170
			8	TW	PM	
160±						160
44±	Stiff Dark Grey with org. mottling occ. silt layers 4 - 8" thick		9	TW	PM	
			10	TW	PM	
144.3			11	TW	PM	150
59.5	Het.mix.of silt, sand and gravel with trace of clay (glacial Till) Compact to very dense Grey		12	SS	15	
			13	SS	44	140
132.3			14	SS	130/4"	
71.5	Limestone Bedrock Sound		15	AXT	100%	
125.3			16	AXT	100%	130
78.5	End of Borehole					
						120

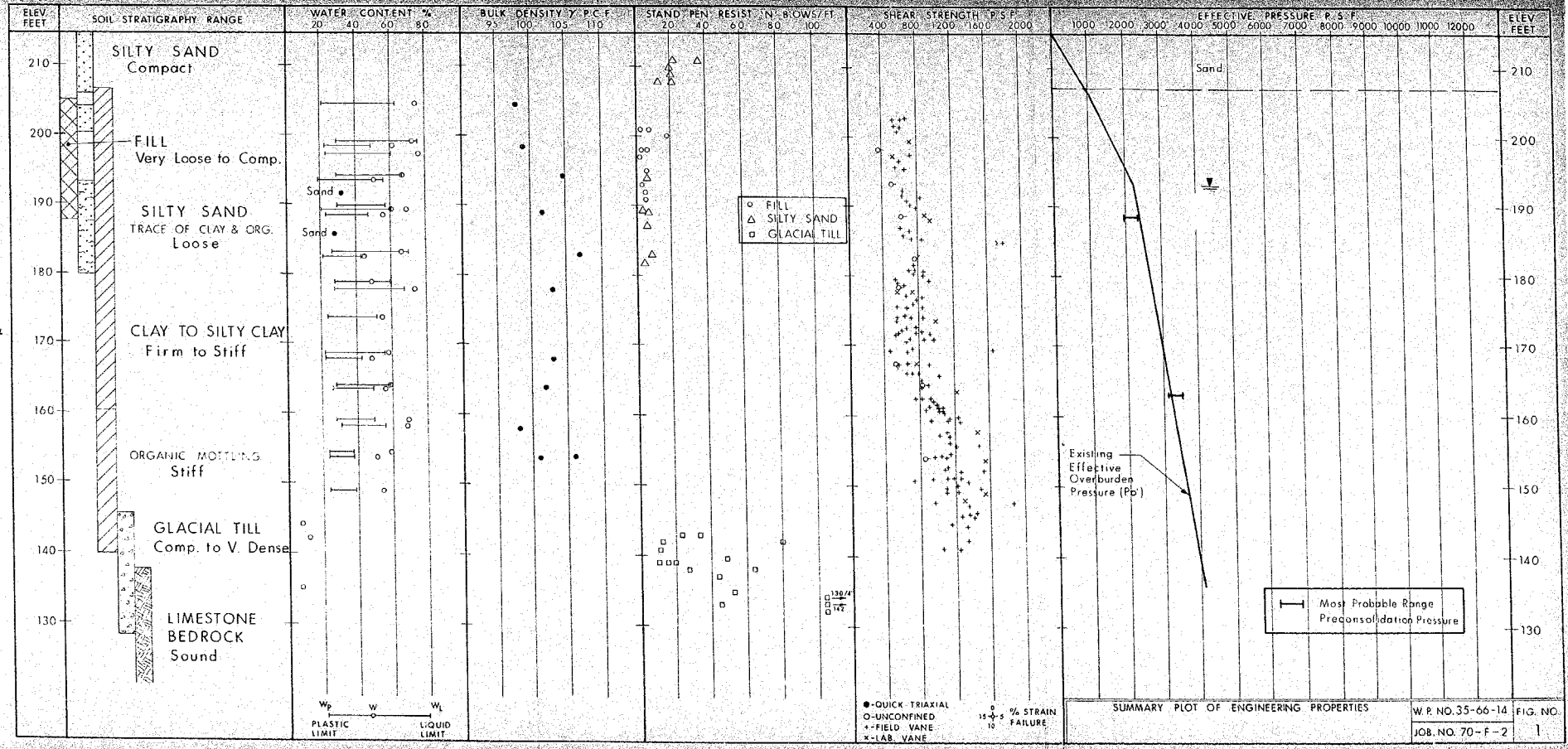
DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
WATER CONTENT %
20 40 60

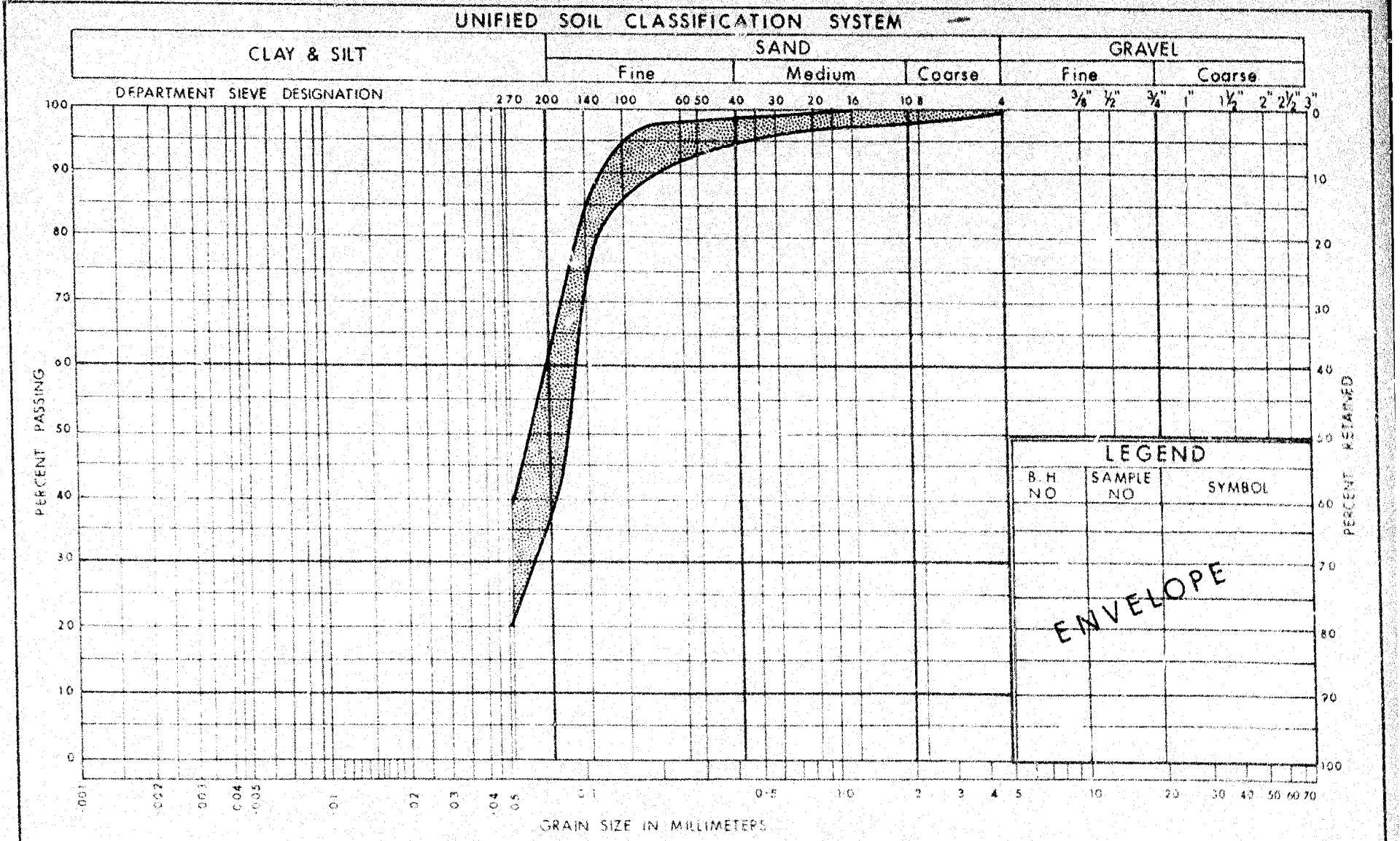
BULK DENSITY γ P.C.F.

BULK DENSITY	REMARKS GR.SA.SI.CL.
	▼ 195.8
105	
107	
103	
	52 32 12 4
	22 39 35 4

15 20 10 5 % STRAIN AT FAILURE


ELEV. FEET
SOIL STRATIGRAPHY RANGE
WATER CONTENT %
BULK DENSITY γ P.C.F.
STAND. PEN. RESIST. N BLOWS/FT.
SHEAR STRENGTH P.S.F.
EFFECTIVE PRESSURE P.S.F.
SILTY SAND
Compact
FILL
Very Loose to Comp.
SILTY SAND
TRACE OF CLAY & ORG.
Loose
CLAY TO SILTY CLAY
Firm to Stiff
ORGANIC MOTTLING
Stiff
GLACIAL TILL
Comp. to V. Dense
LIMESTONE
BEDROCK
Sound
Sand
Sand
FILL
SILTY SAND
GLACIAL TILL
Existing
Effective
Overburden
Pressure (Po')
Most Probable Range
Preconsolidation Pressure
PLASTIC LIMIT
LIQUID LIMIT
●-QUICK TRIAXIAL
O-UNCONFINED
+-FIELD VANE
×-LAB. VANE
% STRAIN
FAILURE
SUMMARY PLOT OF ENGINEERING PROPERTIES
W.P. NO. 35-66-14
JOB. NO. 70-F-2
FIG. NO. 1

FORM 08 MT-17
REV APR 1965

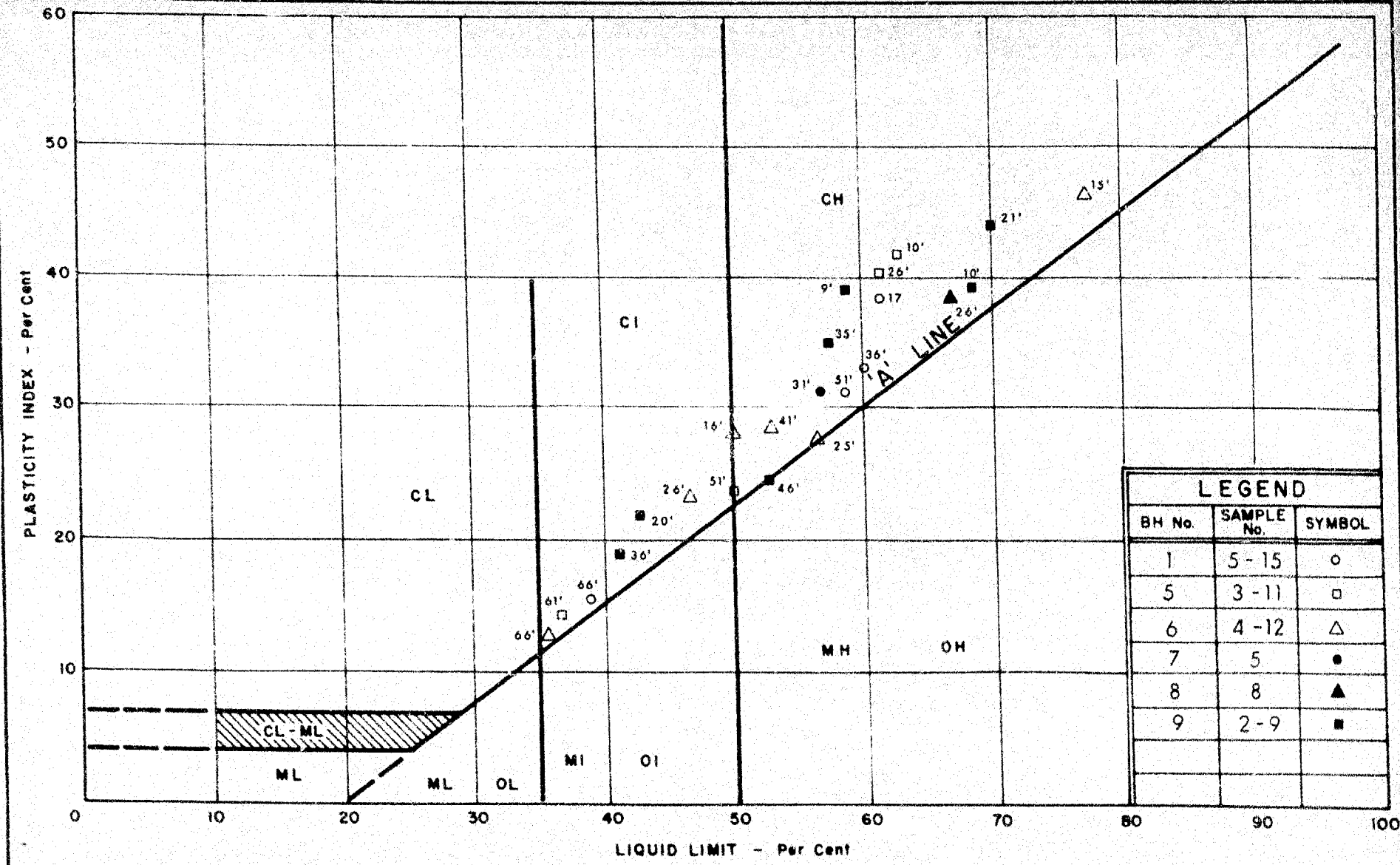


DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION
SILTY FINE SAND

W.P No. 35-66-14
JOB No. 70-F-2
Fig. 2

FORM OB-MT-252
REVISED JUL[illegible] 1966



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

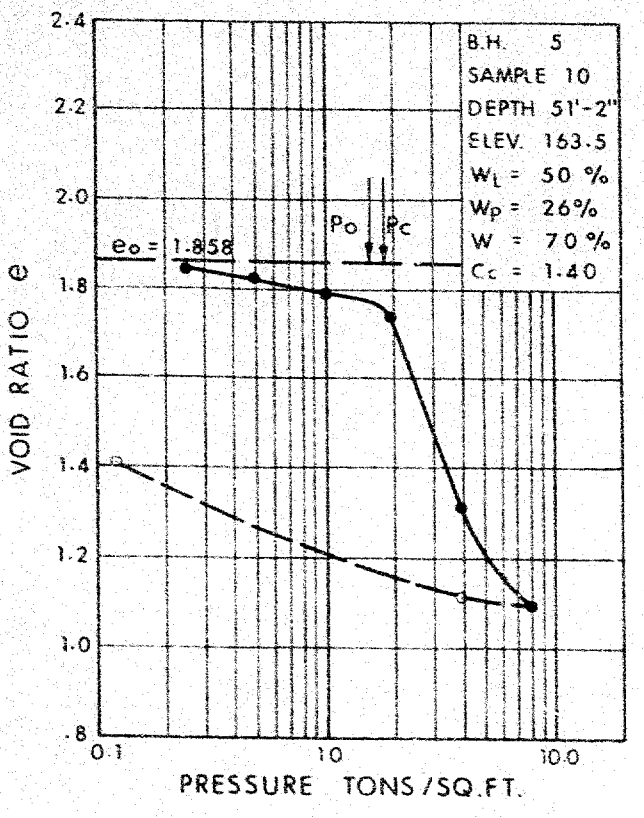
PLASTICITY CHART

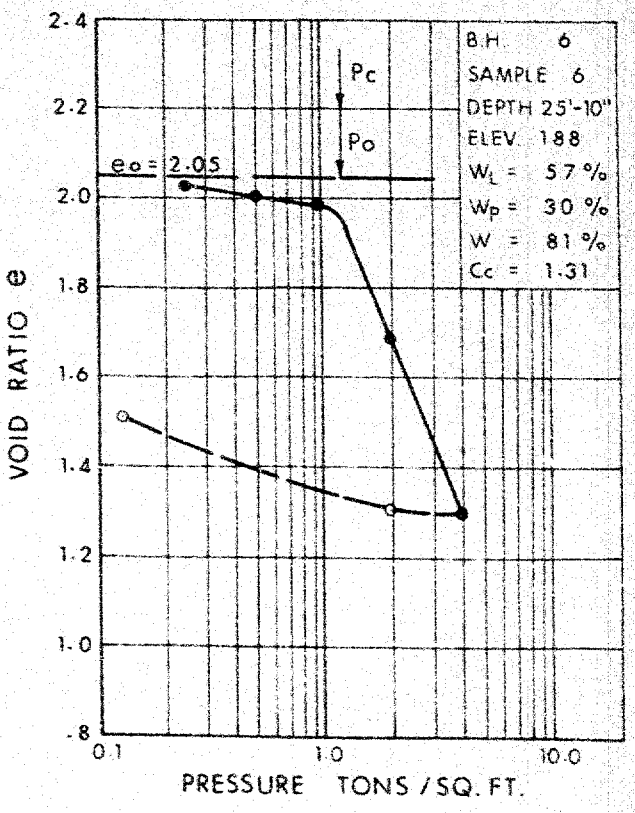
CLAY TO SILTY CLAY

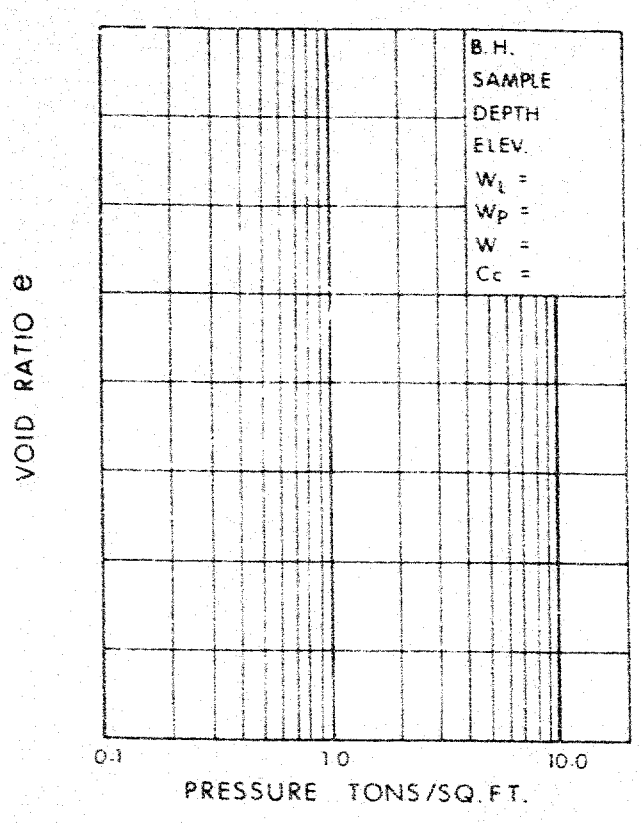
W.P. No. 35 - 66 - 14
JOB No. 70 - F - 2
FIG. NO. 3

VOID RATIO – PRESSURE CURVES

JOB NO. 70 – F – 2







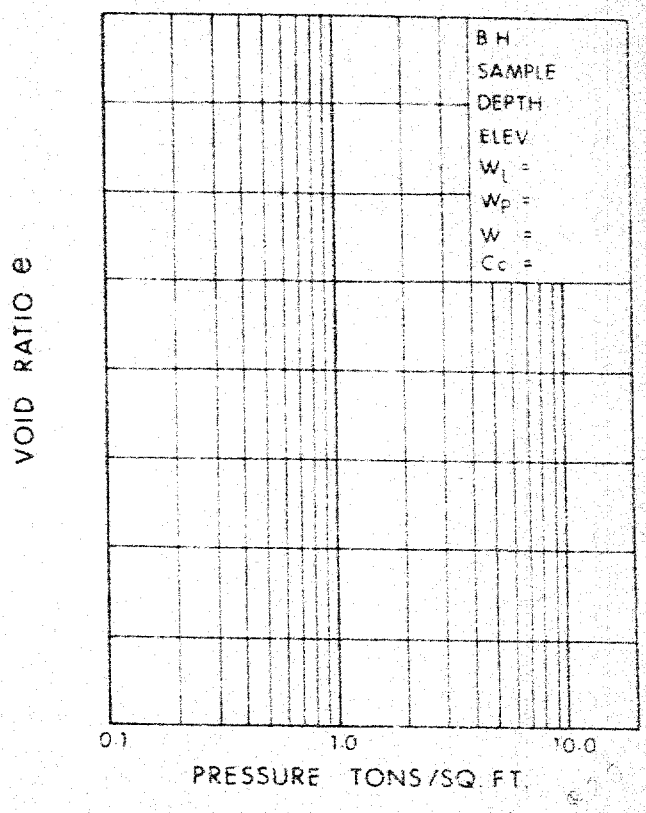
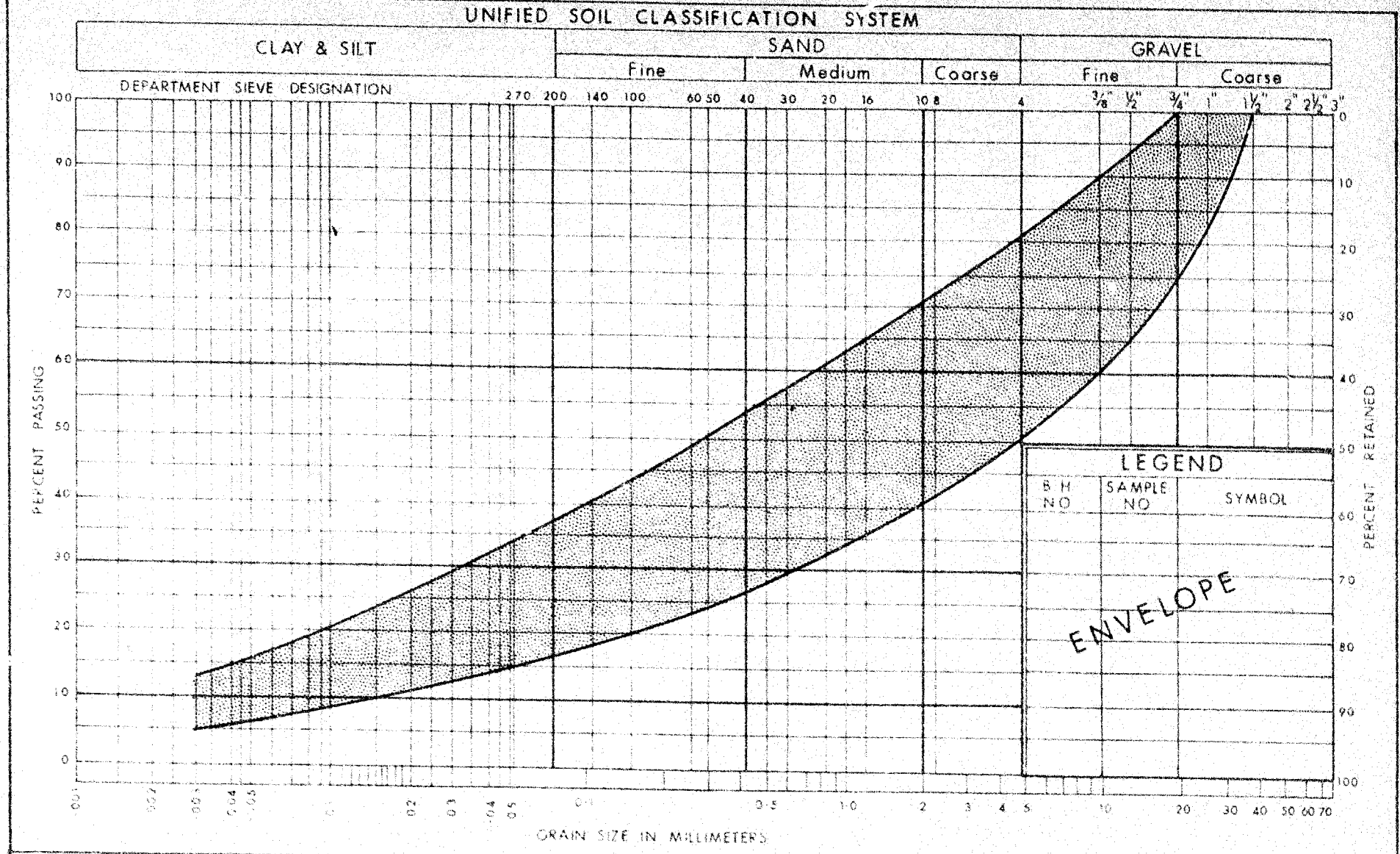


FIG. 4

FORM. OB MT- 17
REV. APR. 1965



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION
GLACIAL TILL

WP No. 35 – 66 – 14
JOB No. 70 – F – 2
Fig 5

APPENDIX D

ConTec Investigation Report

CPT Report for CPT 18-605 to CPT 18-608

PRESENTATION OF SITE INVESTIGATION RESULTS

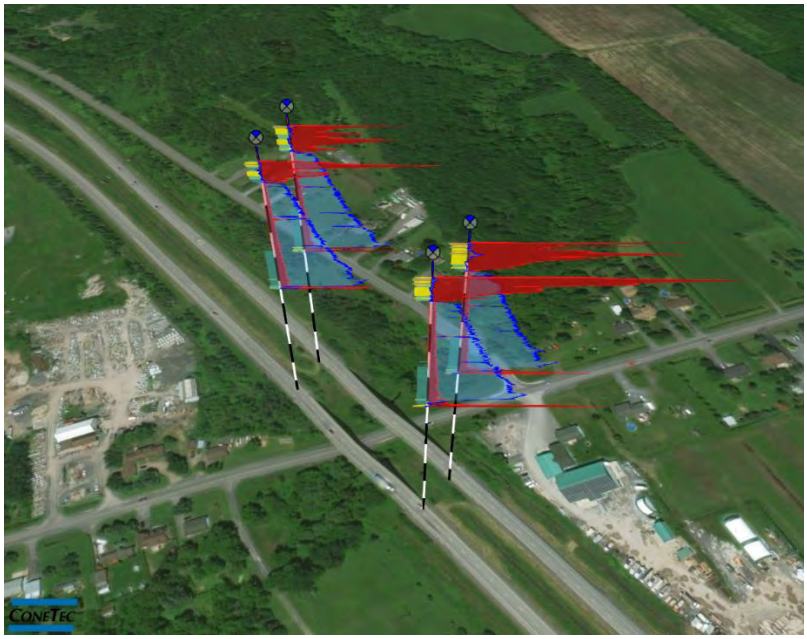
Highway 417 Overpass County Road 3

Prepared for:

Golder Associates

ConeTec Job No: 18-05082

Project Start Date: 12-Dec-2018
Project End Date: 15-Dec-2018
Report Date: 21-Dec-2018



Prepared by:

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Toll Free: (800) 504-1116

Email: conetecon@conetec.com
www.conetec.com
www.conetecdataservices.com

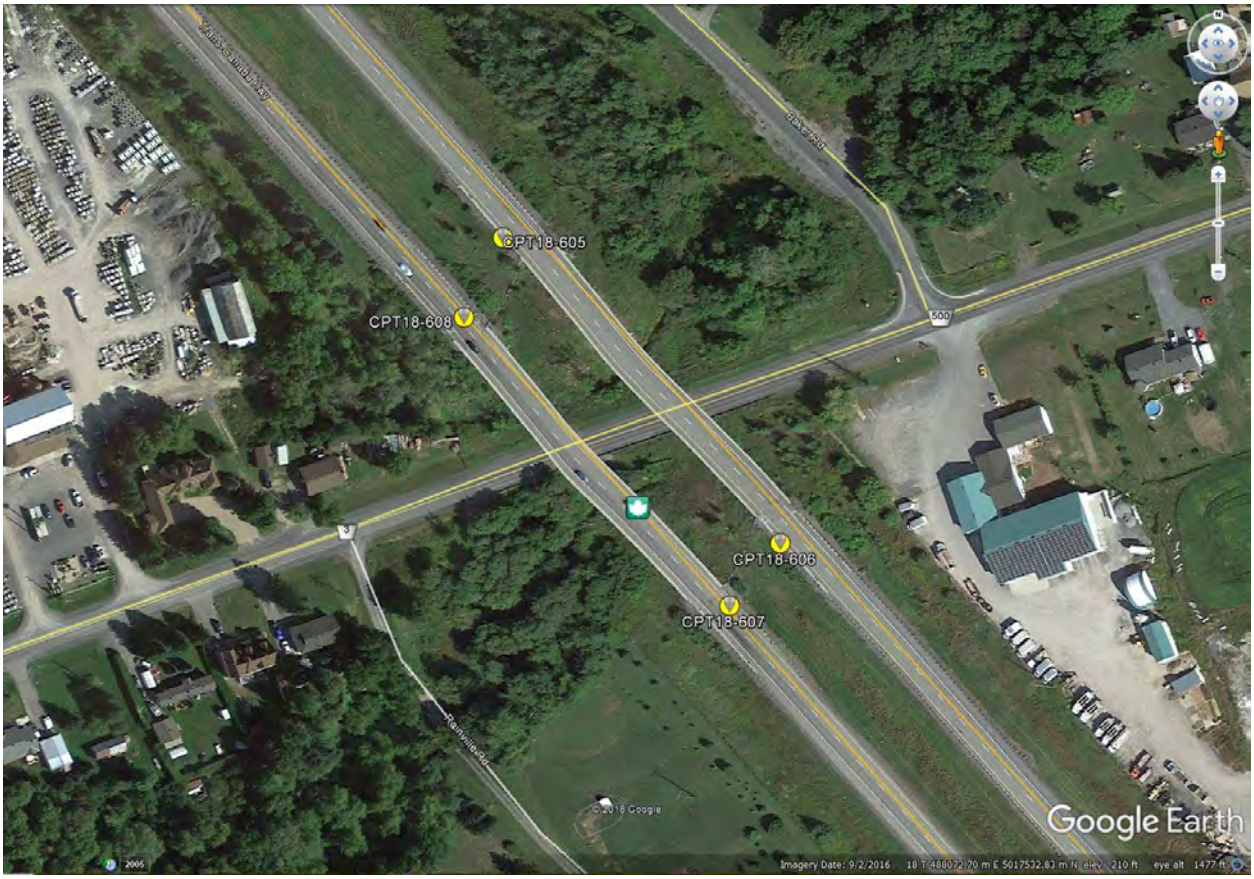
Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Golder Associates at Trans-Canada Hwy and Rte 500 W, Casselman, ON. The program consisted of 4 cone penetration tests (CPT).

Project Information

Project	
Client	Golder Associates
Project	Highway 417 Overpass at County Road 3
ConeTec project number	18-05082

An image from Google Earth including the CPT test locations is presented below.



Rig Description	Deployment System	Test Type
CPT truck rig (C-3)	20 ton rig cylinder	CPT

Coordinates		
Test Type	Collection Method	EPSG Reference
CPT	Consumer Grade GPS	32618

Cone Penetration Test (CPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	Standard Plots with Expanded Scales, Advanced Plots, and Soil Behaviour Type (SBT) Scatter Plots are included in the release files.

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
408:T1500F15U500	408	15	225	1500	15	500
Cone 408 was used for all CPT soundings.						

Calculated Geotechnical Parameter Tables	
Additional information	The Normalized Soil Behaviour Type Chart based on Q_{tn} (SBT Q_{tn}) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPT parameters have been generated and are provided in Excel format files in the release folder. The CPT parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s) and pore pressure (u_2). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behaviour type zones and the assumed equilibrium pore pressure profile. Soils were classified as either drained or undrained based on the Q_{tn} Normalized Soil Behavior Type Chart (Robertson, 2009). Calculations for both drained and undrained parameters were included for materials that classified as silt mixtures (Zone 4).

Limitations

This report has been prepared for the exclusive use of Golder Associates (Client) for the project titled "Highway 417 Overpass at County Road 3". The report's contents may not be relied upon by any other party without the express written permission of ConeTec Investigations Ltd. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

Cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd., a subsidiary of ConeTec.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in 5 cm^2, 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

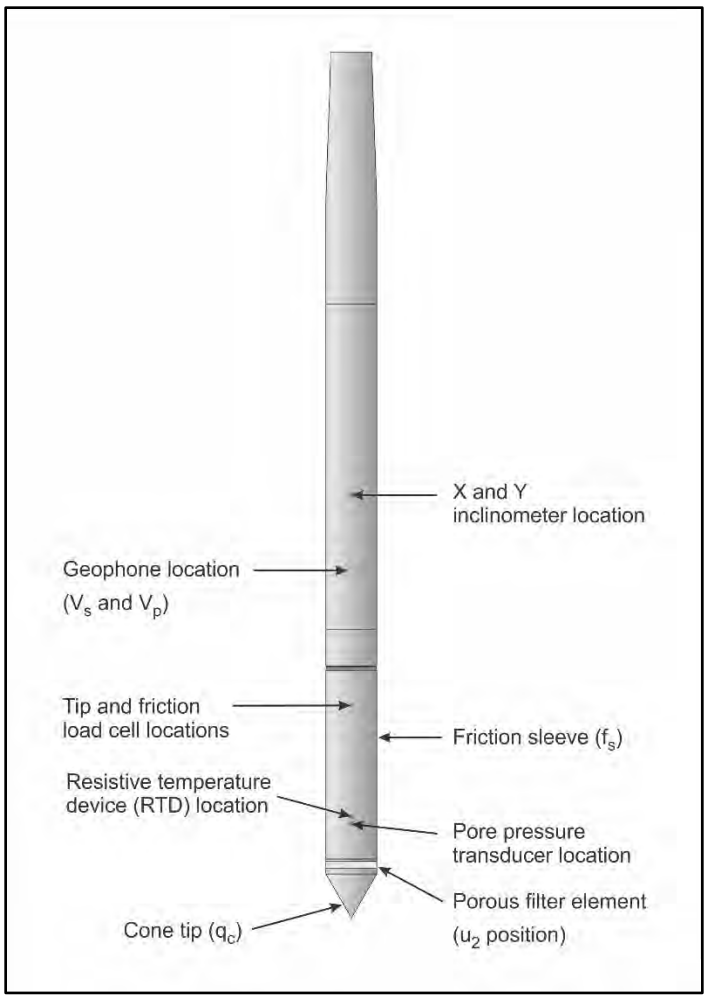


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording interval is 2.5 cm; custom recording intervals are possible.

The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerine or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 38.1 mm are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson et al. (1986) and Robertson (1990, 2009). It should be noted that it is not always possible to accurately identify a soil behaviour type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behaviour type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al. (1986):

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

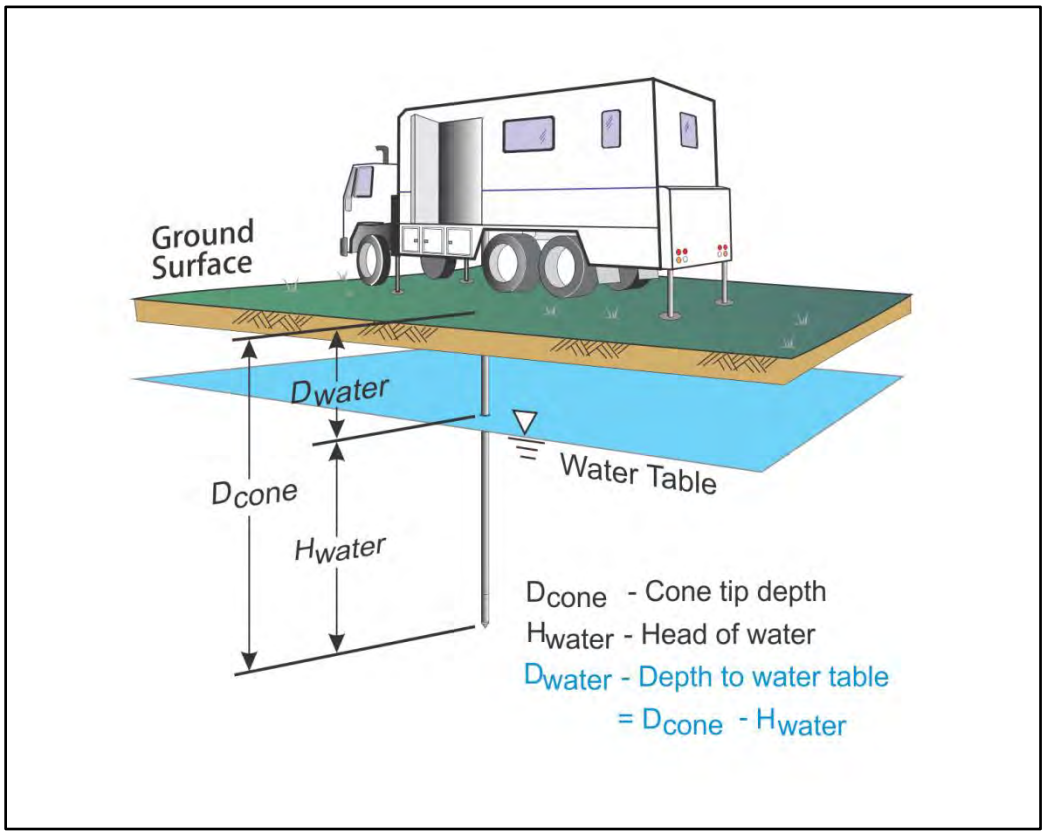


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behaviour.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

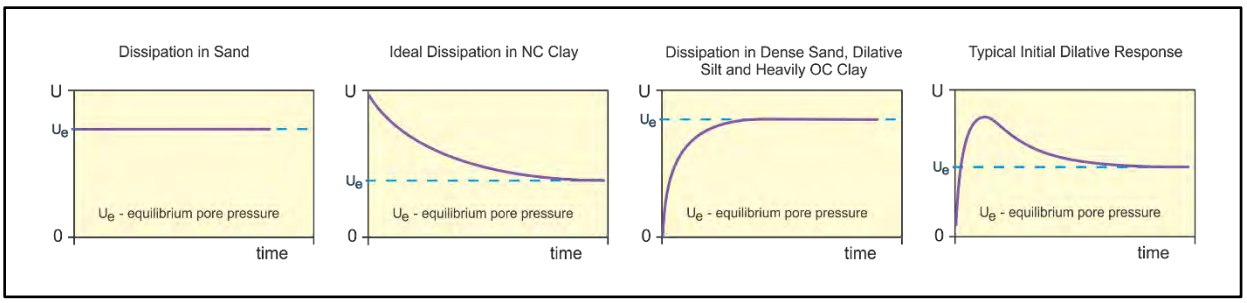


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve in Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby (1991))

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby (1991)), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Burns, S.E. and Mayne, P.W., 1998, "Monotonic and dilatory pore pressure decay during piezocone tests", Canadian Geotechnical Journal 26 (4): 1063-1073.

Burns, S.E. and Mayne, P.W., 2002, "Analytical cavity expansion-critical state model cone dissipation in fine-grained soils", Soils & Foundations, Vol. 42(2): 131-137.

Jones, G.A. and Van Zyl, D.J.A., 1981, "The piezometer probe: a useful investigation tool", Proceedings, 10th International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, "Cone Penetration Testing in Geotechnical Practice", Blackie Academic and Professional.

Mayne, P.W., 2013, "Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests", Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420.

Mayne, P.W., 2014, "Interpretation of geotechnical parameters from seismic piezocone tests", CPT'14 Keynote Address, Las Vegas, NV, May 2014.

Mayne, P.W. and Peuchen, J., 2012, "Unit weight trends with cone resistance in soft to firm clays", Geotechnical and Geophysical Site Characterization *4,* Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27: 151-158.

Robertson, P.K., 2009, "Interpretation of cone penetration tests – a unified approach", Canadian Geotechnical Journal, Volume 46: 1337-1355.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, "Estimating coefficient of consolidation from piezocone tests", Canadian Geotechnical Journal, 29(4): 551-557.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, "An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils", Canadian Geotechnical Journal, 36(2): 369-381.

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Standard Cone Penetration Test Plots with Expanded Scales
- Advanced Cone Penetration Test Plots with Ic, Su(Nkt), OCR and N1(60)Ic
- Soil Behaviour Type (SBT) Scatter Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and Standard Cone Penetration Test Plots

Job No:	18-05082
Client:	Golder Associates
Project:	Highway 417 Overpass at County Road 3
Start Date:	12-Dec-2018
End Date:	15-Dec-2018

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting (m)	Refer to Notation Number
CPT18-605	18-05082_CP605	13-Dec-2018	408:T1500F15U500	6.5	25.550	5017523	488039	
CPT18-606	18-05082_CP606	12-Dec-2018	408:T1500F15U500	6.5	25.550	5017415	488137	
CPT18-607	18-05082_CP607	15-Dec-2018	408:T1500F15U500	6.6	26.175	5017393	488119	
CPT18-608	18-05082_CP608	15-Dec-2018	408:T1500F15U500	6.2	26.675	5017495	488025	

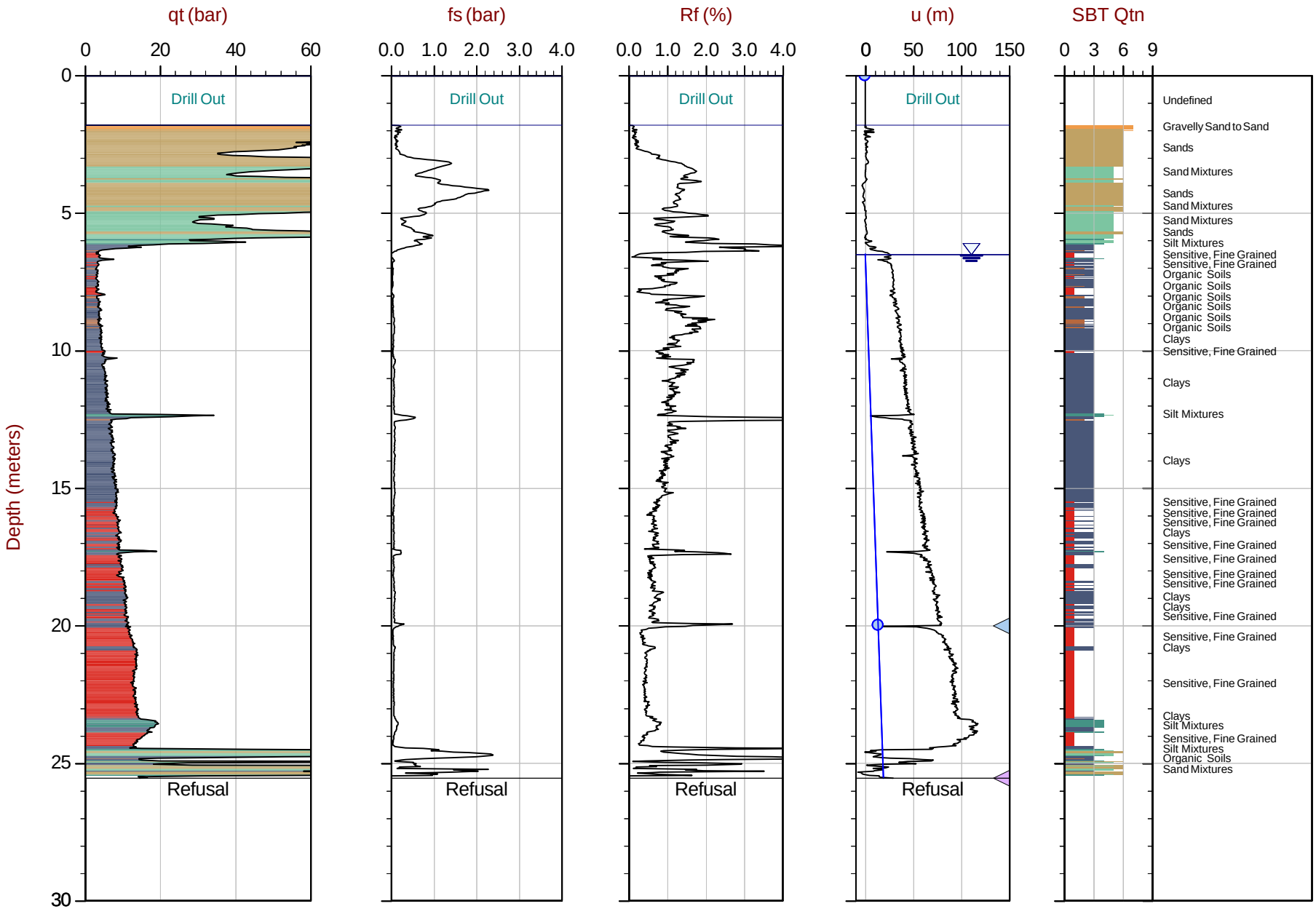
1. The phreatic surface was estimated based on the dynamic pore pressure response. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were acquired based on Google Earth imagery, datum WGS84/UTM 18 North.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-13 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP605.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017523 m E: 488039 m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

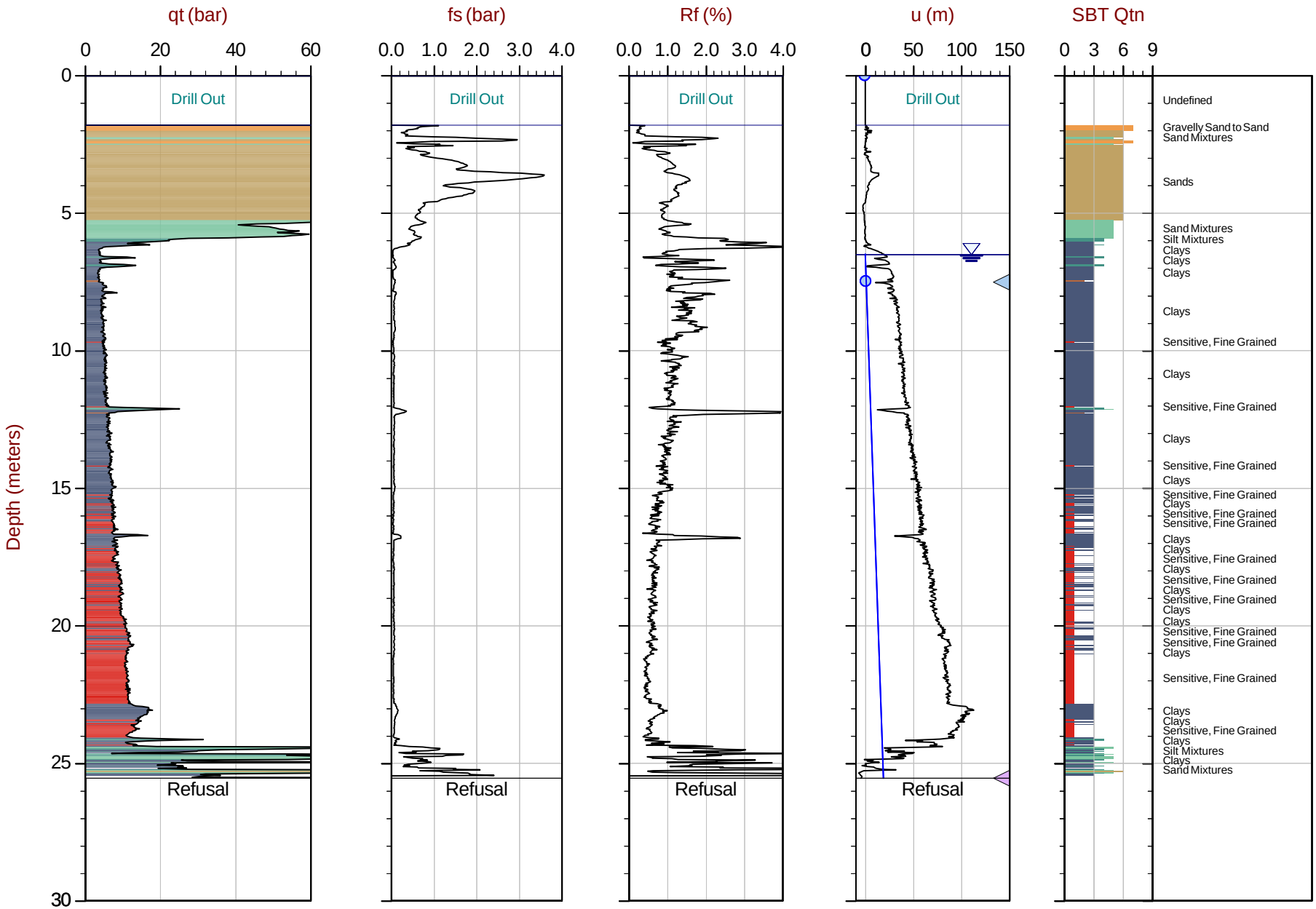
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-12 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP606.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017415m E: 488137m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

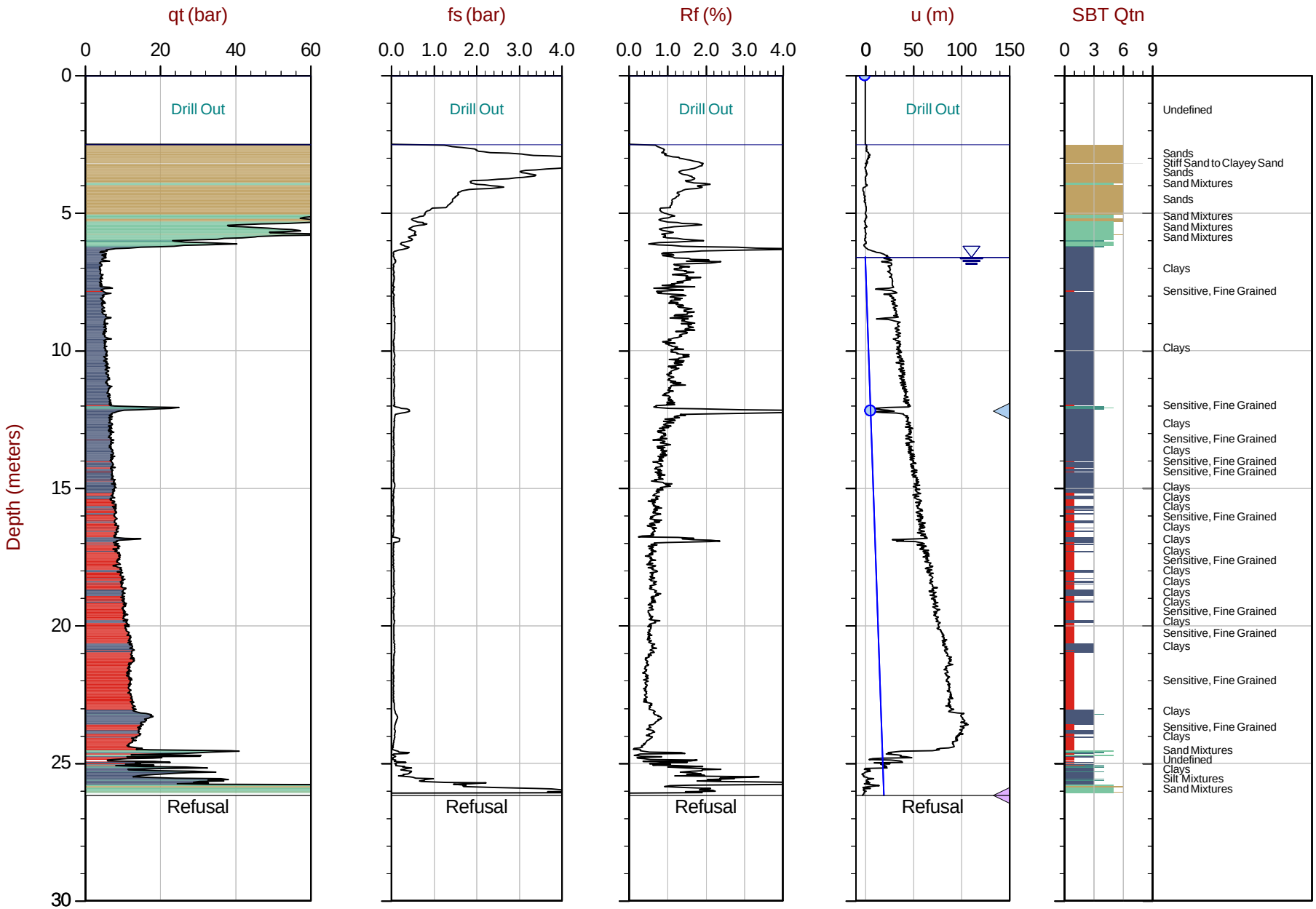
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500



Max Depth: 26.175 m / 85.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP607.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017393 m E: 488119 m
Sheet No: 1 of 1

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

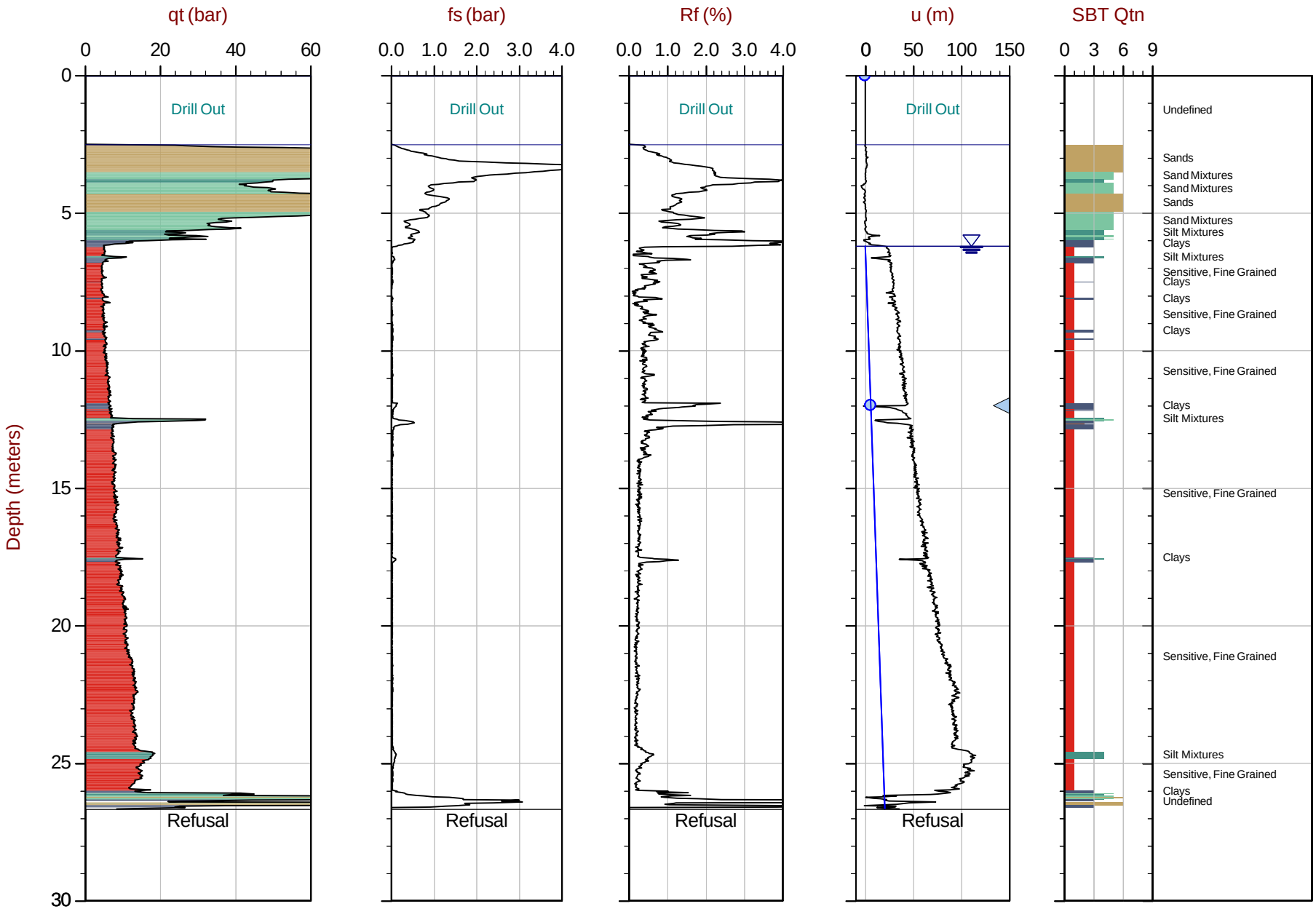
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 08:35
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-608
Cone: 408:T1500F15U500



Max Depth: 26.675 m / 87.52 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP608.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017495m E: 488025m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

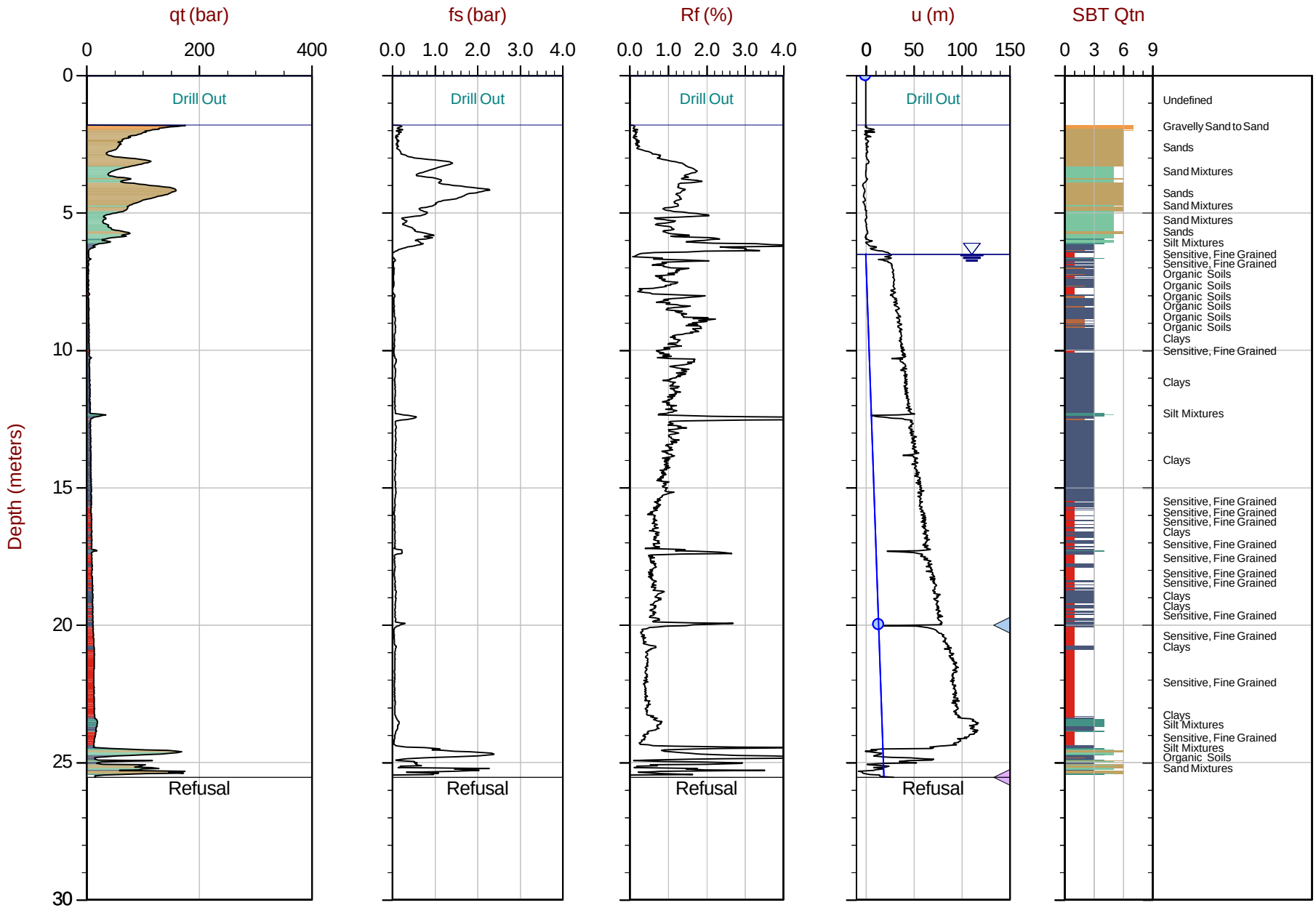
Standard Cone Penetration Test Plots with Expanded Scales

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-13 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP605.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017523 m E: 488039m
Sheet No: 1 of 1

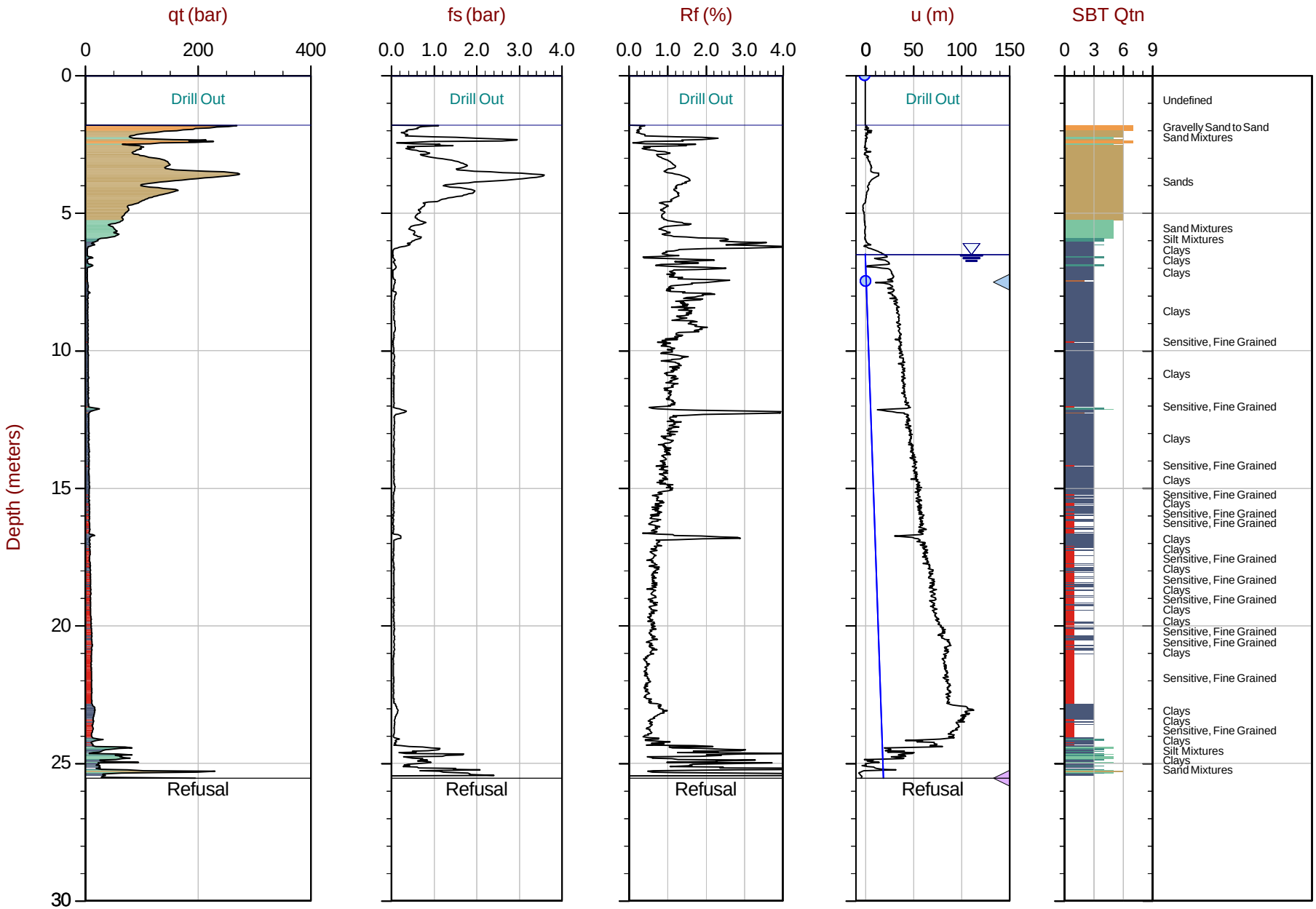
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

Golder Associates

Job No: 18-05082
Date: 2018-12-12 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP606.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017415m E: 488137m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

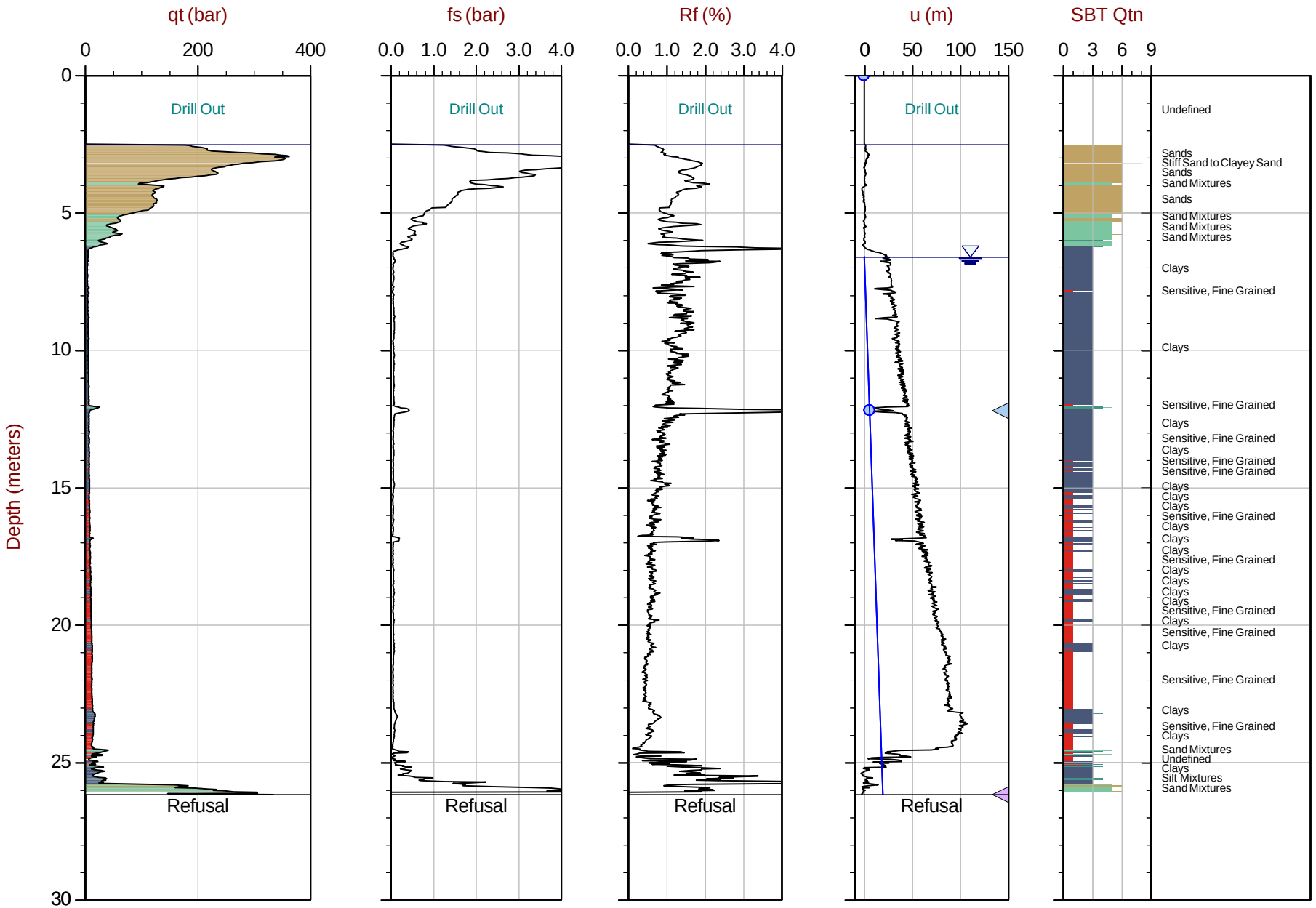
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500



Max Depth: 26.175 m / 85.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP607.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017393 m E: 488119 m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

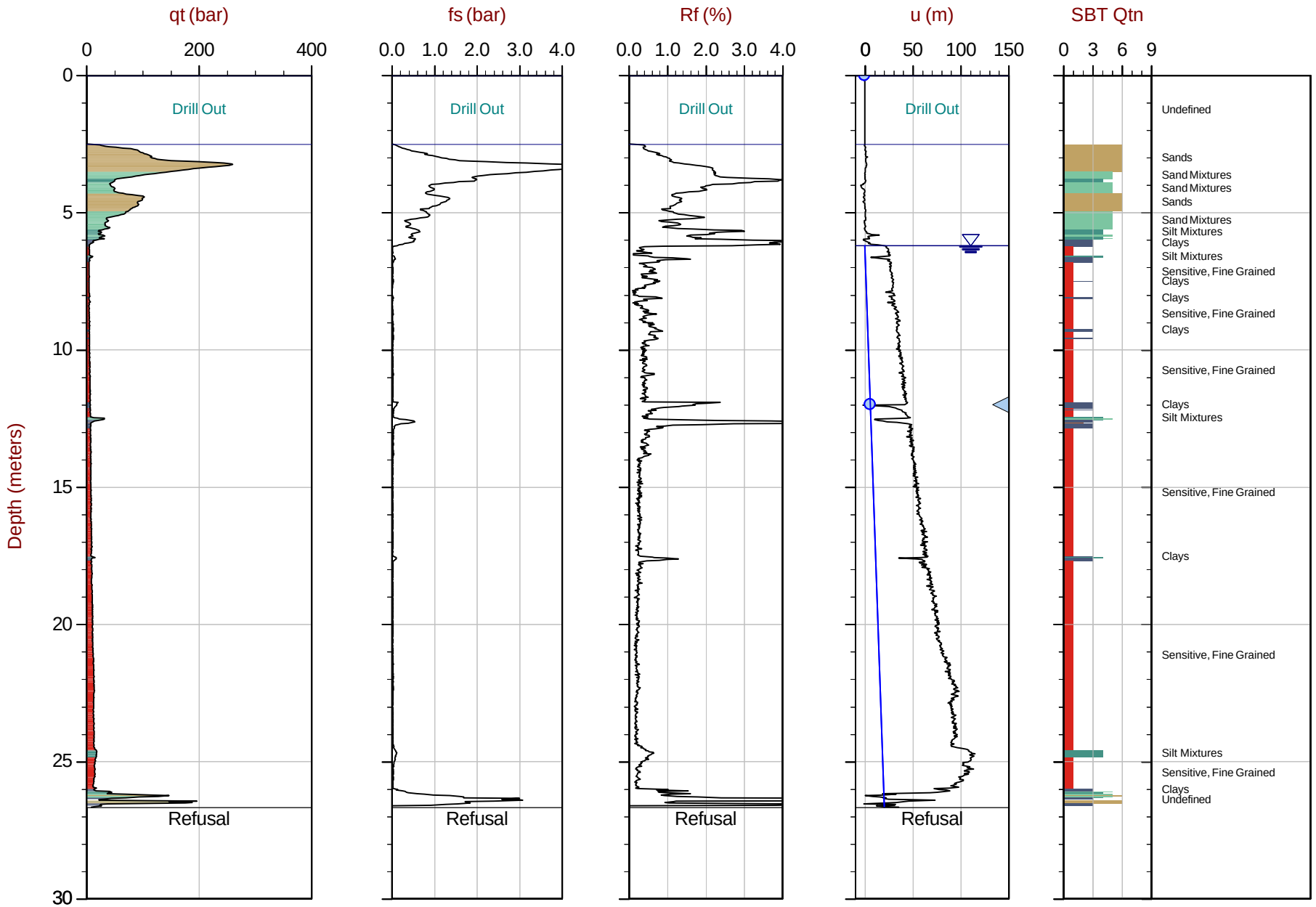
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 08:35
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-608
Cone: 408:T1500F15U500



Max Depth: 26.675 m / 87.52 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP608.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017495m E: 488025m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

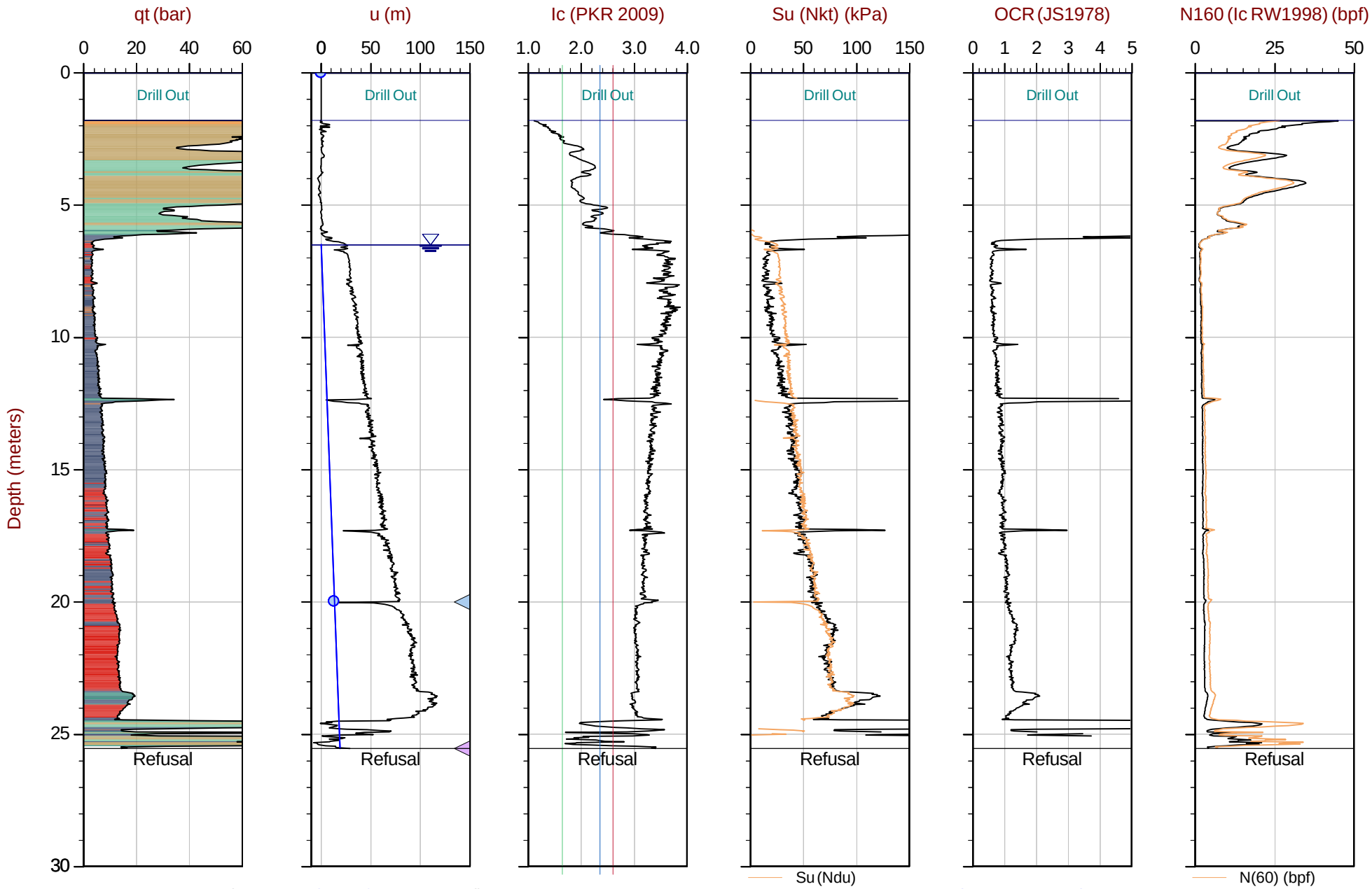
Advanced Cone Penetration Test Plots with Ic, Su(Nkt), OCR, and N1(60)Ic

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-13 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP605.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 12.5 / 10.0

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017523m E: 488039m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

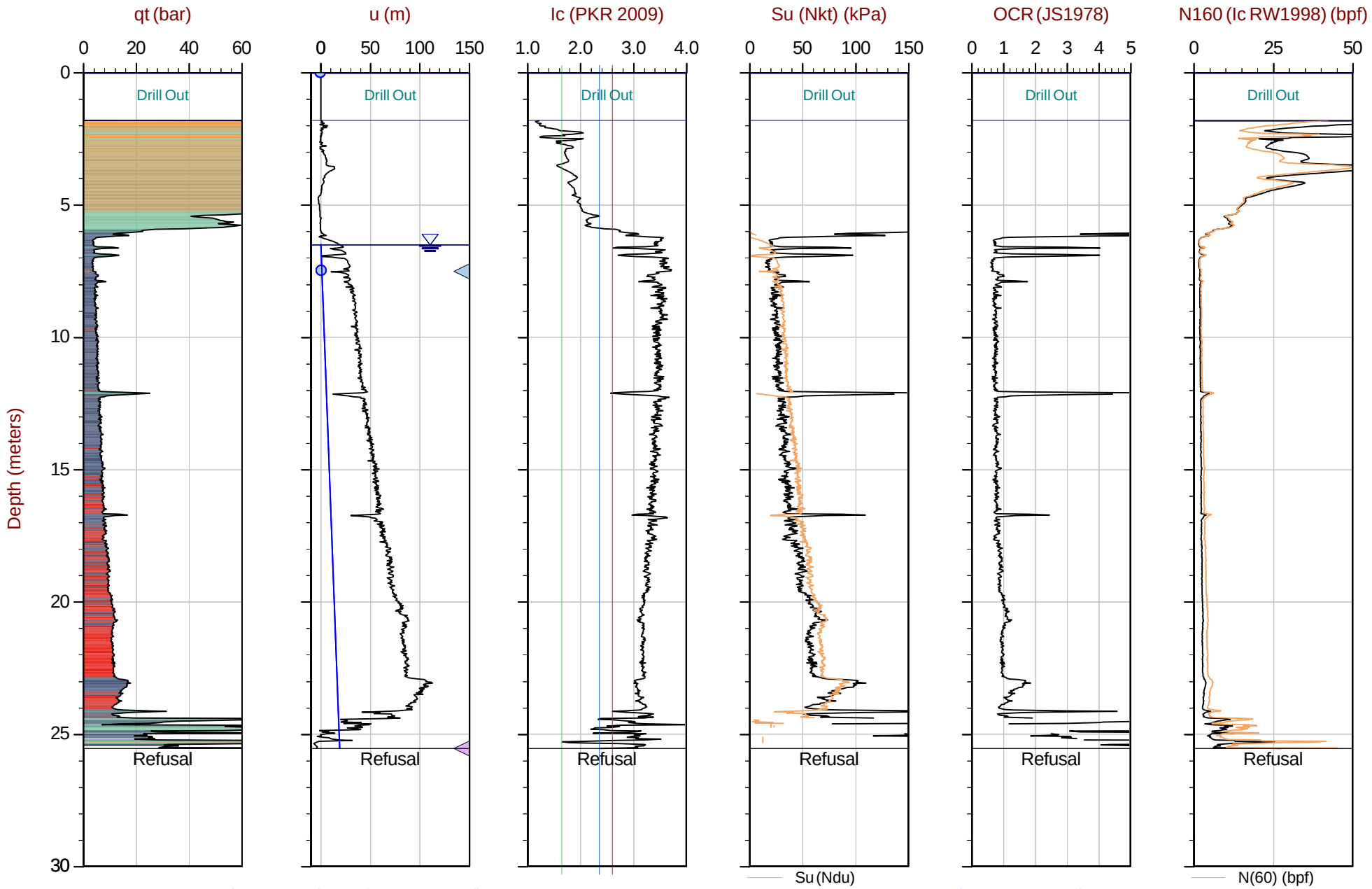
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-12 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500



Max Depth: 25.550 m / 83.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP606.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 12.5 / 10.0

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017415m E: 488137m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

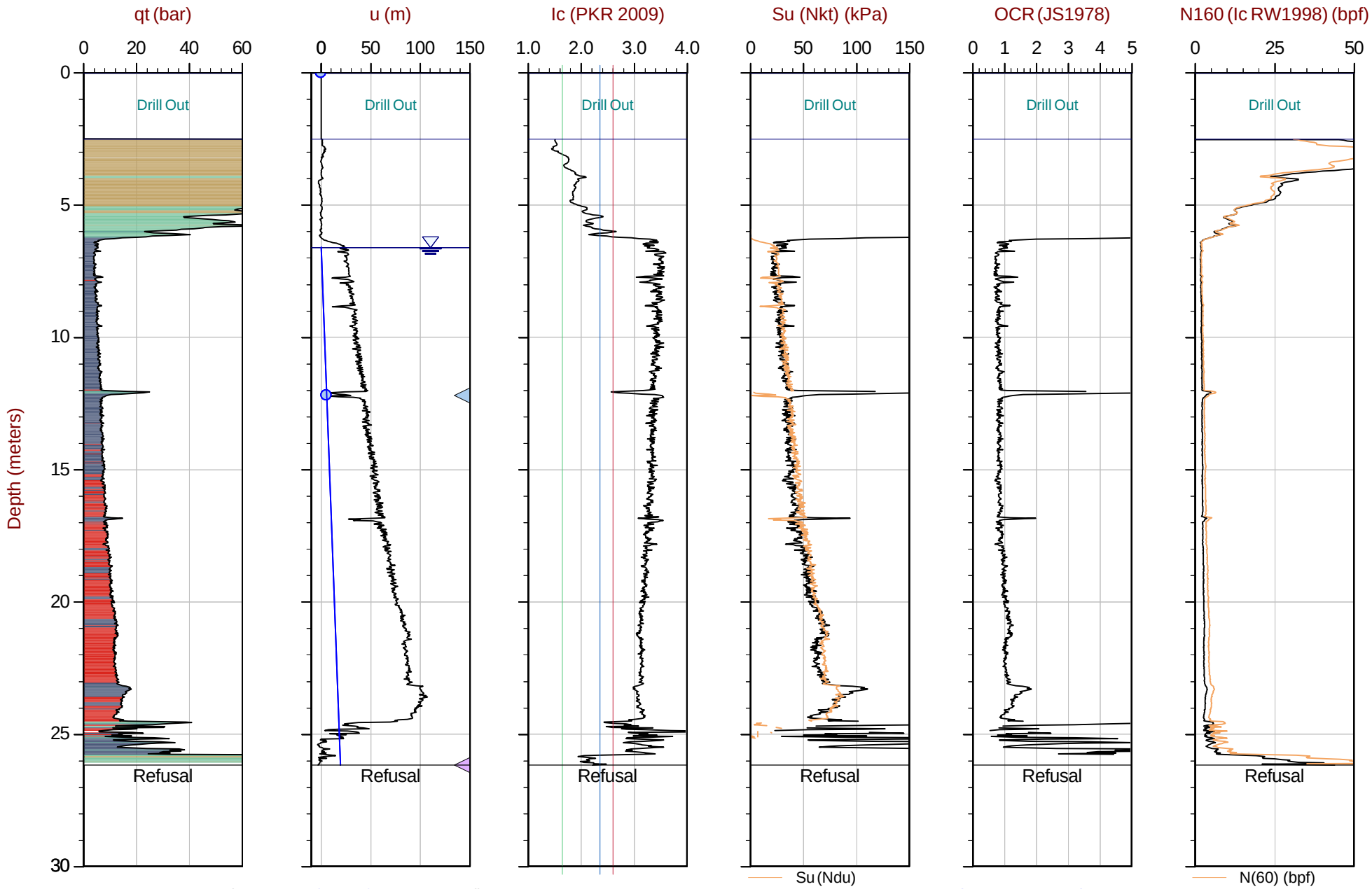
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500



Max Depth: 26.175 m / 85.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP607.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 12.5 / 10.0

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017393m E: 488119m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

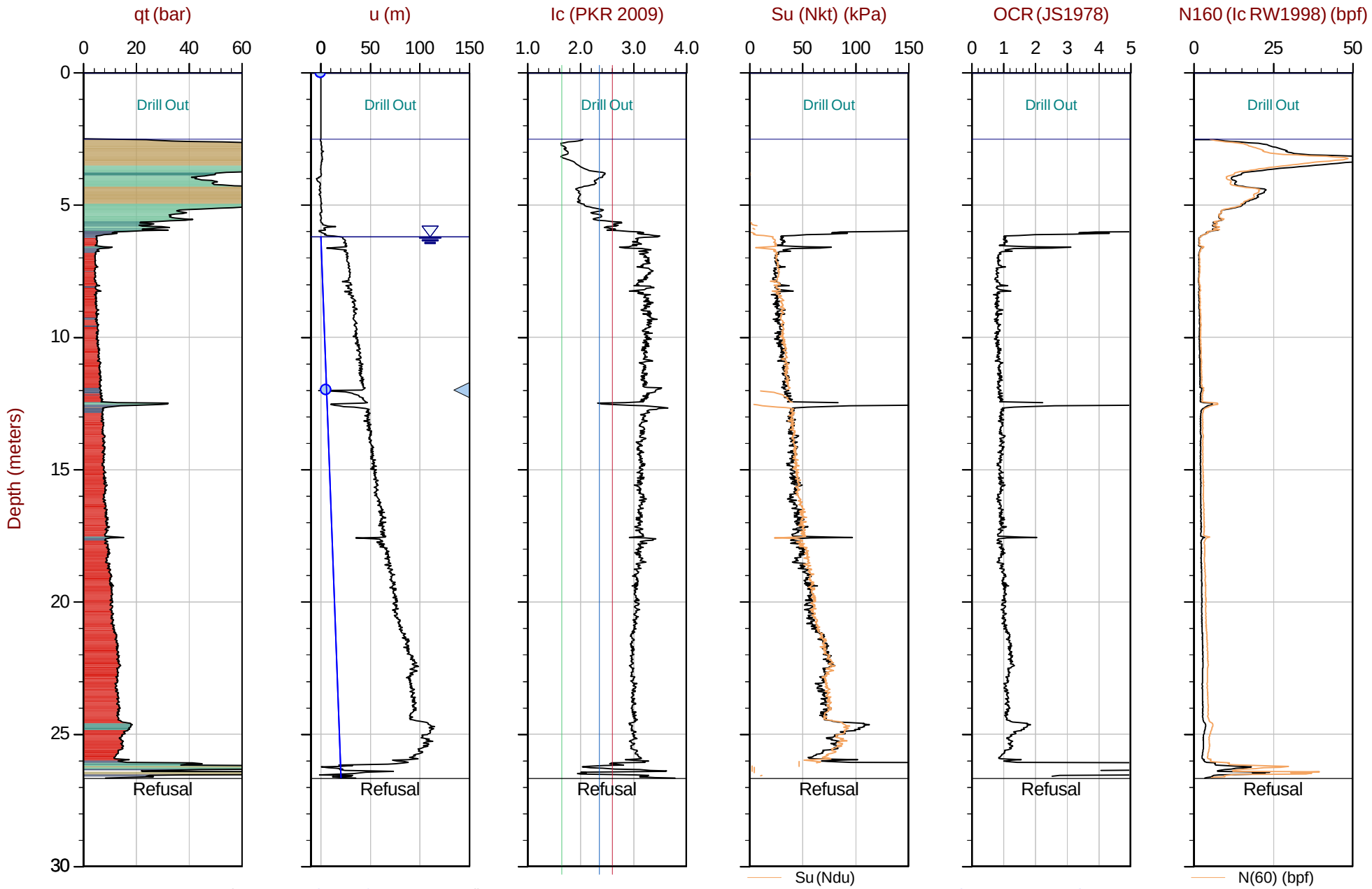
The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Golder Associates

Job No: 18-05082
Date: 2018-12-15 08:35
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-608
Cone: 408:T1500F15U500



Max Depth: 26.675 m / 87.52 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 18-05082_CP608.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 12.5 / 10.0

SBT: Robertson, 2009 and 2010
Coords: UTM 18 N N: 5017495m E: 488025m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Hydrostatic Line

The reported coordinates were acquired based on Google Earth imagery and are only approximate locations. The coordinates should not be used for design purposes.

Soil Behaviour Type (SBT) Scatter Plots

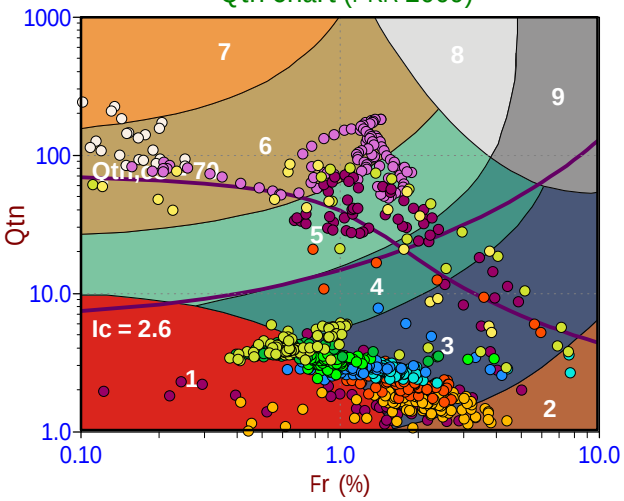
CONETEC

Golder Associates

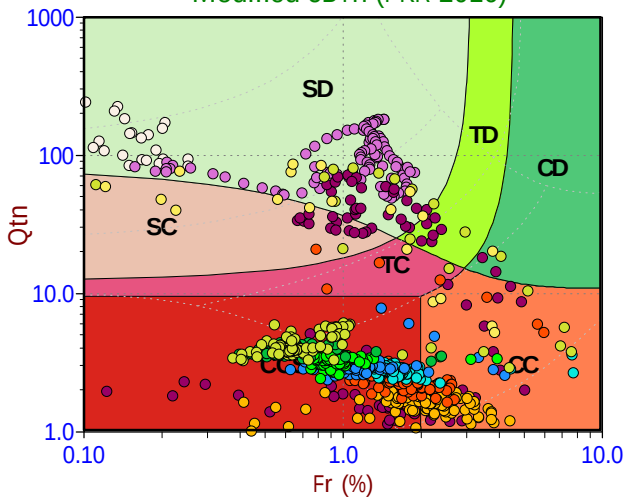
Job No: 18-05082
Date: 2018-12-13 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500

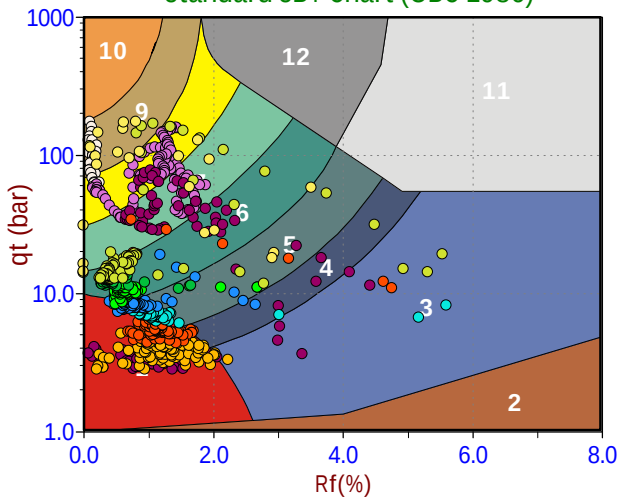
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

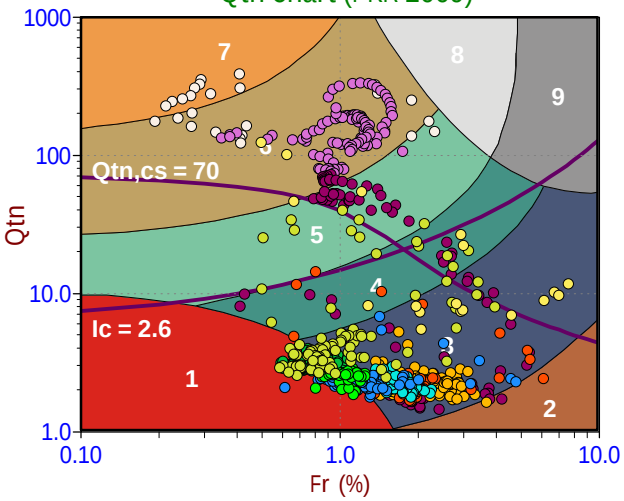
CONETEC

Golder Associates

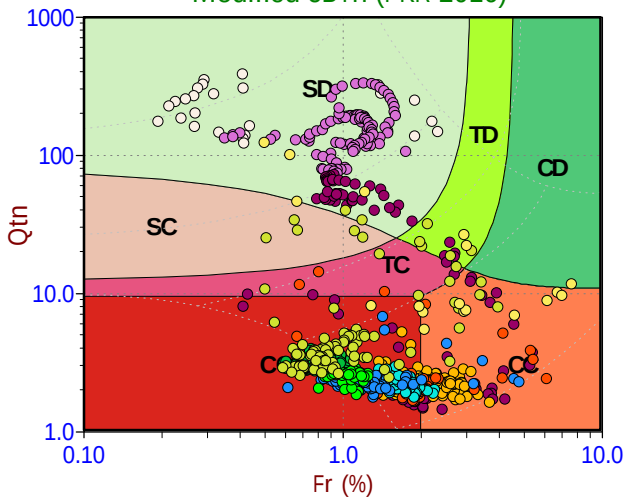
Job No: 18-05082
Date: 2018-12-12 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500

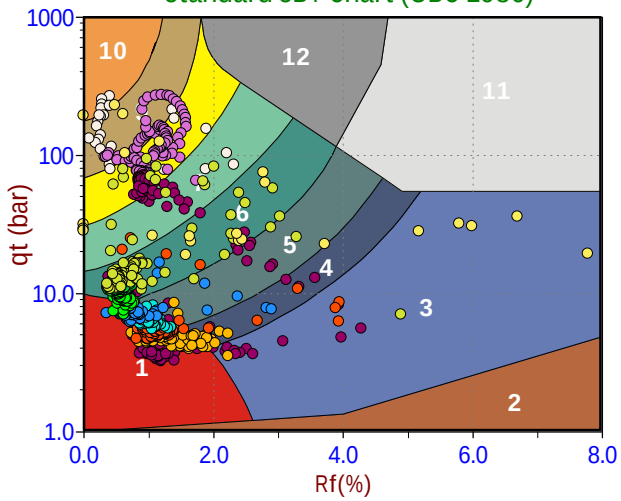
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

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- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

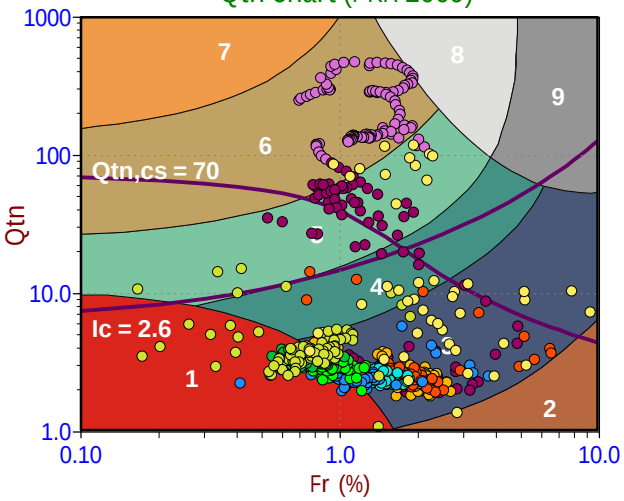
CONETEC

Golder Associates

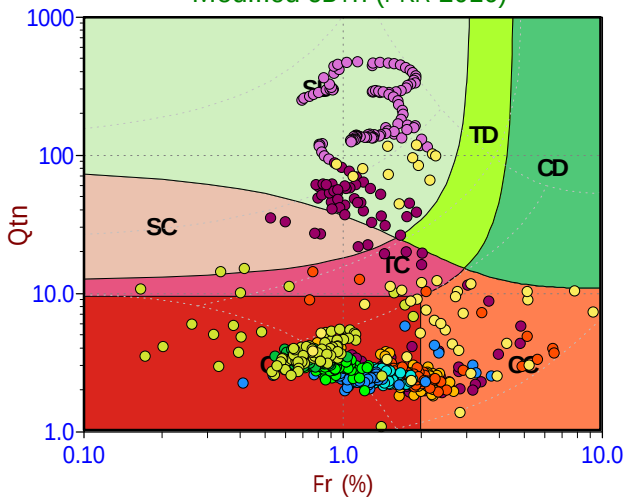
Job No: 18-05082
Date: 2018-12-15 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500

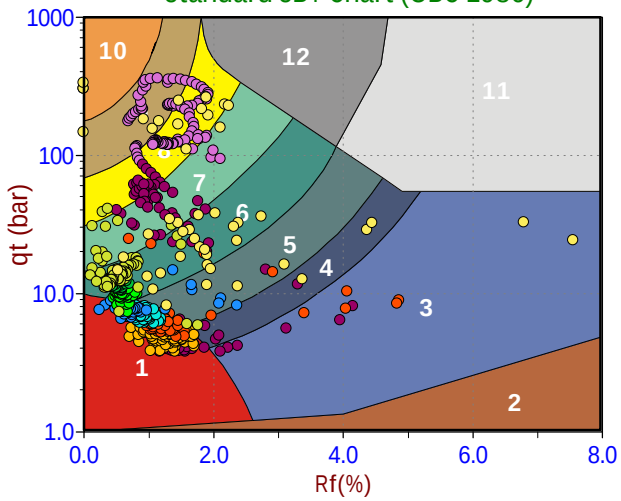
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

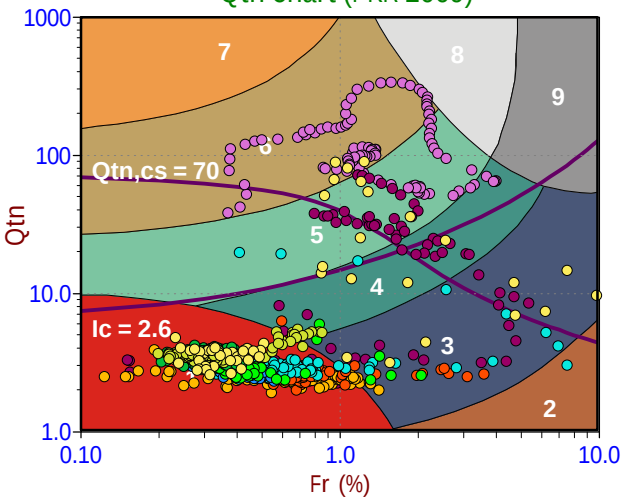
CONETEC

Golder Associates

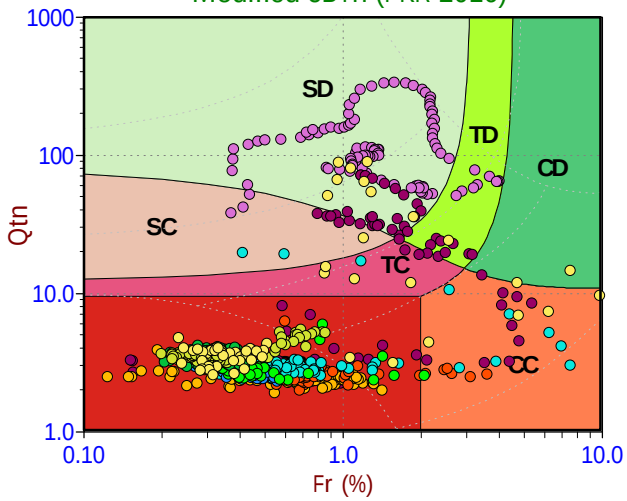
Job No: 18-05082
Date: 2018-12-15 08:35
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-608
Cone: 408:T1500F15U500

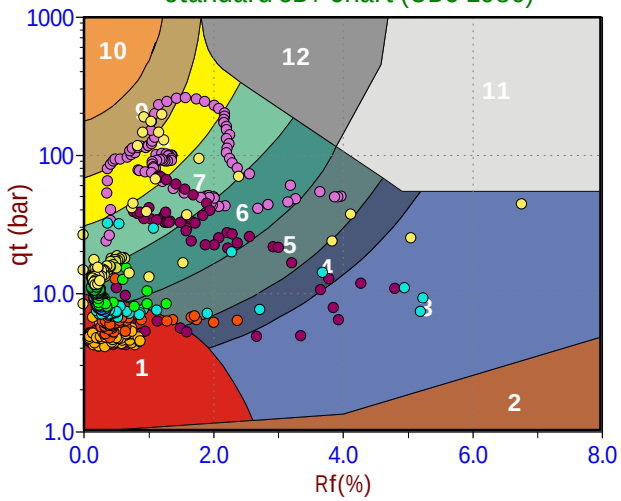
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Pore Pressure Dissipation Summary and
Pore Pressure Dissipation Plots

Job No:	18-05082
Client:	Golder Associates
Project:	Highway 417 Overpass at County Road 3
Start Date:	12-Dec-2018
End Date:	15-Dec-2018

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Calculated Phreatic Surface (m)	Estimated Phreatic Surface (m)	t_{50} [a] (s)	Percent Dissipation (%)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
CPT18-605	18-05082_CP605	15	17500	20.000	13.5		6.5	2014	93.4	100	0.3
CPT18-605	18-05082_CP605	15	300	25.550	Not Achieved						
CPT18-606	18-05082_CP606	15	5820	7.500	1.0		6.5	3748	58.8	100	0.2
CPT18-606	18-05082_CP606	15	600	25.550	Not Achieved						
CPT18-607	18-05082_CP607	15	500	12.200	5.6		6.6	8	99.3	100	85.0
CPT18-607	18-05082_CP607	15	305	26.175	Not Achieved						
CPT18-608	18-05082_CP608	15	7800	12.000	5.8		6.2	1322	91.4	100	0.5

a. Time is relative to where umax occurred

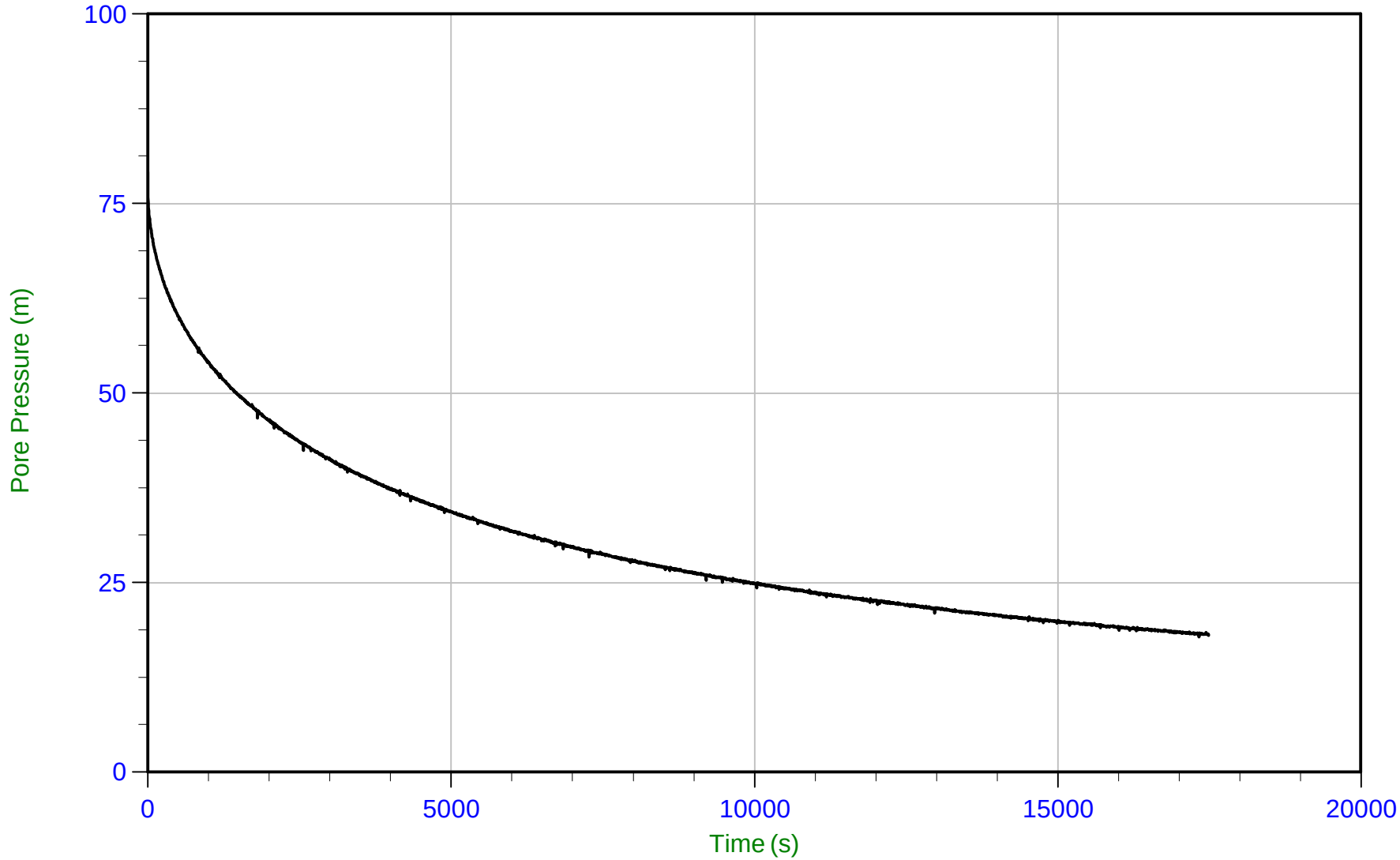
b. Houlsby and Teh, 1991

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/13/2018 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP605.PPF
Depth: 20.000 m / 65.616 ft
Duration: 17500.0 s

U Min: 17.8 m
U Max: 79.2 m

WT: 6.500 m / 21.325 ft
Ueq: 13.5 m
U(50): 46.35 m

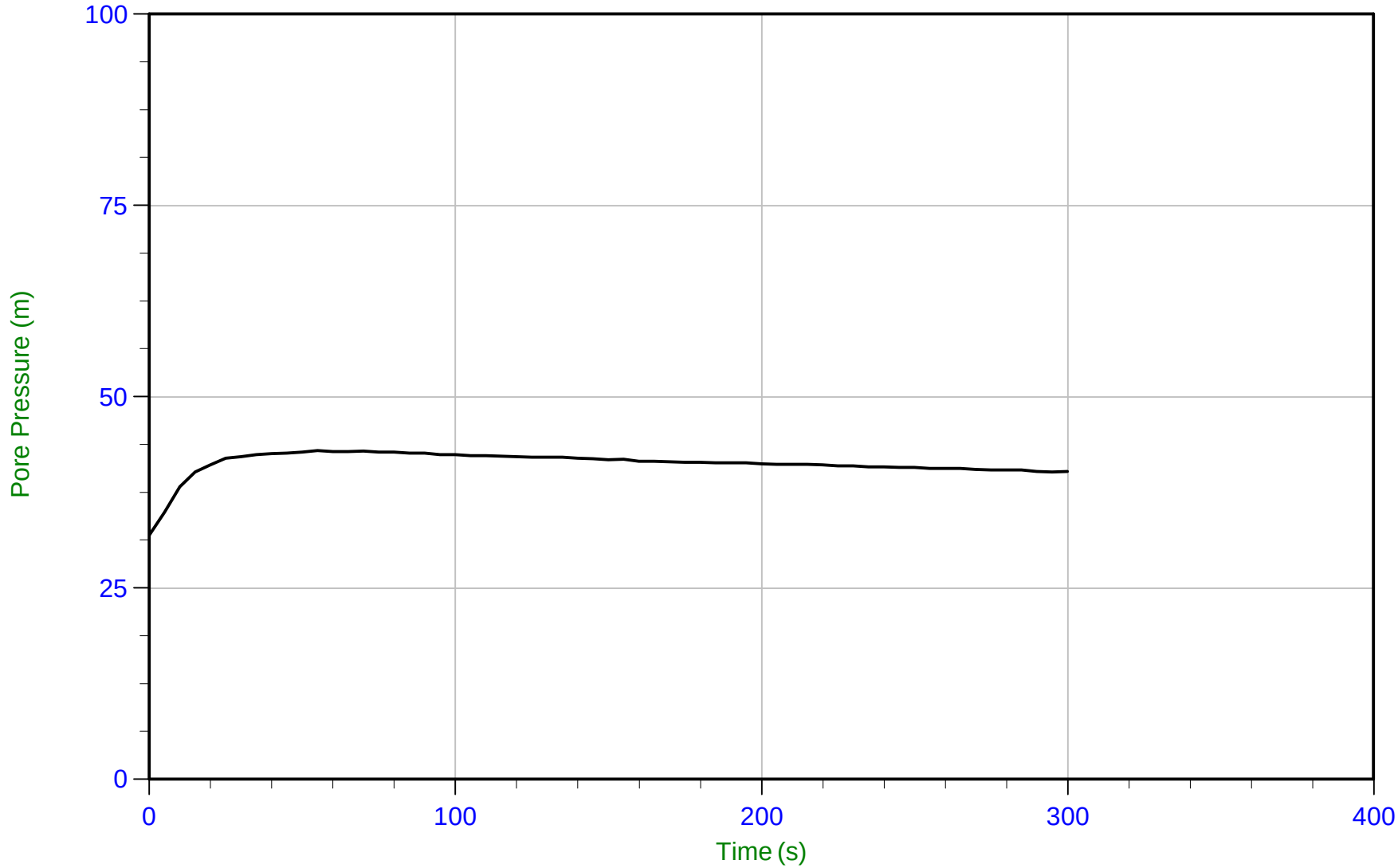
T(50): 2014.0 s
Ir: 100
Ch: 0.3 cm²/min

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/13/2018 09:00
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-605
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP605.PPF
Depth: 25.550 m / 83.824 ft
Duration: 300.0 s

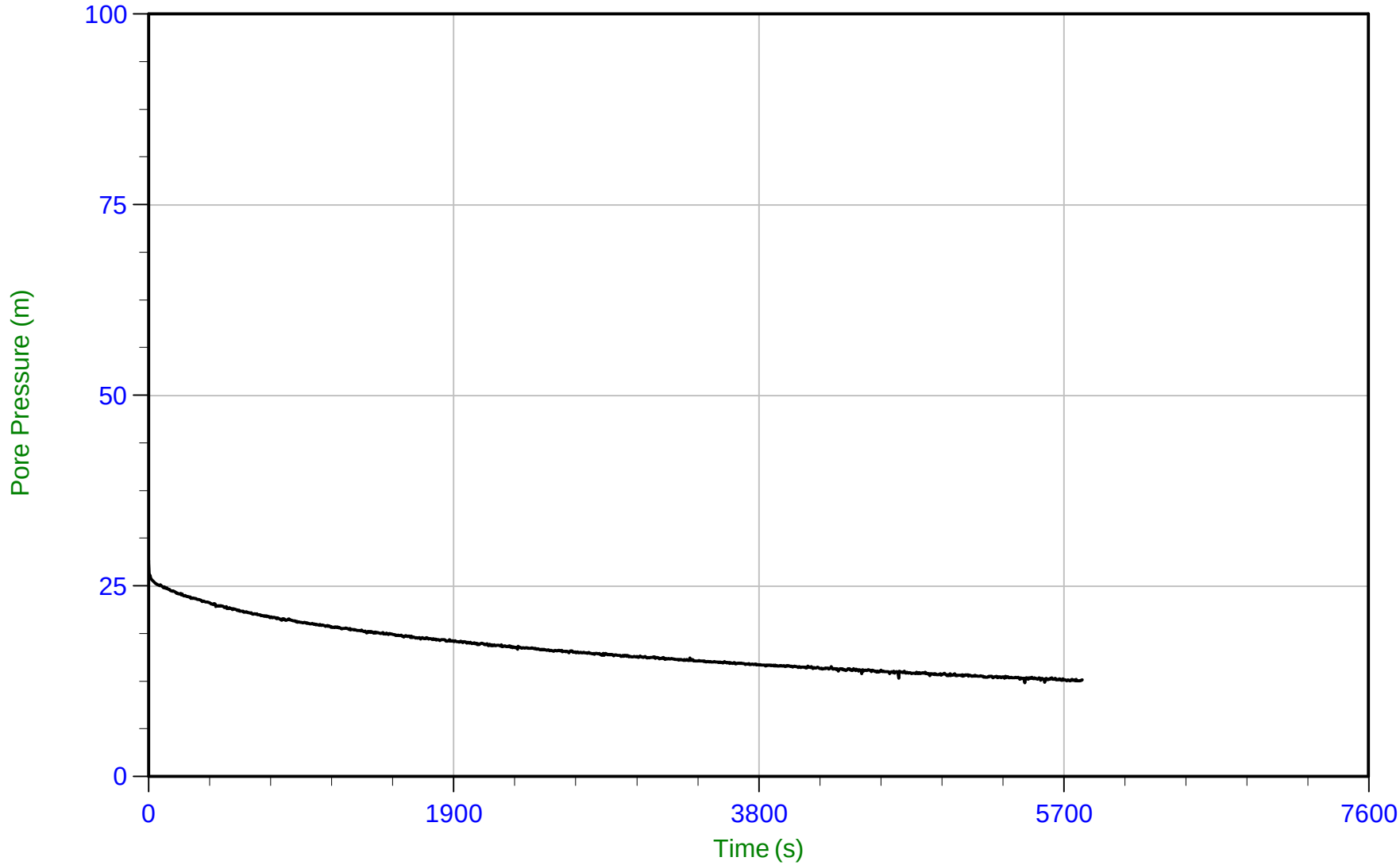
U Min: 31.9 m
U Max: 42.9 m

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/12/2018 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP606.PPF
Depth: 7.500 m / 24.606 ft
Duration: 5820.0 s

U Min: 12.3 m
U Max: 28.4 m

WT: 6.500 m / 21.325 ft
Ueq: 1.0 m
U(50): 14.69 m

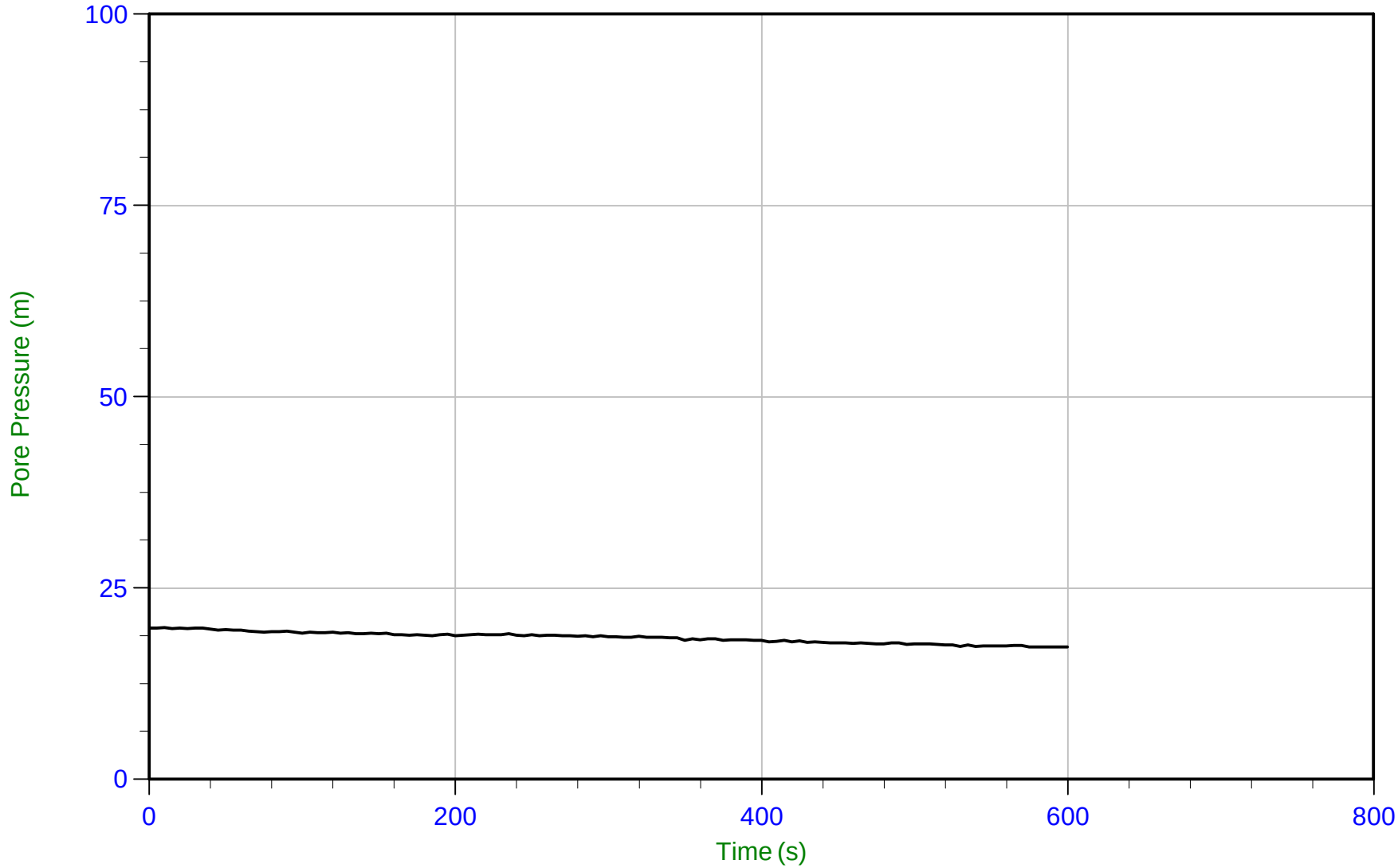
T(50): 3747.6 s
Ir: 100
Ch: 0.2 cm²/min

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/12/2018 12:17
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-606
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP606.PPF
Depth: 25.550 m / 83.824 ft
Duration: 600.0 s

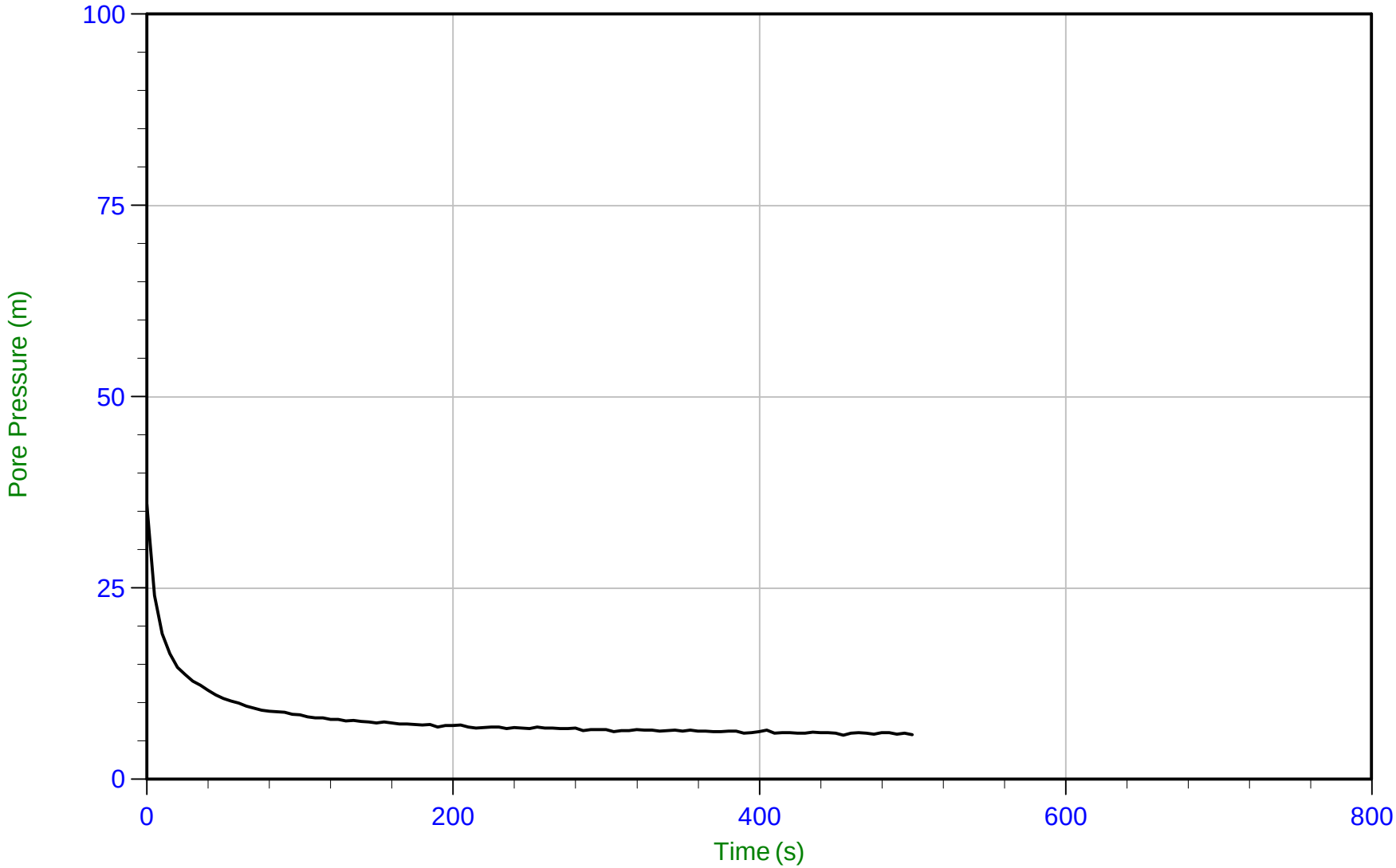
U Min: 17.3 m
U Max: 19.8 m

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/15/2018 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP607.PPF
Depth: 12.200 m / 40.026 ft
Duration: 500.0 s

U Min: 5.8 m
U Max: 35.9 m

WT: 6.600 m / 21.653 ft
Ueq: 5.6 m
U(50): 20.77 m

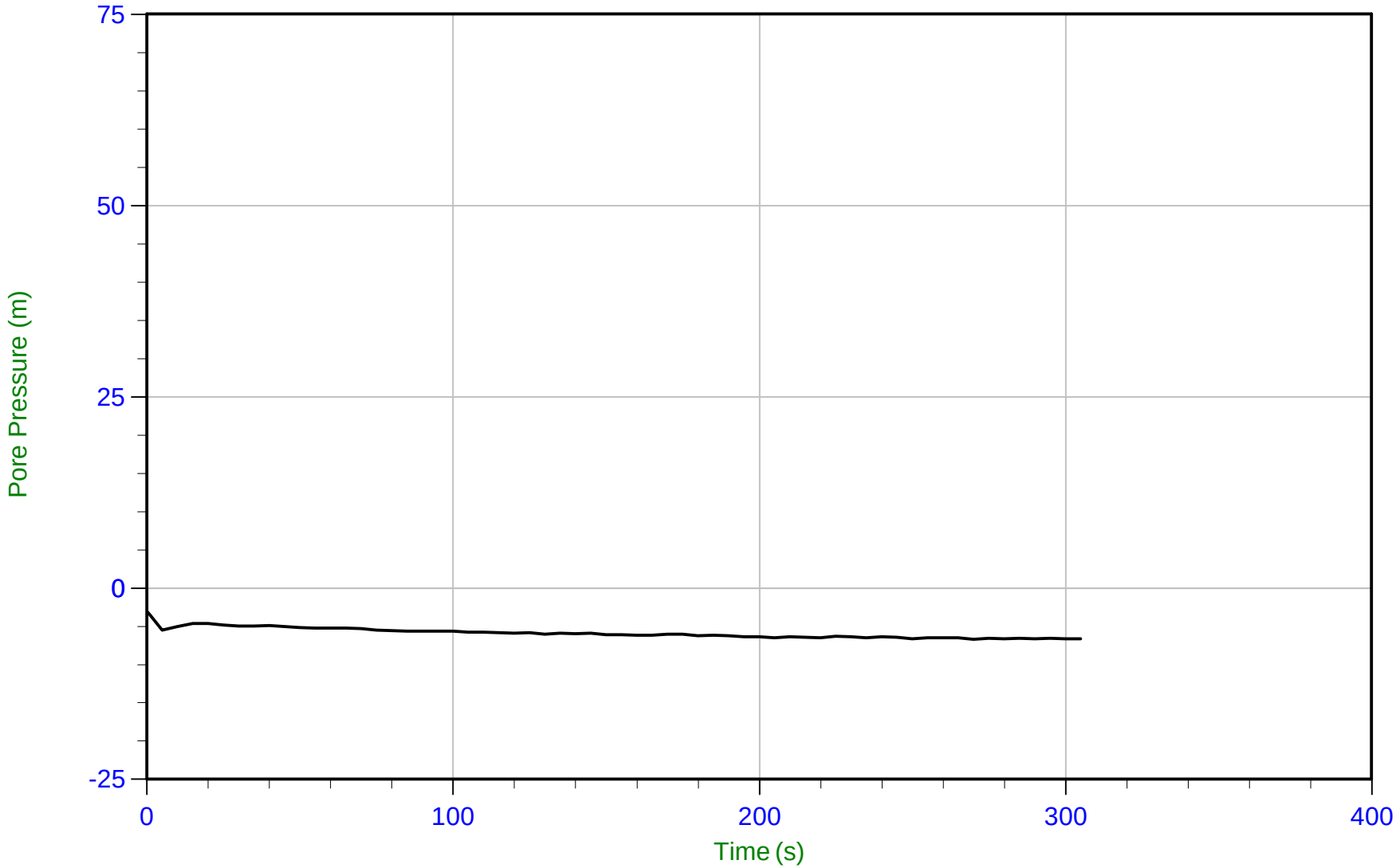
T(50): 8.3 s
Ir: 100
Ch: 85.0 cm²/min

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/15/2018 12:15
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-607
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP607.PPF
Depth: 26.175 m / 85.875 ft
Duration: 305.0 s

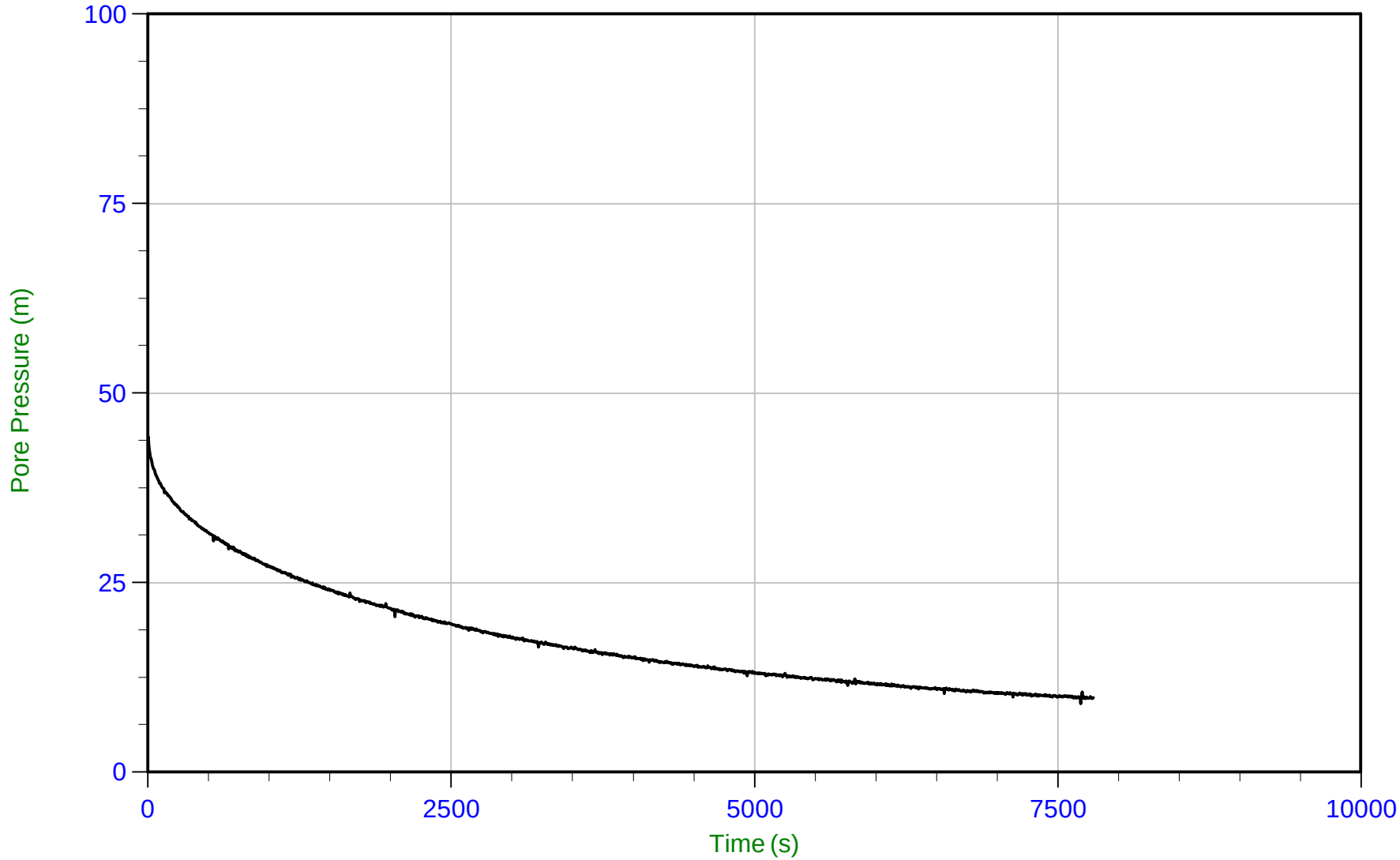
U Min: -6.7 m
U Max: -3.0 m

CONETEC

Golder Associates

Job No: 18-05082
Date: 12/15/2018 08:35
Site: Highway 417 Overpass at Country Road 3

Sounding: CPT18-608
Cone: 408:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-05082_CP608.PPF
Depth: 12.000 m / 39.370 ft
Duration: 7800.0 s

U Min: 9.1 m
U Max: 44.3 m

WT: 6.200 m / 20.341 ft
Ueq: 5.8 m
U(50): 25.03 m

T(50): 1322.0 s
Ir: 100
Ch: 0.5 cm²/min

APPENDIX E

Selected Site Photographs

Photograph 1: CR3 Overpass, Westbound Lane at BH 18-601, looking east (February 1, 2019).

Photograph 2: CR3 Overpass, Westbound Lane at BH 18-601, looking west (February 1, 2019).

CLIENT
DILLON CONSULTING LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2019/03/28
PREPARED	RK
DESIGN	CK
REVIEW	WC
APPROVED	FJH

PROJECT
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1899802	**6000**	**0**	**E1**

Photograph 3: CR3 Overpass, Westbound Lane at BH 18-602, looking east (February 1, 2019).

Photograph 4: CR3 Overpass, Westbound Lane at BH 18-602, looking west (February 1, 2019).

CLIENT
DILLON CONSULTING LIMITED

PROJECT
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO

CONSULTANT
GOLDER

YYYY-MM-DD	2019/03/28
PREPARED	RK
DESIGN	CK
REVIEW	WC
APPROVED	FJH

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1899802	**6000**	**0**	**E2**

Photograph 5: CR3 Overpass, Eastbound Lane at BH 18-603, looking east (February 1, 2019).

Photograph 6: CR3 Overpass, Eastbound Lane at BH 18-603, looking west (February 1, 2019).

CLIENT
DILLON CONSULTING LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2019/03/28
PREPARED	RK
DESIGN	CK
REVIEW	WC
APPROVED	FJH

PROJECT
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1899802	**6000**	**0**	**E3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
0 1m

Photograph 7: CR3 Overpass, Eastbound Lane at BH 18-604, looking east (February 1, 2019).

Photograph 8: CR3 Overpass, Eastbound Lane at BH 18-604, looking west (February 1, 2019).

CLIENT
DILLON CONSULTING LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2019/03/28
PREPARED	RK
DESIGN	CK
REVIEW	WC
APPROVED	FJH

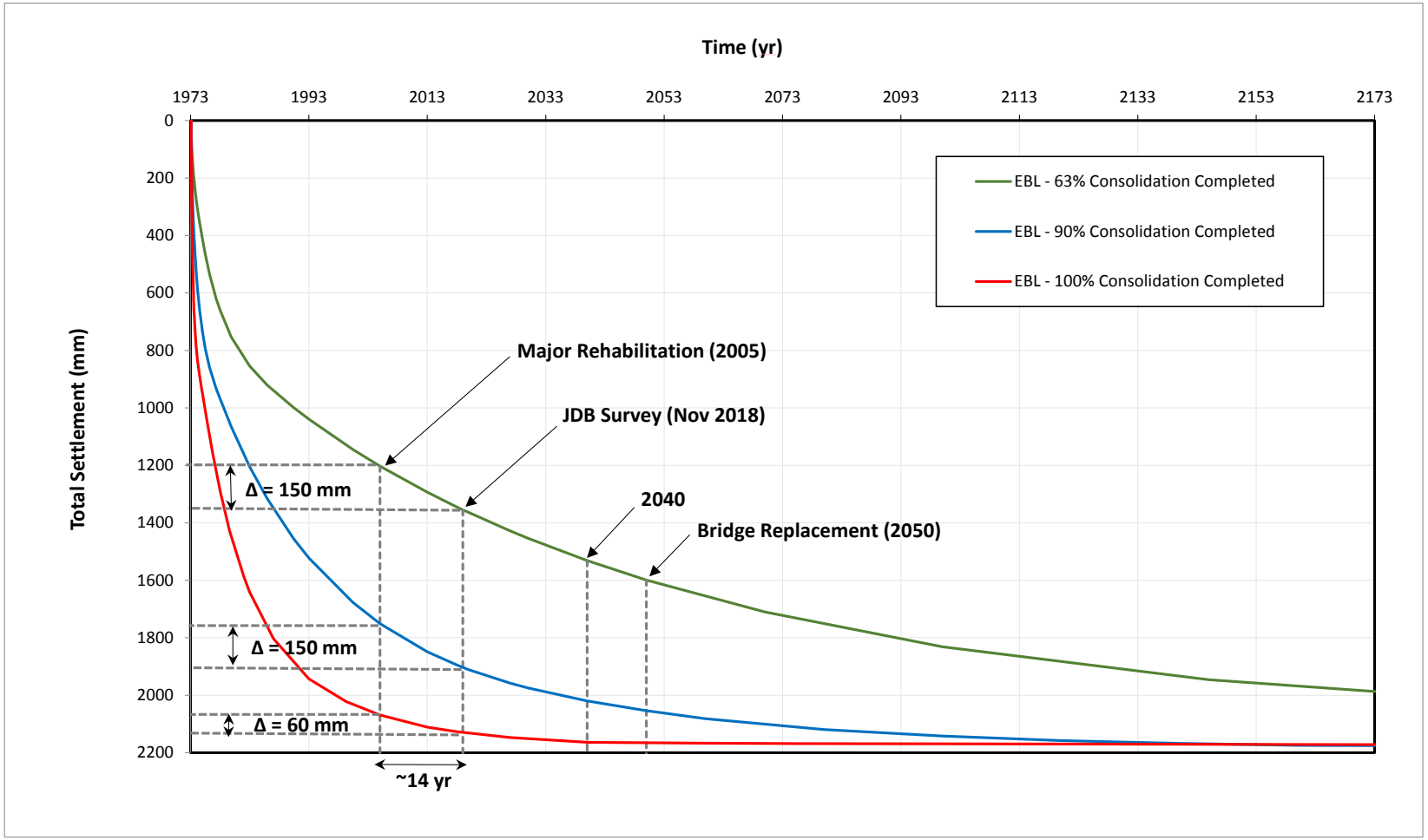
PROJECT
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1899802	**6000**	**0**	**E4**

APPENDIX F

Results of Settlement Analyses



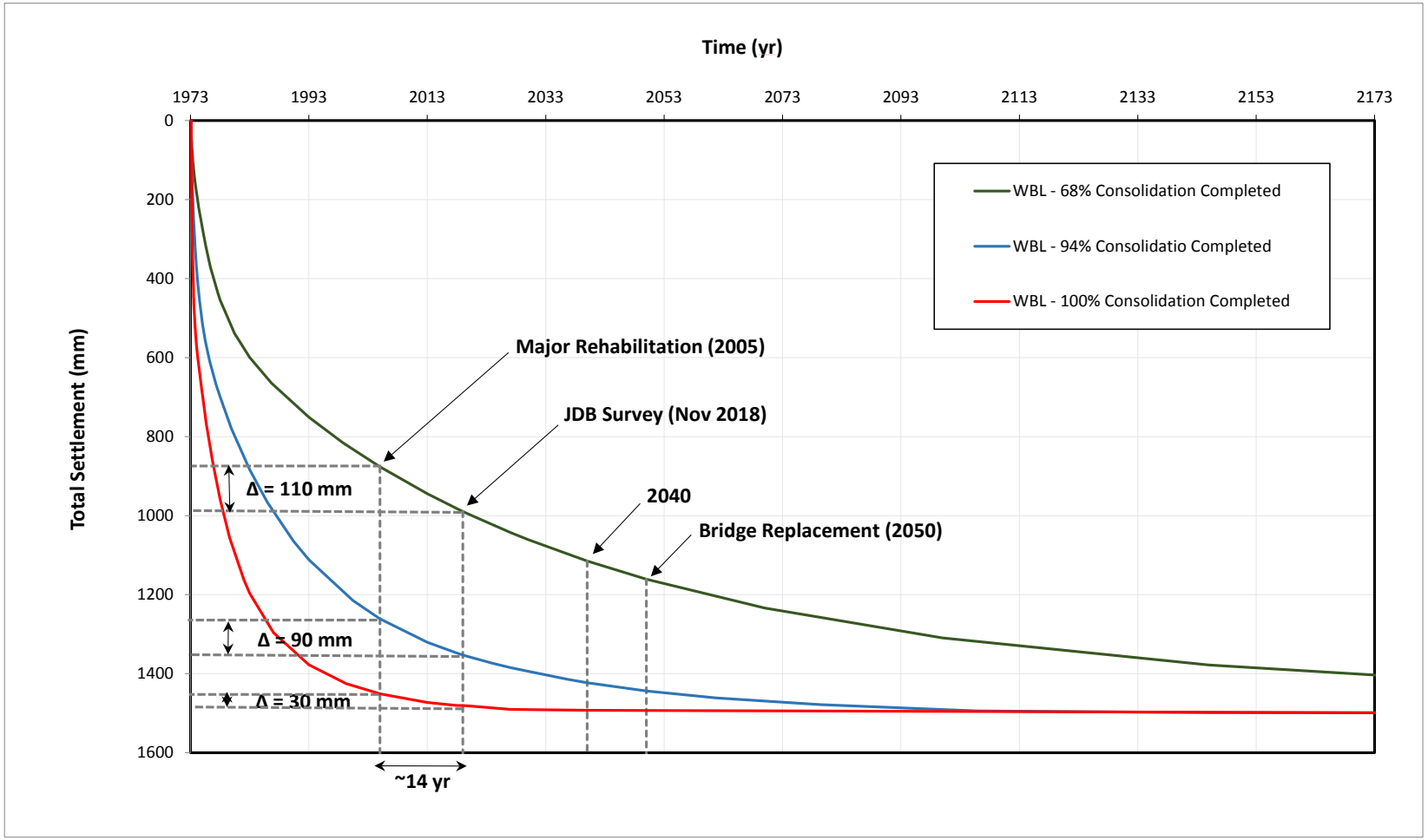
GOLDER

FOUNDATION INVESTIGATION AND PRELIMINARY DESIGN
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO, ONTARIO

TOTAL SETTLEMENT OVER TIME - EASTBOUND LANES

Project No.	1899802
Drawn:	CK
Date:	28/11/2018
Checked:	CK
Review:	WC

FIGURE F1



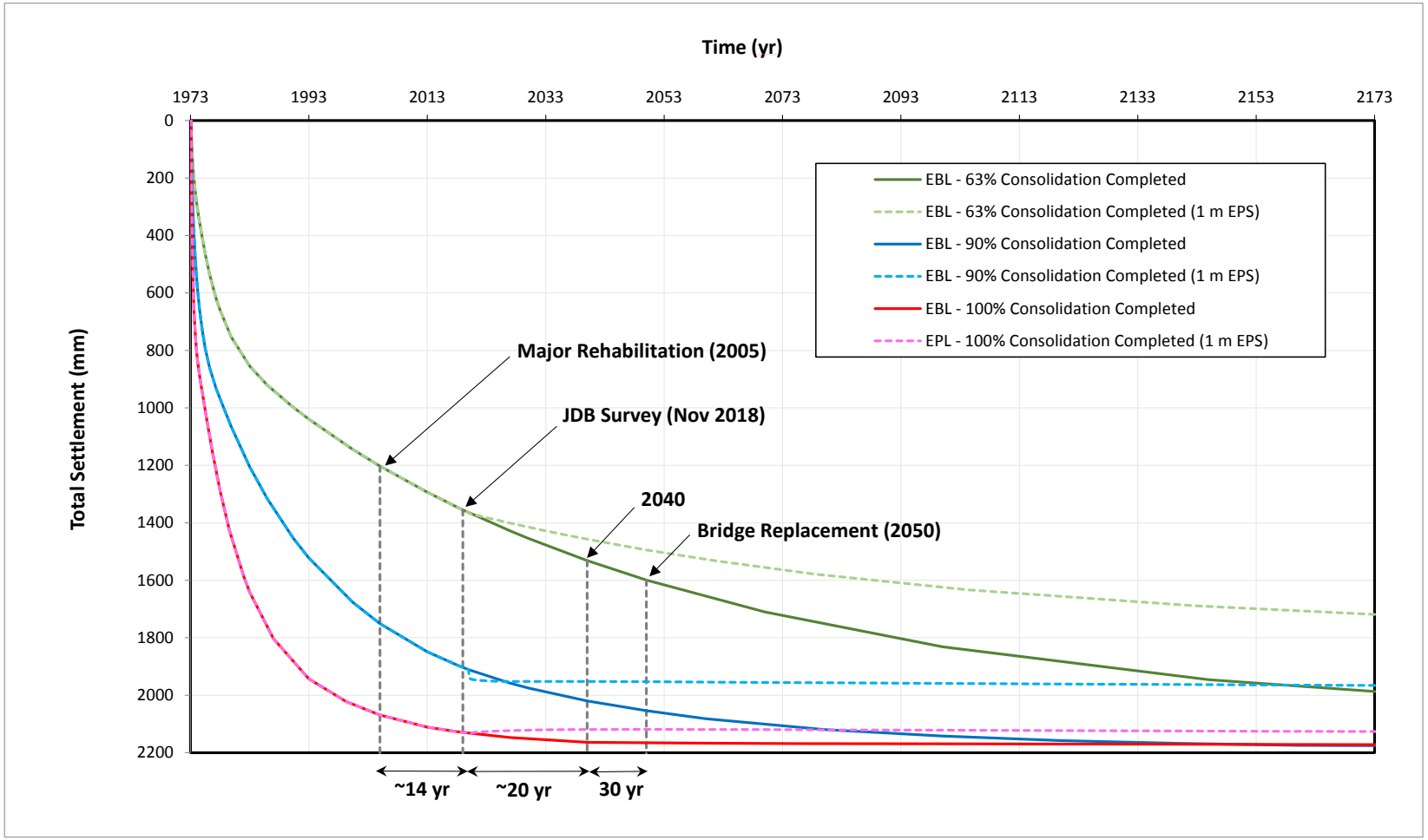
GOLDER

FOUNDATION INVESTIGATION AND PRELIMINARY DESIGN
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO, ONTARIO

TOTAL SETTLEMENT OVER TIME - WESTBOUND LANES

Project No.	1899802
Drawn:	CK
Date:	28/11/2018
Checked:	CK
Review:	WC

FIGURE F2



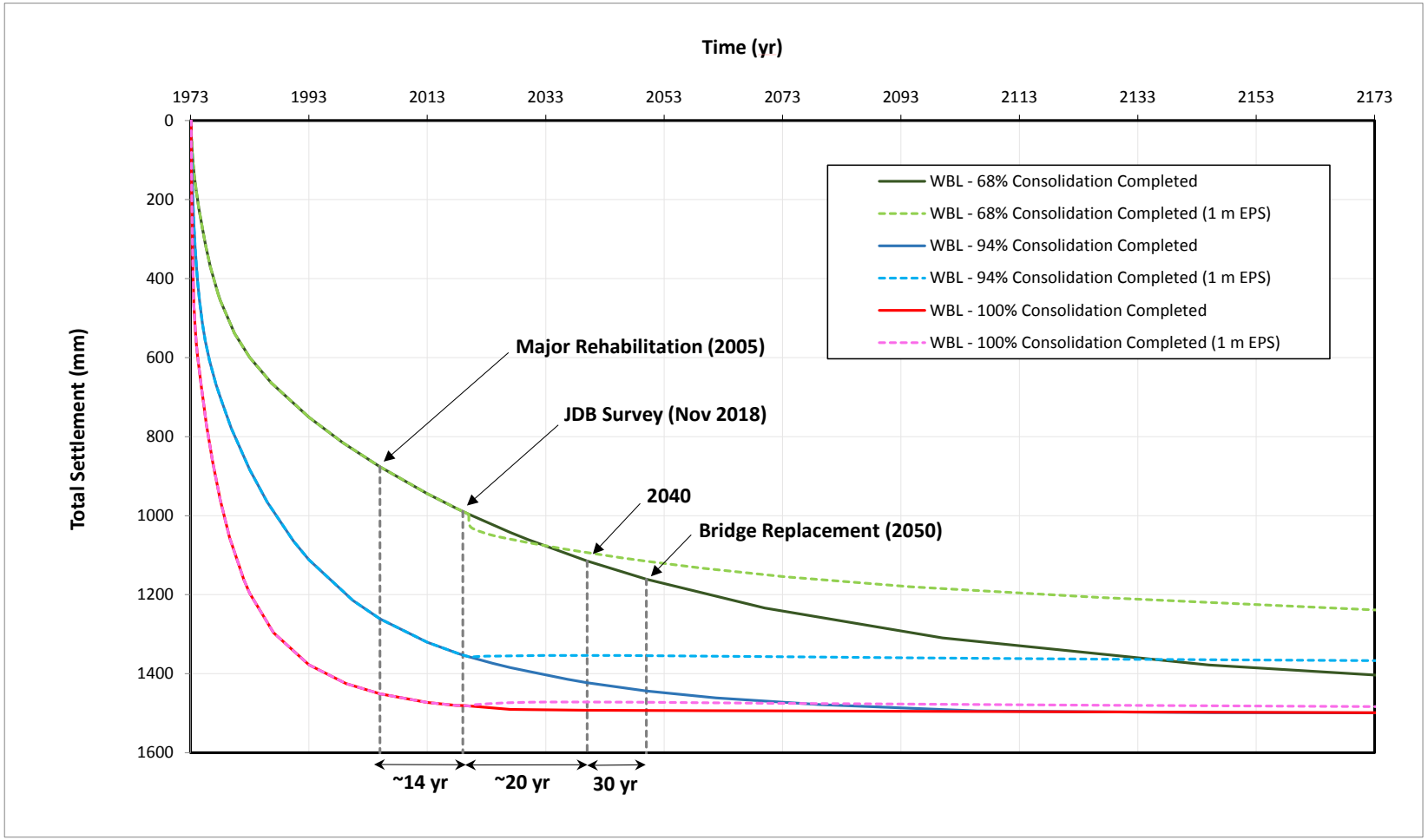
GOLDER

FOUNDATION INVESTIGATION AND PRELIMINARY DESIGN
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO, ONTARIO

TOTAL SETTLEMENT OVER TIME - EASTBOUND LANES (with 1 m EPS)

Project No.	1899802
Drawn:	CK
Date:	28/11/2018
Checked:	CK
Review:	WC

FIGURE F3



GOLDER

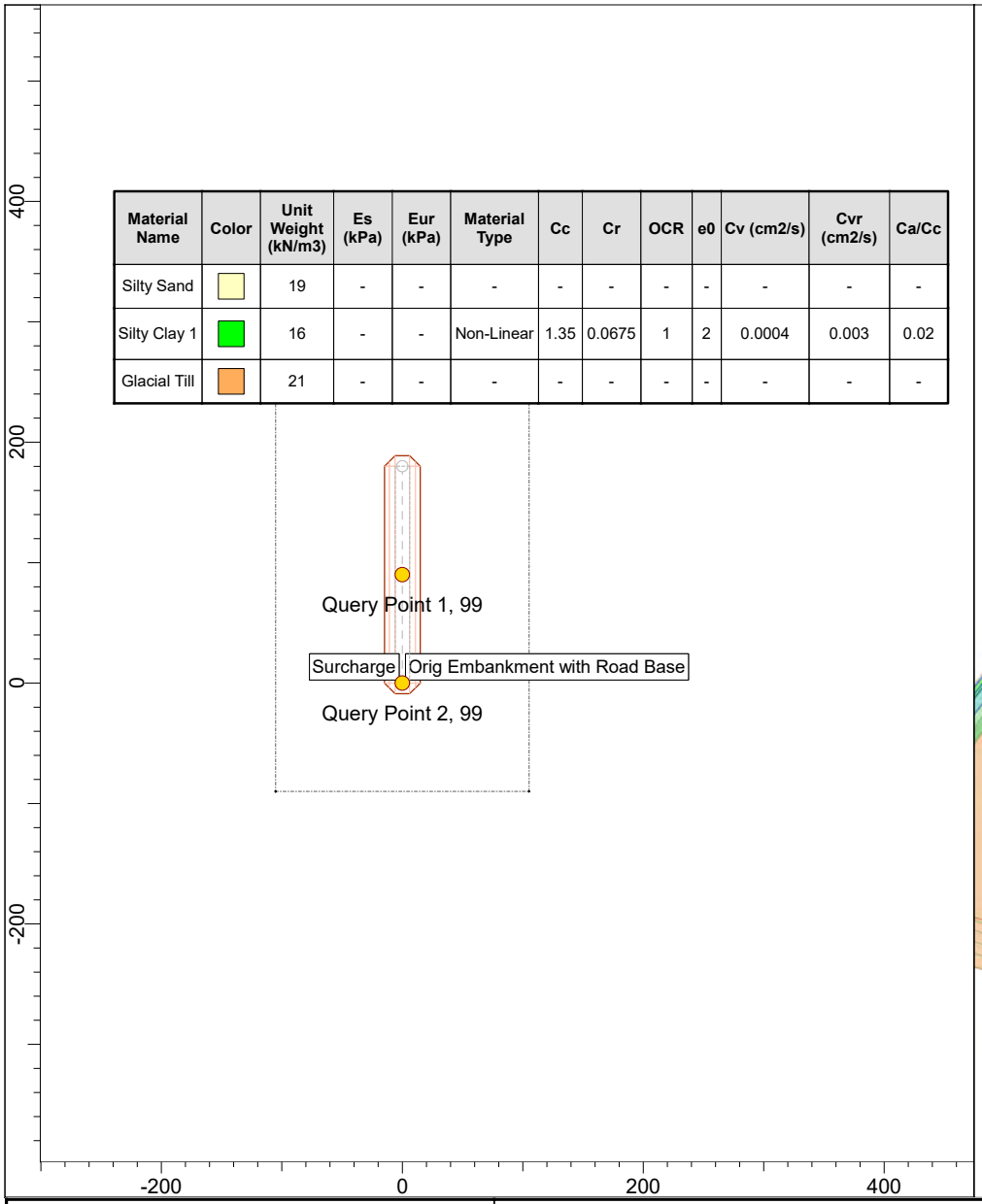
FOUNDATION INVESTIGATION AND PRELIMINARY DESIGN
IMPROVEMENTS TO COUNTY ROAD 3 APPROACHES
HIGHWAY 417, SITE NO. 27-212
UNITED COUNTIES OF PRESCOTT AND RUSSELL, ONTARIO, ONTARIO

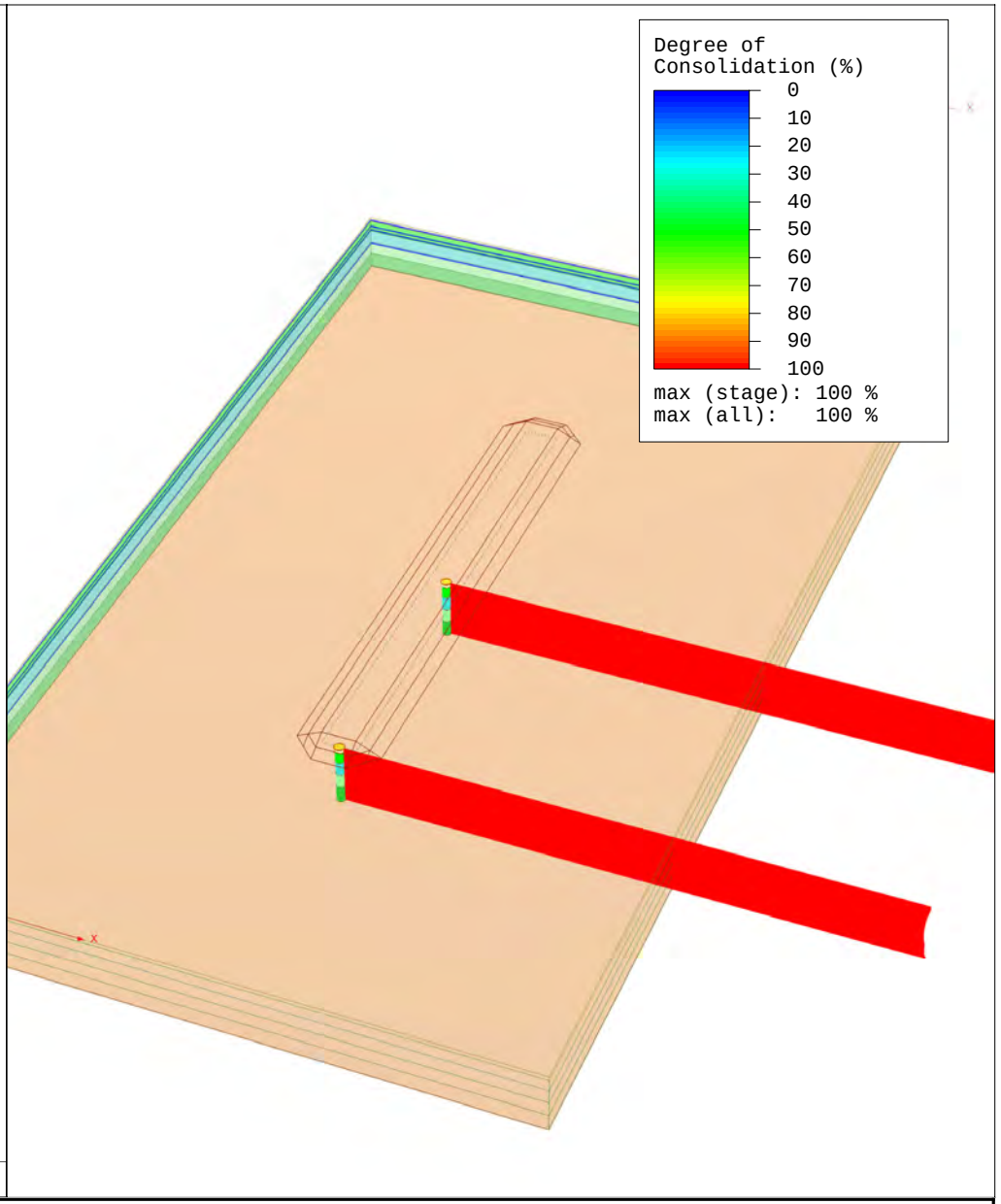
TOTAL SETTLEMENT OVER TIME - WESTBOUND LANES (with 1 m EPS)

Project No.	1899802
Drawn:	CK
Date:	28/11/2018
Checked:	CK
Review:	WC

FIGURE F4

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0004	0.003	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

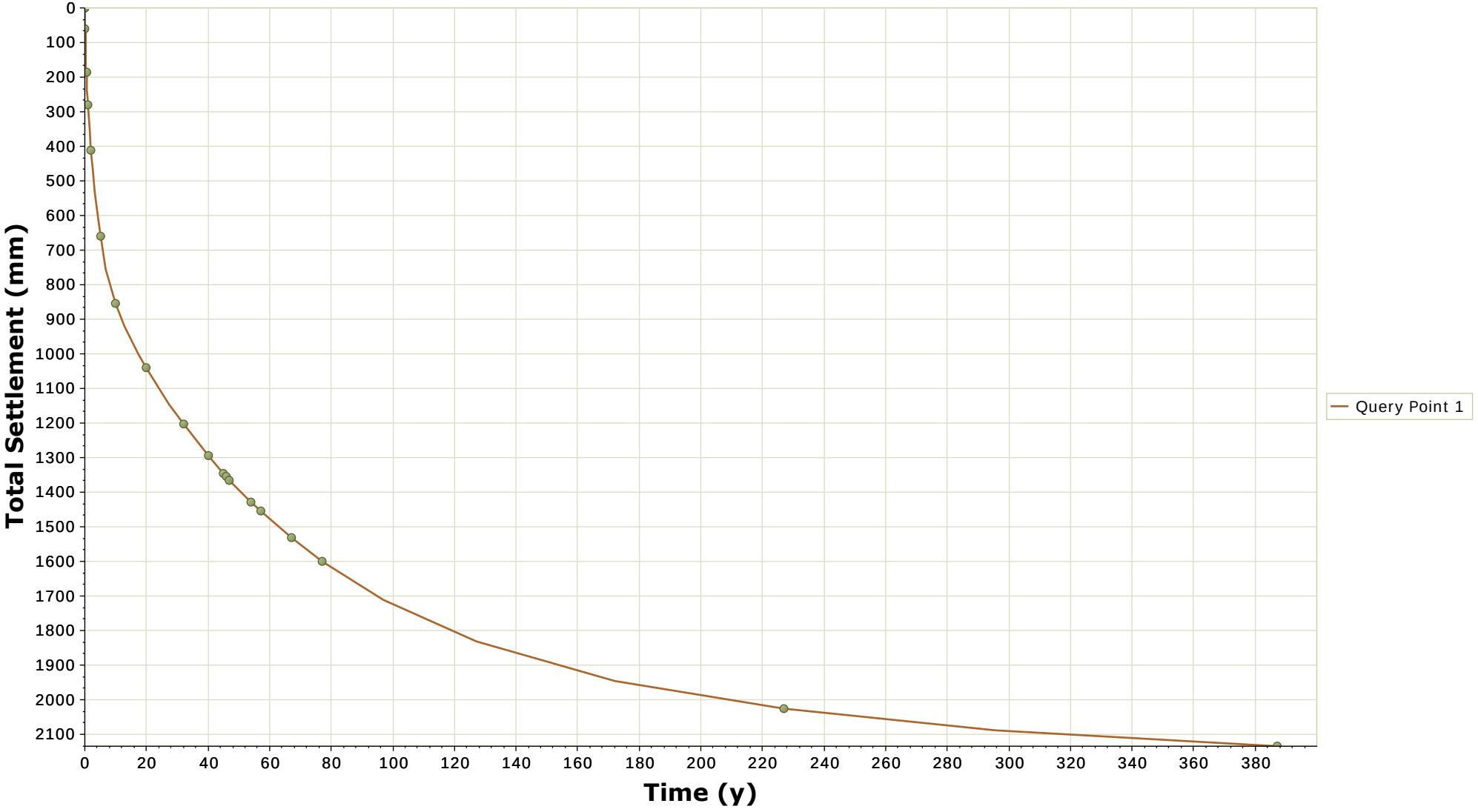




Project	Highway 417 / County Road 3 (EBL)		
Analysis Description	Preload 4 Months		
Drawn By	Ray Kennedy	Company	Golder Associates
Date	2019-03-14, 4:44:22 PM	File Name	1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Time vs. Total Settlement

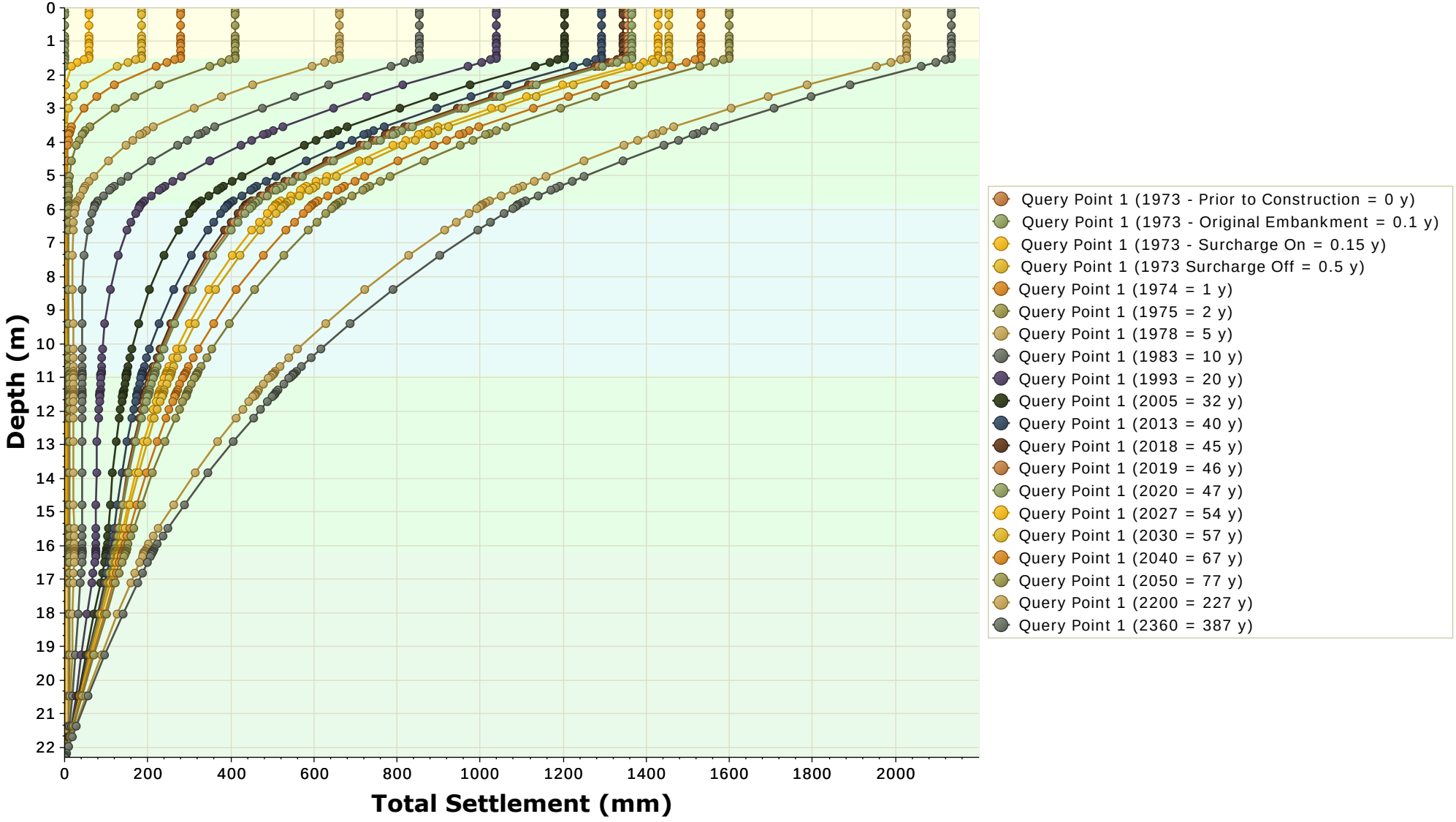


Reference Stage: None
Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Total Settlement vs. Depth

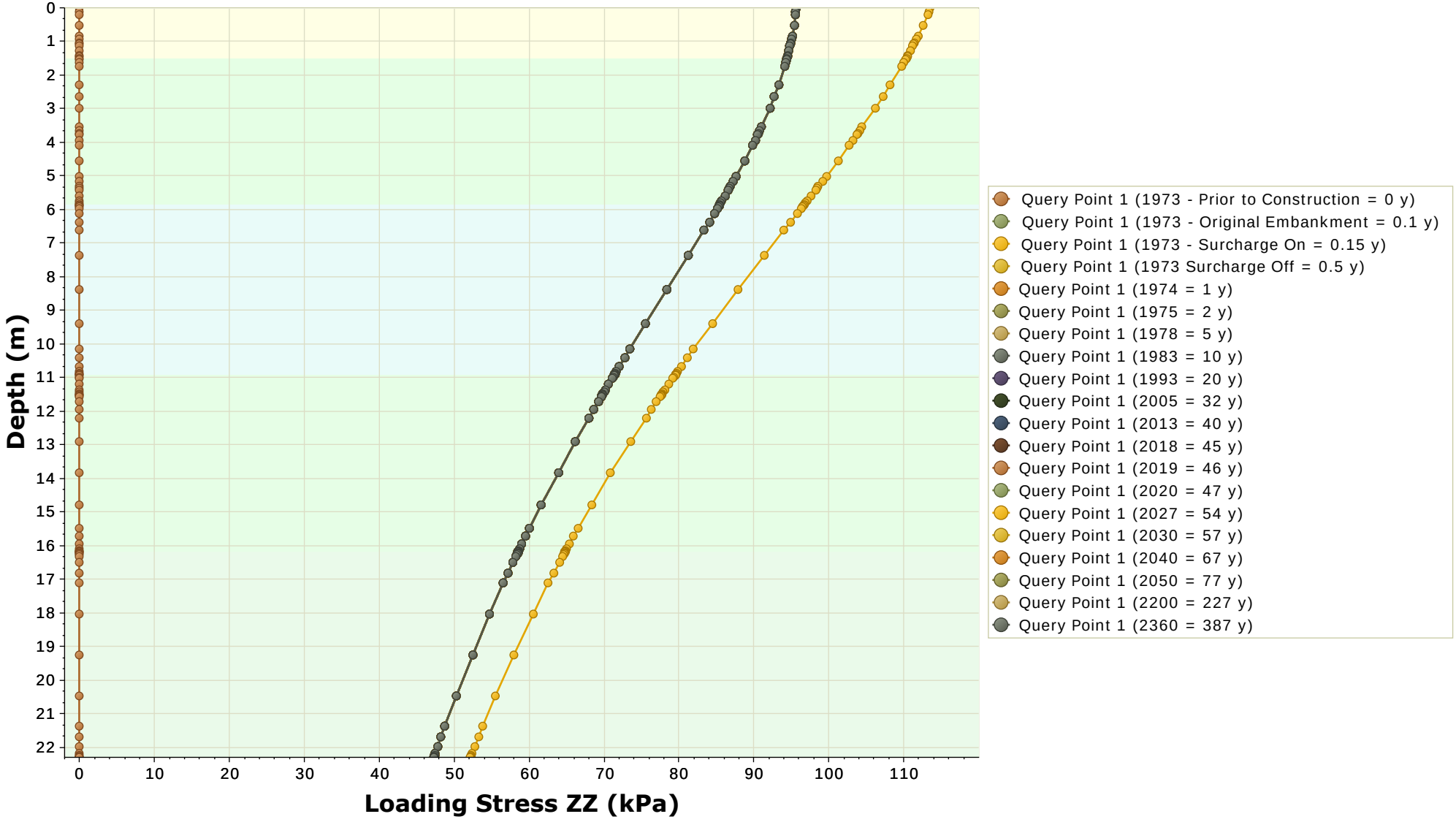


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Loading Stress ZZ vs. Depth

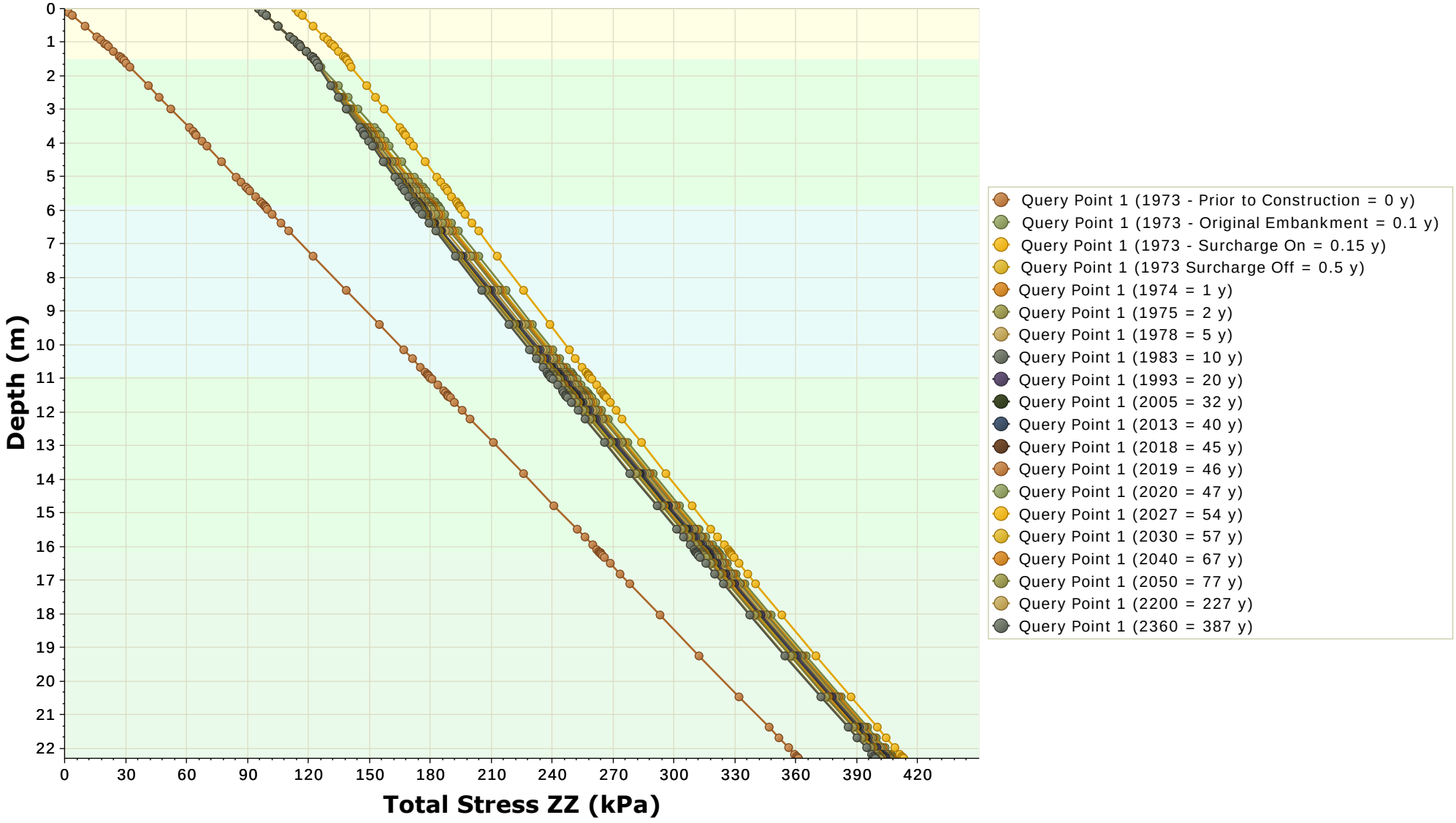


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

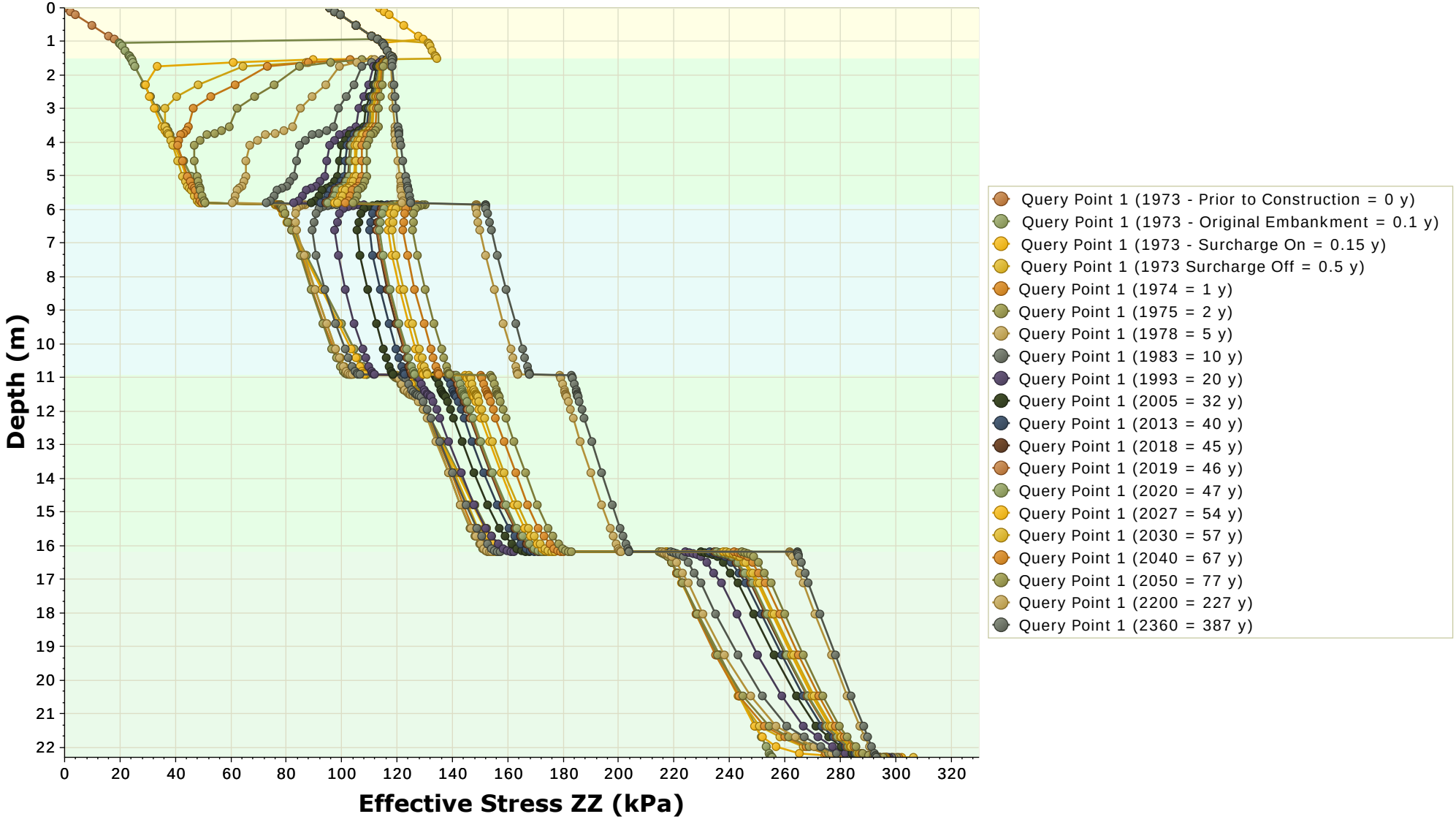
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

Effective Stress ZZ vs. Depth

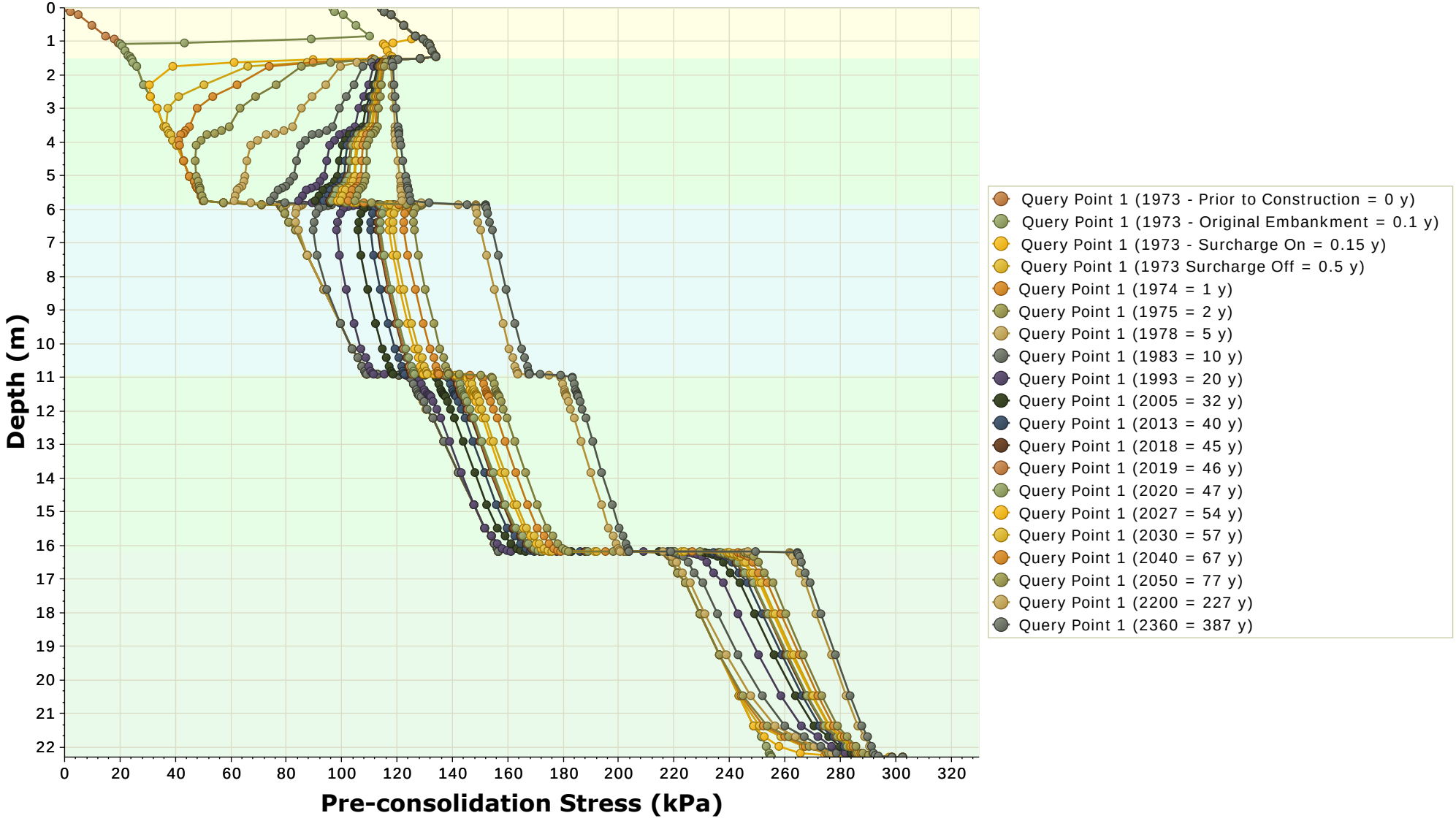


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

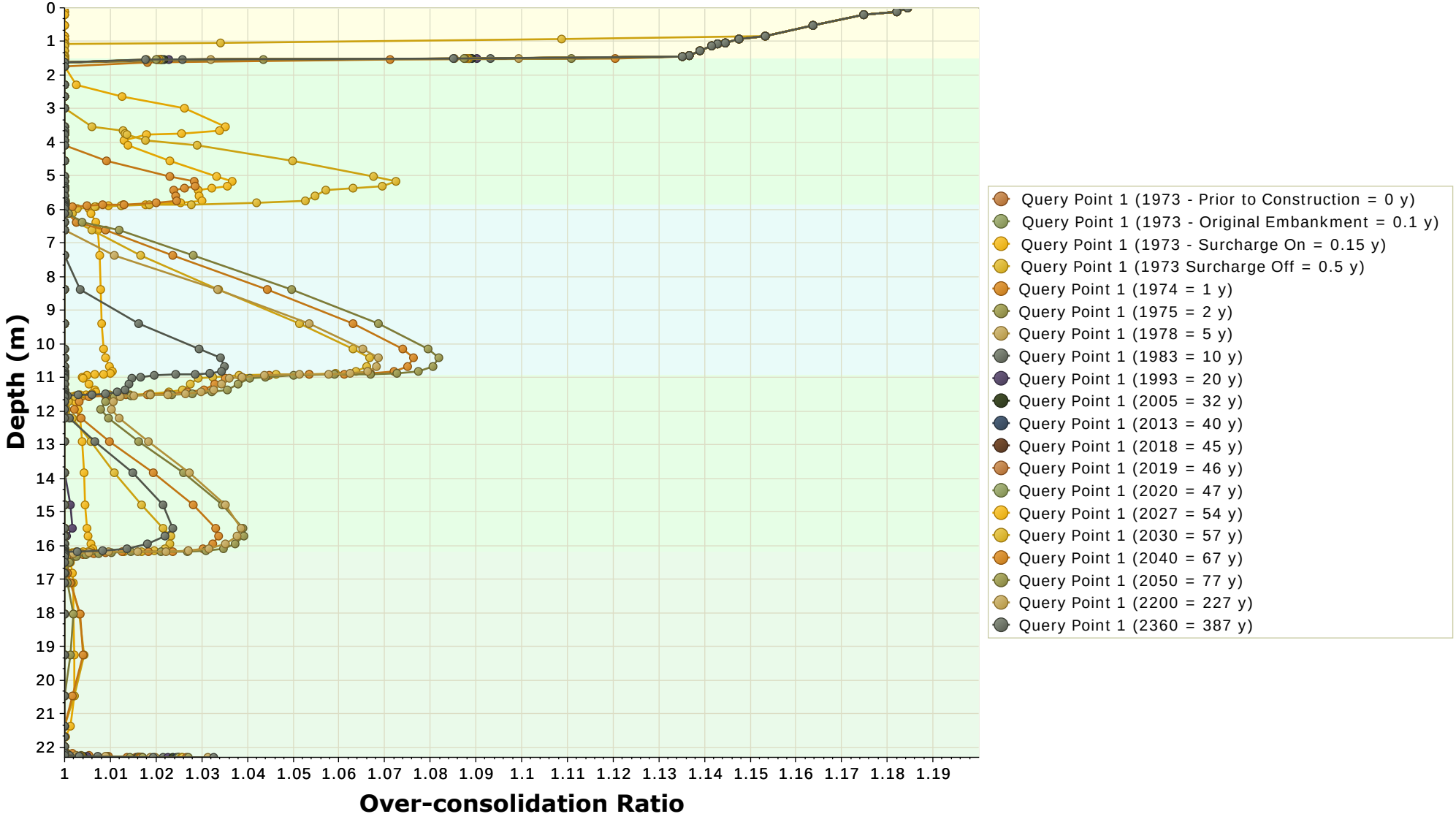


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

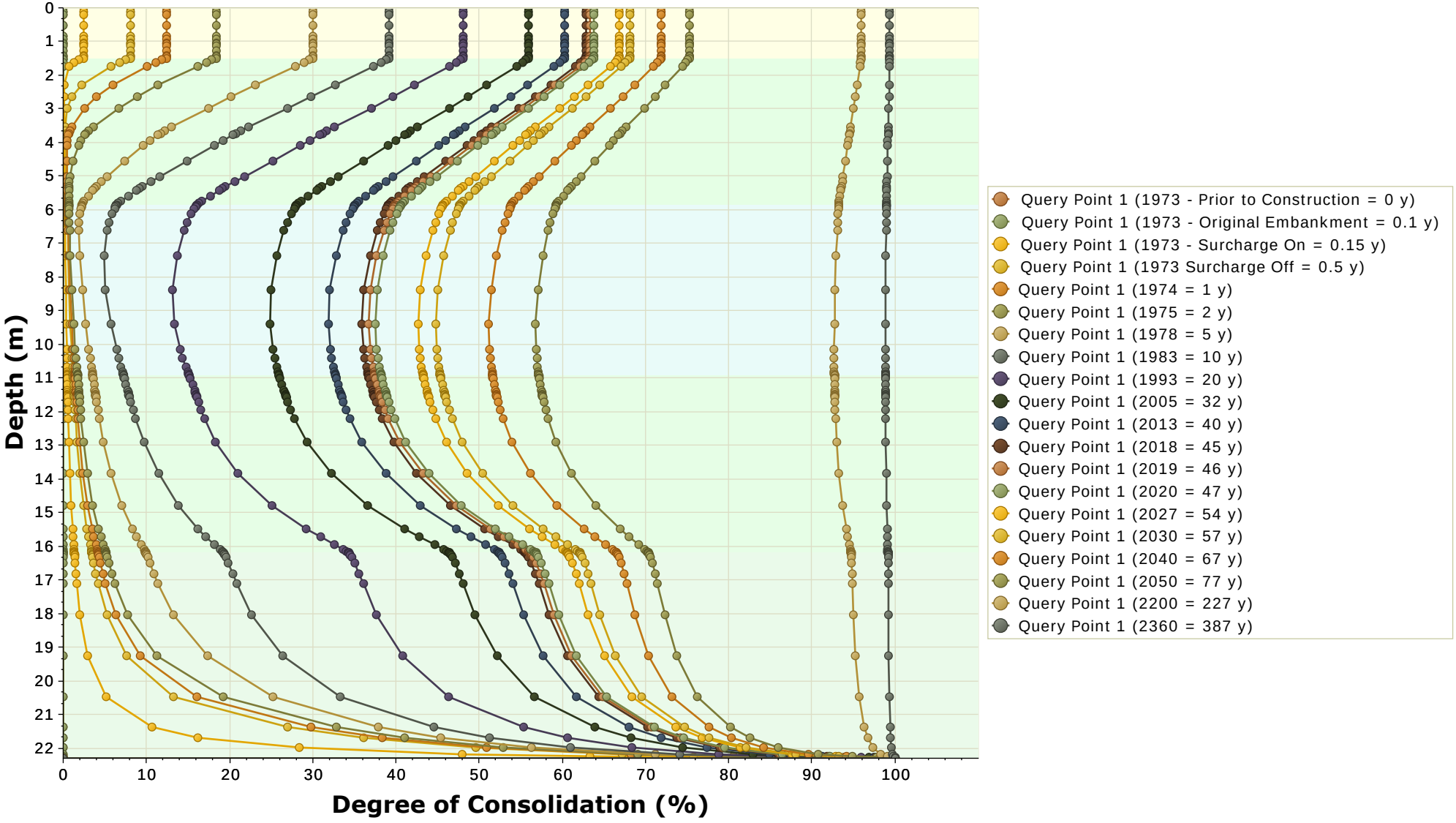


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

Degree of Consolidation vs. Depth

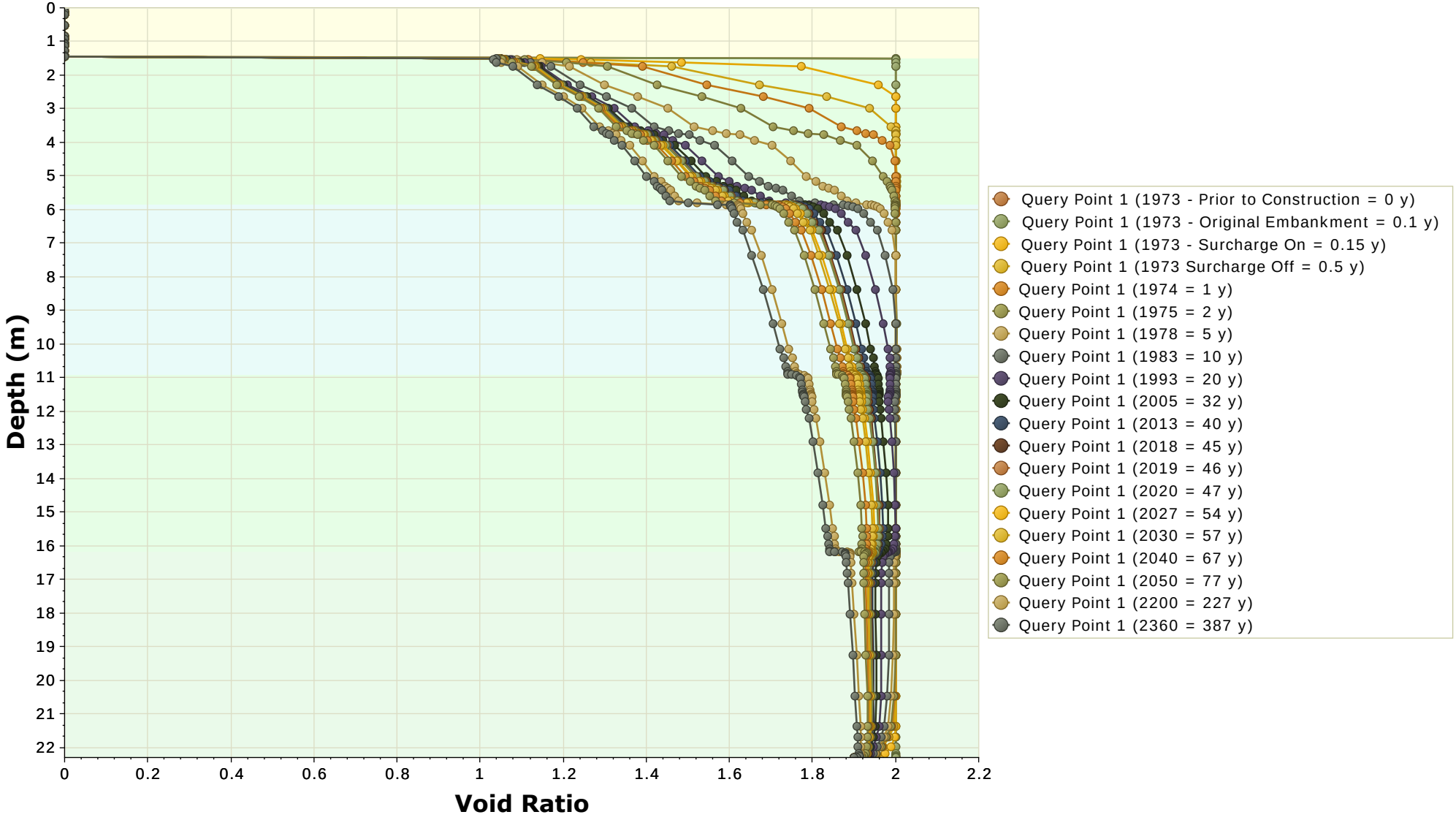


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

SETTLE3D 4.005

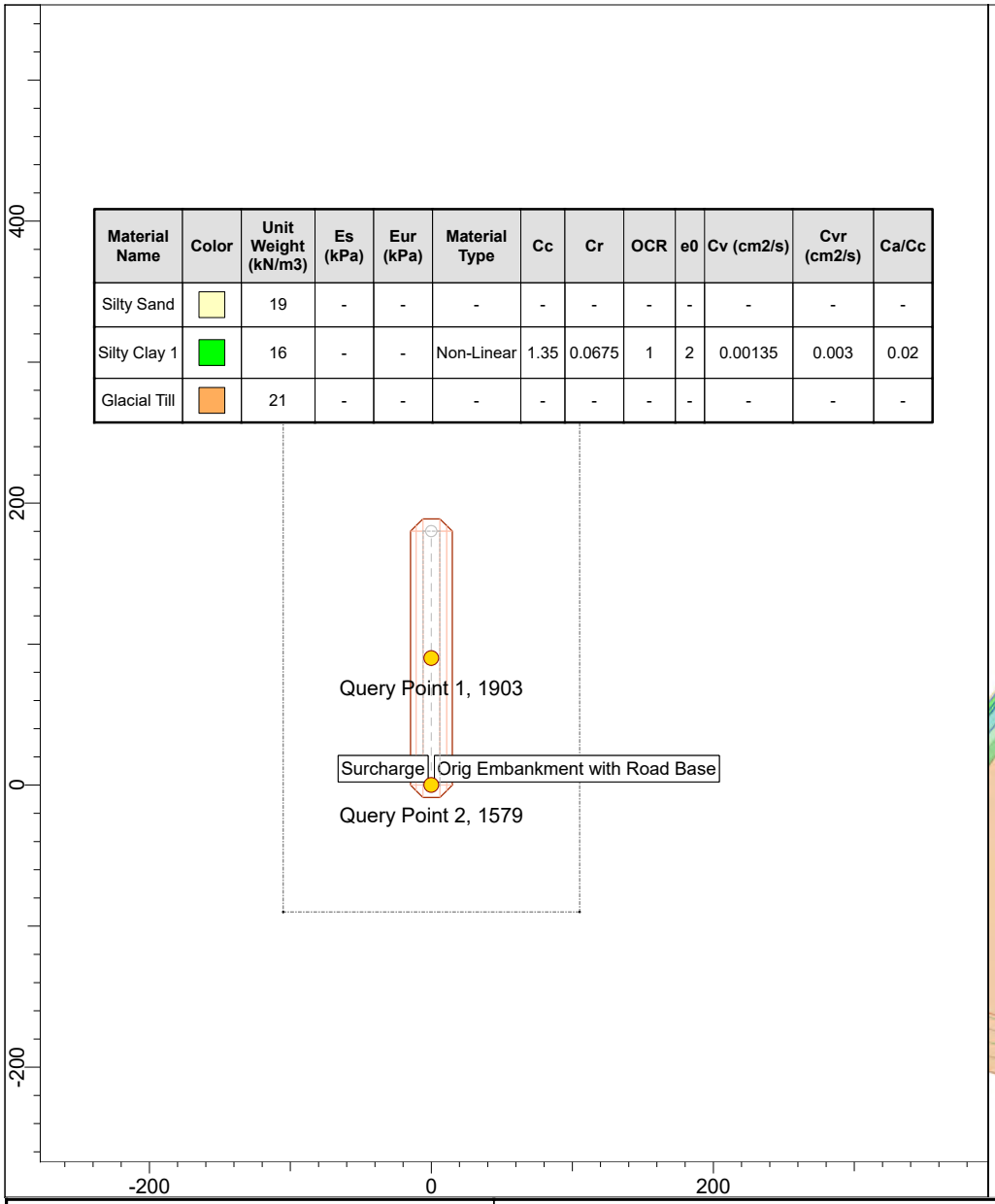
Void Ratio vs. Depth

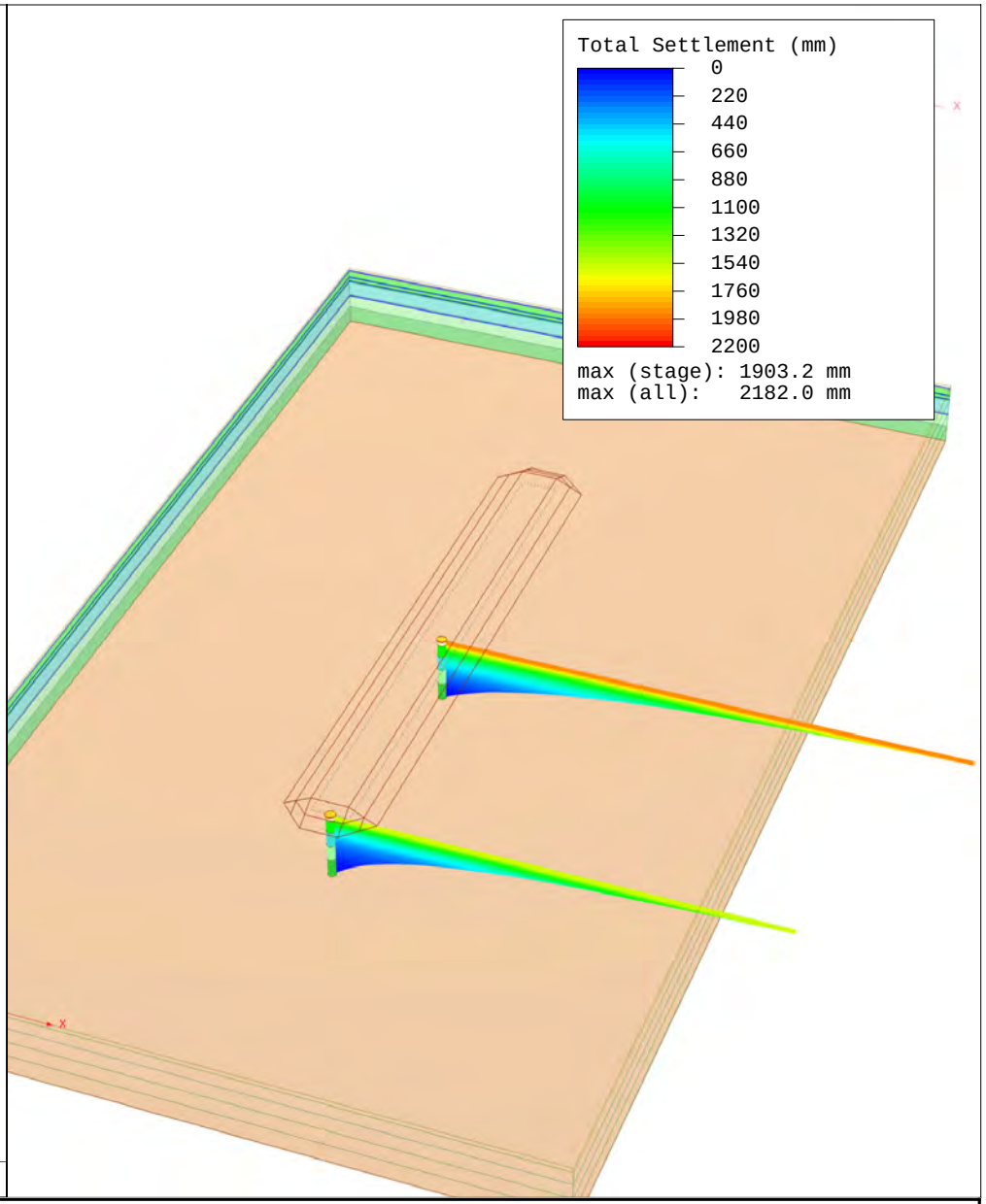


Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.00135	0.003	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

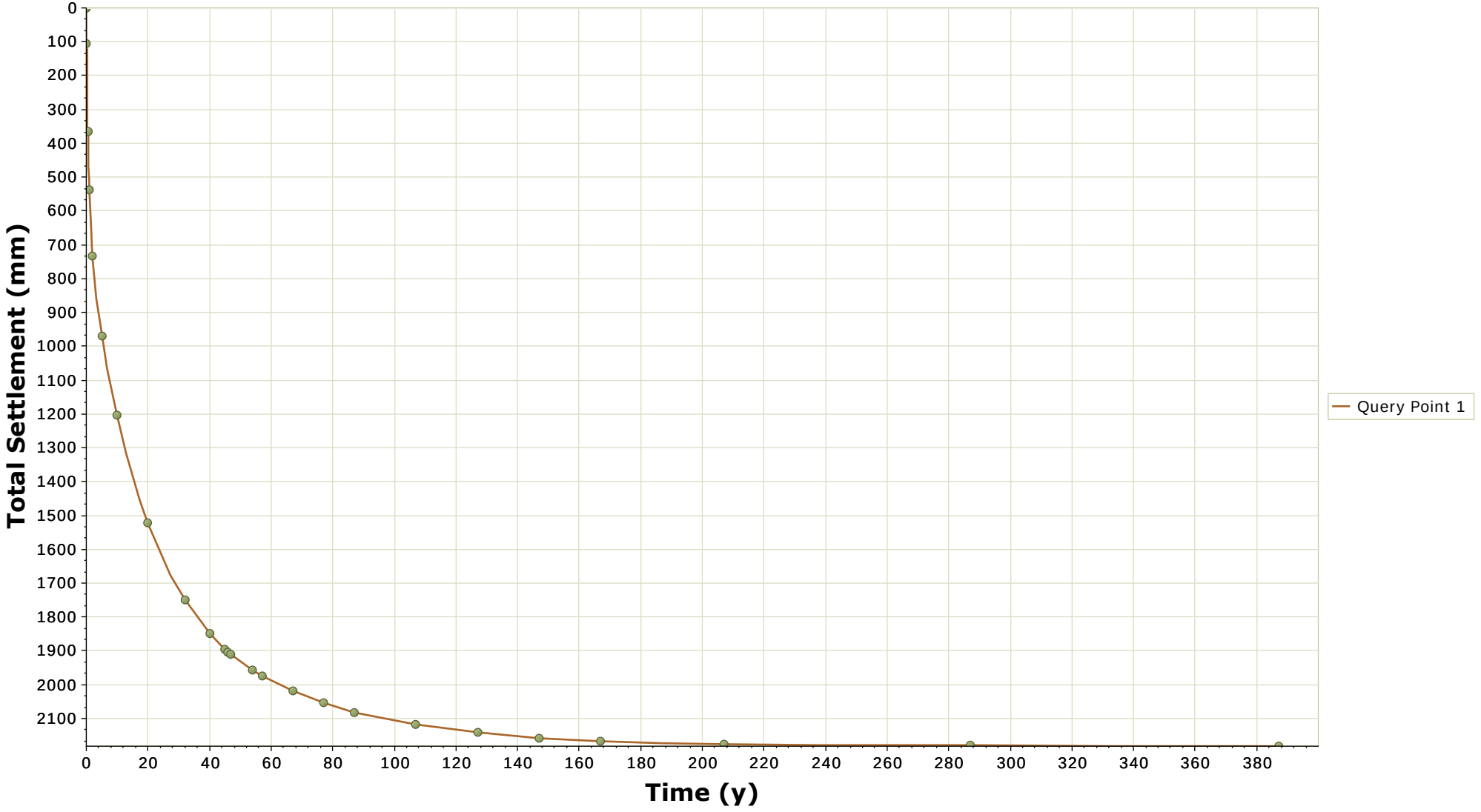




Project	Highway 417 / County Road 3 (EBL)	
Analysis Description	Preload 4 Months	
Drawn By	Ray Kennedy	Company: Golder Associates
Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

SETTLE3D 4.005

Time vs. Total Settlement



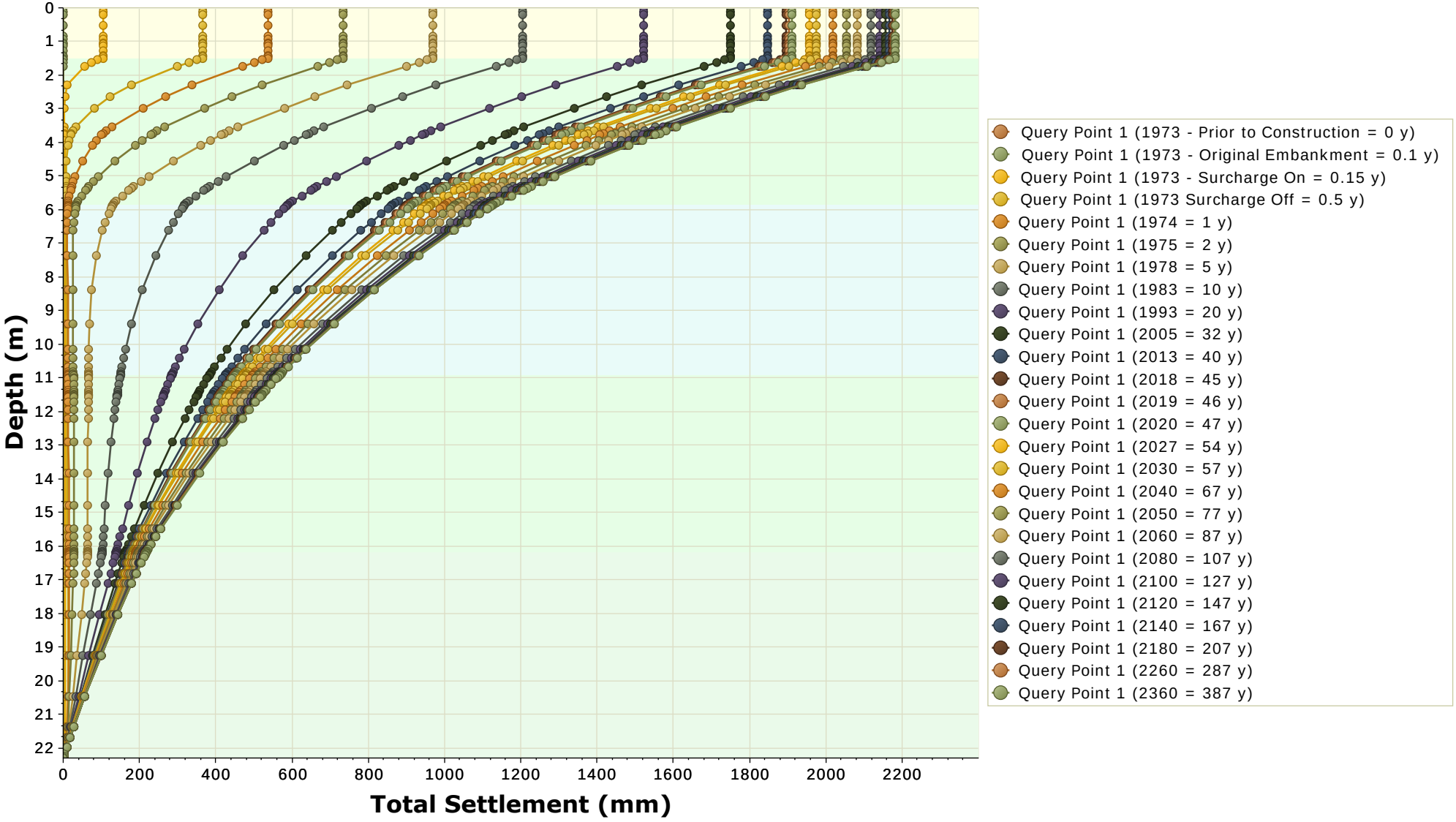
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

SETTLE3D 4.005

Total Settlement vs. Depth

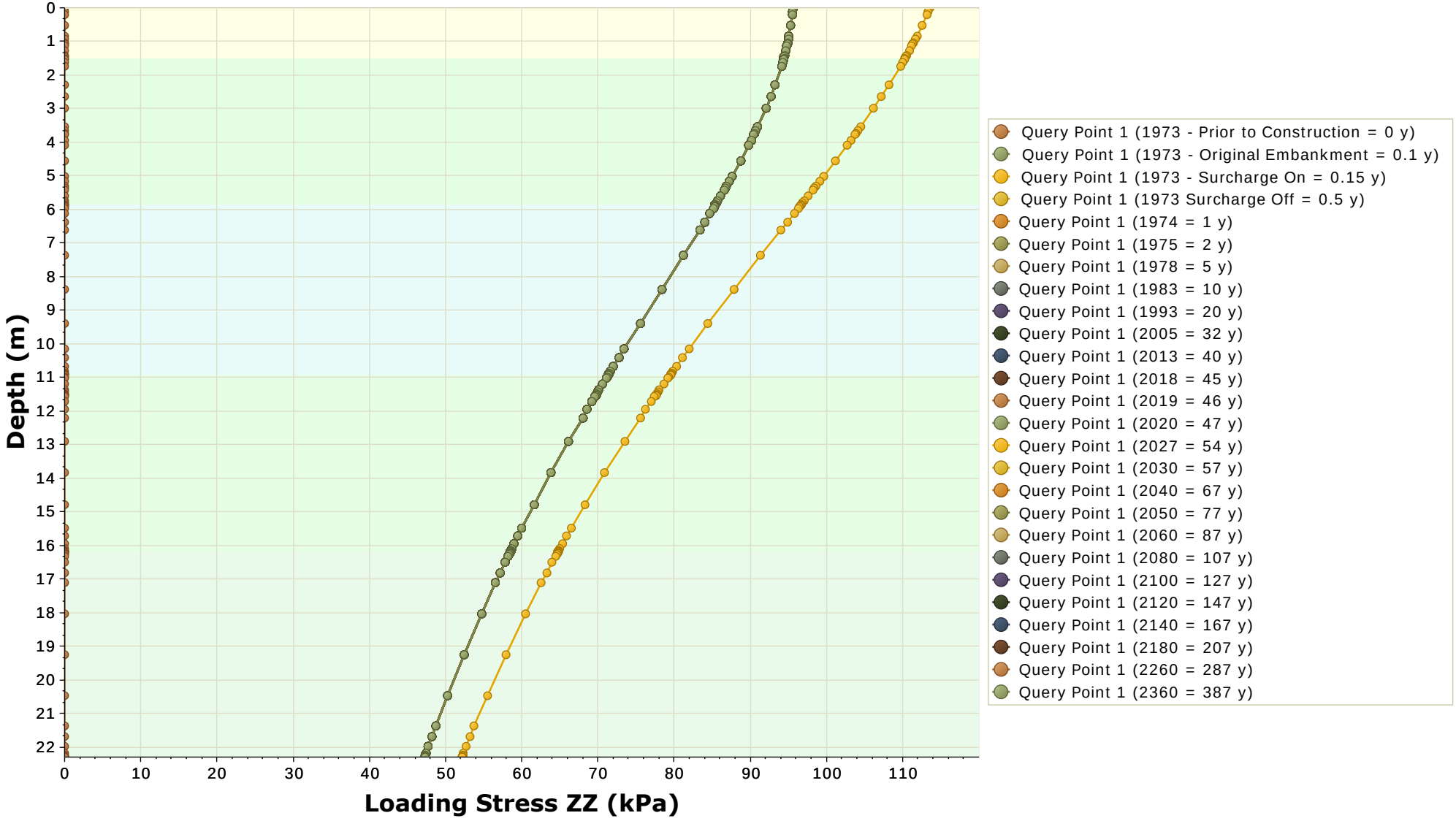


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

SETTLE3D 4.005

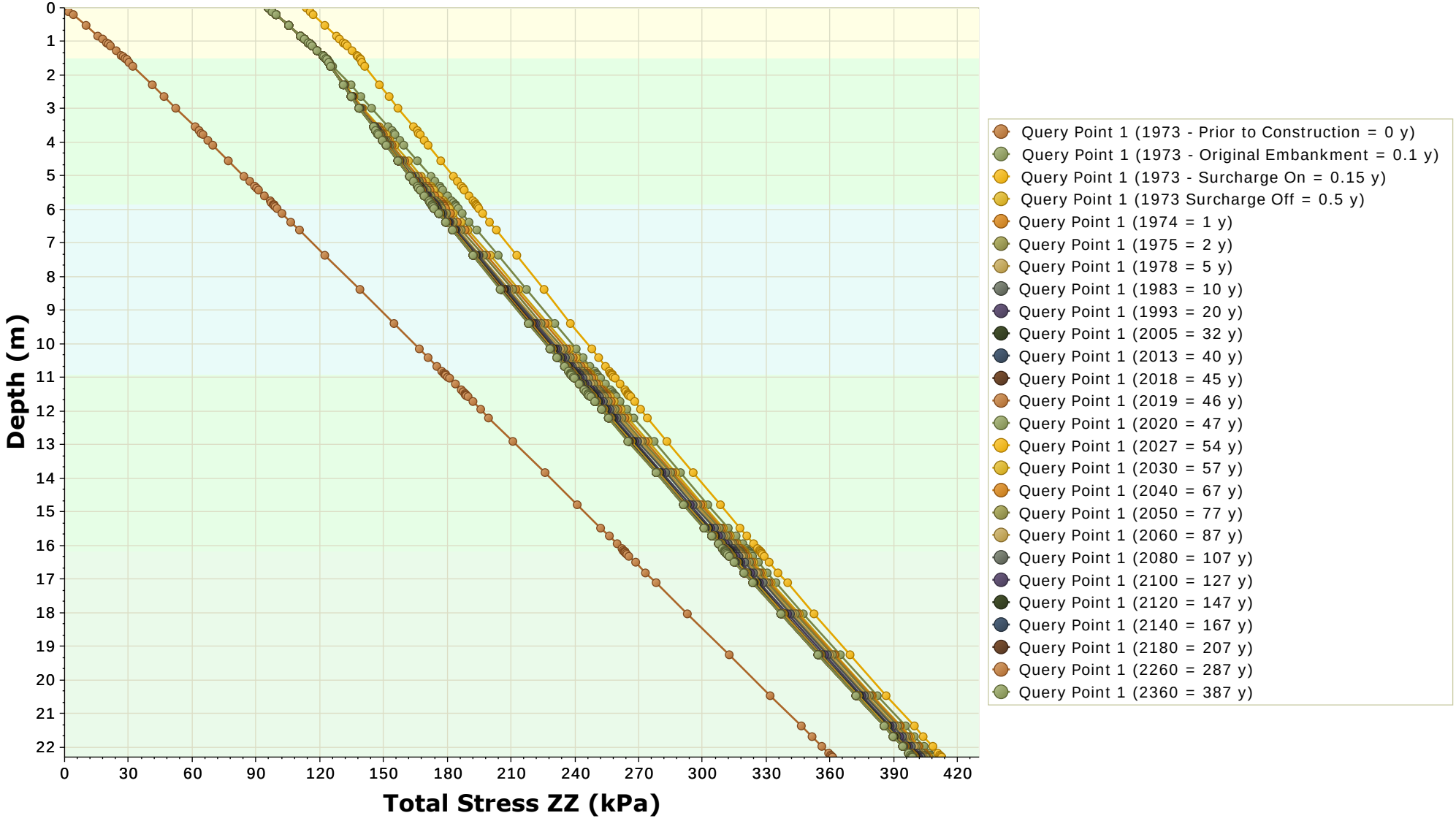
Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

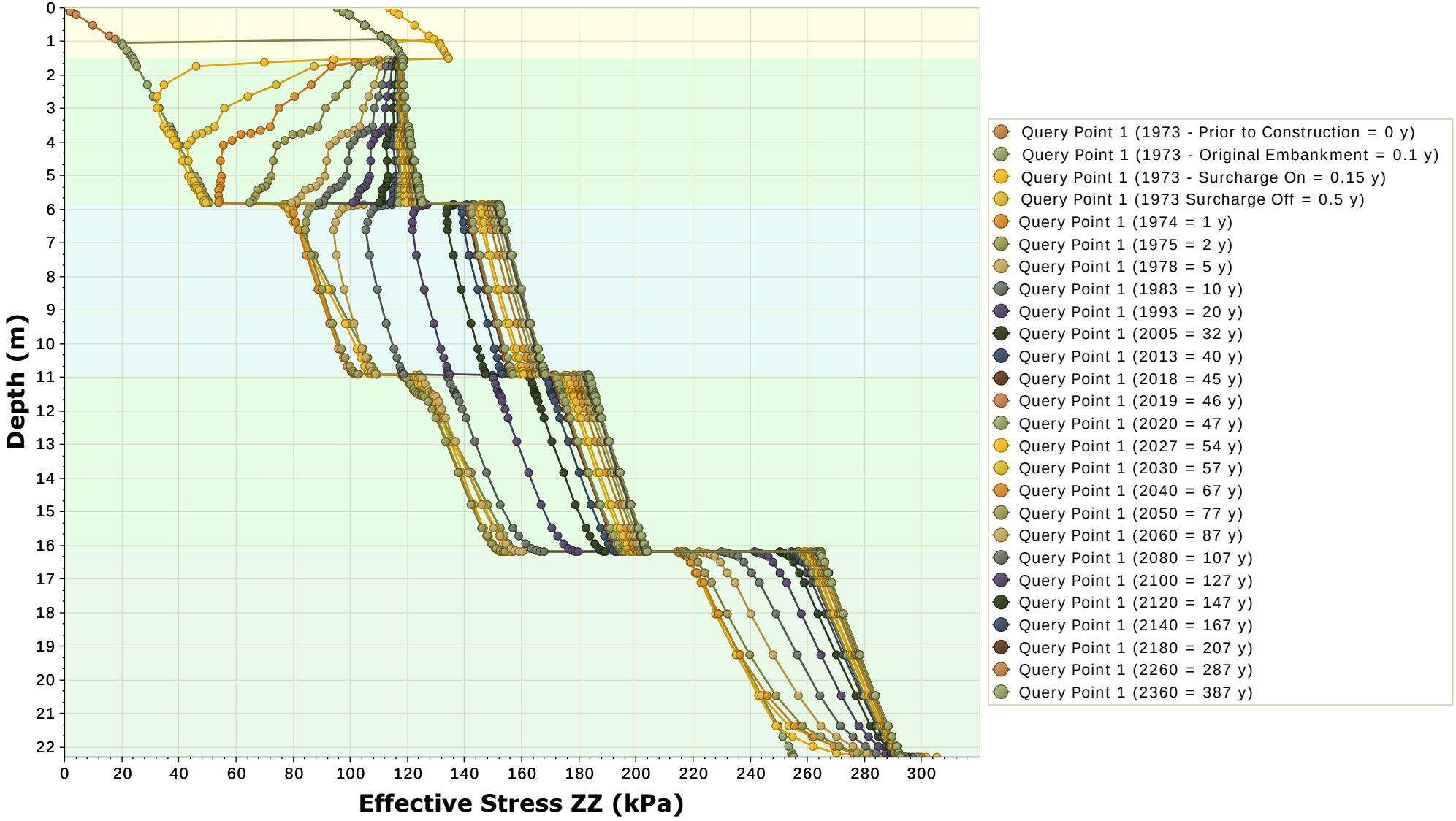
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

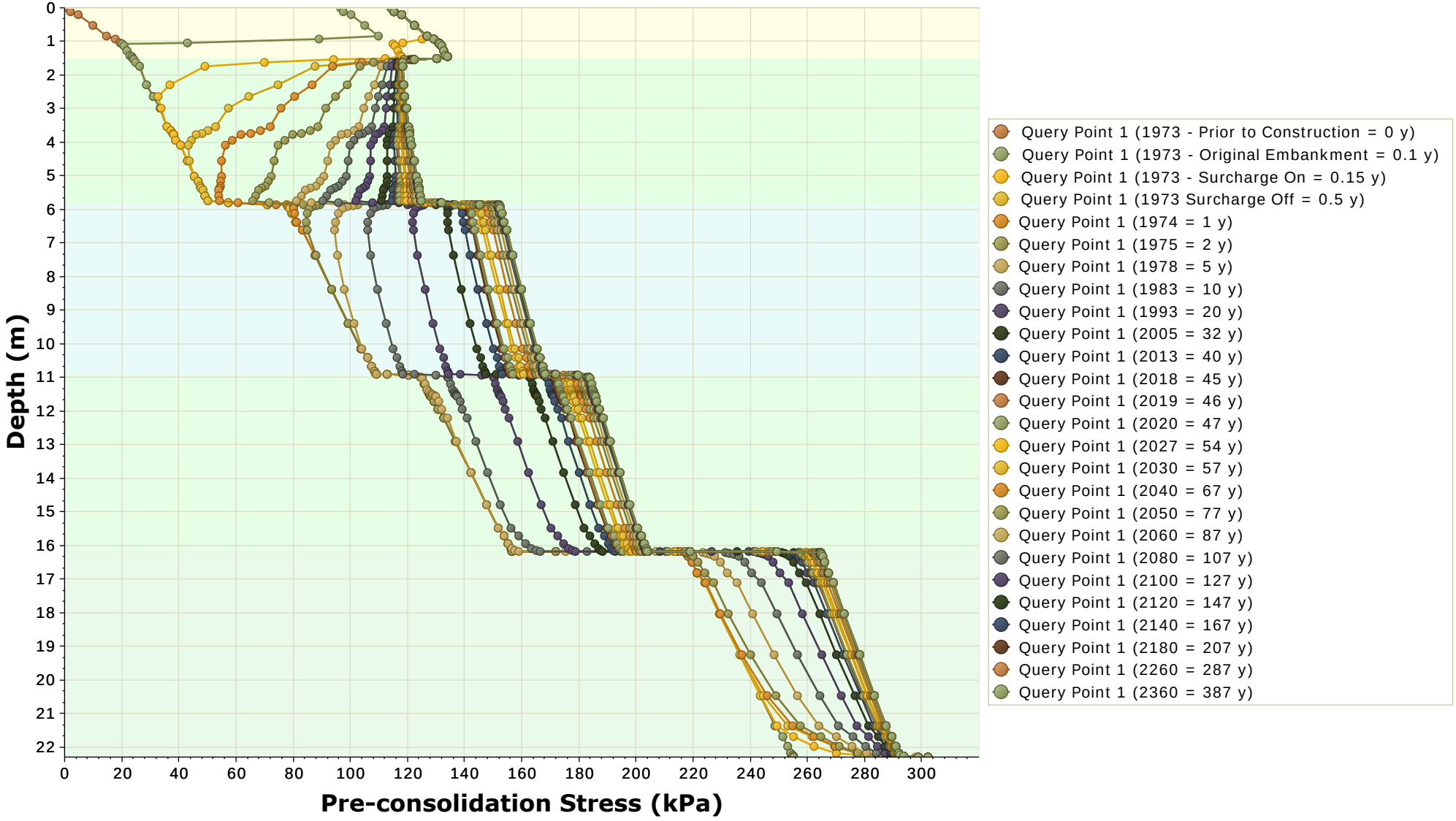
Effective Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

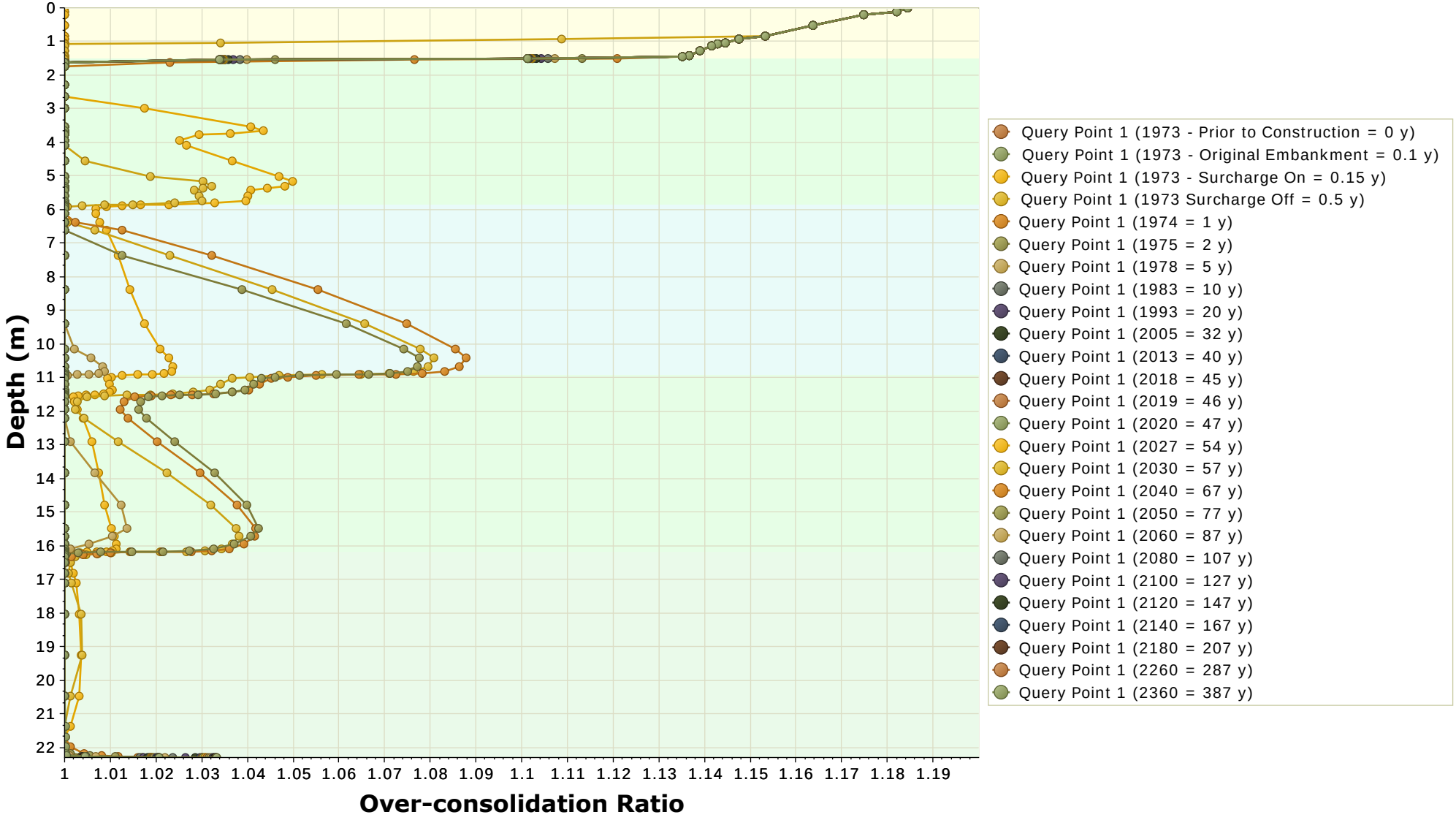
Pre-consolidation Stress vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

Over-consolidation Ratio vs. Depth

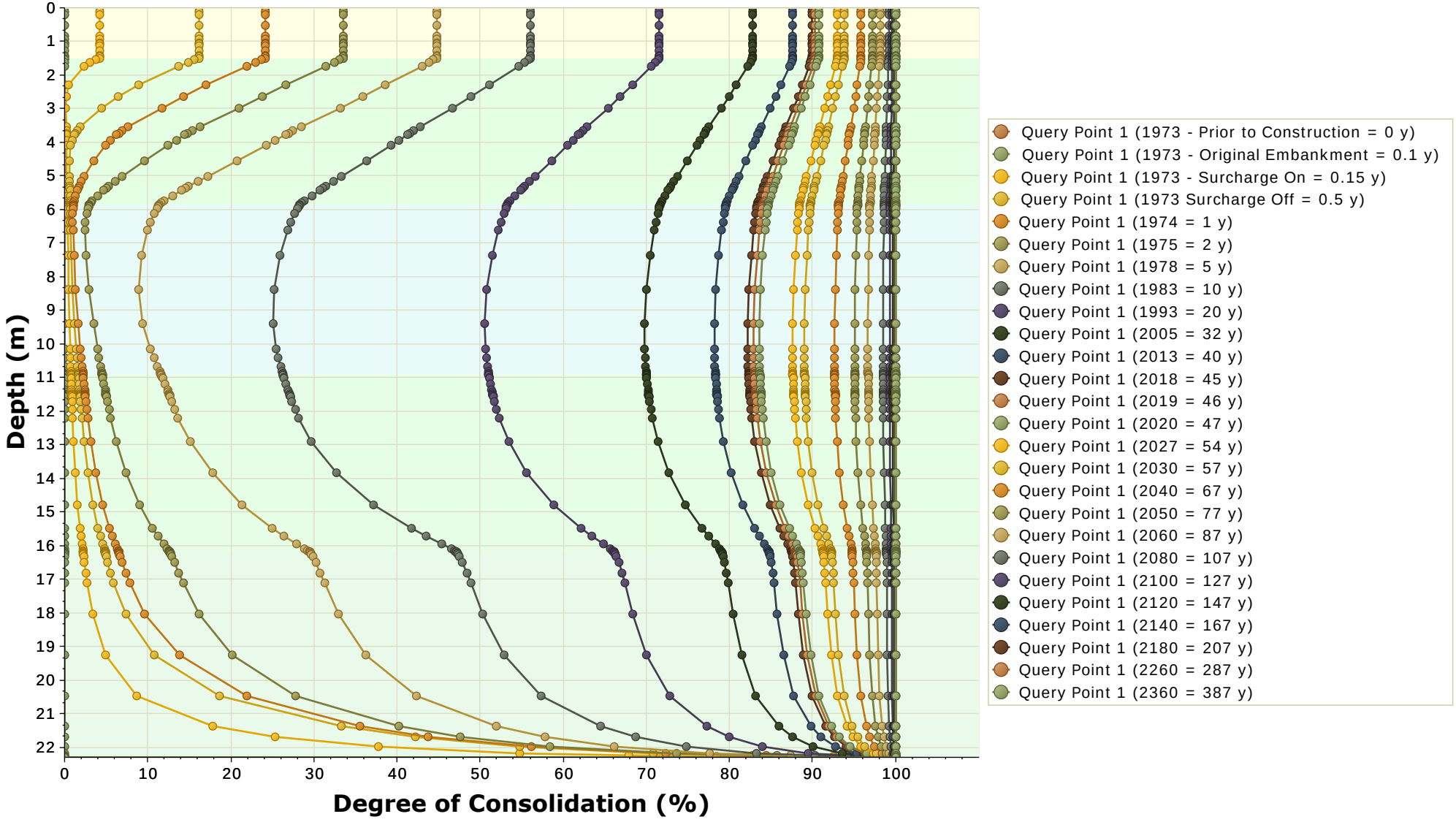


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

SETTLE3D 4.005

Degree of Consolidation vs. Depth

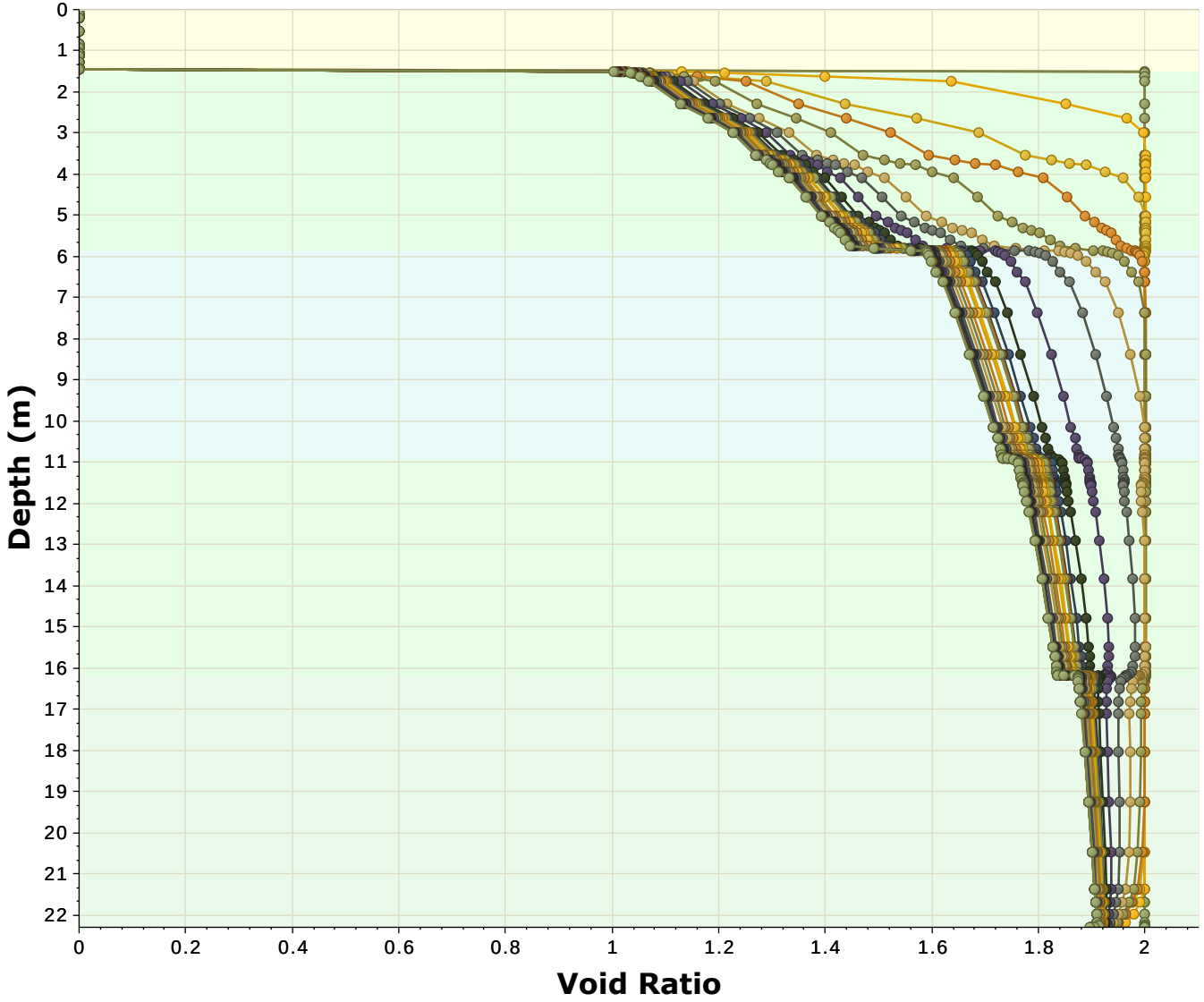


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

SETTLE3D 4.005

Void Ratio vs. Depth

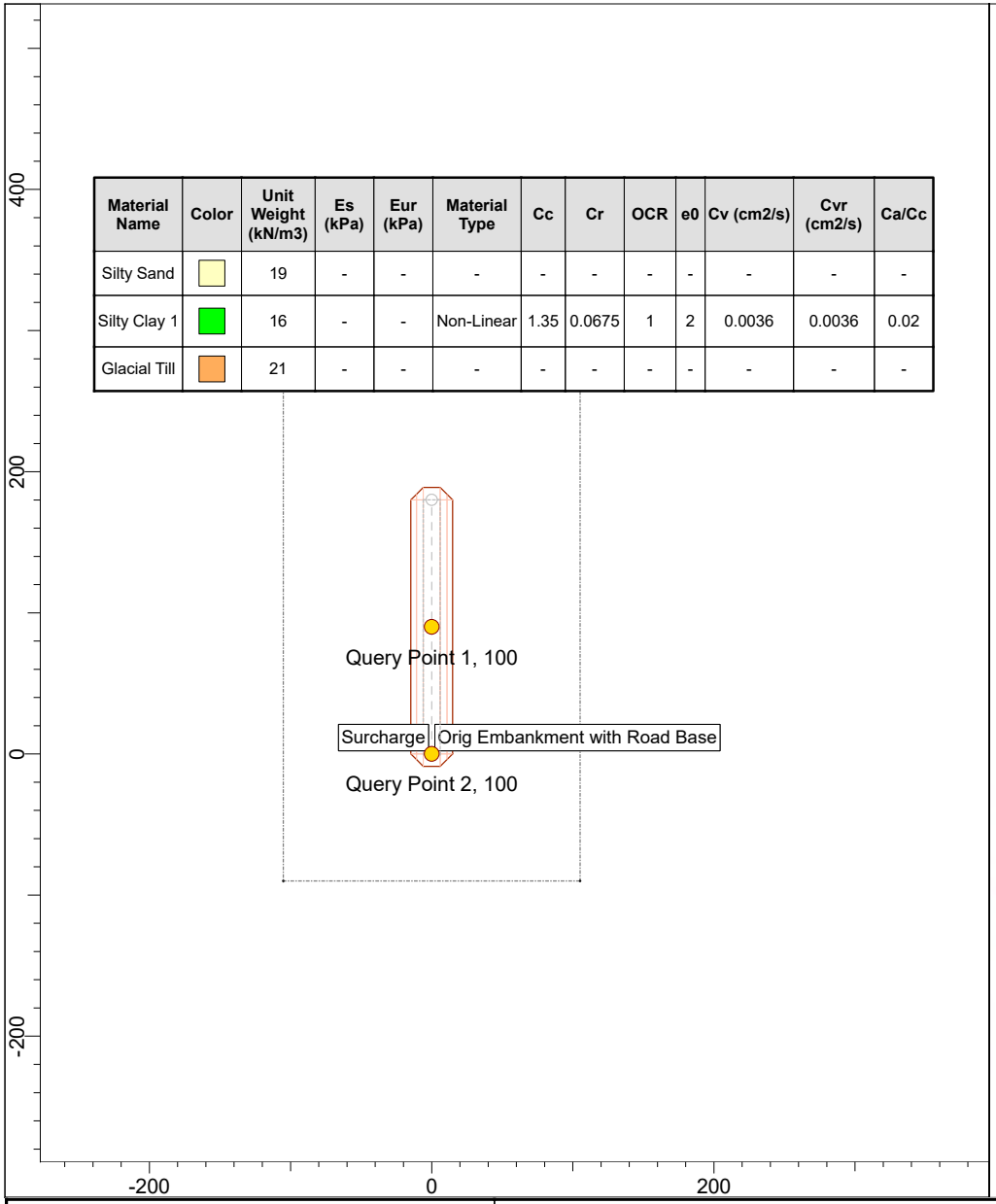


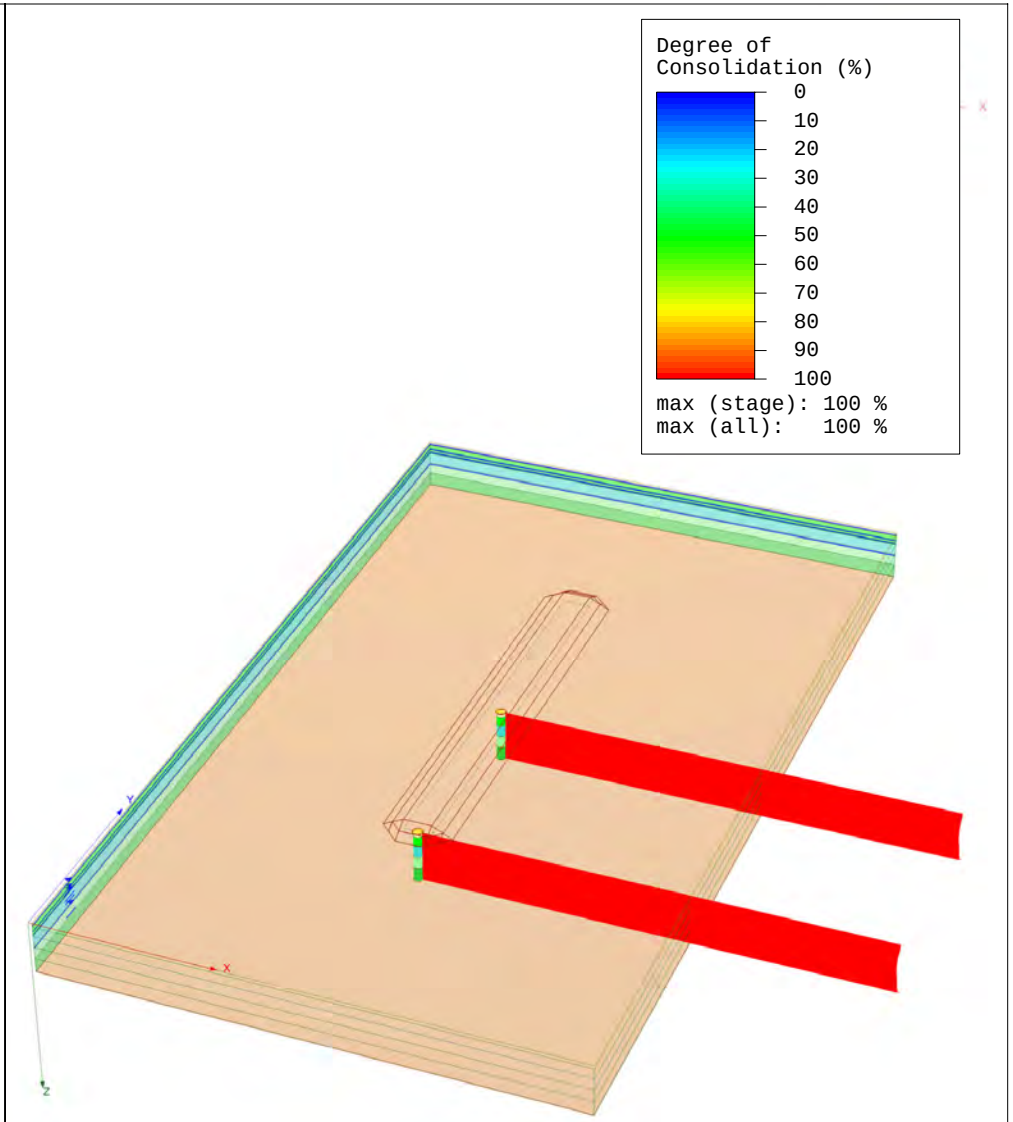
- Query Point 1 (1973 - Prior to Construction = 0 y)
- Query Point 1 (1973 - Original Embankment = 0.1 y)
- Query Point 1 (1973 - Surcharge On = 0.15 y)
- Query Point 1 (1973 Surcharge Off = 0.5 y)
- Query Point 1 (1974 = 1 y)
- Query Point 1 (1975 = 2 y)
- Query Point 1 (1978 = 5 y)
- Query Point 1 (1983 = 10 y)
- Query Point 1 (1993 = 20 y)
- Query Point 1 (2005 = 32 y)
- Query Point 1 (2013 = 40 y)
- Query Point 1 (2018 = 45 y)
- Query Point 1 (2019 = 46 y)
- Query Point 1 (2020 = 47 y)
- Query Point 1 (2027 = 54 y)
- Query Point 1 (2030 = 57 y)
- Query Point 1 (2040 = 67 y)
- Query Point 1 (2050 = 77 y)
- Query Point 1 (2060 = 87 y)
- Query Point 1 (2080 = 107 y)
- Query Point 1 (2100 = 127 y)
- Query Point 1 (2120 = 147 y)
- Query Point 1 (2140 = 167 y)
- Query Point 1 (2180 = 207 y)
- Query Point 1 (2260 = 287 y)
- Query Point 1 (2360 = 387 y)

Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0036	0.0036	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

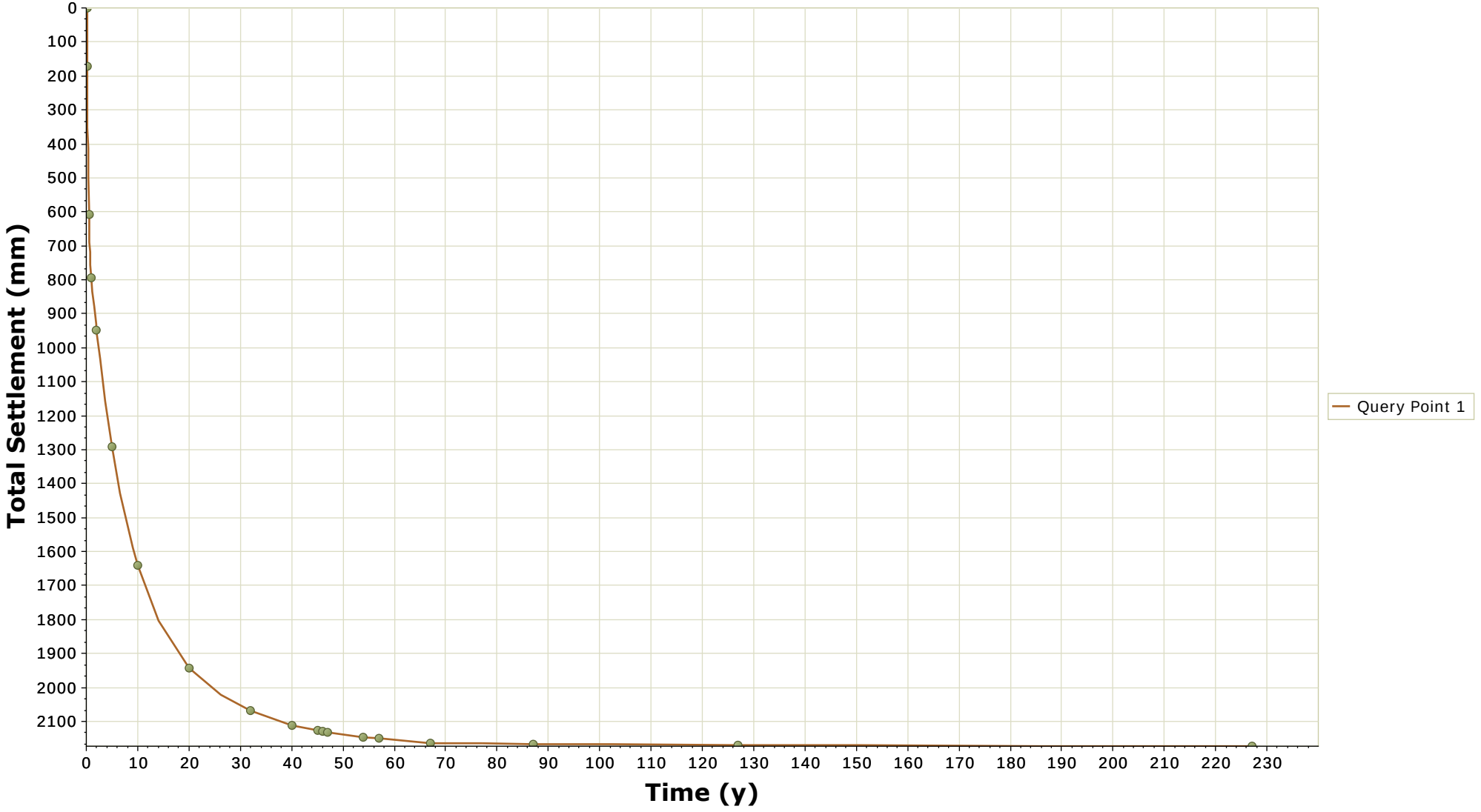




rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Time vs. Total Settlement



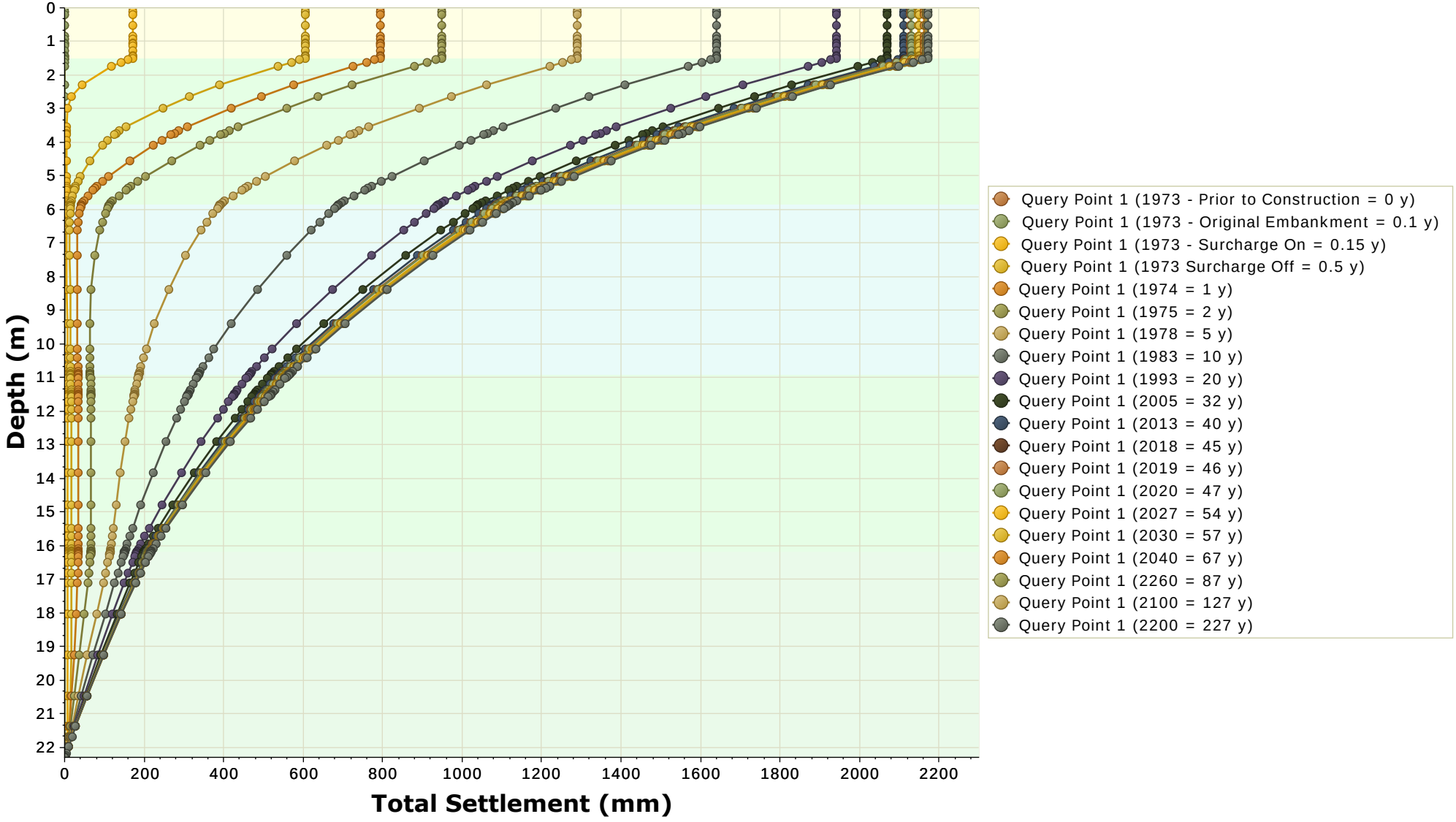
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Total Settlement vs. Depth

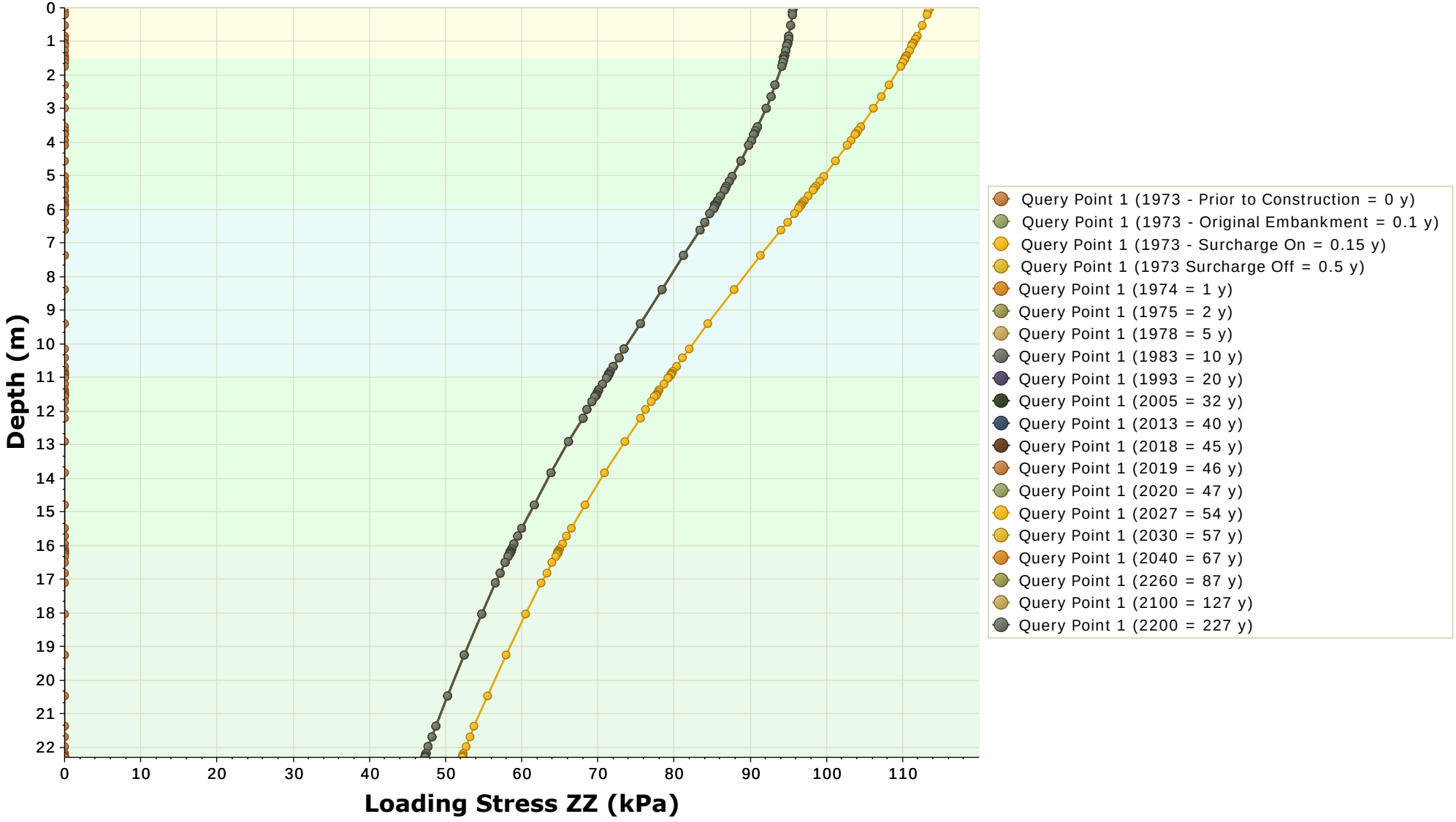


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Loading Stress ZZ vs. Depth

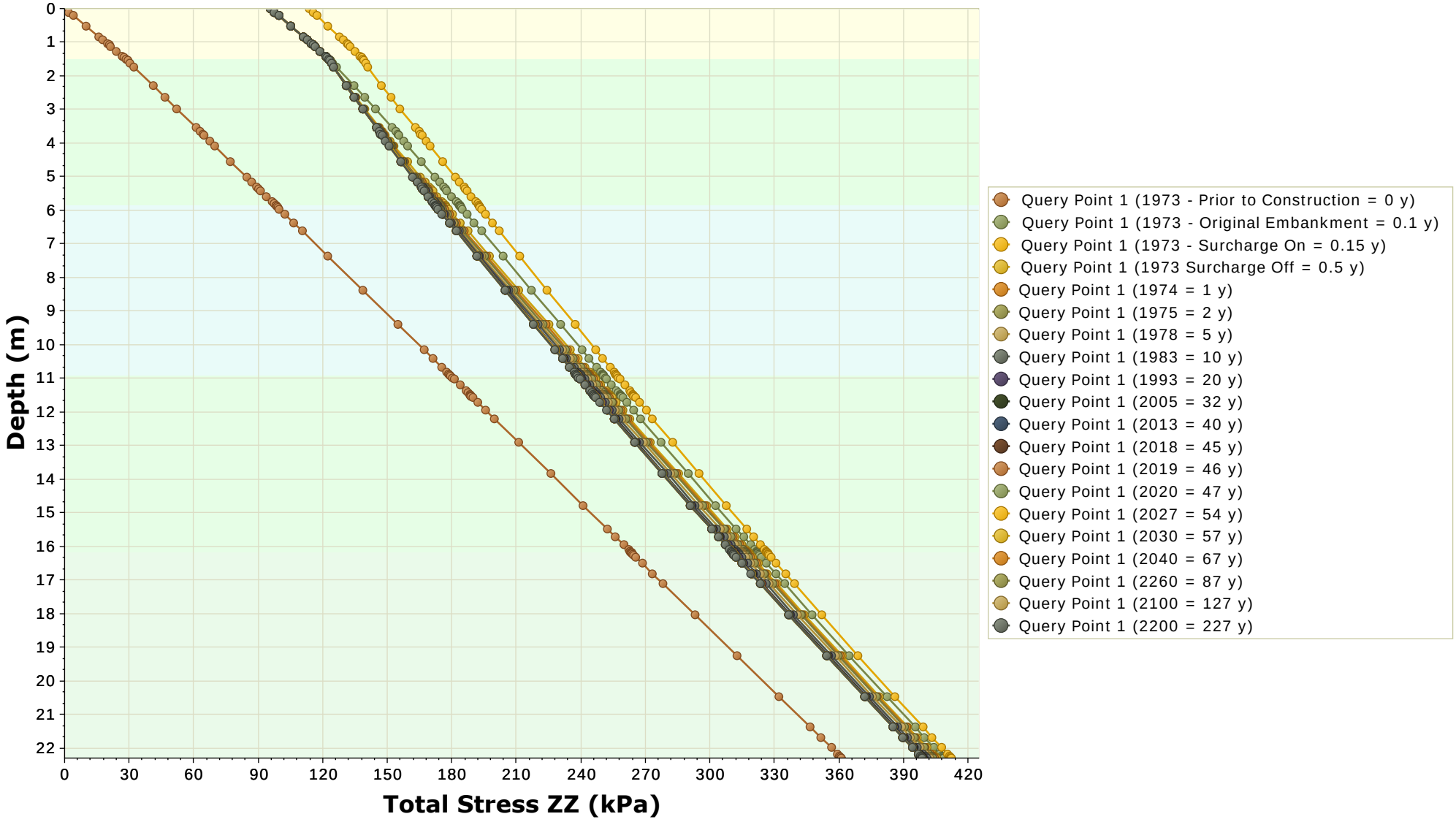


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Total Stress ZZ vs. Depth

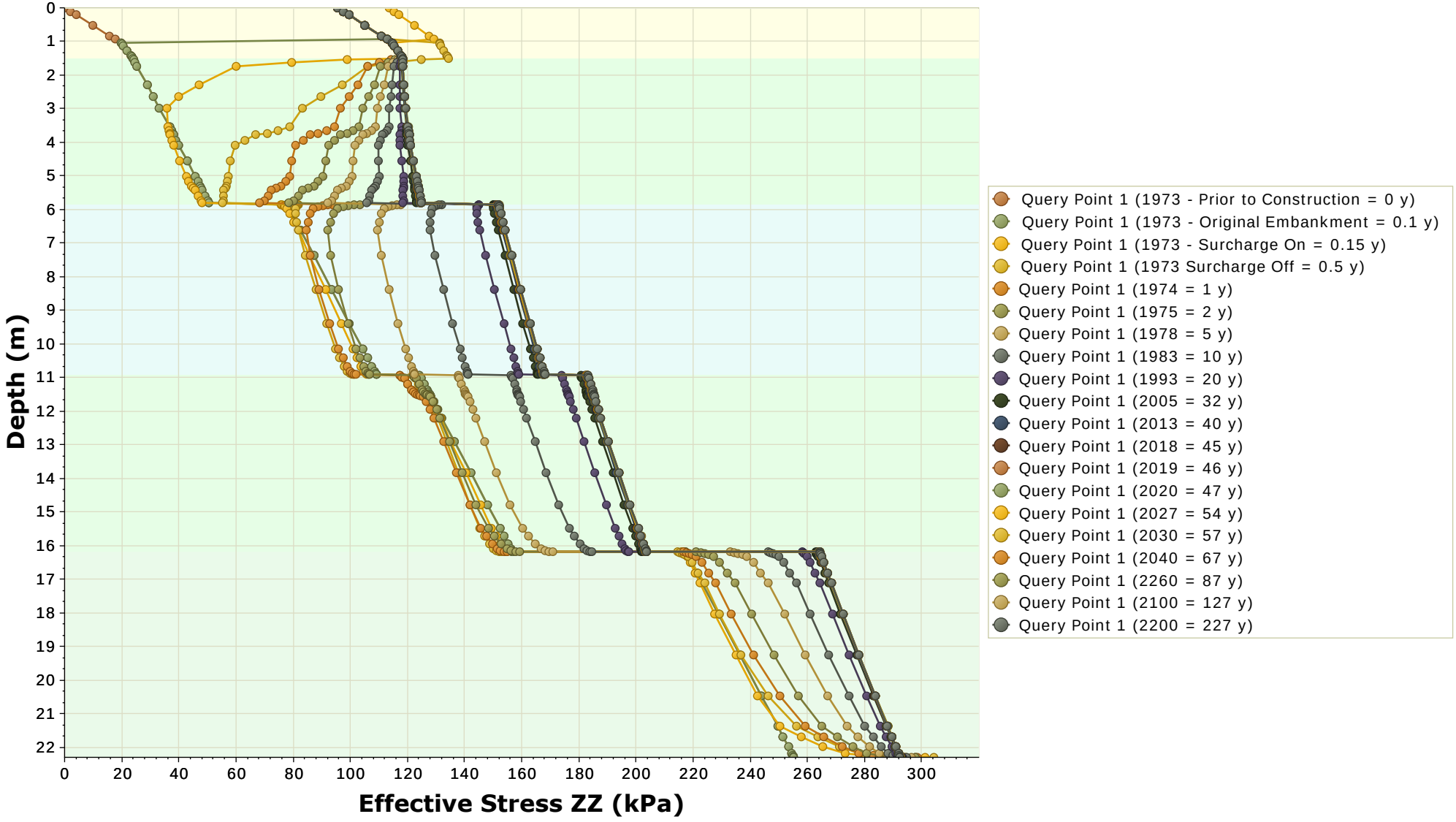


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Effective Stress ZZ vs. Depth

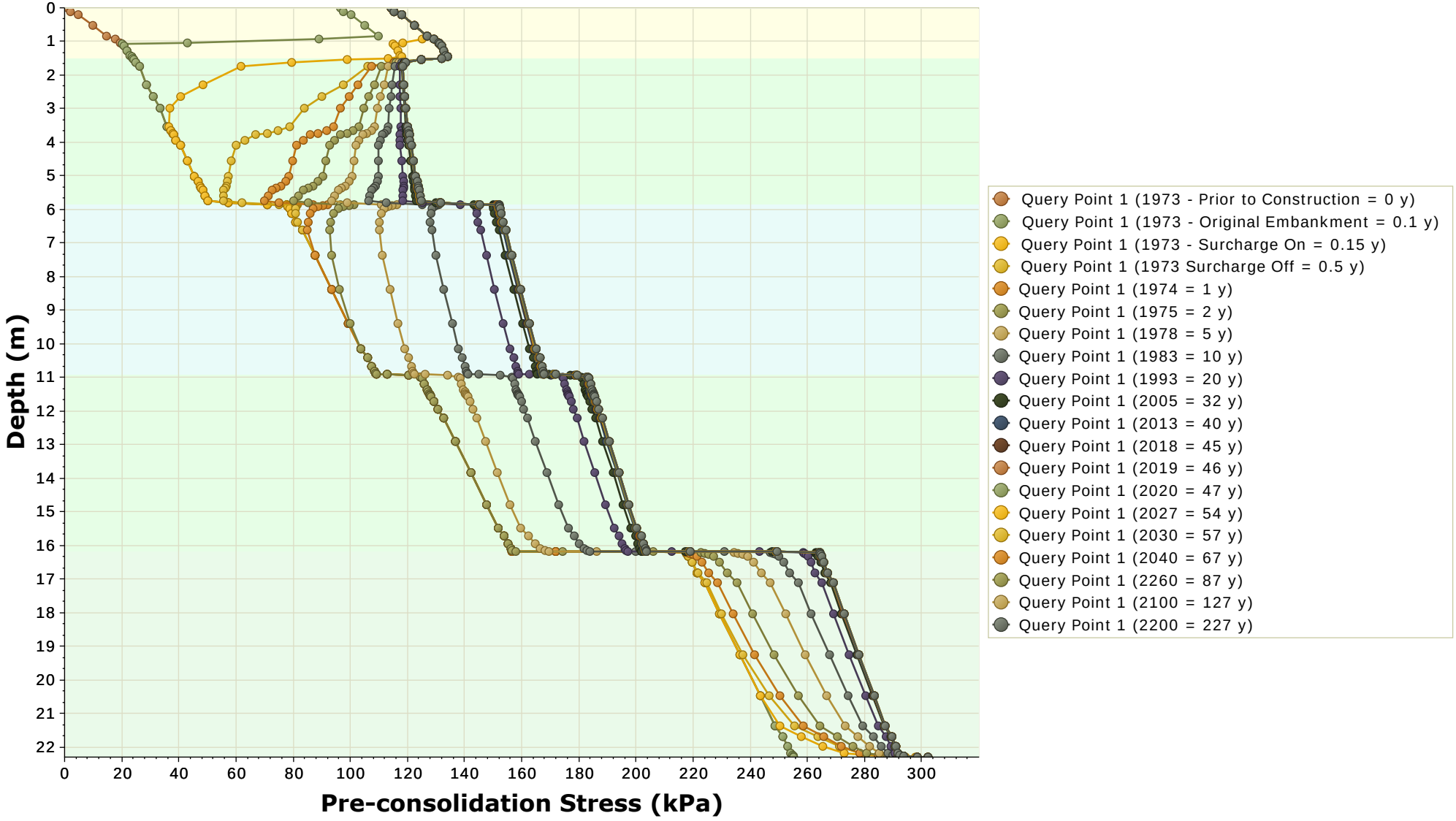


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

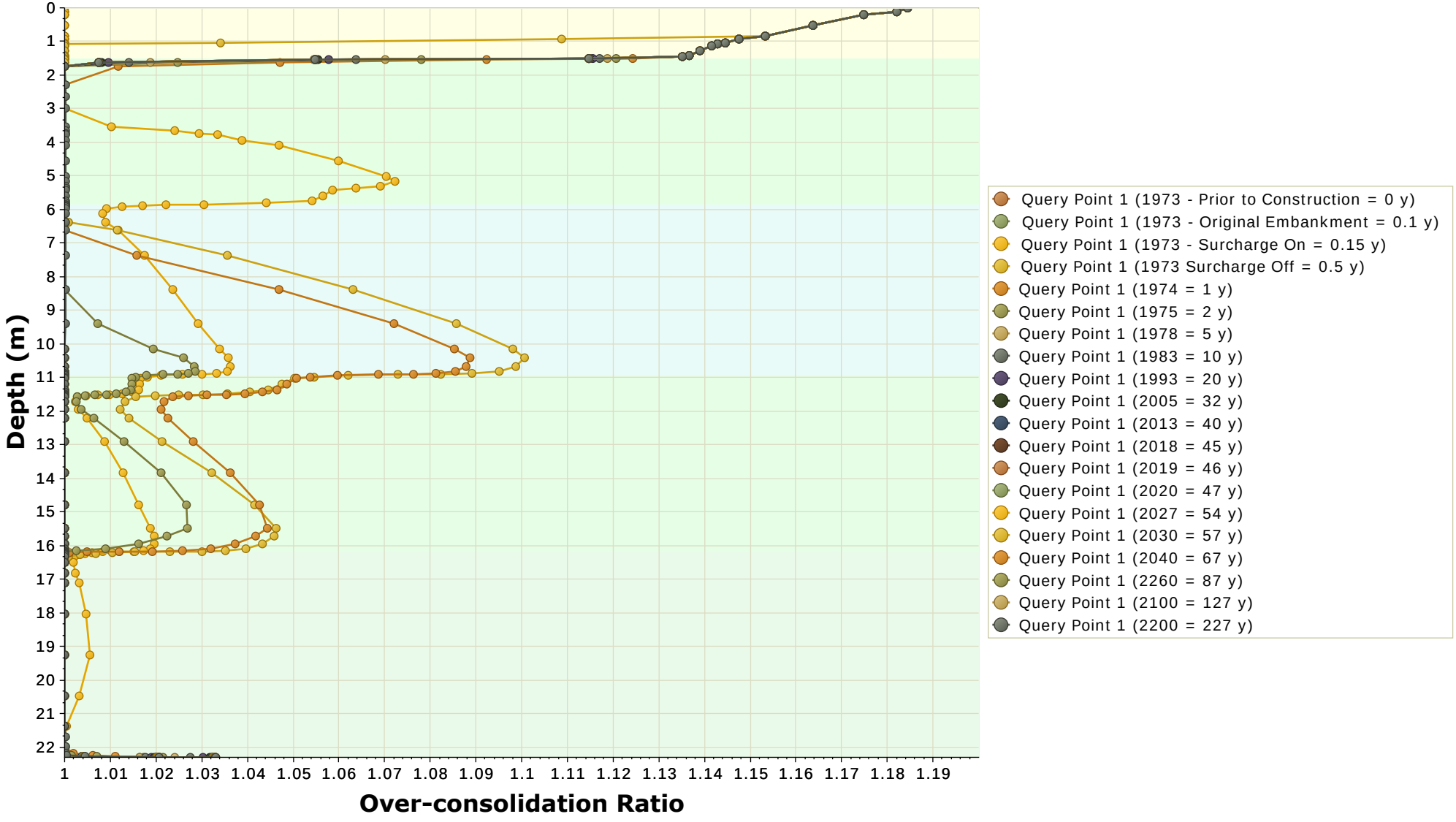


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

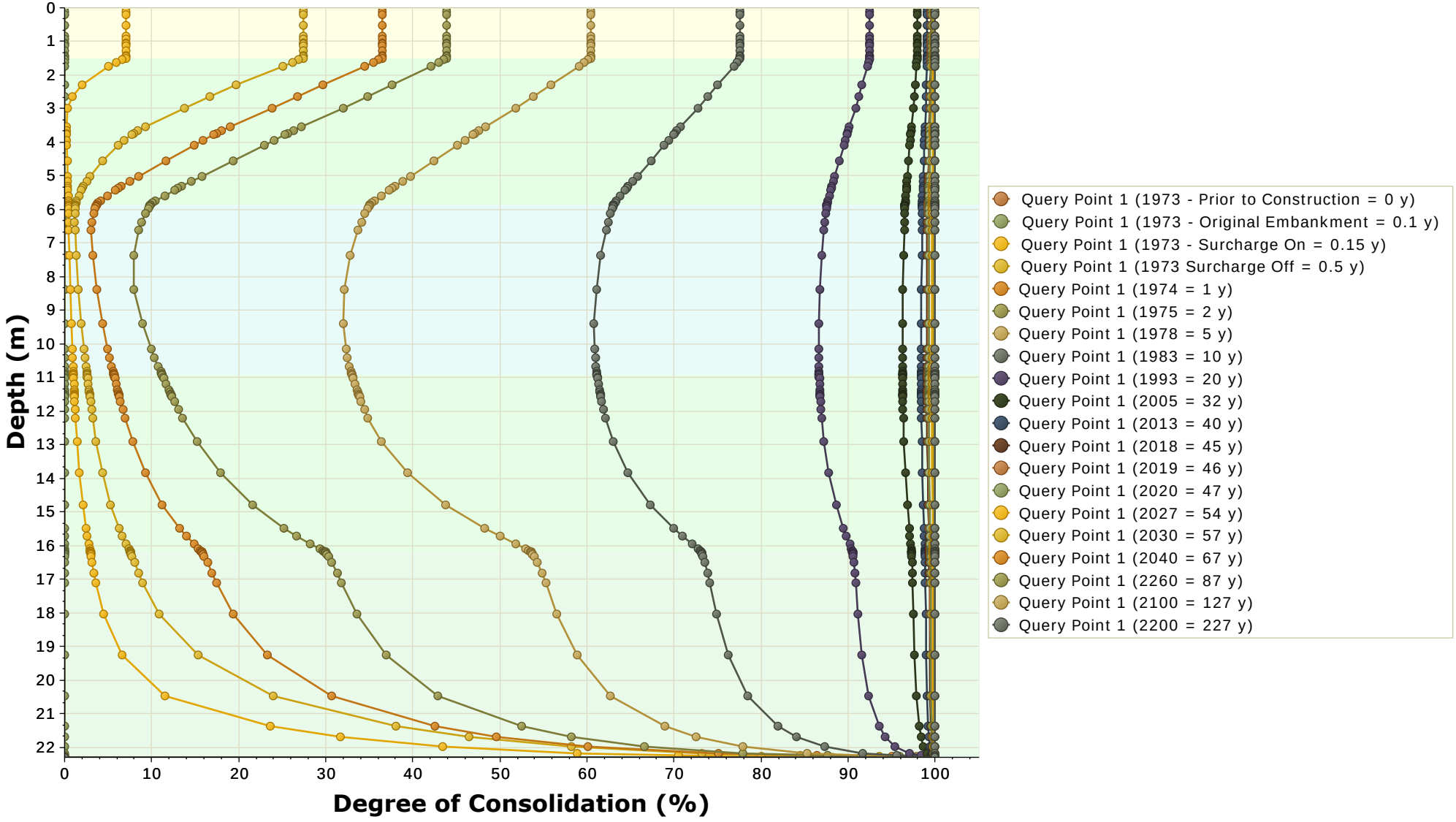


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

Degree of Consolidation vs. Depth

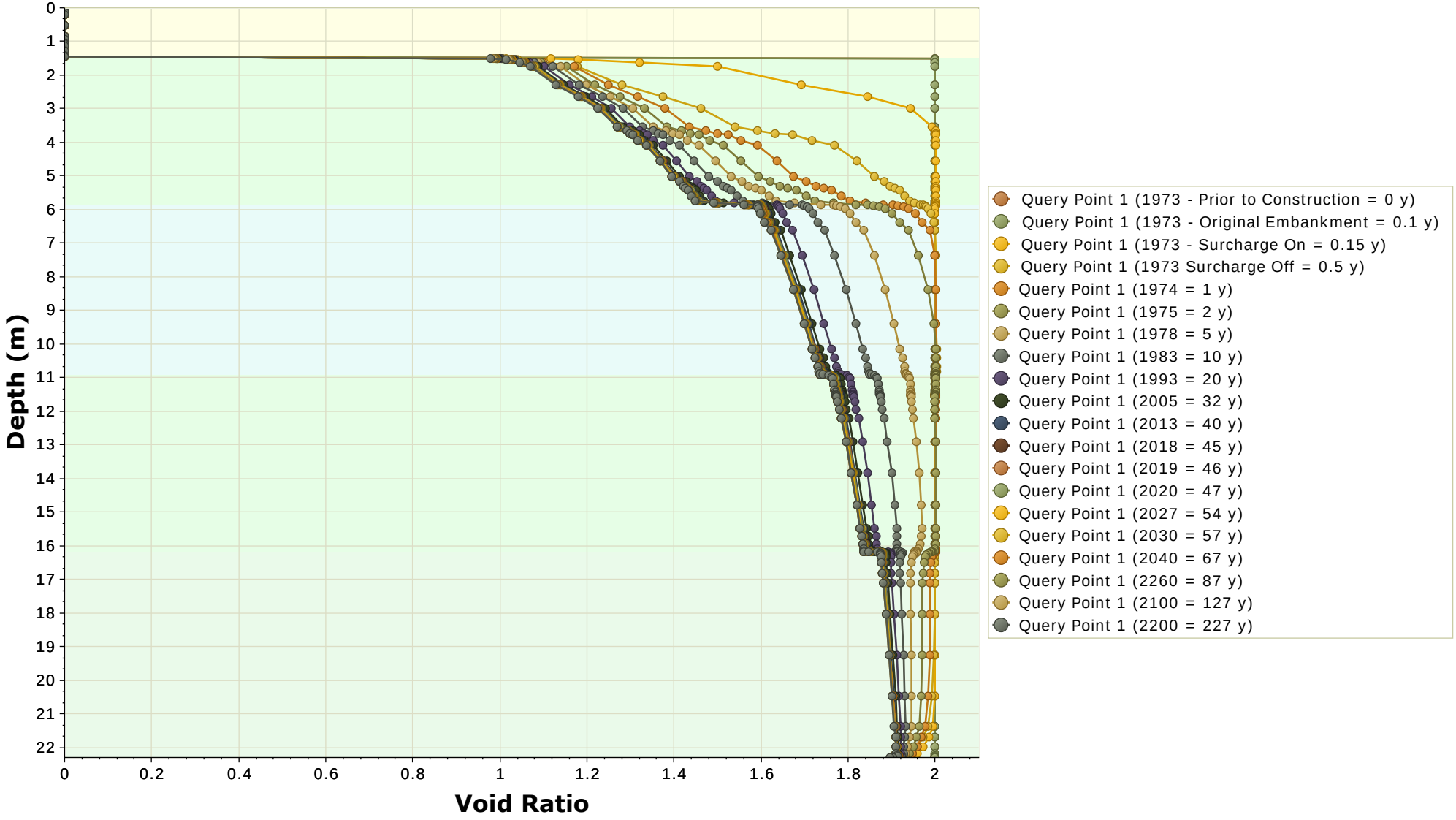


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

SETTLE3D 4.005

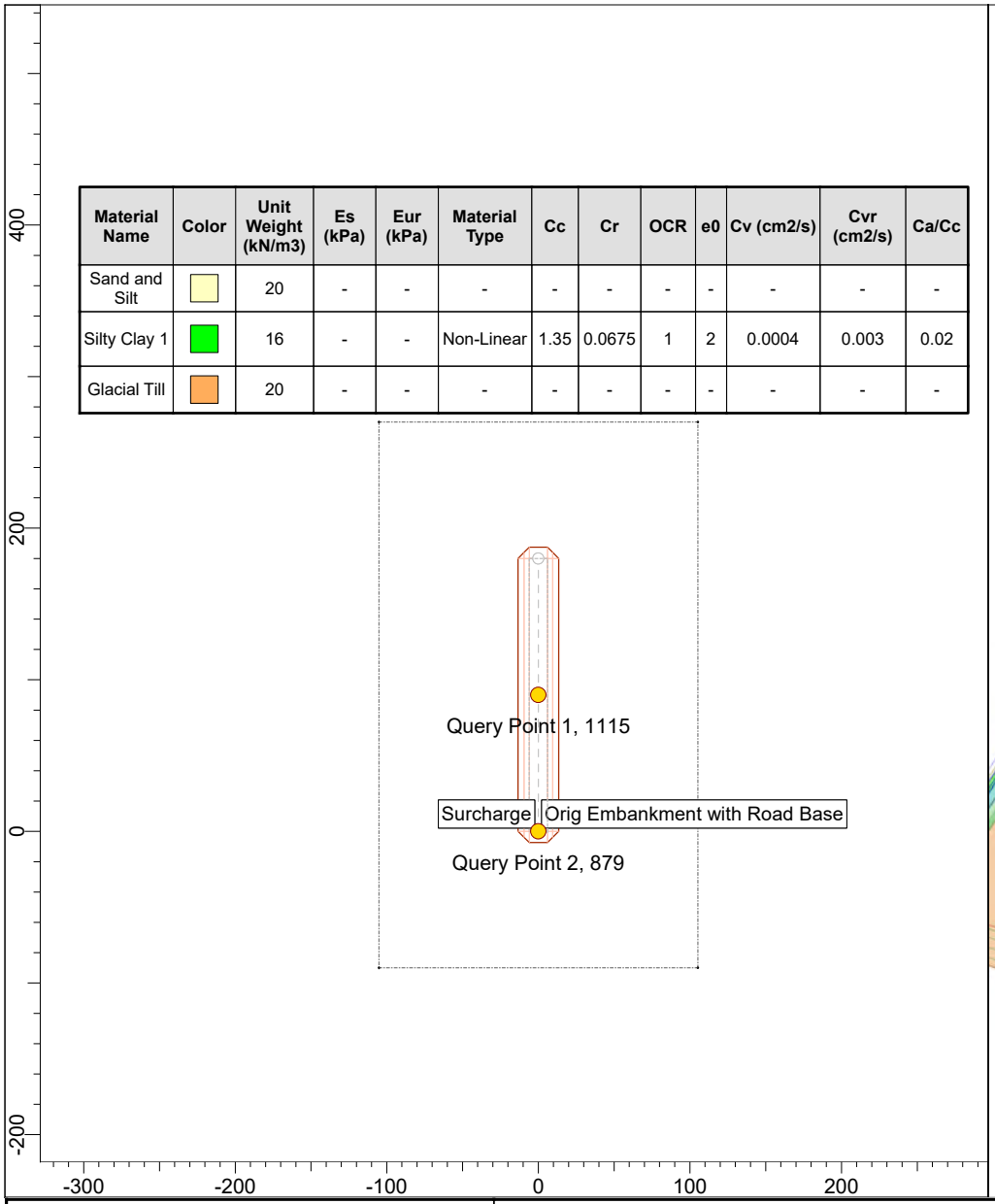
Void Ratio vs. Depth

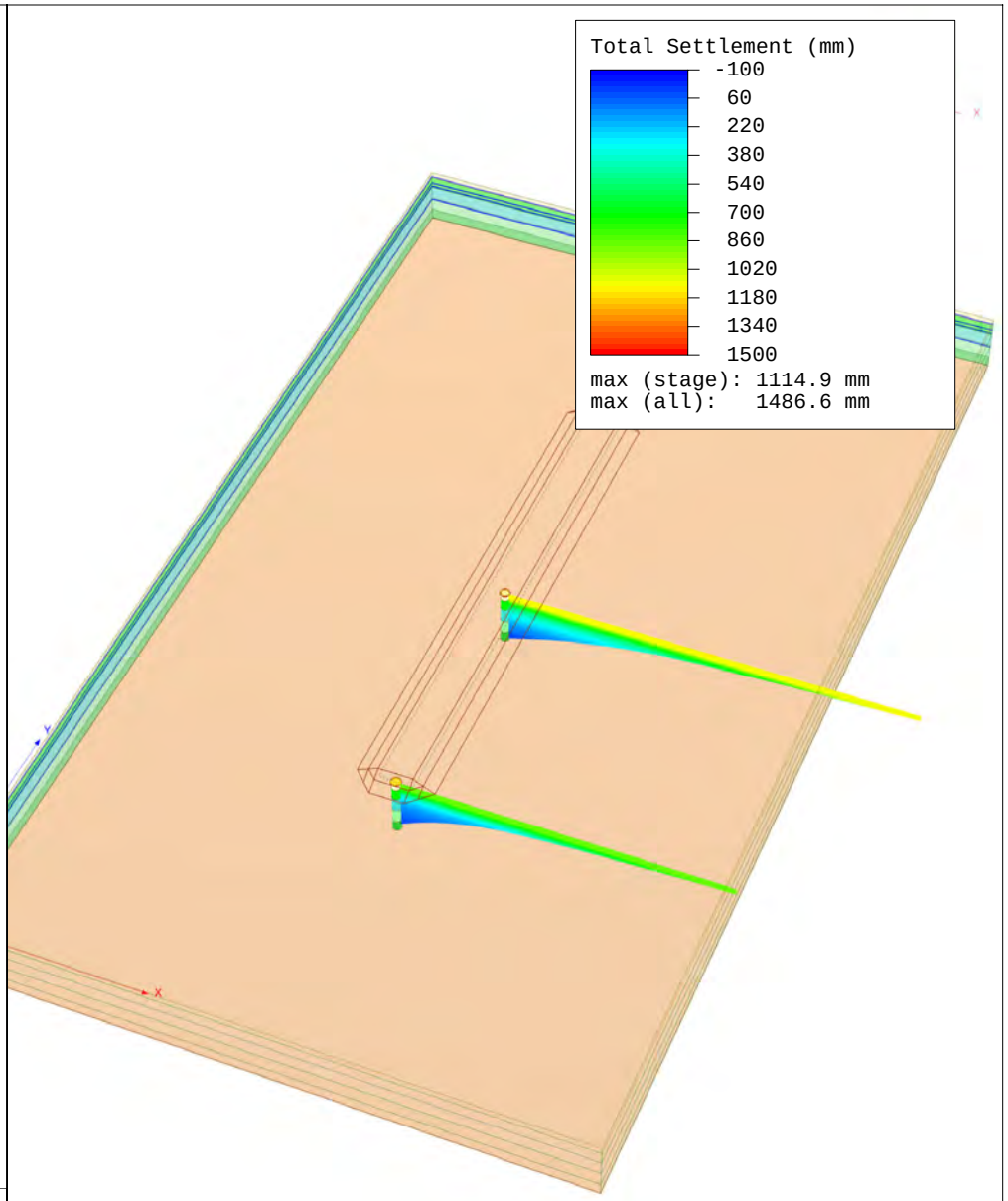


Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0004	0.003	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-

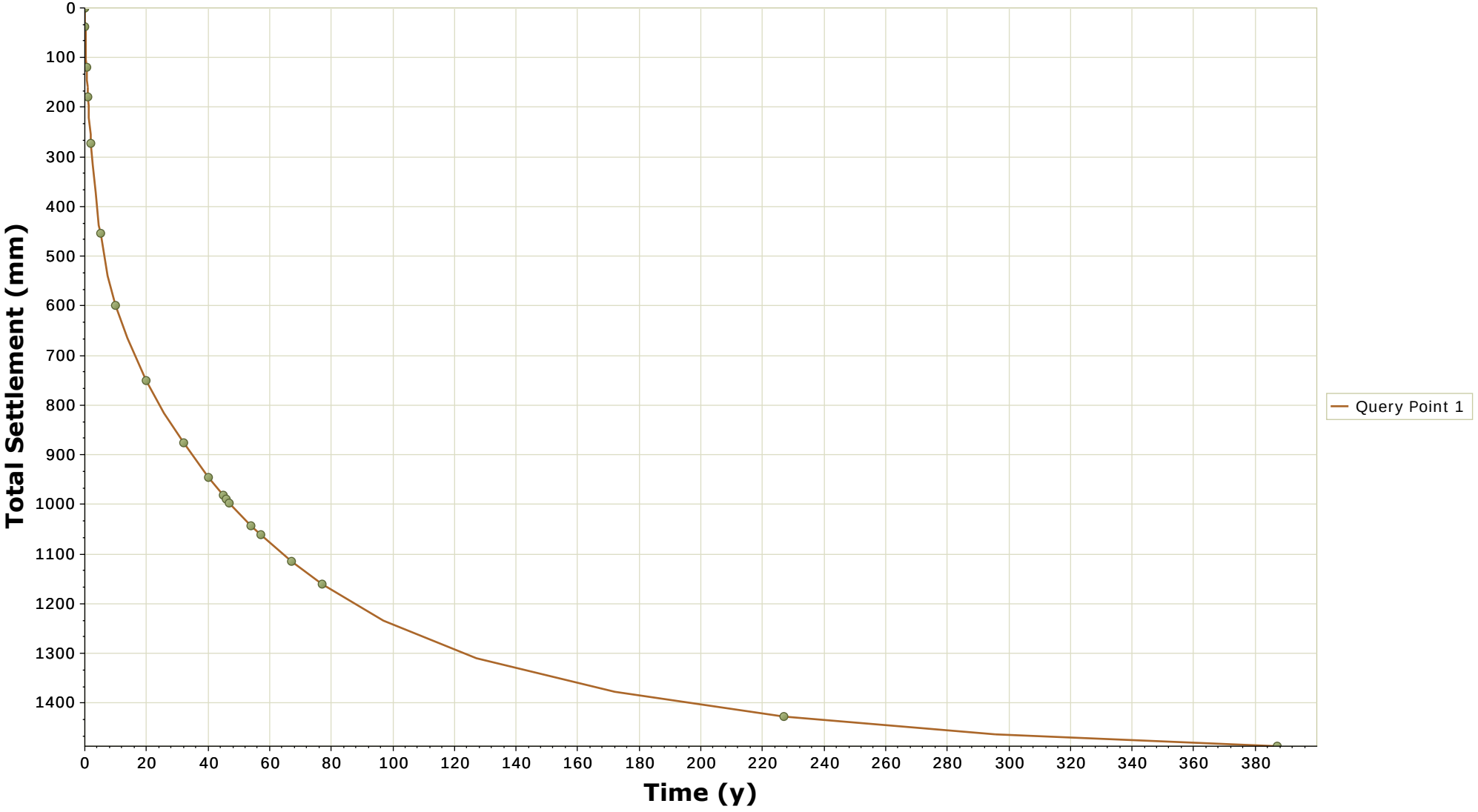




rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

Time vs. Total Settlement

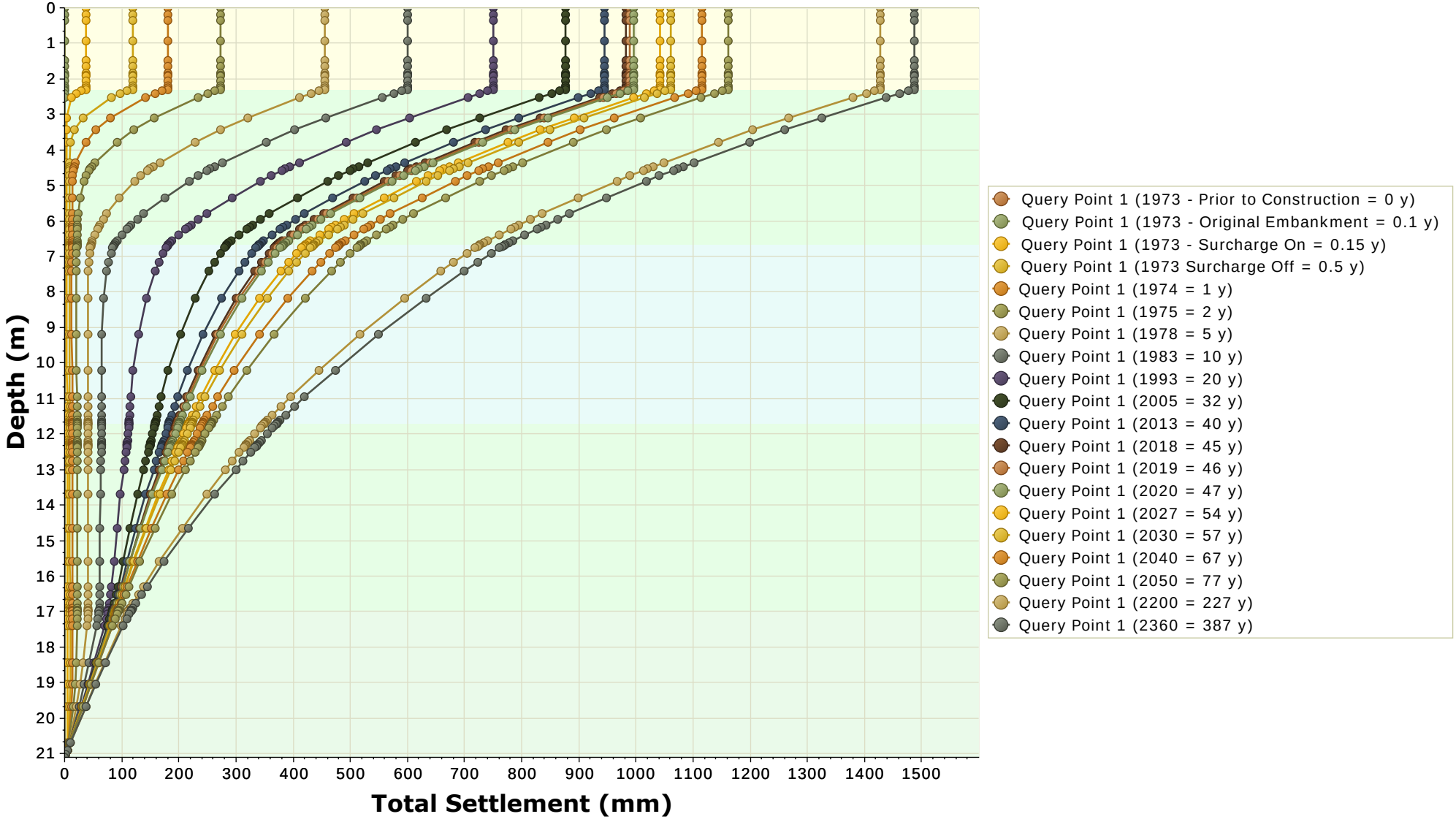


Reference Stage: None
Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

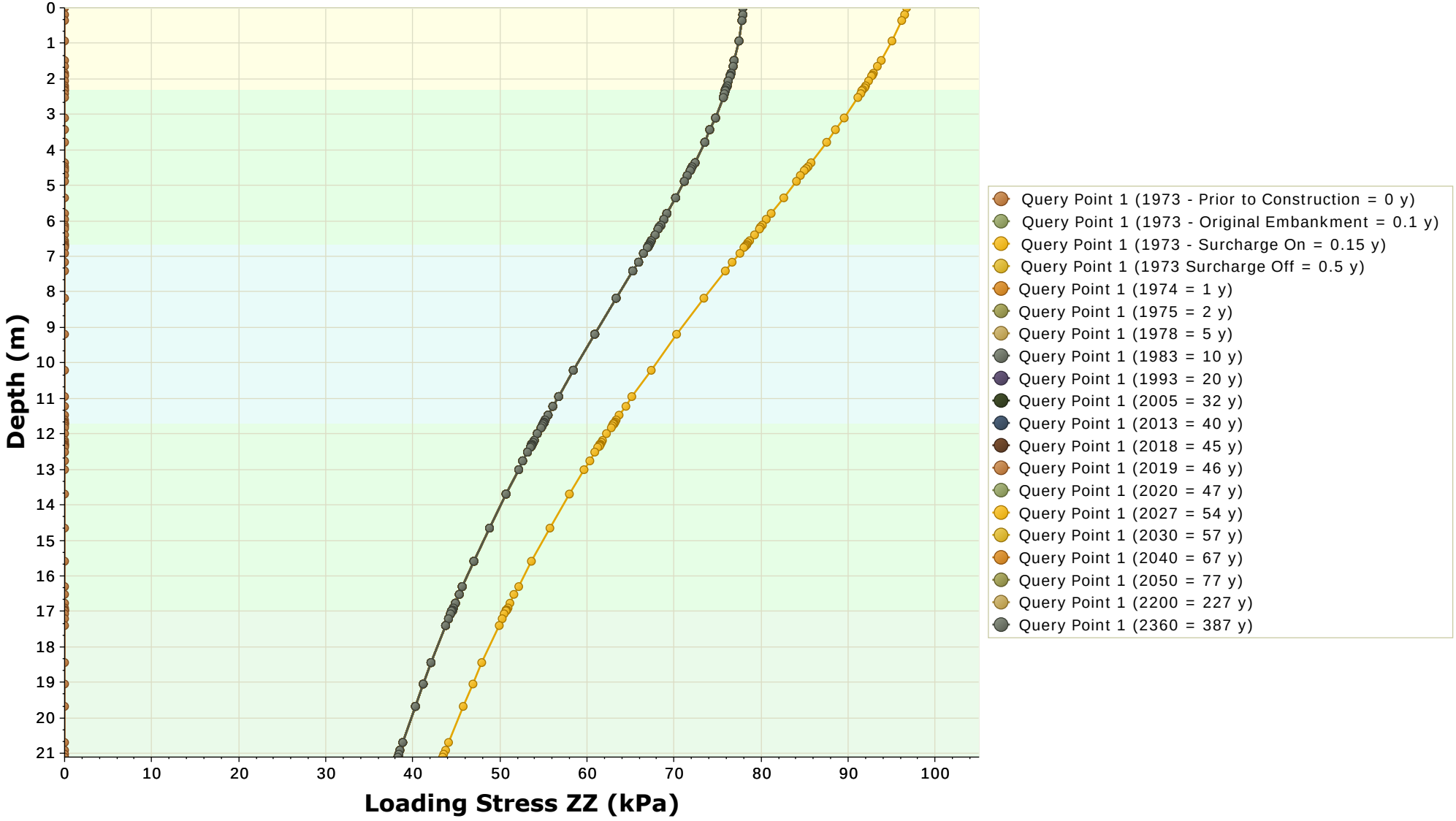
Total Settlement vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

Loading Stress ZZ vs. Depth

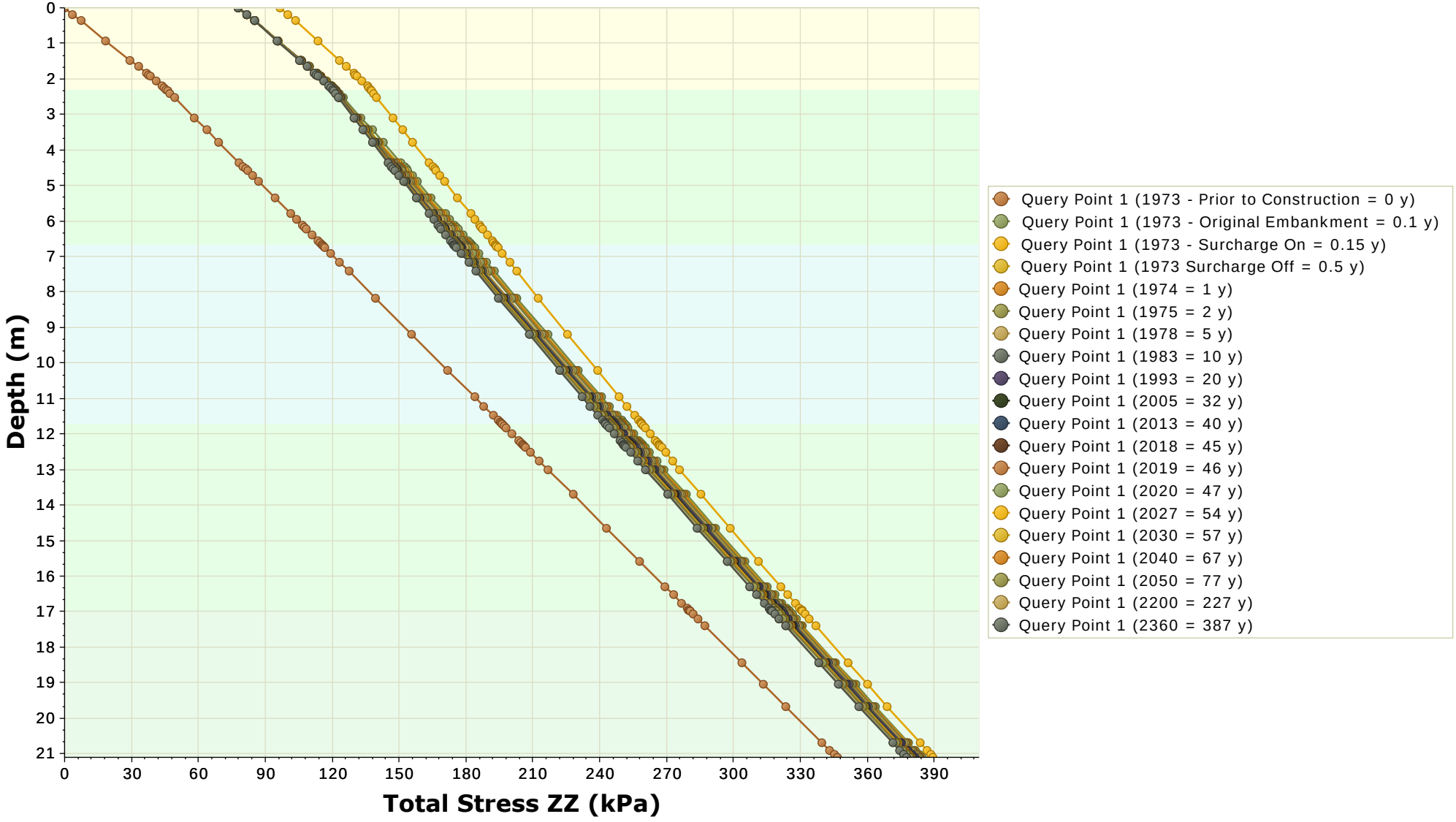


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

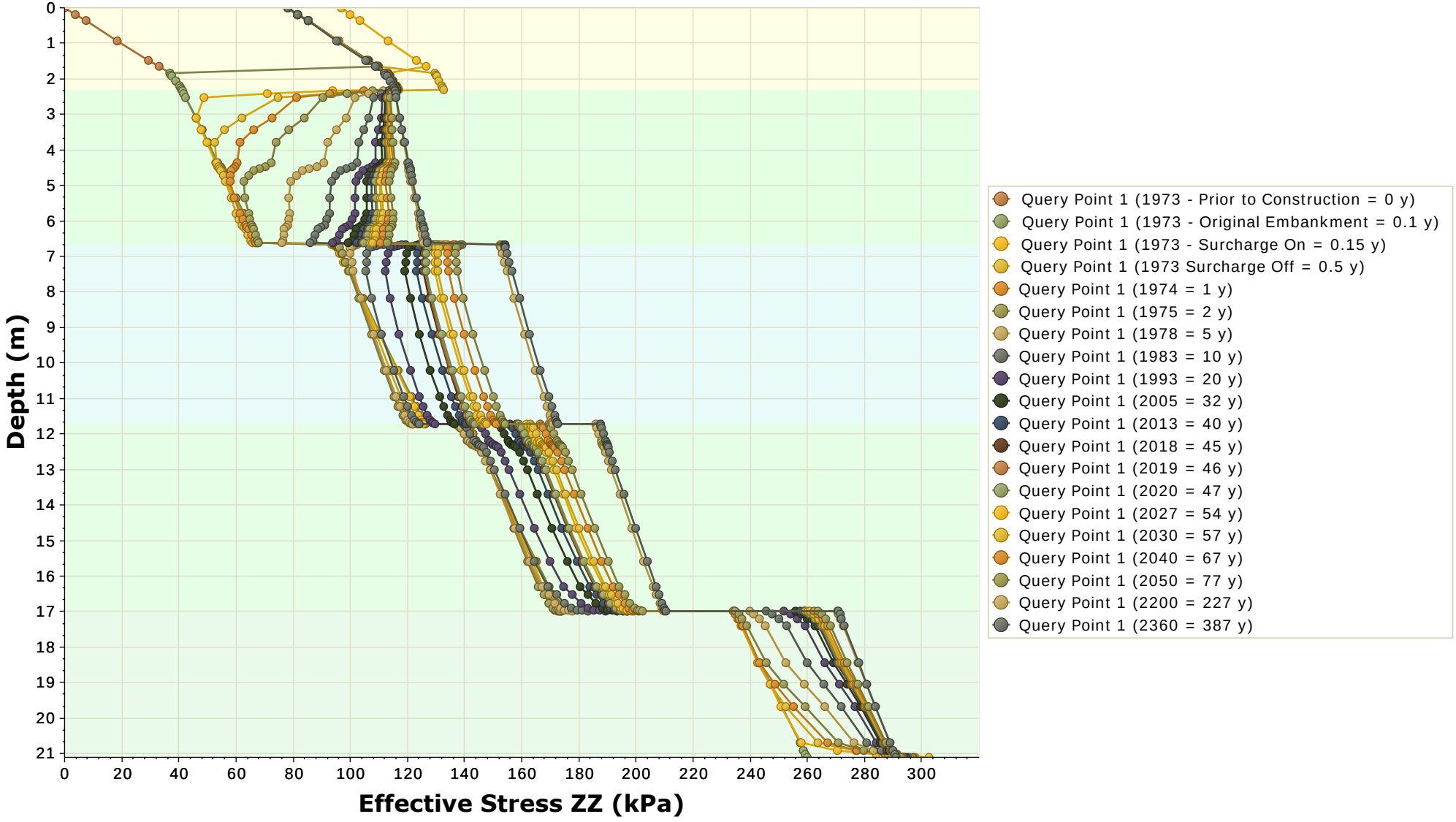
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

Effective Stress ZZ vs. Depth

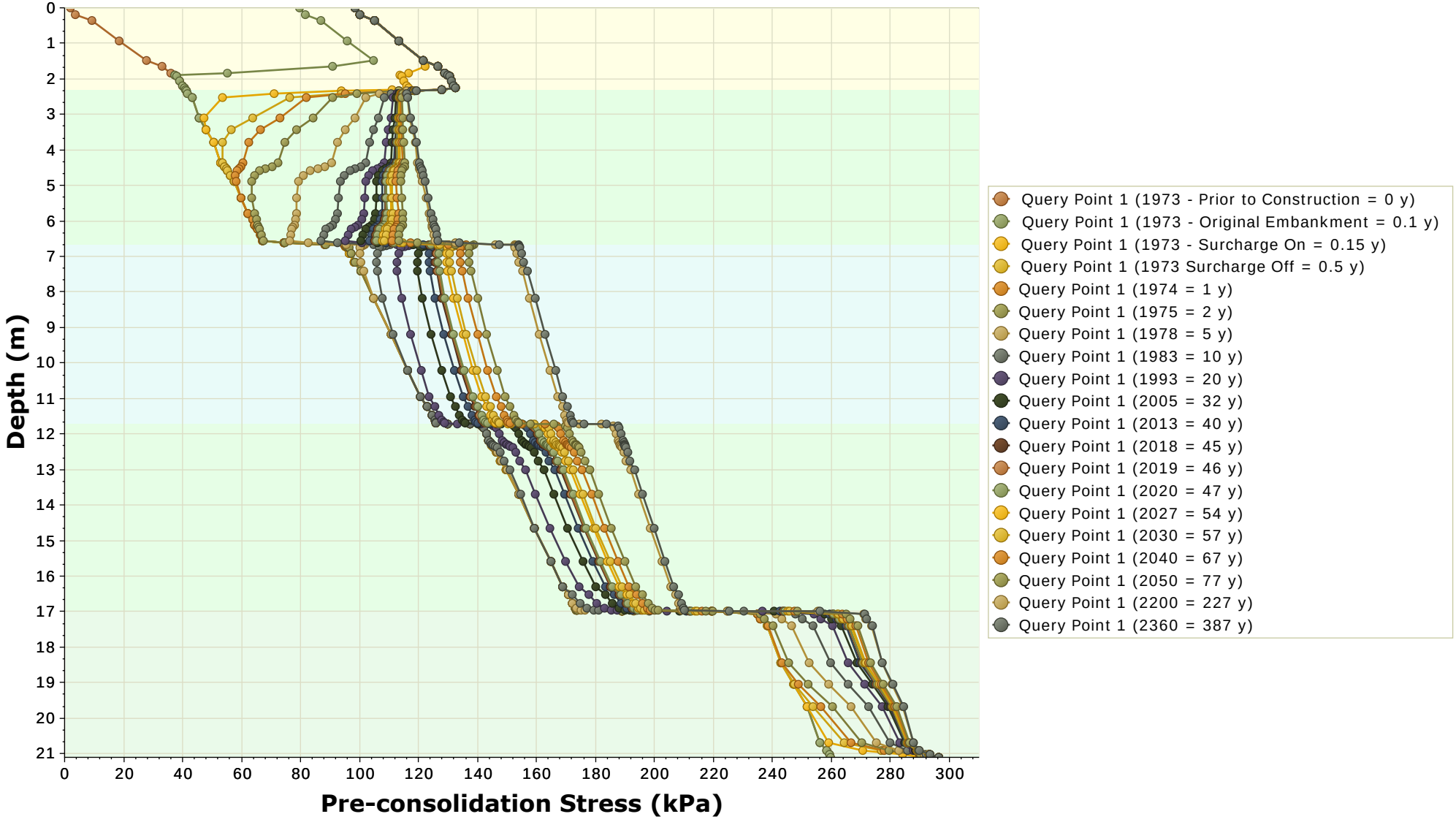


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

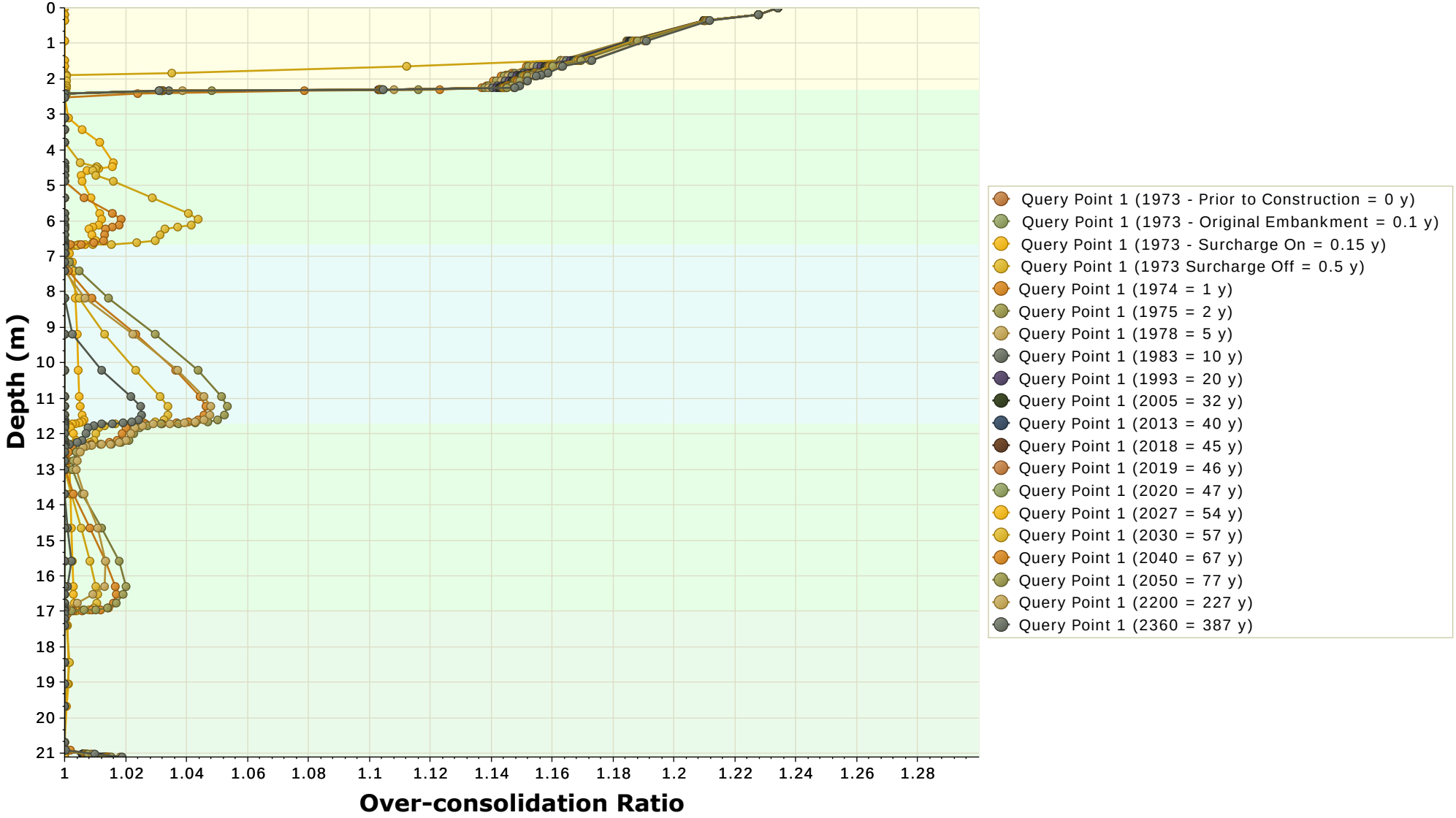


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

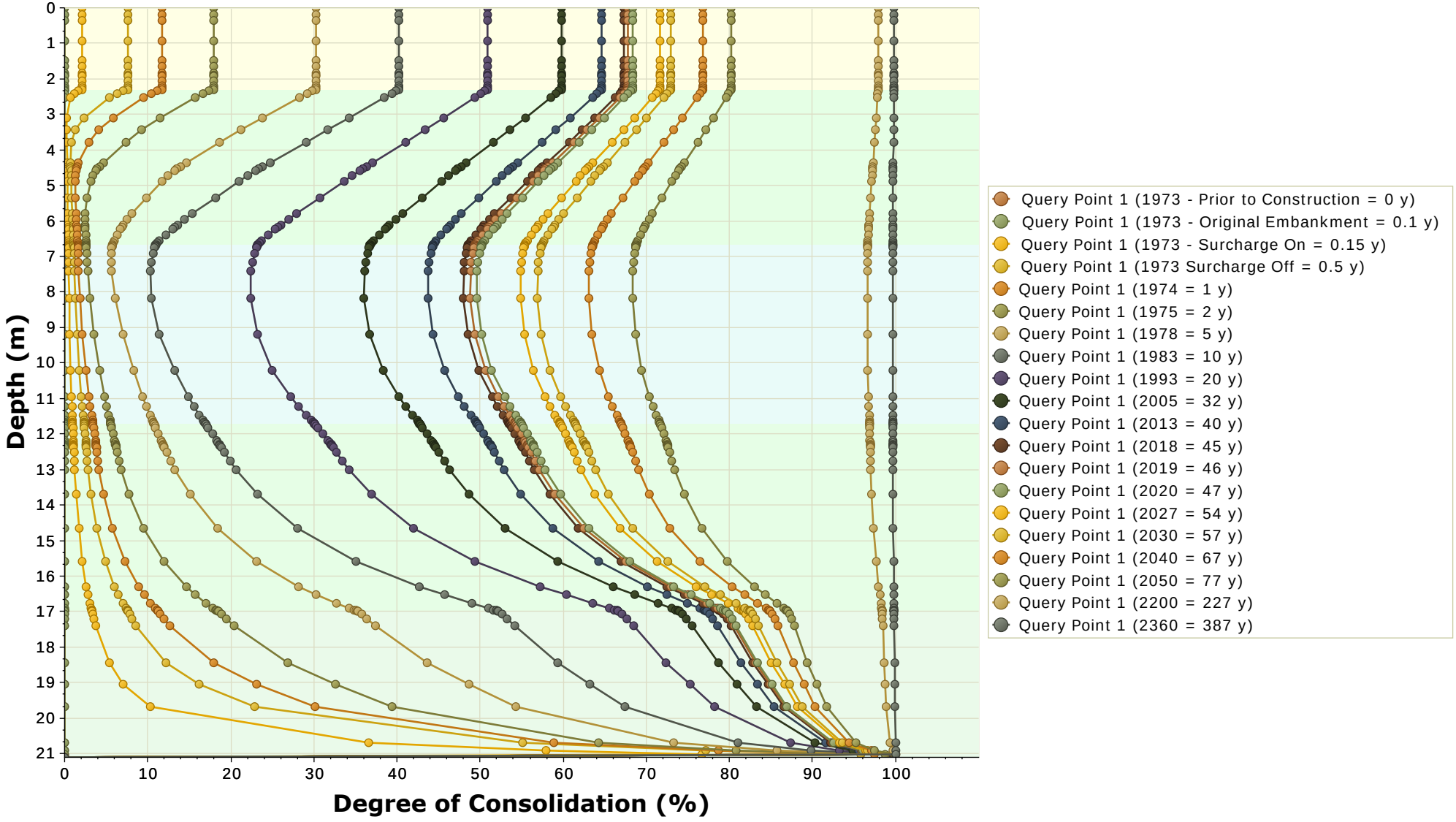
Over-consolidation Ratio vs. Depth



Reference Stage: None

SETTLE3D 4.005	*Project* Highway 417 / County Road 3 (WBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
	Date 2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

Degree of Consolidation vs. Depth

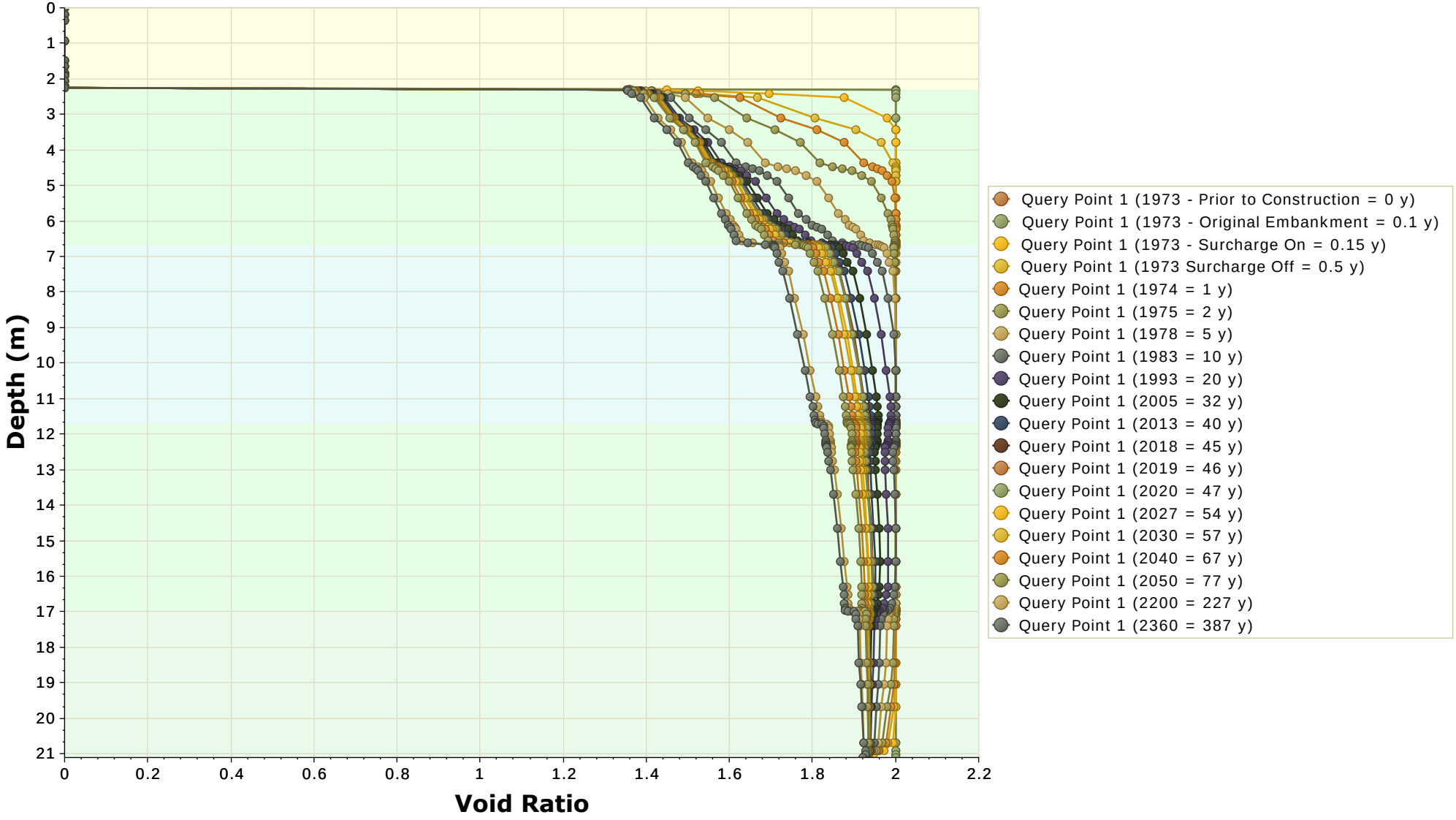


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

SETTLE3D 4.005

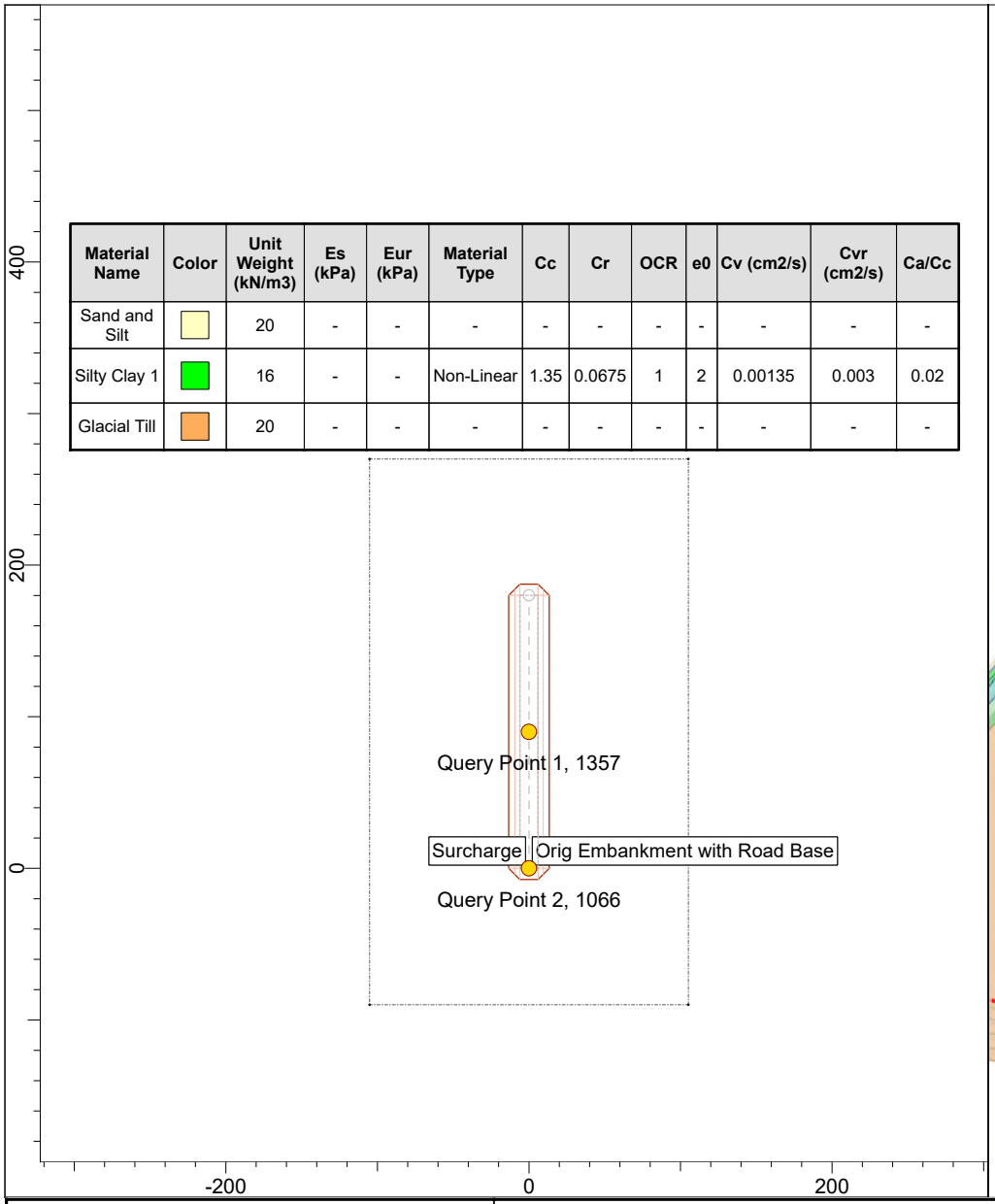
Void Ratio vs. Depth

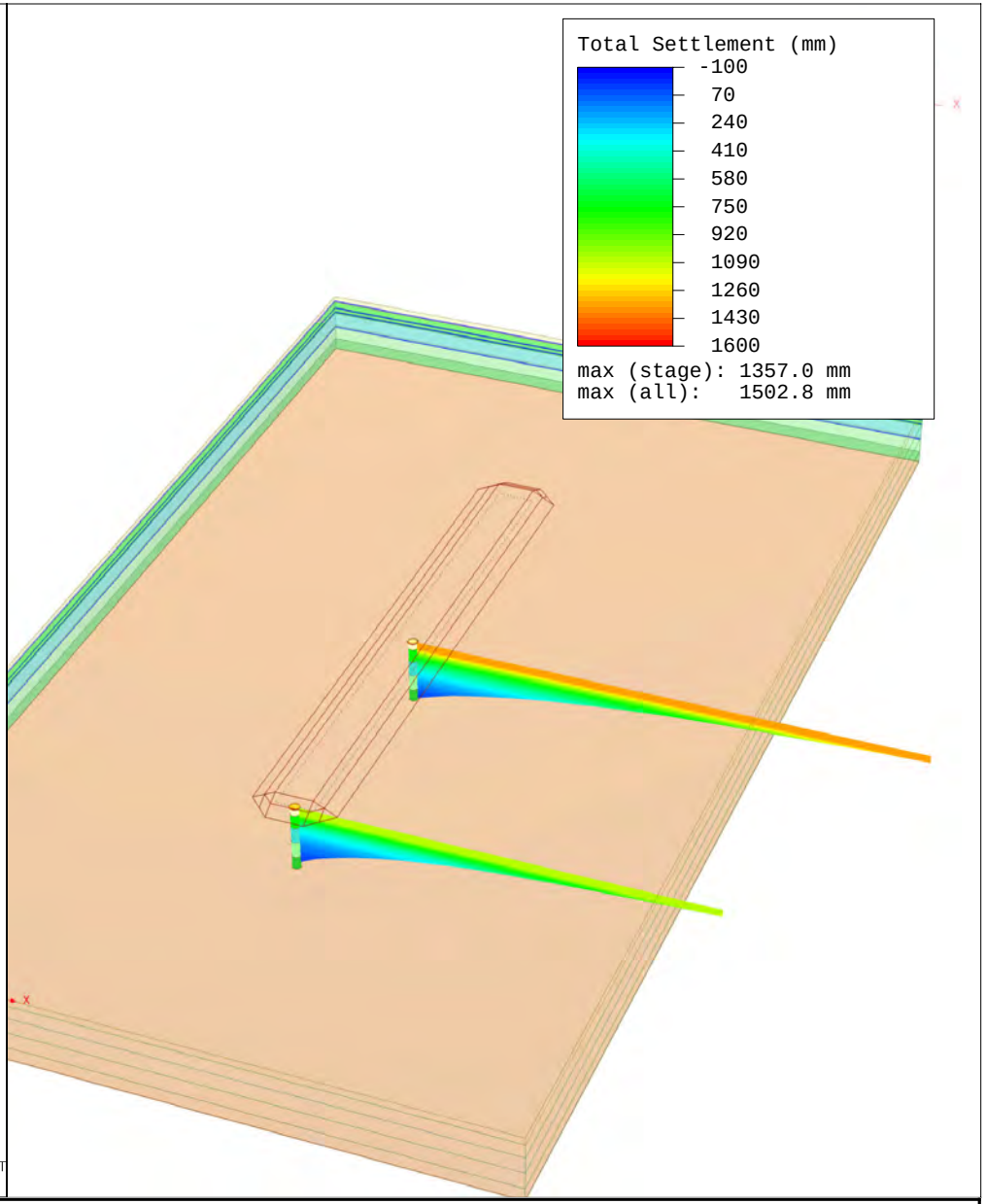


Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.00135	0.003	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-

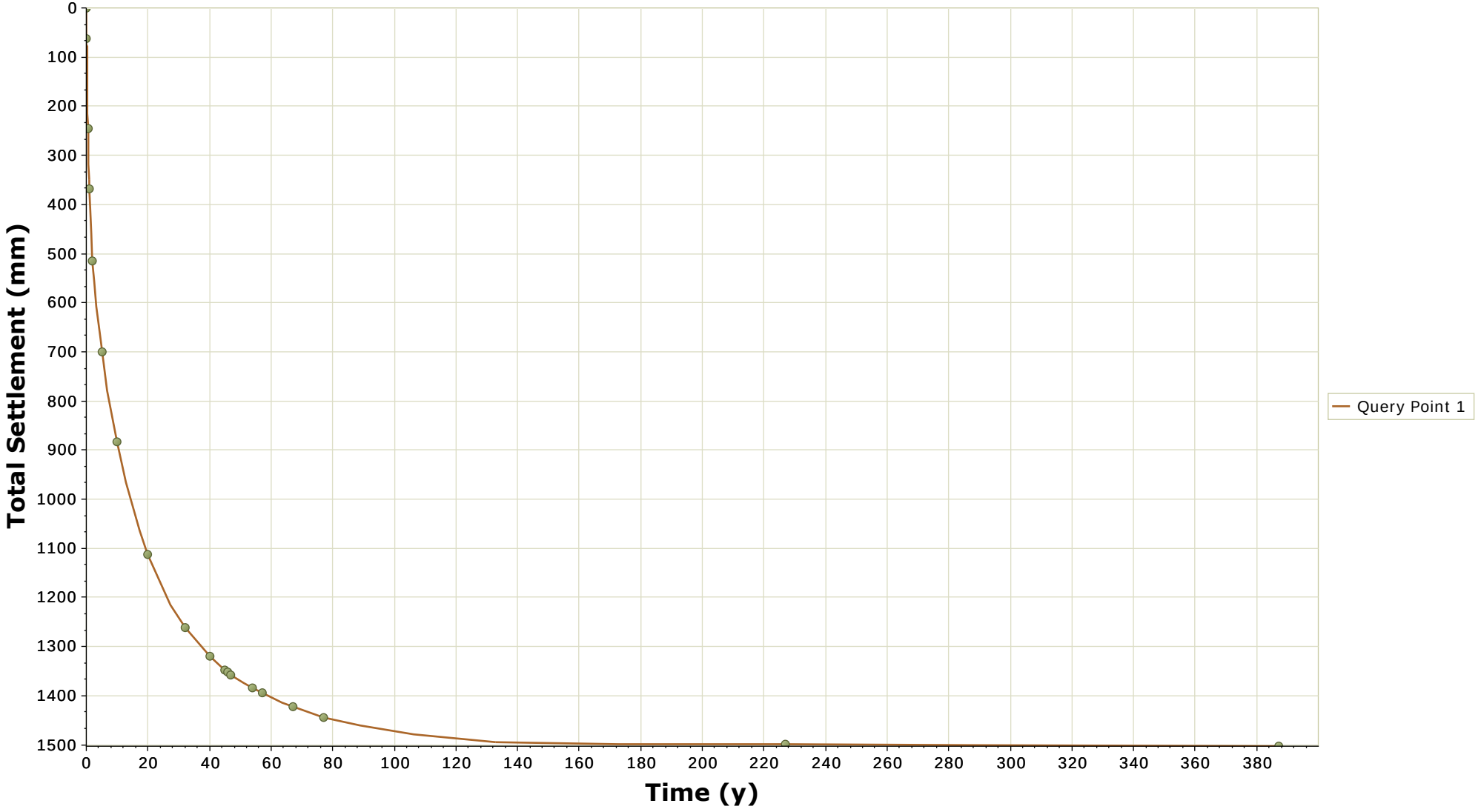




rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

SETTLE3D 4.005

Time vs. Total Settlement



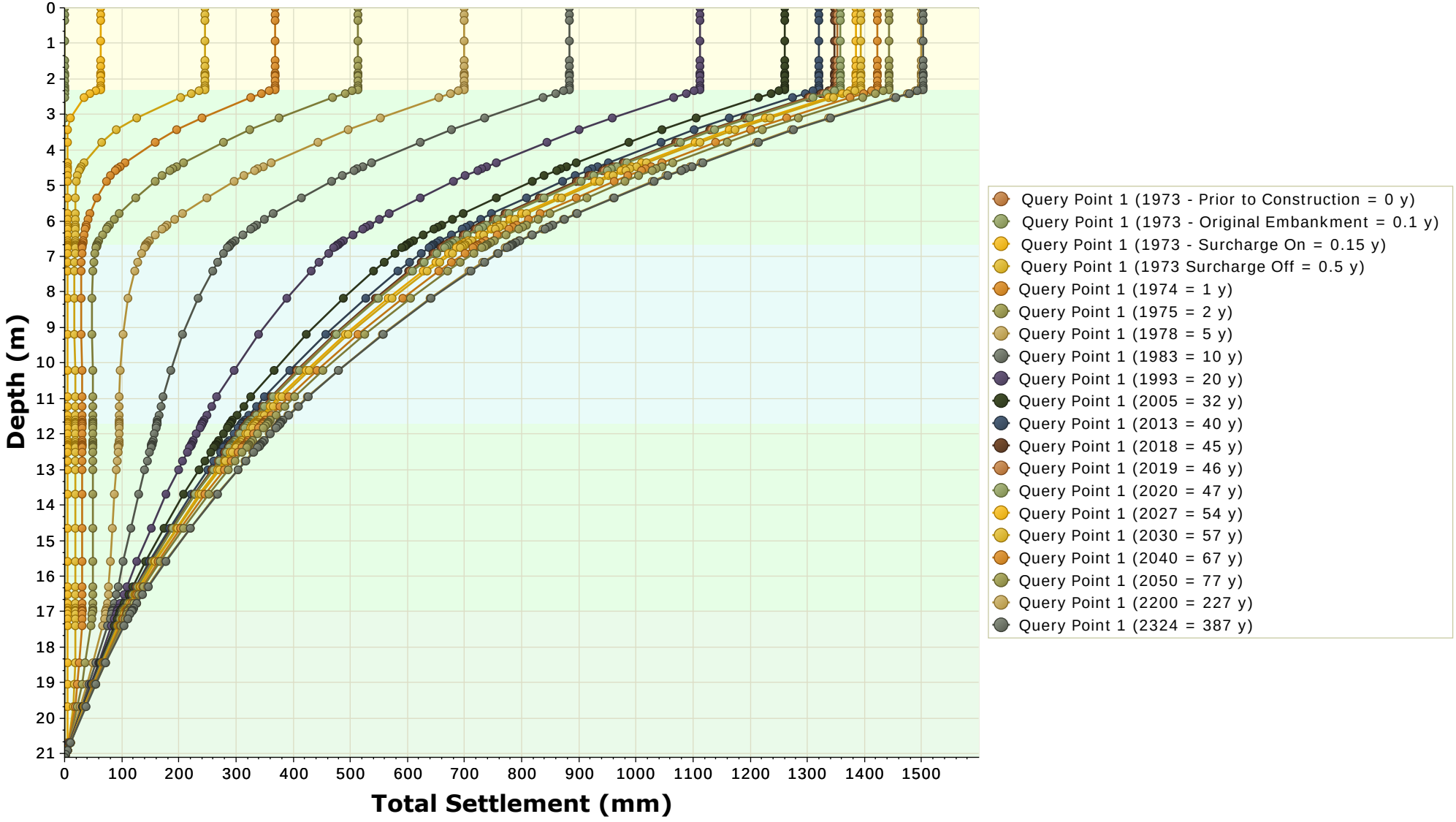
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

SETTLE3D 4.005

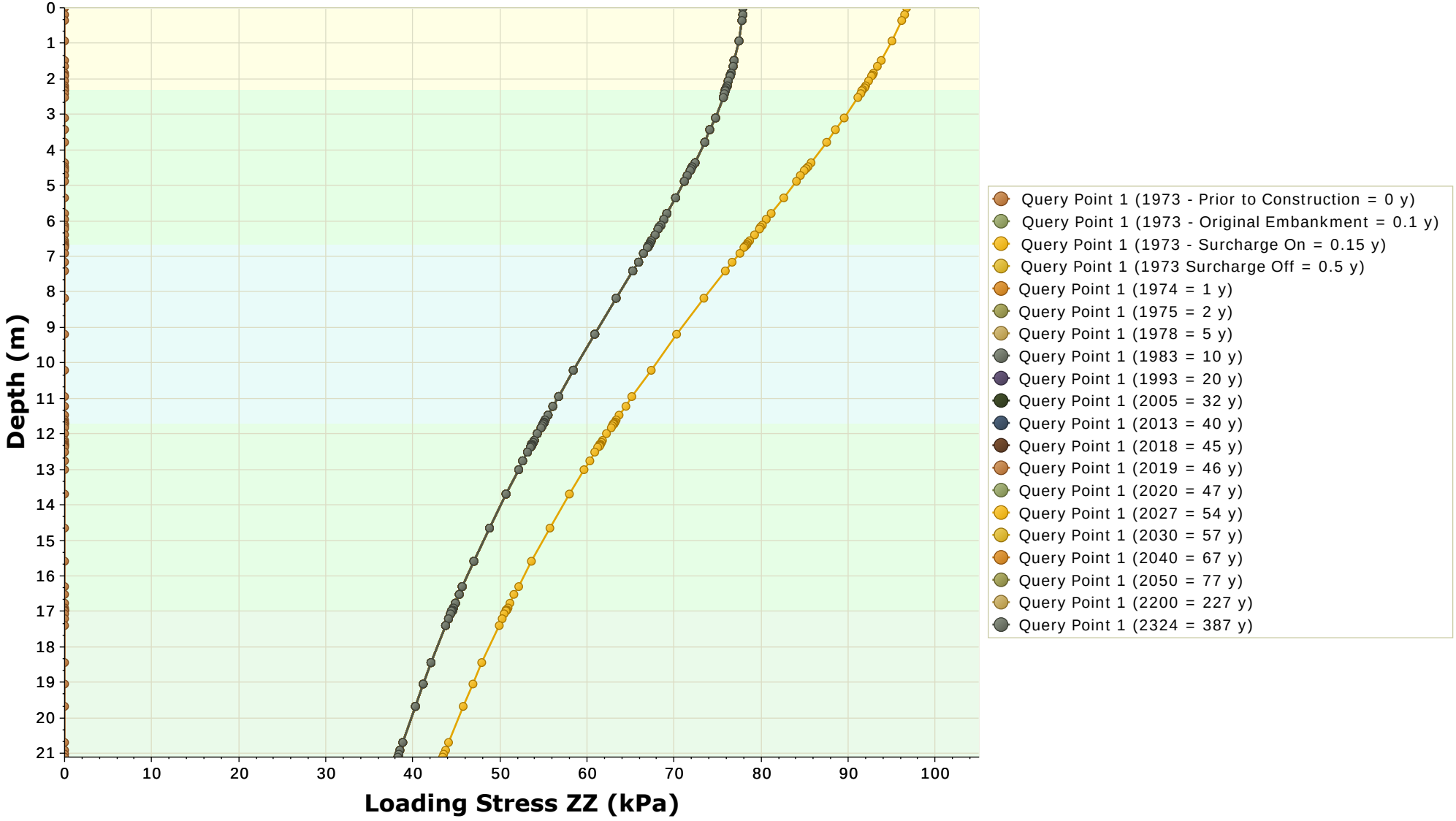
Total Settlement vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

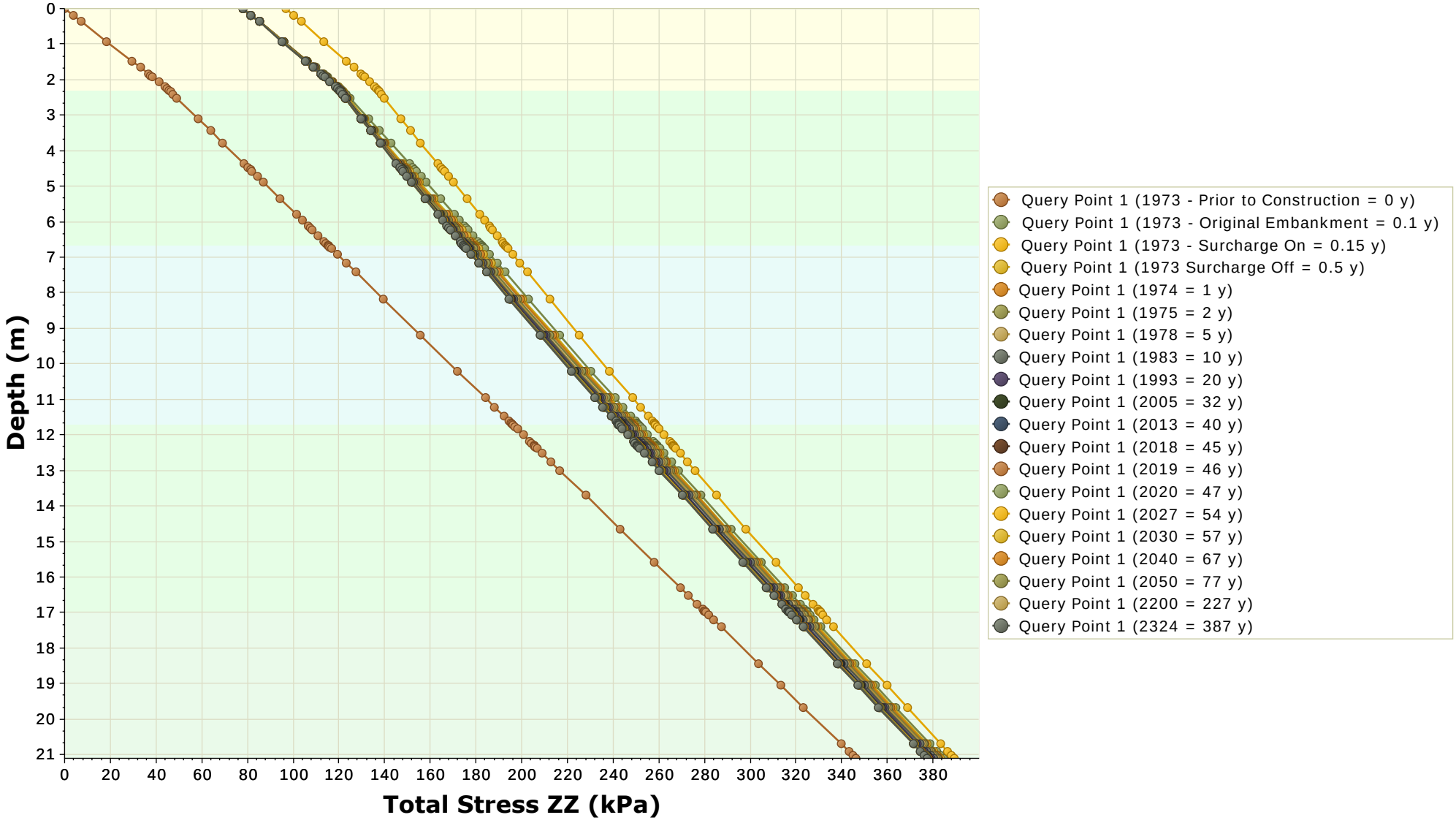
Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

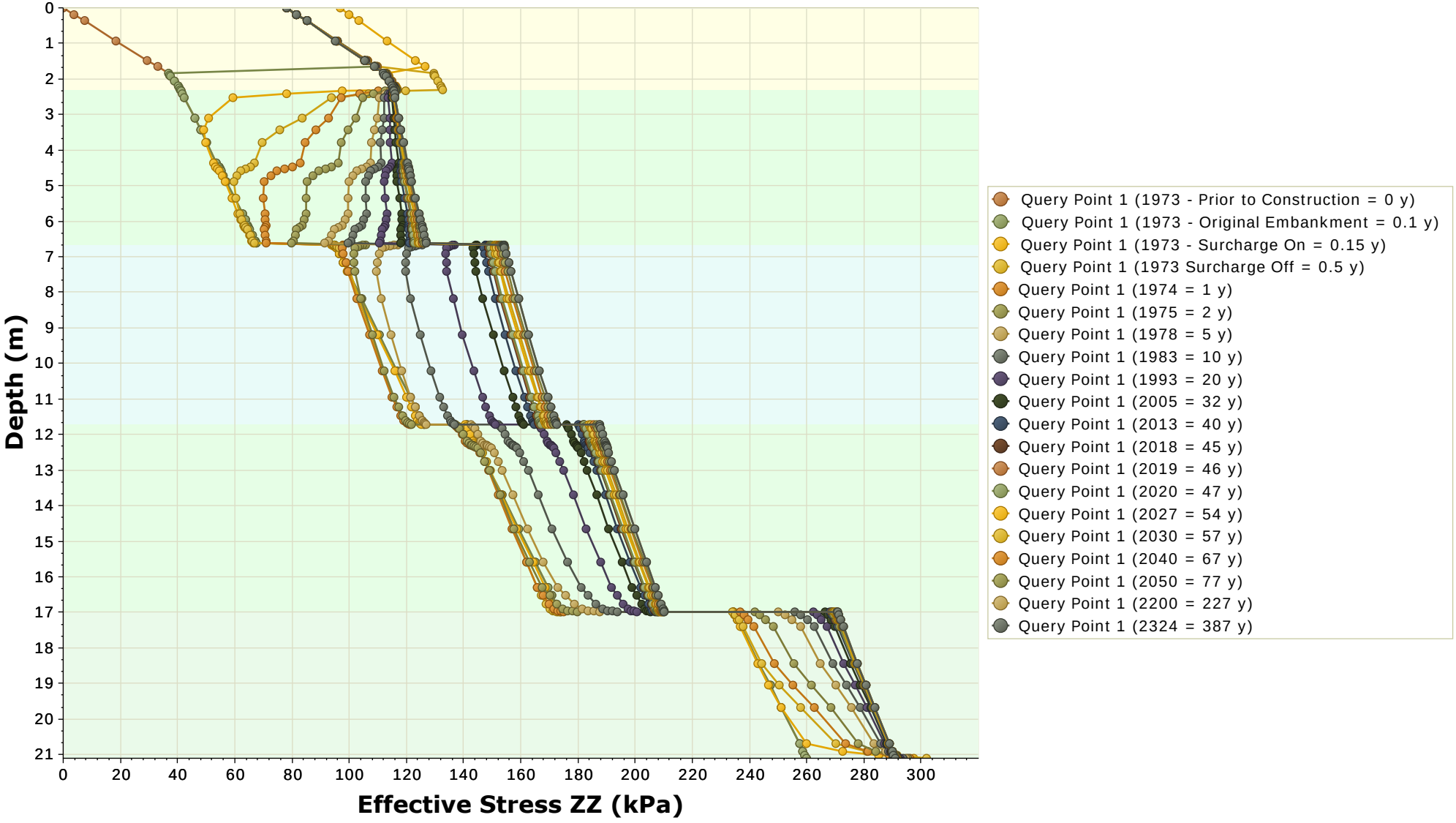
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

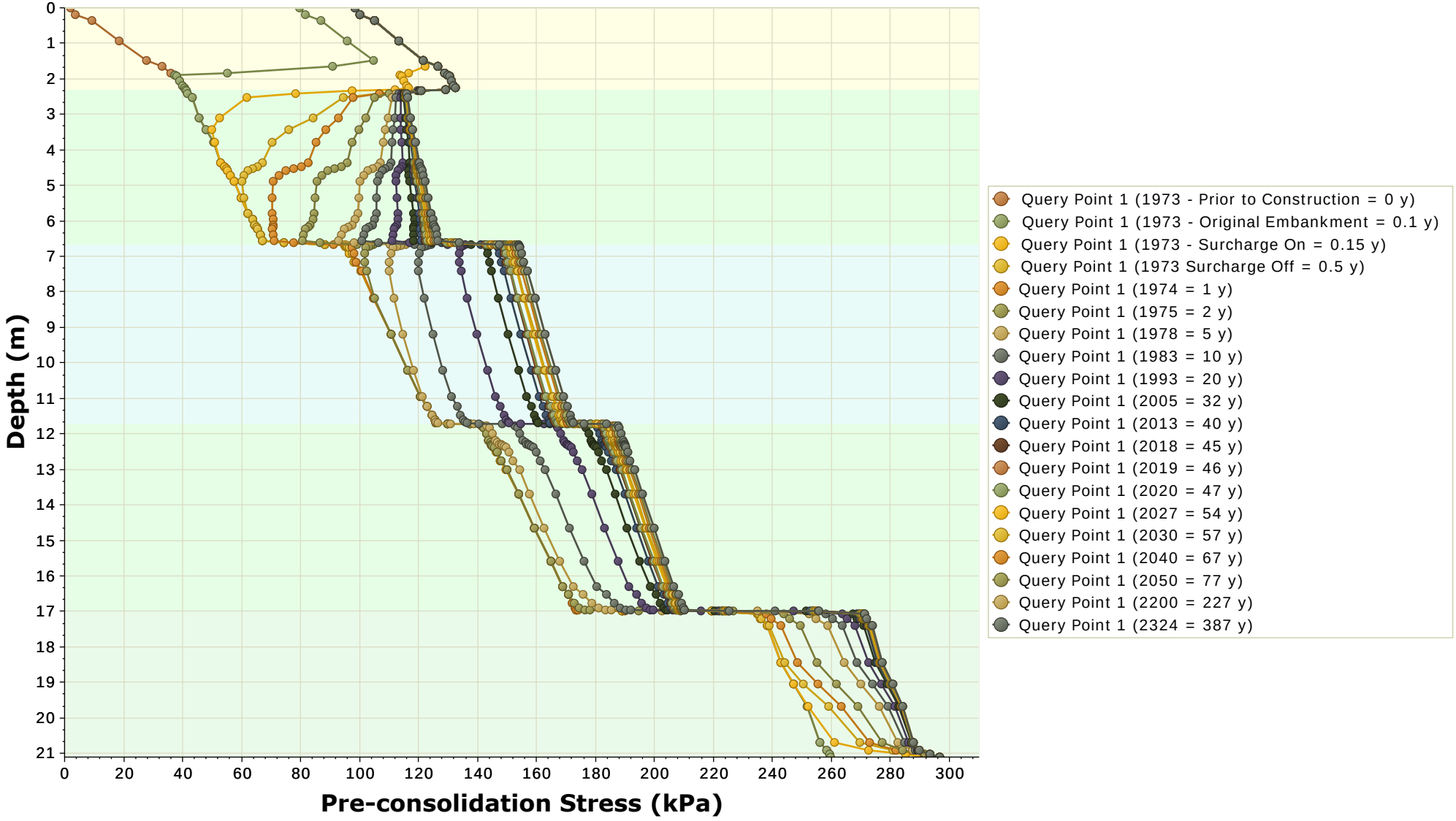
Effective Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

Pre-consolidation Stress vs. Depth

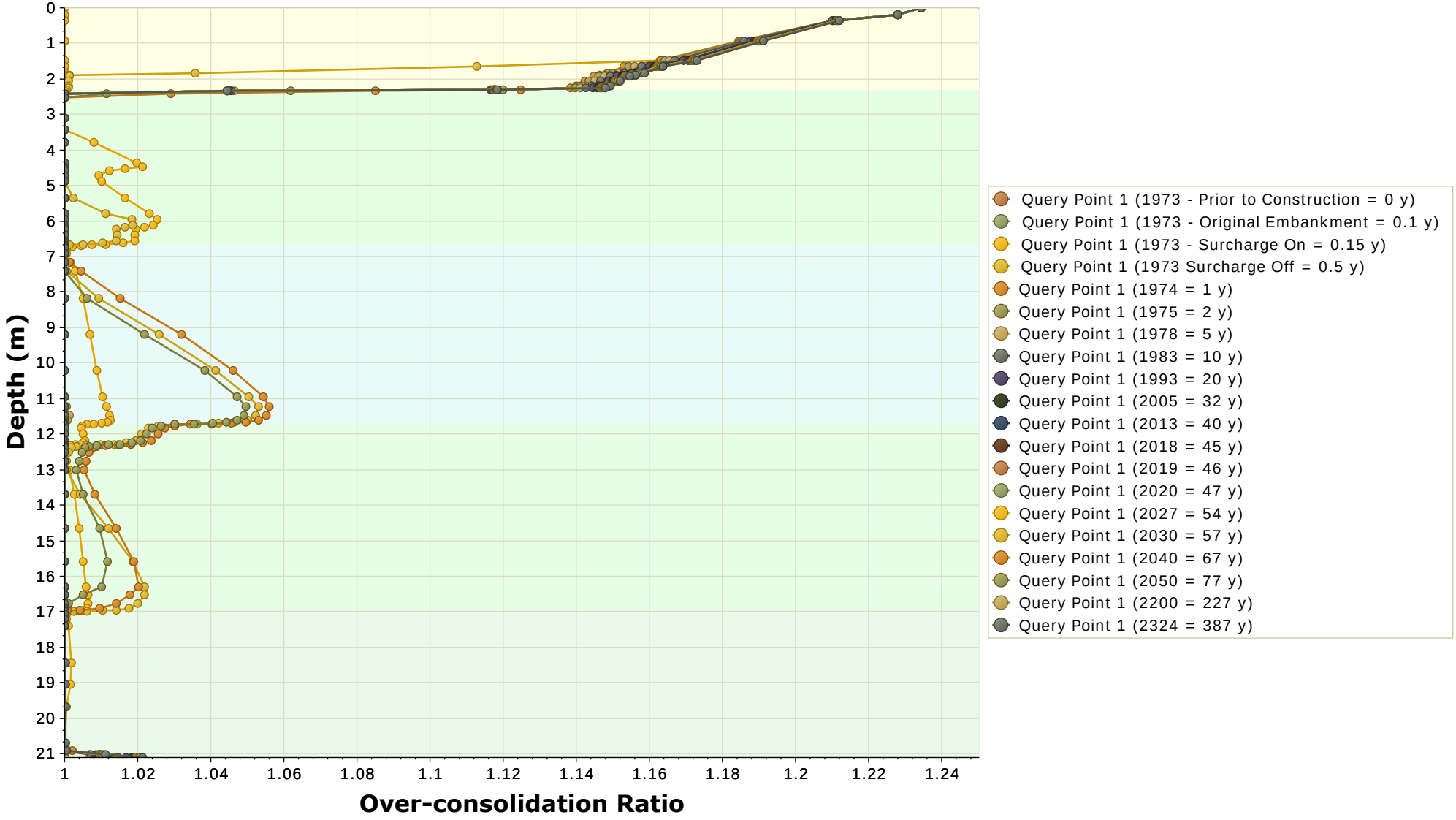


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

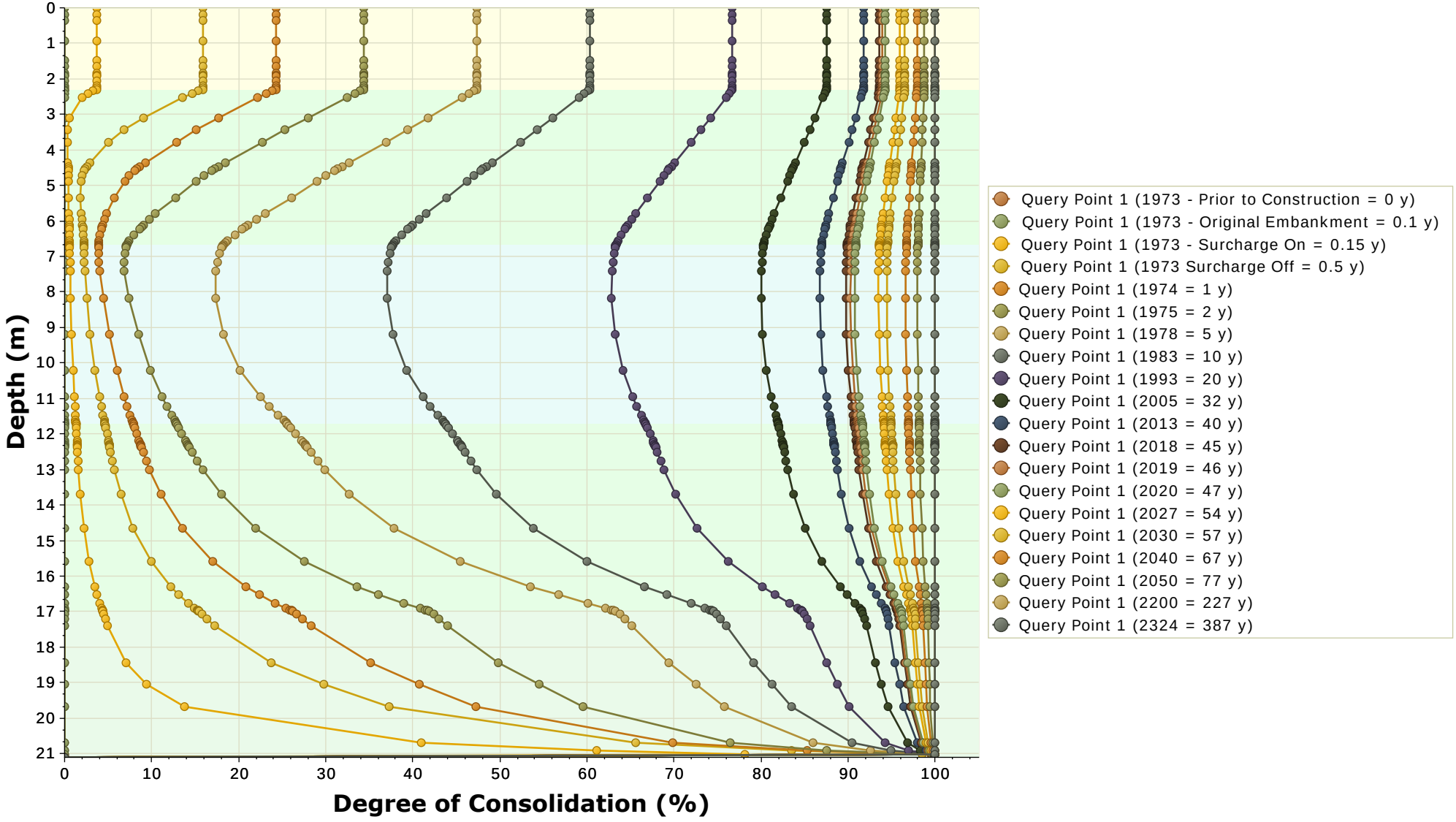


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

SETTLE3D 4.005

Degree of Consolidation vs. Depth

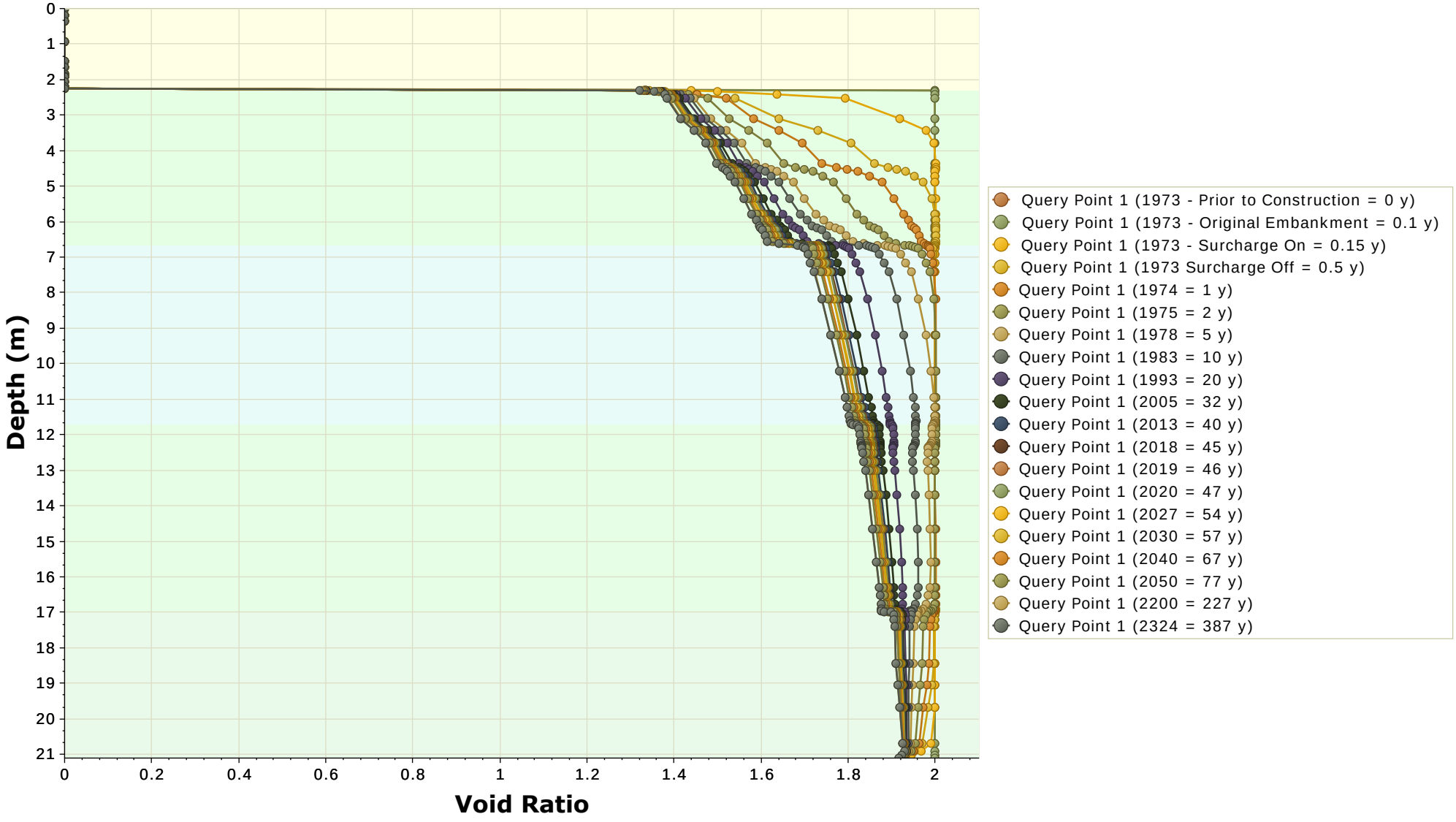


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

SETTLE3D 4.005

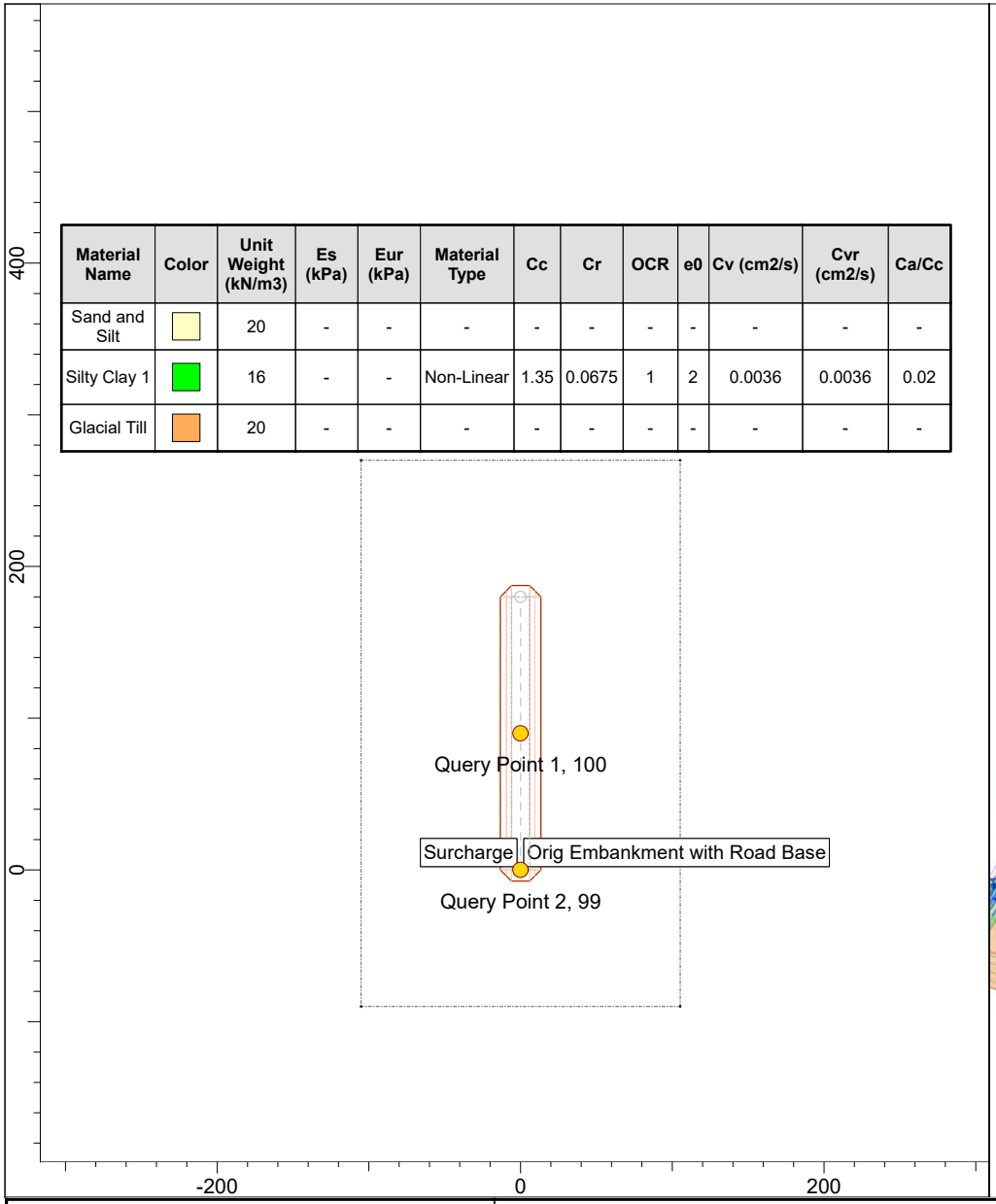
Void Ratio vs. Depth

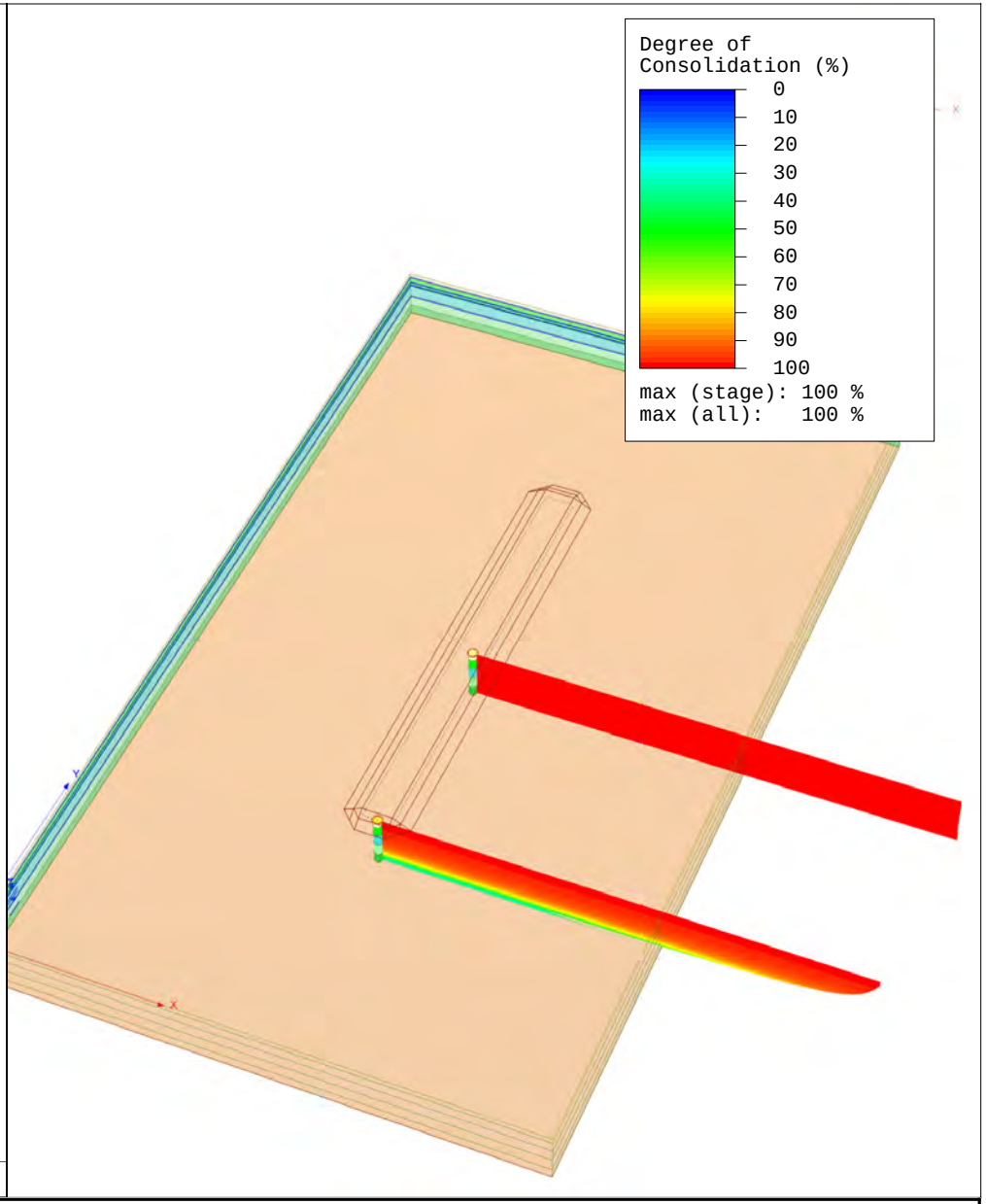


Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0036	0.0036	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-

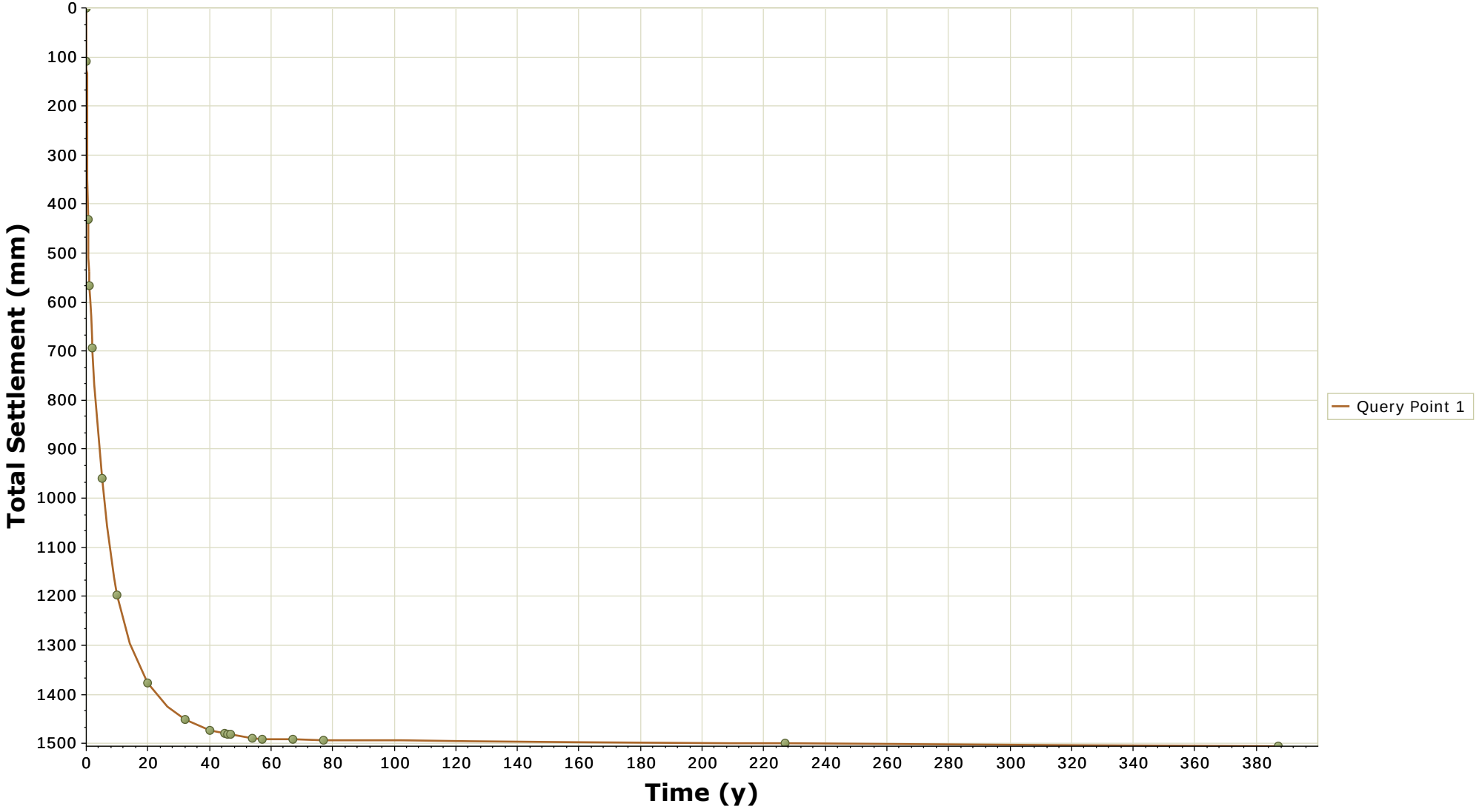




Project	Highway 417 / County Road 3 (WBL)		
Analysis Description	Preload 4 Months		
Drawn By	Ray Kennedy	Company	Golder Associates
Date	2019-03-14, 4:44:22 PM	File Name	1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

Time vs. Total Settlement



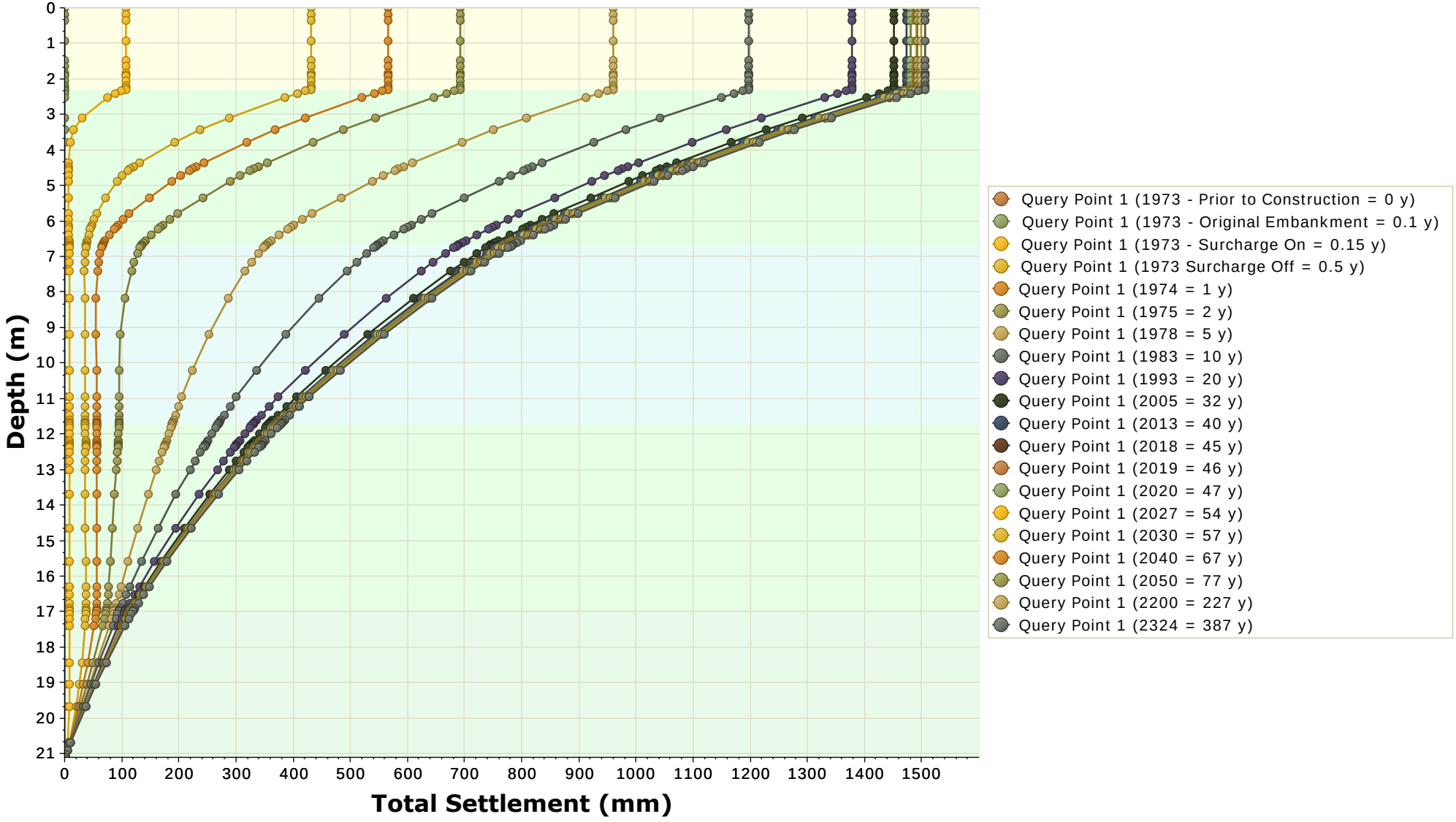
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

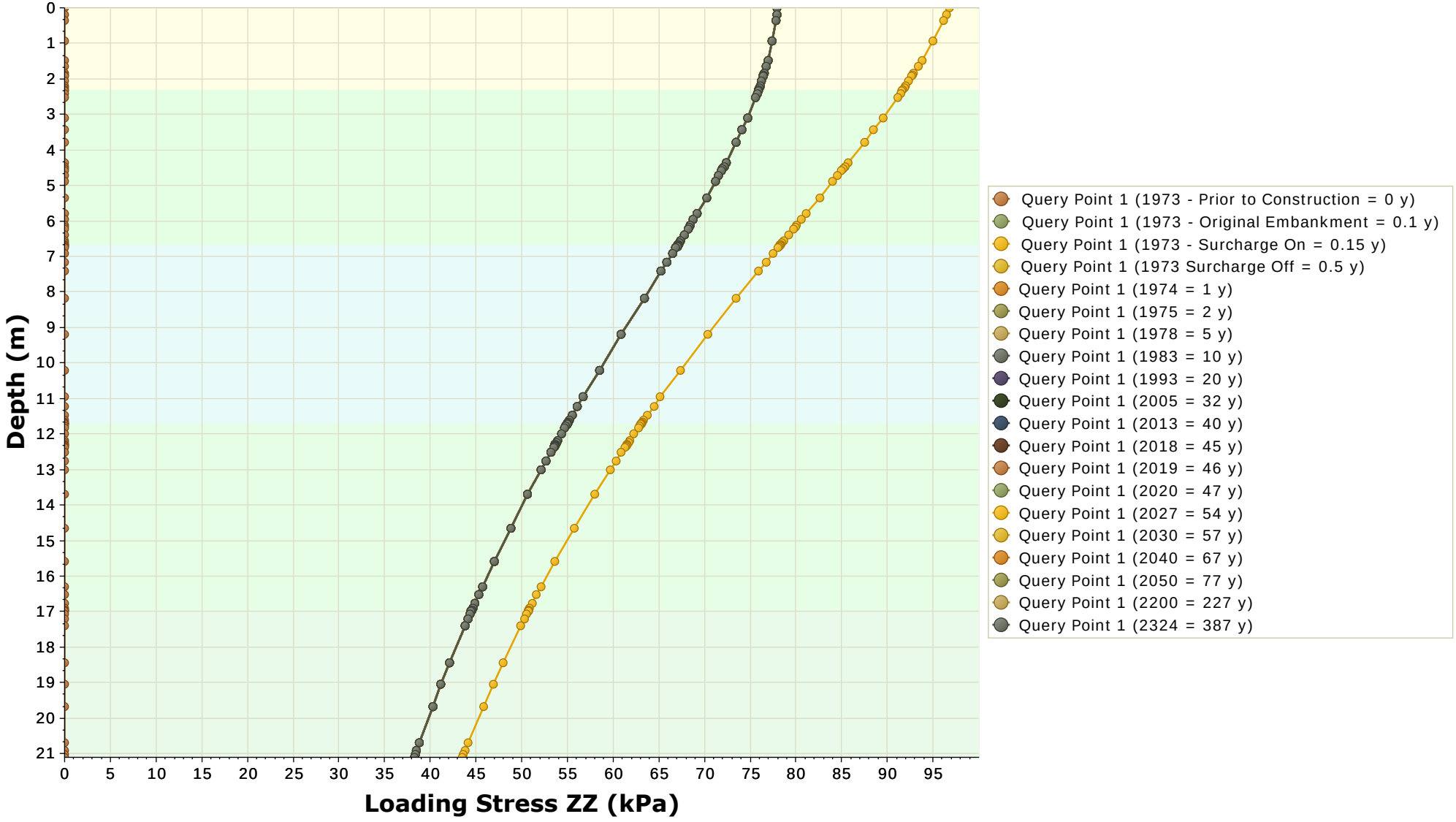
Total Settlement vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

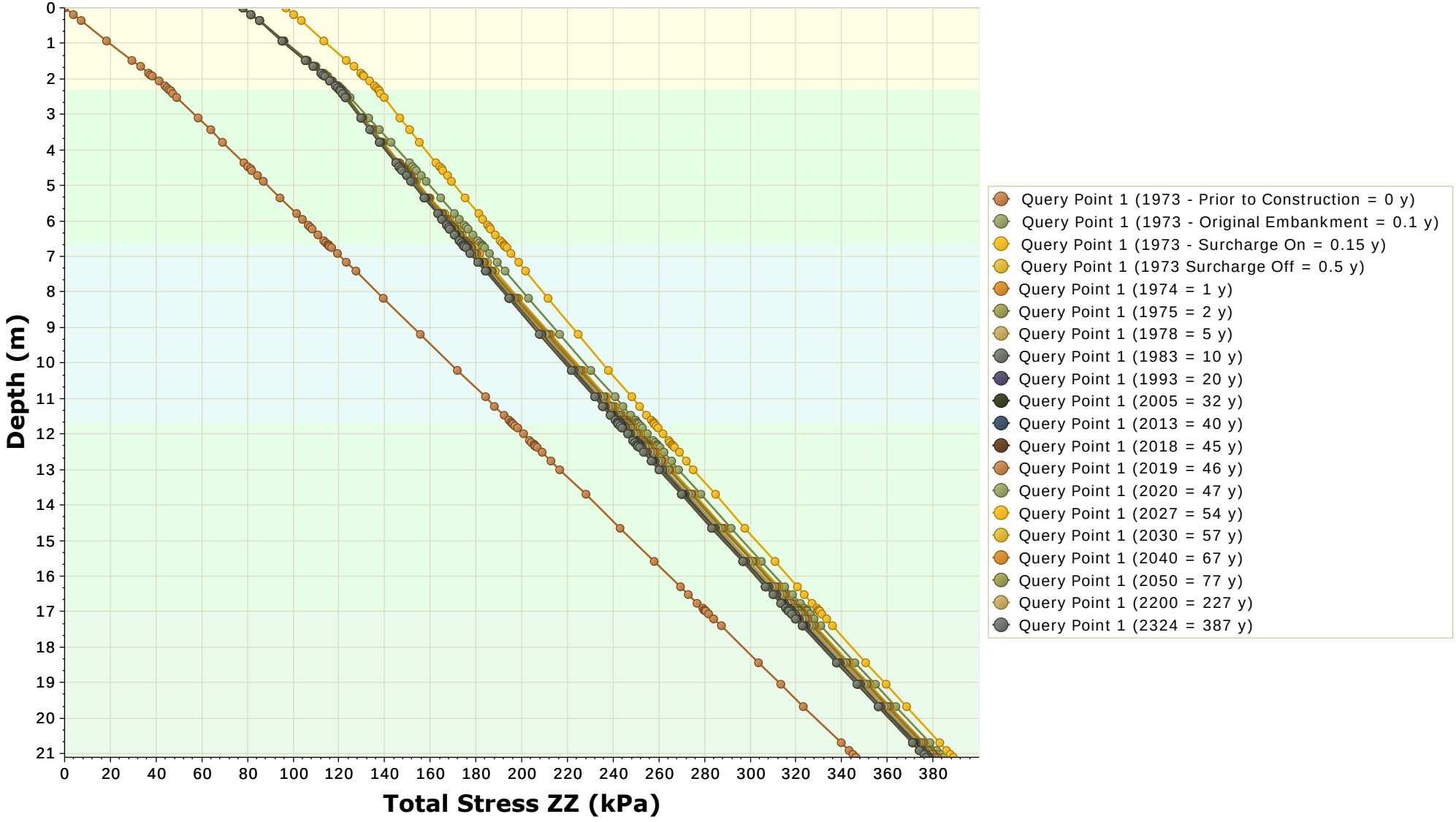
Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

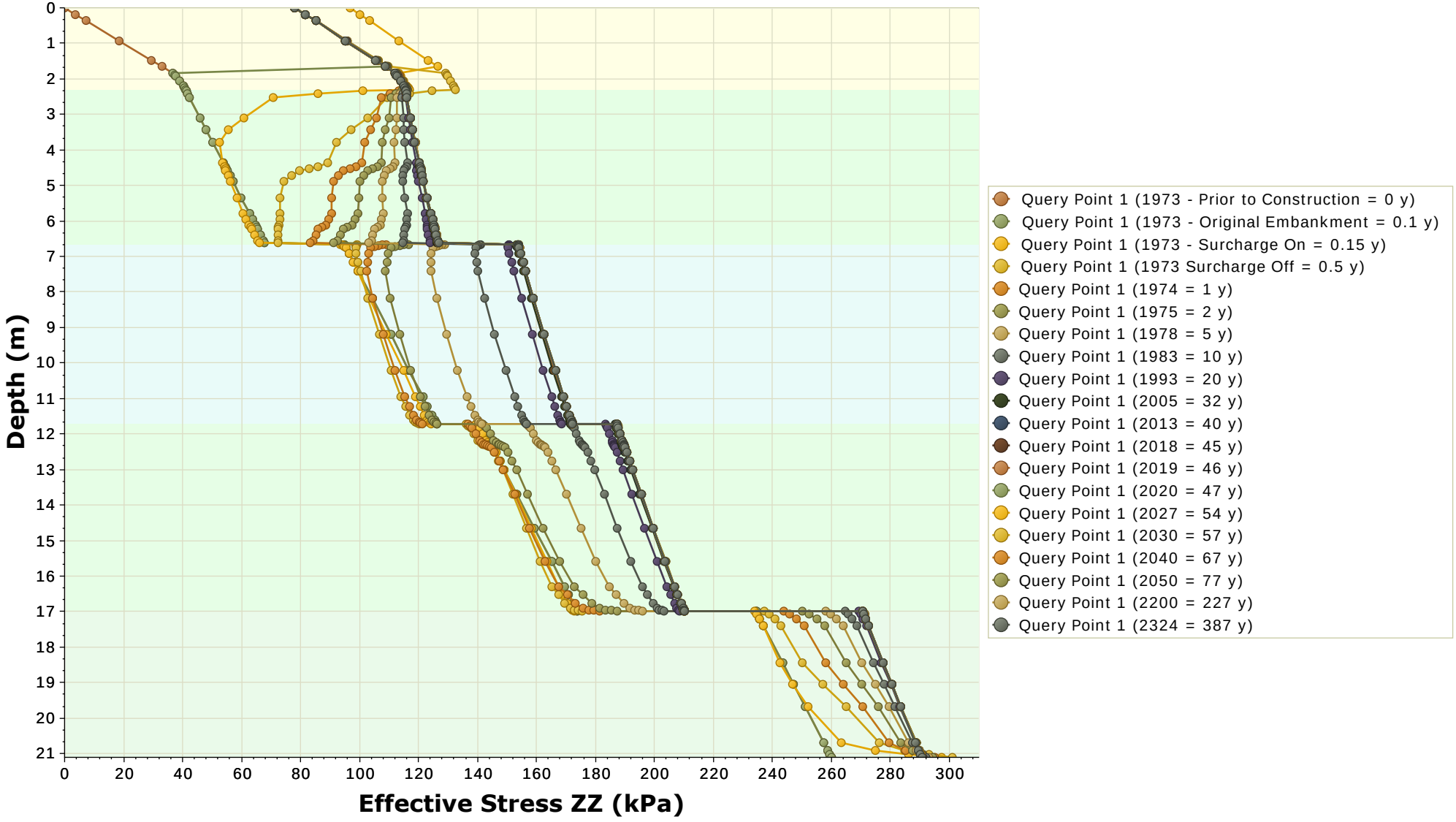
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

Effective Stress ZZ vs. Depth

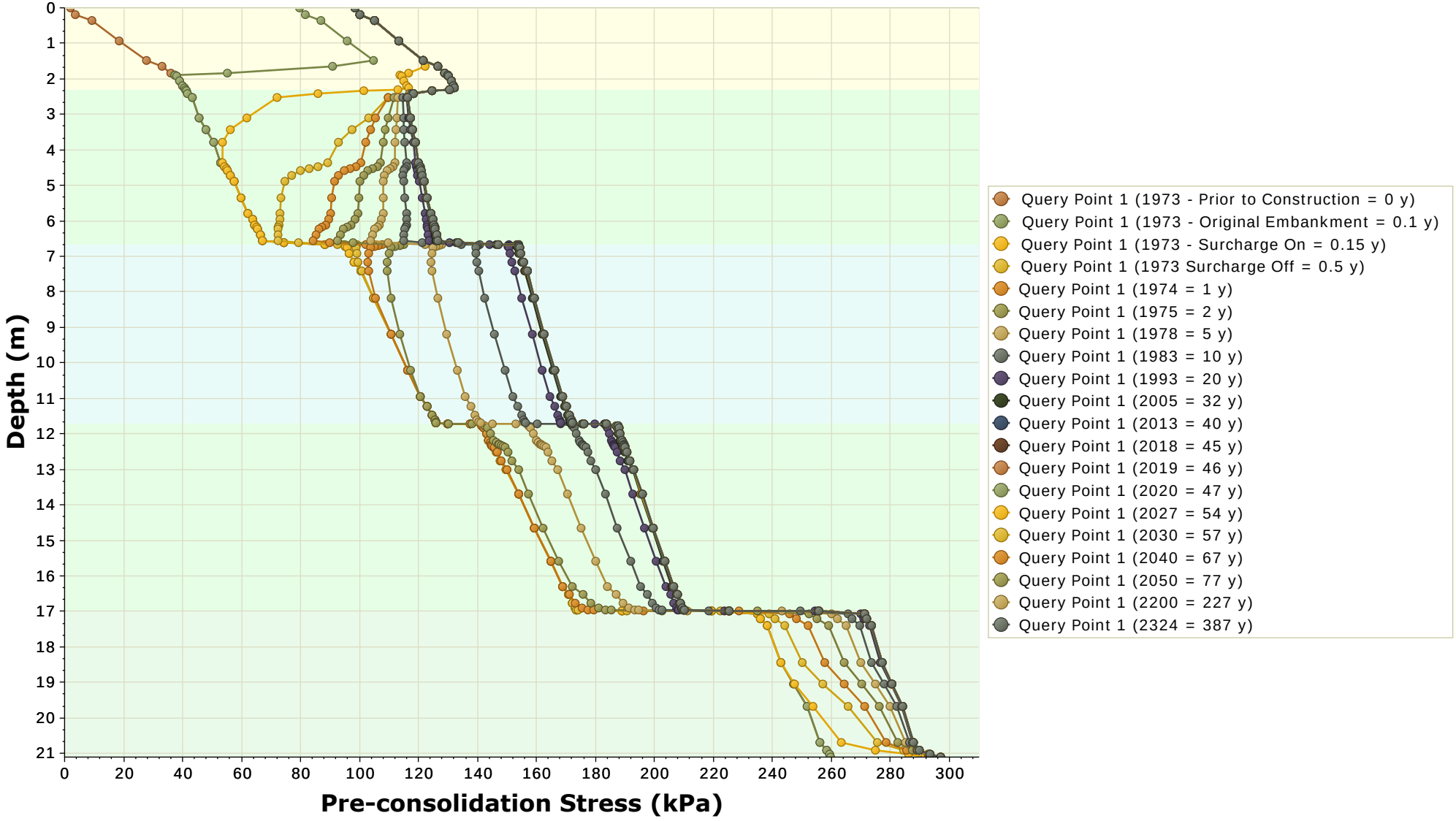


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

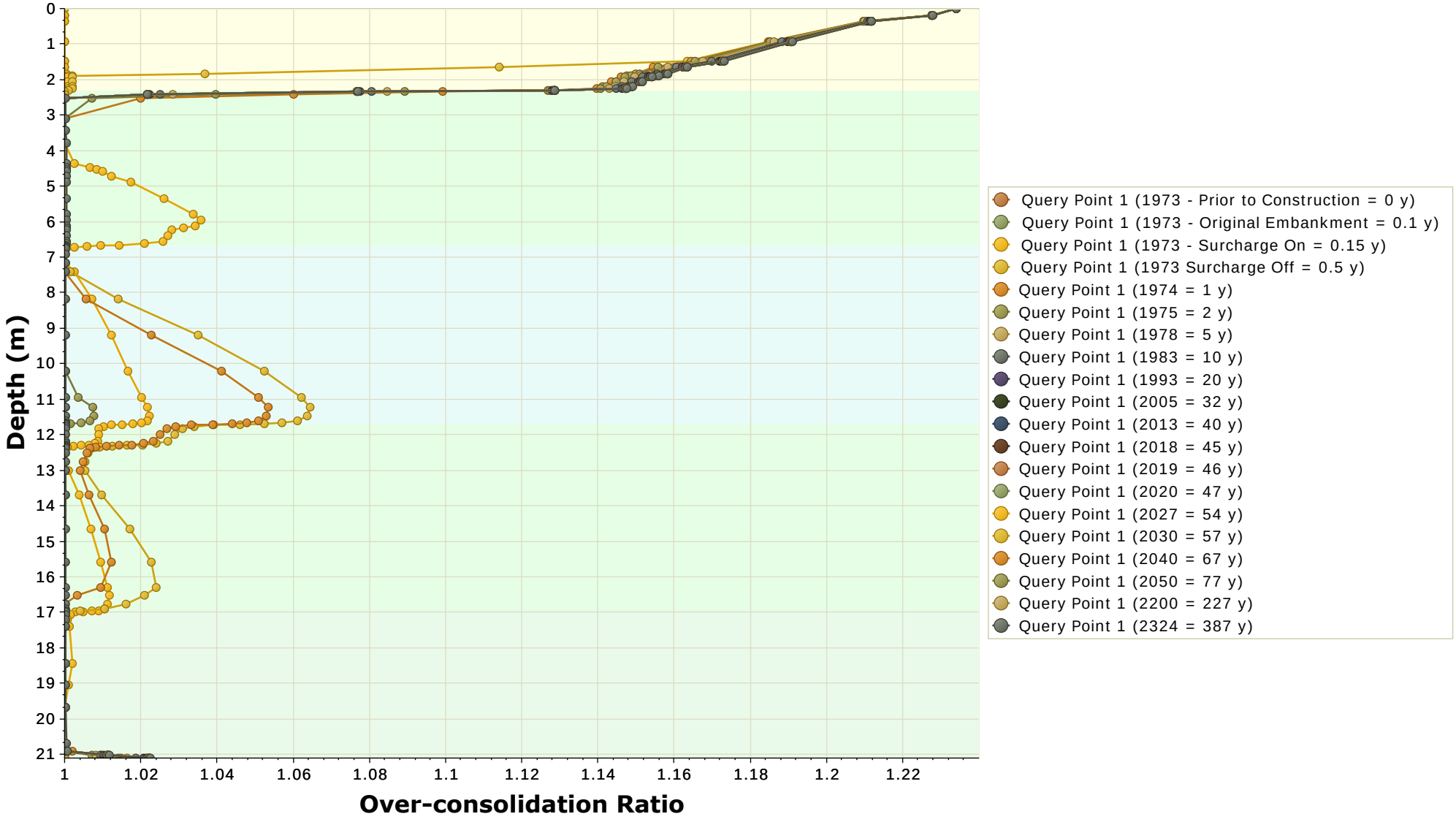


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

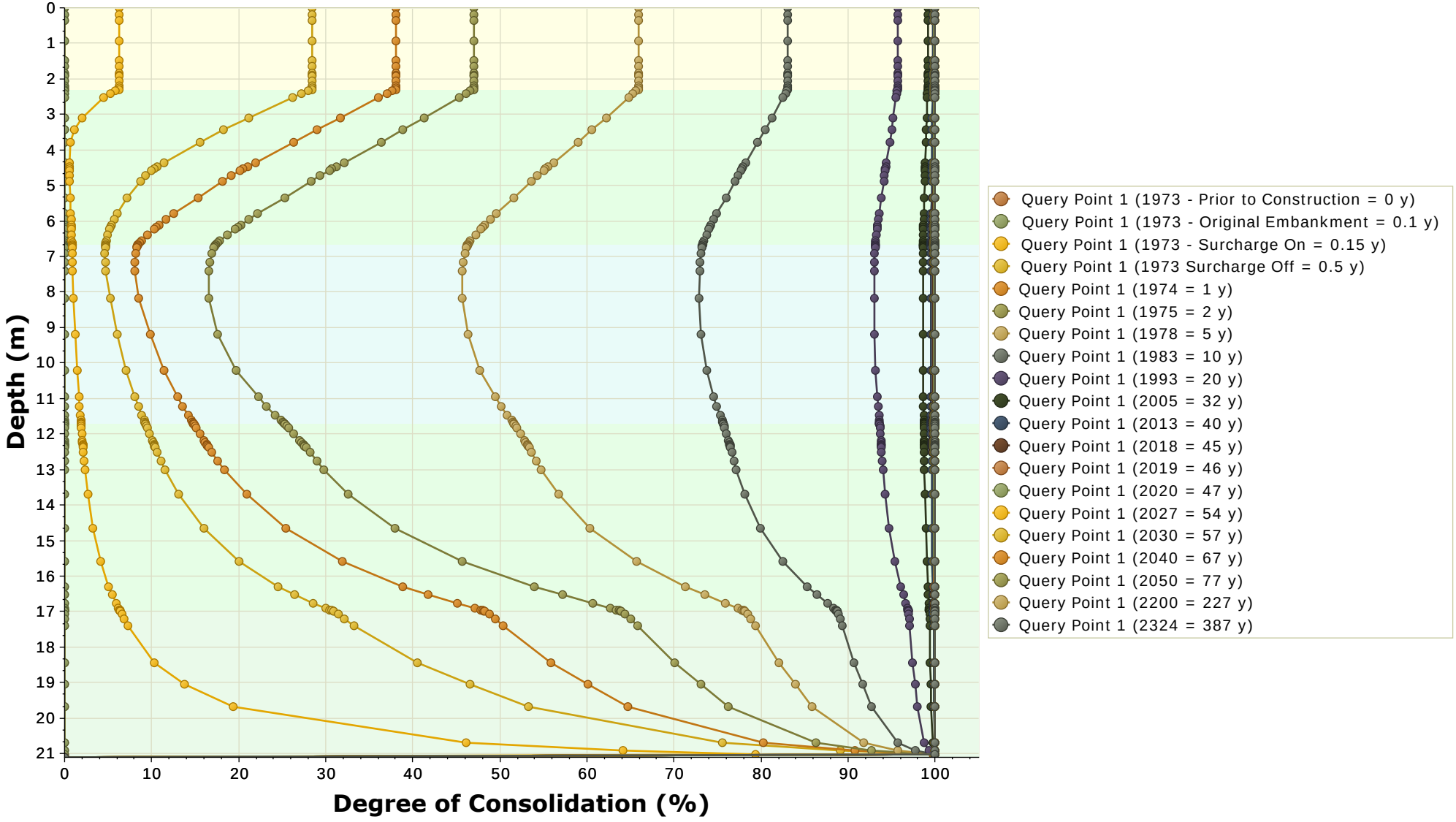


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

Degree of Consolidation vs. Depth

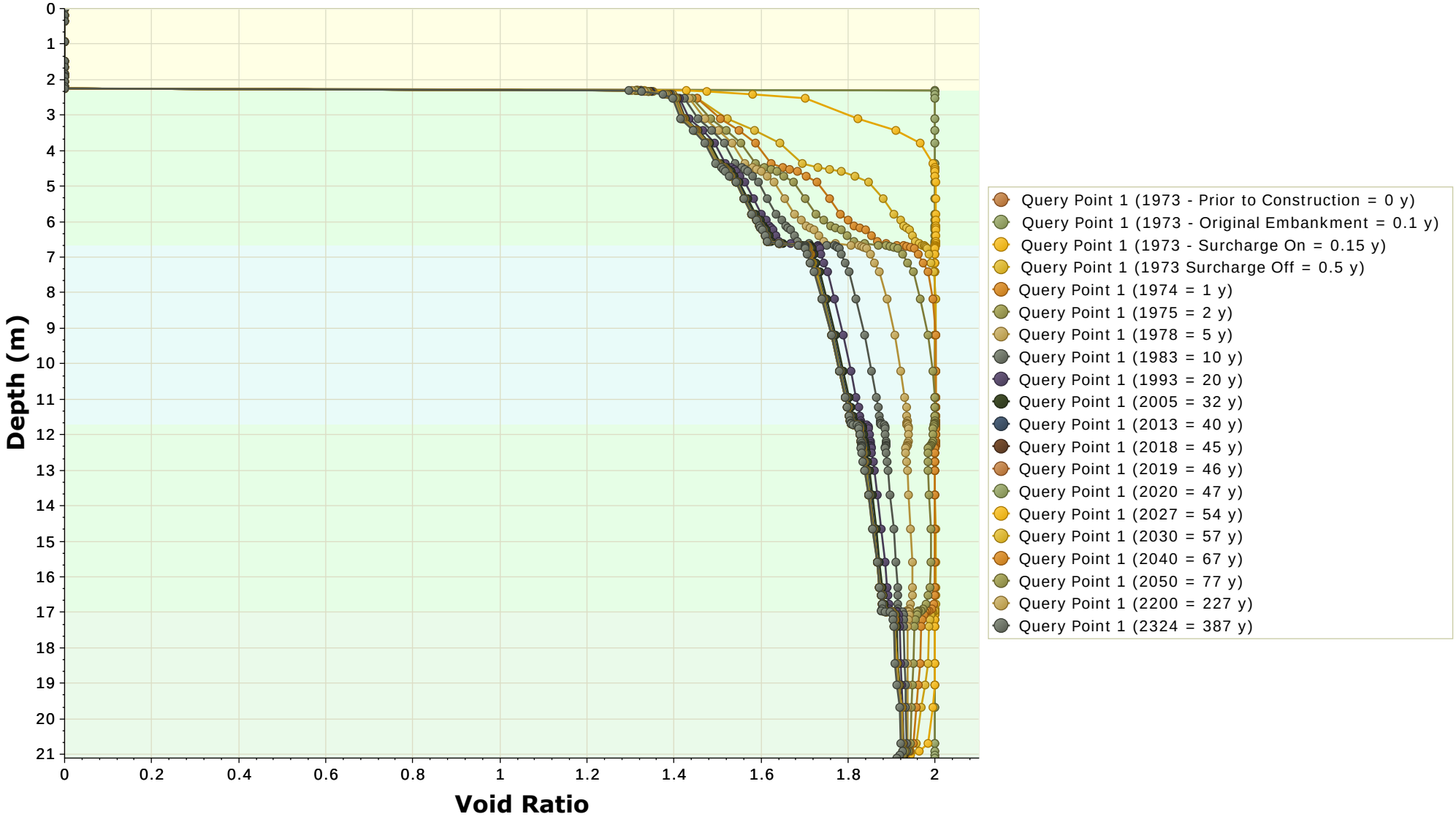


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

SETTLE3D 4.005

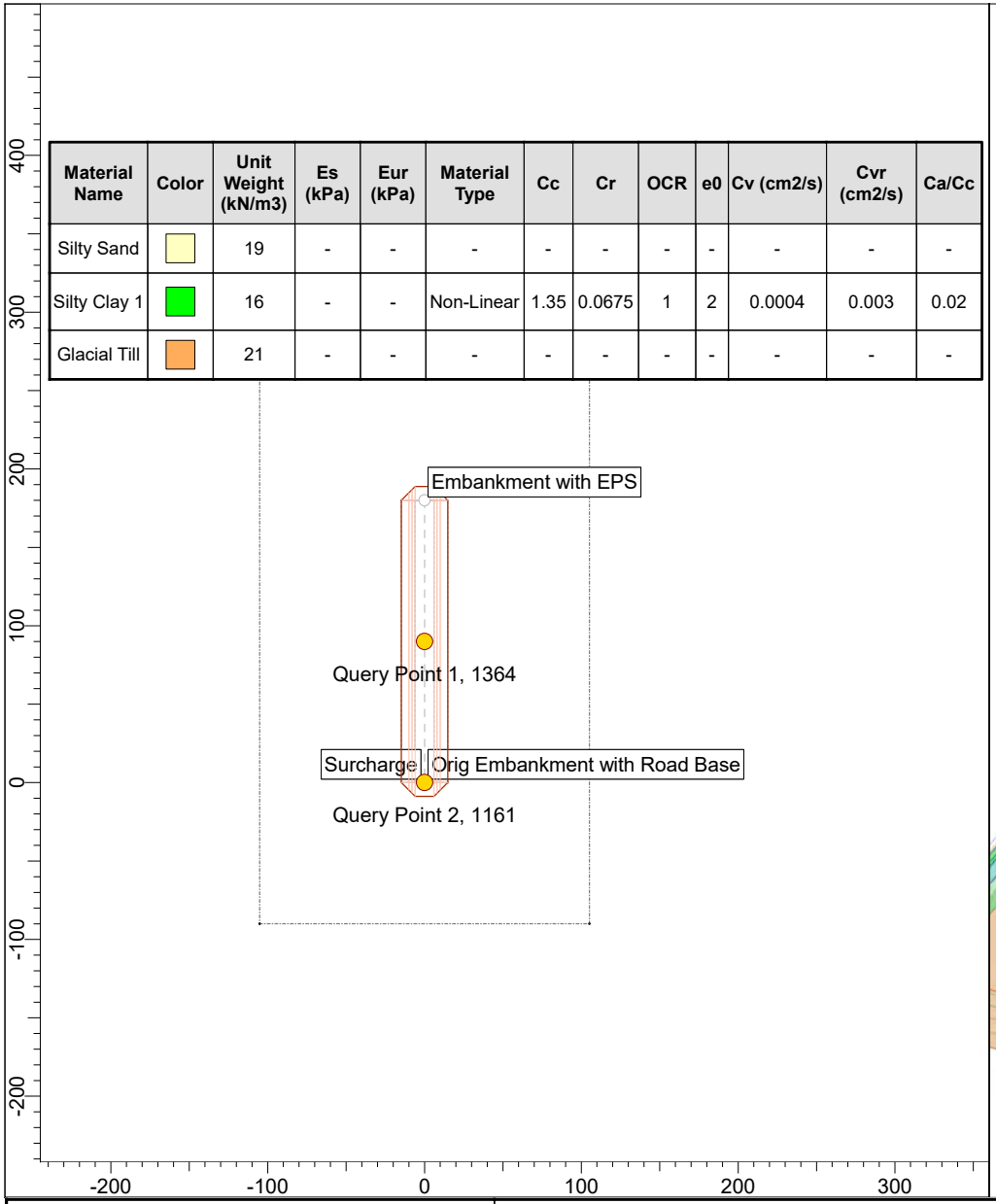
Void Ratio vs. Depth

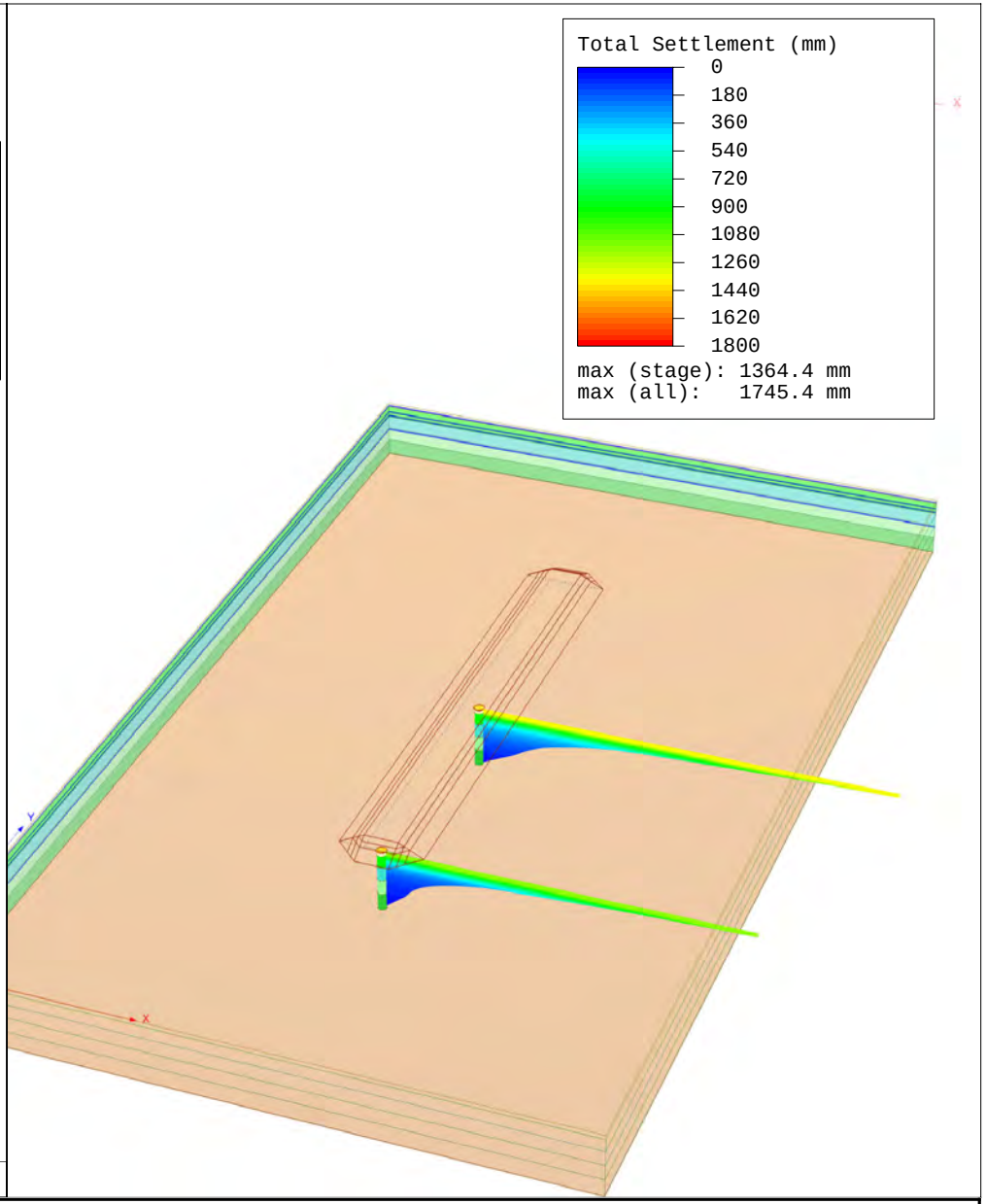


Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0004	0.003	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

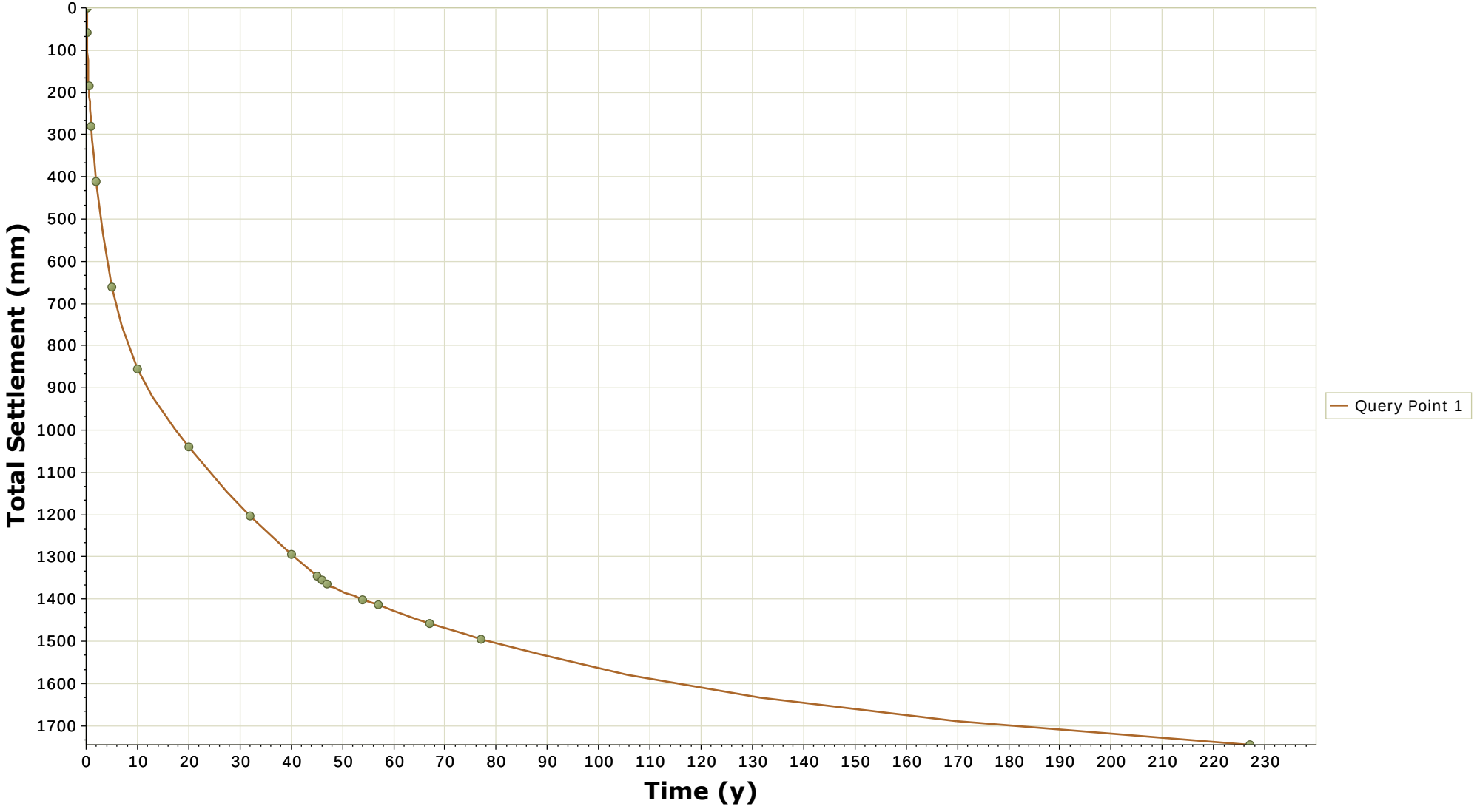




rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Time vs. Total Settlement



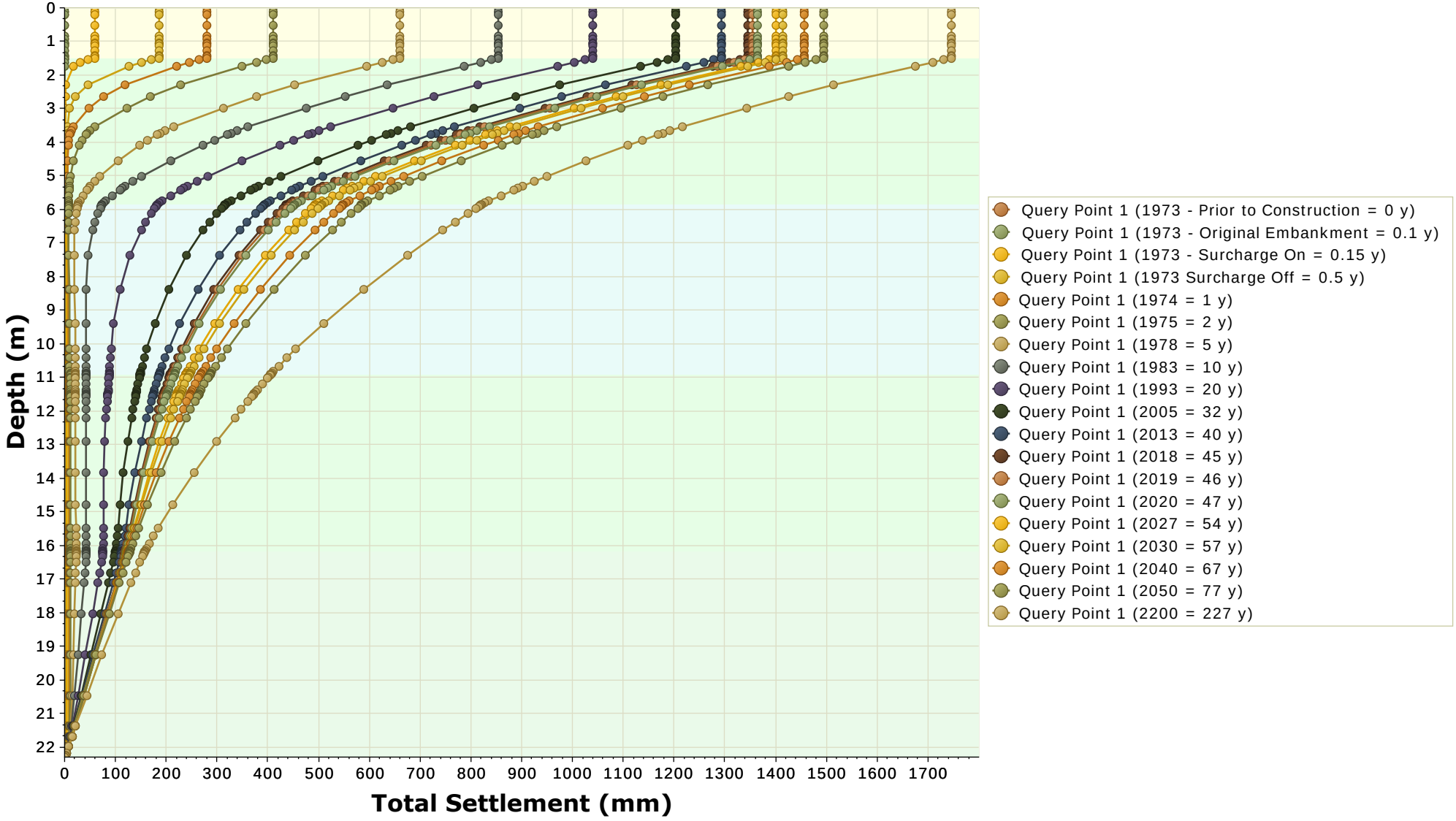
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Total Settlement vs. Depth

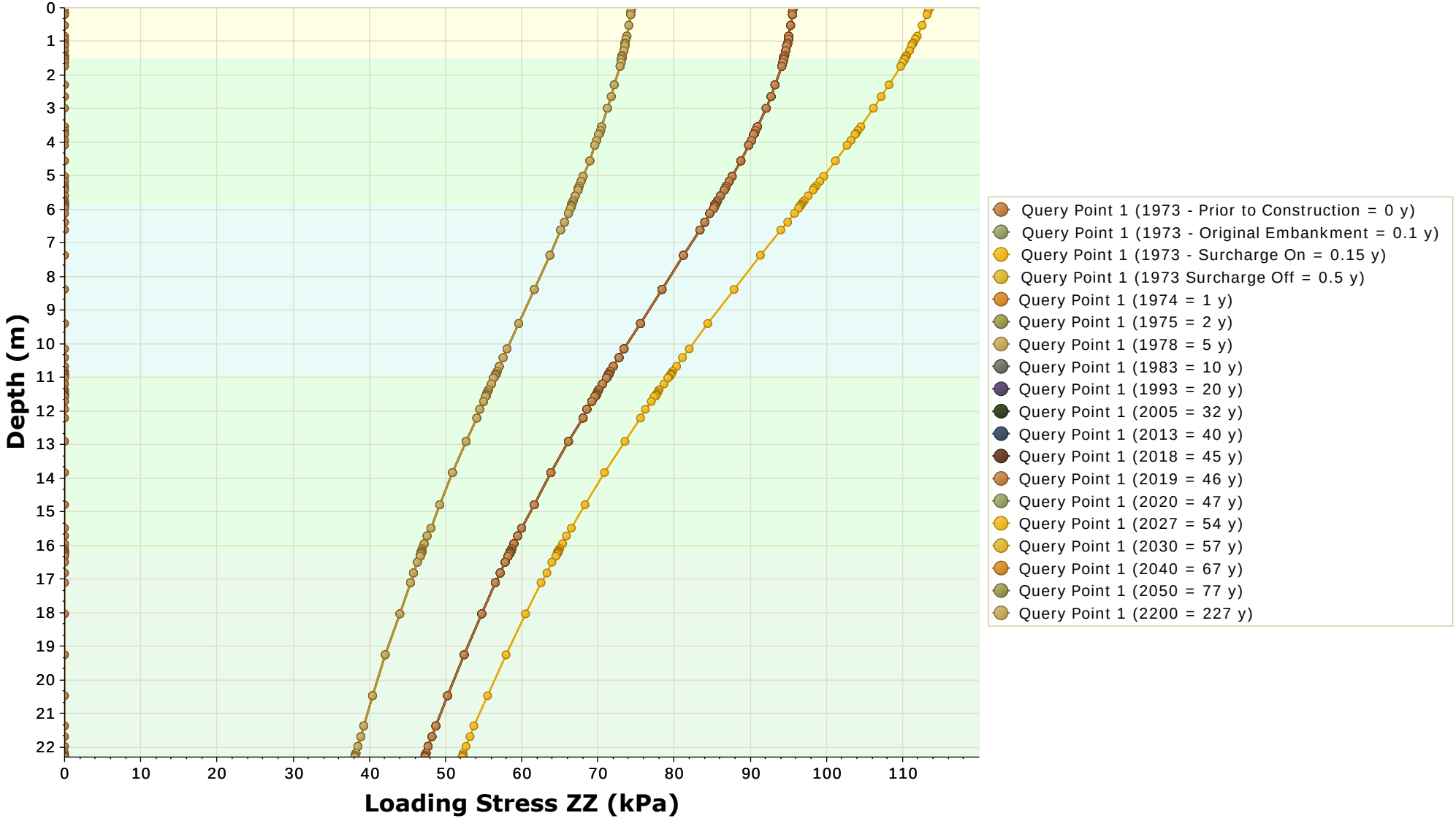


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
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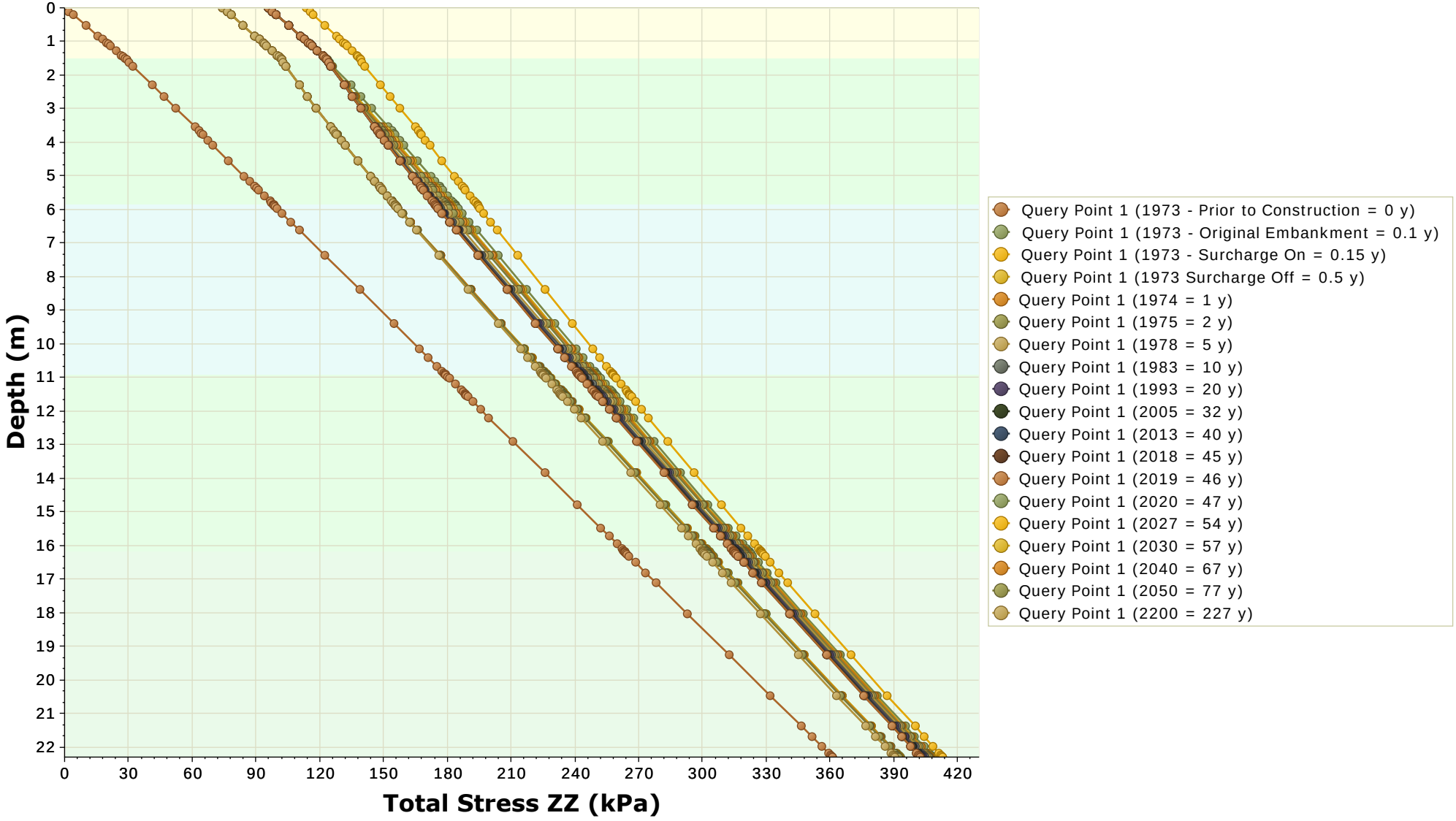
SETTLE3D 4.005

Total Stress ZZ vs. Depth

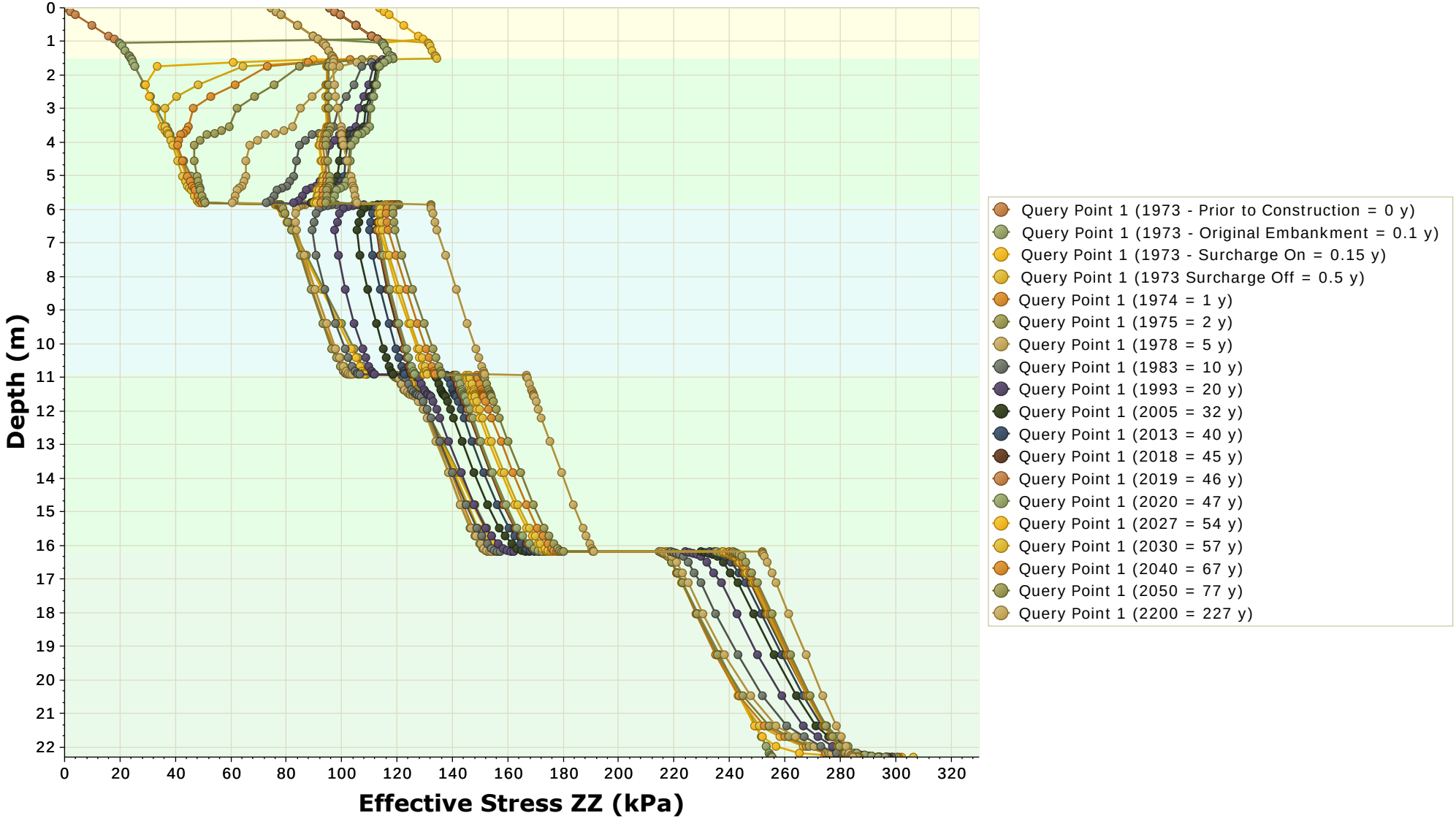


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Effective Stress ZZ vs. Depth

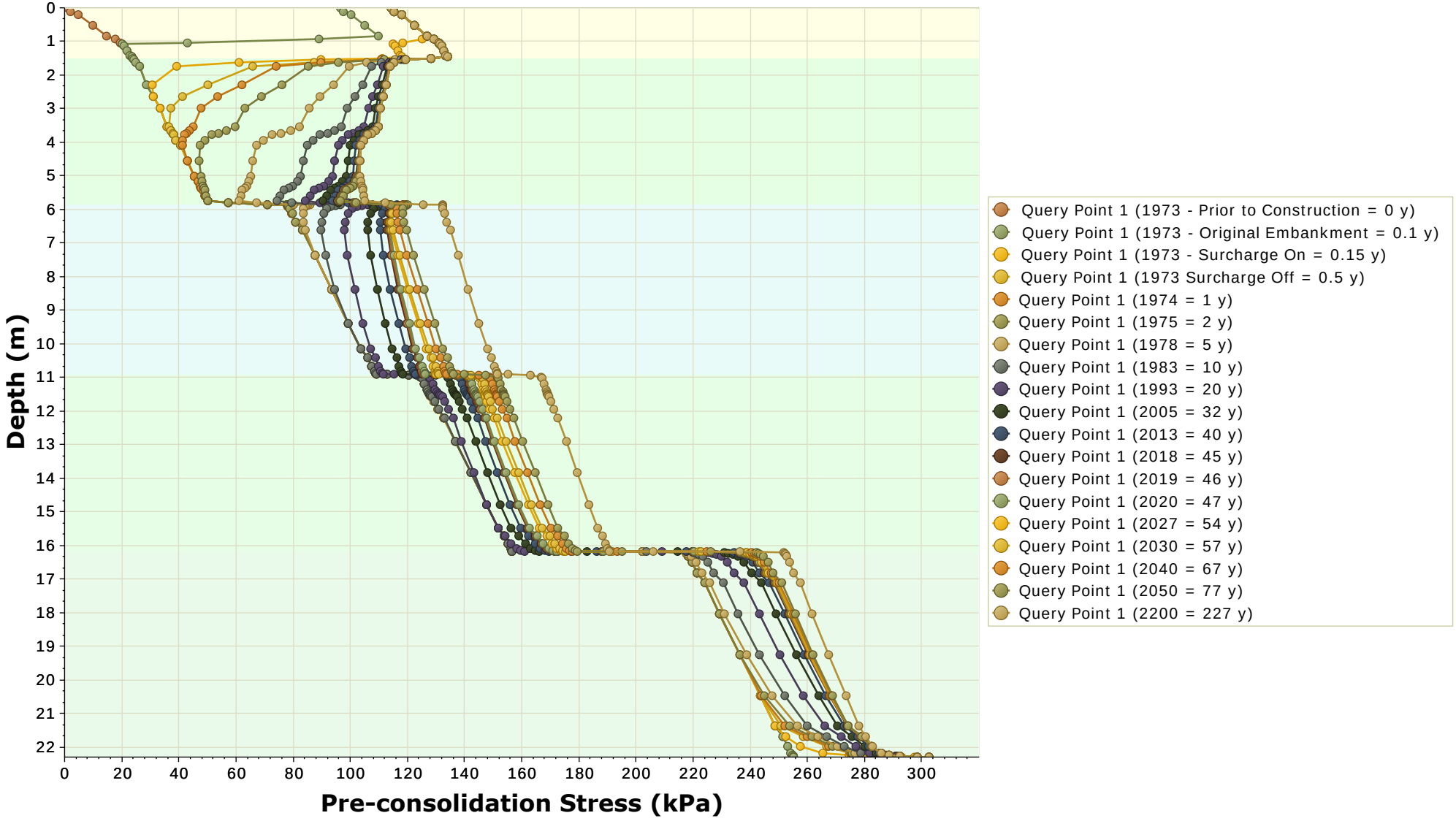


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

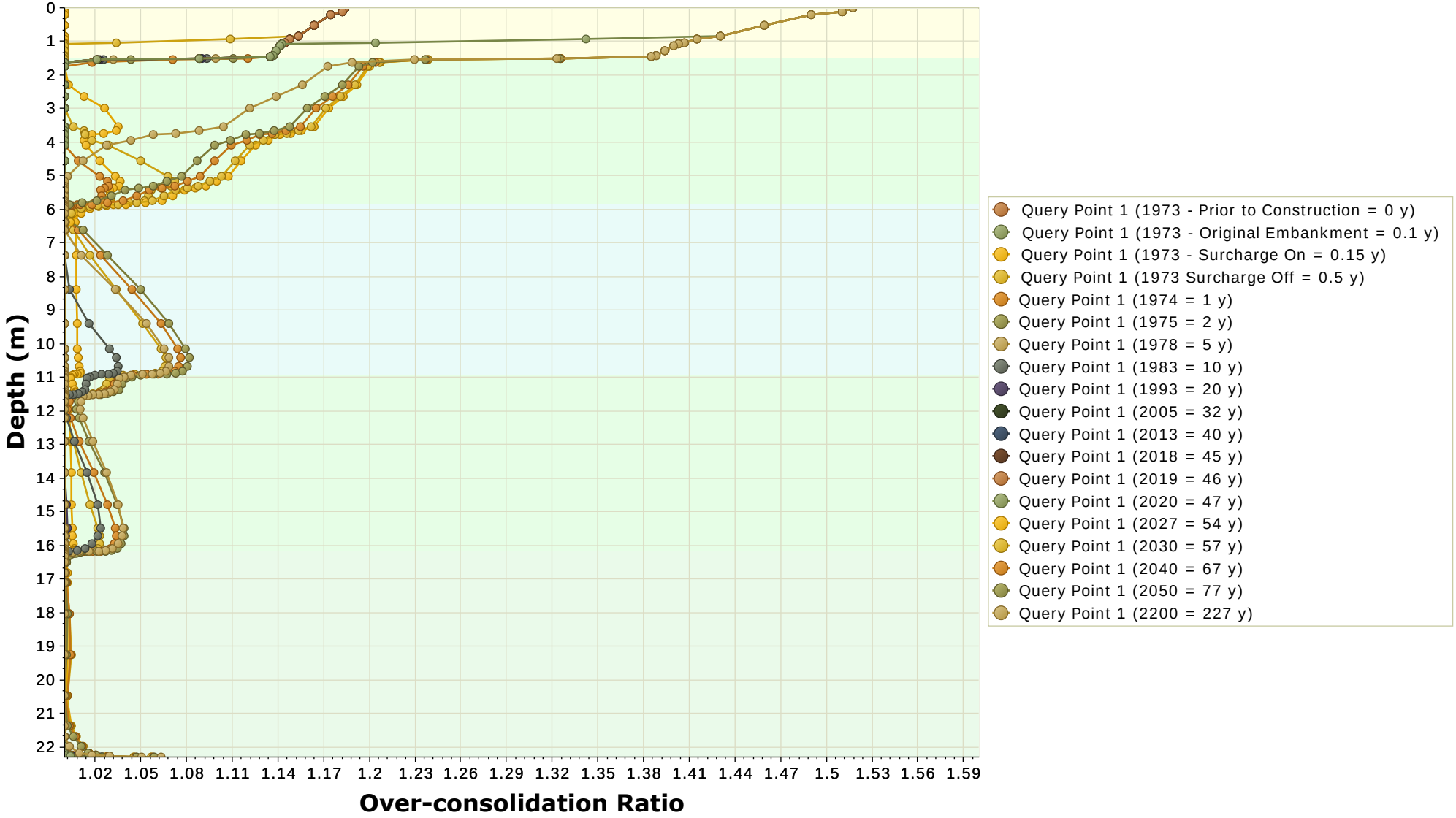


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

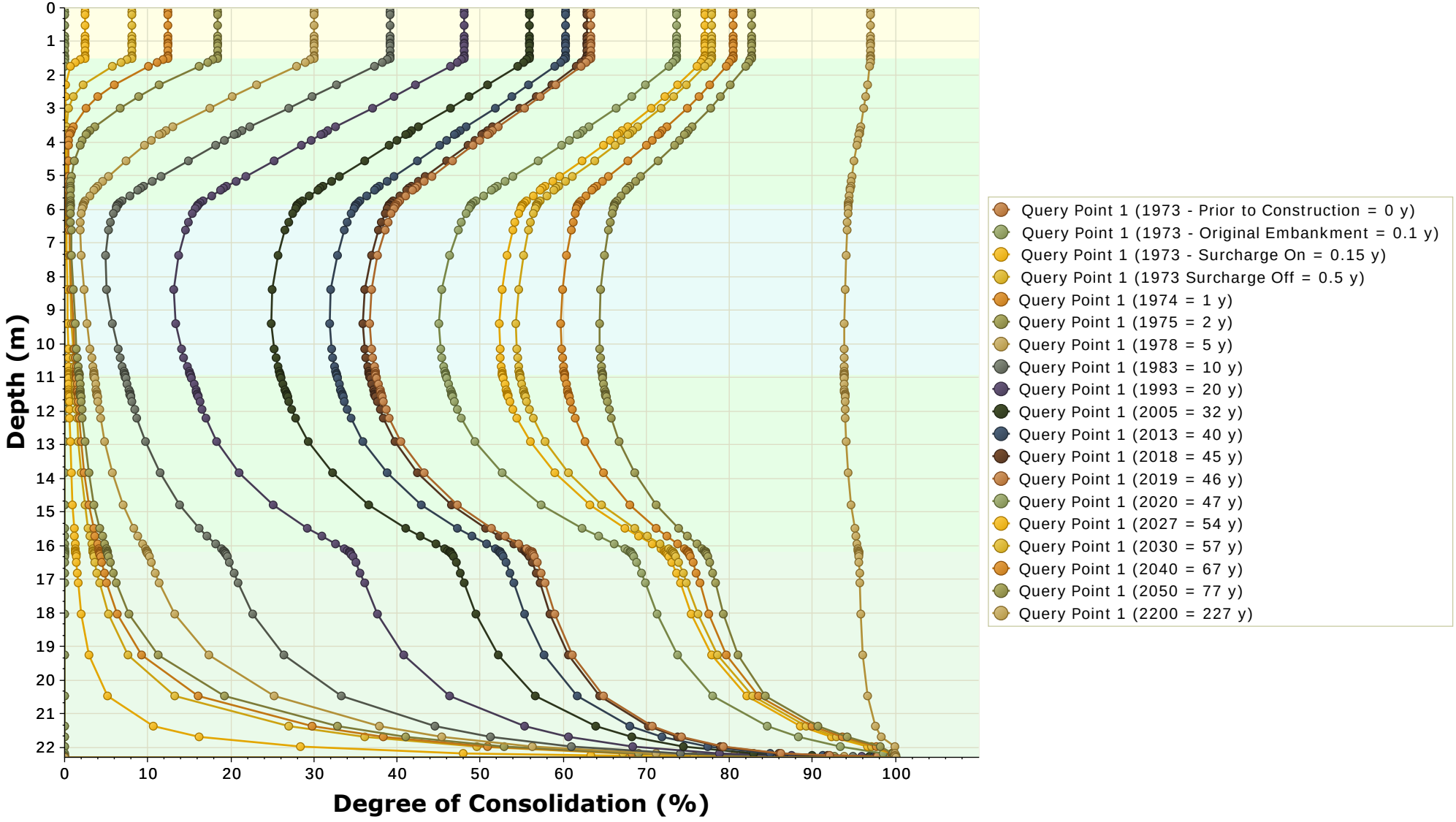


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Degree of Consolidation vs. Depth

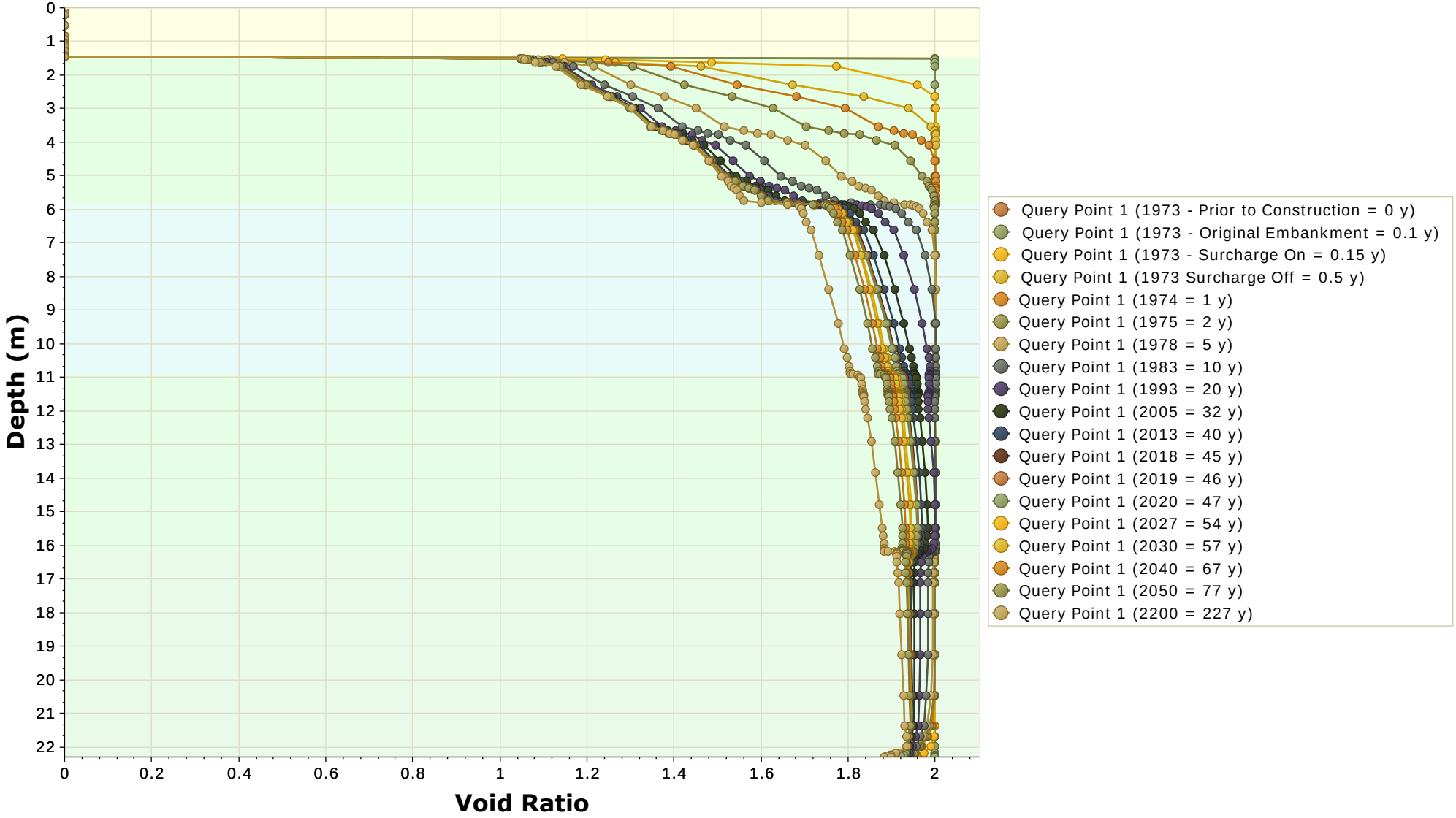


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Void Ratio vs. Depth

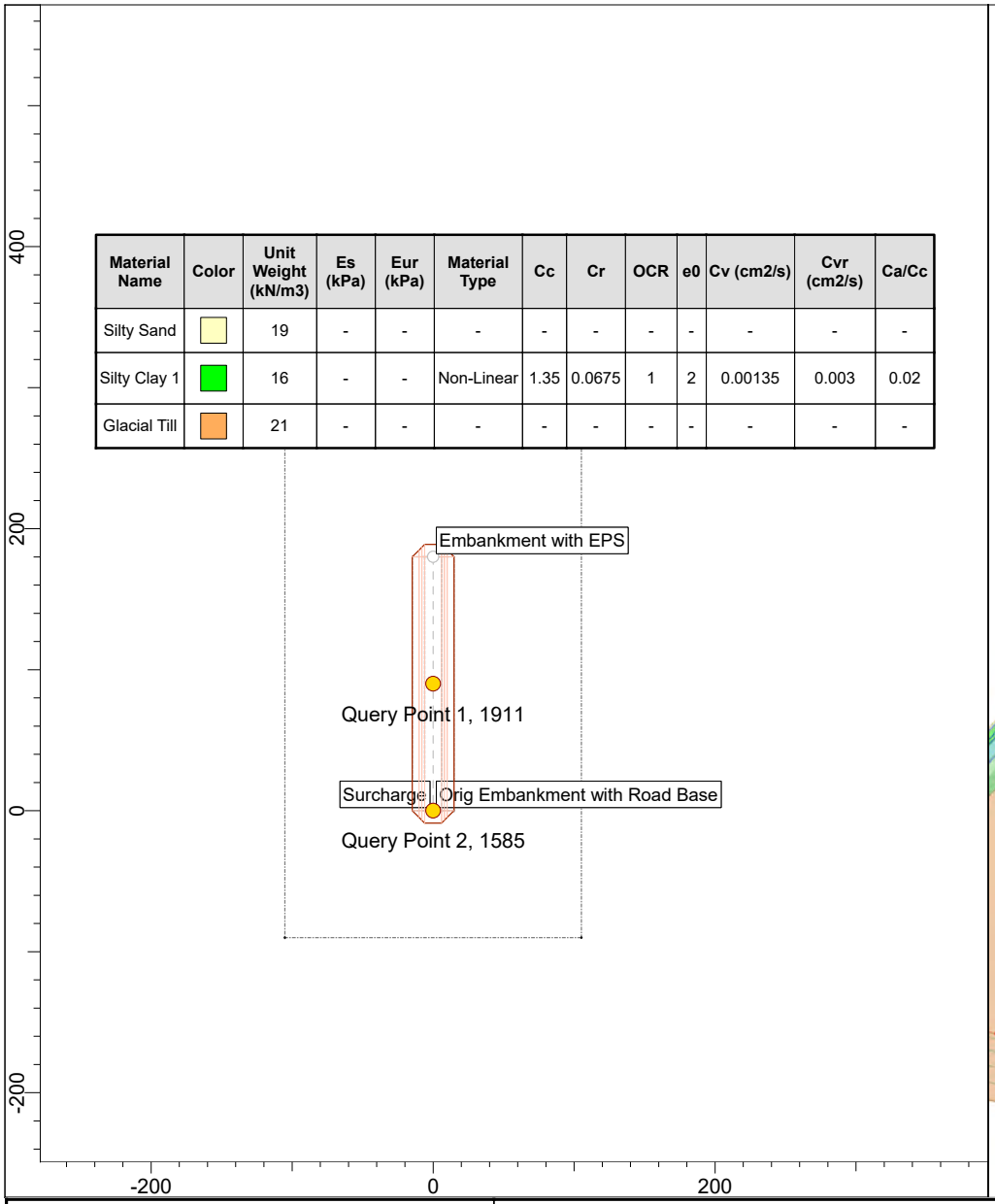


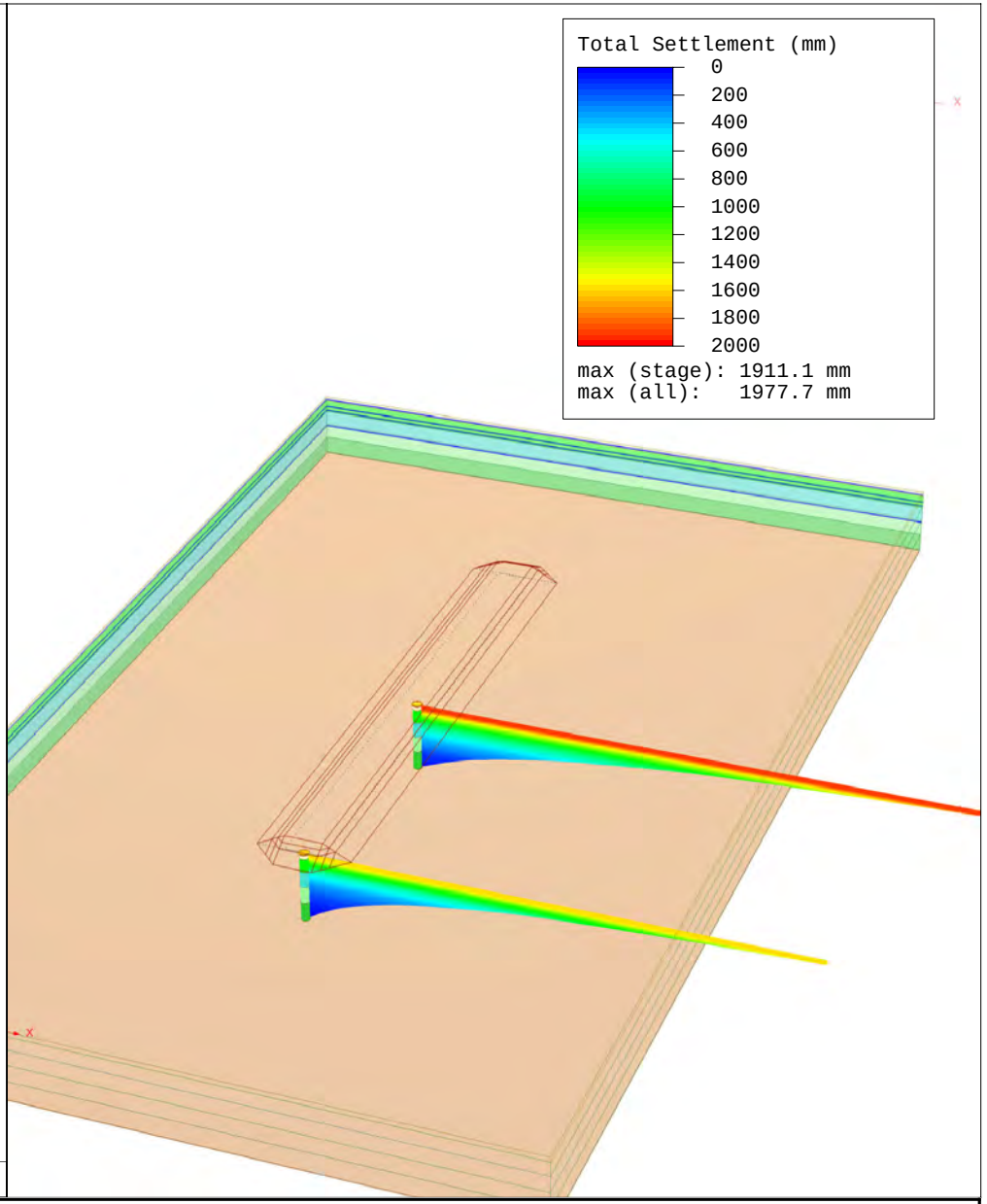
Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_EPS_1m.s3

SETTLE3D 4.005

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.00135	0.003	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

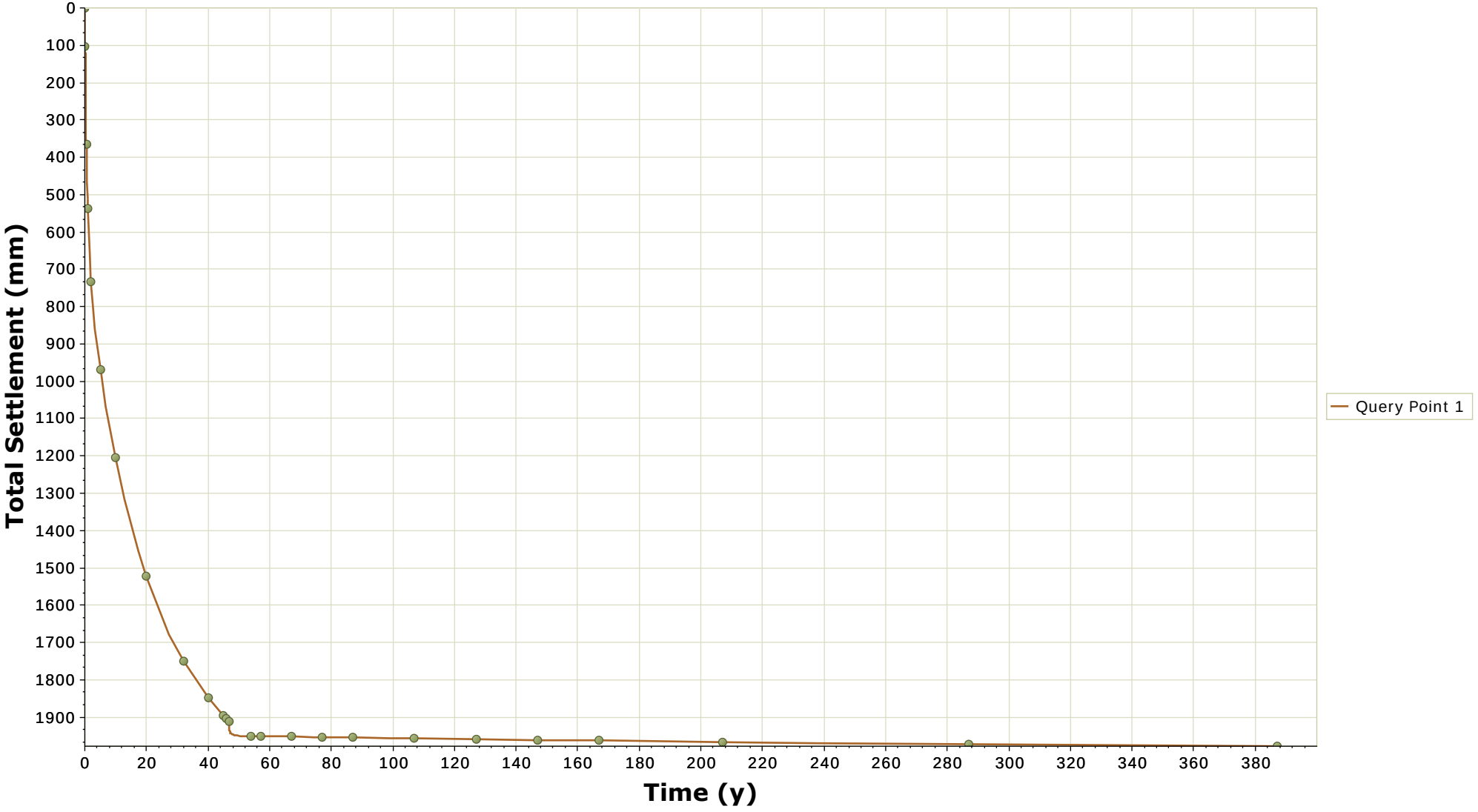




Project	Highway 417 / County Road 3 (EBL)
Analysis Description	Preload 4 Months
Drawn By	Ray Kennedy
Company	Golder Associates
Date	2019-03-14, 4:44:22 PM
File Name	99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Time vs. Total Settlement



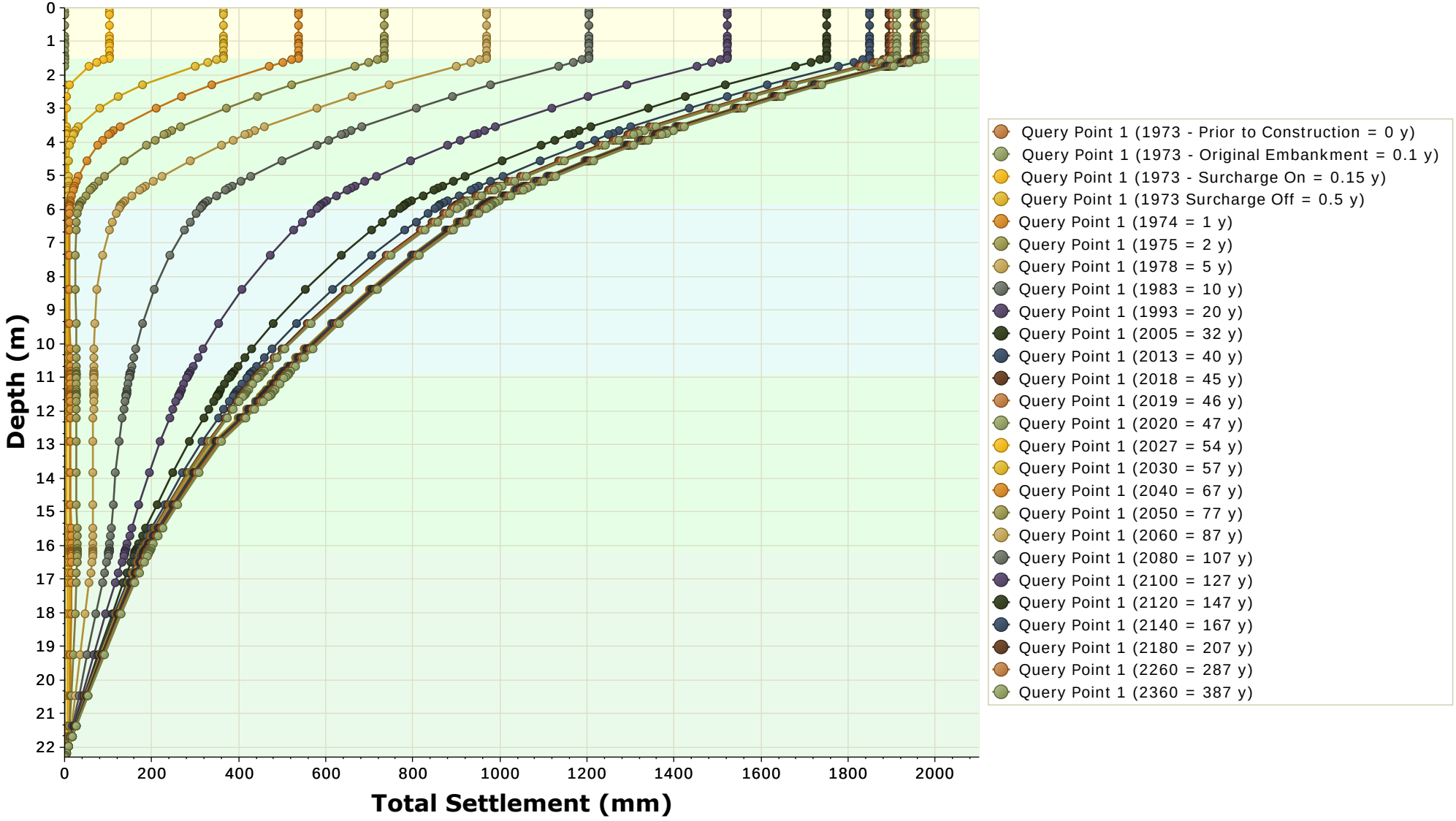
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Total Settlement vs. Depth

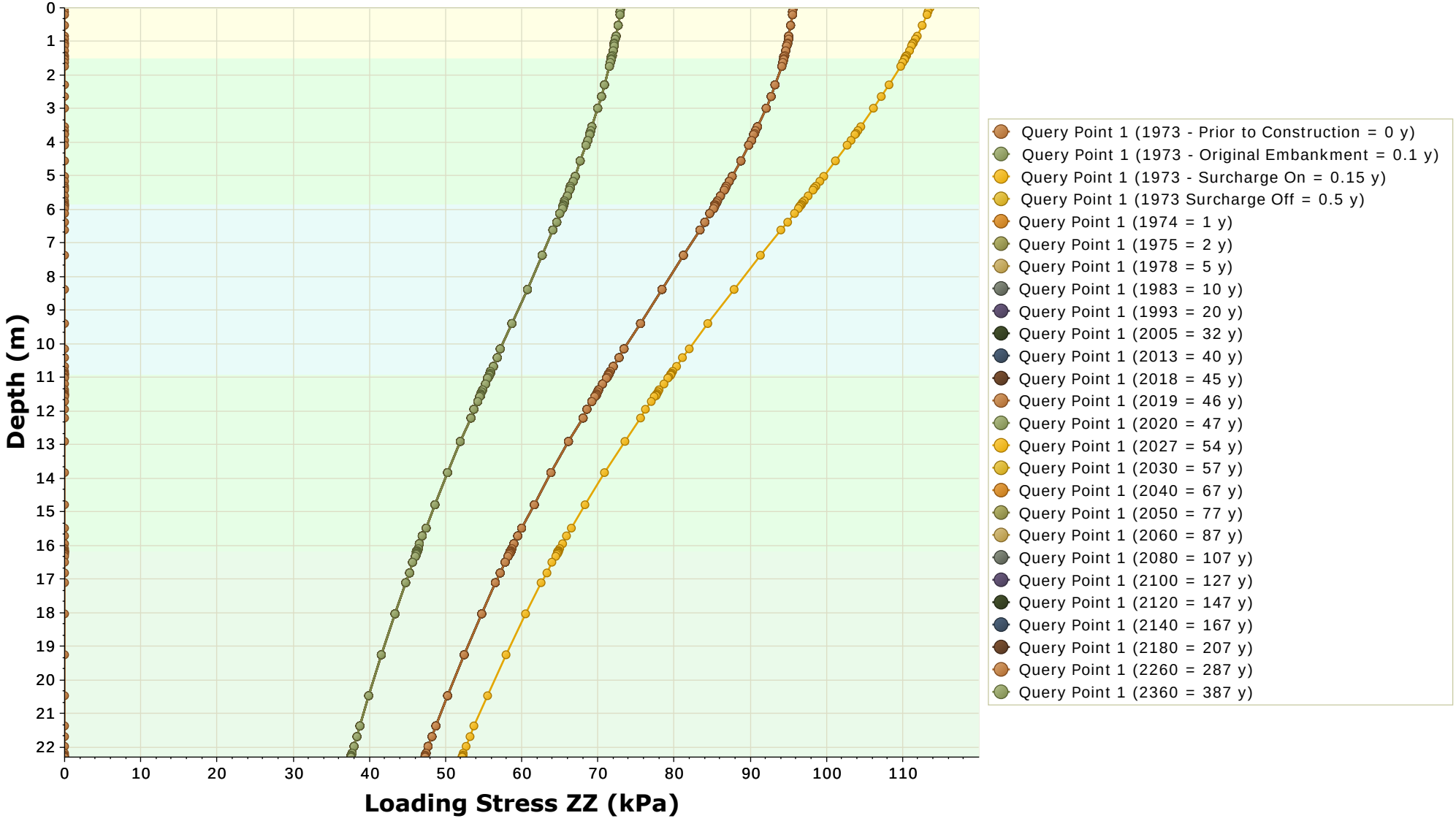


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Loading Stress ZZ vs. Depth

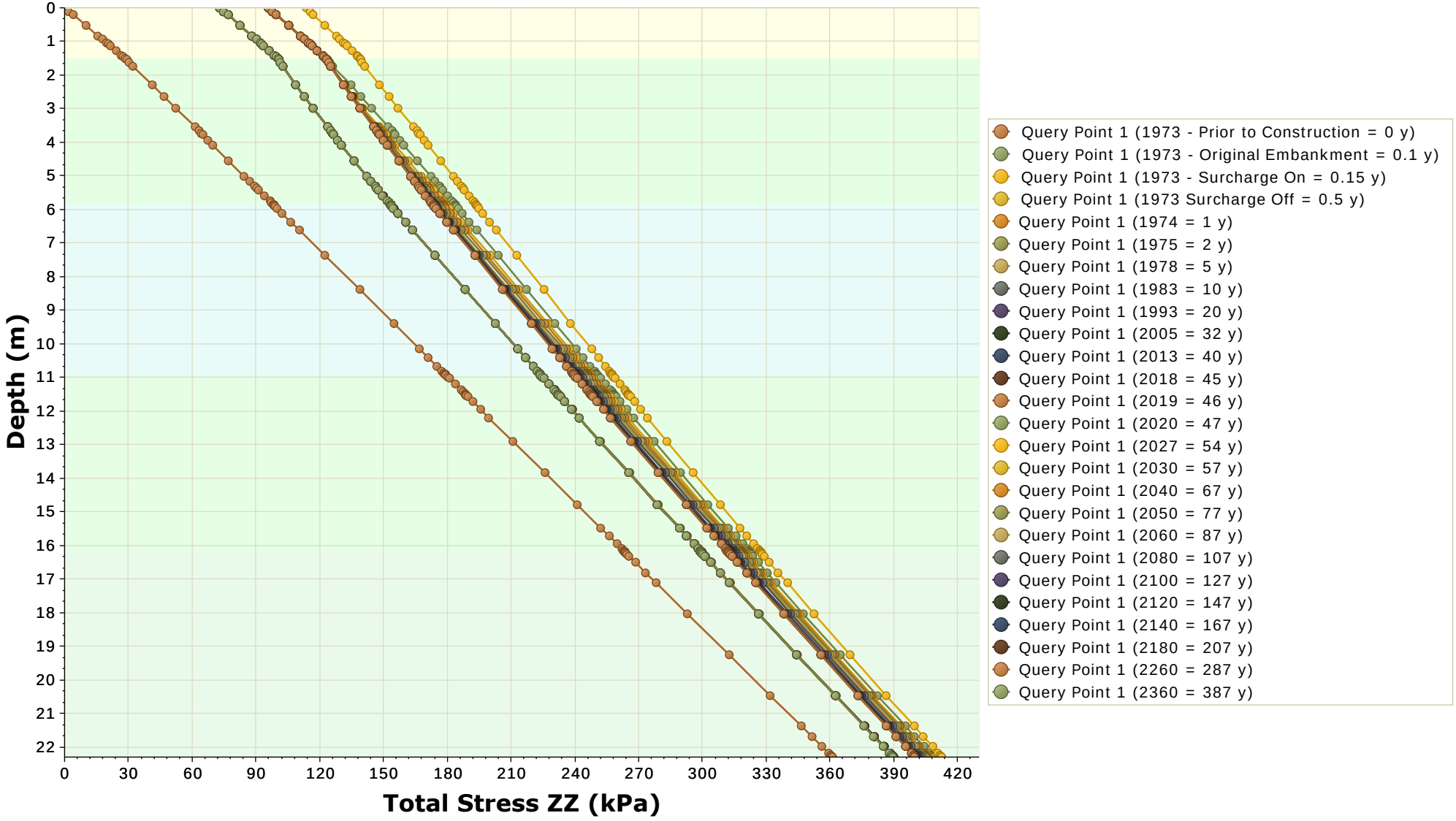


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

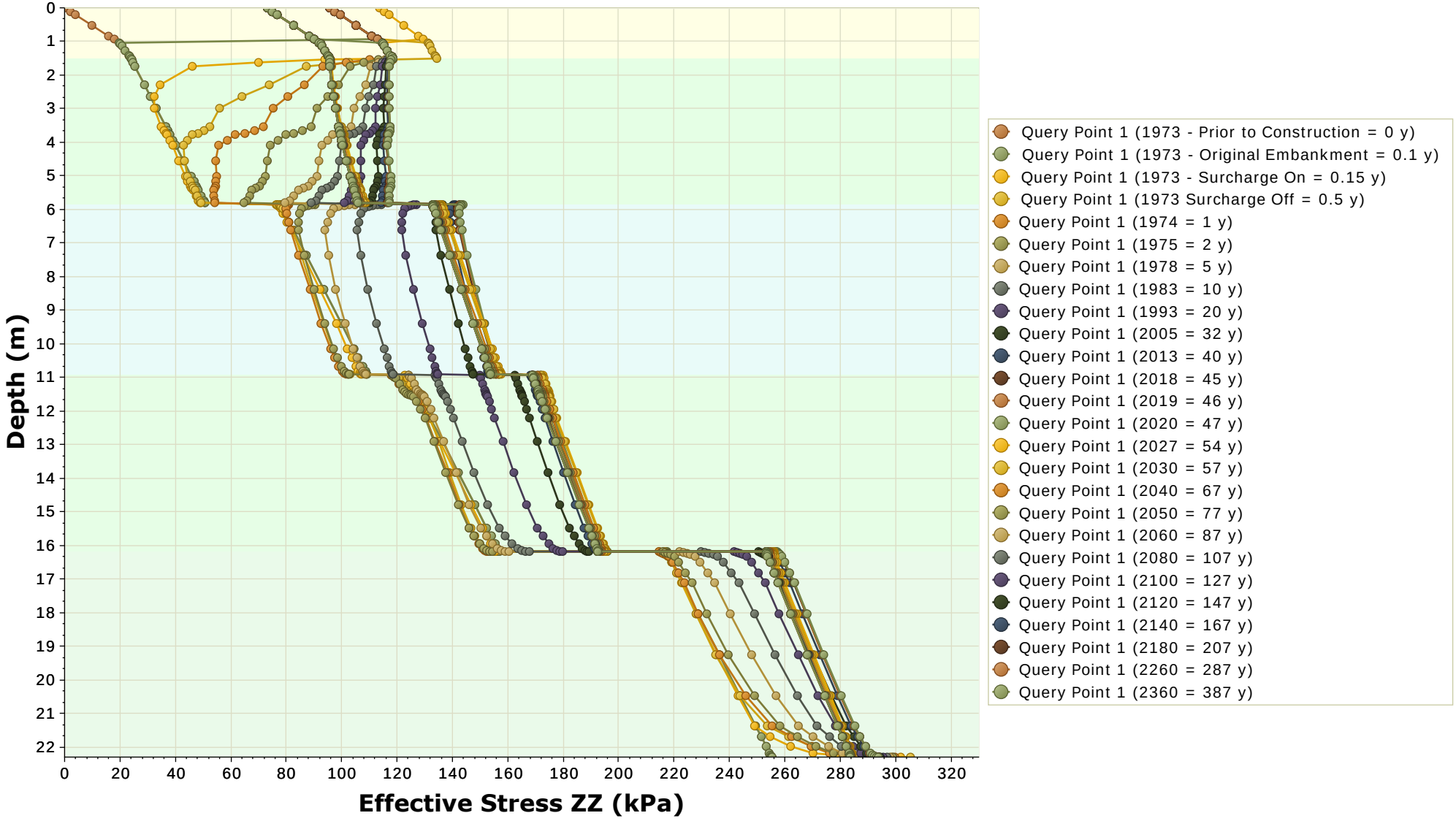
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

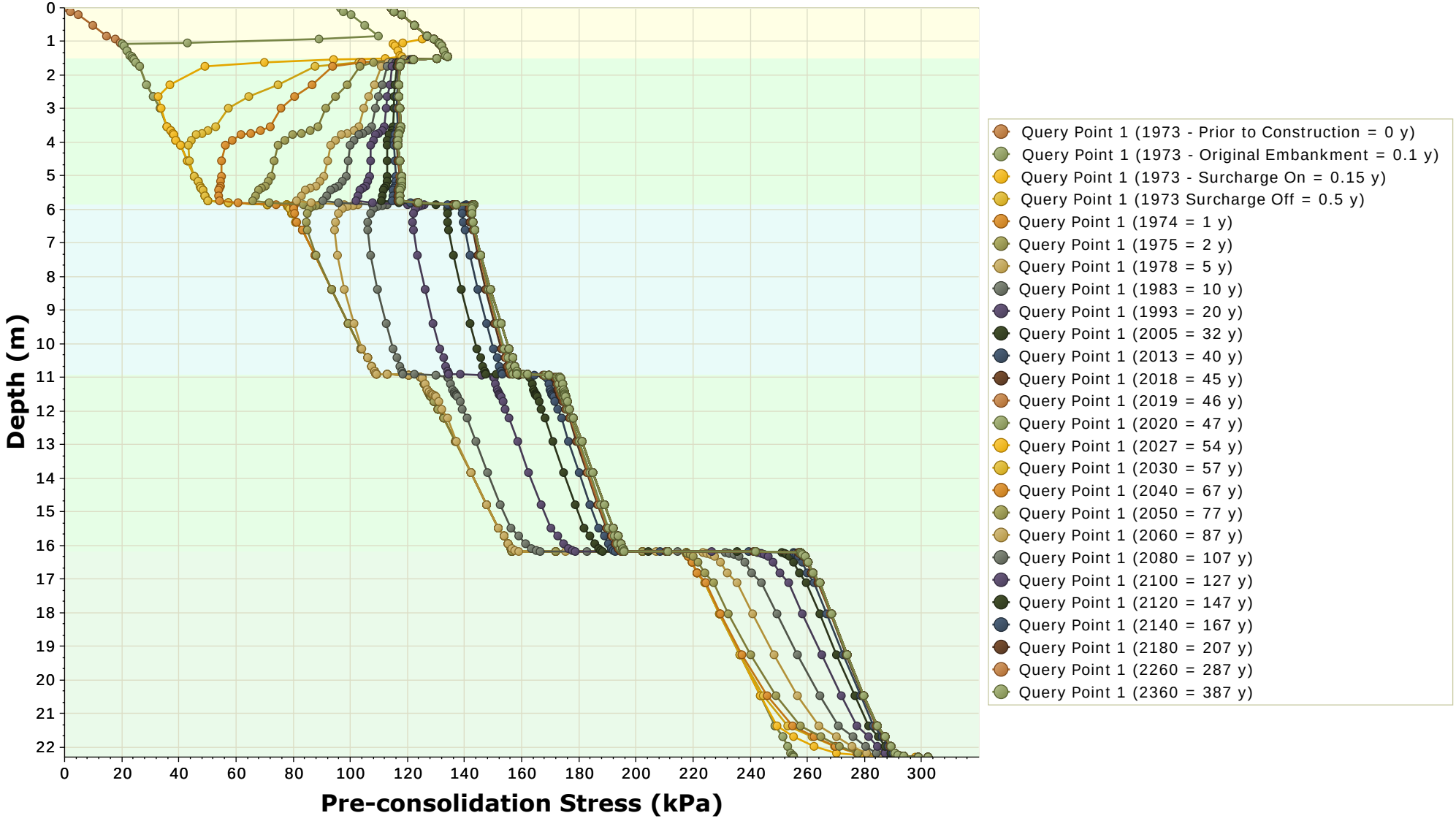
Effective Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

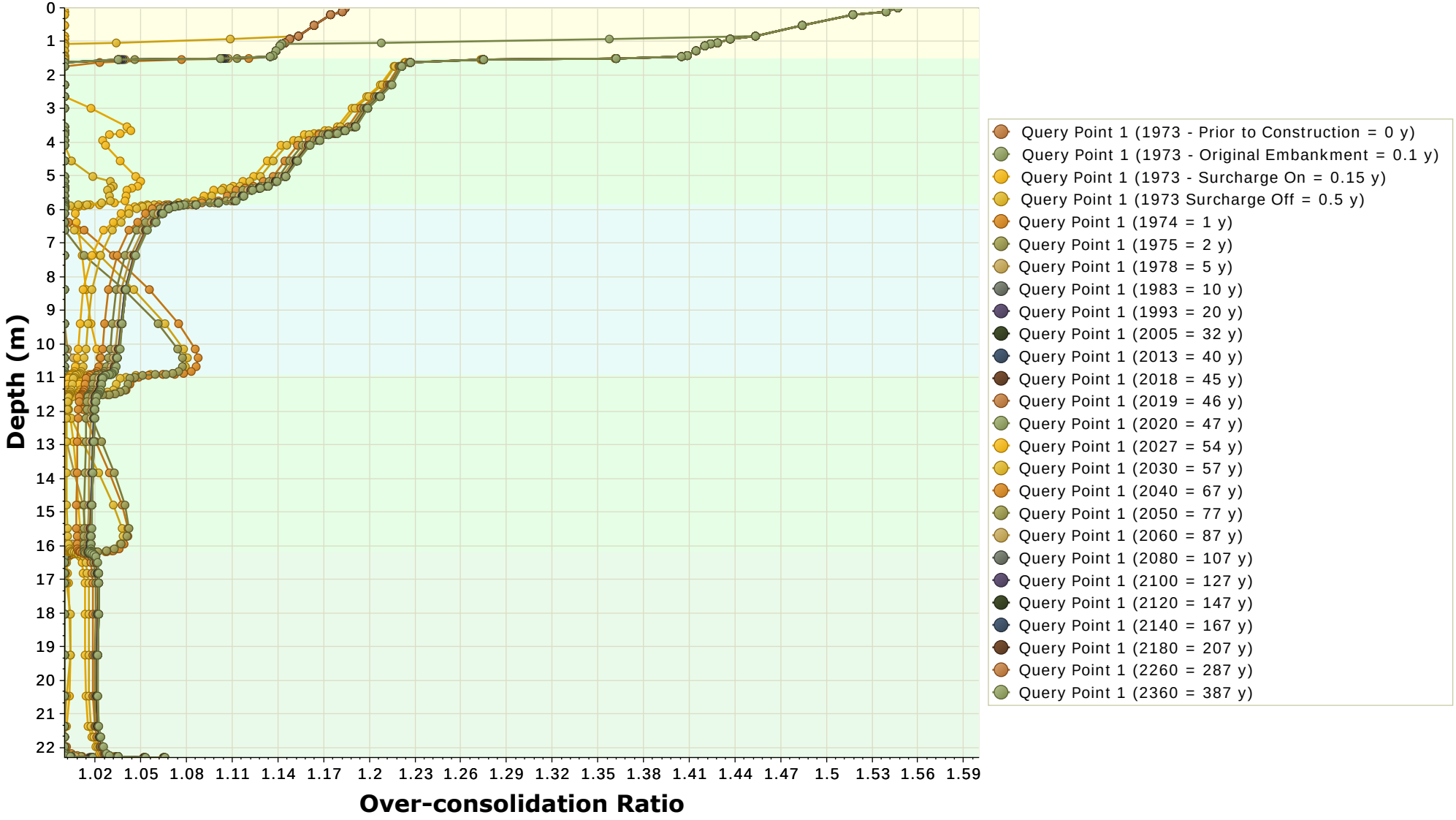
Pre-consolidation Stress vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

Over-consolidation Ratio vs. Depth

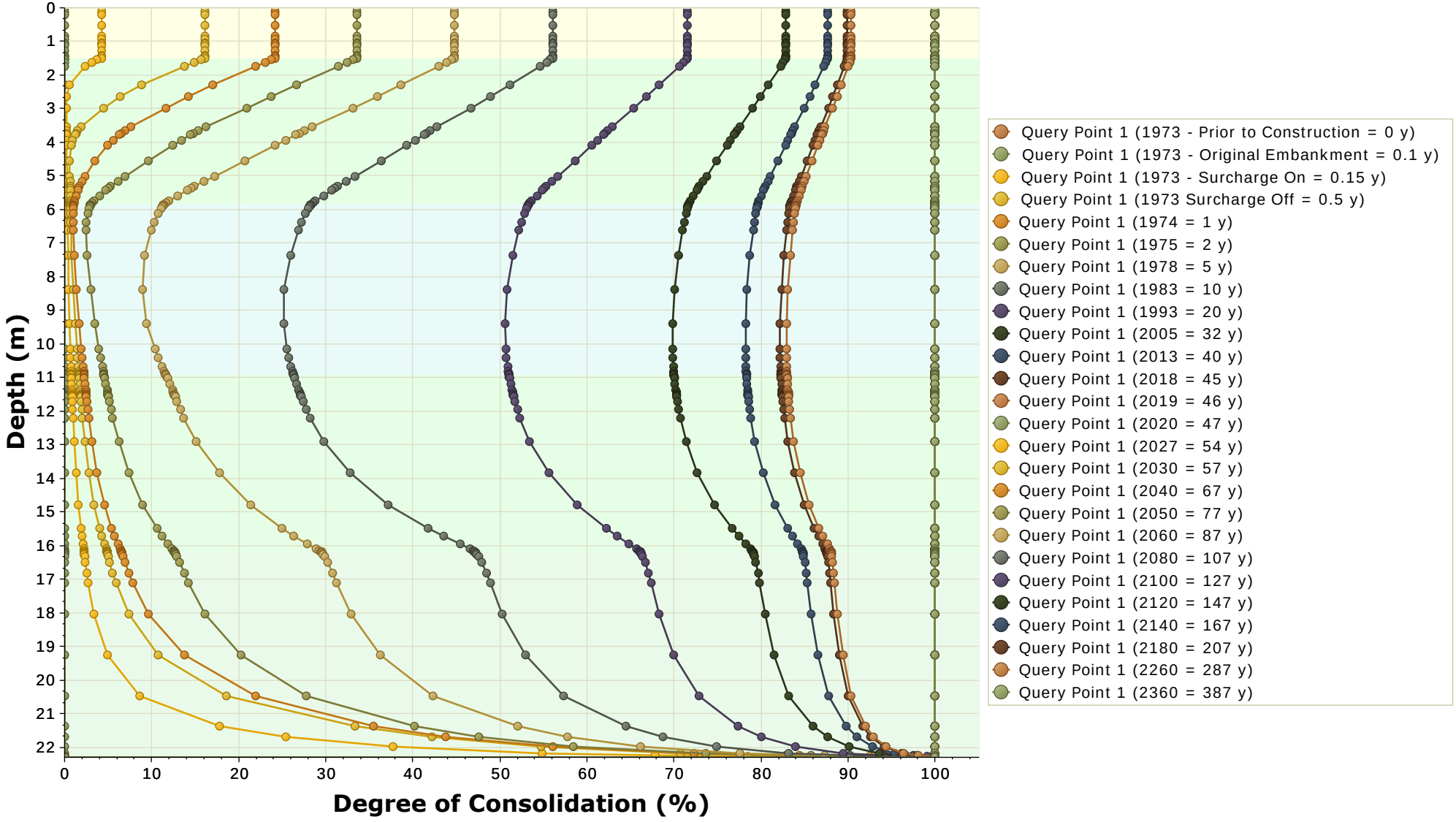


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Degree of Consolidation vs. Depth



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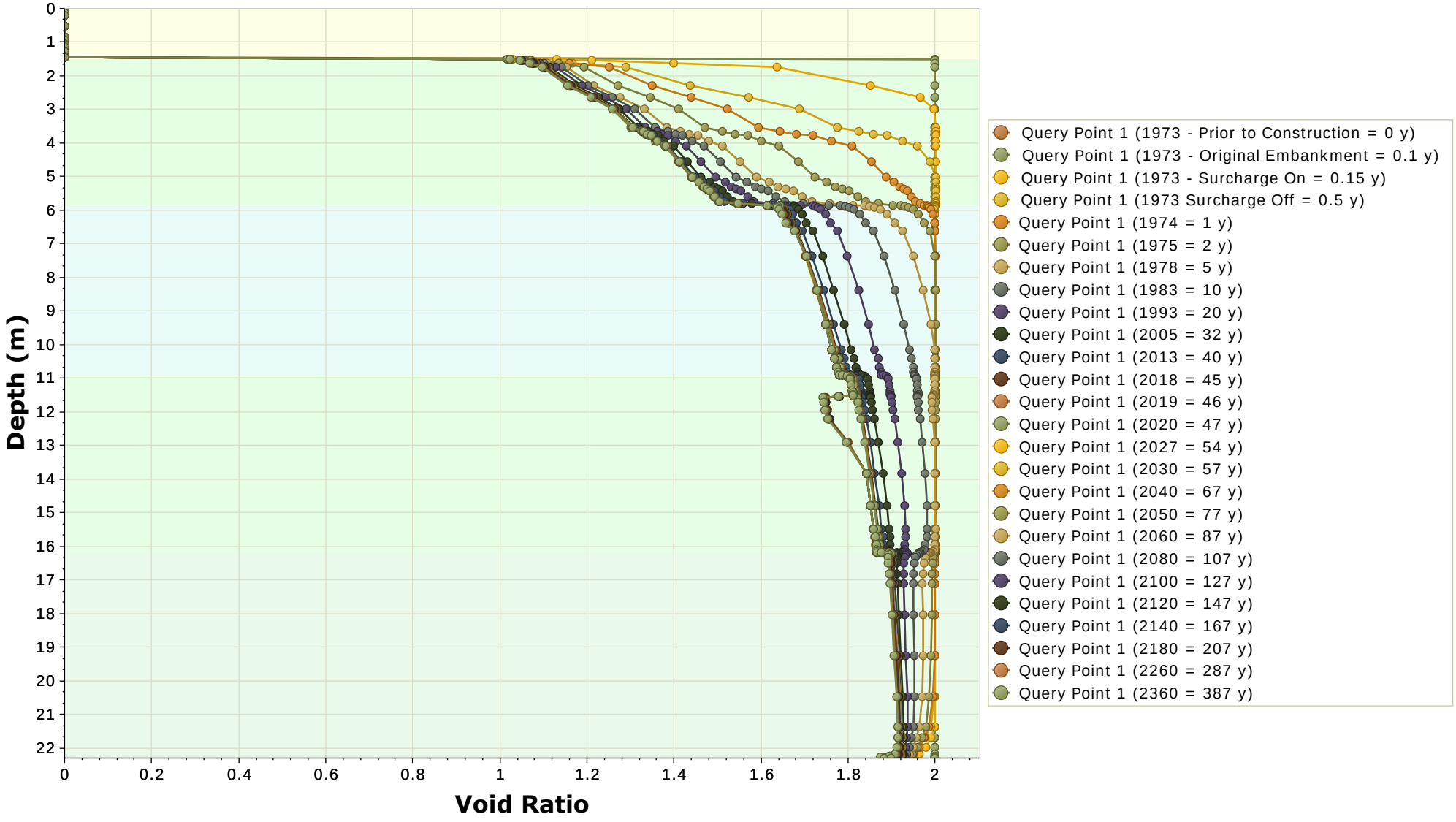
rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Void Ratio vs. Depth

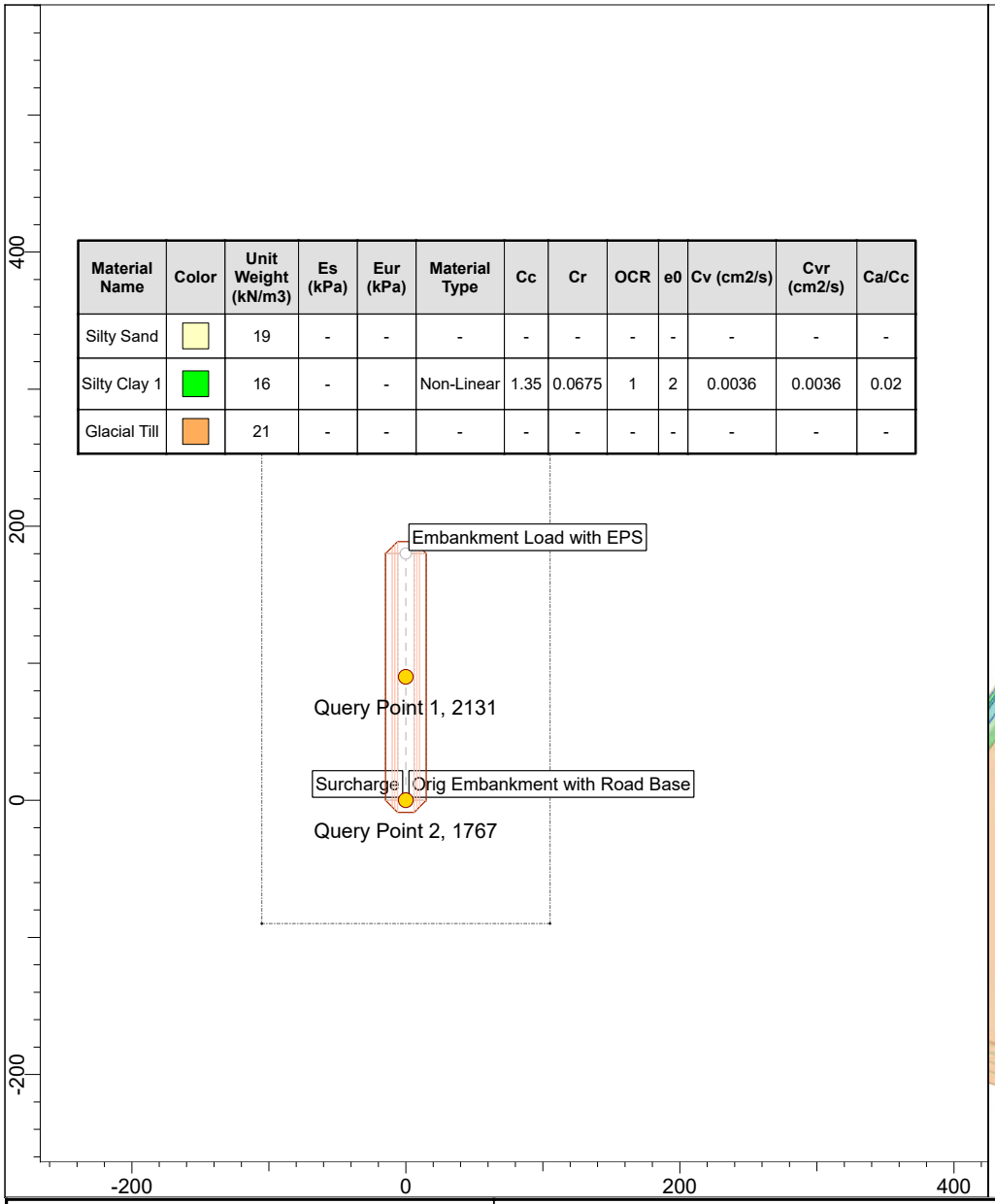


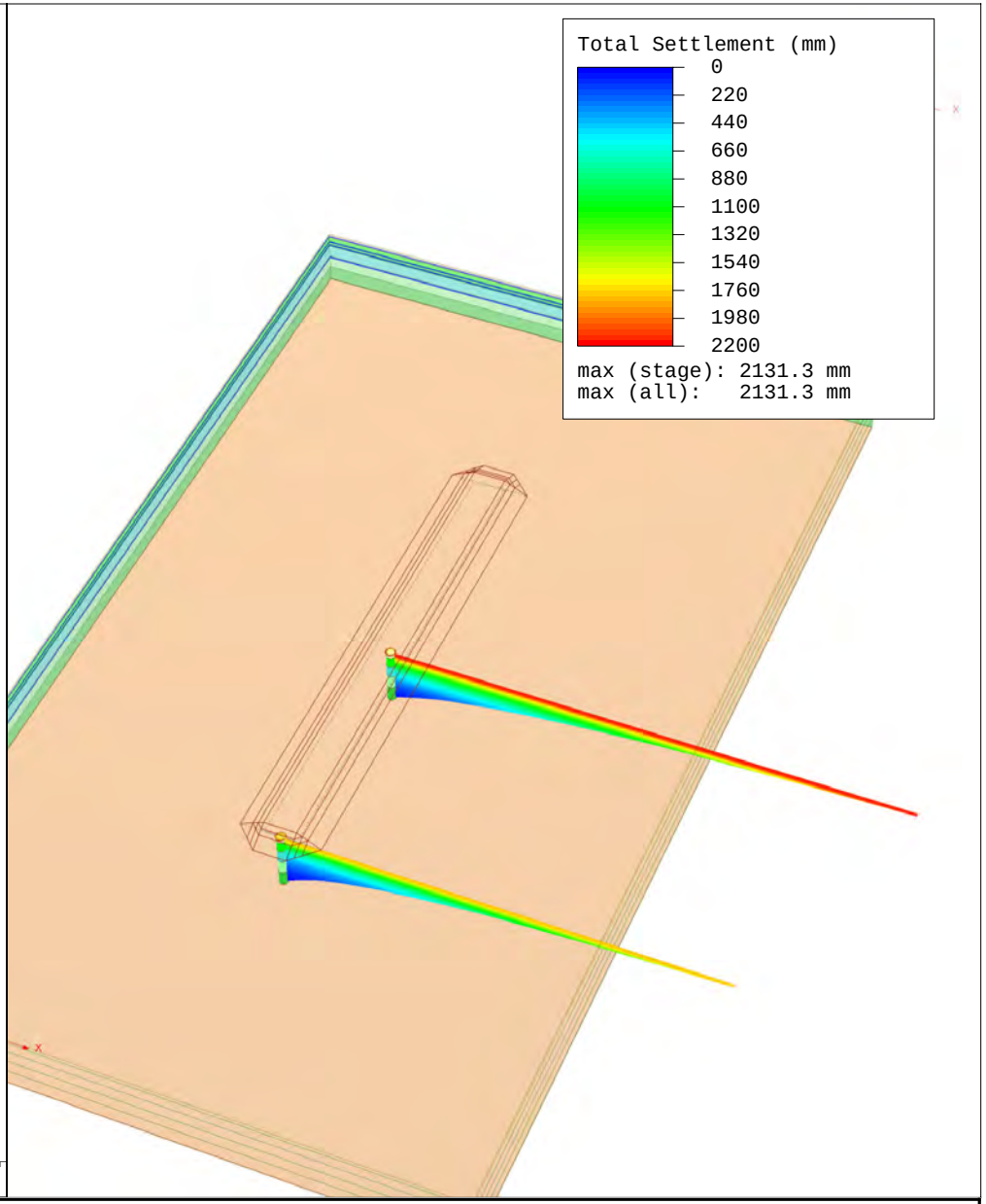
Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_1_EPS_1m.s

SETTLE3D 4.005

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Silty Sand		19	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0036	0.0036	0.02
Glacial Till		21	-	-	-	-	-	-	-	-	-	-

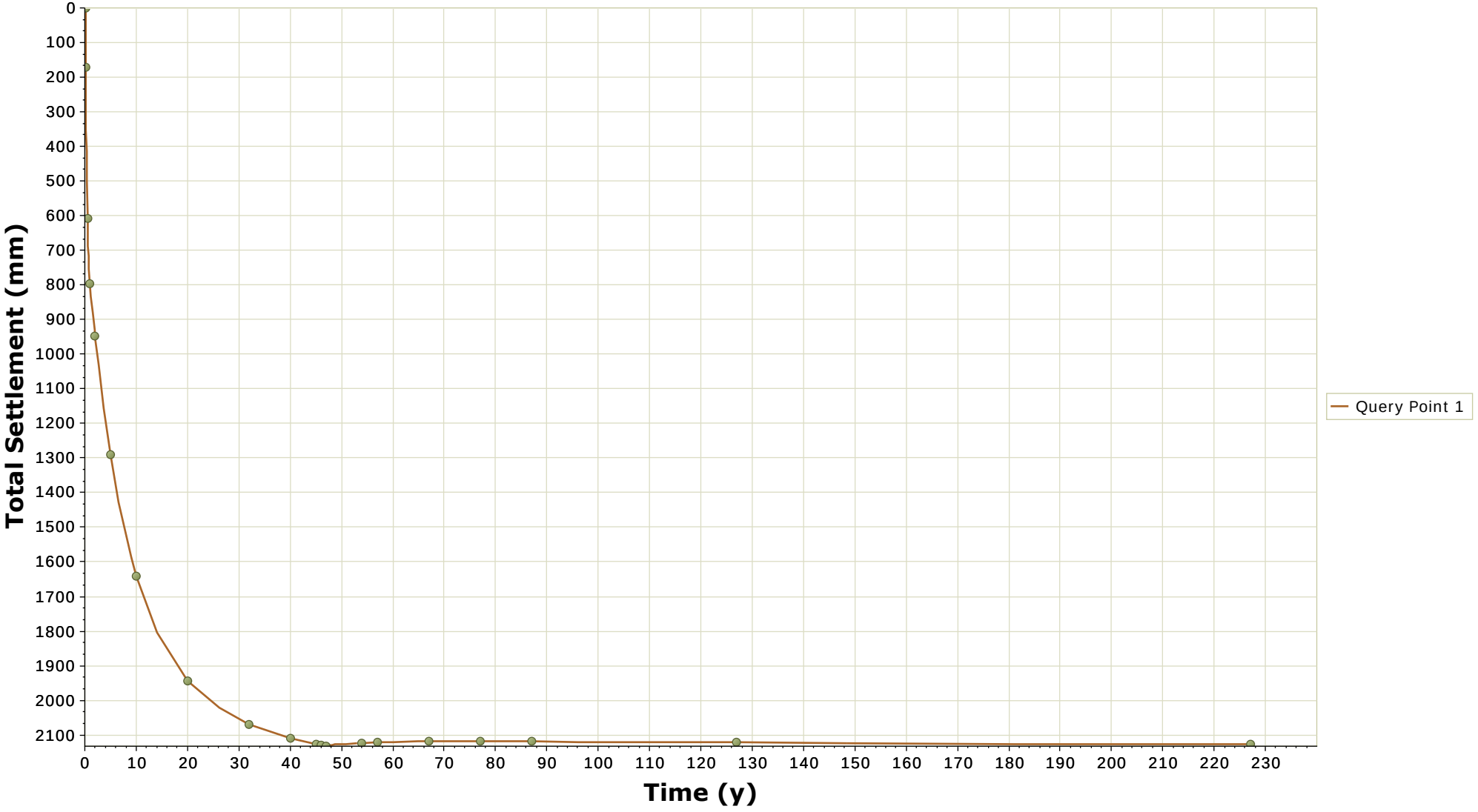




rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1898802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

Time vs. Total Settlement

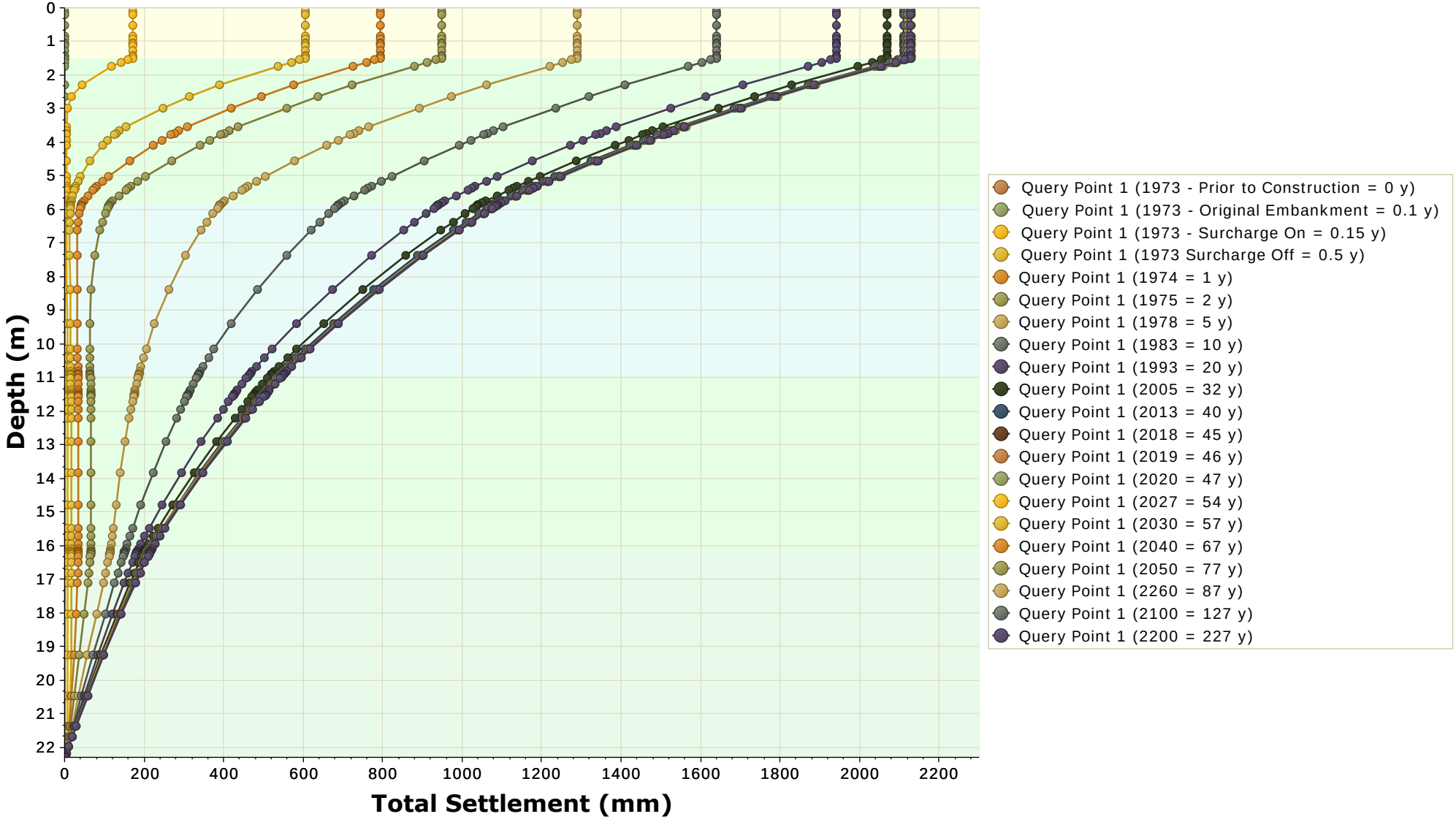


Reference Stage: None
Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 1898802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

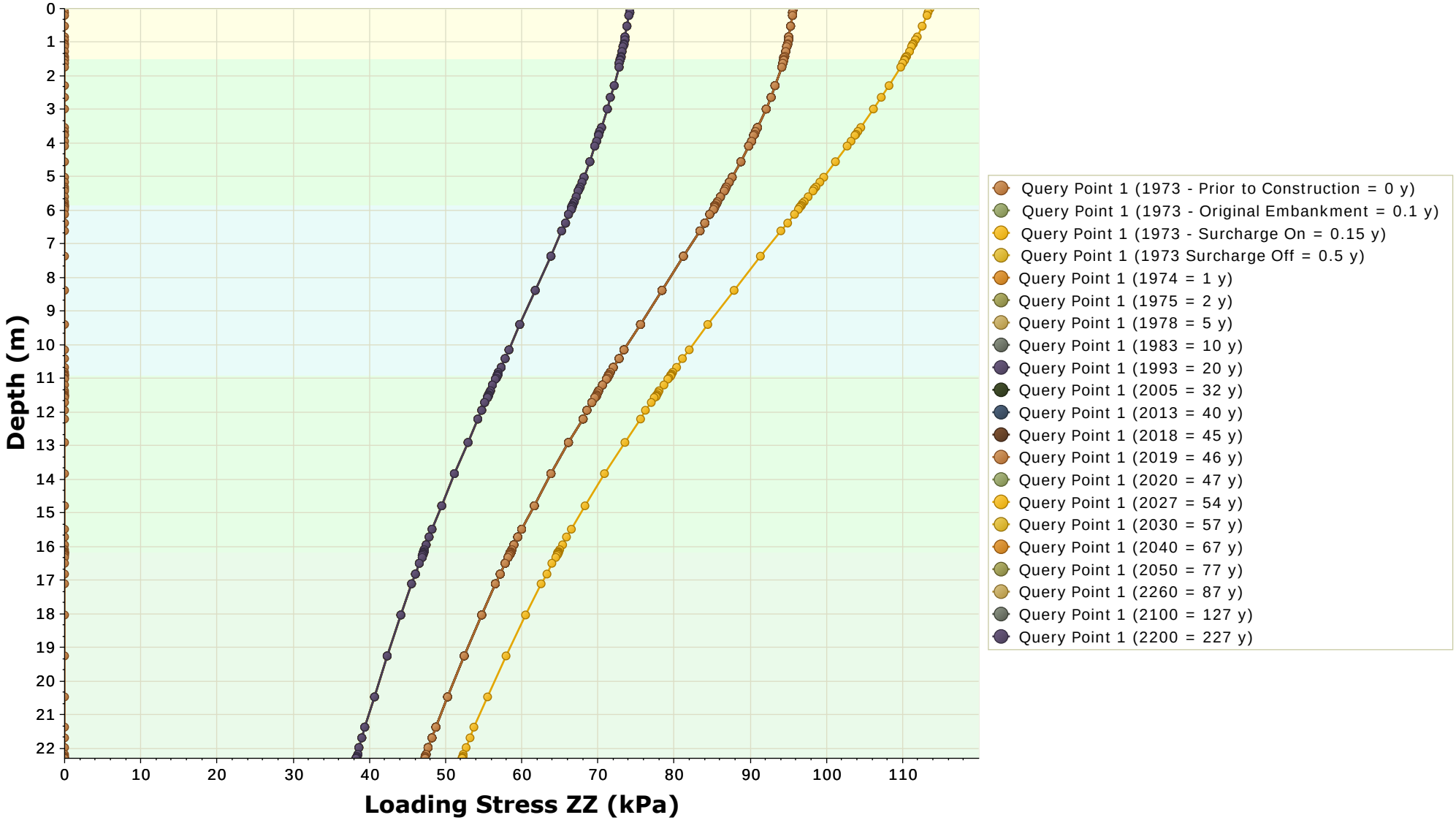
Total Settlement vs. Depth



Reference Stage: None

rocscience	*Project* Highway 417 / County Road 3 (EBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
SETTLE3D 4.005	*Date* 2019-03-14, 4:44:22 PM	*File Name* 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

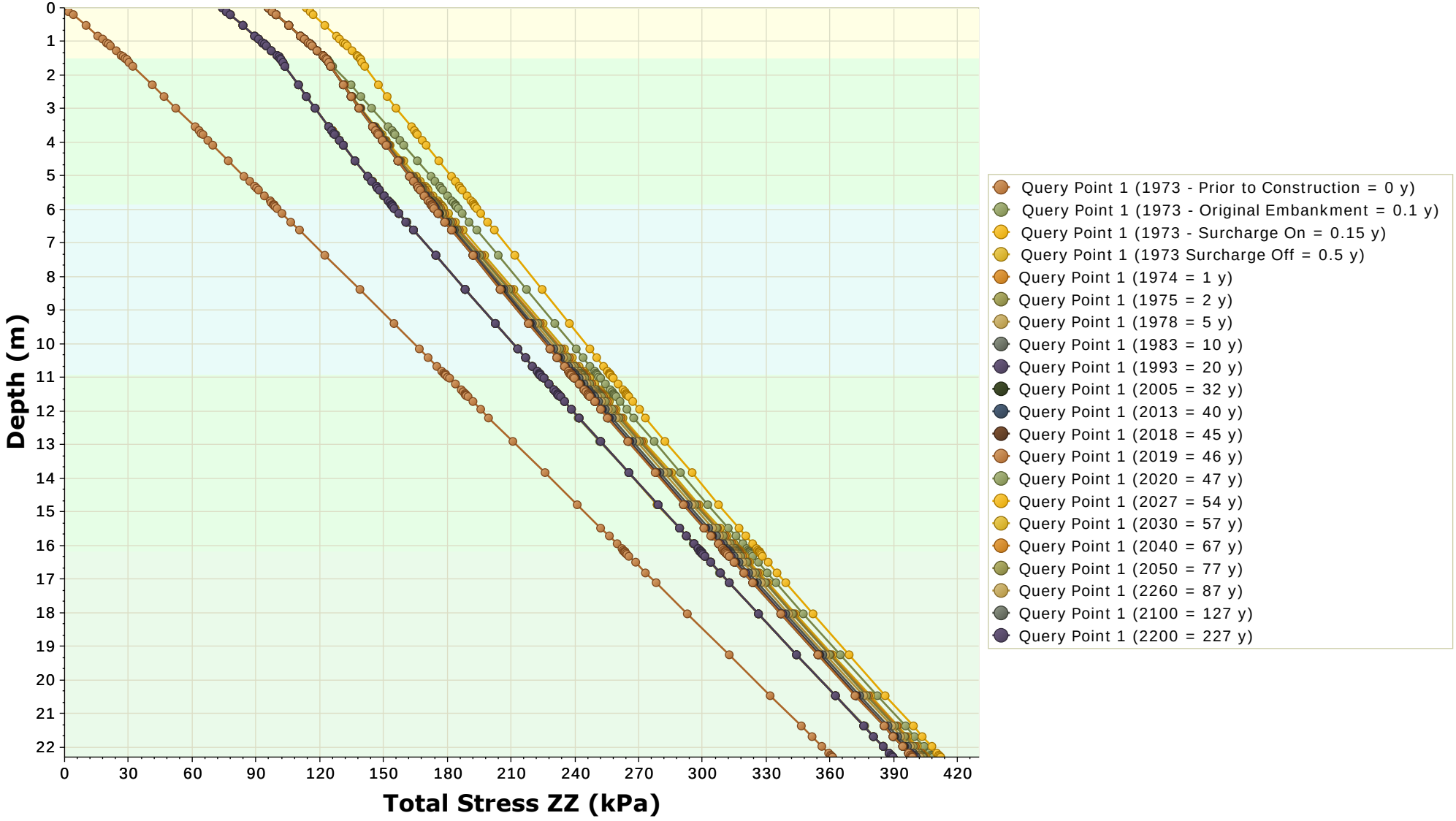
Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project* Highway 417 / County Road 3 (EBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
	Date 2019-03-14, 4:44:22 PM	*File Name* 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

Total Stress ZZ vs. Depth

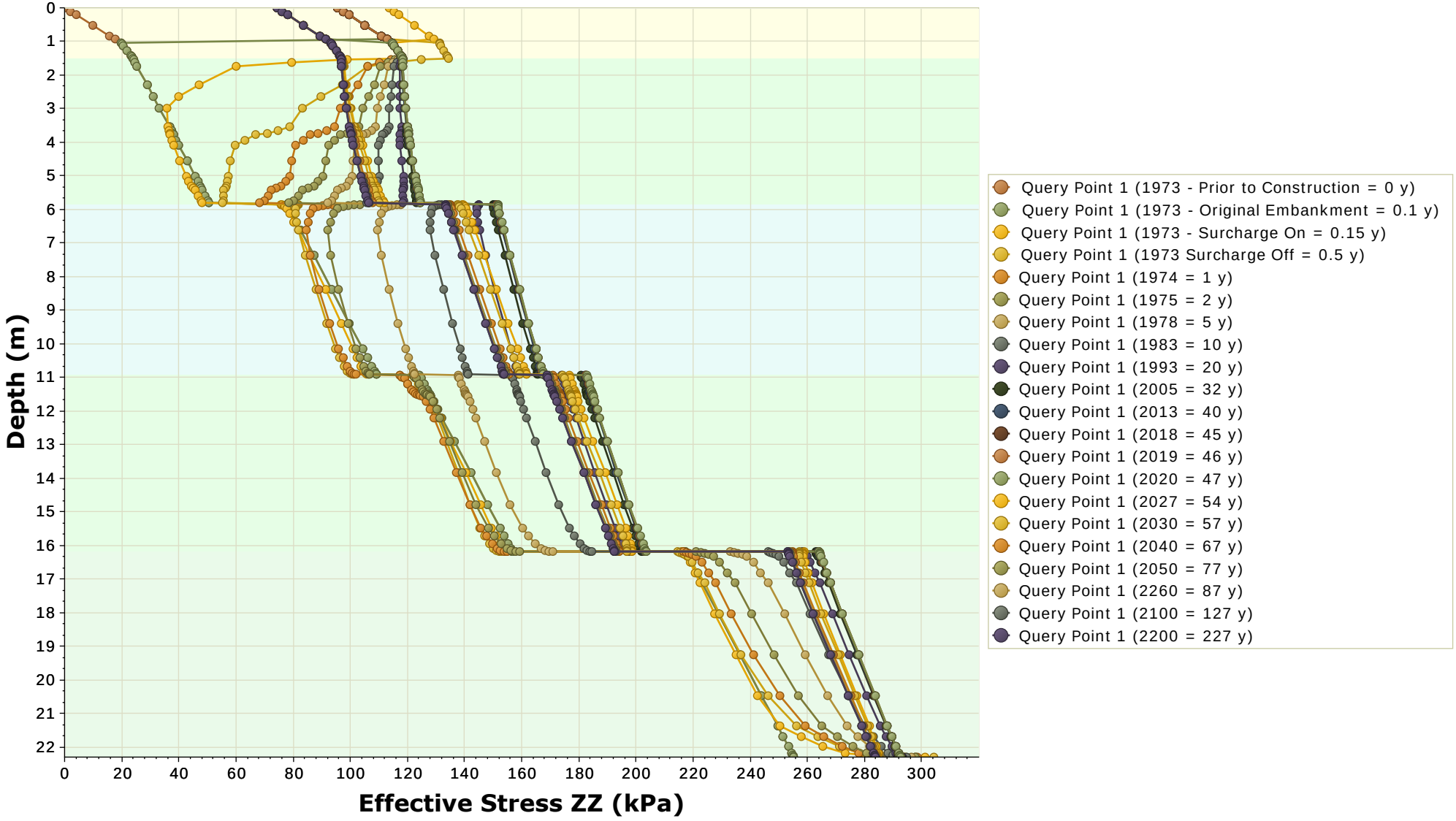


Reference Stage: None

rocscience	*Project* Highway 417 / County Road 3 (EBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
	Date 2019-03-14, 4:44:22 PM	*File Name* 1898802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

Effective Stress ZZ vs. Depth

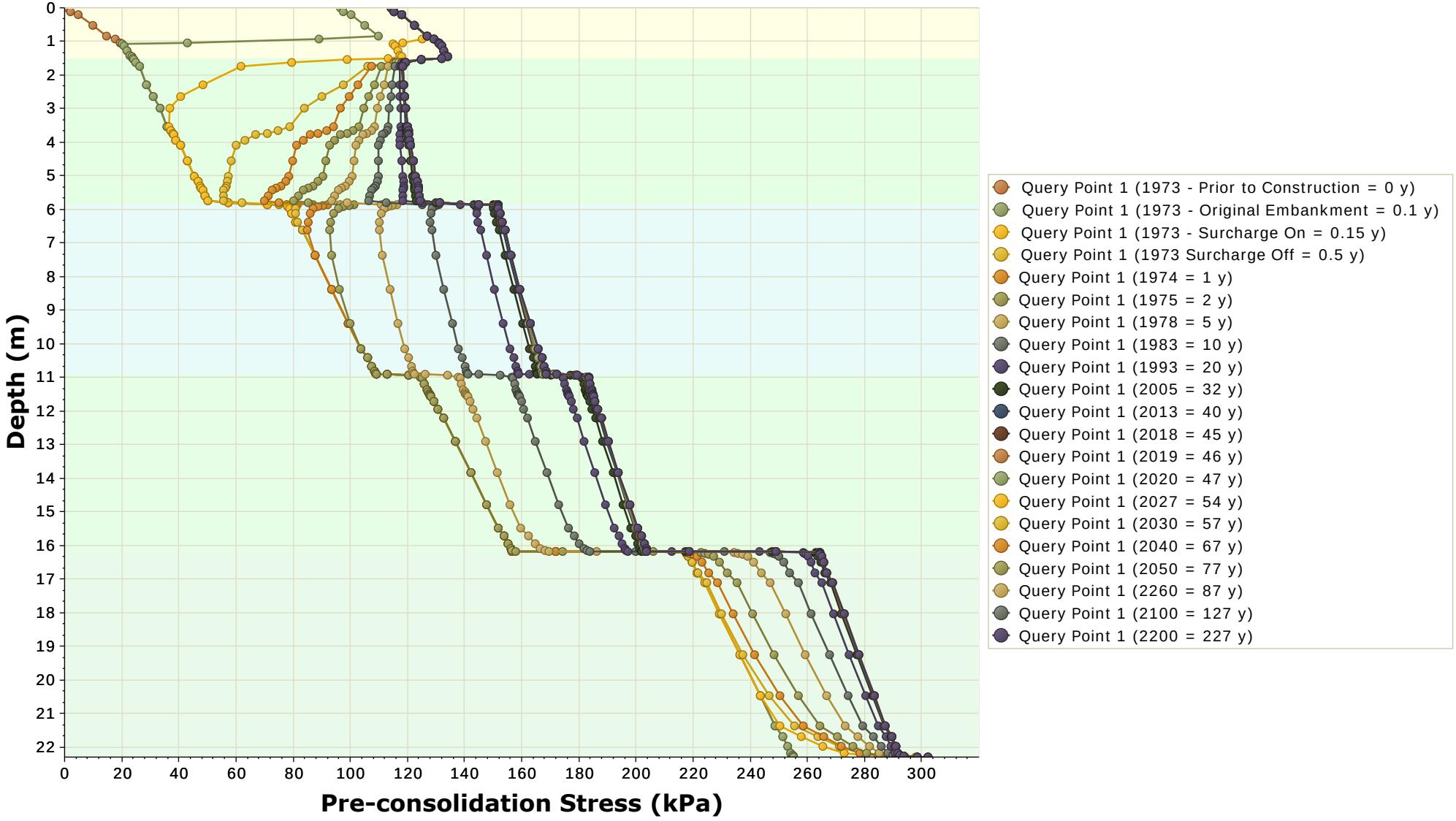


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth

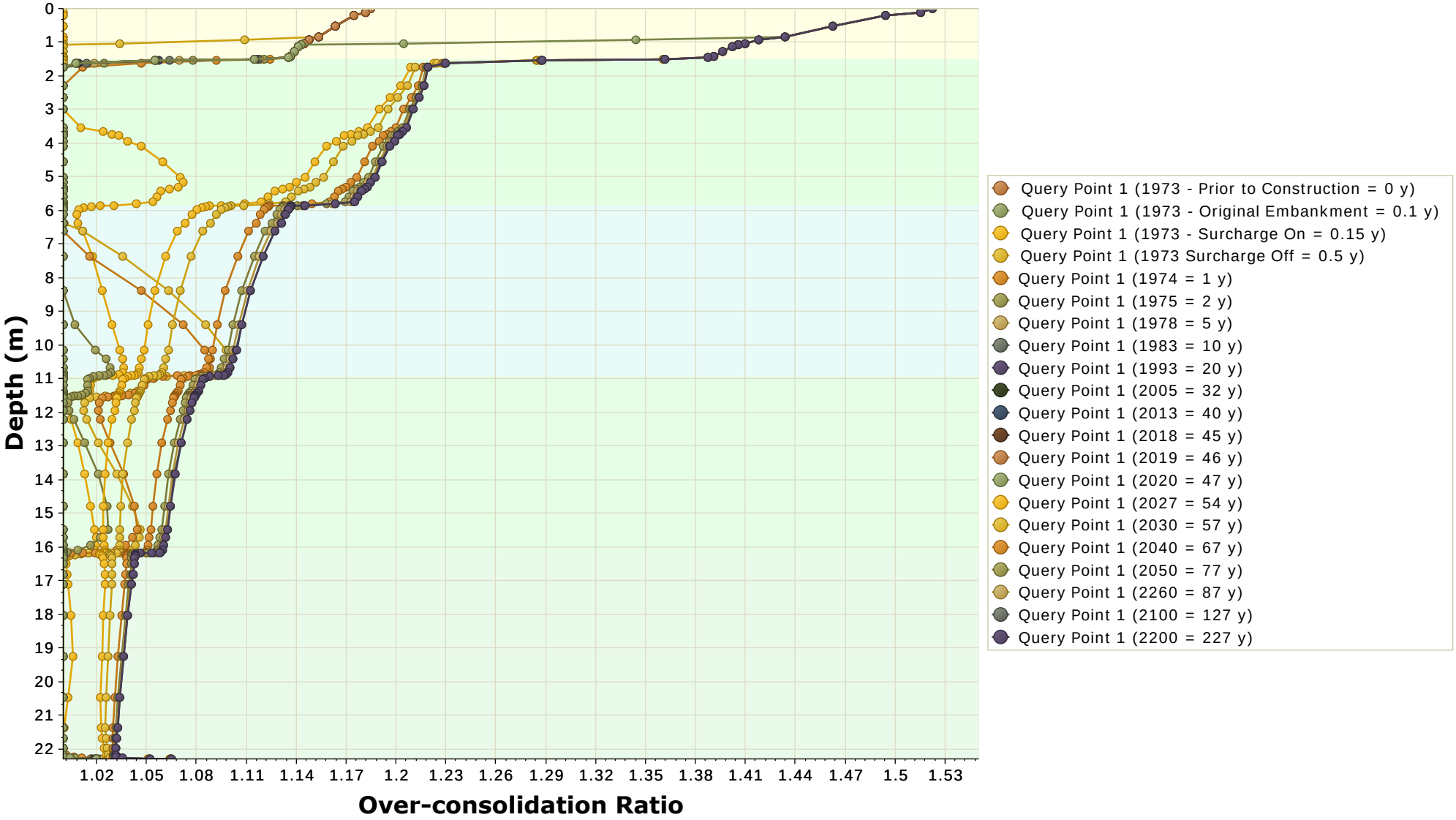


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

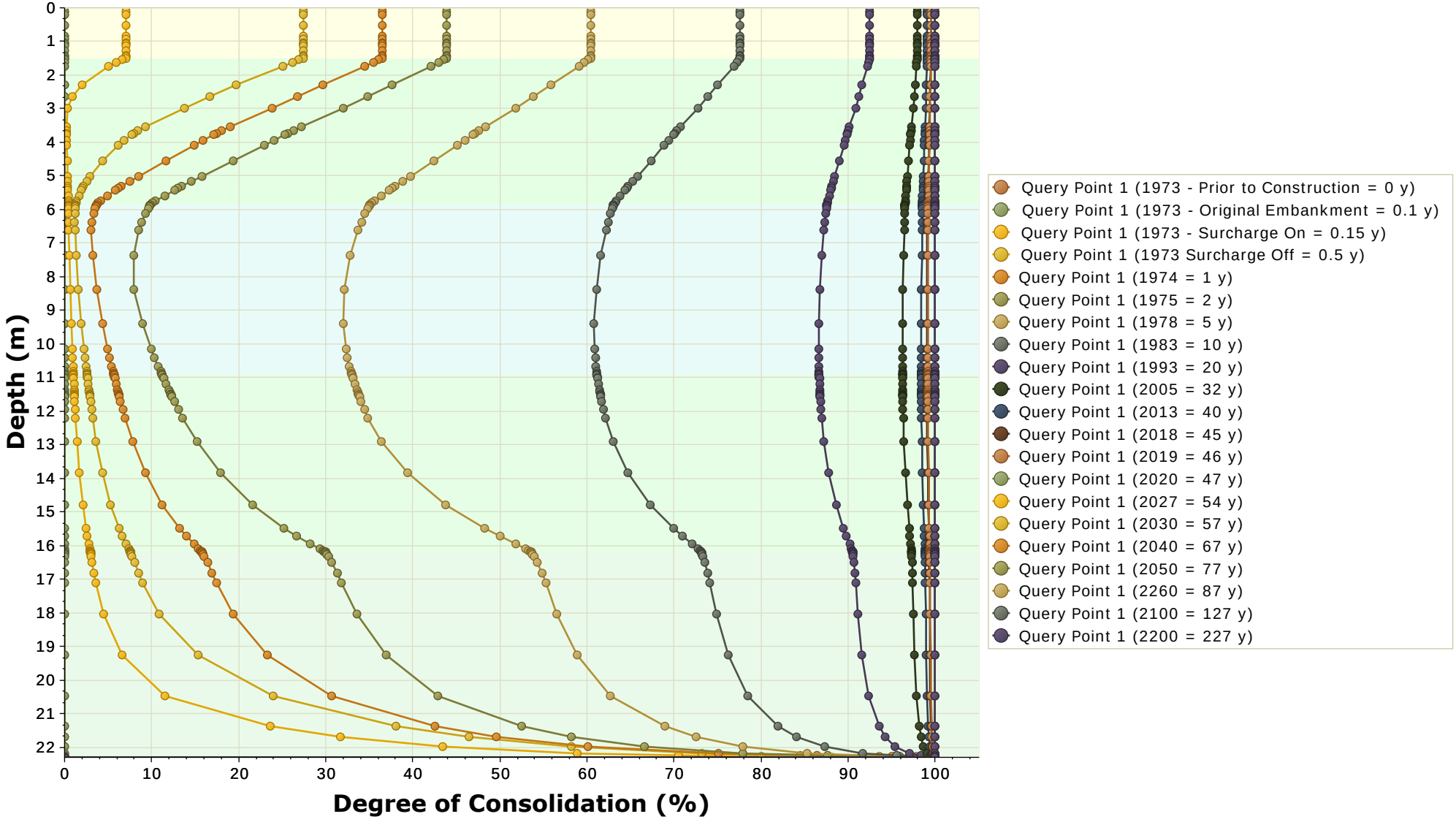


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (EBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

SETTLE3D 4.005

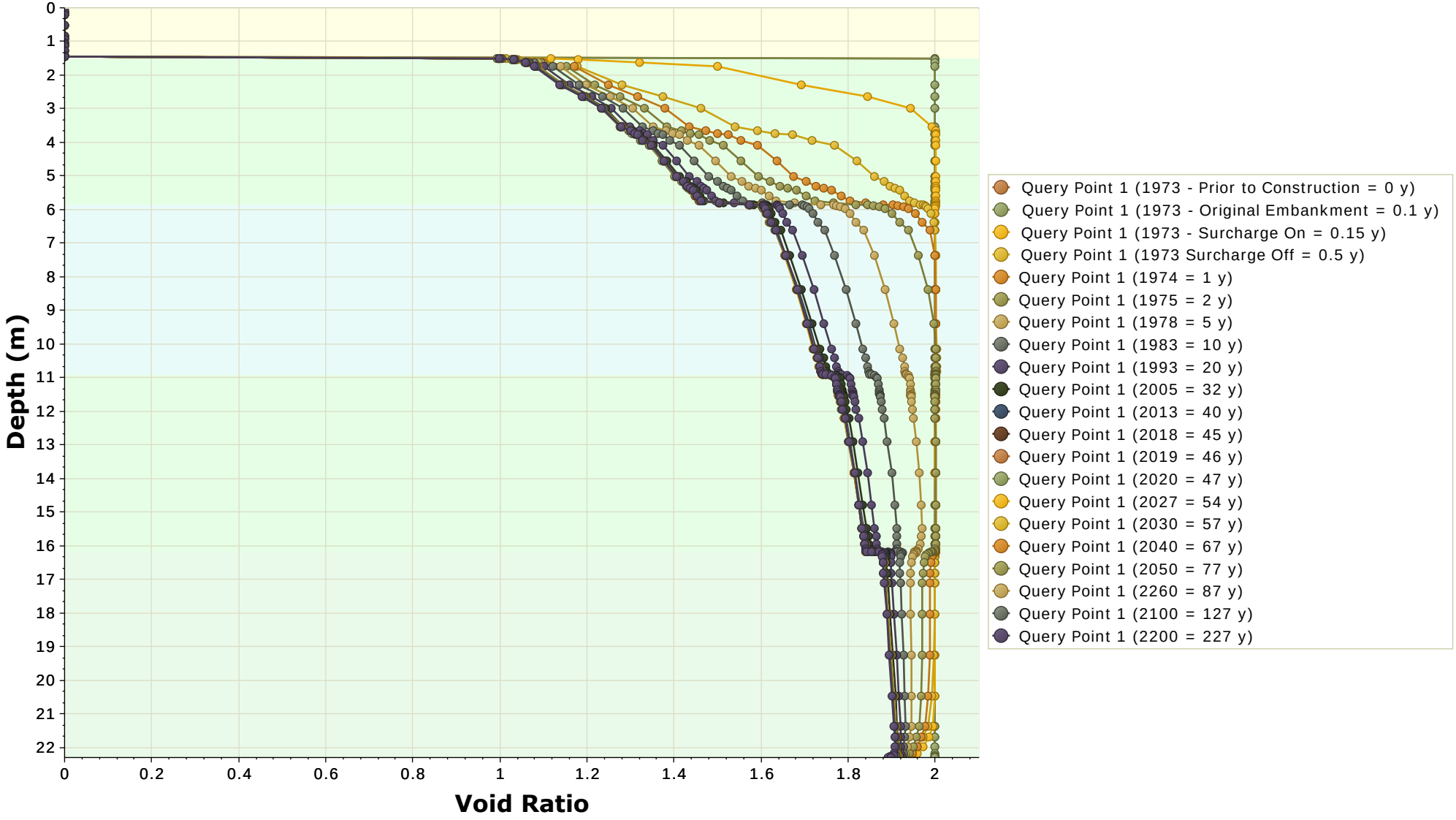
Degree of Consolidation vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	*Project* Highway 417 / County Road 3 (EBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
	Date 2019-03-14, 4:44:22 PM	*File Name* 1808802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

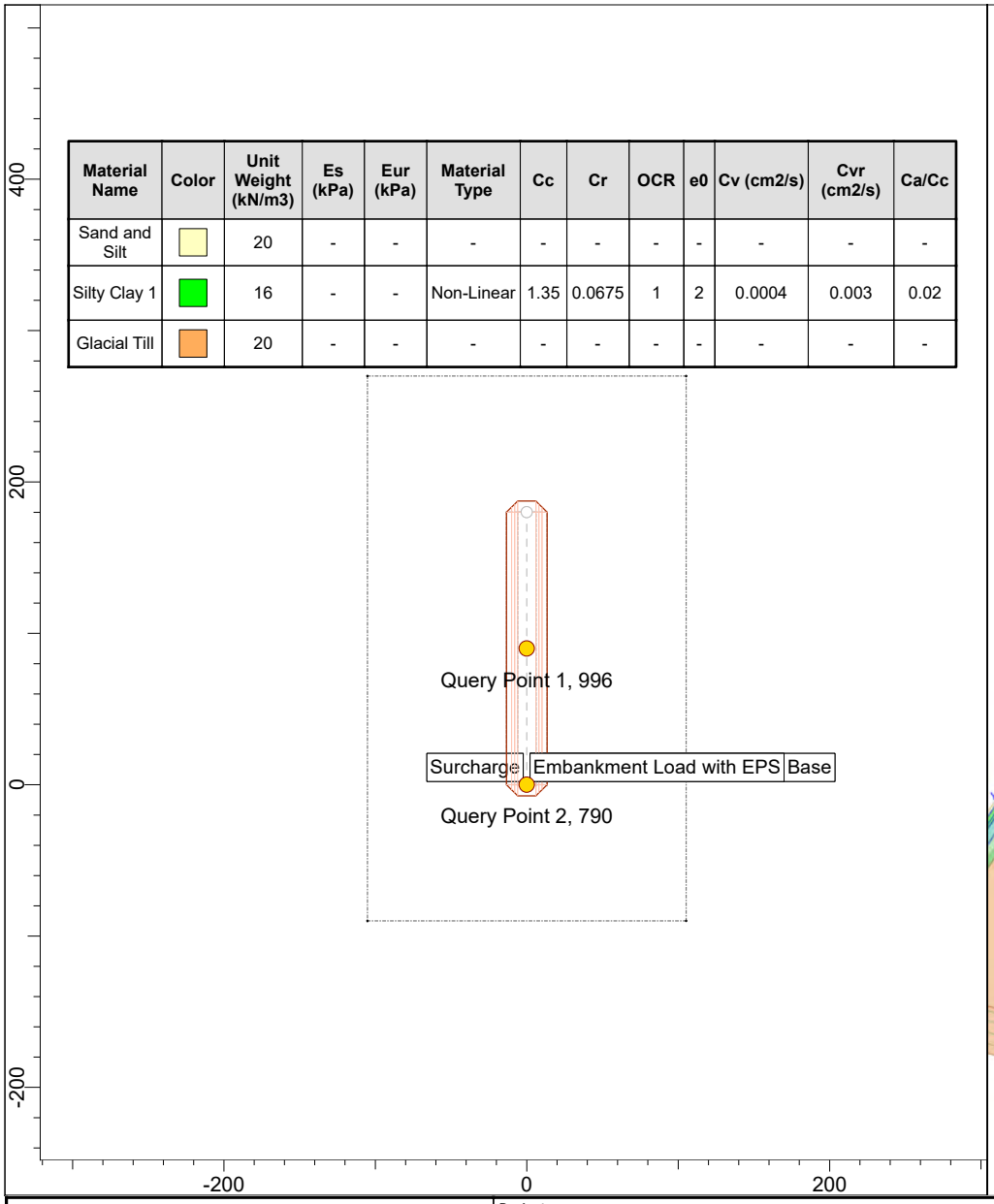
Void Ratio vs. Depth

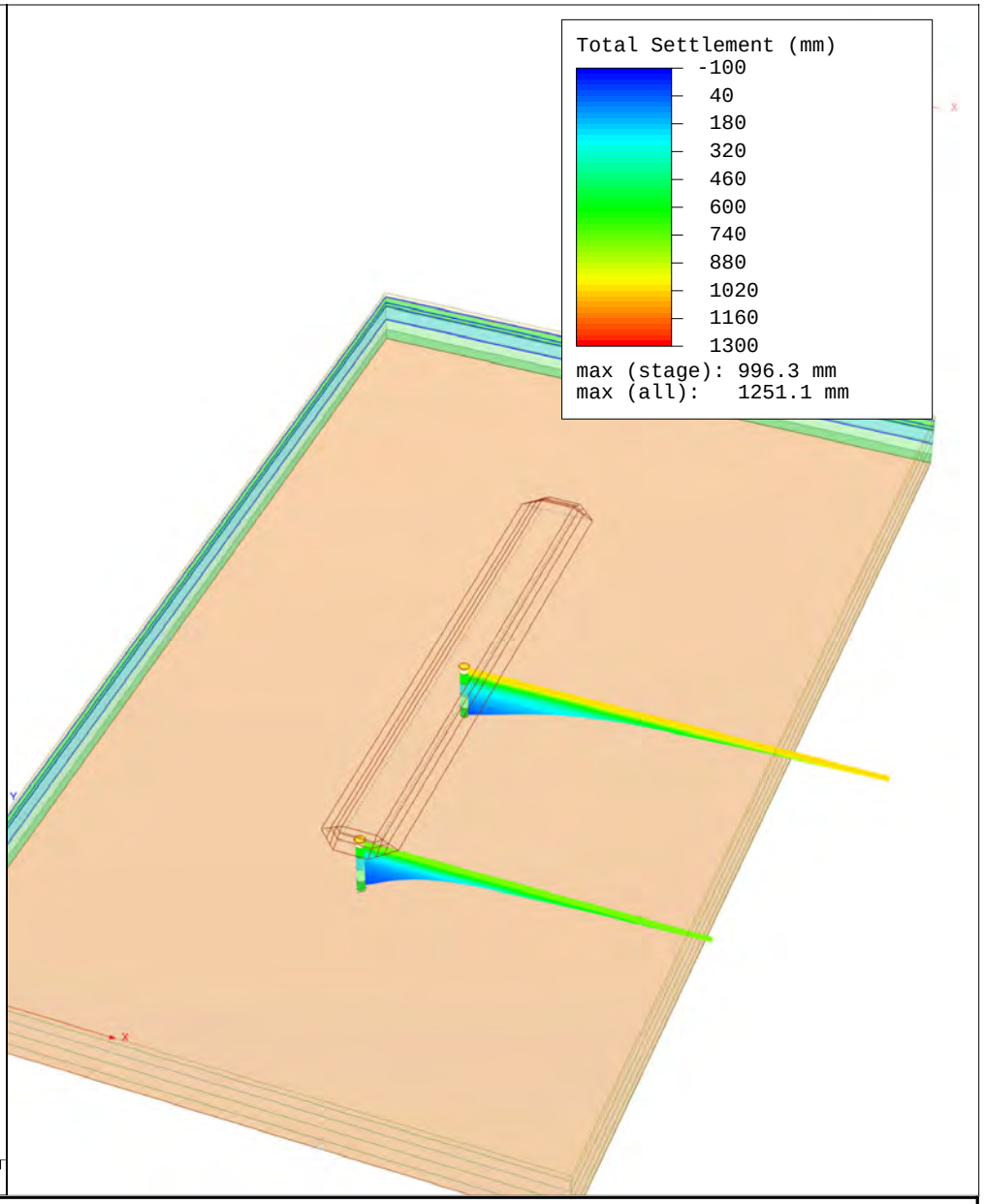


Reference Stage: None

rocscience	*Project* Highway 417 / County Road 3 (EBL)	
	Analysis Description Preload 4 Months	
	Drawn By Ray Kennedy	*Company* Golder Associates
SETTLE3D 4.005	*Date* 2019-03-14, 4:44:22 PM	*File Name* 1898802-6000-Surcharge_4mo_EBL_18-604_VARYING_GWL_2_1m EPS.s3z

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0004	0.003	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-

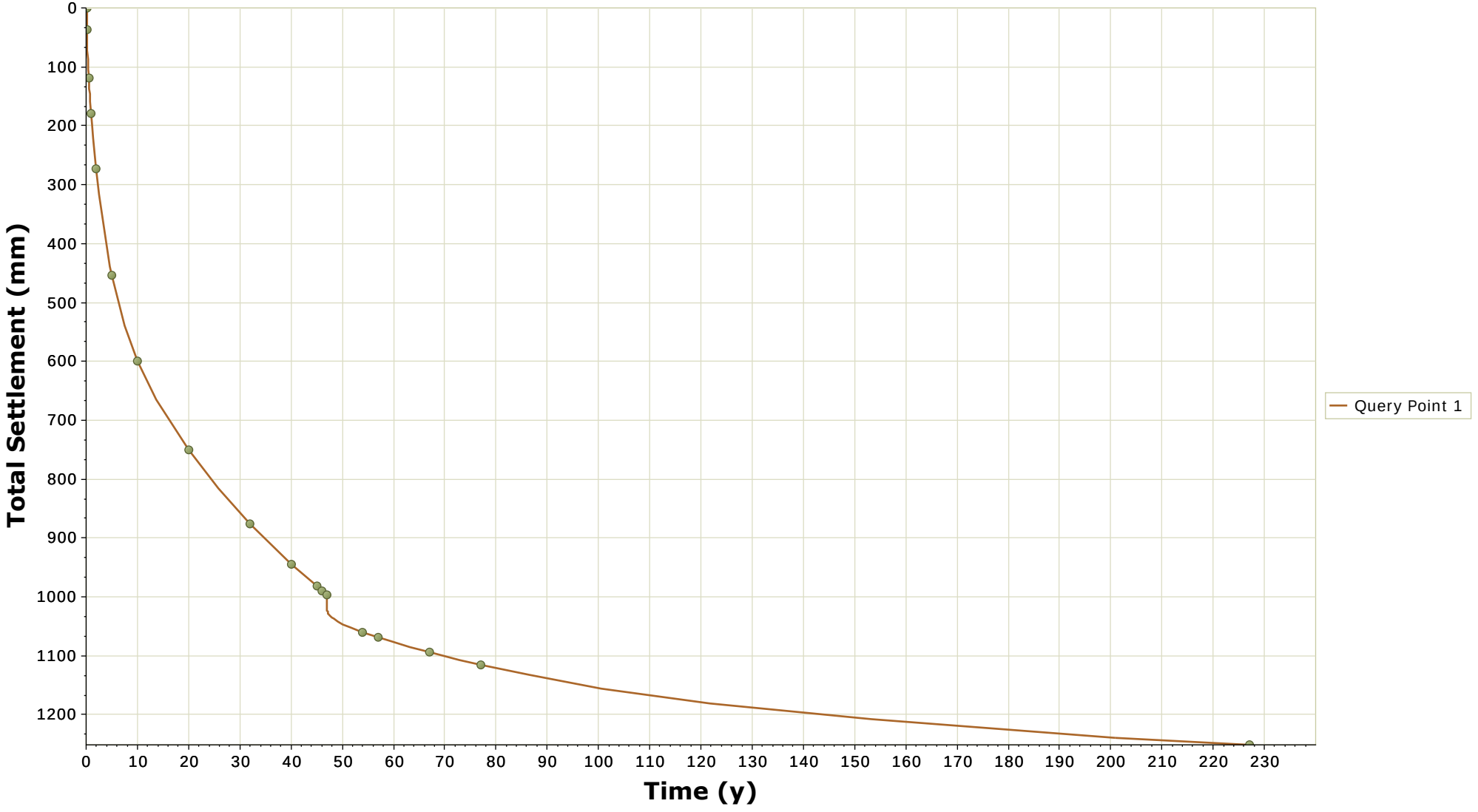




rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 899802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Time vs. Total Settlement



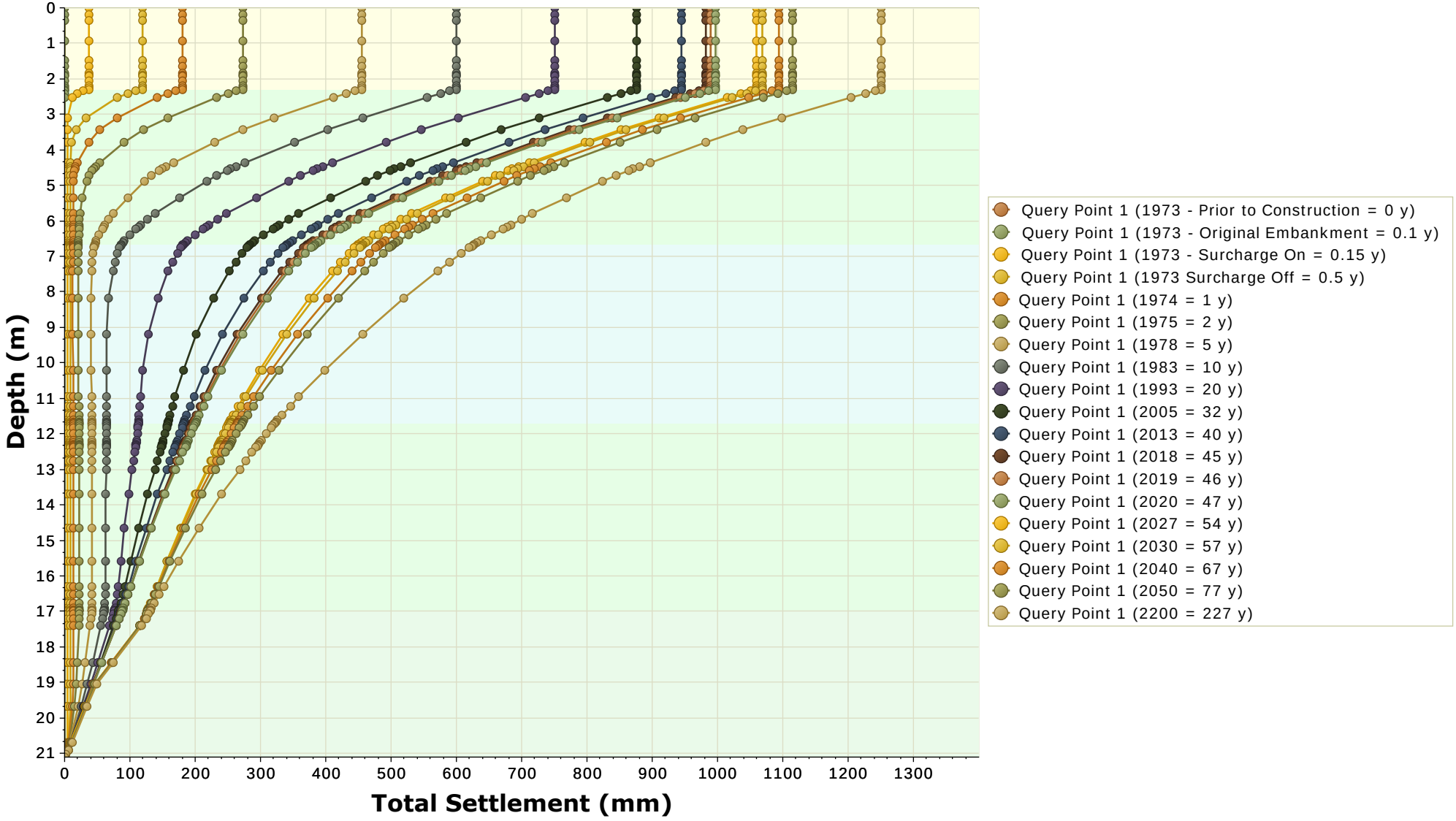
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Total Settlement vs. Depth

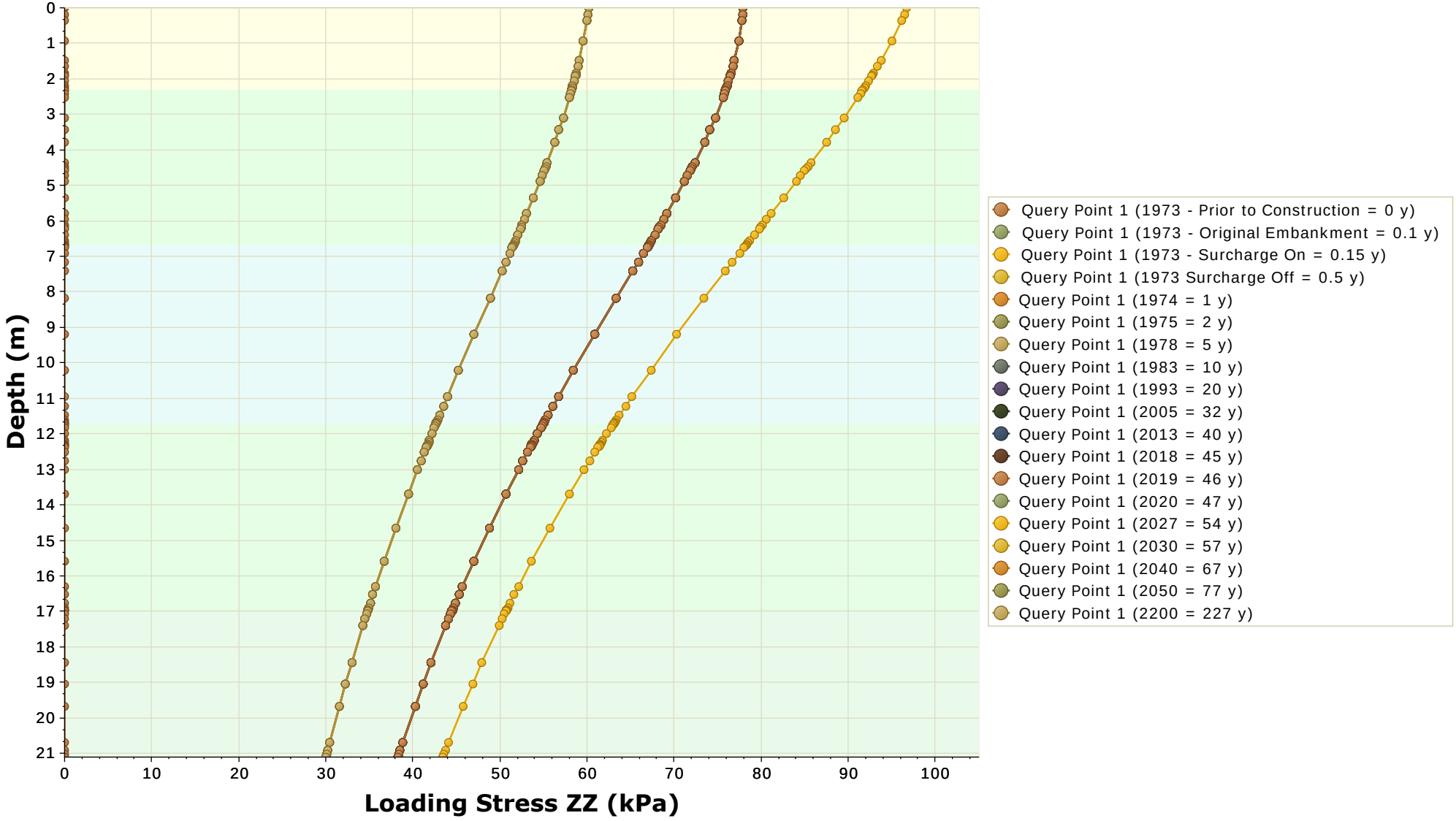


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Loading Stress ZZ vs. Depth

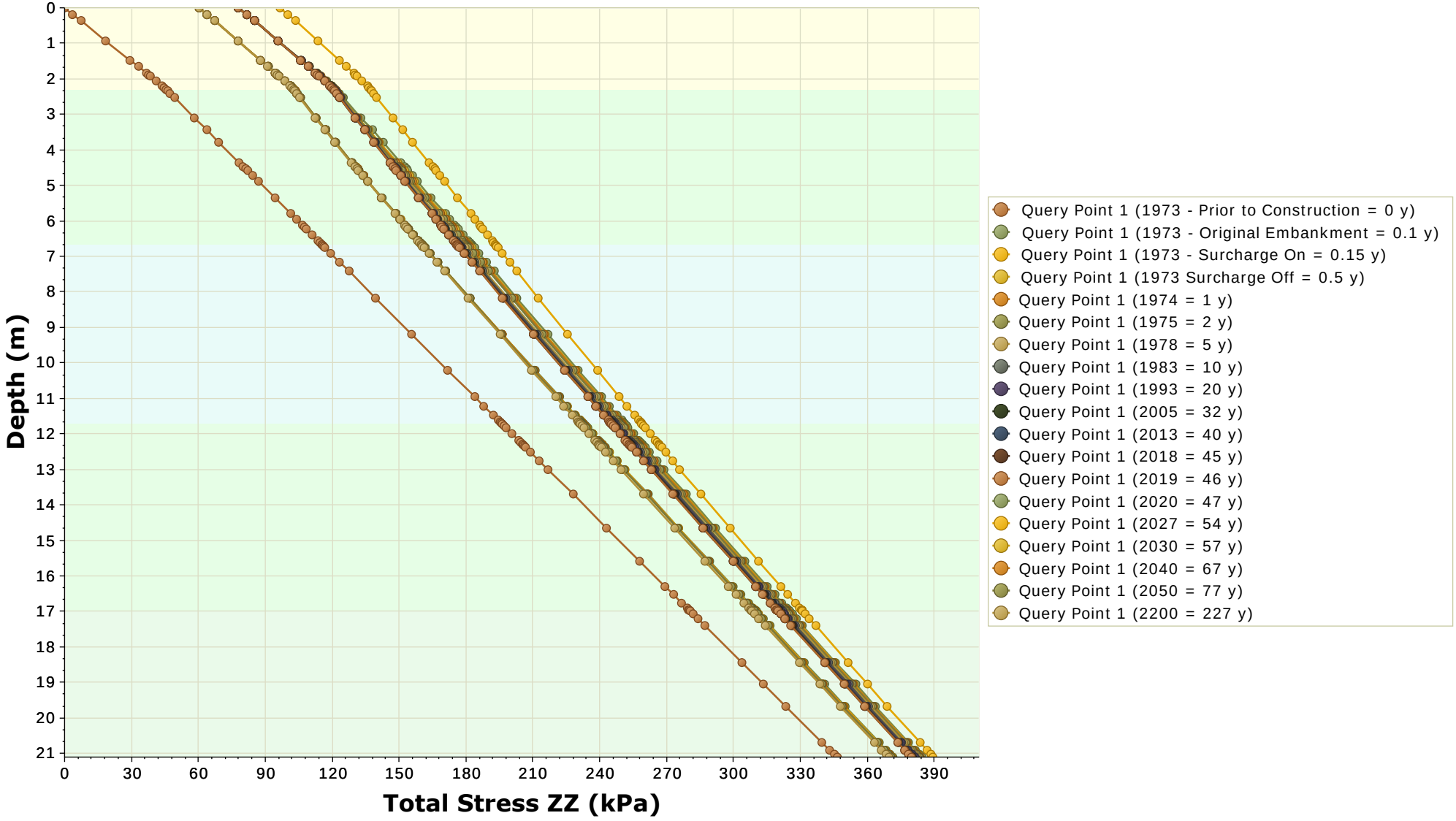


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Total Stress ZZ vs. Depth

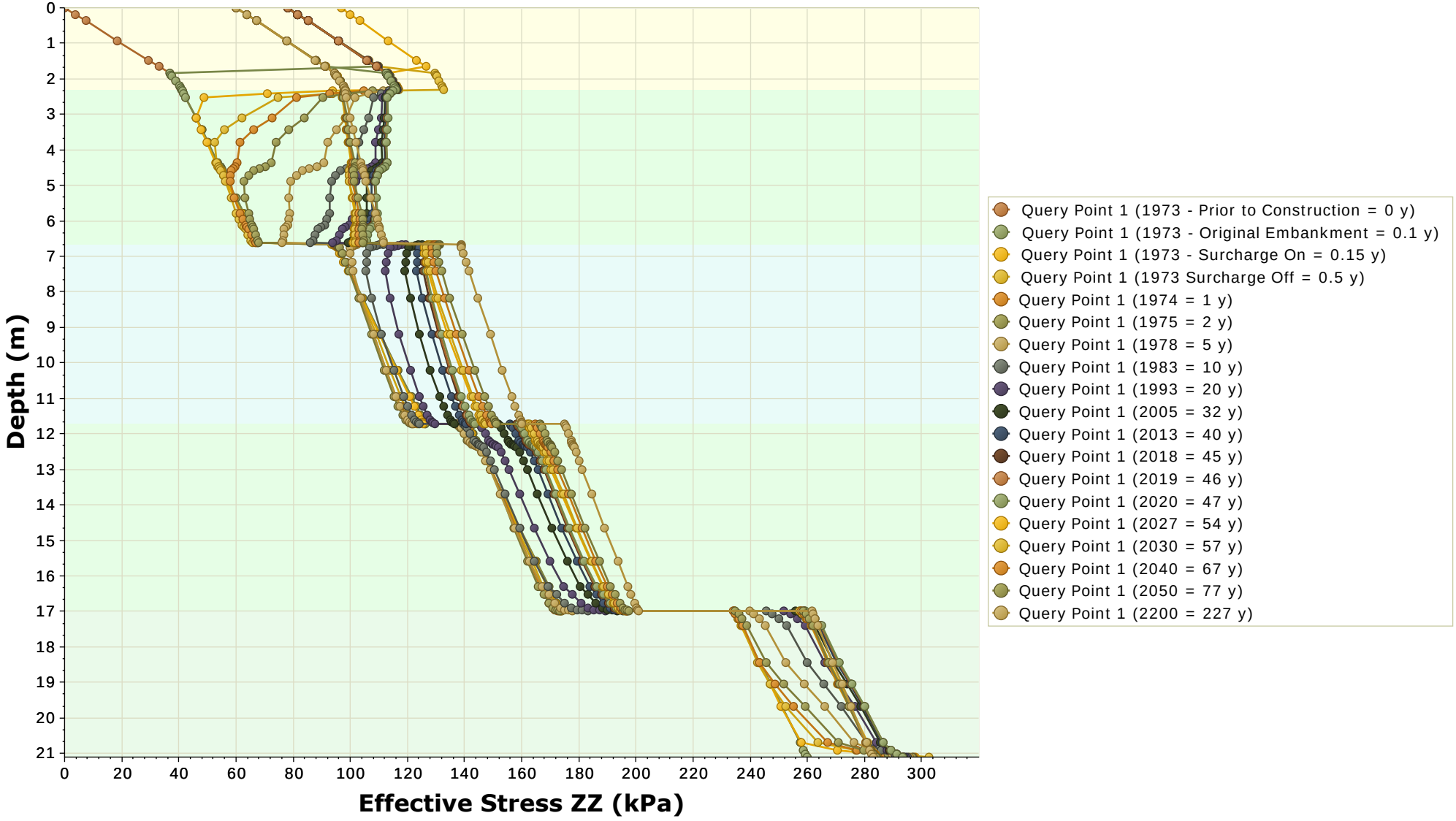


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Effective Stress ZZ vs. Depth

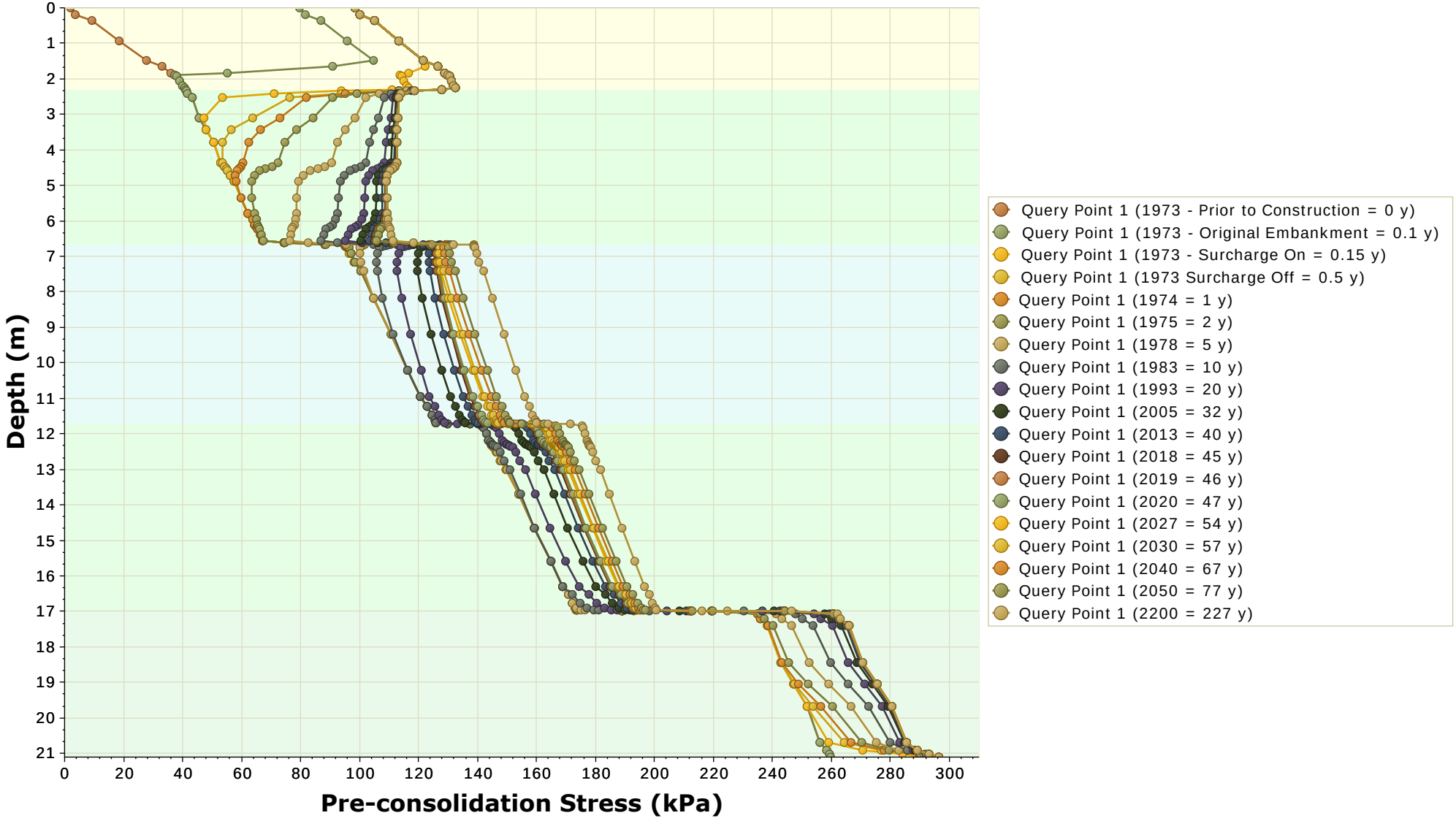


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Pre-consolidation Stress vs. Depth



Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
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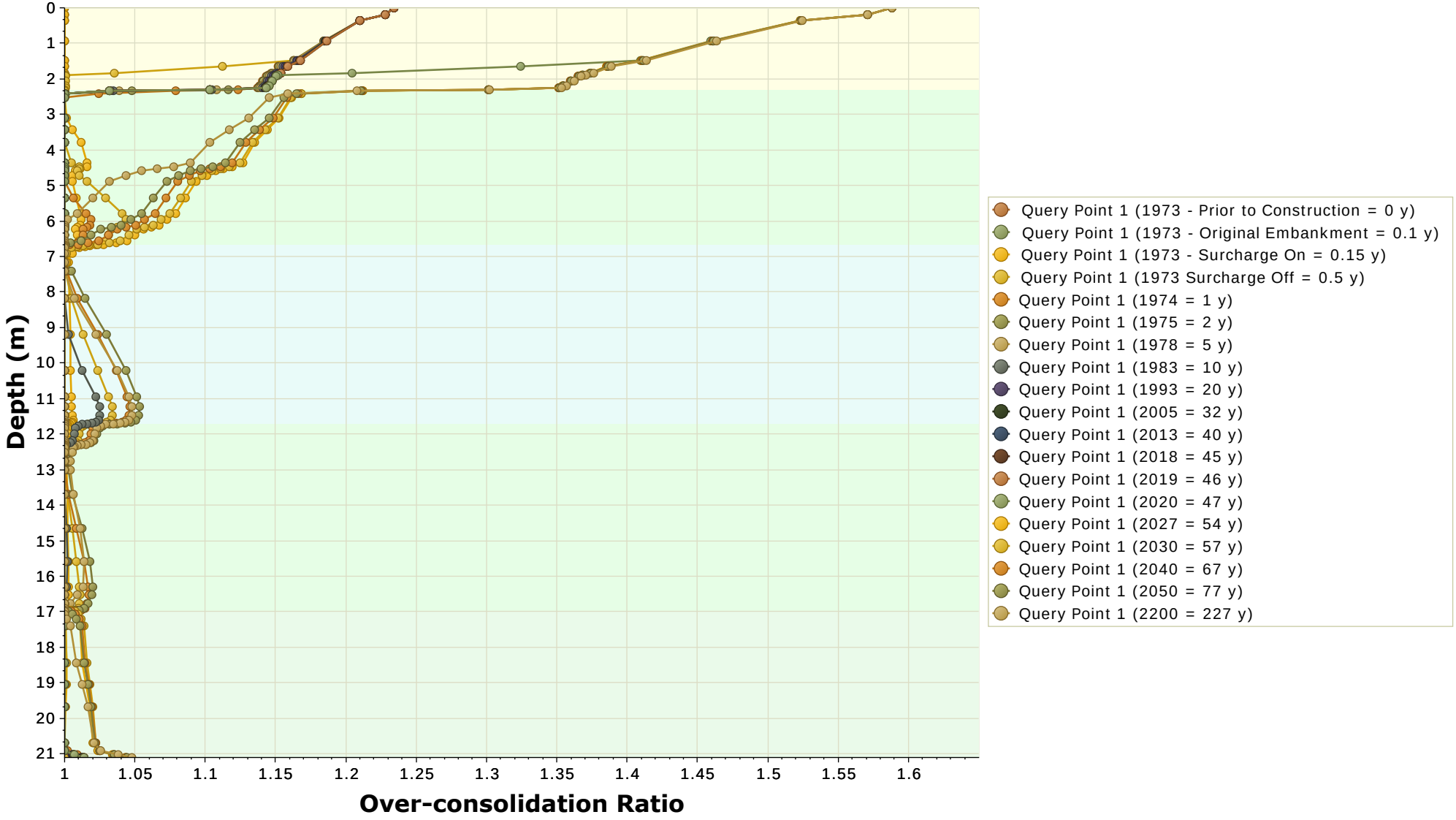
SETTLE3D 4.005

Over-consolidation Ratio vs. Depth

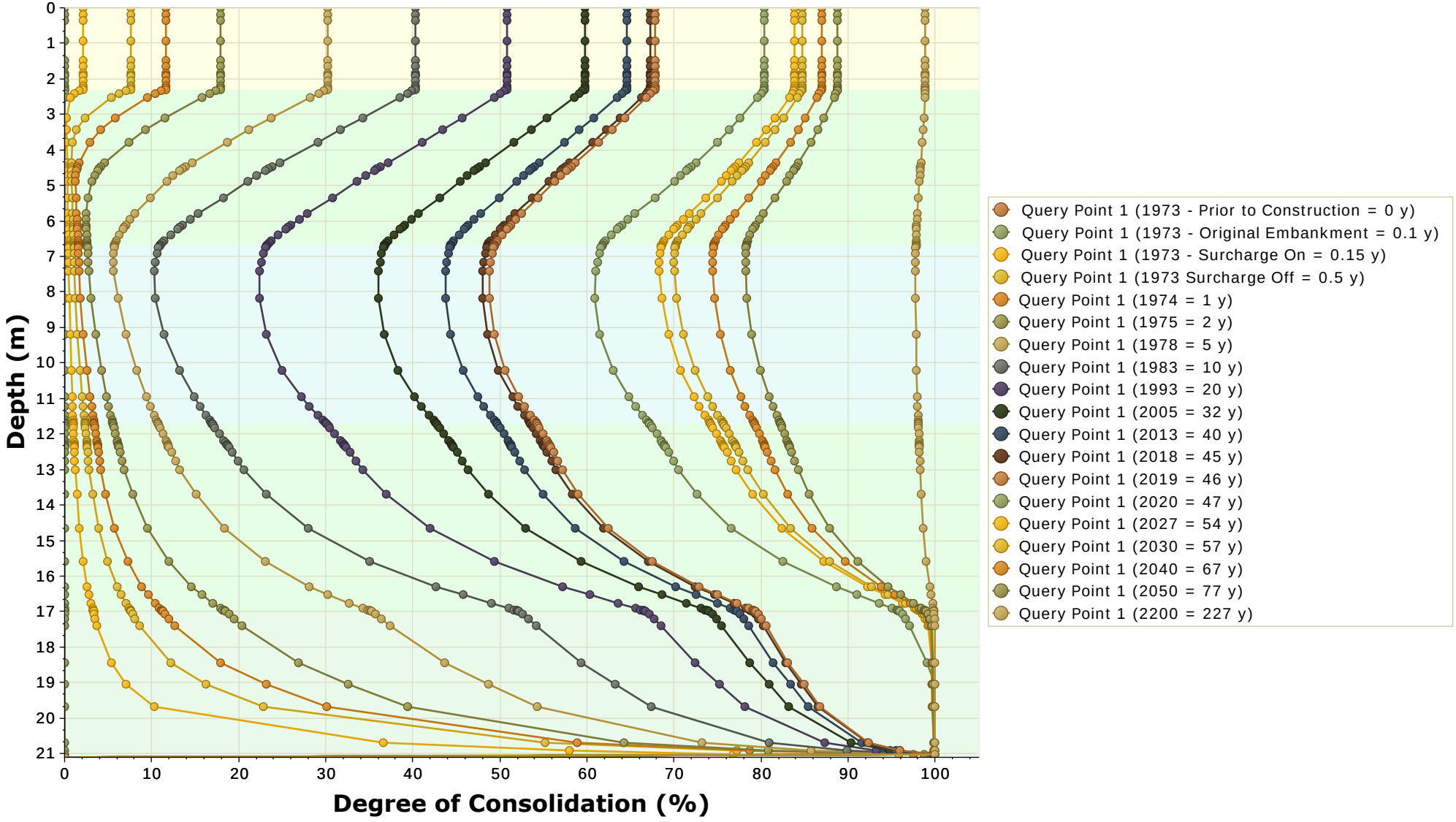


Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Degree of Consolidation vs. Depth



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rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
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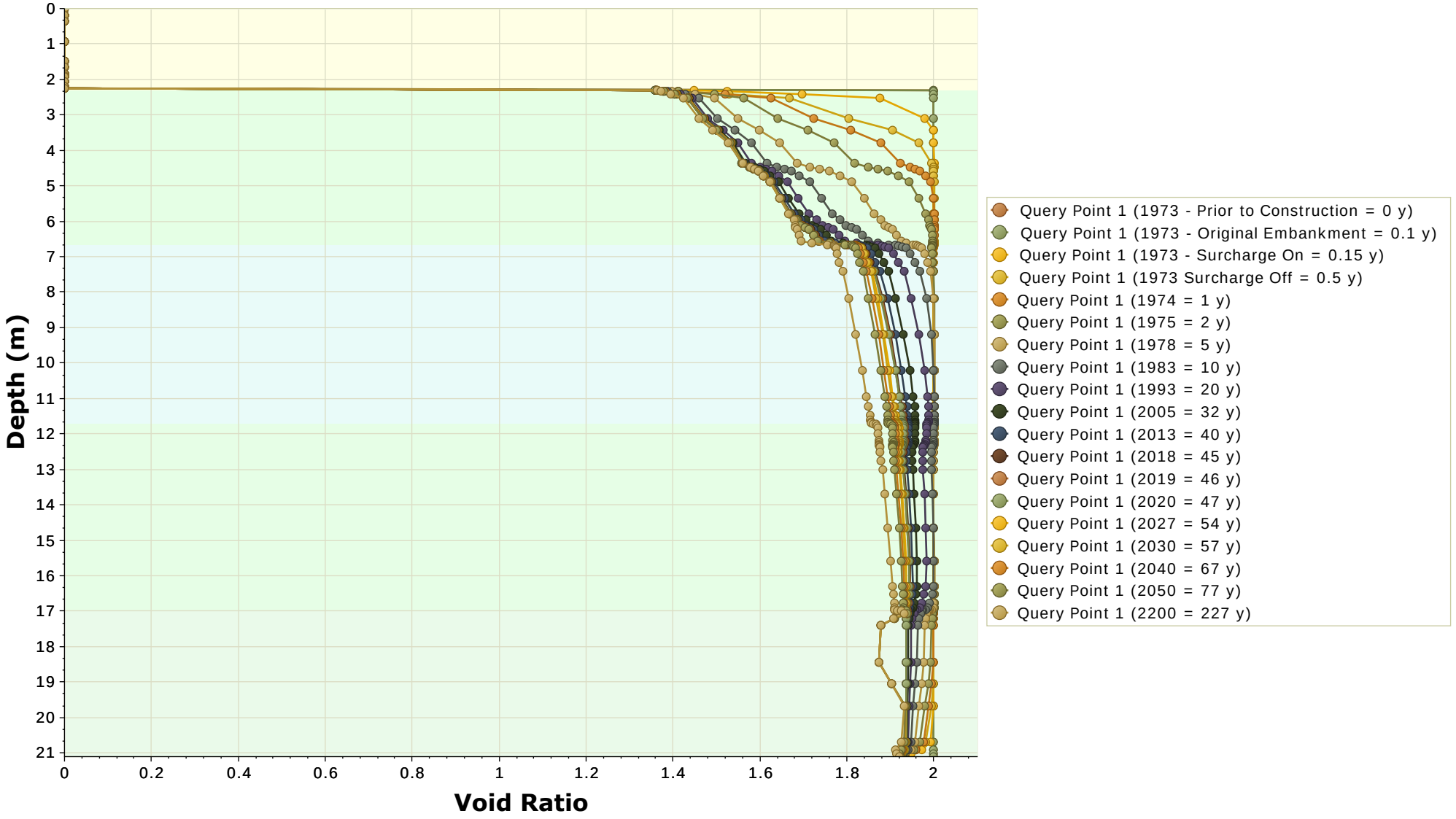
SETTLE3D 4.005

Void Ratio vs. Depth

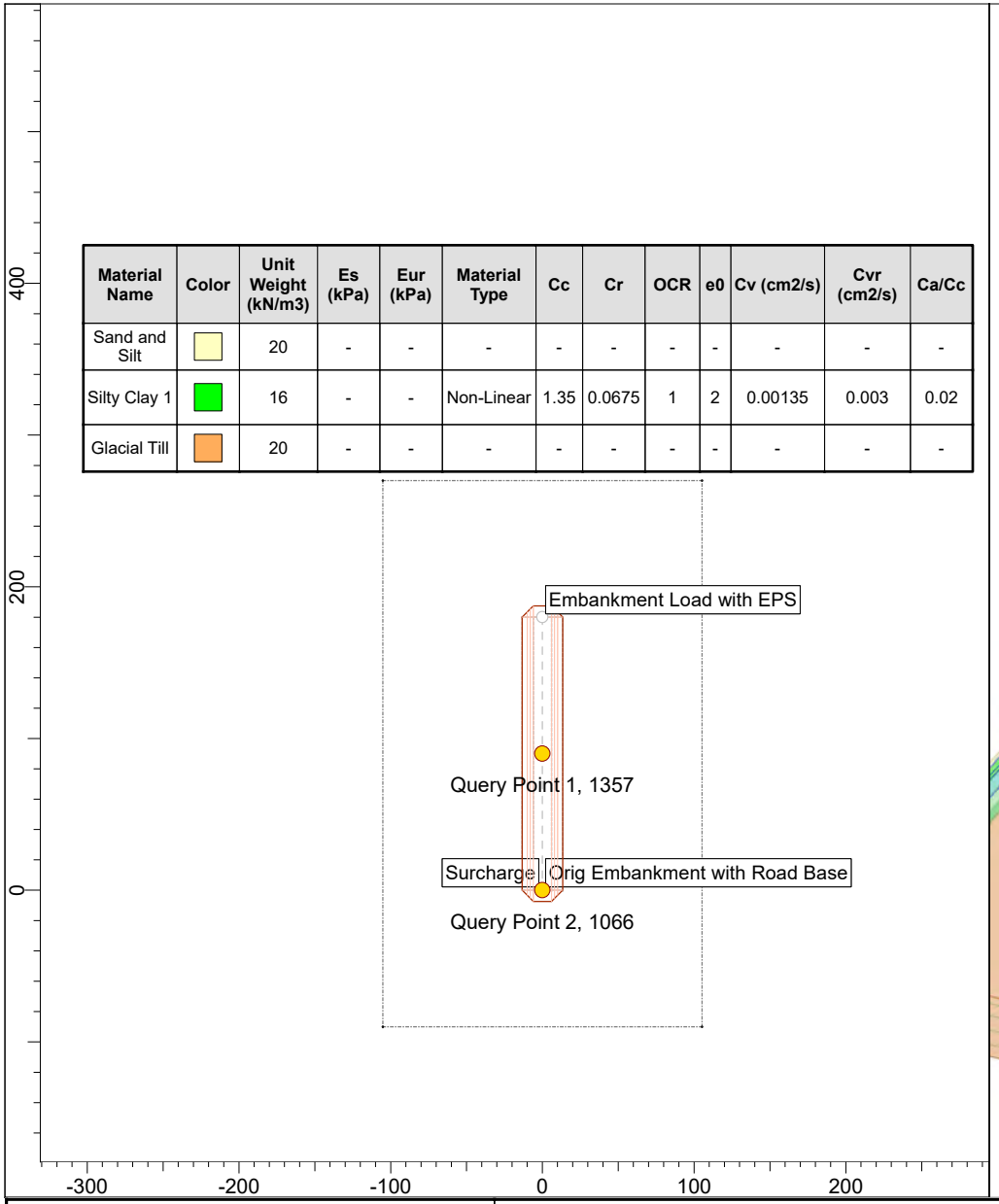


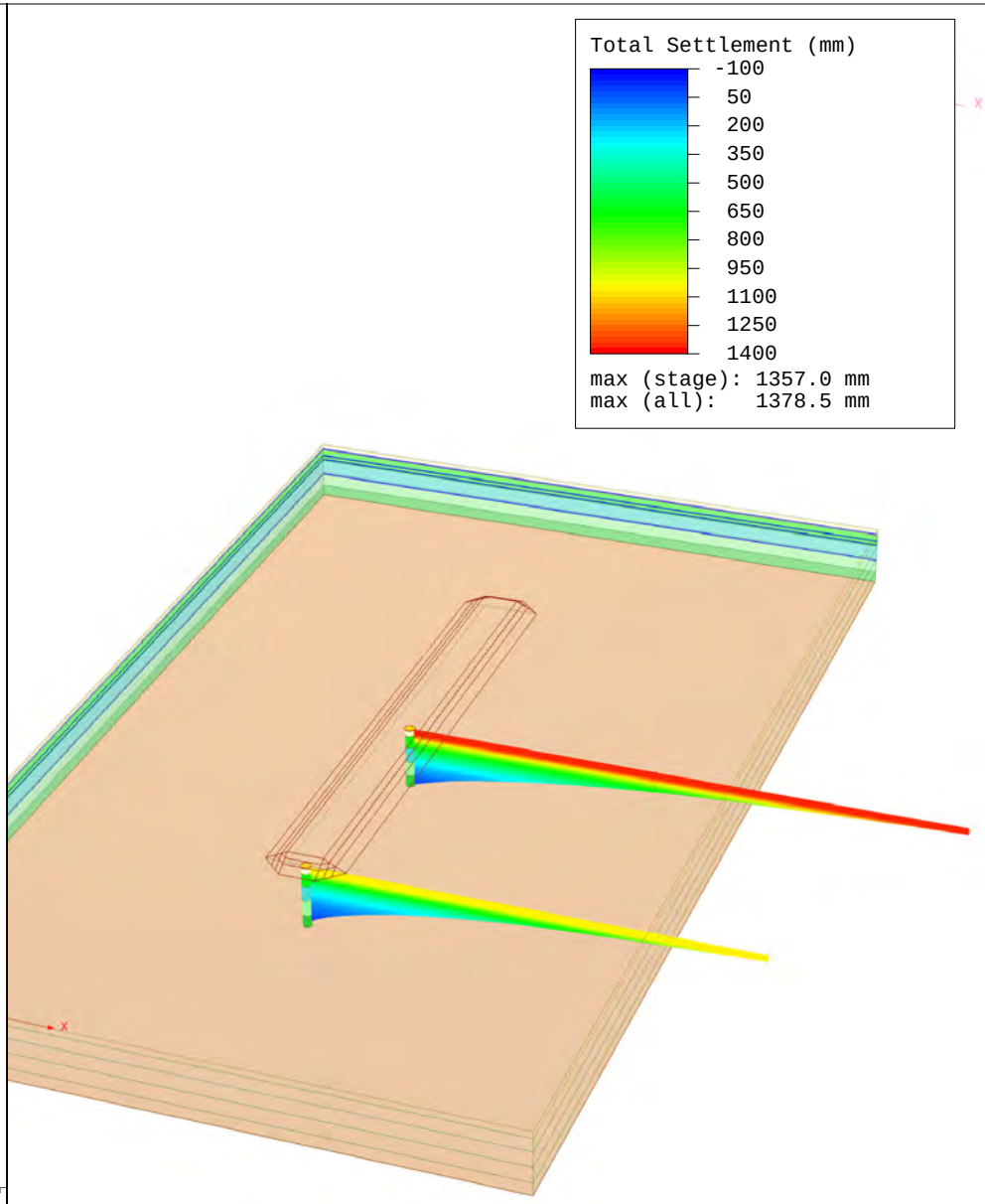
Reference Stage: None

rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 399802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_EPS_1m.s

SETTLE3D 4.005

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.00135	0.003	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-

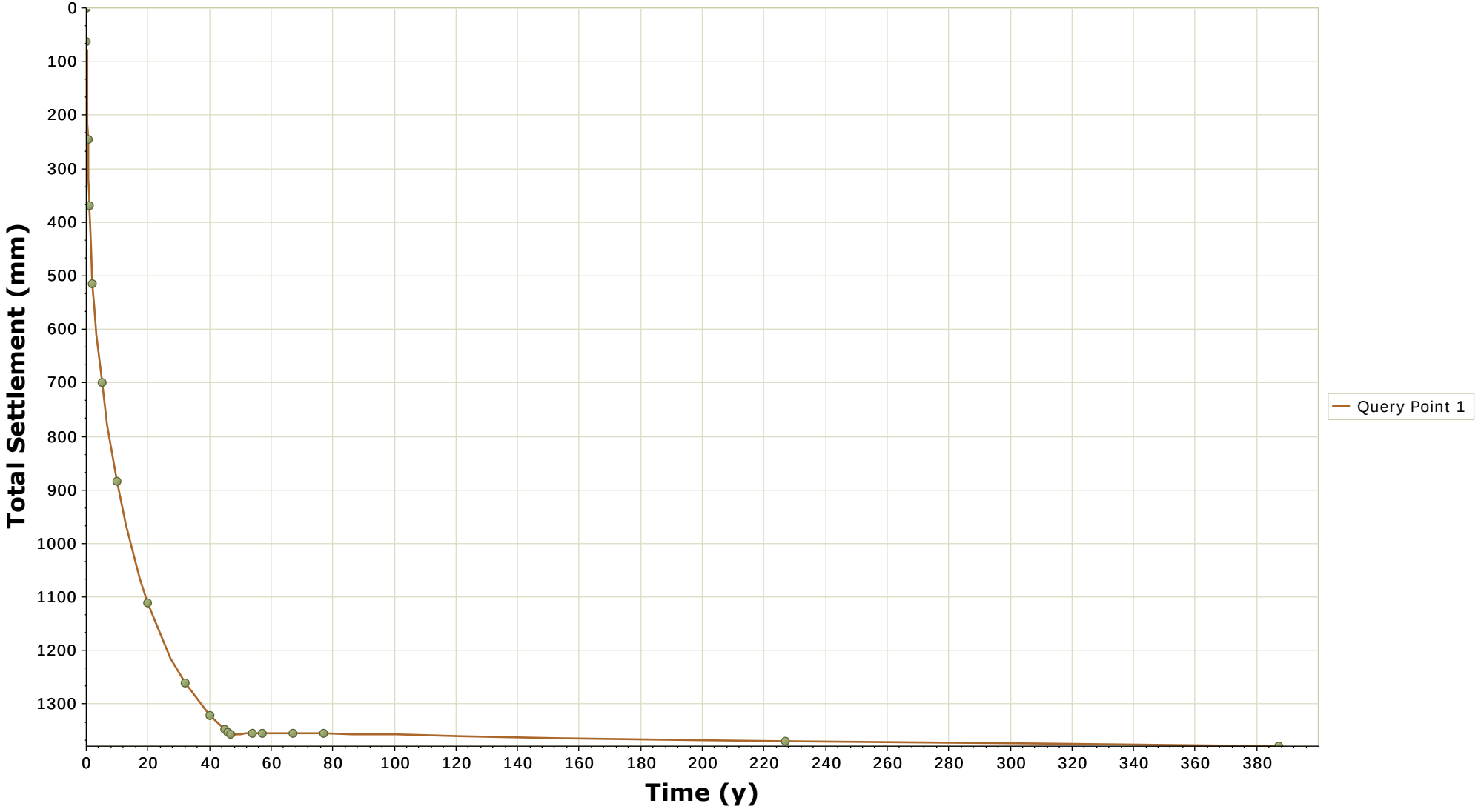




rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m.

SETTLE3D 4.005

Time vs. Total Settlement



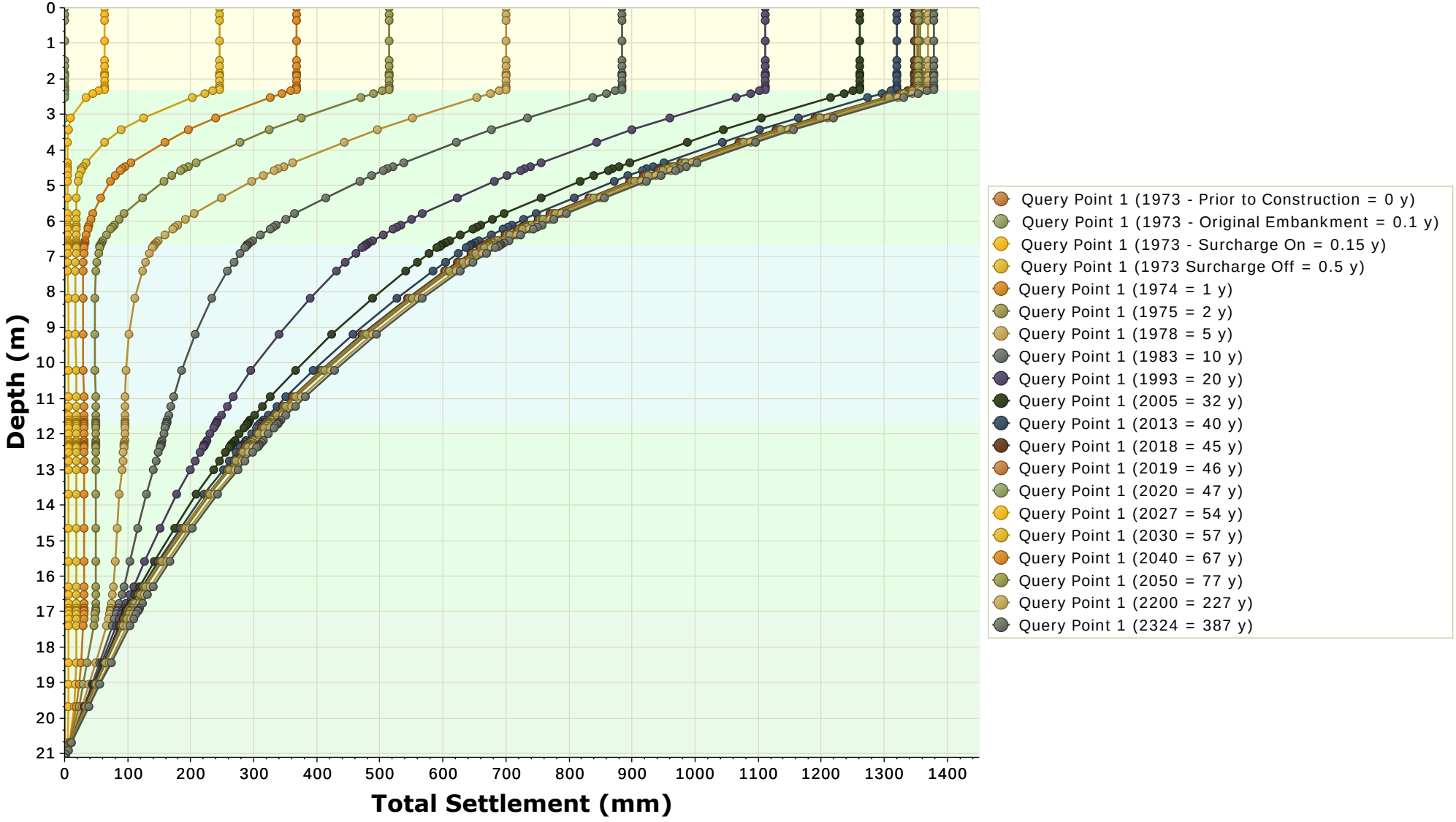
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m..

SETTLE3D 4.005

Total Settlement vs. Depth

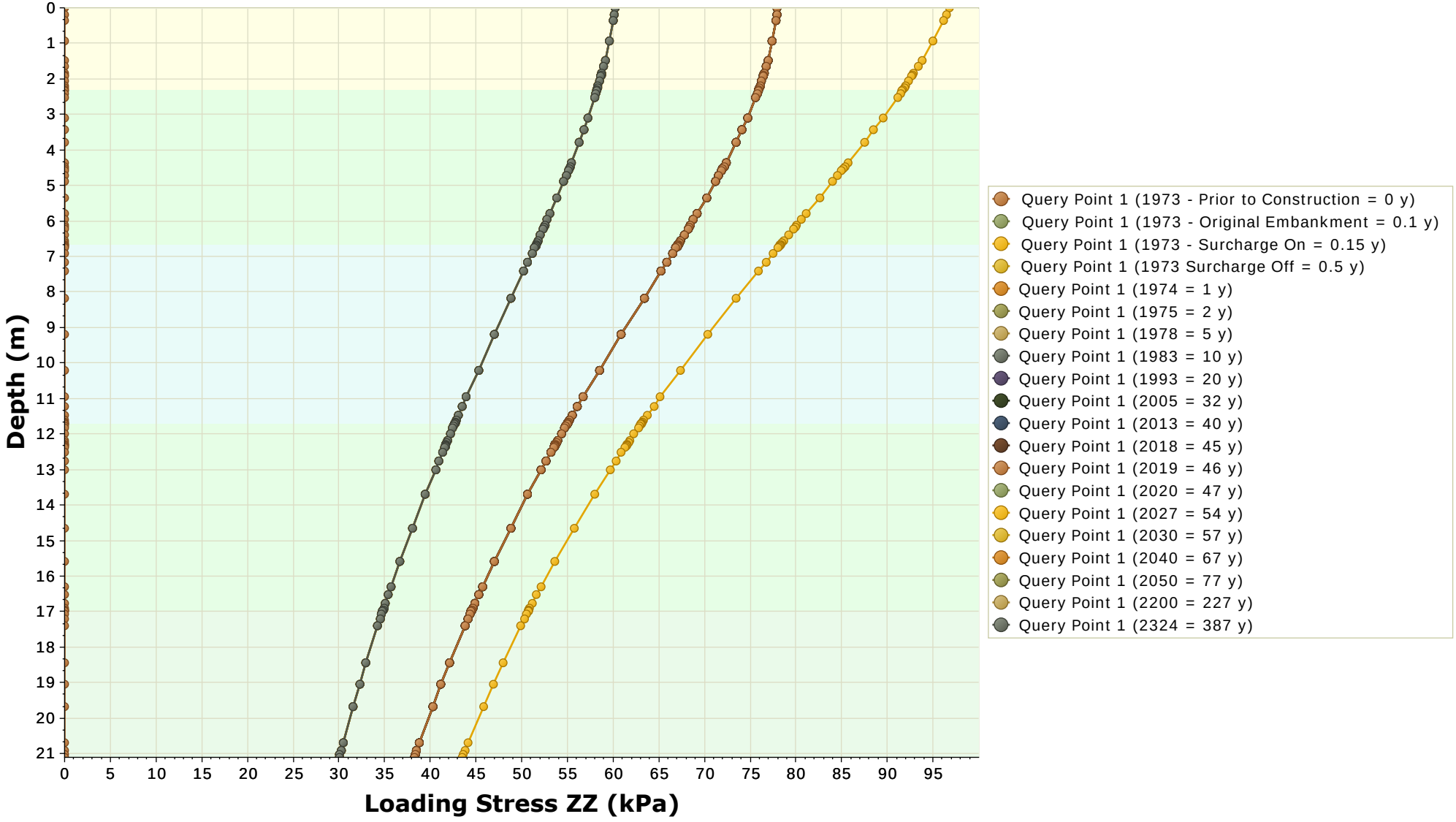


Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m..

SETTLE3D 4.005

Loading Stress ZZ vs. Depth



Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
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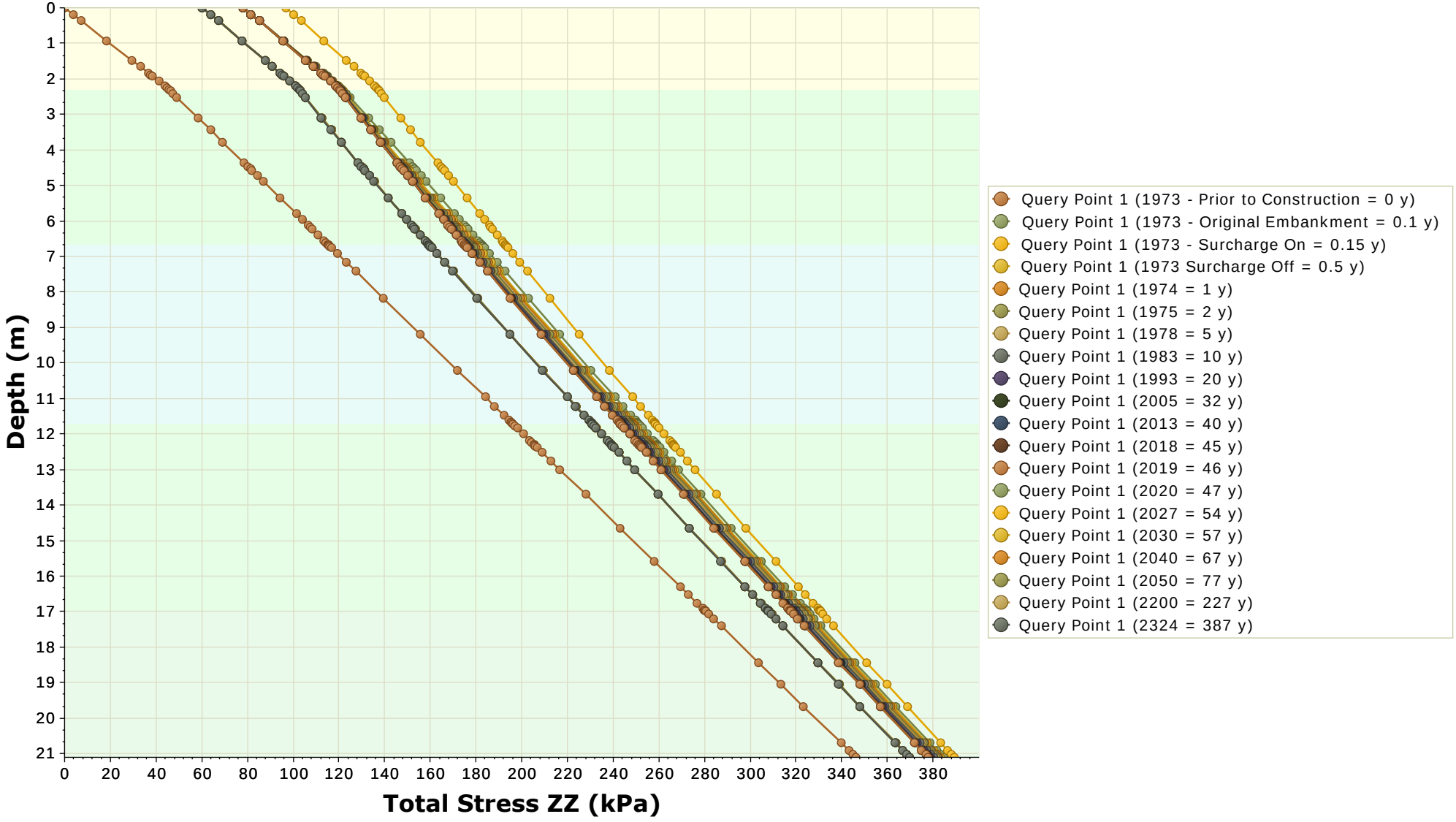
SETTLE3D 4.005

Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (WBL)	
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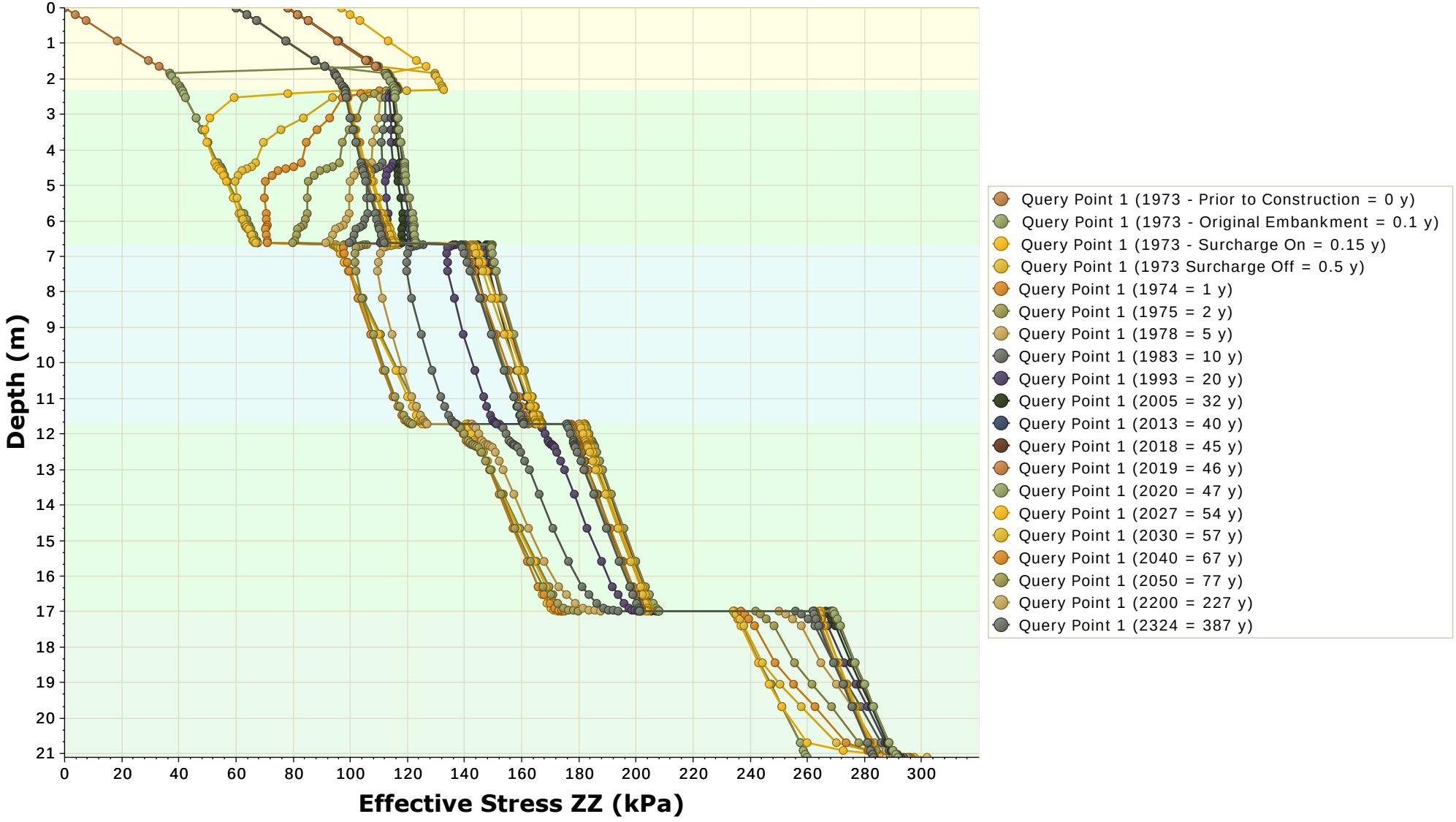
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m..

Effective Stress ZZ vs. Depth



Reference Stage: None

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
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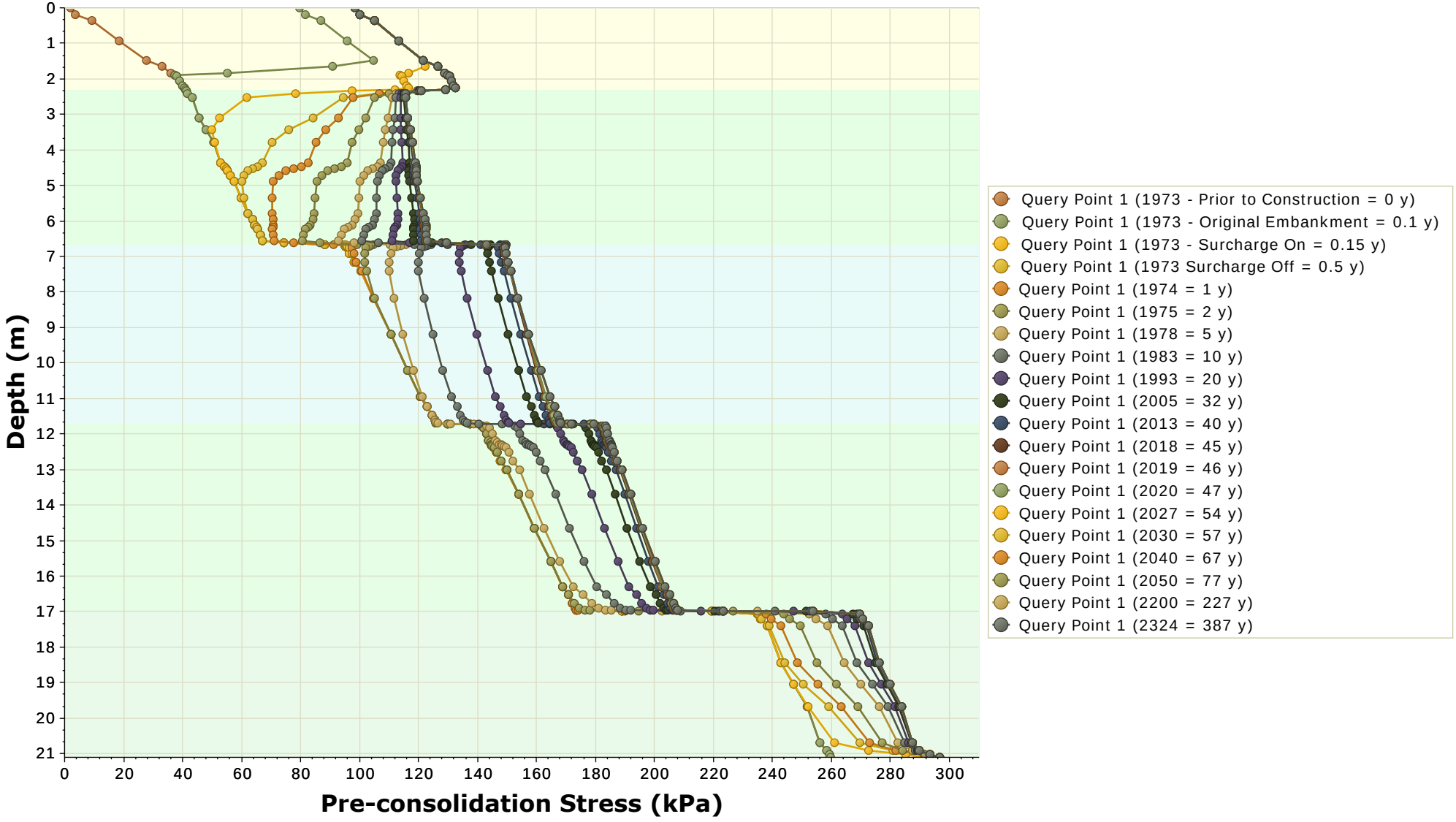
SETTLE3D 4.005

Pre-consolidation Stress vs. Depth



Reference Stage: None

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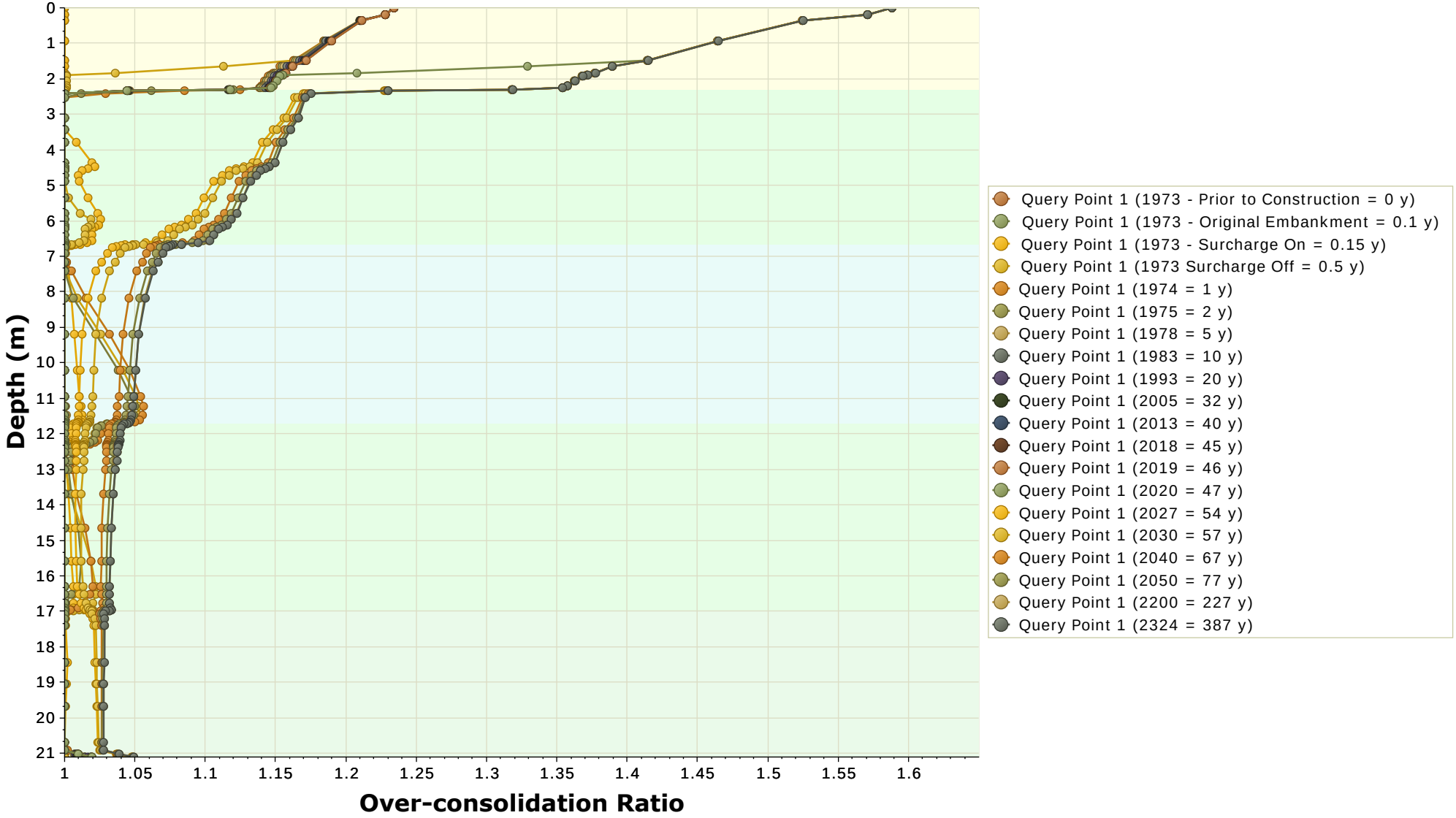
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m..

SETTLE3D 4.005

Over-consolidation Ratio vs. Depth



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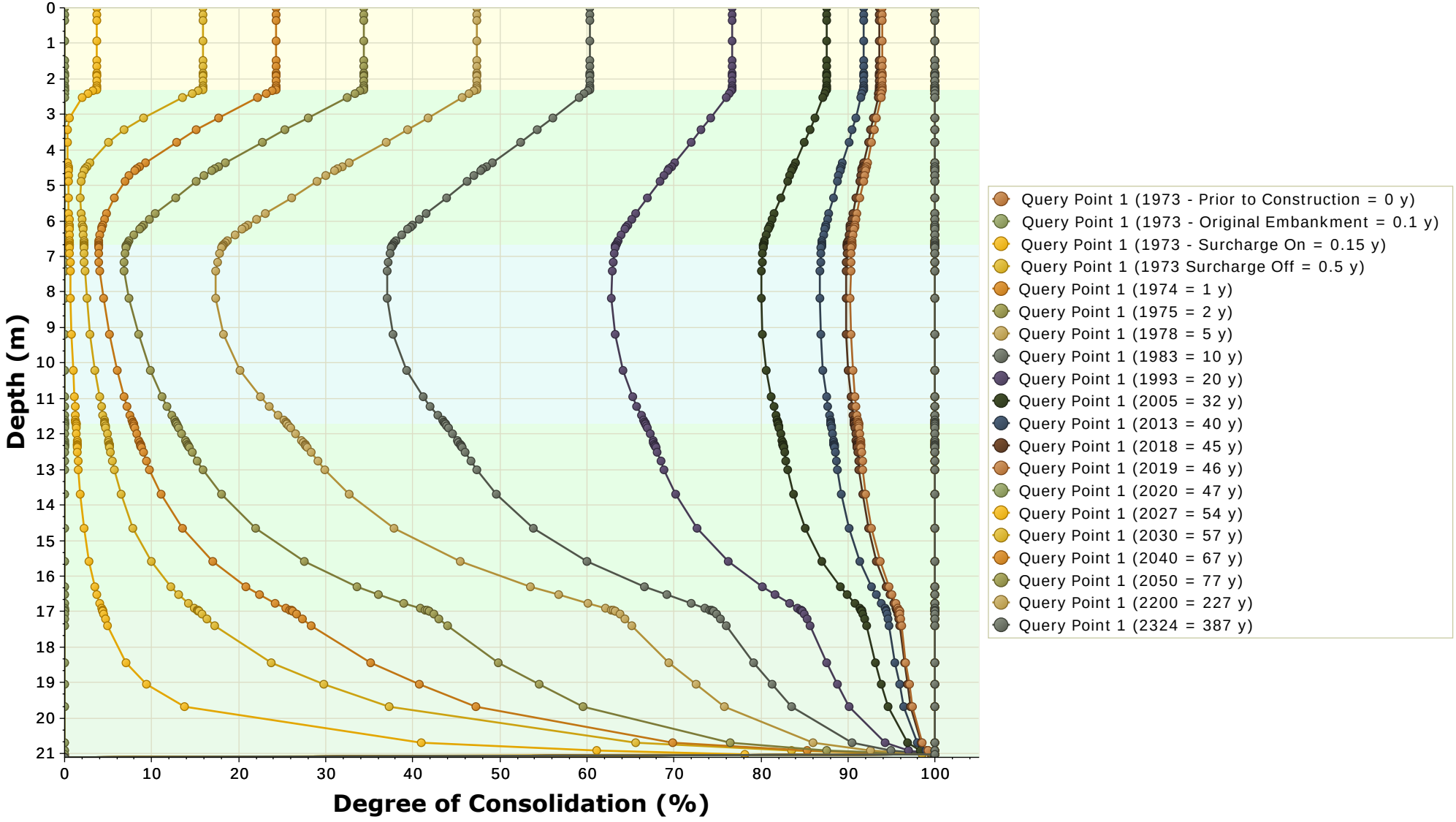
rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_1_EPS_1m.

SETTLE3D 4.005

Degree of Consolidation vs. Depth



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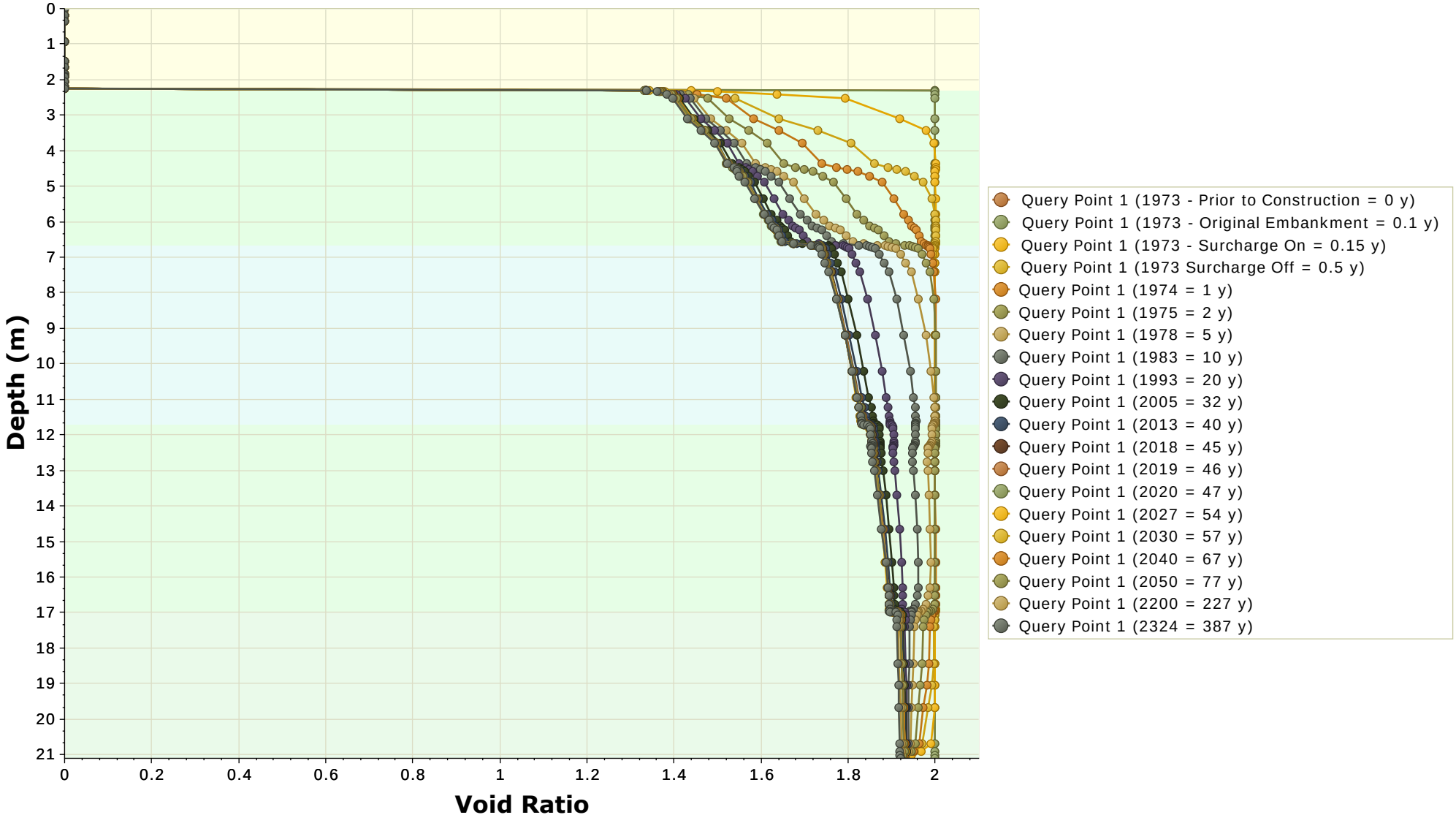
SETTLE3D 4.005

Void Ratio vs. Depth



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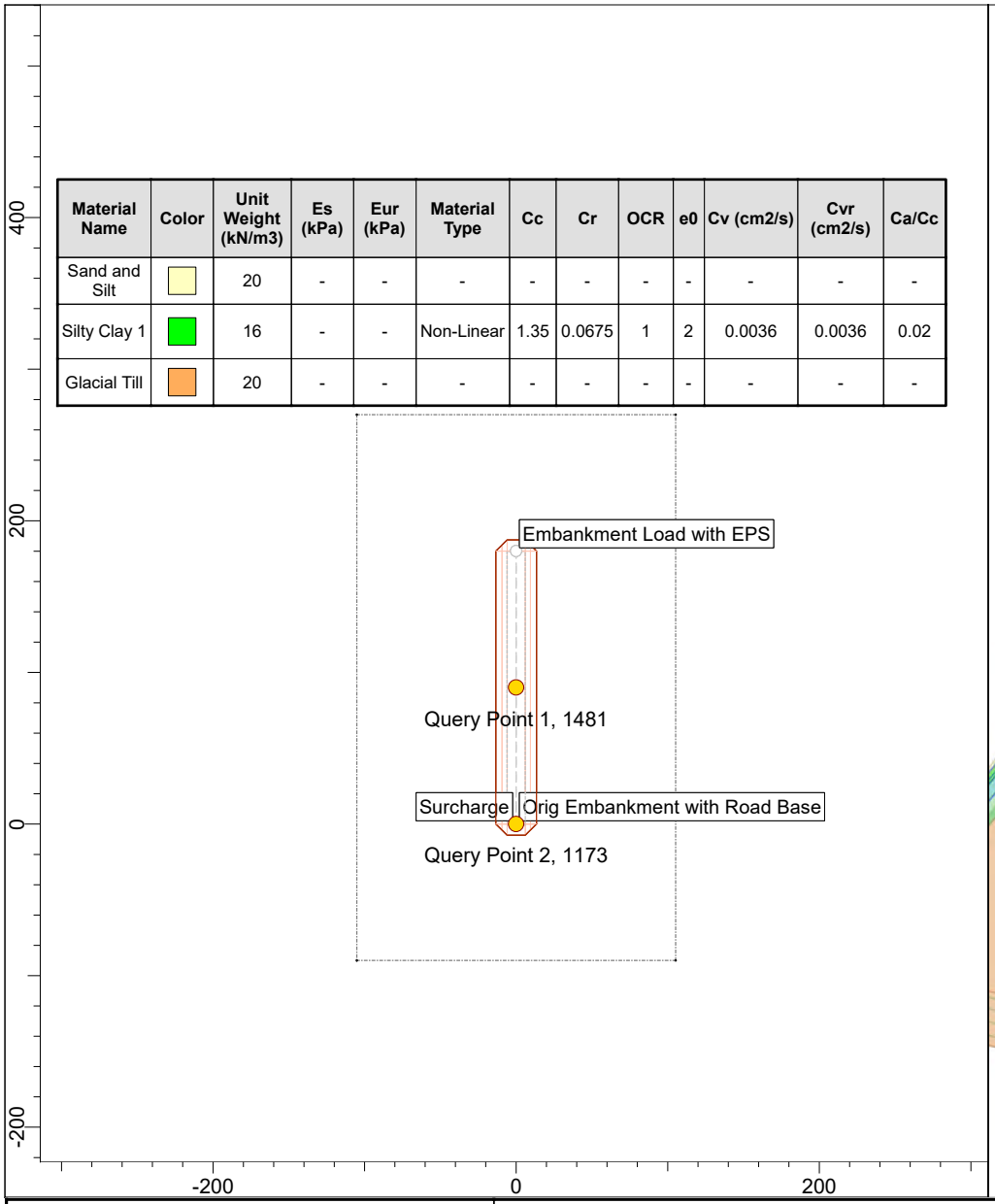
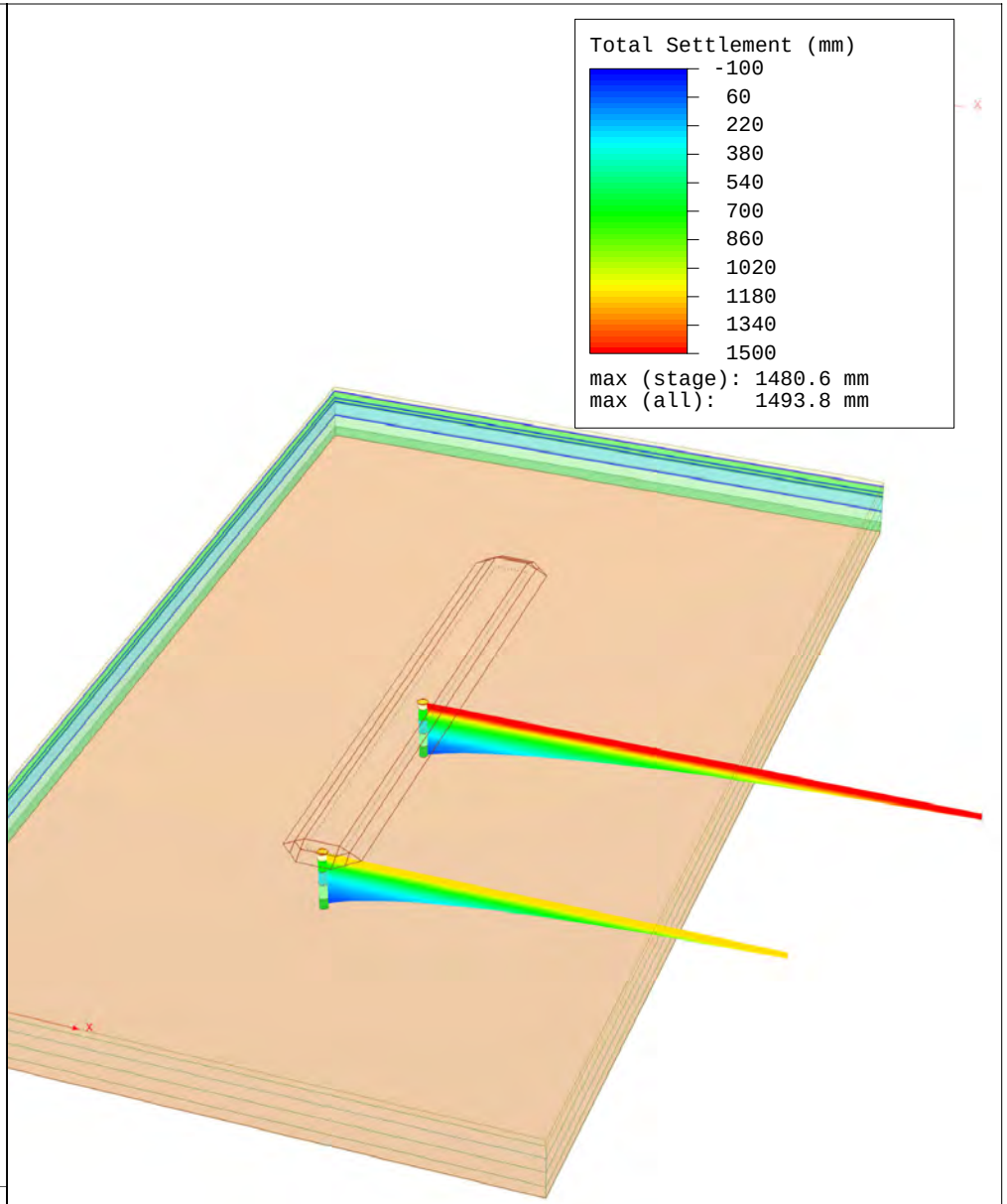
SETTLE3D 4.005

Material Name	Color	Unit Weight (kN/m3)	Es (kPa)	Eur (kPa)	Material Type	Cc	Cr	OCR	e0	Cv (cm2/s)	Cvr (cm2/s)	Ca/Cc
Sand and Silt		20	-	-	-	-	-	-	-	-	-	-
Silty Clay 1		16	-	-	Non-Linear	1.35	0.0675	1	2	0.0036	0.0036	0.02
Glacial Till		20	-	-	-	-	-	-	-	-	-	-





rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
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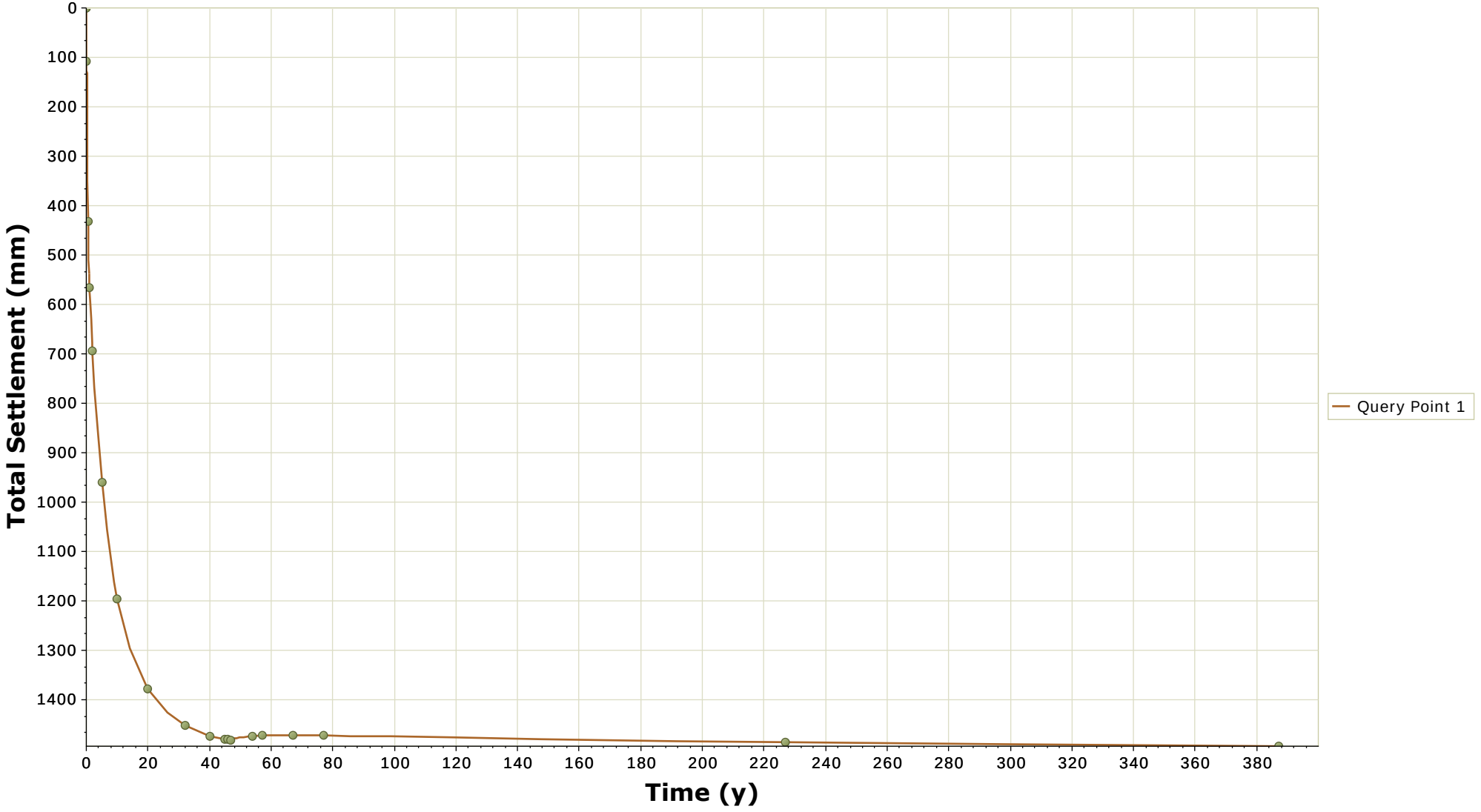
SETTLE3D 4.005

Time vs. Total Settlement



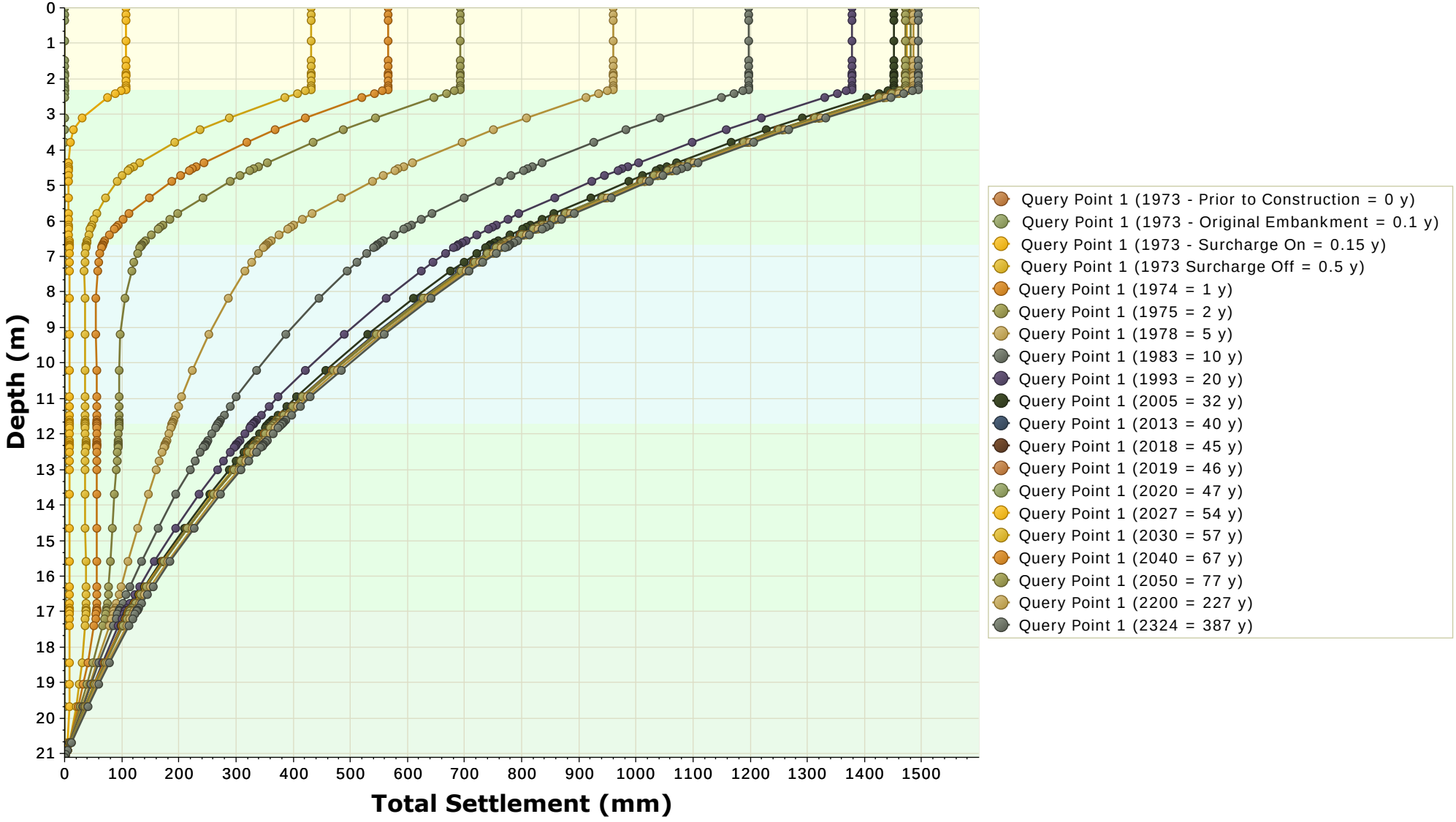
Reference Stage: None

Total Settlement at Depth = 0 m

rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	*Company* Golder Associates
	Date	2019-03-14, 4:44:22 PM	*File Name* 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2_EPS_1m..

SETTLE3D 4.005

Total Settlement vs. Depth



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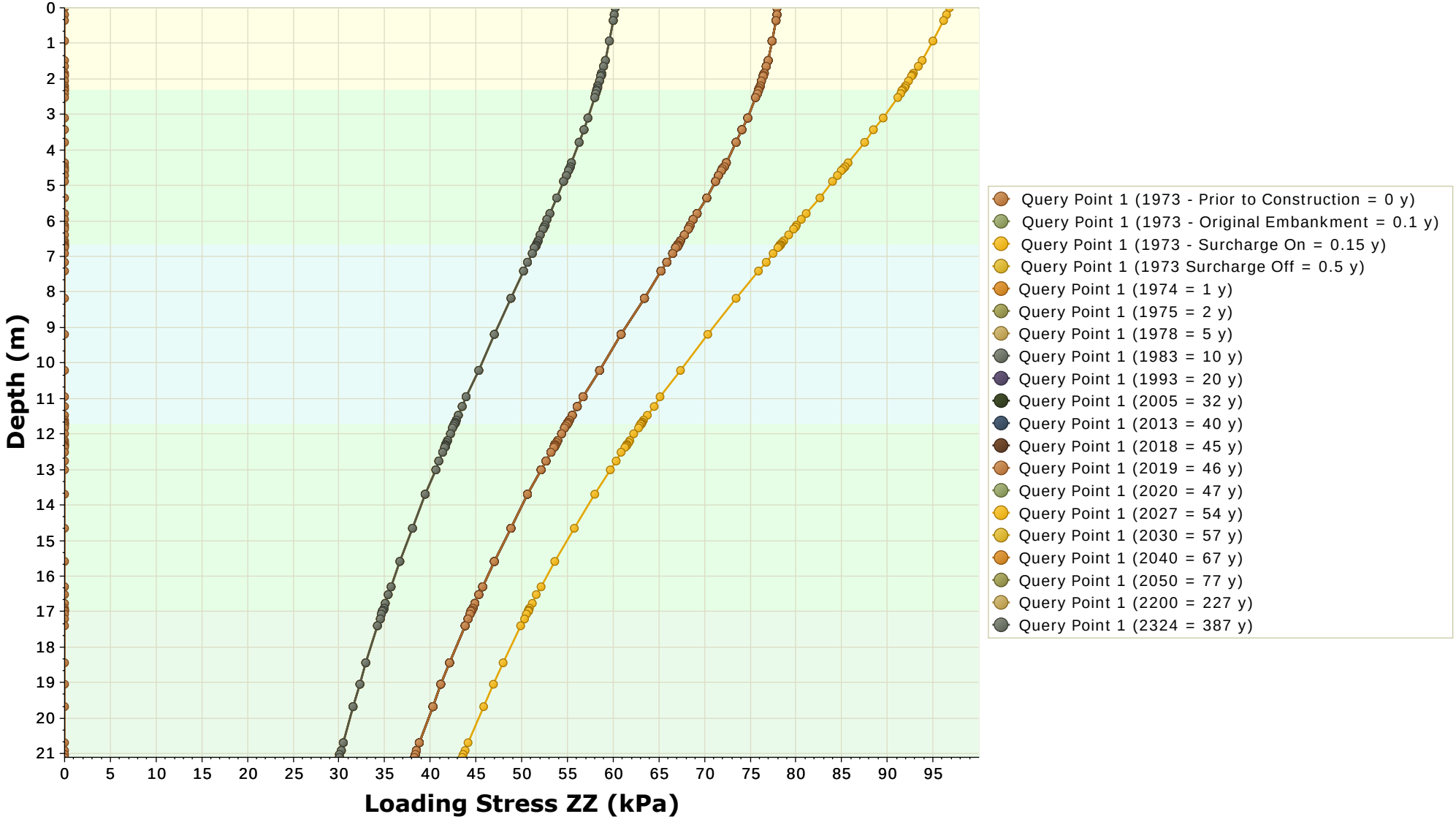
SETTLE3D 4.005

Loading Stress ZZ vs. Depth



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	Analysis Description	Preload 4 Months	
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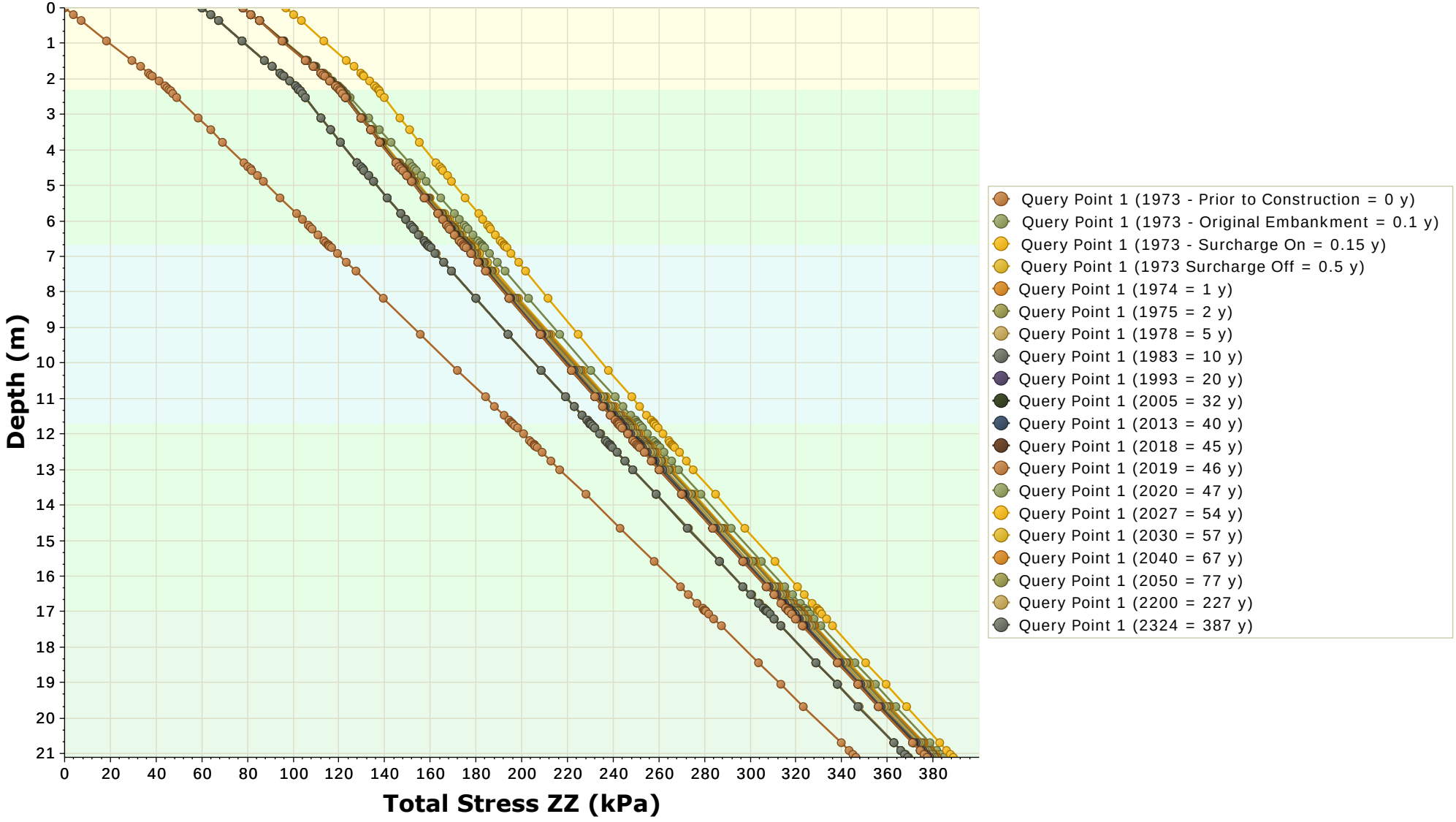
SETTLE3D 4.005

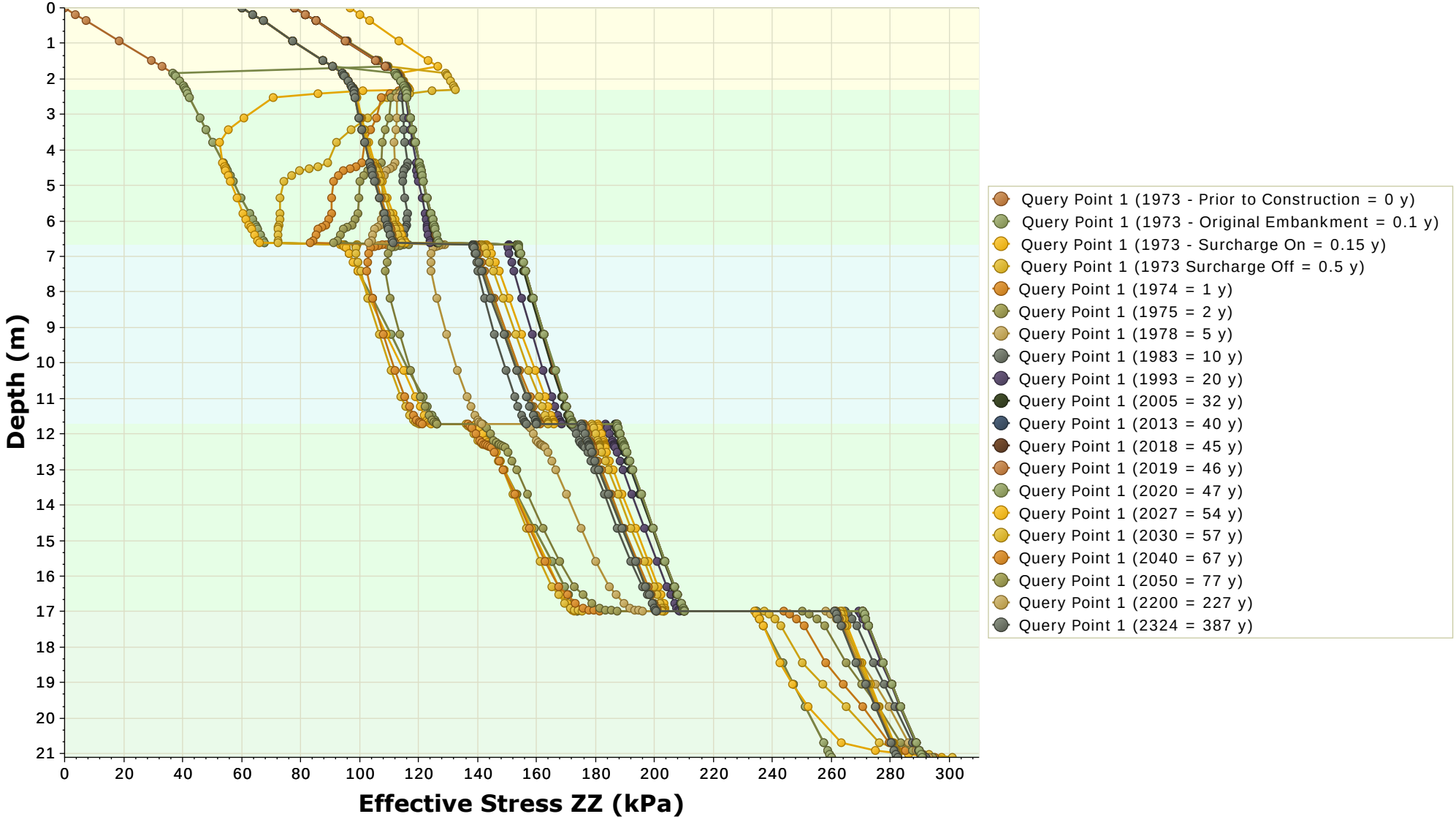
Total Stress ZZ vs. Depth



Reference Stage: None

rocscience SETTLE3D 4.005	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
	Drawn By	Ray Kennedy	Company: Golder Associates
	Date	2019-03-14, 4:44:22 PM	File Name: 99802-6000-Surcharge_4mo_WBL_18-601_VARYING_GWL_2_EPS_1m..

Effective Stress ZZ vs. Depth



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rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
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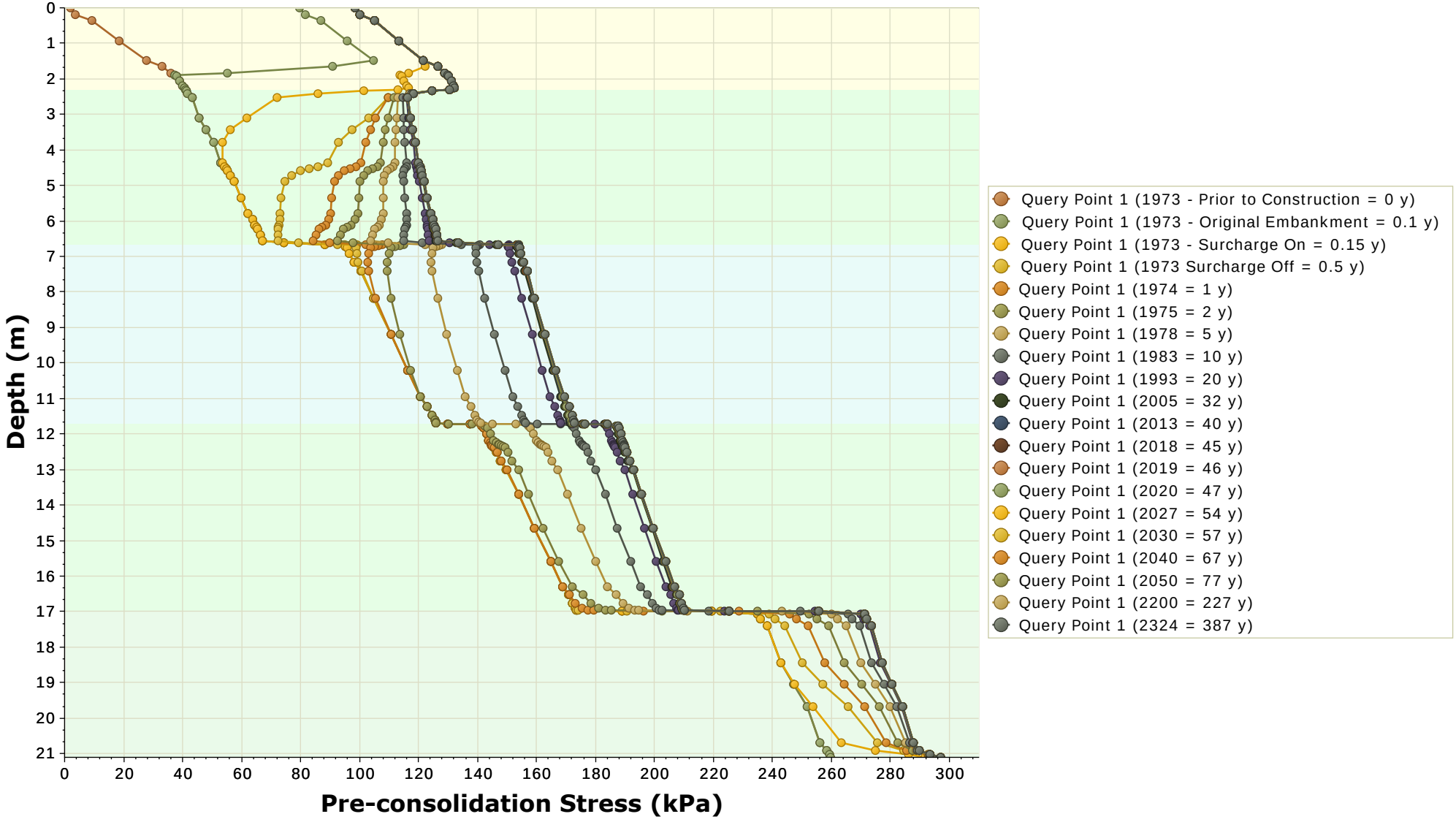
SETTLE3D 4.005

Pre-consolidation Stress vs. Depth



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rocscience	Project	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
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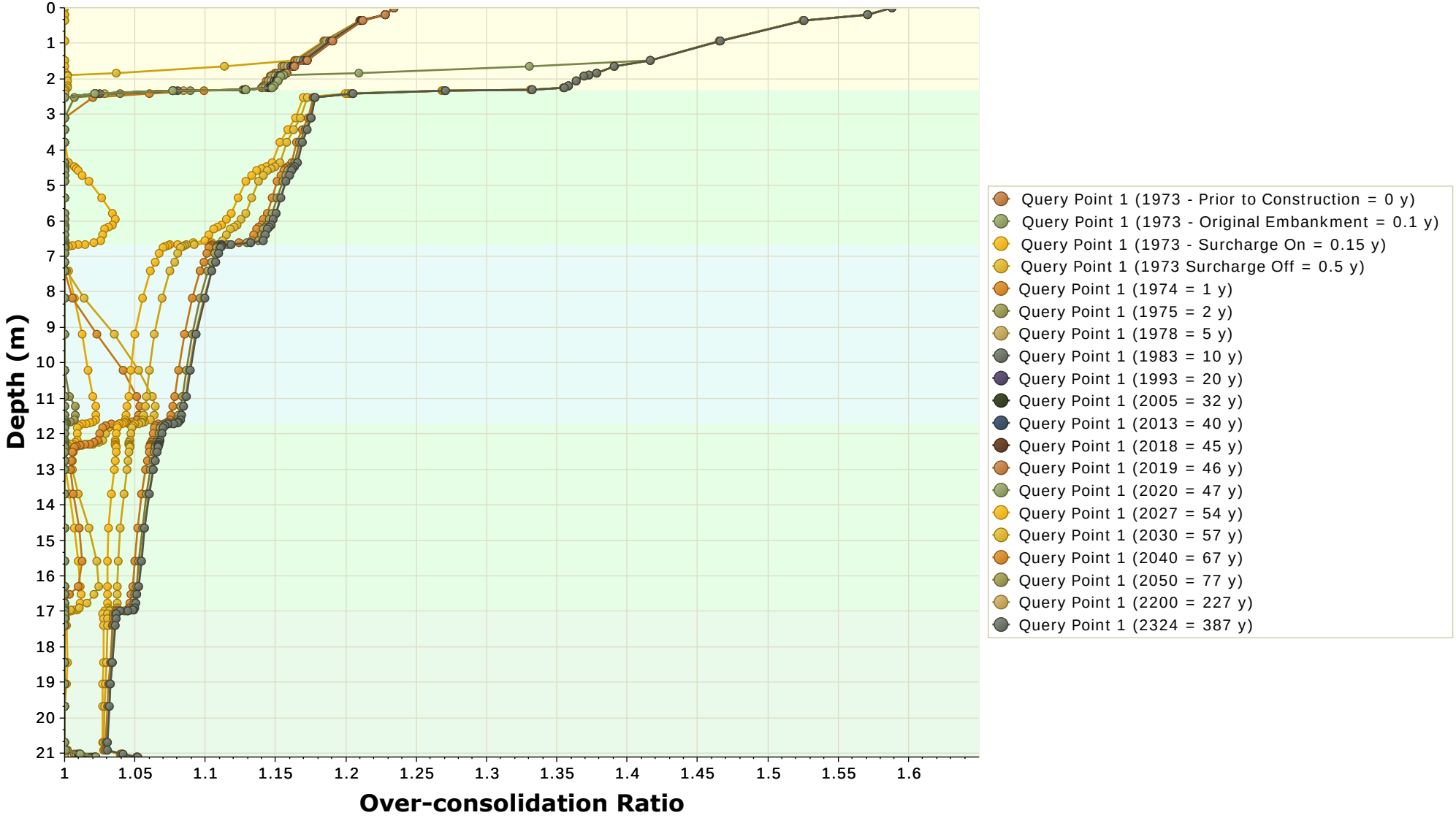
SETTLE3D 4.005

Over-consolidation Ratio vs. Depth



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rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
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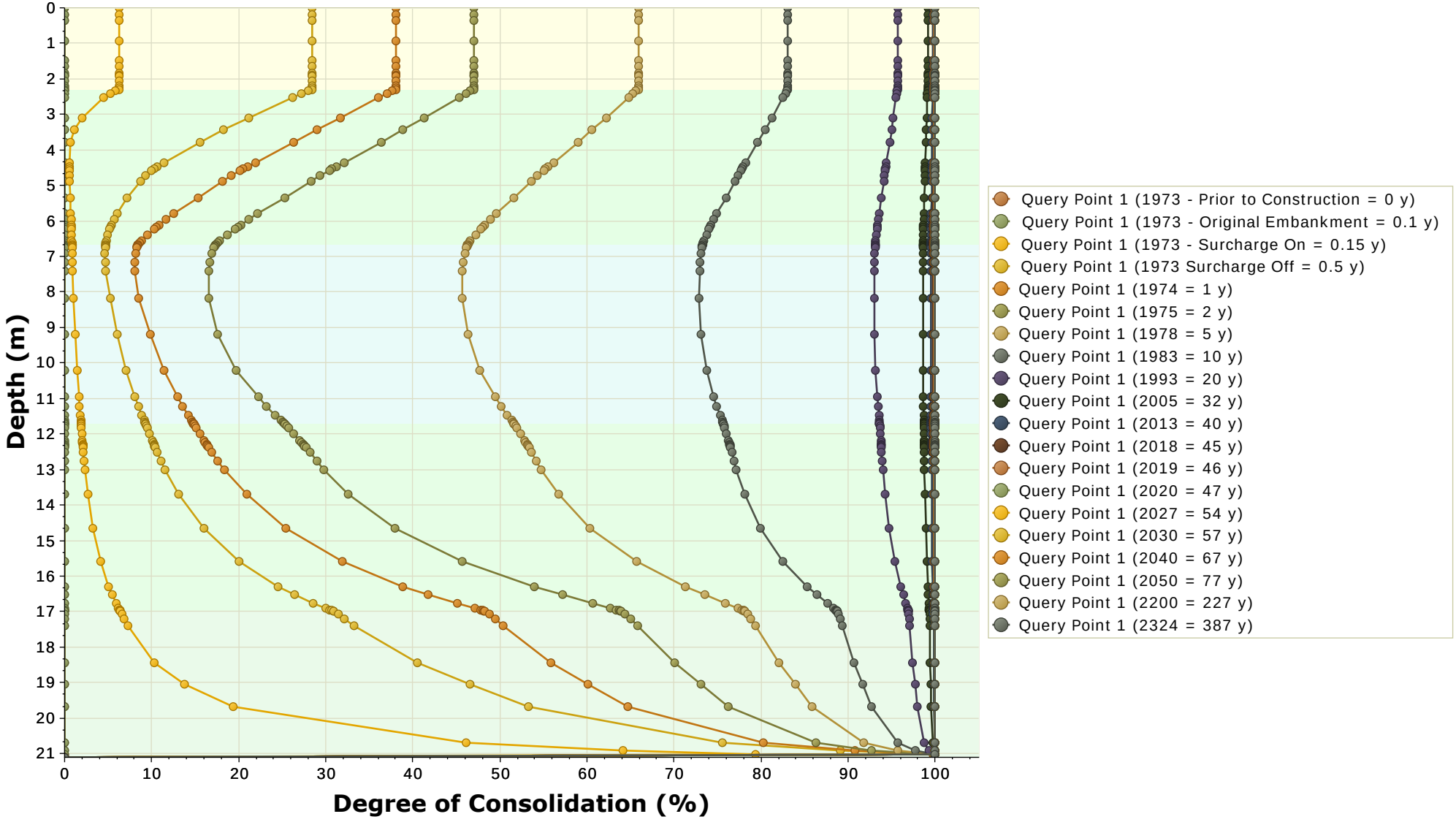
SETTLE3D 4.005

Degree of Consolidation vs. Depth



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rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
	Analysis Description	Preload 4 Months	
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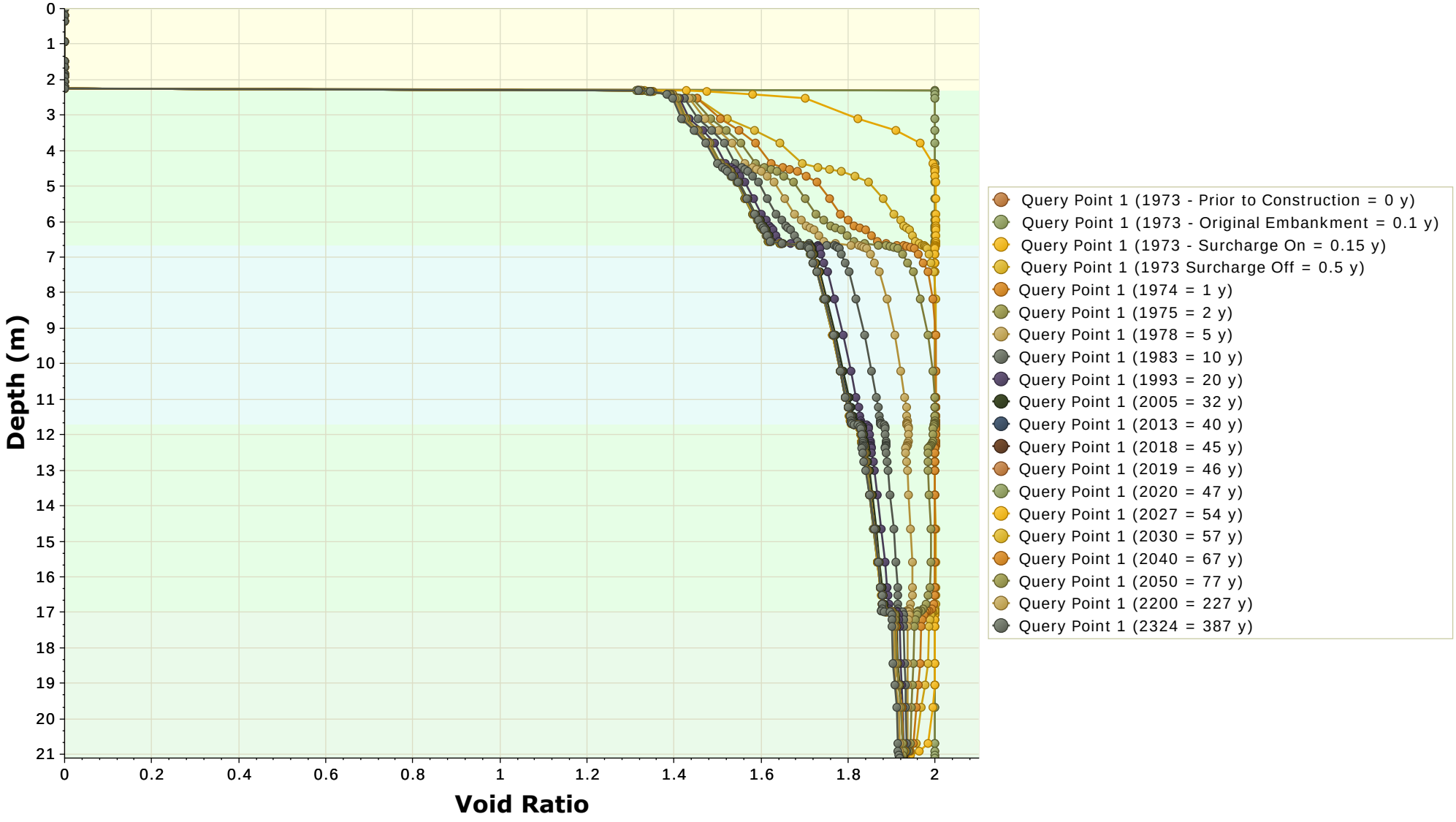
SETTLE3D 4.005

Void Ratio vs. Depth



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rocscience	*Project*	Highway 417 / County Road 3 (WBL)	
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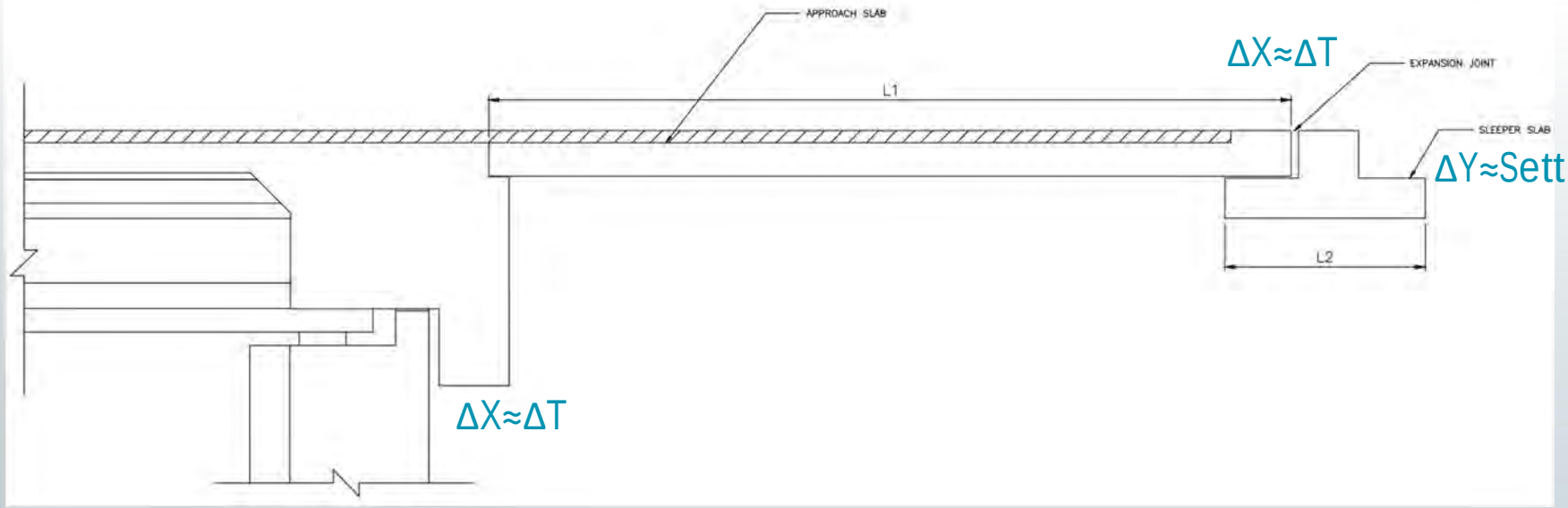
SETTLE3D 4.005

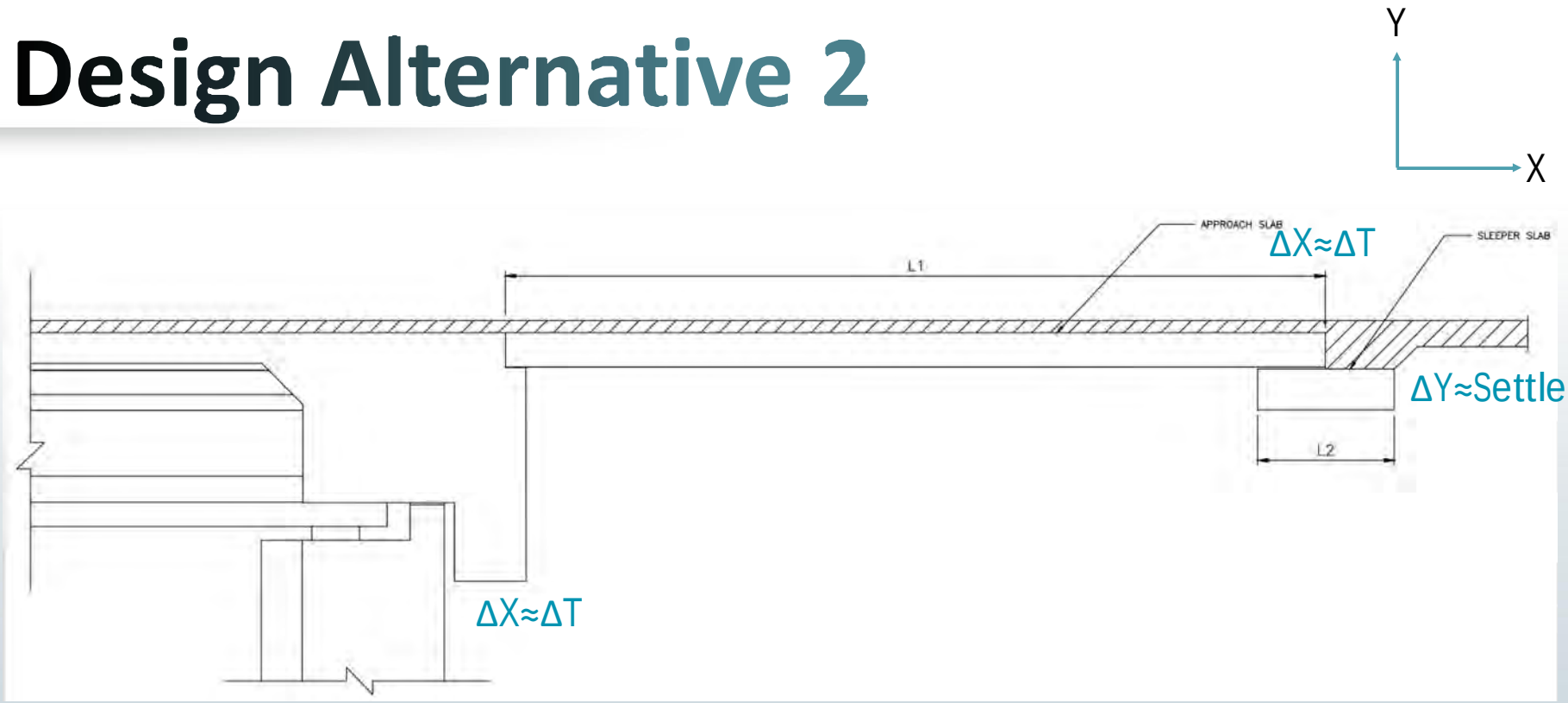
APPENDIX G

Approach Slab Design Alternatives

Design Alternative 1 (Existing Condition)



Design Alternative 2



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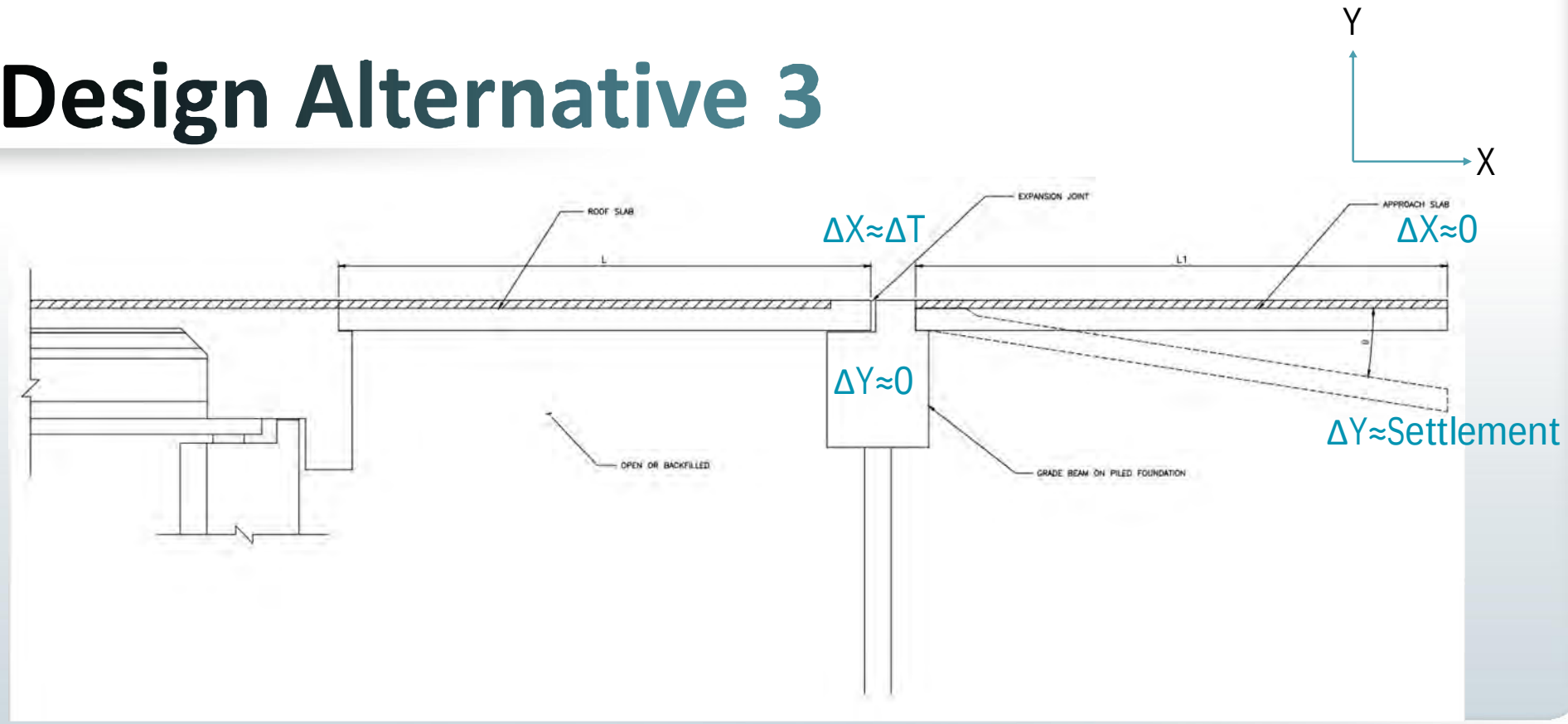
Design Alternative 3



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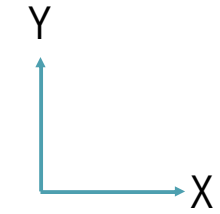
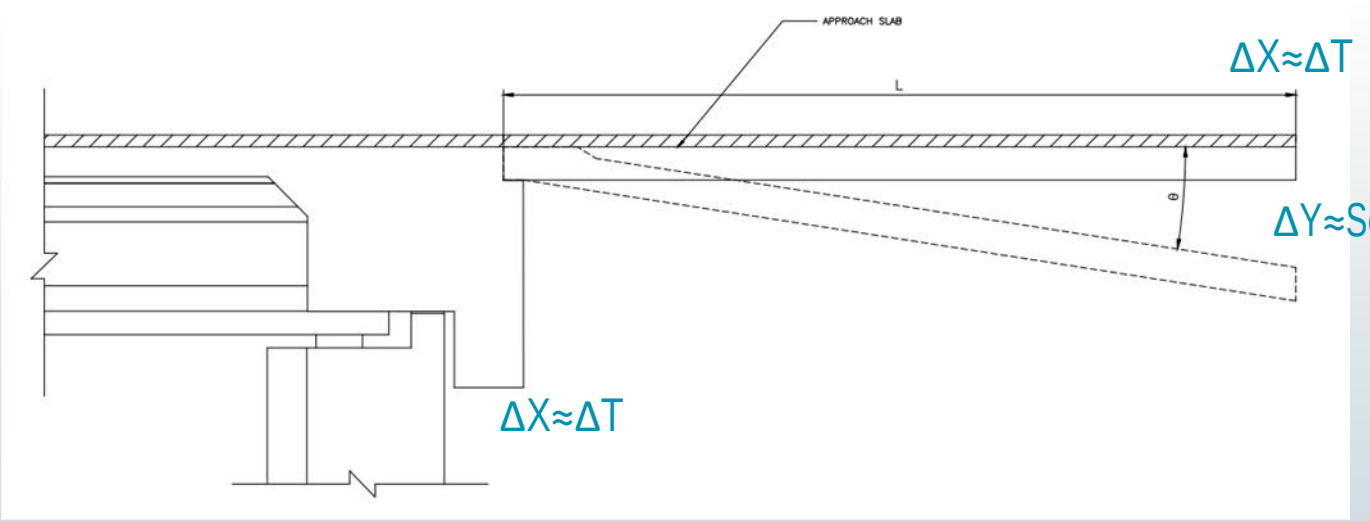
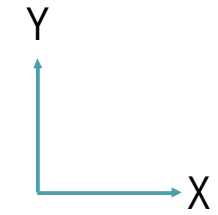
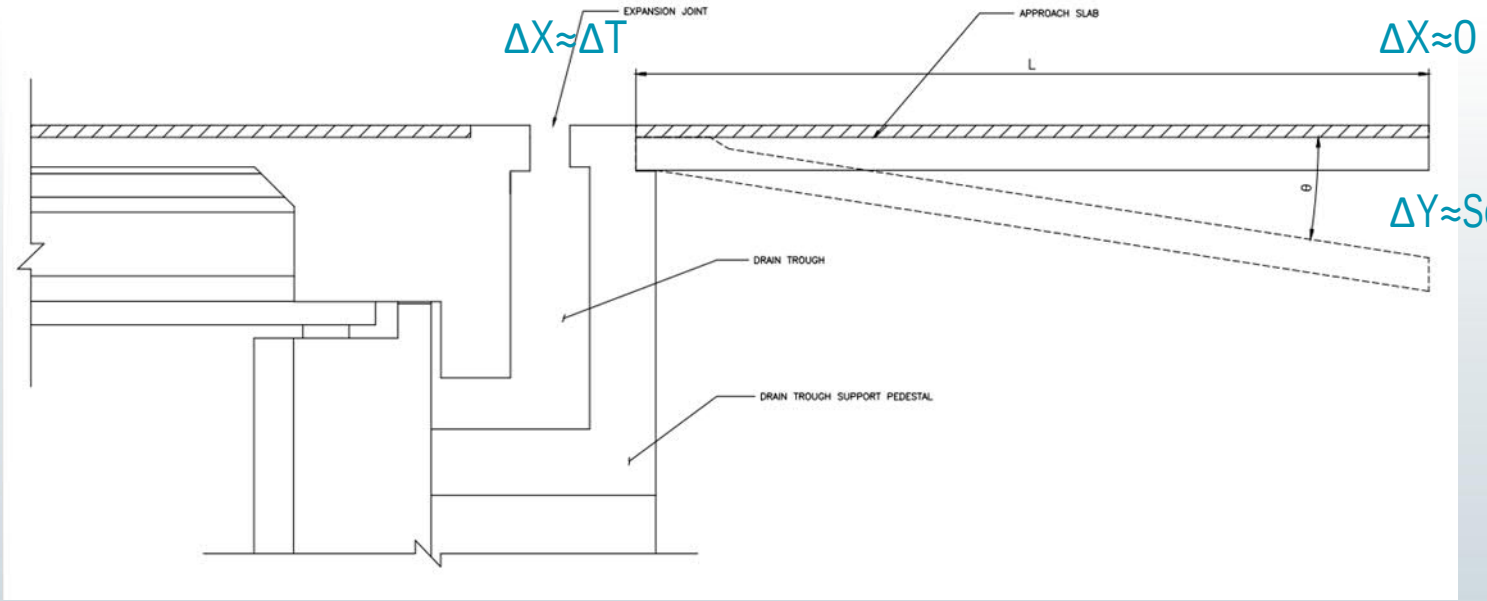
Design Alternative 4



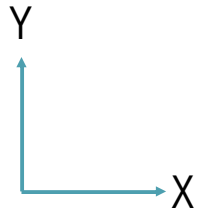


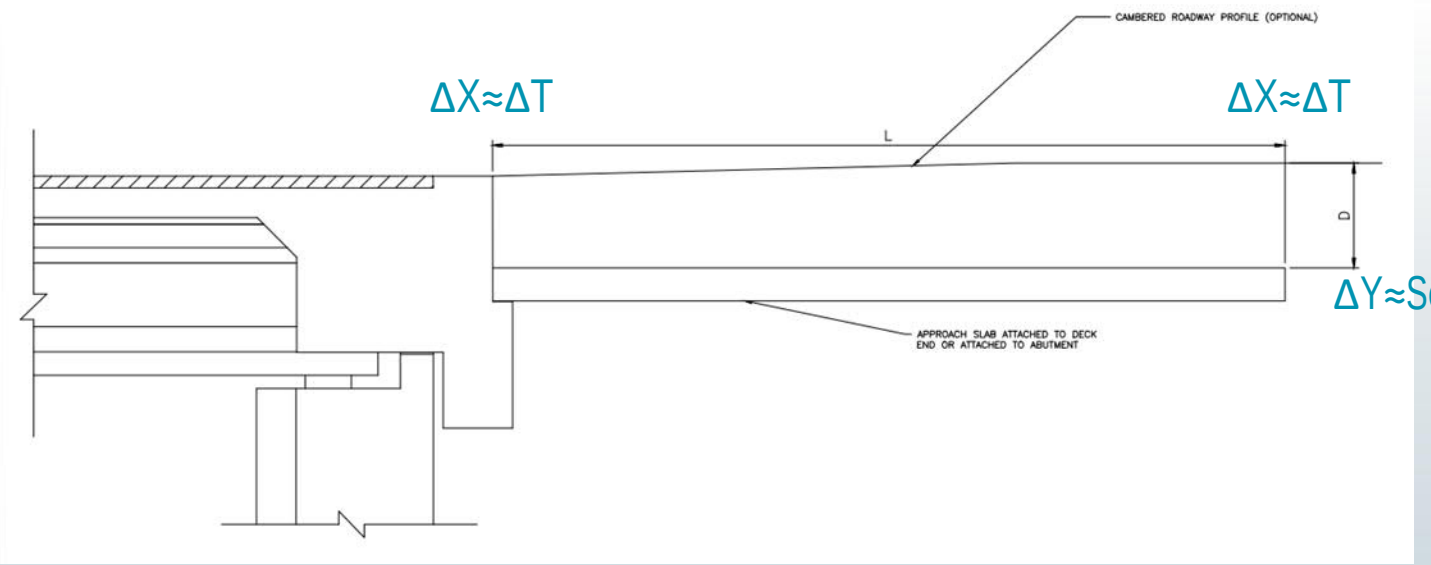
Design Alternative 5





Design Alternative 6





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