

# FRONTIER GEOSCIENCES INC.

## MULTI-CHANNEL ANALYSIS OF SURFACE WAVES SURVEY REPORT MOTION HAZARD MAPPING PROJECT FORT ST. JOHN & DAWSON CREEK, BC

Submitted to:  
**Geoscience BC**  
August 10, 2017

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Project: FGI-1490

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### 1. Introduction

During the period of April 21 to April 23, 2017, Frontier Geosciences Inc. carried out a multi-channel analysis of surface waves (MASW) investigation for Geoscience BC in Fort St. John and Dawson Creek, B.C. Four of the sites were located within Fort St. John, a site plan showing the locations of the Fort St. John lines is presented at a 1:25,000 scale in Figure 1 of the Appendix. The remaining two survey sites were located within Dawson Creek with the exact locations, displayed in a site plan in Figure 10, at a scale of 1:50,000 in the Appendix.

The purpose of the geophysical survey was to determine shear wave velocity information of the subsurface materials, at each of six individual site locations. A total of 705 metres of MASW data was collected along six separate seismic lines.



*Example of computer setup on MASW Line SL-1*

## **2. Multi-Channel Analysis of Surface Waves (MASW)**

### **2.1 Survey Equipment**

The MASW investigation was carried out using two Geometrics, Geode, 24 channel, signal enhancement seismographs and Oyo Geo-Space, 10 Hz geophones. Geophone intervals along the multicored seismic cable was maintained at 2.5 metres in order to ensure high resolution data on subsurface layering. For this survey the active source mode was utilised, with a sledgehammer striking a steel plate, providing the seismic signal energy.

### **2.2 Survey Procedure**

Field procedure entailed setting out two 24 channel geophone cables in a straight line and implanting the geophones. The line was traversed with the sledgehammer source, moving progressively down the array of geophones. The seismic source was operated at each individual shotpoint and 48 channels of data were recorded digitally with the seismograph. The record lengths were planned to be sufficiently long to capture the full surface wave train. For quality assurance, field inspection of raw data after each shot was carried out, with additional shots recorded if first arrivals were unclear. Data recorded during field surveying operations was generally of good to excellent quality.

### **2.3 Interpretive Method**

Interpretation of the MASW data involves a wavefield transformation of the seismogram record. This converts the seismogram from a multichannel shot gather to a dispersion curve that shows the phase velocity of the signal as a function of frequency. The fundamental event is picked on the dispersion curve and this data is inputted into the Geopsy modelling program for inversion. The resulting model reveals the shear wave layer velocity structure, and is plotted at the centre of picked geophone array. The individual models produced are then gridded together to produce a shear wave velocity depth section along the survey lines.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features. Relative elevations along the seismic lines were recorded by chain and inclinometer.

### **3. Geophysical Results**

#### **3.1 General**

The interpreted results of the MASW lines are illustrated in profile in Figures 3, 5, 7, 9, 12, and 14, at a scale of 1:500, in the Appendix. Corresponding individual site plans for each location are displayed at a scale of 1:1,000 in Figures 2, 4, 6, 8, 11 and 13. The shear wave velocity data is displayed as colour contours on these profiles with warm colours indicating higher values and cool colours indicating lower values. MASW lines SL-1, SL-2, SL-5 and SL-6 were located in Fort St. John. While MASW lines SL-3 and SL-4 were located in Dawson Creek. Examples of the raw seismic data together with the corresponding dispersion curve are presented in Figures 15 to 17 in the Appendix.

#### **3.2 Discussion**

MASW line SL-1 is located in Fort St. John, northeast of the Fort St. John Hospital parallel to 112<sup>th</sup> Ave. The interpreted MASW results for the line, displayed in Figure 3 of the Appendix, show increasing shear wave velocities with depth, ranging from approximately 200 m/s at the surface to a maximum approximately 900 m/s at 30 metres depth. Over the section, shear wave velocities steadily increase from a surficial average range of 275 m/s to 550 m/s at an average depth of approximately 8 m. These velocities are consistent with nearby drillhole intersections of with stiff to hard, clay till. Below an average of 8 m depth velocities continue to increase from 550 m/s to an average of 850 m/s at depth. These velocities likely correspond to on the onset of weathered shale bedrock. Higher velocities in this layer may be indicative of more competent sedimentary bedrock, underlying the weathered shale.

Figure 5 displays the interpreted MASW section for line SL-2. SL-2 is located in Fort St. John along 94<sup>th</sup> Ave, north of the Fort St. John Fire Station and east of the Pomeroy Sport Centre. The results of the MASW line illustrate a thick surficial layer with velocities averaging approximately 160 m/s. With an average thicknesses of 9 metres, this layer is consistent with nearby drillhole intersections of silty clay. Underlying this low velocity surficial layer shear wave velocities increase from 250 m/s at 9 m depth to around 750 m/s at approximately 18 metres. These higher shear wave velocities likely corresponds to an increase in sediment density or compaction, or possibly, the onset of bedrock. The lower 10 m of the section shows a relatively uniform shear wave of approximately 875 m/s, consistent with sedimentary bedrock.



Line SL-5 interpreted MASW section is displayed in Figure 7 in the Appendix. The survey line is located at the northern end of the Northern Lights College Campus in Fort St. John and intersects NRCan seismograph station NBC7 at the northwestern end of the line. Velocity contours generally follow topography and similar to the other sites, increase in velocity with depth. The shear wave velocities range from approximately 170 m/s at the surface to a maximum of approximately 730 m/s at depth. The velocities gradually increase with depth reaching 550 m/s at a depth of approximately 15 m. The lower 15 m of the section shows a gradually increasing shear wave velocity of with an average of approximately 700 m/s.



*SL-5 at Northern Lights College and NRCan Seismograph NBC7*

Figure 9 displays the interpreted MASW section for line SL-6. Line SL-6 is located in Fort St. John at the north end of the Ma Murray School site. The results of the MASW line illustrate increasing shear wave velocities with depth, ranging from a minimum of approximately 170 m/s at the surface to the 550 m/s contour at approximately 18 metres depth. Velocities in this zone are consistent with drillhole intersections of firm to stiff silt and clay. Below 20 m depth velocities continue to increase from 550 m/s to a maximum of approximately 750 m/s at depth. These velocities likely correspond to the onset of weathered shale bedrock. Higher velocities in this layer may be indicative of more competent sedimentary bedrock, underlying the weathered shale.

MASW line SL-3 is located in Dawson Creek just south of the 10<sup>th</sup> Street Bridge in Kin Park. Section SL-3, displayed in Figure 12, shows the most gradual increase in shear wave velocities of the lines surveyed with the interpreted shear wave velocities of 200 m/s at the surface to the 550 m/s contour at an average depth of 27 metres. These velocities are indicative of stiff soils and correspond to nearby drillhole intersections of clay till. The higher shear wave velocities below this depth are still consistent with overburden materials, however the increased velocity indicates an increased level of compaction or possibly weathered bedrock.

Located in the northern edge of Dawson Creek city, north of the Frank Ross School and south of the Alliance Church, is MASW line SL-4. Figure 14 shows the interpreted profile for this line, which displays shear wave velocity contours that continuously increase with depth, to approximately 12 metres. Velocities in this layer increase from a minimum of 170 m/s at the surface to the 550 m/s contour and can be correlated with very dense compact clays, with higher velocities possibly indicative of weathered shale or claystone. Beneath the 550 m/s velocity contour, the shear wave velocities still increase with depth, but at a much slower rate and reach a maximum of approximately 785 m/s at around 30 m depth.

#### **4. Limitations**

The multi-channel analysis of surface waves (MASW) method is carried out in the Active or Passive mode with the Active mode generally the most accurate for evaluation of shallow, shear wave velocities. Limitations include reflection and scattering of surface and body waves due to extreme surface topography and in-homogeneous conditions in the subsurface such as boulder concentrations or isolated soil lenses with contrasting properties. The method is generally accepted as an effective means of determining shear wave velocities of geological units.

The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the multi-channel analysis of surface waves method.

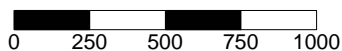
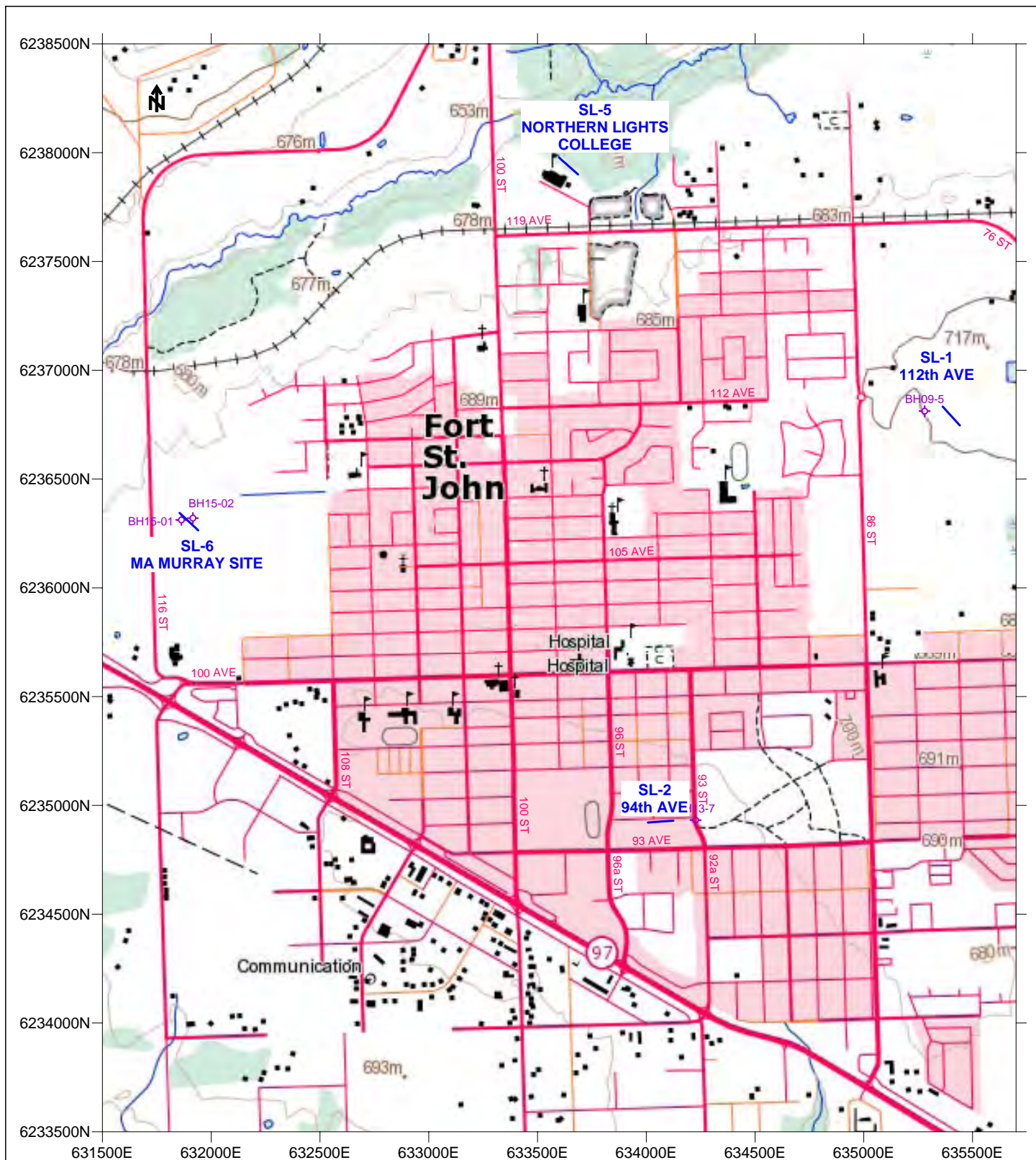
For: Frontier Geosciences Inc.

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**APPENDIX**



METRES

GEOSCIENCE BC  
FORT ST. JOHN, BC

MASW SURVEY

FORT ST. JOHN  
SITE PLAN

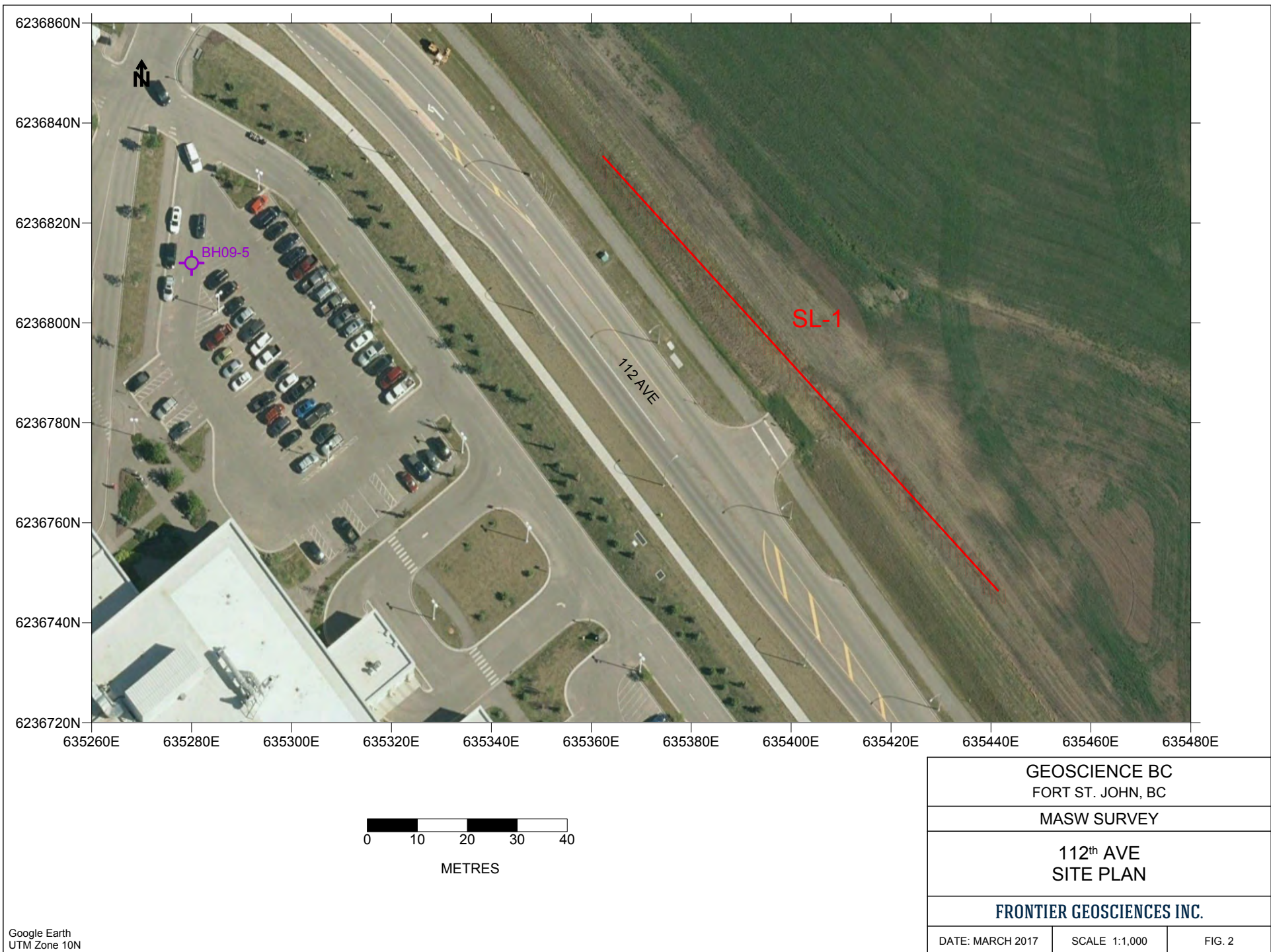
FRONTIER GEOSCIENCES INC.

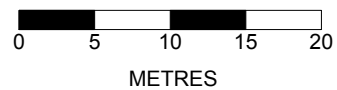
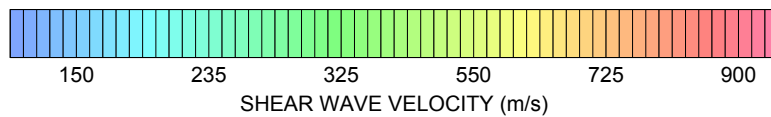
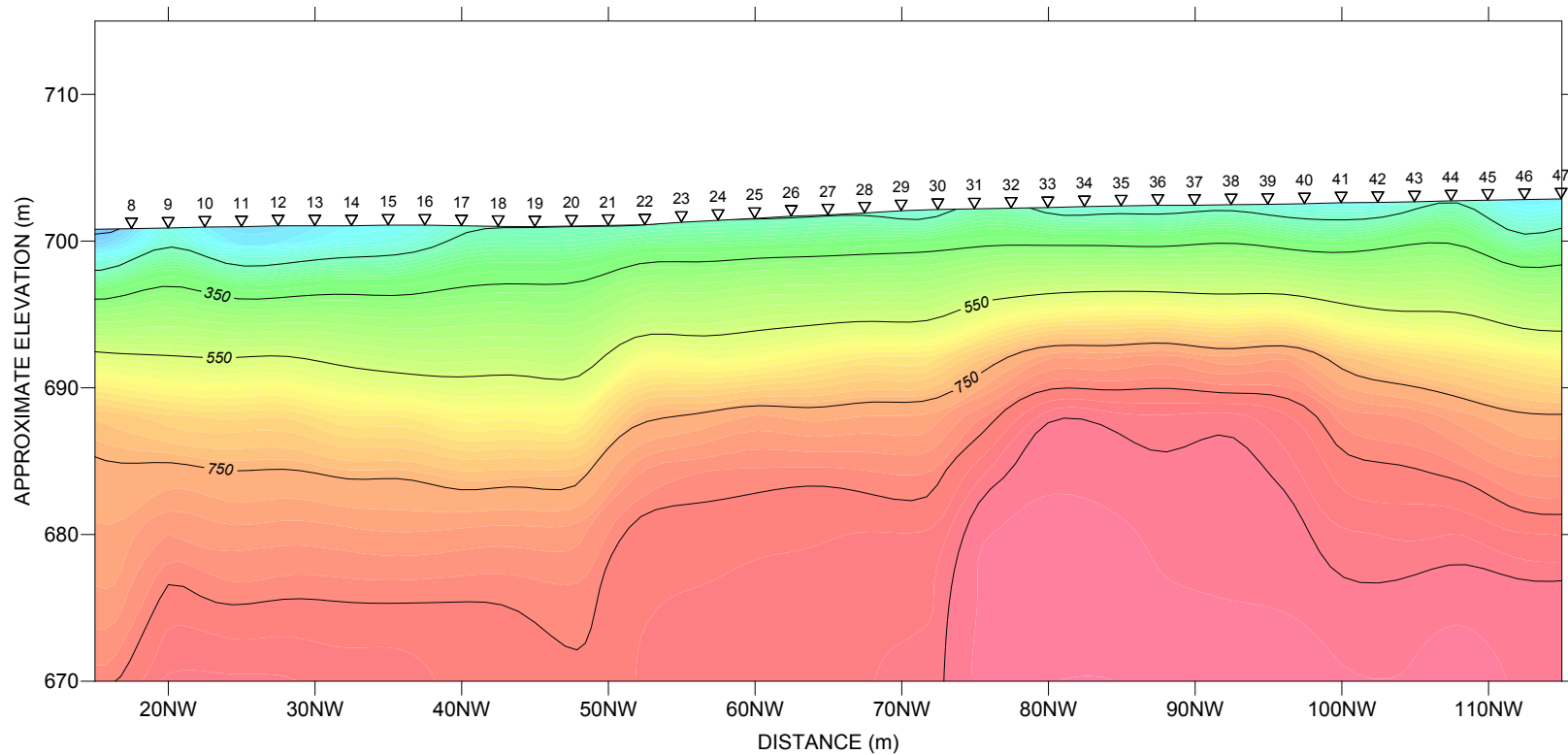
DATE: MARCH 2017

SCALE 1:25,000

FIG. 1







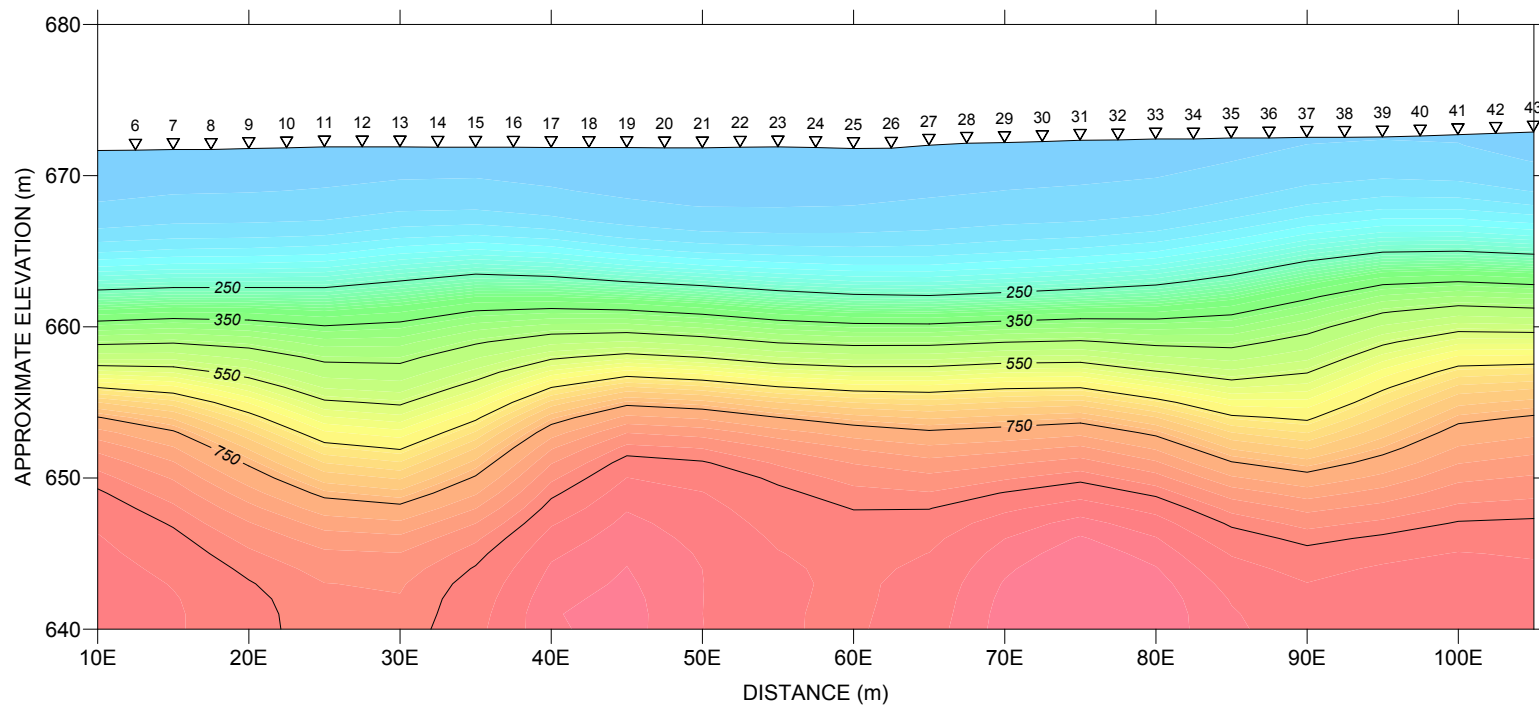
GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
INTERPRETED MASW SECTION SL-1 (112TH AVE)		
FRONTIER GEOSCIENCES INC.		
DATE: APR. 2017	SCALE 1:500	FIG. 3





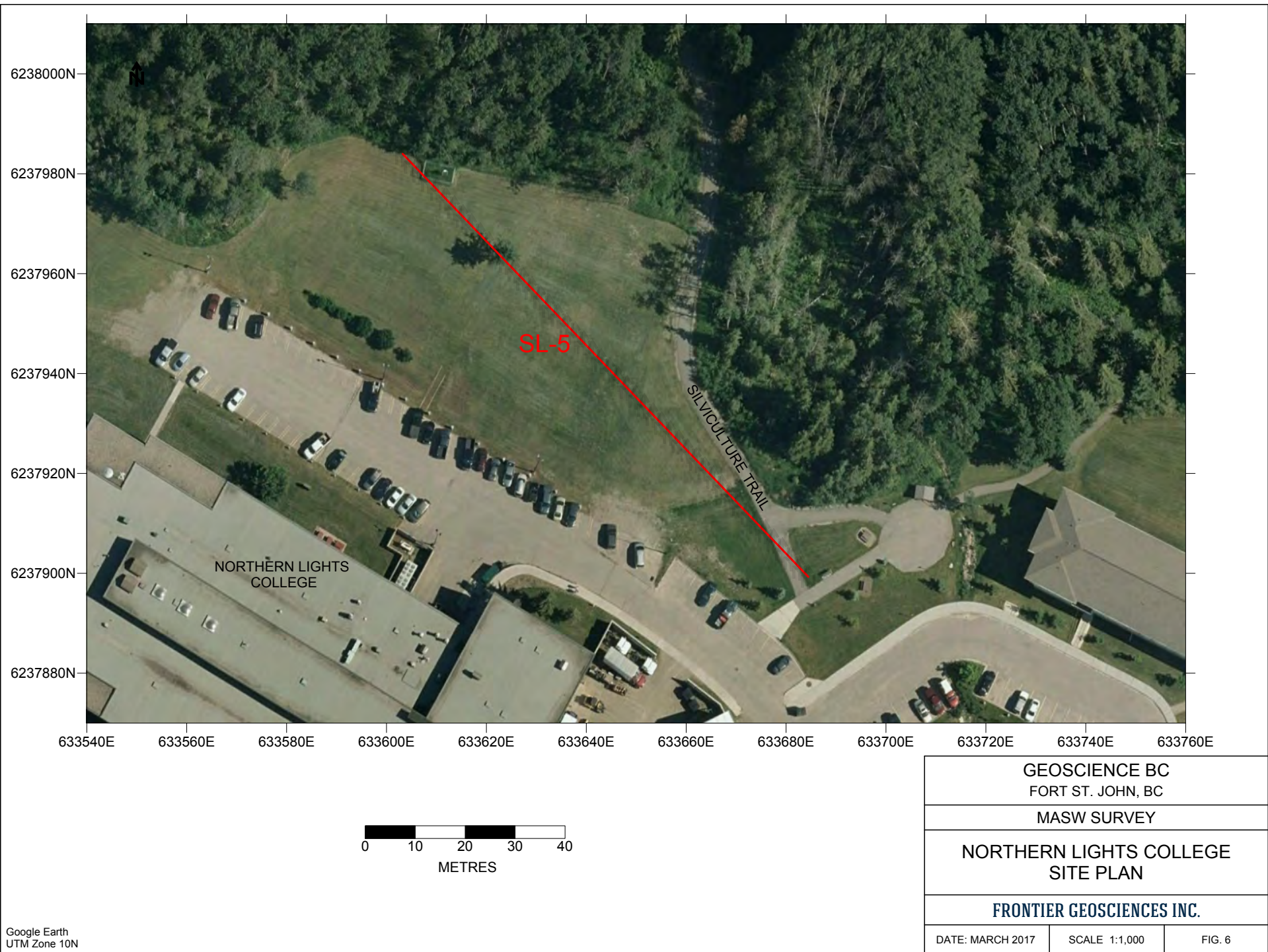
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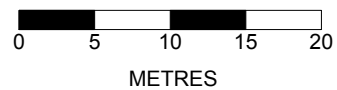
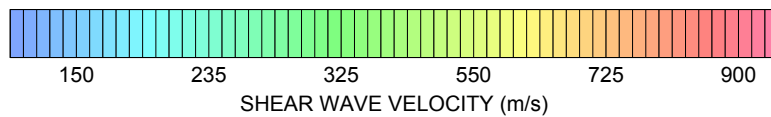
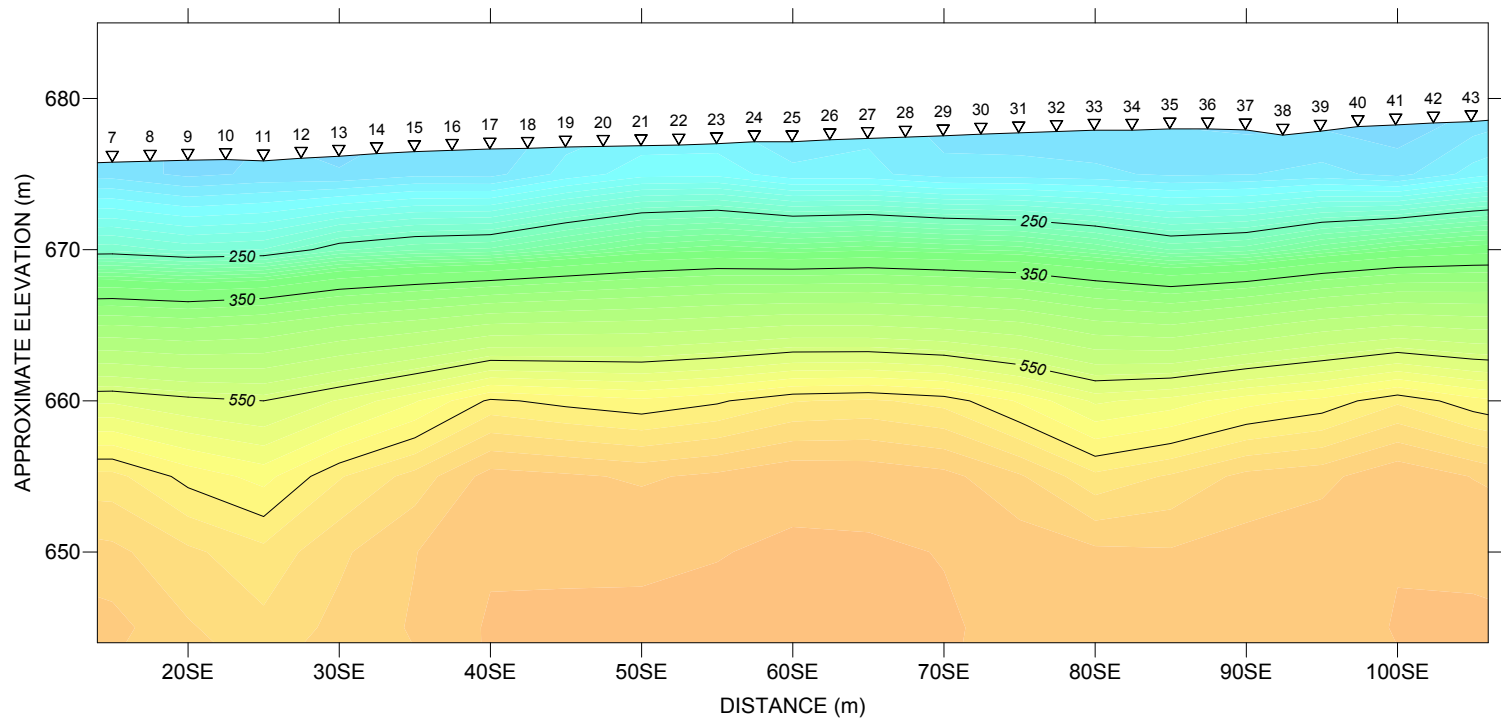
GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
94 <sup>th</sup> AVE SITE PLAN		
FRONTIER GEOSCIENCES INC.		
DATE: MARCH 2017	SCALE 1:1,000	FIG. 4



GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
INTERPRETED MASW SECTION SL-2 (94TH AVE)		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: APR. 2017	SCALE 1:500	FIG. 5

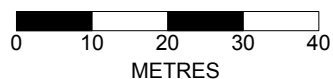






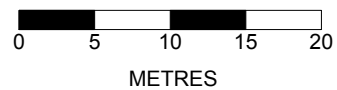
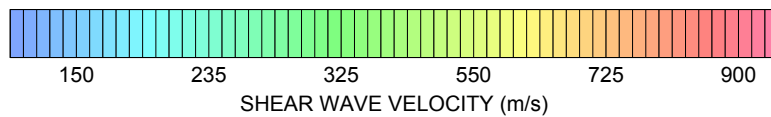
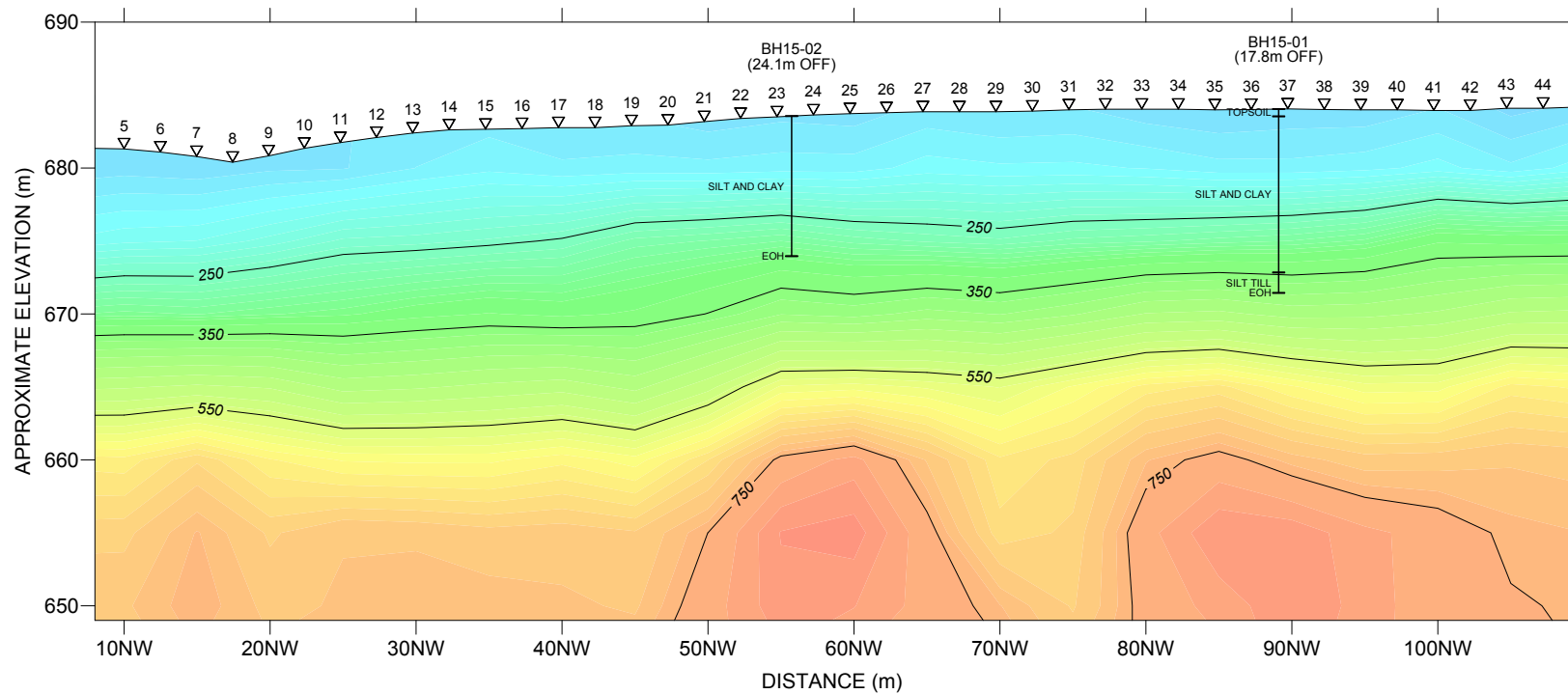
GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
INTERPRETED MASW SECTION SL-5 (NORTHERN LIGHTS COLLEGE)		
FRONTIER GEOSCIENCES INC.		
DATE: APR. 2017	SCALE 1:500	FIG. 7





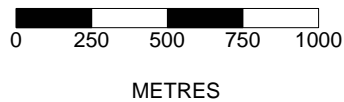
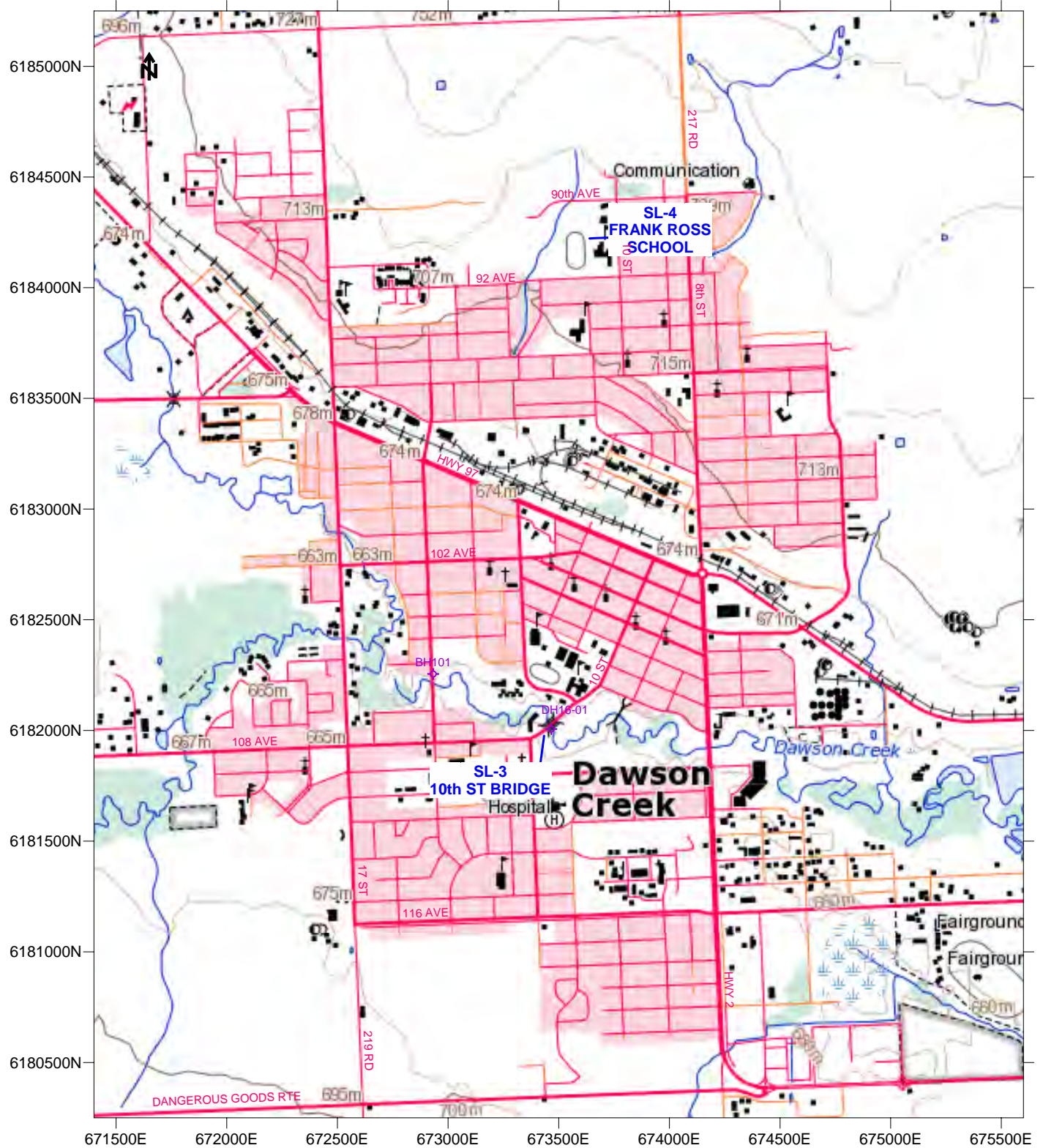
Google Earth  
UTM Zone 10N

GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
MA MURRAY SITE PLAN		
FRONTIER GEOSCIENCES INC.		
DATE: MARCH 2017	SCALE 1:1,000	FIG. 8



GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
INTERPRETED MASW SECTION SL-6 (MA MURRAY SITE)		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: APR. 2017	SCALE 1:500	FIG. 9





GEOSCIENCE BC  
DAWSON CREEK, BC

MASW SURVEY

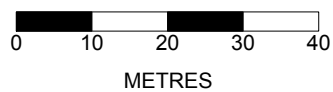
DAWSON CREEK  
SITE PLAN

FRONTIER GEOSCIENCES INC.

DATE: MARCH 2017

SCALE 1:50,000

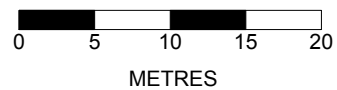
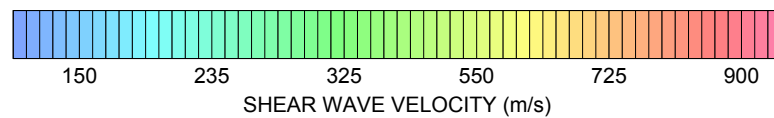
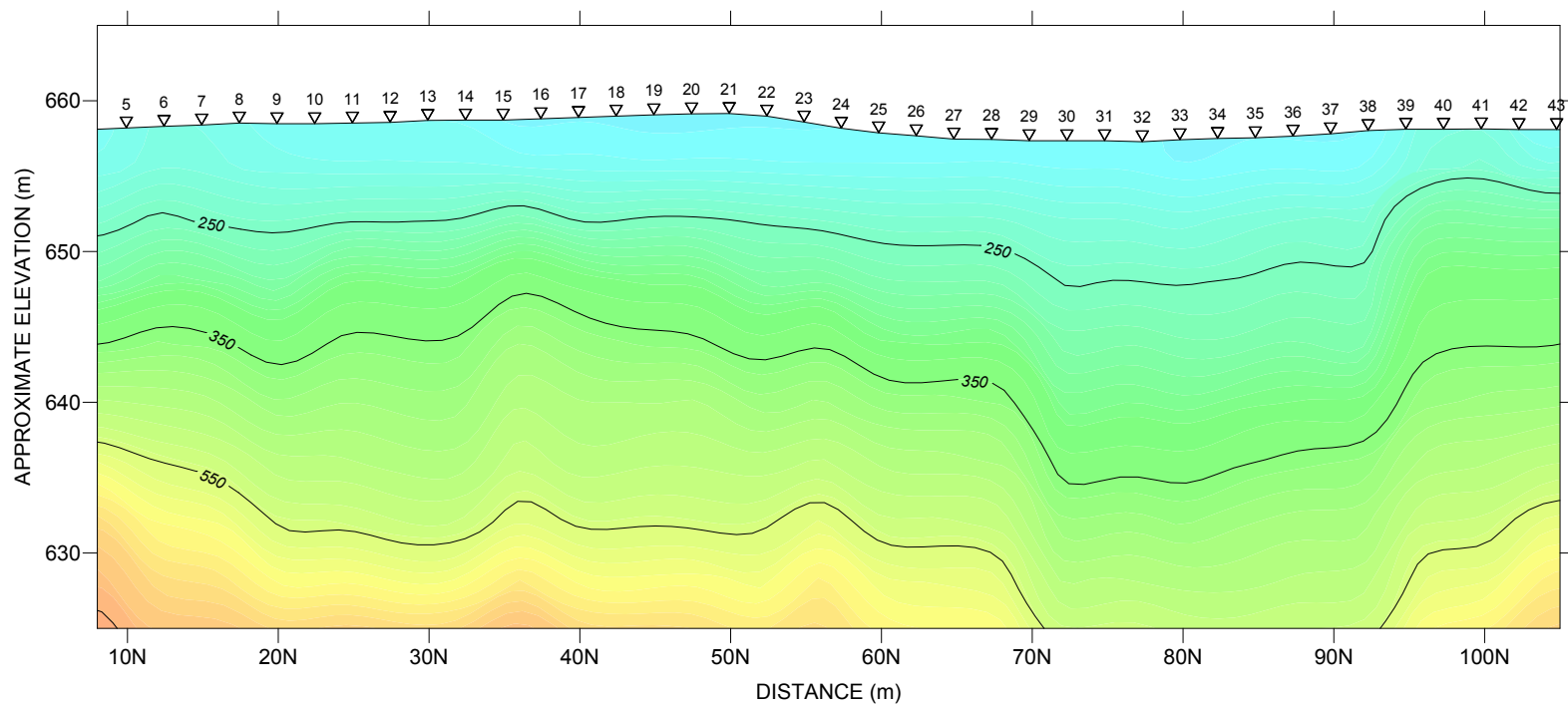
FIG. 10



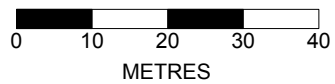
Google Earth  
UTM Zone 10N

GEOSCIENCE BC DAWSON CREEK, BC		
MASW SURVEY		
10 <sup>th</sup> ST BRIDGE SITE PLAN		
FRONTIER GEOSCIENCES INC.		
DATE: MARCH 2017	SCALE 1:1,000	FIG. 11



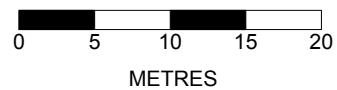
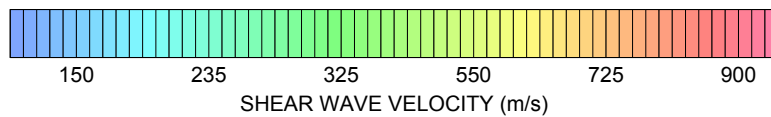
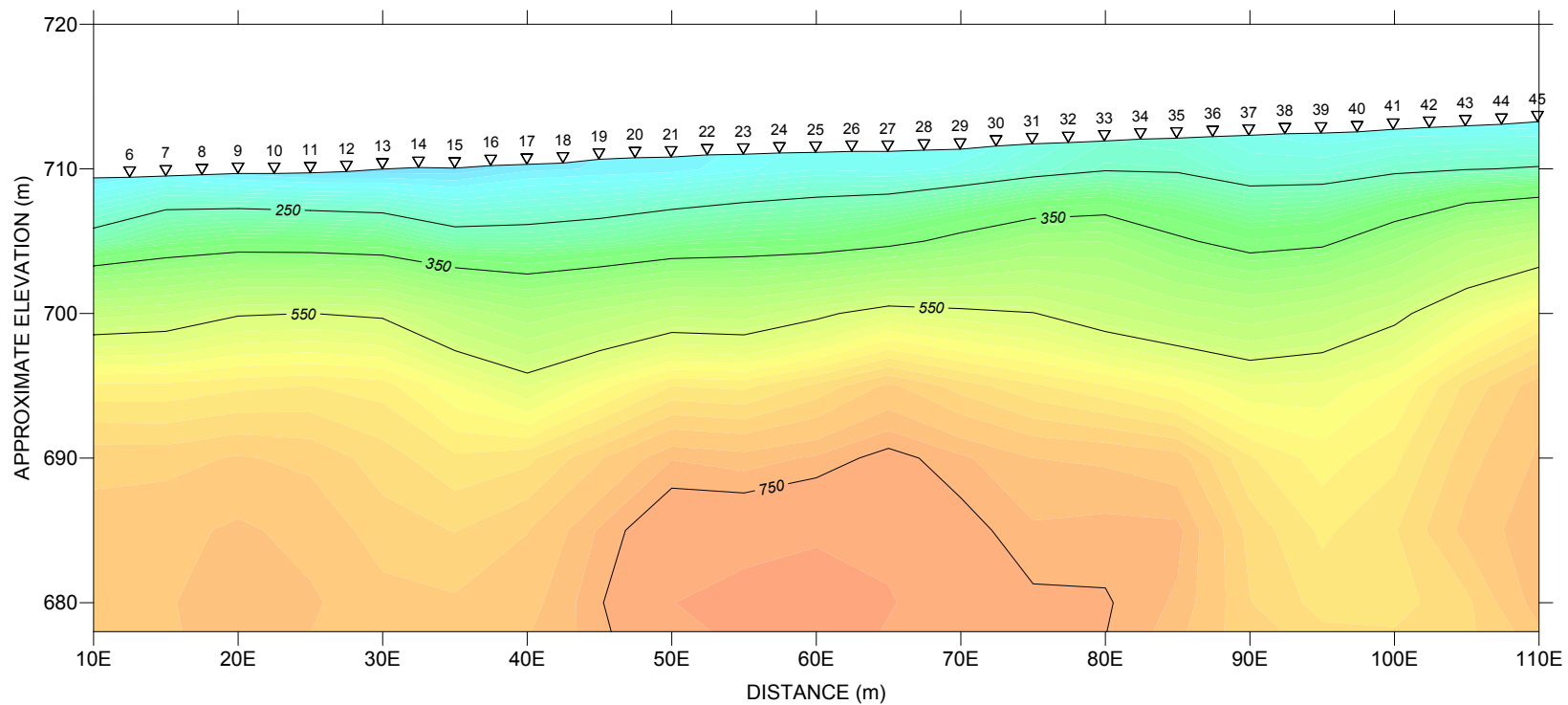


<b>GEOSCIENCE BC</b> DAWSON CREEK, BC		
<b>MASW SURVEY</b>		
<b>INTERPRETED MASW SECTION</b> <b>SL-3 (10TH STREET BRIDGE)</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: APR. 2017	SCALE 1:500	FIG. 12

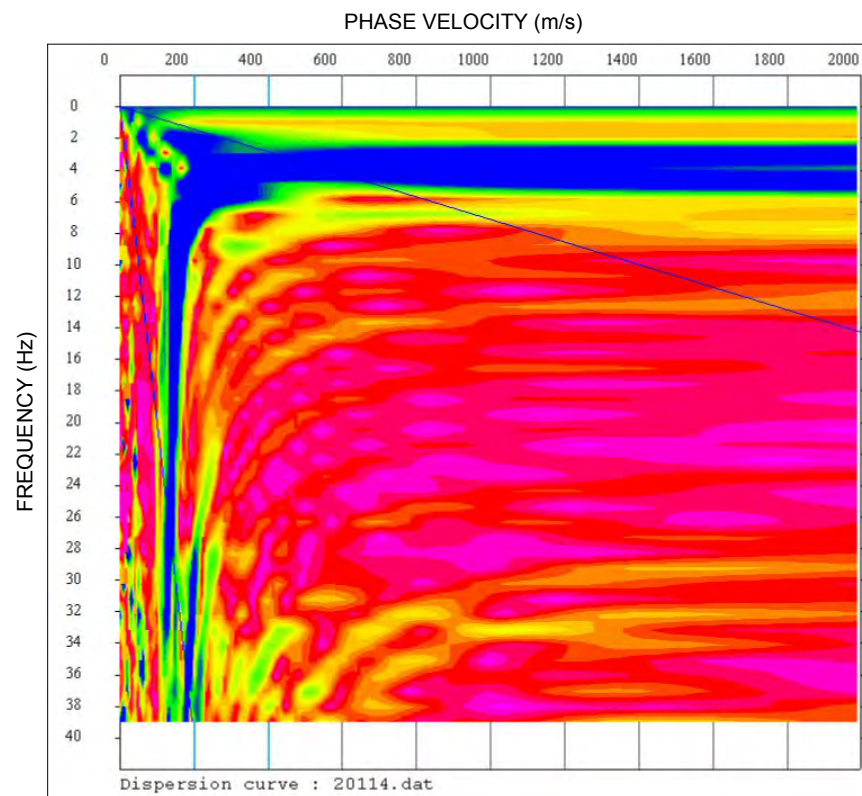
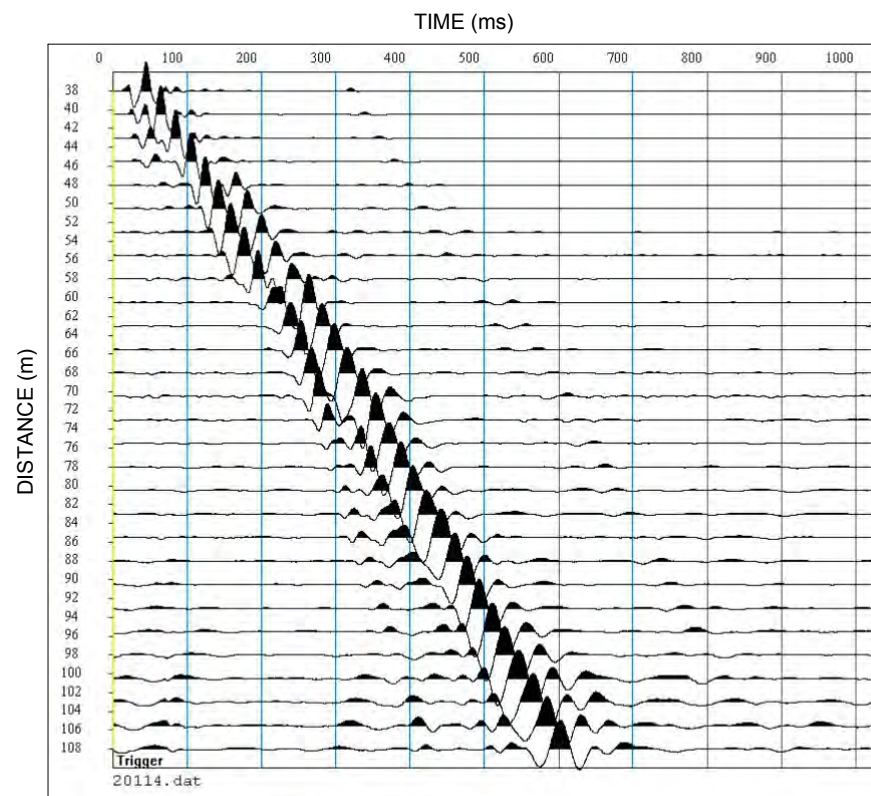


Google Earth  
UTM Zone 10N

GEOSCIENCE BC DAWSON CREEK, BC		
MASW SURVEY		
FRANK ROSS SCHOOL SITE PLAN		
FRONTIER GEOSCIENCES INC.		
DATE: MARCH 2017	SCALE 1:1,000	FIG. 13



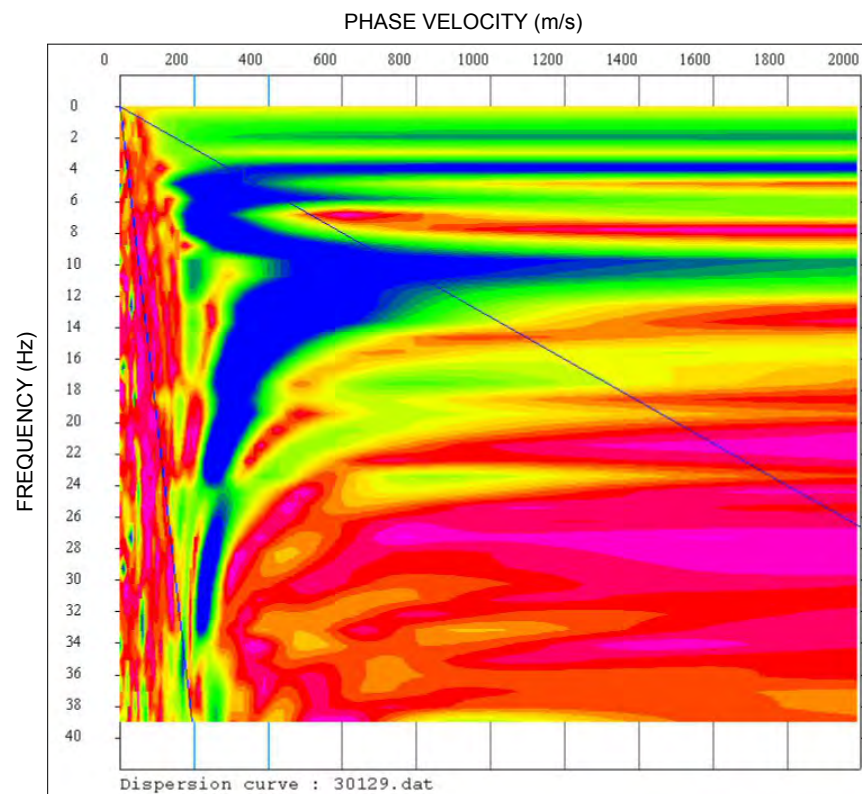
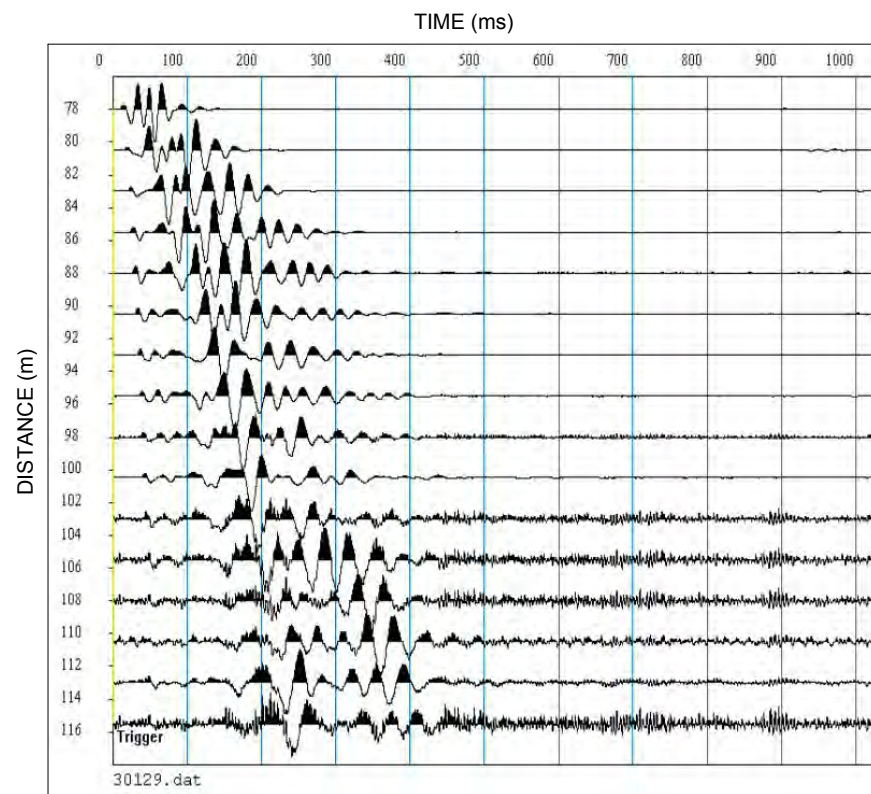
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MASW SURVEY		
INTERPRETED MASW SECTION SL-4 (FRANK ROSS SCHOOL)		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: APR. 2017	SCALE 1:500	FIG. 14



LINE: SL-2  
 SHOT NUMBER: 14  
 SOURCE LOCATION: 33.75m

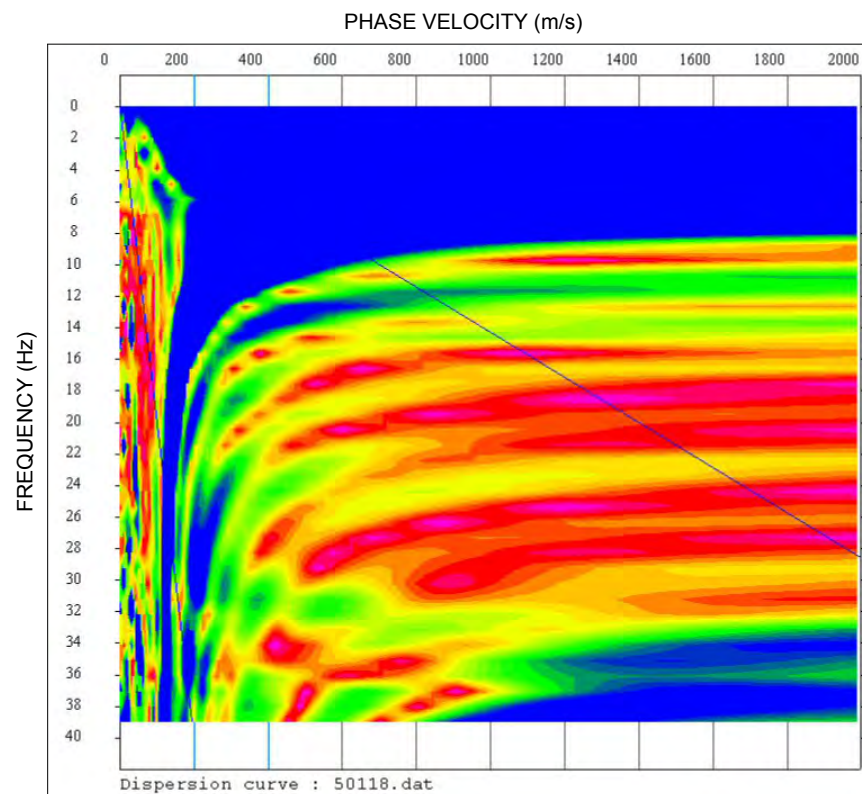
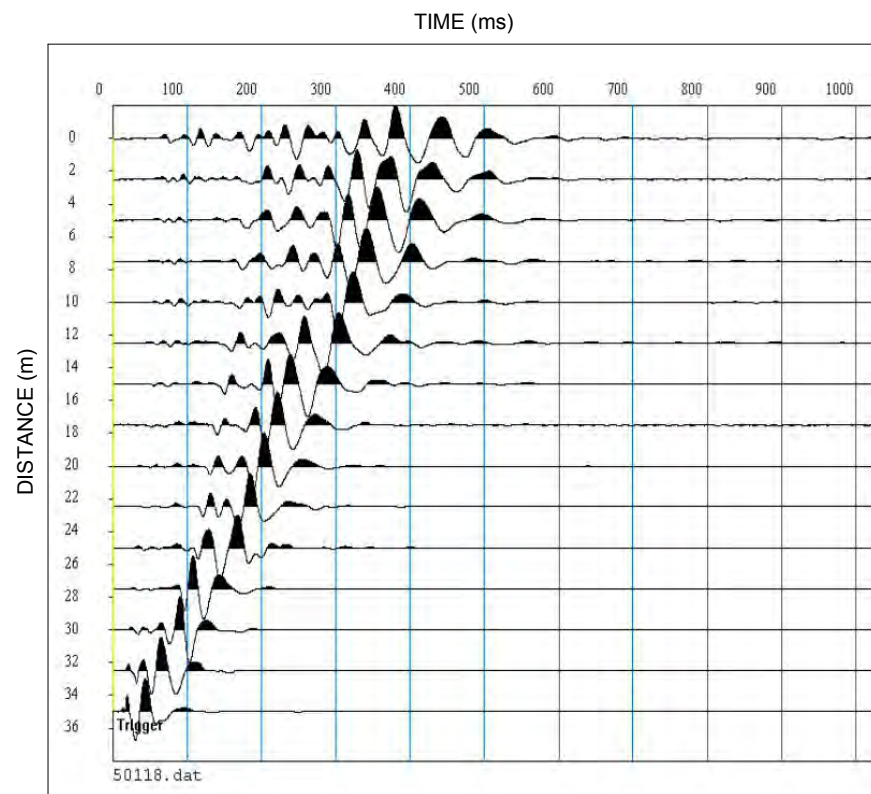
GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
EXAMPLE DATA SL-2 (94TH AVE)		
FRONTIER GEOSCIENCES INC.		
DATE: APR. 2017		FIG. 15





LINE: SL-3  
 SHOT NUMBER: 29  
 SOURCE LOCATION: 73.75m

GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
EXAMPLE DATA SL-3 (10TH STREET BRIDGE)		
FRONTIER GEOSCIENCES INC.		
DATE: APR. 2017		FIG. 16



LINE: SL-5  
 SHOT NUMBER: 18  
 SOURCE LOCATION: 38.75m

GEOSCIENCE BC FORT ST. JOHN, BC		
MASW SURVEY		
EXAMPLE DATA SL-5 (NORTHERN LIGHTS COLLEGE)		
FRONTIER GEOSCIENCES INC.		
DATE: APR. 2017		FIG. 17