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H.L. Crow, L.C. Olson, R.P.M. Mulligan, T.J. Cartwright, and A.J.-M. Pugin

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Contents

1. Introduction 1
2. Field work 2
   2.1 Geophysical logging 3
3. Data processing 6
4. Observations from geophysical logs 6
   4.1 Key geophysical properties of the hydrostratigraphic units 6
   4.2 Fluid Temperature 10
5. Summary 11
6. Acknowledgements 13
7. References 13

Appendix A – Geophysical Log Suites 15

1. Introduction

The Ontario Geological Survey (OGS) is conducting a three-dimensional (3-D) Quaternary sediment mapping project in central Simcoe County as part of their provincial groundwater mapping initiative (Mulligan, 2014; 2015; 2016). The Geological Survey of Canada (GSC) is collaborating in this work through its regional Southern Ontario Groundwater Project (2014-2019; Russell and Dyer, 2016). Borehole geophysical logs and high-resolution seismic reflection profiles (74 line-km) were acquired by the GSC to better understand the *in situ* physical and chemical properties of the sediments, and their lateral variability across the study area.

Geophysical logs were collected in six PVC-cased sediment boreholes that range in depth from 30 – 140 m (Figure 1). This new data set complements existing data collected in Quaternary sediments of southern Ontario, published as part of a national compilation (Crow et al., 2015). Natural gamma and induction logs were acquired to investigate lithological variation within the sediments. Downhole seismic logs were collected using the GSC's Minivib source to investigate material velocities, and verify the conversion of seismic reflection time sections into depth sections. High-resolution fluid logs were recorded to identify temperature changes within each borehole, and regional groundwater trends across the study area.

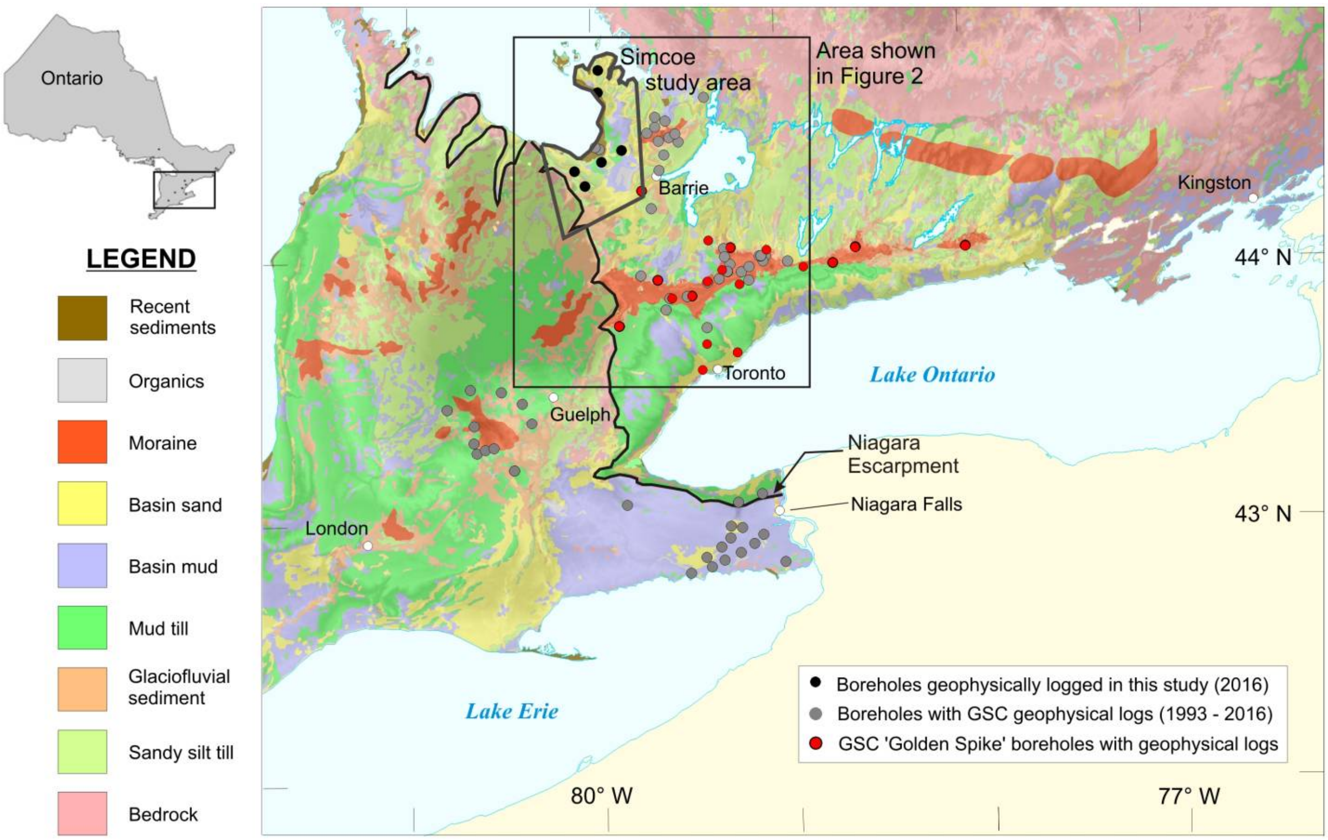

Figure 1. Locations of sediment boreholes geophysically logged by the GSC in Southern Ontario, including the six new boreholes logged in the Simcoe study area. Surficial geology modified from Barnett et al. (1991).

This Open File report documents the borehole geophysical logging conducted in 2016 in Simcoe County, and provides some preliminary log observations in the context of the regional hydrostratigraphic units identified in the study area. Figures of the log suites are provided at the end of this report in Appendix A, and log data are provided in an accompanying digital Appendix B. The seismic reflection profiles from this area will be published in an upcoming GSC Open File report.

2. Field work

In 2015 and 2016 the OGS drilled 14 continuously cored PQ (126 mm) boreholes in Simcoe County (Mulligan, 2016). Six of these boreholes were converted into monitoring wells to allow for geophysical logging, three of which are located on GSC seismic reflection lines (Figure 2, Table 1). The wells are cased with 2.5" (63.5 mm) diameter schedule 40 PVC, with a PVC 10 slot screen (ranging from 1.5 to 4 m in length) within each well. Filter sand was used around each screen and a bentonite-based grout was used to seal the wells. Details of the well completion are shown alongside the geophysical logs in Appendix A. The wells are currently maintained by the Nottawasaga Valley Conservation Authority (CS-15-03, -07, CS-16-01, -06) and the Severn Sound Environmental Association (CS-16-04, -05) as part of their groundwater monitoring networks.

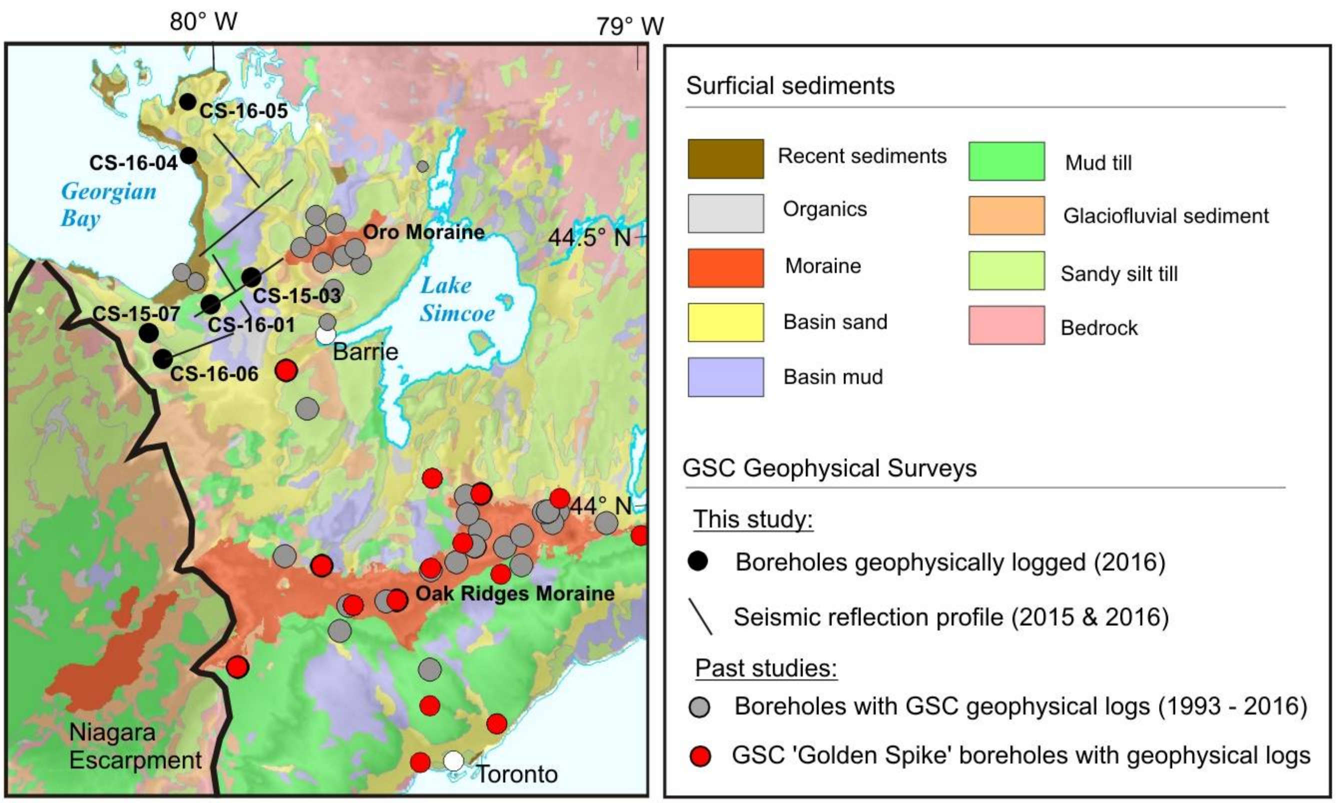

Figure 2. Locations of six geophysically logged boreholes and seismic reflection lines in County Simcoe.

Table 1. Boreholes geophysically logged in central Simcoe County.

OGS borehole name	UTM (Zone 17) Easting	Northing	Dates Geophysically Logged	Logged Depth (m)	Log Suite
CS-15-03	590 587	4 929 374	Oct 23-25, 2016	141.78	Gam, Cond, Mag, Temp, Vp, Vs
CS-15-07	570 354	4 920 160	Oct 27, 2016	30.66	Gam, Mag, Temp
CS-16-01	581 428	4 924 041	Oct 22, 25, 2016	96.70	Gam, Cond, Mag, Temp, Vp, Vs
CS-16-04	577 807	4 951 821	Oct 18-19, 2016	59.57	Gam, Cond, Mag, Temp, Vp, Vs
CS-16-05	577 815	4 962 960	Oct 18, 20-21, 2016	138.57	Gam, Cond, Mag, Temp, Vp, Vs
CS-16-06	573 347	4 913 449	Oct 24-26, 2016	86.09	Gam, Cond, Mag, Temp, Vp, Vs

Acronyms and abbreviations: Gam=natural gamma, cond=apparent conductivity, mag=magnetic susceptibility, temp=fluid temperature, Vp=compressional wave velocity, Vs=shear wave velocity.

2.1 Geophysical logging

Logging was carried out between October 18 and 27, 2016. Natural gamma, induction (apparent conductivity and magnetic susceptibility), and fluid temperature logs were acquired using a Mount Sopris logging system with a Matrix console and interchangeable downhole probes. A laptop computer recorded the data using Matrix Logger Software. The velocity logging was carried out using downhole geophone receiver arrays and the GSC's Minivib I as a seismic source (Figure 3). This non-standard application of the Minivib was used to ensure sufficient energy would reach the base of the deeper wells, given the complex velocity structure of the sediments. A brief description of logging parameters and the practical interpretation of each log are presented in Table 2.

Before running any instruments downhole, water level loggers were carefully removed, and water levels were measured and recorded. The first instrument run downhole was the fluid temperature tool in the undisturbed borehole fluid. The tool was lowered just below the water level, allowing the thermistor and electronics to stabilize in the borehole fluid for approximately 15-20 minutes before the logging was started. At the end of the run, the tool was brought to surface and a bailor of fluid from the top of the water column was recovered. A calibrated handheld fluid temperature probe and conductivity sensor (manufactured by Oakton) was immediately used to record the fluid temperature, conductivity (corrected to 25°C), and the corresponding frequency of the downhole temperature tool for later processing. Borehole fluid levels, temperatures and conductivities recorded at the well are provided in Table 3.

Gamma and induction tool data was then collected. On-site calibrations were carried out with the conductivity and magnetic susceptibility probes prior to each run using known calibration points (low point: 0 (null), and a high point for conductivity using calibration coils of 95 mS/m). All logs were corrected for sensor offsets and casing stick ups, and recorded relative to the ground surface. At the end of each field day, water levels were re-measured, and water level loggers replaced.

Velocity logging was carried out on a subsequent day due to required changes in equipment set-up. Downhole geophone receiver arrays were lowered to the bottom of the wells and pulled up hole at 1 metre spacings, where stationary readings were recorded. For the compressional (P-) waves, data were recorded using a 24-channel array of vertical hydrophones (spaced 0.5 m apart) in the water-filled portion of the borehole. Shear (S-) wave records were obtained on a separate run using a clamped, 3-

component downhole receiver with 15 Hz omni-directional geophones. This tool contains a magnetometer and rotating motor to orient the geophone block to magnetic north when the tool is clamped in place. The Minivib was driven as close to the borehole collar as possible, resulting in a source-collar offset of 3.85 to 3.90 metres at each borehole (Figure 3). For recordings at each depth, a signal containing frequencies of 20 to 200 Hz was transmitted into the ground over a 3.6 second sweep. The signal was correlated, reviewed on screen, and recorded as 0.4 second record using Geometrics Seismodule software.

In boreholes 16-01, 16-04, 16-05, 16-06, a high density till was identified during the core logging within 10-12 m of the ground surface. The Minivib motor creates noise in the very near surface, so to better quantify the velocities of this near-surface till, the Minivib was turned off and a hammer source striking an angled plate (designed for shear wave logging) was used to directly record travel times in the upper 20 m.

Figure 3. Velocity logging at borehole CS-15-03 using the GSC's Minivib as a high energy seismic source.

Table 2. Basic downhole geophysical log parameters.

Geophysical Log *[Manufacturer]*	**Logging Unit**	**Radius of Investigation**	**Logging Speed**	**Logging Interval**	**Practical interpretations**
Apparent Conductivity (EM39) *[Geonics/Mount Sopris]*	milliSiemens/ metre (mS/m)	0.3 m	3 m/min	0.02 m	Formation conductivity, (grain and/or pore water conductivity), lithological boundaries
Magnetic Susceptibility (EM39S) *[Geonics/Mount Sopris]*	parts per thousand SI (ppt SI)	0.3 m	3 m/min	0.02 m	Magnetite (heavy mineral) concentration, lithological boundaries
Natural Gamma (2SNA) *[Mount Sopris]*	Counts per second (cps)	0.3 m	1 m/min	0.01 m	Variation in grainsize and mineralogy, lithological boundaries
Fluid temperature *[GSC]*	(°C)	influenced by materials surrounding borehole	1.0 m/min	0.01 m	lithology (as related to thermal conductivity), anomalies due to groundwater flow
Compressional (P) Wave *[Pro-Seismic Services Ltd.]*	(m/s)	metres	Stationary readings	0.5 m	Relative sediment compaction, reflecting horizons
Shear (S) Wave *[Geostuff Ltd]*				1.0 m	

Table 3. Fluid temperature and conductivity from fluid samples recovered from top of water column on the day of geophysical logging. Water levels presented in metres below top of PVC casing (m btoc). Fluid conductivities corrected to 25°C. Five boreholes are screened in sediment and one borehole (CS-16-04) is screened in bedrock. A sample was not recovered in 16-05 due to water depth.

Borehole	Logging Date	Water Level	Fluid Temperature	Fluid Conductivity
		m btoc	°C	µS/cm
CS-15-03	23-Oct-2016	14.15	8.49	329
CS-15-07	27-Oct-2016	2.77	9.62	387
CS-16-01	21-Oct-2016	10.78	8.90	482
CS-16-04	18-Oct-2016	8.80	9.70	1124
CS-16-05	18-Oct-2016	78.55	-	-
CS-16-06	24-Oct-2016	29.12	8.80	470

3. Data processing

All log data were imported into WellCAD software (v5.1) for processing and interpretation. Induction logs were truncated where collected inside metal surface casings, but otherwise did not require post-processing. Upward and downward runs were overlaid to check for temperature drift and ensure repeatability.

For the velocity analyses, seismic recordings at each depth were merged separately to form a vertical seismic profile (VSP) for both P and S-wave datasets. Unfiltered multi-fold P-wave and single fold S-wave travel times were picked at the peak of the correlated seismic wavelet using a semi-automatic picking program (Ivanov and Miller, 2004). The picking program selects arrival times through pick-to-pick cross correlation using spline interpolation. The array of 24 vertical hydrophones (spaced at 0.5 m intervals) used for the P-wave logging (pulled up-hole at 1 m intervals) produced 12 travel times per depth, which were statistically analysed to calculate one average travel time per depth. The S-wave downhole instrument with one in-line horizontal geophone produced one travel time per depth. To calculate velocities, a three point weighted-average filter was applied to each travel time dataset, and interval velocities were computed using the difference in travel time (dT) between successive readings divided into the difference in depths (dZ) between recordings. The distance between the source and the downhole tool was computed using the hypotenuse of the tool depth downhole and the source-borehole collar offset.

Logs are displayed alongside one another as a complete suite to identify variations in downhole response. Water levels in the borehole and well completion details (screen depths, sand pack, seal positions and grout) were integrated into the log suite figures. Lithological information and preliminary hydrostratigraphic unit boundaries interpreted from core analyses were integrated into the figures (presented in Appendix A).

4. Observations from geophysical logs

4.1 Key geophysical properties of the hydrostratigraphic units

With some exceptions, the natural gamma and apparent conductivity logs have a relatively elevated response to clay-sized particles (< 2 micron) versus coarser grain sizes, while magnetic susceptibility is more positively influenced by the presence of sand. A unit rich in clay-sized particles containing clay minerals will have a more elevated gamma and conductivity response than one which contains clay-sized grains, but few clay minerals (e.g. rock flour from the Precambrian Shield). A sediment with a greater percentage of magnetic minerals (e.g. magnetite) will have a higher magnetic susceptibility response than a carbonate-rich sediment. Therefore, log response is strongly influenced by the mineralogy of the source material, the depositional setting, and the distribution of the grain sizes within the unit. As mineralogical data does not yet exist for these core samples, all references to clay in this report refer to clay-sized grains (< 2 micron).

In this context, the log responses are briefly discussed below in relation to six hydrostratigraphic units (aquitards and aquifers) defined in the study area by Mulligan (2016). The sediment packages described below are working definitions and may be refined in future with the acquisition of further data and analytical results. Representative images of the sediments are provided in Figure 4, and Table 4 indicates which units were intersected by the geophysically logged boreholes.

Table 4. Hydrostratigraphic units logged using the geophysical tool suite. A grey ☒ indicates where a unit is present, but less than 1 m thick.

	CS-15-03	CS-15-07	CS-16-01	CS-16-04	CS-16-05	CS-16-06
Glacial Lake Algonquin and Postglacial Deposits	✓	✓	✓	☒	✓	
Newmarket Till	✓	✓	☒	✓	✓	✓
Thorncliffe Formation Equivalents	✓	✓	✓		✓	✓
Lower Fine-Grained Till	✓		✓	✓	✓	
Lower Glaciolacustrine Deposits	✓		✓	✓	✓	
Lower Coarse-Grained Till	✓	✓	✓	✓		✓
Bedrock	✓	✓	✓	✓		✓

Bedrock

Five of the boreholes intersect a few metres of bedrock at the base of the well. In borehole CS-15-03 a Precambrian bedrock inlier (Easton and Carter, 1995) of the Grenville Province Central Gneiss Belt was intersected. The gamma response is elevated (~50 cps), as is the magnetic susceptibility (reaching 180 ppt SI) indicating a strong influence from heavy mineral content.

In the other boreholes, Paleozoic (Pz) bedrock is fine-grained Simcoe Group Ordovician limestone (Armstrong and Carter, 2010). Log response is low in the gamma (<10 cps) and conductivity (15-30 mS/m). Slightly higher gamma response (15-30 cps) in boreholes 15-07 and 16-06 to the west agrees with the intersection of the increasingly shale-rich upper part of the Lindsay Formation. Magnetic susceptibility is unvarying and low in all Pz bedrock (<5 ppt SI).

Lower Coarse-Grained Till (LCT)

The lower coarse-grained till unconformably overlies bedrock, and contains a high proportion of angular bedrock clasts. The till is characteristically massive and overconsolidated and contains abundant sand and large cobbles and boulders. The cobbles and boulders include relatively large quantities of Precambrian rocks, especially where the till overlies Precambrian inliers. Limestone clasts are typically gouged, faceted and striated (Mulligan, 2016).

Five of the six boreholes intersect this unit. Generally, the response of the gamma and conductivity logs tends to be low due to the presence of sand, cobbles and boulders. The magnetic susceptibility logs also tend to be low (5 – 10, occasionally reaching 20, ppt SI), but more elevated than the underlying carbonate bedrock (< 5 ppt SI) indicating the presence of Precambrian material incorporated into the till in varying quantities. The characteristic geophysical property of this unit is the elevated velocity, particularly in Vs which commonly reaches 1500 m/s. The top of this unit forms an impedance contrast with the overlying unit, producing a reflecting horizon in shear (Vs) modes.

This contrast in Vp does not increase as dramatically, potentially due to the presence of gas in some locations (Figure 4).

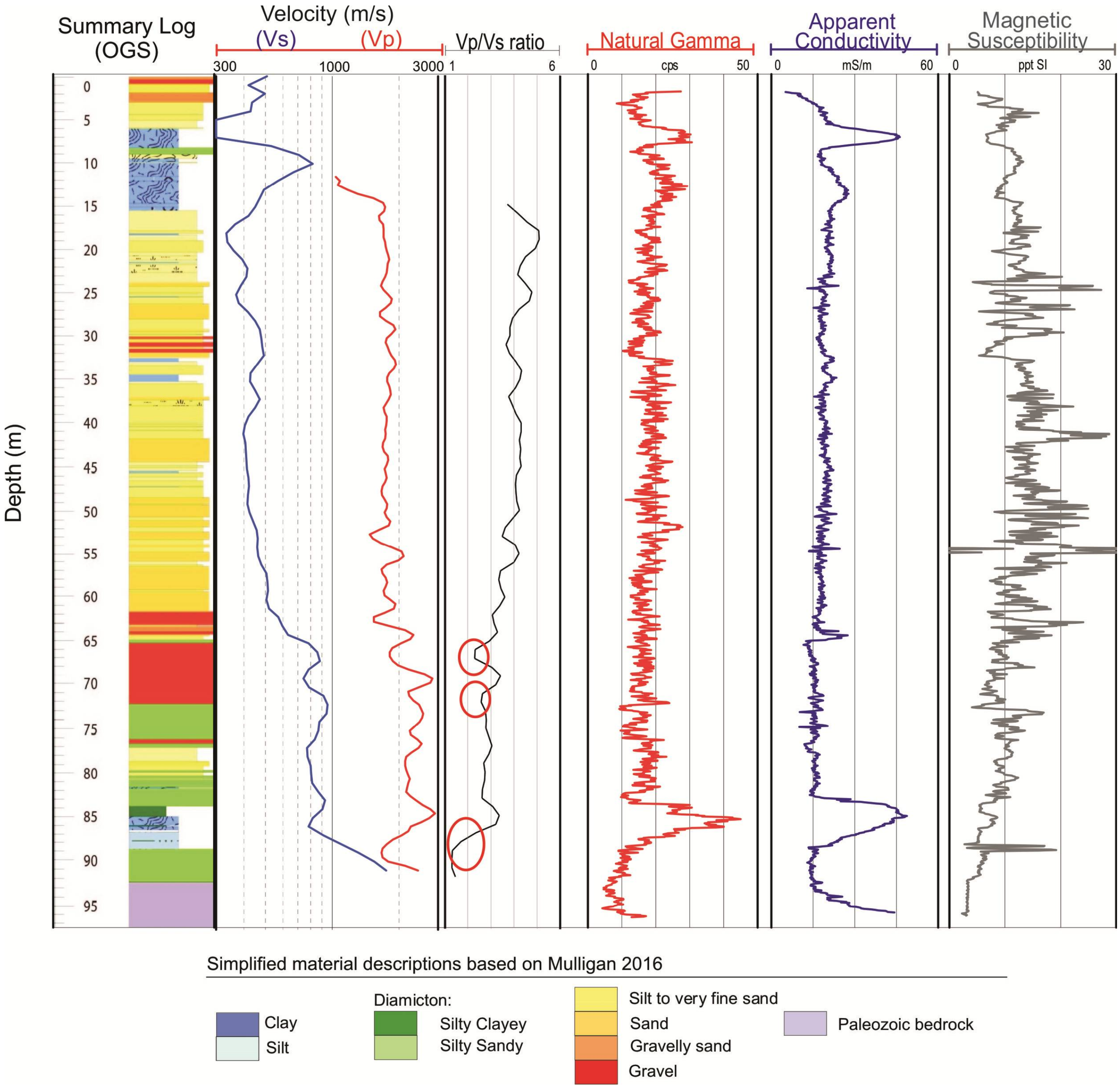

Figure 4. Log suite from CS-16-01. Circled intervals show where Vp decreases while Vs increases causing the Vp/Vs ratio to drop below 2. This effect may indicate the presence of gas.

Lower Glaciolacustrine Deposits (LGL)

The lower glaciolacustrine deposits are intersected in four boreholes, and the deposits range in grain size from rhythmically laminated silt and clay (CS-16-01 and CS-16-04) to sand (CS-15-03) to cobble-rich gravel or all of the above (CS-16-05). Geophysical logs suggest the unit gently coarsens upward in these wells, however, vertical grain size and facies relationships at a regional scale are complicated, and at present, are incompletely understood. With the exception of clayey intervals in the base of 16-

01 and 16-05 which display a relatively elevated gamma (40 - 50 cps) and conductivity (50 - 60 mS/m) response, the laminated silts and clays in this unit produce relatively subdued gamma (<30 cps) and conductivity (<40 mS/m) responses, suggesting a predominantly silty sediment. In CS-15-03, the unit has an elevated and highly varying magnetic susceptibility response indicating a more active depositional setting with sands containing heavy minerals. A significant temperature anomaly is seen within and below the screened interval coincident with the sand interval previously noted. However, the unit also appears somewhat silty, as conductivity is moderate (~25 mS/m, i.e. not a clean sand).

Velocities in this unit tend to be relatively stable through the finer grained sediments (Vp ~1800-2200 m/s, Vs ~500-600 m/s, Vp:Vs ratio ~3) but can fluctuate in the presence of till and gravel.

Lower Fine-Grained Till (LFT)

Lower fine-grained till is intersected in four boreholes, and is quite variable in thickness from 4 to 30 m. The unit has a consistent composition of clayey to sandy silt till which is typically massive, highly consolidated to overconsolidated, and contains many granules and pebbles, with fewer cobbles and boulders.

In boreholes CS-16-01, -04, and -05, the conductivity response is relatively elevated (45 mS/m) in the clayey silty diamicton relative to the other units, forming a distinguishing geophysical property. A clay interval in this unit seen in 16-01 and 16-04 produces the most elevated gamma (40 cps) and conductivity responses (45 - 60 mS/m) within the boreholes. In borehole 15-03, the unit is dominated by coarser grained tills and gravels, and the conductivity and gamma responses are low.

The contrast in velocities at the top of the LFT in 15-03 forms a distinct acoustic impedance boundary, which creates a high-amplitude and continuous reflecting horizon in the seismic profiles.

Thorncliffe Formation Equivalents (TF)

Thorncliffe Formation equivalents is intersected in five of the six boreholes. The unit can be grouped into fine- and coarse-grained sediment facies. The fine-grained facies seem to overlie, and are partially interbedded with, the coarse-grained facies. The coarse-grained facies form thick successions of interbedded, generally upward fining sand and gravel with some silt. The fine-grained facies are either rhythmically laminated, or deformed clayey silt with ice-rafted debris.

In the finer-grained facies, the gamma and conductivity are relatively elevated in contrast to the coarser grained intervals, but as both facies contain silt, the transitions appear gradational. The presence of coarse sand tends to produce an elevated and highly varying magnetic susceptibility response, particularly evident in 16-01. Temperature anomalies in the coarser grained facies are seen in 16-01 and 16-06. Velocity increases at the top of the gravels in 16-01, 16-05, and 16-06 form a significant acoustic impedance contrast, creating high-amplitude reflecting horizons in the seismic profiles.

Newmarket Till (NT)

Based on core recovery and observation, a widespread and highly consolidated to overconsolidated till, (interpreted conditionally to be the Newmarket Till) is intersected in all the boreholes. It is massive with few stratified interbeds and a silty to sandy composition. To the north, it is typically coarser with more Precambrian content and its composition is more variable than to the south in

Simcoe County and the Greater Toronto Area (Sharpe et al., 2002; Bajc et al., 2014). The magnetic susceptibility log reflects this observation as log response can be quite variable within the unit, and from hole to hole, but average values are generally more elevated in the north end of the study area versus intervals of NT logged to the south. Gamma and conductivity logs in this unit are low and unvarying relative to the other units.

The most characteristic property of the NT regionally throughout southern Ontario is its elevated velocity (e.g. Pugin et al., 1999; Pullan et al., 2002; Crow et al., 2017). In four of the five boreholes where velocity logs were collected, this unit is identified in core above borehole fluid levels, allowing for only the collection of Vs. In 16-01, an interval of 1 m is logged between 8.1 and 9.1 m. The unit does contain one elevated shear wave data point (990 m/s), and the gamma and conductivity logs are characteristically low, but this is a thin unit, and hence, difficult to assess. In 16-04 and 16-05 elevated Vs values are within (and in the case of 16-04, exceed) the expected range of NT Vs values measured in other boreholes in southern Ontario where NT is identified (Crow et al., 2017). In 16-06, velocities are elevated in an interval of sandy till between 5 – 9 m with corresponding drops in gamma and conductivity. From 9 m to the base of the unit at 27 m, the velocities are below the expected range for a high velocity (Newmarket) till. Similarly, in 15-03, Vs and Vp and the Vp/Vs ratio of the interval interpreted as NT are below the expected ranges for this material.

Glacial Lake Algonquin and Postglacial Deposits

The silt and clay size-rich laminated sediments of glacial Lake Algonquin and postglacial deposits are commonly capped by stratified sands and gravels. The gamma and conductivity log responses tend to be elevated in this unit when sediments rich in clay-sized particles are present (15-03, 16-01, 15-07). It is otherwise difficult to characterize geophysically, as it is thin and very near surface.

4.2 Fluid Temperature

All boreholes were logged after several months (up to a year) of temperature equilibration following drilling. Although water level loggers were removed in the upper few meters of the water column on the day of logging, the fluid was otherwise undisturbed by recent monitoring activities (e.g. pumping, sampling) in the weeks preceding the logging.

Fluid temperature logs from all 6 boreholes are displayed relative to depth below ground surface in Figure 5. Regionally, fluid temperature trends increase from east to west by approximately 1.5°C (7.6 to 9.1°C). Individually, logs tend to be stable through units of low permeability, but often show fluid anomalies (up to 0.25°C) in intervals where gravel and coarse sands are present indicating fluid flow (recharge) occurring within the sediments.

Fluid samples taken from the top of the water column in five of the six boreholes were tested with a handheld conductivity meter (Table 3). In the four boreholes cased in sediment, fluid conductivity was less than 500 µS/cm (and less than 400 µS/cm in the 15-series boreholes). In the borehole screened in bedrock (16-04), the fluid conductivity was 1124 µS/cm.

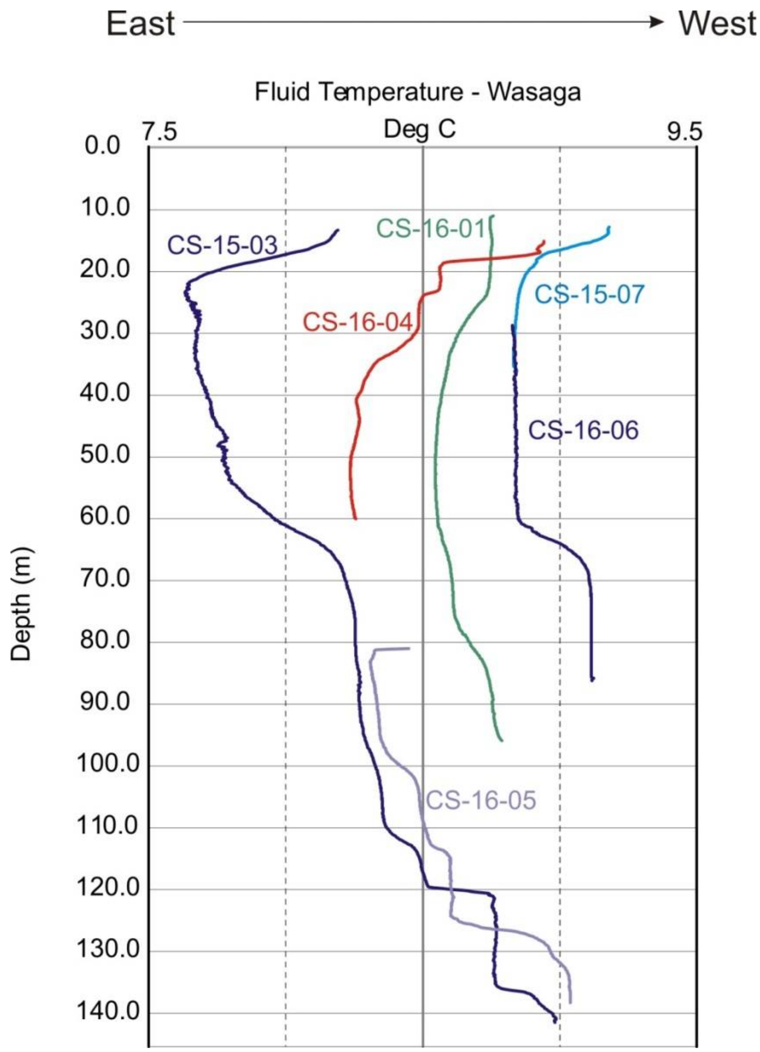

Figure 5. Fluid temperature logs from all 6 boreholes in Simcoe County. Regionally, logs indicate a warming trend from east to west.

5. Summary

Geophysical logging was carried out in six PVC-cased boreholes to investigate the physical and mineralogical properties of Quaternary sediments within the Laurentian Channel in Simcoe County. This report presents log figures and digital data from the logging carried out in October 2016.

A number of preliminary observations are made from the logs:

- Geophysical logs, displayed alongside the sediment descriptions, have natural gamma, apparent conductivity and magnetic susceptibility (litho-log) signals that identify variation between sediments rich in clay-sized particles (elevated conductivity and gamma response) versus those with elevated sand content (elevated magnetic susceptibility response). Silt-rich units also produce elevated responses in the conductivity/gamma logs relative to clean sands (but lower than clays);

- Litho-logs have log response-grainsize relationships that help define aquitard versus aquifers, and have some characteristic geophysical properties within the hydrostratigraphic units identified across the site. The interpretation of NT requires velocity logs.

- Litho-logs also identify subtle upward coarsening or fining trends, and the nature of the transition between units (gradational vs erosional);

- The relatively elevated (25-30 ppt SI) and highly varying magnetic susceptibilities in the boreholes intersecting the coarse grained sediments of the Thorncliffe Formation contain elevated levels of heavy minerals which reflect sediment transport, separation and concentration within specific bedforms. Temperature anomalies are often observed in these coarse grained sand intervals;

- Highly variable velocity logs (Vp, Vs) indicate a complex velocity structure exists within the Quaternary sediments. Significant velocity contrasts are seen at boundaries between higher velocity gravels or consolidated tills and other lower velocity materials (clays, silts, sands), which can occur within hydrostratigraphic units. Therefore, velocity and litho-logs are together needed for stratigraphic interpretation;

- Near surface (<100 m) borehole fluid temperatures increase regionally from east to west by approximately 1.5°C. Anomalies up to 0.25°C within individual wells suggests groundwater movement (recharge) in coarse-grained sediments may be occurring at several horizons.

Follow up research could involve:

- Further examination of the velocity logs and their Vp:Vs ratios in the context of other measured velocities in Quaternary sediments of southern Ontario. Velocity ratios have potential to assist in the glacial reconstruction of the region, and also to distinguish between high velocity tills which are otherwise difficult to distinguish geophysically;

- Characterizing the mineralogical properties of the sediment and bedrock in the region, using results from grain size and heavy mineral analyses, portable x-ray fluorescence (pXRF) data, and Chittick analyses. These results would better constrain the interpretation of geophysical properties of the hydrostratigraphic units;

- Further analyses of fluid temperature logs looking at groundwater movement in the sediments surrounding the boreholes. These data could be integrated into existing conservation authority datasets (groundwater chemistry, temperature, water level variation, and flow models) to investigate fluid flow through the sediments.

Preliminary analyses of the logs indicate that the gamma, induction, velocity, and fluid logs together provide useful, qualitative information which can help to characterize hydrostratigraphic units found within central Simcoe County. This information, and future analyses of this dataset, will contribute toward the 3D sediment mapping project and groundwater studies underway in the region.

6. Acknowledgements

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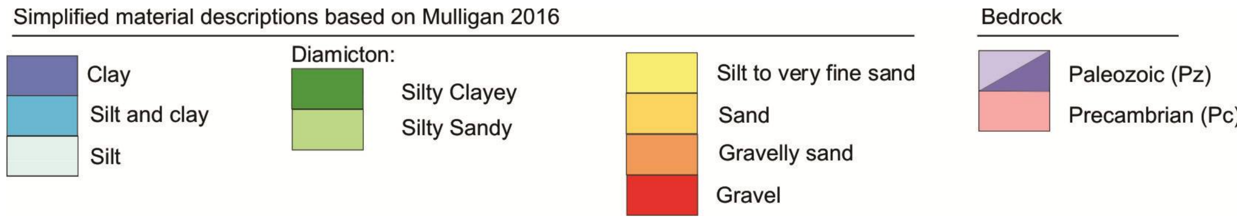
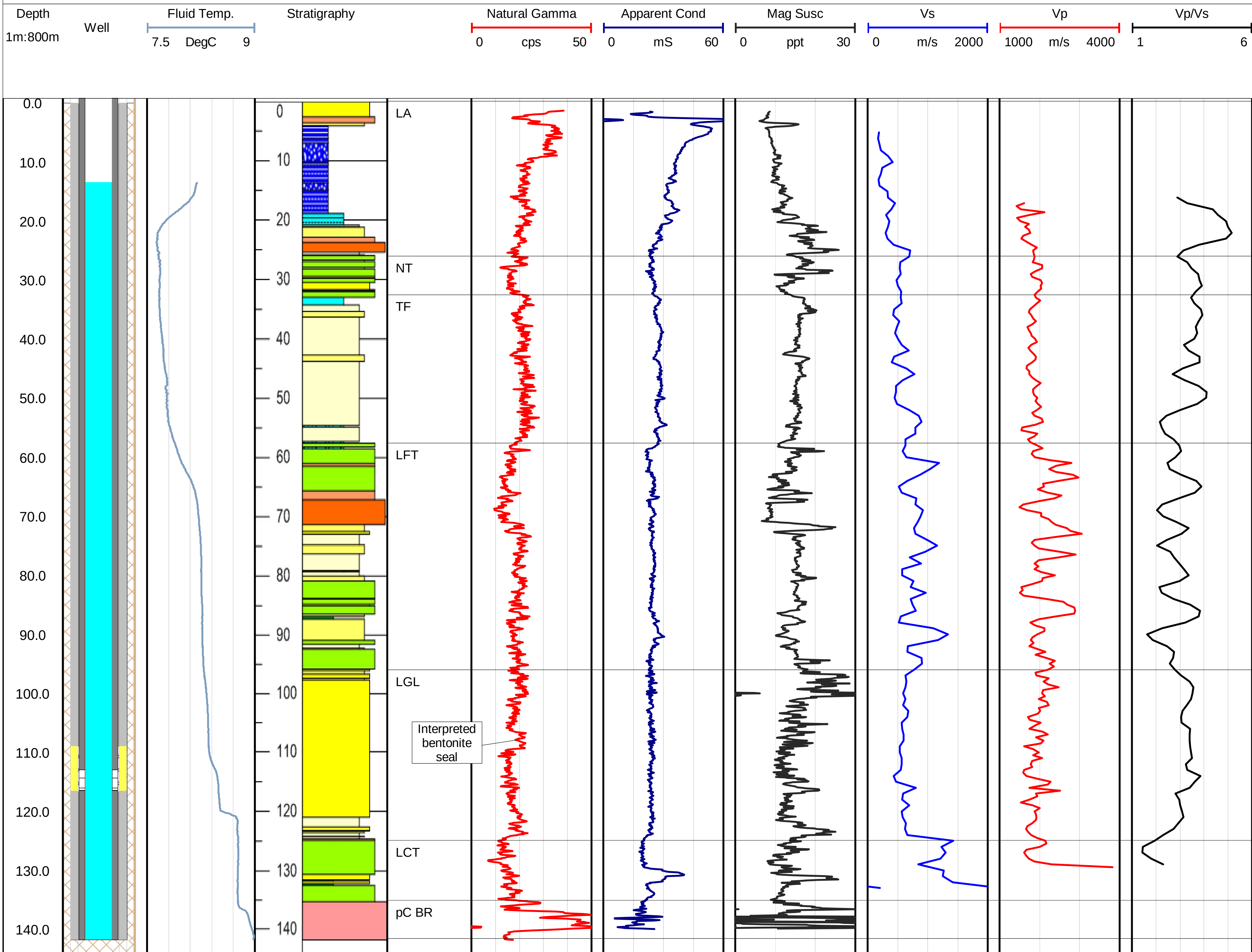
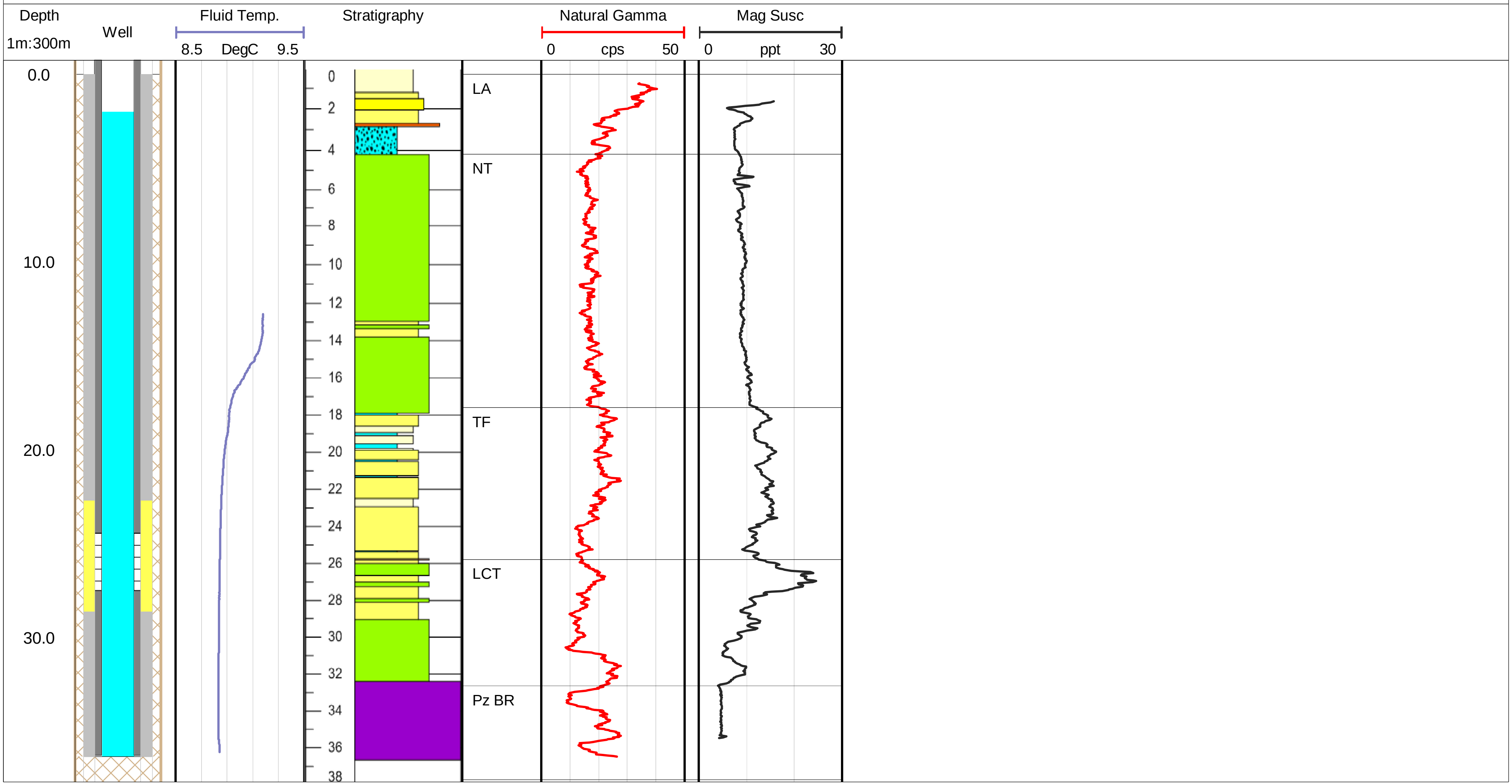
Appendix A – Geophysical Log Suites



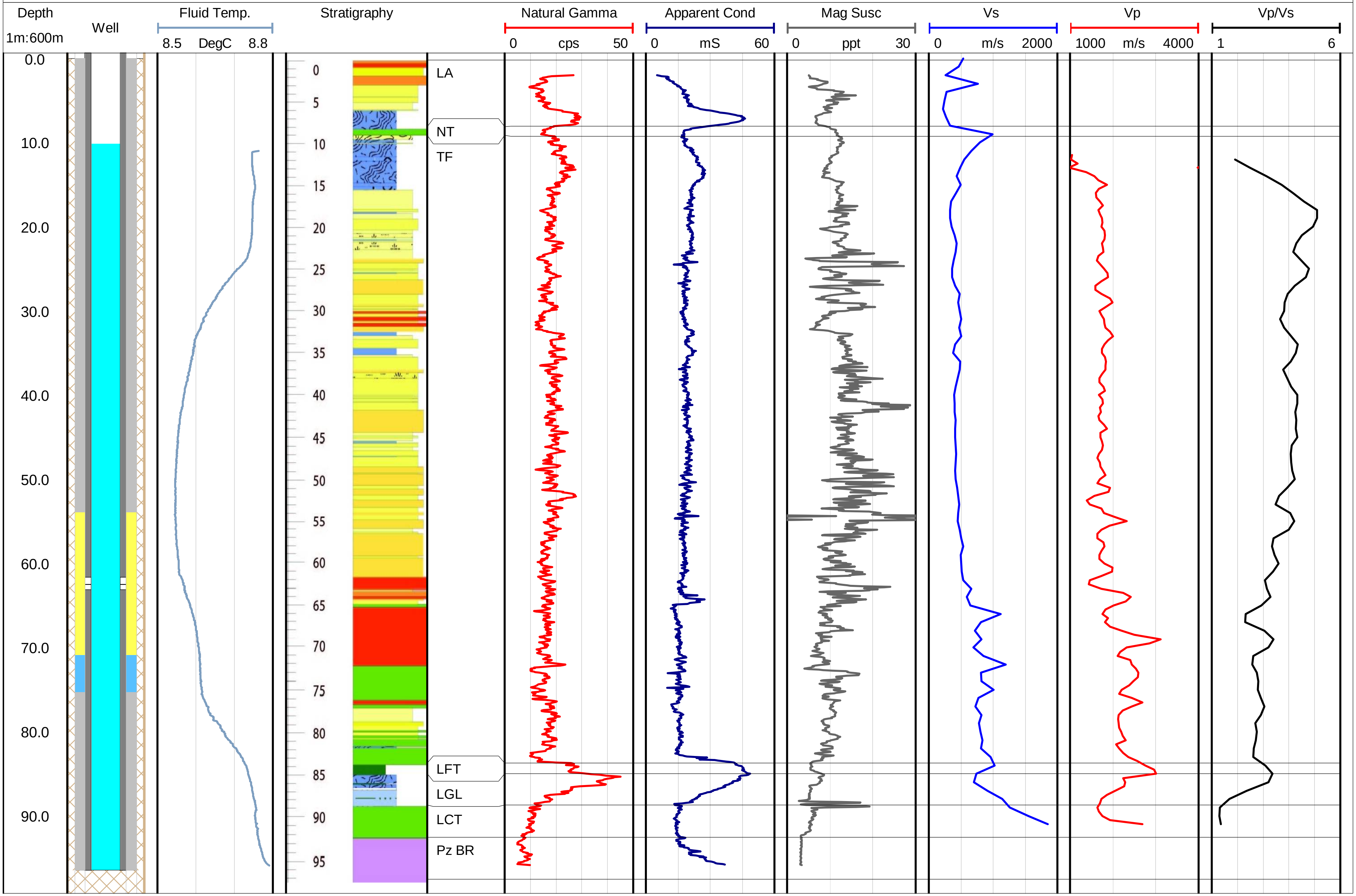
Borehole:	CS-15-03	Easting:	590 587 m	Date Drilled:	2015	Date Logged:	Oct 23-25, 2016
Location:	Phelpston, ON	Northing:	4 929 374 m	Hole Dia:	126 mm	Water Level:	13.39 m bgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.76 m	Depth Referece:	Ground Surface



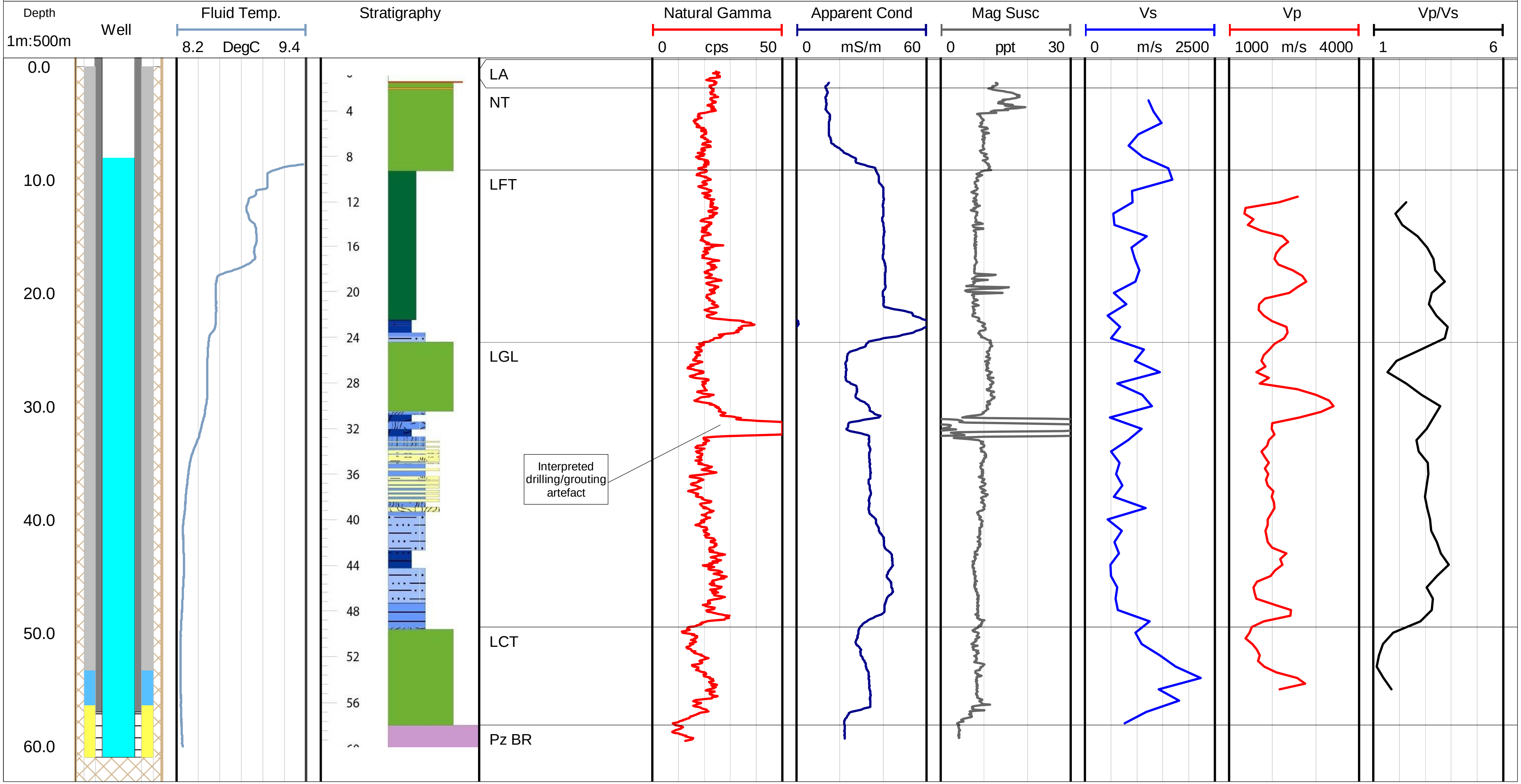
Borehole:	CS-15-07	Easting:	570 354 m	Date Drilled:	2015	Date Logged:	Oct 27, 2016
Location:	Stayner, ON	Northing:	4 920 160 m	Hole Dia:	126 mm	Water Level:	2.02 m bgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.75 m	Depth Referece:	Ground Surface



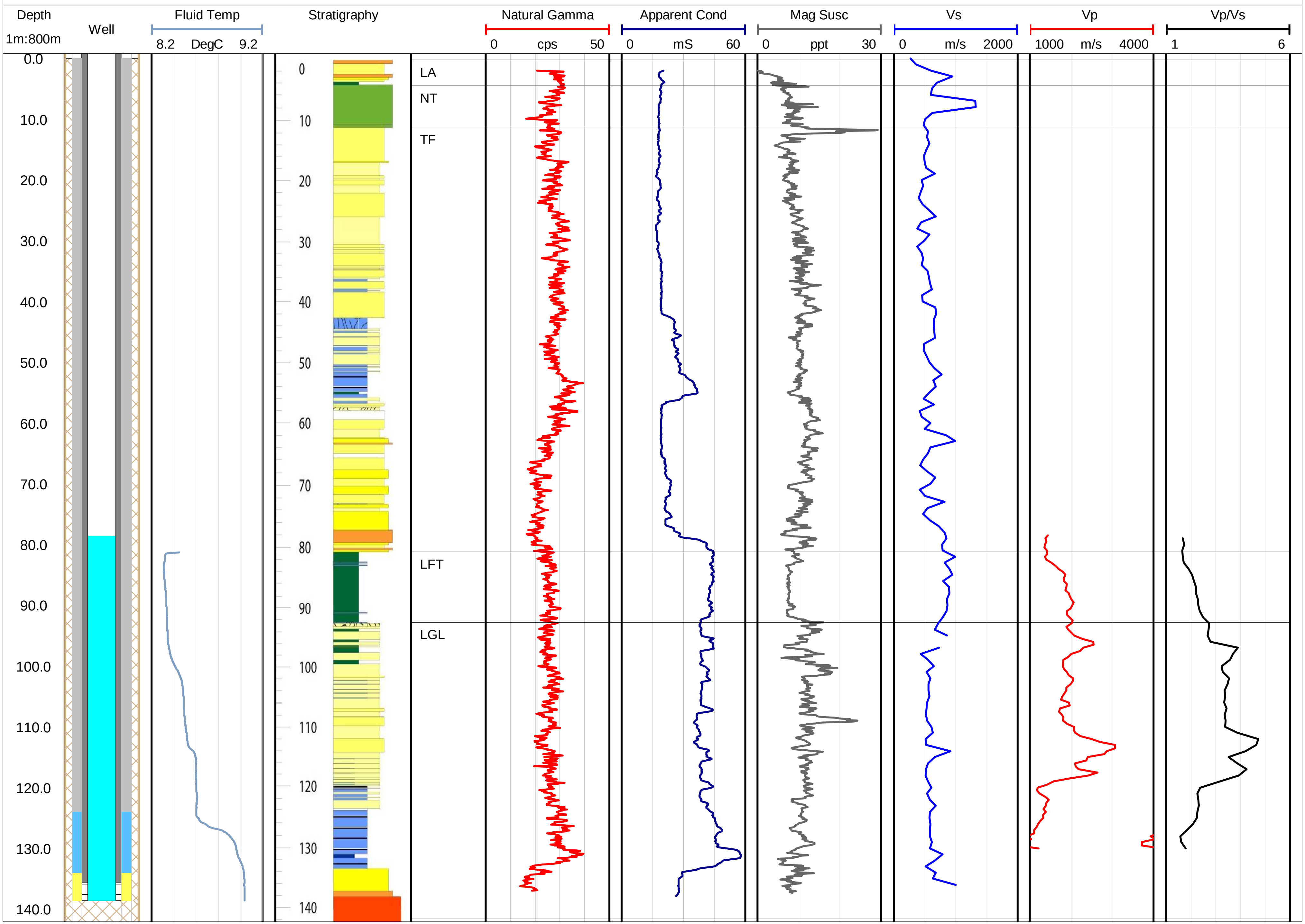
Borehole:	CS-16-01	Easting:	581 428 m	Date Drilled:	2016	Date Logged:	Oct 22, 25, 2016
Location:	Wasaga Beach, ON	Northing:	4 924 041 m	Hole Dia:	126 mm	Water Level:	10.14 m bgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.64 m	Depth Referece:	Ground Surface



Borehole:	CS-16-04	Easting:	577 807 m	Date Drilled:	2016	Date Logged:	Oct 18-19, 2016
Location:	Midland, ON	Northing:	4 951 821 m	Hole Dia:	126 mm	Water Level:	8.05 m bgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.75 m	Depth Referece:	Ground Surface



Borehole:	CS-16-05	Easting:	577 815 m	Date Drilled:	2016	Date Logged:	Oct 18, 20-21, 2016
Location:	Midland, ON	Northing:	4 962 960 m	Hole Dia:	126 mm	Water Level:	78.55 m bgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.79 m	Depth Referece:	Ground Surface



Borehole:	CS-16-06	Easting:	573 347 m	Date Drilled:	2016	Date Logged:	Oct 24-26, 2016
Location:	Stayner, ON	Northing:	4 913 449 m	Hole Dia:	126 mm	Water Level:	28.35 mbgl
Project:	Groundwater Assessment	UTM Zone:	17	Casing Dia:	63.5 mm	Logged By:	GSC
Study Area:	County Simcoe, ON	Datum:	NAD83	Casing Stick-up	0.77 m	Depth Referece:	Ground Surface