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WEST QUESNEL LAND STABILITY STUDY
VOLUME 2 OF 2
APPENDICES A TO I

DRAFT

Submitted To:

City of Quesnel
410 Kinchant Street
Quesnel, BC
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By

AMEC Earth & Environmental
A division of AMEC Americas Limited

KX04397

May 2007

APPENDIX A

FILE COPY

WEST QUESNEL
INSAR DEFORMATION ASSESSMENT
QUESNEL, BRITISH COLUMBIA

Submitted To:

CITY OF QUESNEL
BRITISH COLUMBIA, CANADA

Submitted By:

AMEC EARTH & ENVIRONMENTAL
EDMONTON, ALBERTA

22 November 2004

File No. KX0439702

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APPENDICES

1.0 INTRODUCTION

AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, was retained by the City of Quesnel to undertake an assessment of ongoing slope movements for the area of West Quesnel using Synthetic Aperture Radar Interferometry (InSAR). The main purposes of the assessment were to:

1. Identify and/or confirm the boundaries of the main slide mass that is currently being monitored using other methods, and;
2. Identify zones of differential movement within the slide mass in order to delineate more active zones or zones of differential movement, if any.

The proposed methodology for conducting the InSAR assessment was contained within AMEC's letter to the City of Quesnel dated 5 July 2004. Authorization to proceed was provided by Mr. Jack Marsh of the City of Quesnel in a letter dated 21 July 2004.

This report does not provide a detailed discussion of the background of the study area in relation to the geology, landslide mechanisms and review of historical data trends. Further more detailed information has been outlined previously in other reports by AMEC for the City of Quesnel.

2.0 BACKGROUND

Since 1997, the presence of large-scale landslide features in a suburban area of West Quesnel has been postulated by various geotechnical assessments. These assessments were largely based on airphoto interpretation, surface reconnaissance, and a review of reported utility breaks. Due largely to the absence of detailed subsurface information, reviews of past work had been unsuccessful at documenting the clear existence of a deep-seated landslide. Subsequently, lateral movements of up to 250 mm over an area at least 1.5 km by 1.5 km square were reported at Global Positioning System (GPS) ground movement monitoring hubs installed in West Quesnel by BC Gas (now Terasen).

Between September 2000 and July 2002, AMEC conducted a sub-surface geotechnical investigation in a portion of the affected area of West Quesnel. The findings of the investigation were presented in a report to the City of Quesnel entitled *West Quesnel Land Stability Study, Quesnel, B.C.*, dated 25 October 2002. Based on subsurface information collected from seven slope indicator installations, AMEC concluded that a large, deep-seated, active but slow moving landslide underlies part of the West Quesnel area. Relatively high (in some places artesian) groundwater levels were evident in the slide area. AMEC's report concluded that potentially the most practical and cost effective way of improving the stability of the area (reducing movement rates to manageable levels or possibly stopping further movement) would likely be via extensive surface and sub-surface drainage measures focused on dewatering and/or reduction of groundwater pressures within the slide area.

From July 2003 to March 2004, AMEC conducted a preliminary dewatering well test in an isolated section of the study area in order determine the feasibility of using pumping wells to lower water pressures within the slide mass. The results of the dewatering test were provided in a report to the City of Quesnel entitled *Pilot Dewatering Well Test, West Quesnel Land Stability Study*, Quesnel B.C., dated 28 May 2004. Over the same time period, AMEC continued to monitor slope inclinometers, groundwater levels, and gather GPS movement hub data provided by Terasen. This information was last reported in an AMEC report to the City of Quesnel entitled *On-going Monitoring, West Quesnel Land Stability Study*, dated 20 January 2004.

During AMEC's previous work it became apparent that additional information regarding geological and groundwater conditions was needed over a wider area of the study area than had been previously investigated. In order to optimize location of future drill and instrumentation locations, a number of recommendations for additional study were made, including continued monitoring of ground movements via GPS surveys, installation of additional slope indicator casings, and the possible use of innovative satellite based remote sensing techniques (e.g. InSAR).

3.0 INSAR ASSESSMENT

3.1 THEORY

Synthetic aperture radar (SAR) is an active sensor that can be used to measure the distance between the sensor and a point on the earth's surface. A SAR satellite typically orbits the earth at an altitude of approximately 800 km. The satellite constantly emits electromagnetic radiation to the earth's surface in the form of a sine wave. The electromagnetic wave reflects off the earth's surface and returns back to the satellite. This reflected signal is used to create a SAR satellite image (a black and white representation of the ground reflectivity).

SAR images are made up of pixels, which represent an area of ground surface 20 m across for the satellite data under discussion. Each pixel has a specific size determined by the SAR satellite resolution, the higher the resolution the smaller the pixel size. The ground reflection is averaged over the pixel area. For this current assessment, the ERS data utilized is uses a 20 m x 20 m pixel and therefore each pixel represents average deformations within this area.

To measure differential ground movements over a specified time period, InSAR requires two SAR images of the same area taken from the same flight path from positions within 500 m apart. InSAR compares the phase of the echoed signal to the reference signal on a pixel by pixel basis. Thus, the differences in phase between the two SAR images can be used to determine ground movement in the line of sight of the SAR satellite for each pixel.

The wavelength of the electromagnetic signals emitted by the SAR sensor is typically in the order of a few centimeters. Because InSAR measures the phase difference resulting from the path length change between the sensor and a point on the earth's surface, the magnitude of ground movement between the two satellite passes can be measured to millimeter accuracy.

InSAR has proven highly successful in detecting ground movements in several locations and applications around the world. For example, one of the early users of the technology was the oil sector in the United States, which used spaceborne InSAR to detect very small surface movements (settlements) above deeply buried reservoirs during hydrocarbon production (Van der Kooij, 1997). More recently, examples of successful detection of ground motion for landslides in Canada have been presented by Kosar et al (2003a, b).

Currently there are two agencies operating SAR satellites in the civilian sector, the Canadian Space Agency (CSA) and the European Space Agency (ESA). CSA has had one SAR satellite, RADARSAT-1 in orbit since 1996. ESA recently launched its third SAR satellite, Envisat, in 2002. Its predecessors, ERS-1 and ERS-2 collected SAR images from 1992 to 2000 and from 1995 to 2001, respectively.

The main considerations in choosing and collecting data for the interferometry assessment are as follows:

1. Satellite Path/Trajectory: One of the main considerations for mapping slope deformations is the satellite trajectory. A satellite will pass over the same position on the earth on both an ascending and descending orbit due to the rotation of the earth and the orbit of the satellite. On the ascending orbit, data the satellite sensors are facing approximately to the ENE while the descending orbit will face approximately to the WNW. The terms "ascending" and "descending" refer to the apparent directions of the orbits when viewing the earth from space as a globe. For example, an "ascending" orbit is going from the south toward the north. The sensors always point to the right looking in the direction of the satellite orbit and so point in opposite directions relative to the same point on the ground for ascending and descending passes.

   For Central British Columbia the trajectory of the ascending orbit, for both ERS and RADARSAT, is 344° with a look direction (line of sight) of 074°. The descending orbit has a trajectory of 195° with a look direction of 285°. In order to have the best possible chance for success, it is desirable to choose a satellite look angle that is approximately along and parallel to the movement vector of the slope. For the slopes of West Quesnel, in general the slope is east facing and is relatively flat, either an ascending or descending trajectory would be considered to be acceptable for mapping deformation and therefore the choice of trajectory was made based on data availability.

2. Incidence Angle/Slope Geometry: Another important consideration for detecting slope movements is the direction of movement in relation to the angle off vertical of the satellite look direction down the slope. This is termed the Incidence Angle. The best case for detecting movements using InSAR is when movements are completely parallel to the beam path, and the worst case being that where movements are completely perpendicular to the beam path. This is more of an issue for steep mountainous slopes and less so for the relatively flat slopes present in the landslide topography along the Fraser River. For relatively flat slopes, the best case is to have the highest incidence angle possible as this correlates with the flattest angle at which the satellite views the earth's surface. The incidence angle for the data utilized for the West Quesnel project is 23.3°.

3. Vegetation/Snow Cover: For Quesnel, as there may be snow on the ground between the end of October and mid-April, scenes were chosen outside this time frame. Another factor considered is the vegetation cover on the ground. For heavily vegetated sites, the leaves/branches on the trees will scatter the electromagnetic waves emitted from the satellite and not provide a coherent return and are therefore not suitable for deformation measurement. As much of West Quesnel is a developed urban/suburban area and there are large non-vegetated patches, this produces ideal conditions for deformation monitoring and suitable for obtaining deformation results over longer time frames (a year or two vs. the few months that are possible in more vegetated areas).

4. Range of Motion: Typically motion ranging between a fraction of a wavelength and a full wavelength can be recorded using InSAR. For C-Band satellites (ERS and Radarsat) a 5.6 cm wavelength is utilized. For this assessment a lower bound cut off of 5 mm was utilized to filter out potential atmospheric effects and poor data with a practical upper bound for deformation mapping of 6 cm. In choosing the most suitable time period for deformation monitoring using InSAR for West Quesnel, the aim was to choose a time period that would capture the largest range of motion based on the historical GPS monitoring data. This is discussed in more detail in Section 5.2.

A more detailed discussion of the application of InSAR to landslide movement detection is provided by Froese et al. (2004).

3.2 METHODOLOGY

In order to attempt to map deformations over West Quesnel using InSAR the following information was evaluated:

- Existing GPS and geotechnical instrumentation ground monitoring data
- Lists of archival ERS and RADARSAT-1 satellite data available since 1992.

The results of the historical monitoring up to the spring of 2003 were compiled by AMEC (2004) and reviewed to assess the optimum time frame for selection of satellite data sets. Differential GPS ground movement monitoring hubs were first installed in West Quesnel in the fall of 1998 by Terasen in order to assess movement potentially impacting on their existing gas pipeline network. A second set of 10 hubs were installed in 2001 by Terasen. In the fall of 2001 AMEC installed a series of seven slope inclinometers. Based on this available data, the overall movement trends suggested a period of larger movements occurred up to the fall of 2002 with rates decreasing significantly since that time. This change in rate of movement has been attributed to significantly lower precipitation levels since the fall of 2002. This is discussed in more detail by AMEC (2004).

Based on these movement trends, the optimum period for InSAR deformation assessment was determined to be between September 1998 and fall 2002. This time frame captured the maximum rate of movements detected by ground based instrumentation. Based on this time frame, a search of the available ERS and RADARSAT ascending and descending data was undertaken. From the search, there were found to be a large number of images available at suitable times over this time period. The following ascending or descending scenes were chosen for generation of preliminary interferograms that would allow a preview of the data quality and to provide an initial indication of deformation patterns:

- July 26, 1997
- October 24, 1998
- July 31, 1999
- November 13, 1999
- September 23, 2000

Based on the preliminary review of the interferograms, there appeared to be good quality data available for the October 24, 1998 to July 31, 1999 time frame that also spanned a period during which the Terasen GPS movement hubs detected movements up to 7 cm. It was expected that this range would allow the best chance for the differentiation of zones of movement within the landslide mass and determination of the boundaries of the landslide.

Once the choice of data was made, more detailed processing was undertaken by Atlantis Scientific Inc. (ASI) and deformation maps were generated. A more detailed discussion of the methodology utilized in the generation of the deformation maps is provided in ASI's report (ASI, 2004), which is appended to this report. Based on the more detailed processing, the deformation data was orthorectified and overlain on an orthophoto base of West Quesnel. Two types of deformation products were provided to AMEC: slant range and flow line deformation maps. Each of these products allowed AMEC to gather different types of deformation data and these two products are discussed in more detail in the following paragraphs:

- **Slant Range Maps :** These maps depict the deformations as they occur either away from or towards the satellite. Positive values represent for away from the satellite (lengthening of wave travel distance) and negative values represent movements towards the satellite (shortening of wave travel distance). On the attached Figure 1, the slant range data has been presented overlain on the orthophoto data. The slant range data provides important information as to the style of movement and an indication of data decorrelation, which may be indicative of either ground movements that exceed a wavelength (~6 cm) or where the ground surface has changed for other reasons over this time period (e.g. agricultural activity, site regrading, heavy vegetation).

- **Horizontal Flow Line Map:** This map (Figure 2) take the slant range data and, for simplicity, resolves it into the direction of the slope surface, assuming that movements are in the direction of the fall line of the slope. These movements are then represented as absolute downslope deformation values. As most movements are not purely in the maximum a downslope gradient direction, this assumption will never be totally correct but provides a reasonable depiction to be used to overall zonation of landslide movements and as a reasonable indication of the magnitude of the deformation over the specified time period. Caution must be taken in the interpretation of the flow line results as:

- The movement direction may not necessarily be parallel to the slope and therefore the results may be misleading. For deep seated landslides, movements are often near horizontal and the projection of movement along the slope may be slightly greater than actually exists, and

- If there are subtle changes in the topography along the slope, the projections along the slope may yield pockets of deformation that are not real but rather created due to geometric corrections based on the DEM that is utilized.

4.0 RESULTS

InSAR deformation results were obtained over the West Quesnel study area for the time period between October 24, 1998 and July 31, 1999. The following provides a discussion of the features observed in the slant range and flow line maps on Figures 1 and 2, respectively, in relation to the overall correlation with the existing ground movement instrumentation, the boundaries of the slide mass and zones of differential movement within the slide mass:

Comparison with Existing Instrumentation: The deformation vectors from previous GPS ground movement hubs have been overlain on both the slant range and flow line data on Figures 1 and 2. As GPS readings were taken in September 1998, December 1998, April 1999 and December 1999, the results were graphed to look at overall movement trends over that time. As the overall movement trends appeared to be relatively linear over that time frame, the specific cumulative movement vectors for the GPS movement hubs over the October 24, 1998 to July 31, 1999 time frame were interpolated and have been provided on the flow line map on Figure 2. As can be seen the results of the flow line InSAR and the GPS hubs agree fairly well in terms of the magnitude of deformations observed, especially when comparing movements within the more active zone to those outside to the east. Overall movements on the GPS hubs over this time frame range from 28 to 70 mm, while deformations up to 80 mm are observed in the InSAR assessment. As the InSAR assessment is looking at strictly two different scenes and movements are averaged within a 20 m x 20 m pixel, it would not be expected that the results would be exactly the same but rather show similar trends to those obtained from the GPS hubs. There are also potential inherent errors in the GPS monitoring that could lead to variations (+/- 25mm). In the northern portion of the slide, where movements have a bit of a northerly component, the movement direction is at more of an oblique angle to the satellite look direction. The associated geometric errors have led to noise in the data that has been filtered out of the flow line data and therefore movements in these areas have not been quantified by InSAR. Also, as indicated in the flow line discussion, the deformations shown on the flow line map have been resolved along the slope surface, instead of in a purely horizontal component, which is the plane in which the GPS hubs are monitored.

Slide Boundaries: There are two boundaries of the main slide mass that appear to be defined by the InSAR: the east and northern boundaries. The breaks in these boundaries are most apparent on the slant range data. On the northern edge of the site there is colour shift between the blue and yellow zones that appears to be the break between slopes that are moving to the east, where Baker Creek flows northwest to southeast, and between slopes that are moving towards the northeast, where Baker Creek wraps around to run east-west. This is not a distinct boundary but an inferred boundary has been sketched on Figure 1. On the flow line deformation map, these are portions of the study area that are moving with more of a northerly component (more of an oblique angle to the look direction of the satellite) and therefore there is more noise (error) in the data and it is not well quantified in the flow line data.

Along the eastern edge of the study area, there appears to be a distinct change between the blue and yellow tones that agrees well with the GPS monitoring hub data and previous AMEC mapping of the suspected toe of the slide mass. Although this represents a very distinct and clear change in levels of slope movement activity, this boundary likely has an error range of +/- 50 metres due to averaging of data in this area. This boundary also appears distinct as it wraps around to the south east portion of the study area.

Along the southern edge of the study area, with the exception of the area in the southeast that appears to be well defined, there is a general loss of coherence of data in the middle portion and a significant loss of coherence in the vegetated areas to the west that does not allow for a reasonable delineation of the boundaries of the slide mass. While it is not possible to assess the boundaries in the southern and western portions of the study area, there is some movement data available upslope, to the west that suggests movements with a similar range of motion (up to and exceeding 6 cm) as seen in the urban area. Based on AMEC's experience in the area, it is not clear whether a southern boundary would be expected as the similar processes as are occurring at West Quesnel may be occurring to the south.

Differential Movements: The slant range data (Figure 1) appears to show zones of differing movement magnitudes within the urban area that may correspond to differential movement within the slide mass. These data trends are the same as shown in the flow line data and appear to vary between 4 cm to >6 cm over the Oct 98 to July 99 time frame considered. As there is some level of noise (error) in the data, and while the trends appear to be real, definitive zones of movement within the slide cannot be determined based on only two scenes of data. A method of providing a more accurate delineation of movements within the mass would be to use an InSAR technique called Coherent Target Monitoring (CTM) over this site. CTM was not originally provided as an option as the overall costs would likely be three to four times that of the current assessment. This technique utilizes more frequent ERS or RADARSAT scenes, identifiable hard targets (houses), and has the potential to delineate very fine movements (within +/- 5 mm) for individual areas that approximate the pixel resolution area of the SAR sensor. For West Quesnel, this technique would likely be able to collect data from hundreds of houses to provide refined delineation when compared to the small number of existing GPS hubs. This method has been shown to be financially competitive with equivalent density differential GPS surveys on other sites.

5.0 CONCLUSIONS AND SUMMARY

The discussion provided above has been based on a review of the available flowline and slant range interferometry data, coupled with the ongoing work at West Quesnel being undertaken by AMEC and others.

Overall, InSAR appears to have been able to provide reasonable delineation of the eastern and southeastern boundaries of movement within the developed area of West Quesnel where terrain is not heavily vegetated. In addition, based on the interpretation of the slant range data, a poorly developed boundary appears along the northern edge which likely represents the break between slopes that are moving with more of a northerly component versus the overall West Quesnel slide which moves to the east. In many of the areas that have been discussed in this report, there have been ongoing visual observations of deformation, and in some cases, actual deformation data available. In many cases, the InSAR may be detecting centimeter level movement over the time periods assessed that may not be detectable using visual methods. Kosar et al (2003) have documented the use of InSAR to detect movements within Central British Columbia along the Fraser River in which deformations associated with a highway and railway alignment that were initially not observed visually prior to InSAR analysis were subsequently confirmed after completing a follow up field check. It is recommended that more detailed field visits be undertaken for the sites highlighted in this report to initiate examination of slide areas that have not been previously monitored or field checked.

This project has involved the application of InSAR as a tool for detection of ground movements within West Quesnel in order to provide additional information on which to plan further field assessment and investigation as part of an overall risk management framework for mitigating the impacts of large scale landsliding on this area. Caution should be used in utilizing InSAR as a specific monitoring tool to replicate and replace existing slope instrumentation, but rather it should be utilized to supplement existing information.

6.0 CLOSURE

The information provided in this report is for the exclusive use of the City of Quesnel in conjunction with ongoing West Quesnel land stability studies being carried out by AMEC. The user is cautioned that due to the nature of InSAR measurements a complete movement vector is not provided and some movements may not be detected. The information in this report should be reviewed together with other information before finalizing actions or conclusions relative to ground movements in or near the study area. This study has been undertaken utilizing the InSAR and available published data and no field truthing by the authors has been competed as part of this study. Use of the data provided is subject to the Atlantis Scientific Inc. licensing agreement that is provided with the submission of the electronic data to the City of Quesnel. Any use or further interpretation of this data by others is subject to the licensing agreement and neither AMEC nor Atlantis Scientific Inc. will be held responsible for interpretations of the data provided made by other parties.

If you have any questions or require any further information, please contact Nick Polysou P.Eng. at (250) 564-3243 or nick.polysou@amec.com.

We have enjoyed working with the City of Quesnel on this interesting project and look forward to continued involvement in the future.

Respectfully submitted,

AMEC Earth & Environmental

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7.0 REFERENCES

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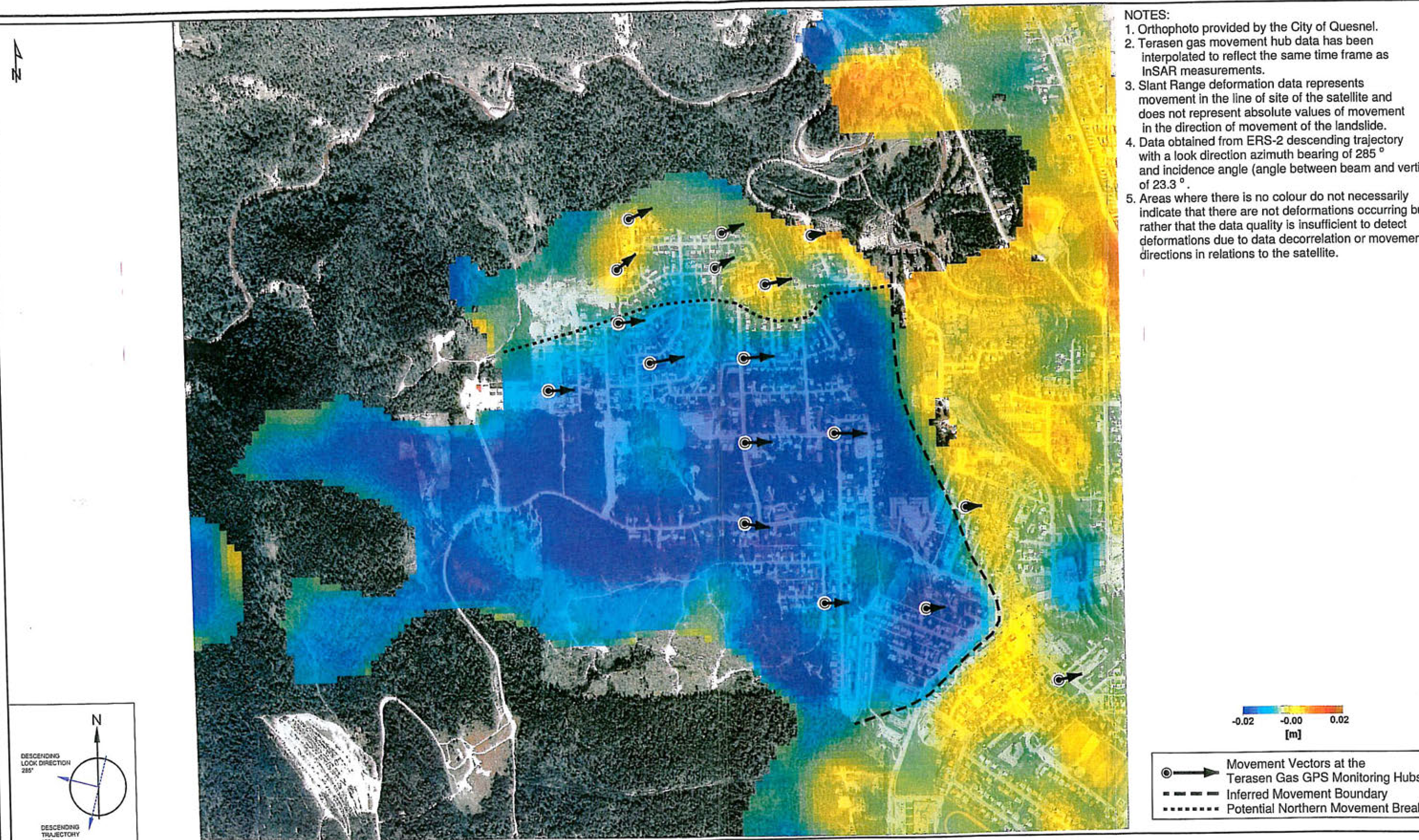
Kosar, K., Martin, S.J., Harbicht, T., Revering, K.F. and Stewart, I.J. 2003b. Characterization Of Fountain Landslide Using Spaceborne InSAR. Proceedings of 12th Panamerican Conference on Soil Mechanics and Geotechnical Engineering and the 39th US Rock Mechanics Symposium, Soil and Rock America 2003, Boston, MA.

LIST OF FIGURES

NOTES:

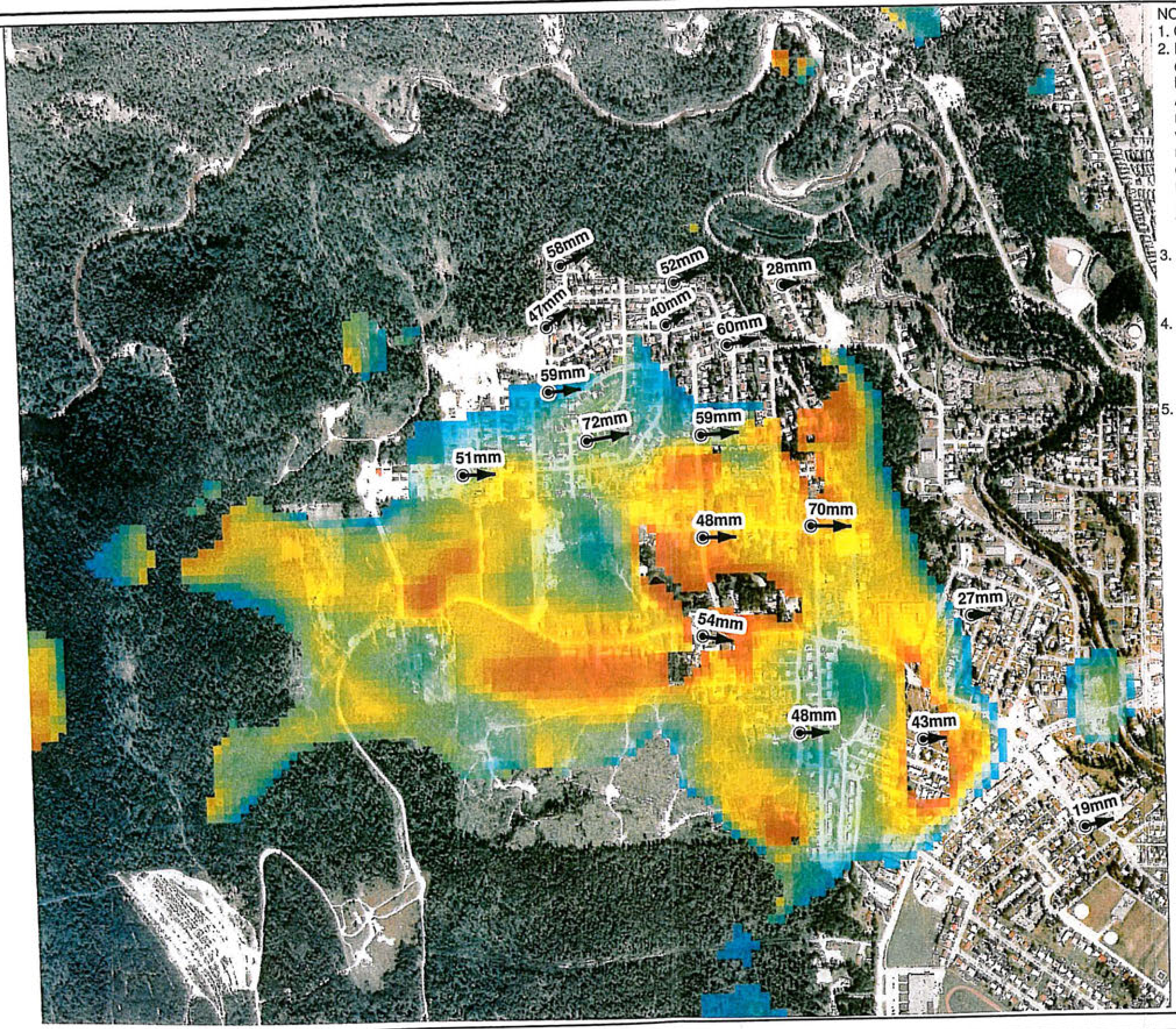
1. Orthophoto provided by the City of Quesnel.
2. Terasen gas movement hub data has been interpolated to reflect the same time frame as InSAR measurements.
3. Slant Range deformation data represents movement in the line of site of the satellite and does not represent absolute values of movement in the direction of movement of the landslide.
4. Data obtained from ERS-2 descending trajectory with a look direction azimuth bearing of 285 ° and incidence angle (angle between beam and vertical) of 23.3 °.
5. Areas where there is no colour do not necessarily indicate that there are not deformations occurring but rather that the data quality is insufficient to detect deformations due to data decorrelation or movement directions in relations to the satellite.



Deformation Results Provided By ATLANTIS

Orthophoto: Scanned BCC97136 No. 73 (1997)

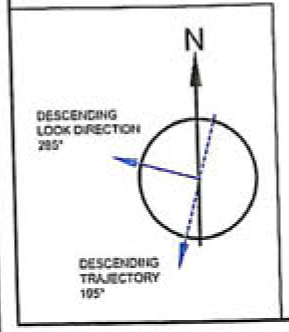
Client: City of Quesnel	Projection: UTM Zone 10	WEST QUESNEL INSAR ASSESSMENT SLANT RANGE DEFORMATION OCTOBER 24, 1998 TO JULY 31, 1999	AMEC Project: KX0439702
	Datum: NAD83		File: WQuesnel_Slant.mxd
AMEC Earth & Environmental amec	Scale: 1:10 000		Figure 1
	Date: November 2004		



NOTES:
1. Orthophoto provided by the City of Quesnel.
2. Flow line deformation data provides the deformations observed from the satellite (slant range) that have been resolved in the direction of the ground surface. As movements for deep seated landslides are often not parallel to the slope surface, these movements will vary from actual deformations but have provided a reasonable estimation of the magnitude of the deformation over this time period. Caution must be used in interpretting the values shown on this map as minor changes in ground topography could lead to changes of deformation magnitude within the overall slide mass that are not actually present.
3. Data obtained from ERS-2 descending trajectory with a look direction azimuth bearing of 285 ° and incidence angle (angle between beam and vertical) of 23.3 °.
4. Areas where there is no colour do not necessarily indicate that there are not deformations occurring but rather that the data quality is insufficient to detect deformations due to data decorrelation or movement directions in relations to the satellite.
5. The deformation values provided for the GPS monitoring hubs represent an interpolation of the Terasen data to correspond to the same time period as considered for the InSAR assessment in order to provide a gross comparison of deformation rates over this time period.

0.00 0.04 0.08
[m]

Movement Vectors at the Terasen Gas GPS Monitoring Hubs



Deformation Results Provided By ATLANTIS

Orthophoto: Scanned BCC97136 No. 73 (1997)

Client: City of Quesnel	Projection: UTM Zone 10	WEST QUESNEL INSAR ASSESSMENT FLOW LINE DEFORMATION OCTOBER 24, 1998 TO JULY 31, 1999	AMEC Project: KX0439702
	Datum: NAD83		File: WQuesnel_Flow.mxd
AMEC Earth & Environmental amec	Scale: 1:10 000		Figure 2
	Date: November 2004		

APPENDIX A
INSAR SUBSIDENCE MONITORING: DEFORMATION MAPPING WEST QUESNEL

InSAR Subsidence Monitoring:
Deformation Mapping
West Quesnel

Prepared For:
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October 15, 2004

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Table of Contents

1. Introduction

Atlantis Scientific has executed approximately 150 projects using InSAR technology since 1997. The objective of these projects was to create very accurate maps of displacement using spaceborne radar technology. These projects have resulted in a number of operational monitoring projects in North America and the Middle East.

This report describes the generation of deformation maps of the West Quesnel site using SAR interferometry for the time period October 24, 1998 to July 31, 1999 using ERS descending data The report will give a short introduction in InSAR deformation mapping technology and will provide details of the processing including intermediate and final results The objective is to create suitable format, projection and visualization of the final results.

Figure 1 indicates the West Quesnel site. The co-ordinates for site are given by a box with coordinates 53° 00' 21" N 122° 34' 26" W to 52° 56' 40" N 122° 28' 06"W. The extent is approximately 6.8km x 7.2km.

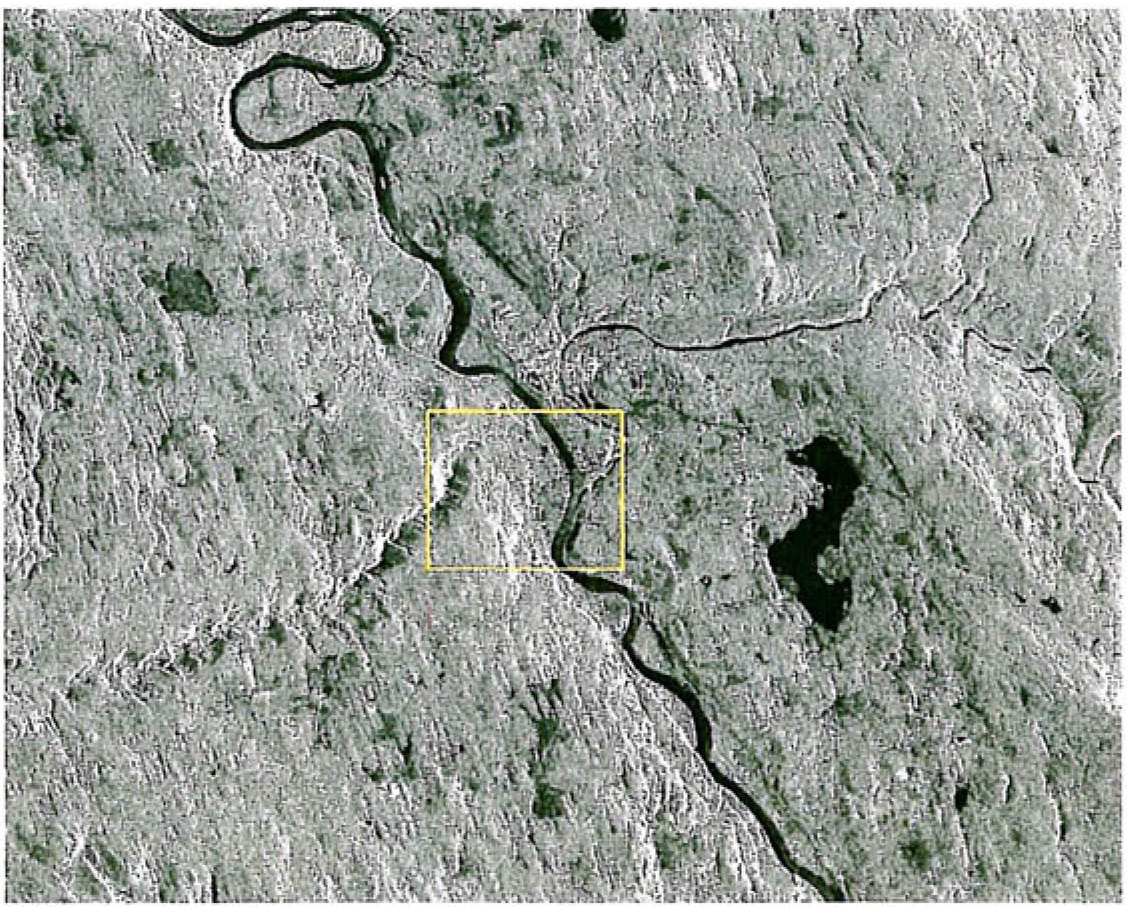


Figure 1: West Quesnel Site

2. Deformation Mapping Using InSAR

SAR systems measure both the magnitude and the phase of the transmitted electromagnetic signal that is backscattered from the earth's surface. The magnitude is what we usually associate with a remotely sensed image. It indicates the "brightness" of the surface as detected by the SAR. The phase represents the combination of two factors; the first is a quantity related to the distance from the SAR to the surface, and the second is the surface scattering effect on the incident electromagnetic wave. Given that this scattering effect is independent from point to point on the ground, the phase of a SAR image is in general quite random and of no practical purpose on its own.

If a second SAR data set is collected from nearly the same location as the first then upon subtracting the phase of the second image from the first an interferogram is formed. If the distance (called the baseline) between the two locations of the SAR platform is small then the surface scattering effects will be the same for the two images and are thus canceled in the formation of the interferogram. Therefore the interferogram exhibits information related to the difference in distances from the surface to the two SAR locations. Knowing the geometry involved, topography can be derived from this information. It is shown that the sensitivity of the phase to height is proportional to the baseline. Heights can typically be measured to an accuracy of 1 to 10 metres.

If surface motion occurs between the acquisition times of the two imaging passes of the SAR platform then the interferogram phase represents a combination of topographic information and surface change. If the topography for the area before the change is known it can be used to remove the topographic phase information from the interferogram leaving simply the surface change phase. The sensitivity of the phase to surface change is proportional to the wavelength of the transmitted electromagnetic wave. Thus surface change can potentially be measured with accuracy at the centimetre level or better.

The steps to generating a deformation map using InSAR are

- **SAR data set selection**
- **SAR raw data processing.** Both scenes are processed to a product that include intensity information plus phase information.
- **Image coregistration.** Both scenes are very accurately co-registered (lined up) to sub-pixel accuracy.
- **Interferogram generation.** The interferogram is an image of the phase difference between corresponding pixels of the 2 images.
- **Topographic phase removal.** An external Digital Elevation Model (DEM) of moderate accuracy is used to remove effects of stationary topography (see more in next section).
- **Phase unwrapping.** For the generation of a quantitative deformation product it is crucial to create a map of "absolute phase" from "wrapped phase" values. This process is called "phase unwrapping.
- **Terrain distortion correction (orthorectification).** This process removes specific distortions due to the radar geometry.
- **Ground control point collection and position refinement.** This process is required as the geographical location of the SAR data is not accurate enough. Ground control points from standard topographical maps are generally sufficient to create horizontal accuracies of ~25-50 m.
- **Deformation map generation in requested format and projection/datum**

These steps are described in the following subsections, as they pertain to the data processed in this project.

3. Final Data Selection

In general, for final selection of the InSAR pair of interest a number of criteria is used:

1. Proper geometry for a pair of interest. This means that the so-called "baseline distance" between the repeated satellite passes is sufficiently small to allow interferometry. The maximum distance is in the order of 1000 m. Typically most of the Radarsat pairs of interest have a baseline within that range
2. The surface conditions are such that a satisfactory phase coherence level is to be expected. Poor conditions could include: (wet) vegetation, snow cover. Phase noise could also be high over areas that experience farmer activities such as plowing. In order to optimize the phase coherence Atlantis utilizes weather data and has the capability to assess phase coherence levels before committing to the purchase of a specific pair.
3. Continuity with previous acquisitions. It is attempted to create continuity with previous InSAR surveys. In some cases it is possible that there is an overlap with previous surveys or perhaps a small temporal gap might occur.

After assessing the geometry and phase coherence levels it was decided to commit to two differential pairs of descending data and ascending data. Table 1 lists the RADARSAT data purchased and Table 2 provides the interferometric pairs processed and Table 3 provides the final pair used for interferometric analysis.

In order to create a so-called differential interferogram it is required to use a Digital Elevation Model (DEM) to remove "Elevation Phase Effects". A height accuracy of ~ 10 m is required to remove these elevation effects in order to focus on the extraction of highly accurate deformation phase information. Perhaps the most confusing aspect of SAR interferometry for new users of this technology is the fact that it is possible to use a relatively low quality digital elevation model for this purpose while still being able to estimate surface deformation at sub-cm level. The key is to recognize that an InSAR deformation map is created from a pair of SAR data and that only ***changes*** in distance between the ground and the satellite can be measured and not the absolute height at sub-cm level accuracy. Figure 2 shows a colour representation of the SRTM data that was used for the removal of topography. Area of interest is outlined with a black box.

SAR ID #	Sensor	Dates	Look	Orbit
01	ERS-2	1997-07-26	desc	11848
02	ERS-2	1998-10-24	desc	18361
03	ERS-2	1999-07-31	desc	22369
04	ERS-2	1999-09-04	desc	22870
05	ERS-2	1999-11-13	desc	23872
06	ERS-2	2000-09-23	desc	28381
07	ERS-2	2000-12-02	desc	29383

Table 1: List of SAR data

Pair	Date	Baseline
01-02	1997-07-26 to 1998-10-24	146
01-03	1997-07-26 to 1997-07-31	294
03-05	1999-07-31 to 1999-11-13	0.661
03-06	1999-07-31 to 2000-09-23	73
05-06	1999-11-13 to 2000-09-23	72
06-07	2000-09-23 to 2000-12-02	-3

Table 2: List of possible Interferometric pairs for analysis

Pair	Date	Baseline
02-03	1998-10-24 to 1999-07-31	148 m

Table 3: Interferometric pairs used for analysis

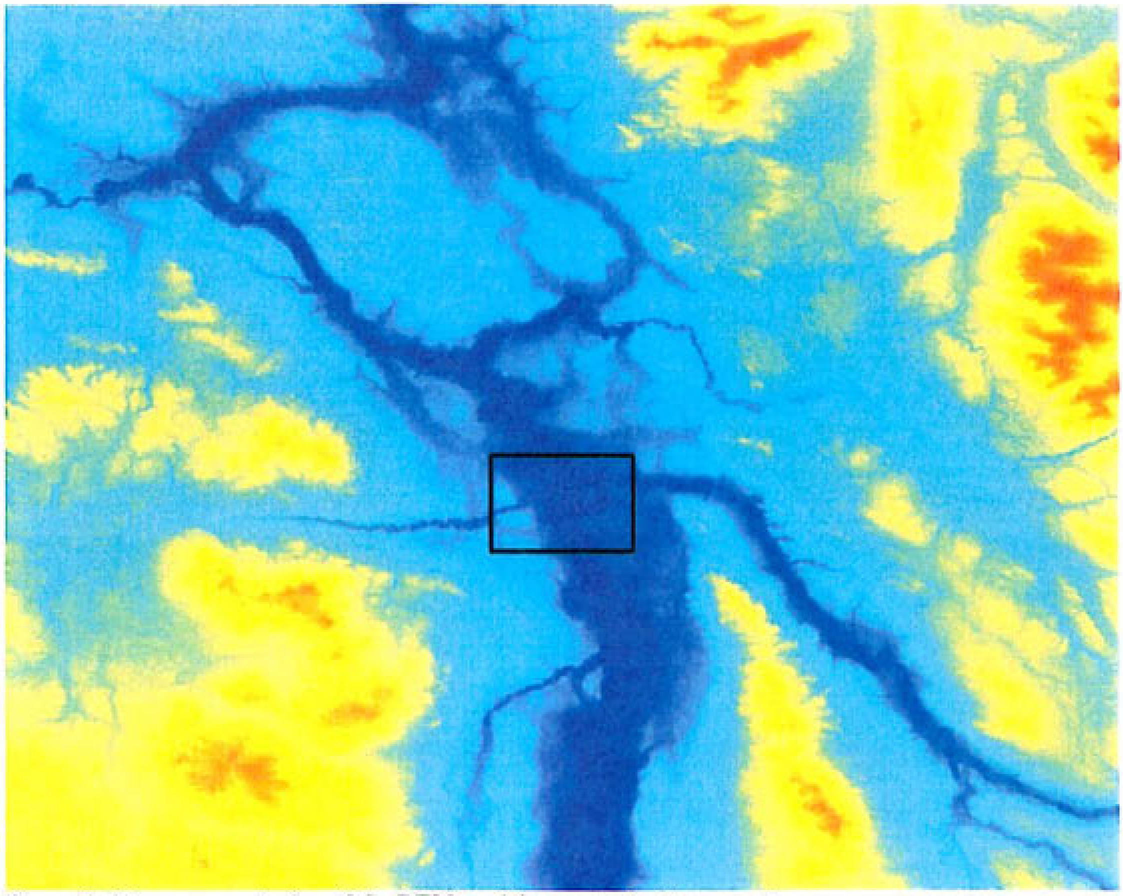


Figure 2: Color representation of the DEM used for removal of topography.

4. Results of Processing

4.1 Processing of the Raw SAR Signal Data

The raw data was processed using the EarthView™ Advanced Precision Processor (APP). The scenes were processed to a zero Doppler, slant range projection, and as phase preserved single-look complex (SLC) imagery. SLC scenes represent the focused images and are the required input for InSAR processing.

4.2 Image Coregistration and Interferogram Generation

Before an interferogram can be formed the input SAR images (master and slave) must be very accurately co-registered. Since the images are collected from slightly different locations, one, referred to as the slave, must be transformed to be coincident with the other, and referred to as the master. Given that under the condition of sufficient coherence the images differ only slightly, it is relatively straightforward to co-register them automatically.

If the baseline distance is nonzero then the interferometric phase will vary with the surface topography. If surface deformation occurred between the first SAR acquisition and the second SAR acquisition, it will also contribute to the interferometric phase, as a SAR signal-path difference. Thus in order to extract surface deformation measurements the topographic phase component must be removed. The DEM must first be co-registered with the master SAR image. This is done using the georeferencing of the DEM and the SAR geometry corresponding to the master. However, the absolute georeferencing is often not accurate enough to provide exact coregistration and usually it must be refined manually. The phase due to the topography is calculated directly from the DEM using the SAR geometry corresponding to the master image and is simply subtracted from the interferogram phase. Once the topographic phase has been removed the result is termed a differential interferogram. The phase information in a differential interferogram solely represents temporal differences (surface movement, atmospheric effects). Figure 3 (a) (b) and (c) shows the backscatter image, coherence image and enhanced interferogram of pair 02-03. The intensities in the coherence maps range from 0 (black, low coherence = high phase noise) to 1 (high coherence, low phase noise) and are indicative of the quality of the interferogram. The phase colour scheme is next to the interferogram. Negative phase identified by fringes going from blue to red to green, which is represented as negative values on the deformation. Positive phase is identified by fringes going from red to blue to green and is represented as positive values on the deformation map.

4.3 Phase Unwrapping and Deformation Map Generation

The phase as measured by the SAR and represented in the interferogram is referred to as wrapped, having values only in the range between 0 and 2π. In order to relate the phase to topography or surface deformation the phase must be unwrapped. In generating a DEM with areas of rugged terrain phase unwrapping can be a difficult task. However for determining surface change the nature of deformations that can be detected are typically not as complex and it is straightforward to unwrap the phase.

The surface deformation is related directly to the unwrapped phase, through the SAR geometry and transmitted signal wavelength, and is straightforward to calculate.

4.4. Georeferencing and calibration of deformation values

The images were projected into UTM, WGS-84 map coordinate and accurately georeferenced by identifying common features from the SAR backscatter image and an orthorectified SAR image.
The deformation map was calibrated using the assumption that the deformation outside of the area where motion occurs is negligible.

Figure 5 shows the slant range change map of ERS2 descending data for the time periods October 24, 1998 to July 31, 1999.

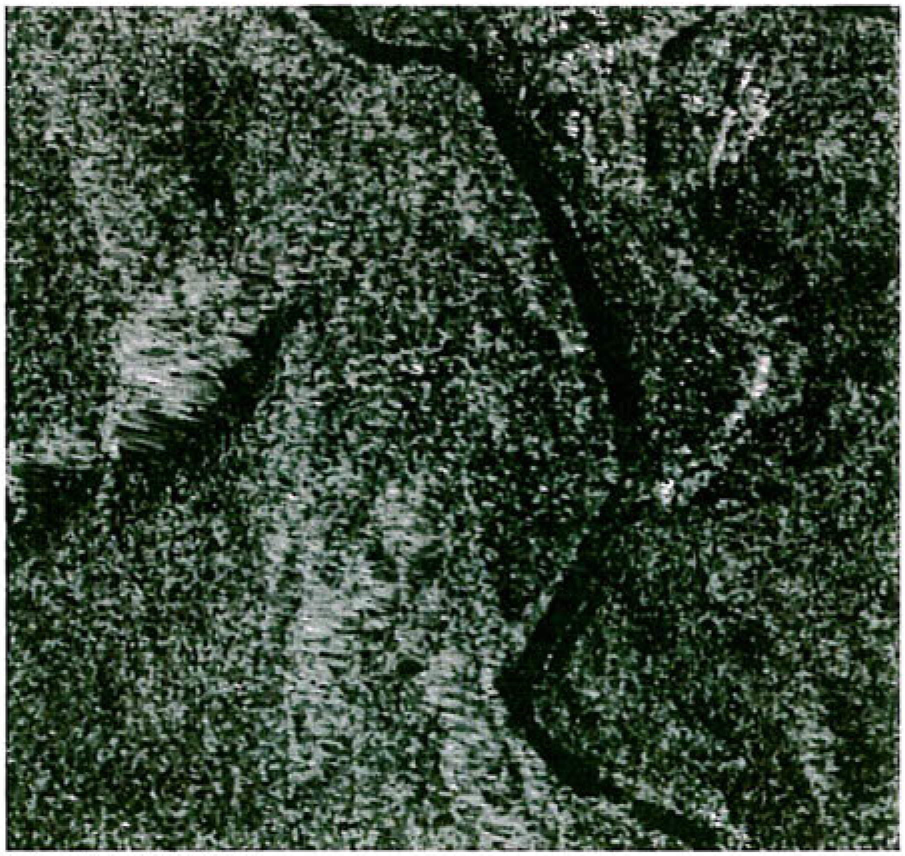


Figure 3(a) Backscatter

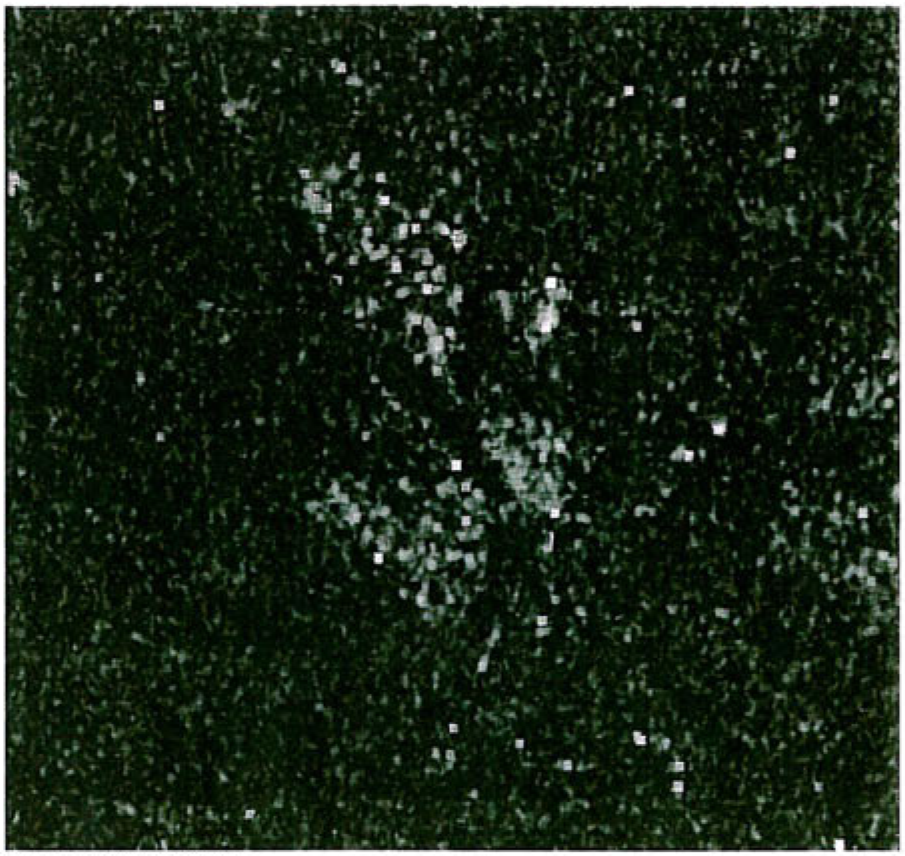


Figure 3 (b) Coherence

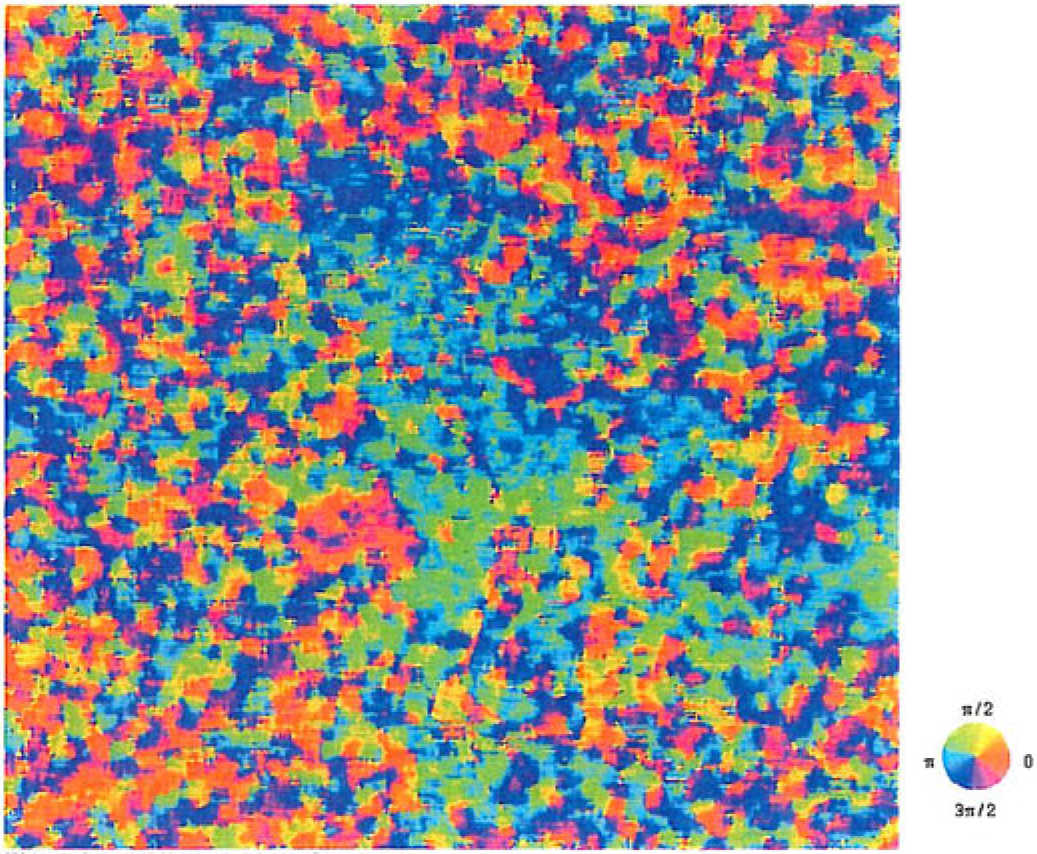


Figure 3 (c) Differential interferogram

Figure 3: Coherence and differential interferogram of the ERS pair October 24, 1998 to July 31, 1999 (Descending).

4.5. Flow-line Deformation Map

A flow line deformation map is a slant range change map projected to the line of local terrain slope. The local terrain slope was obtained by calculating gradient vector from Canadian Topographic Map. Then, slant range change derived from InSAR data was projected to the line of the gradient vectors. Figure 4 displays the geometry used for the calculation of the flow line deformation. Figure 8, shows the flow line deformation map. Since both positive and negative slant range change are projected to down slope, both features are shown with same negative sign in the flow line deformation. Because of the geometry, flow line deformation could become large when the angle between slant range vector and flow line vector is close to 90 degree. Therefore, the area was masked out.

Figure 5 shows the slant range change map of ERS descending data for the time period October 24, 1998 to July 31, 1999 with the vectors showing the direction of the motion. The vectors on the slant range change value greater than 5mm are only displayed. Also, the vectors on the layover area, low coherence area (less than 0.2), and the area where the angle between flow-line vector and slant range vector is close to 90 degrees, has been masked out. Figures 6 and 7 shows the slant range change deformation vectors displayed on the orthophoto image and the LANDSAT image.

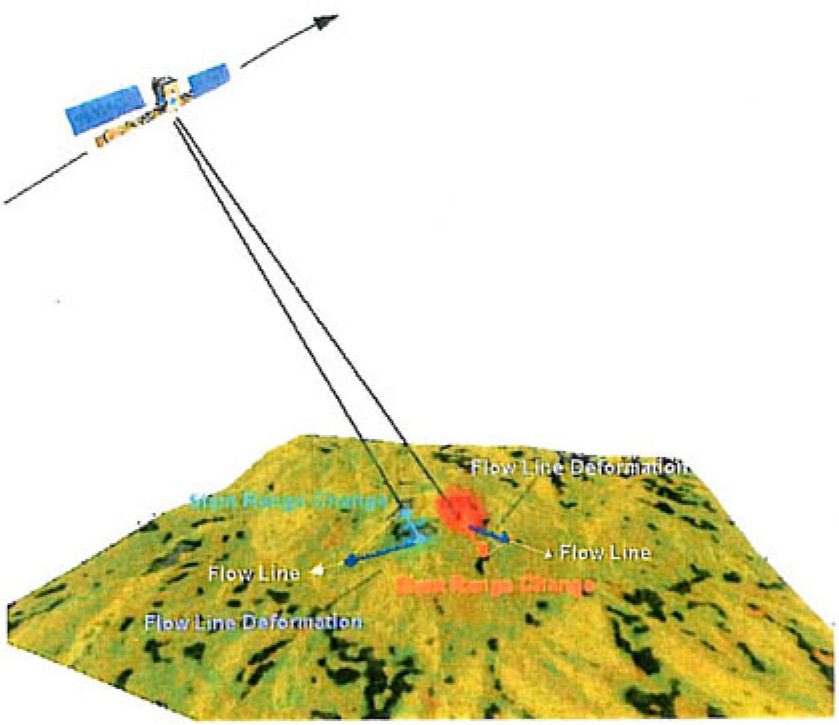


Figure 4: Geometry used for calculation of flow line

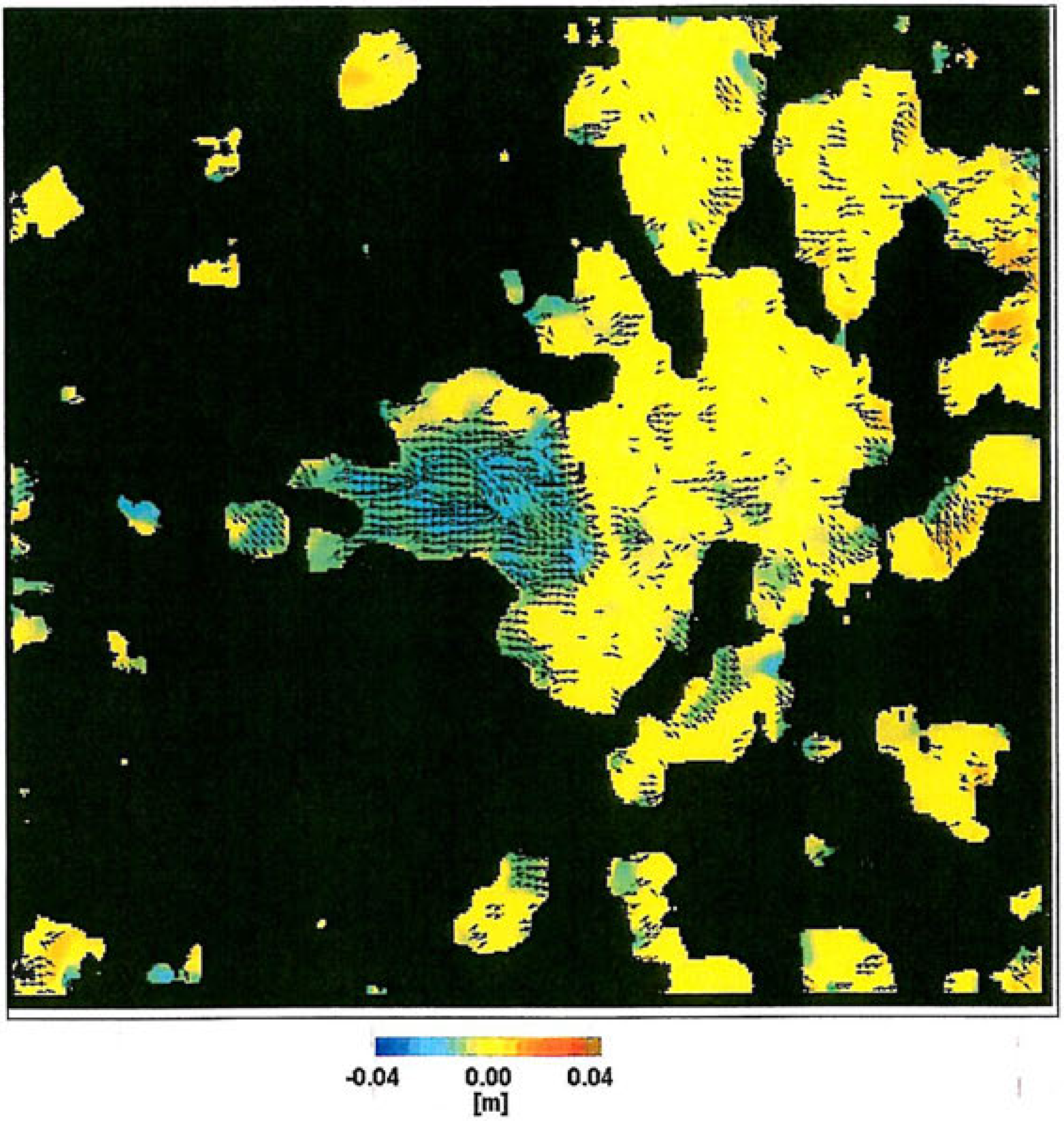


Figure 5: Slant range change map for ERS pair October 24, 1998 to July 31, 1999.

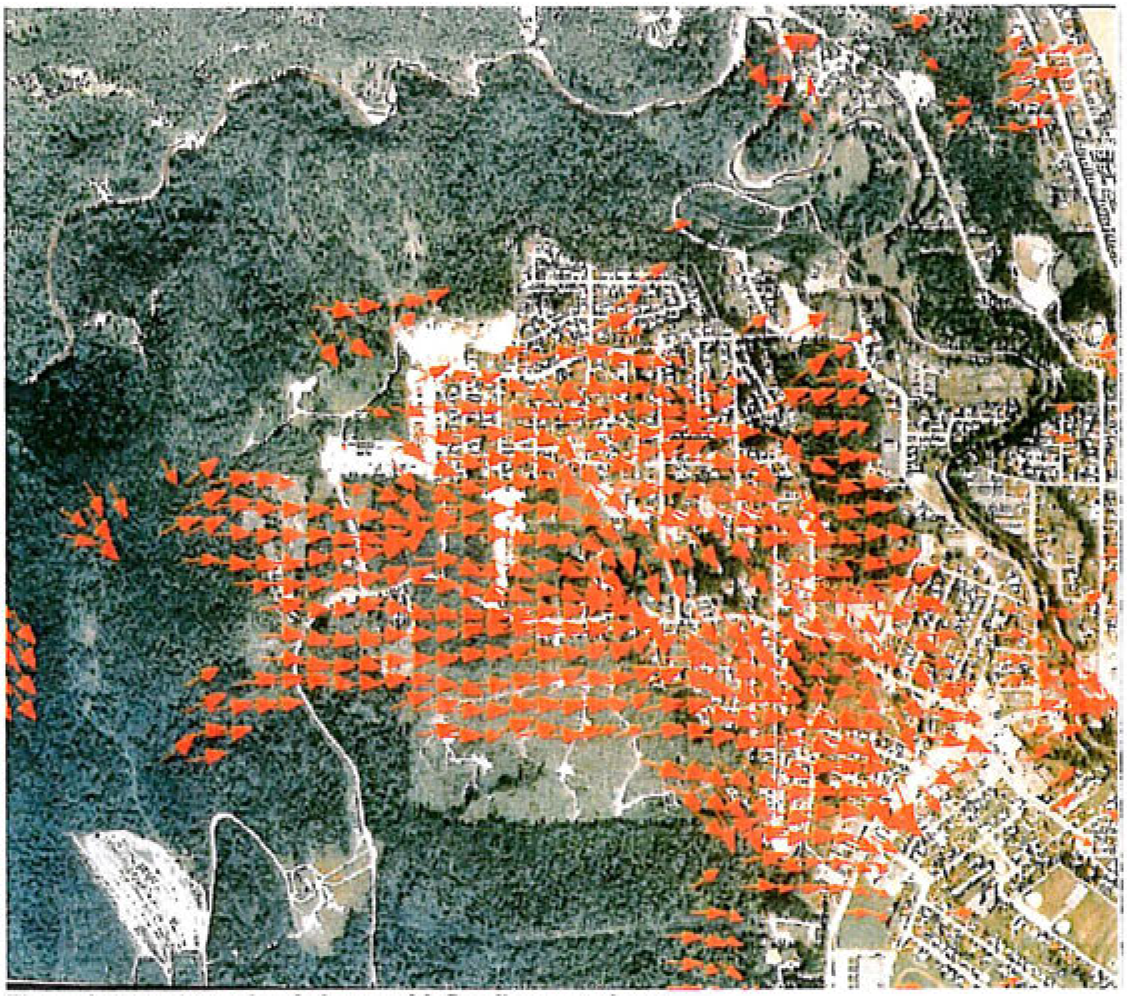


Figure 6: West Quesnel orthoimage with flow line vector layer.

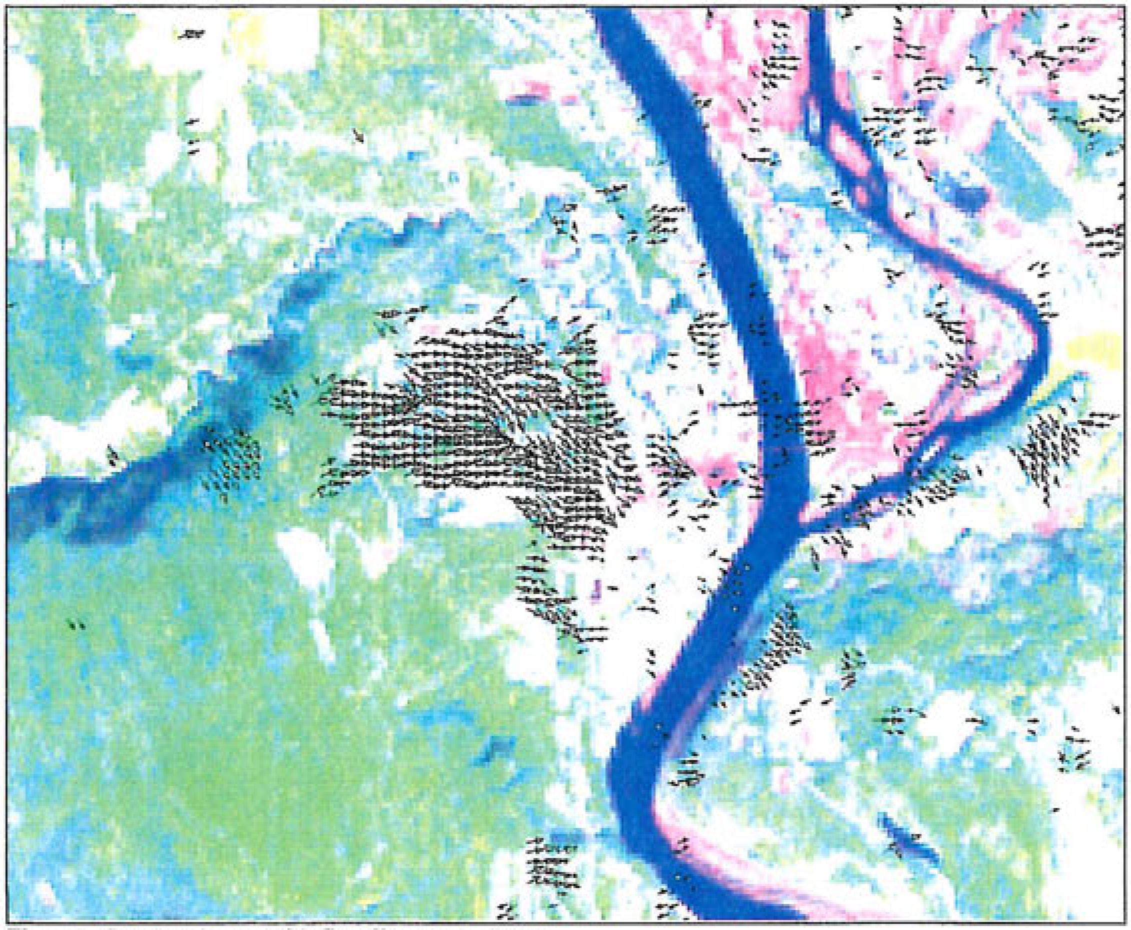


Figure 7: Landsat image with flow line vector layer.

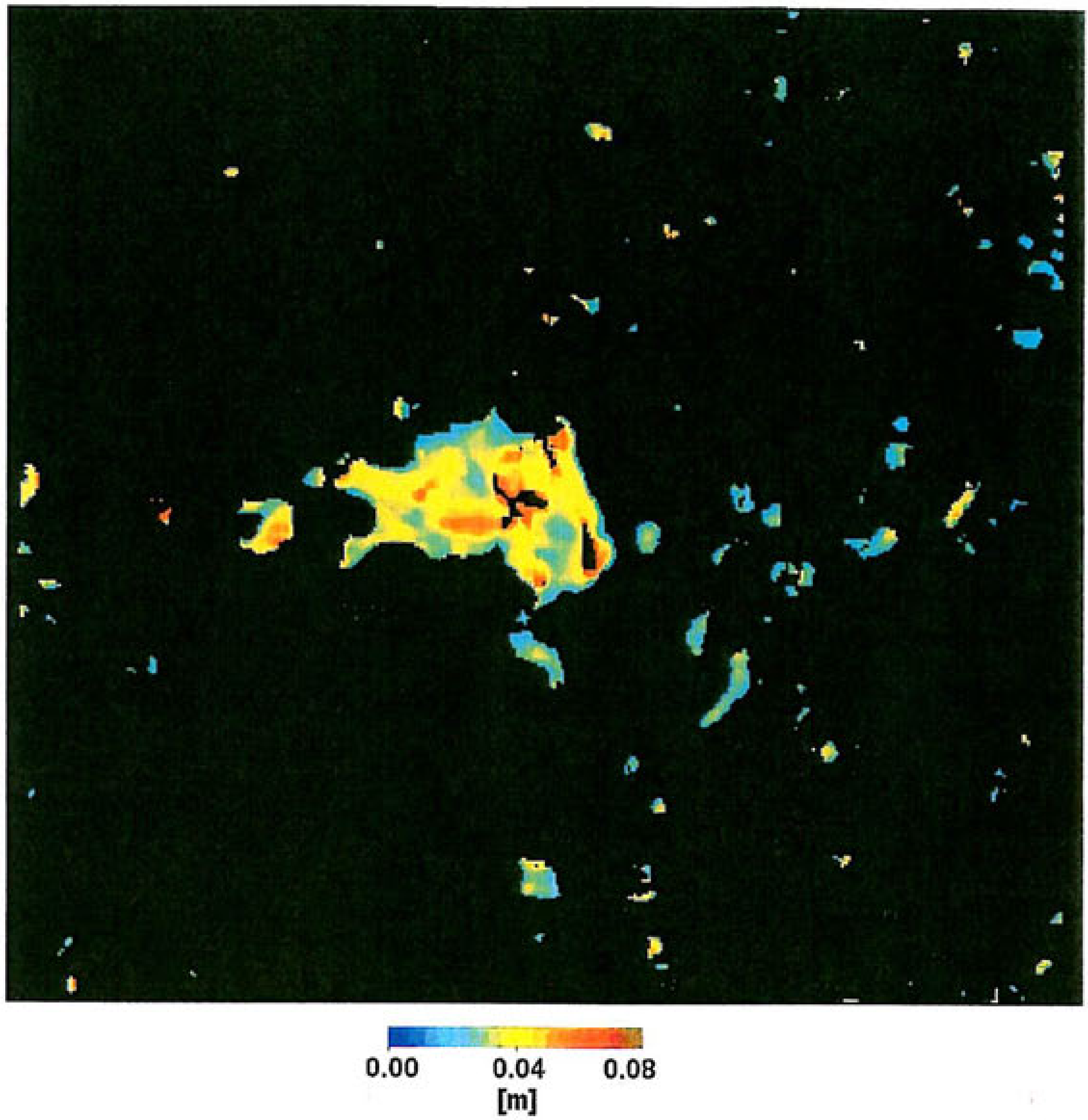


Figure 8: Flow line deformation map for ERS pair October 24, 1998 to July 31, 1999.

5. Discussion

The interferogram of ERS descending data for the time period October 24, 1998 to July 31, 1999 show the major deformation within the area 122d32'28"W 52d58'54"N and 122d30'43"W 52d58'10"N.

6. Deliverables

The deliverables consist of this report, projection report and flow line vector in shape file format. Backscatter, coherence, slant range change map and the flow line deformation map are also provided in GeoTiff file format. All files are in UTM projection system, Datum WGS84. Deformation values in metres.

West Quesnel_v1.0.doc

Descending data:

102498_073199_coherence.tif
102498_073199_backscatter.tif
102498_073199_slrg_change.tif
102498_073199_slrg_color.tif
102498_073199_flowline.tif
102498_073199_flowline_color.tif
102498_073199_vector.dbf
102498_073199_vector.shp
102498_073199_vector.shx

APPENDIX B

Surface Search Inc.
Engineering and Environmental Geophysics

12038 Lake Emerald Cr SE
P.O. Box 6042 Stn A
Calgary, Alberta
Canada, T2H 2L3
Phone (403) 531-9721
Fax (403) 294-1240

January 18, 2004

The City of Quesnel
c/o: AMEC Earth & Environmental Limited
610 Richard Road
Prince George, BC
V2K 4L3

Attention: Mr. Nick Polysou, P. Eng.

Re: West Quesnel, BC Slope Study Project – Electrical Resistivity Tomography Survey

Dear Mr. Polysou;

Please find enclosed a letter report, prepared by Surface Search Inc., on behalf of The City of Quesnel and AMEC Earth & Environmental Ltd, for the Electrical Resistivity Tomography (ERT) survey completed in August of this year within West Quesnel, BC.

Included herein are details of the ERT methodology used by Surface Search Inc, to probe subsurface conditions below West Quesnel and a discussion of the results obtained.

1. INTRODUCTION

In July 2004, Surface Search Inc. (SSI) received authorization from AMEC Earth & Environmental Ltd (upon approval from The City of Quesnel) to undertake and complete a Electrical Resistivity Tomography (ERT) geophysical survey within West Quesnel, BC.

The primary objective of the geophysical ERT survey was to obtain cross-sectional subsurface information, to be used by AMEC Earth & Environmental Ltd. (AEE) in their on-going study / assessment of slope ground movement within the West Quesnel residential area.

The scope of the ERT survey included:

1) Acquisition of approximately 7.5 line kilometers of ERT data along north-south and east-west running transects within the West Quesnel residential area;

2) Processing and interpretation of modeled ERT inversion results for all the acquired data;

3) Production of hard copy data results including ERT model inversion cross-sections for all of the survey transects, and cross-sectional diagrams depicting interpred subsurface geologic features based on the ERT model inversions correlated with available borehole information;

4) And finally, production of a letter report detailing the ERT survey methodology used and a discussion of the ERT survey results obtained.

2. SURVEY METHODOLOGY

SURVEY DESIGN & LOGISTICS

Survey design, field work logistics and the scope of the ERT survey program were established in consultation with Mr. Nick Polysou, P. Eng., of AEE, prior to commencement of the geophysical program. To design a geophysical survey program for the West Quesnel Slope Study Project, ground surface conditions and potential subsurface conditions within the survey area were discussed. At this time, subsurface conditions were anticipated (from available AEE borehole information) to consist primarily of unconsolidated silt and clay deposits overlying slightly more consolidated tertiary silt and clay sediments and/or consolidated bedrock. The primary target of interest, to potentially be delineated by ERT, was the interface boundary between unconsolidated sediments overlying the partially consolidated Tertiary deposits. Based on the available borehole data, this interface was anticipated to lie within the upper 80 m from ground surface throughout the survey area. Of secondary importance was the delineation of the upper surface of consolidated bedrock, underlying the Tertiary deposits.

To satisfy these objectives, an ERT survey program was proposed which included the acquisition of ERT data measurements to 80 m in depth below ground levels. The ERT transects were to be laid out along existing residential roads and pathways in both north-south and east-west line orientations.

ERT DATA COLLECTION

The ERT data acquired for this project were collected using a multi-electrode Syscal R1 Plus ground resistivity system. The R1 Plus ERT instrumentation is comprised of a highly sensitive resistivity meter, an electrode switch-box, four 120 m long multi-core cables, and 48 stainless steel electrode ground stakes. To set up the ERT system for survey measurements, electrodes are pushed into the ground at evenly spaced distance intervals and connected to the multi-core cables, which in turn, are connected to the R1 Plus resistivity meter / switch-box.

The ERT survey setup used for this project involved pushing electrodes (i.e. stainless steel stakes) 0.1 to 0.2 m into the ground at 10 m station intervals. The grounded electrodes were then attached to the multi-core cables, which in turn, were connected to the R1 Plus switchbox and resistivity meter.

Electrode contact tests were completed at all electrode positions, prior to the acquisition of ERT measurement data, to ensure sufficient electrical current transmission between the electrodes and the ground. Where contact test measurements exceeded 5000 Ohm m, adjustments were made to attempt to improve the electrical contact between the electrode(s) and the ground. Typically, these adjustments involved pounding suspect electrodes further into the ground or checking to ensure proper jumper wire connections between the electrode and the array cable. At relatively infrequent intervals throughout the survey area, individual electrodes could not be pushed into the ground because of the presence of concrete driveways, associated with residential lots, and/or asphalt road crossings.

All of the ERT data recorded for this project were acquired using Wenner current/potential electrode activation sequences with automatic power input ranging up to 200W.

The aforementioned ERT survey parameters provided 5.0 m vertical resolution subsurface tomography imagery to a maximum survey depth of 80 m below the ground surface along the survey transects.

Survey position control for the ERT transect layouts and all electrode positions were referenced to Global Satellite Positioning (GPS) measurements acquired from a hand-held Garmin 76 GPS unit. Topographical control for the ERT transects was accomplished using NASA DEM data downloaded off the internet.

ERT DATA PROCESSING AND ANALYSIS

The ERT data acquired for this project were processed using RES2DINV ERT inversion software. Prior to running the inversion program and creating ground resistivity profile models, measurement data values with greater than 1% RMS error were removed from the raw data sets. To further improve data quality, an ILFA smoothing routine was used to remove isolated noise spikes from the raw data sets.

Filters, dampeners, surface topography, and model constraint parameters were then adjusted using iterative pre-inversion routines to account for:

- Measurement geometry and noise levels;
- Range and distribution of recorded resistivity values;
- Range and distribution of model sensitivity.

The pre-inversion iterative process gave specific consideration to:

- Topographic corrections (using NASA DEM data);
- Vertical compression of the inverse model grid;
- Spatial smoothing of the inverse model resistivity values
- Limiters on the range of resistivity values produced during inversion to decrease the influence of spurious values and/or noise;
- Values of the robust constraints on the resistivity values produced during forward modeling
- Dampener levels

All of the ERT data were inverted using selected parameters until model iterations stabilized to produce interpretable ground resistivity cross-section models of less than 5% RMS error (in comparison with the pseudo-section ERT values).

Data values from the modeled ERT results were overlain onto cross-section profile drawings for each ERT transect. Analysis of the combined ERT model data and available borehole data was completed to interpret / infer subsurface geologic conditions beneath the surveyed transect areas.

3. RESULTS

The results of the West Quesnel ERT survey include:

1. A plan map showing all of the ERT transect line locations acquired within the West Quesnel area (see Drawing No. 04-860-00);
2. Cross-section plot diagrams showing contoured electrical resistivity values, in Ohm m, produced from the inverted ERT data transects (see Drawing No.s 04-860-01 through 04-860-10, inclusive);
3. Cross-section plot diagrams showing contoured electrical resistivity values, in Ohm m, produced from the inverted ERT data transects, plotted alongside available borehole information and including our interpretation of the possible sedimentary interface between unconsolidated Quaternary deposits overlying slightly consolidated Tertiary deposits (see Drawing No.s 04-860-01A through 04-860-10A, inclusive);
4. Plan maps showing residual data values taken from the inverted ERT models at pre-defined depths below ground surface levels (i.e. at 10, 20, 40 and 60 m respectively (see Drawing Nos. 04-860-0R1 – 04-860-0R4).

4. DISCUSSION OF THE ERT SURVEY RESULTS

The inverted ERT model cross-sections obtained for this project are believed to contain reasonably reliable information about the electrical properties of the subsurface conditions below the surveyed areas, to a maximum depth of 80 m below ground surface levels. Although these results may be imperfect (see section below discussing possible sources for error in the data results), it is our belief that they are of significant value in providing direction for subsequent subsurface investigation and assessment initiatives within the West Quesnel area.

Our initial attempt at understanding or interpreting the ERT results, given the available borehole log data, is provided below. It should be noted however, that given the scope of the ERT survey, in comparison with the limited borehole log data available, we do not believe that there is sufficient ground control information to provide a fully detailed interpretation of the ERT results at this time. Should additional geotechnical information become available within the ERT survey area, it is recommended that these data be reviewed.

PRELIMINARY DISCUSSION ON THE WEST QUESNEL ERT DATA RESULTS

In correlation with borehole logs BH-3A, BH-4A and BH-6A, we interpret the 30 Ohm m interface boundary, within each of the ERT model sections, to depict the possible interface between unconsolidated Quaternary deposits overlying slightly more consolidated Tertiary deposits. In the slope indicator data obtained for SI-3, SI-4 and SI-6A, our inferred sedimentary interface appears to be in close approximation, in depth, with zones of maximum ground movement. However, in the slope indicator data obtained for SI-5, our interpreted sedimentary interface is shown to be significantly higher in elevation in comparison to the zone of maximum ground movement recorded by the slope indicator.

In addition to our interpretation of the upper Tertiary boundary interface, relatively high electrical resistivity value anomalies (e.g. modeled resistivity values in excess of 500 Ohm m) are noted within ERT profiles B-B', C-C', H-H' and I-I'. We believe these anomalies indicate the presence of granular sediment deposits (e.g. sand and/or gravel deposits) at depth. They may also be associated with the presence of water bearing unconsolidated sediments at depth.

To illustrate the lateral extent of the relatively high resistivity value anomalies, residual data values, taken from within the contoured ERT cross-sections, have been extracted at specified depths (e.g. at 10, 20, 40 and 60 m) at 50 m intervals along the length of each ERT data profile. Each depth layer of residual resistivity values was then contoured to provide a pseudo-plan view of the modeled ERT data results.

NOTES ON HOW TO INTERPRET THE WEST QUESNEL DATA

1 The ERT method measures the electrical resistivity of ground conditions below the surface. Resistivity, measured in Ohm m (or Ω·m), is the mathematical inverse of conductivity. It is a bulk physical property of materials that describes how difficult it is to pass an electrical current through the material. Resistivity measurements can be made with either an alternating current (AC) or a direct current (DC). As resistivity measurements are frequency dependant, care must be taken when comparing resistivity values collected using different techniques.

Clay materials, metallic oxides, and sulphide minerals are the only common sedimentary materials that can carry significant electrical current through the material itself. As such, the resistivity of most near surface sedimentary materials is primarily controlled by the quantity and chemistry of the pore fluids within the material. Any particular material can have a broad range of resistivity responses that is dependant on the level of saturation, the concentration of ions, the presence of organic fluids (such as non aqueous phase liquids, NAPLs), faulting, jointing, weathering, etc.

Table 1. provided below characterizes the normal range of resistivity values for common geologic materials.

Table 1. Normal range of resistivity values for common geologic materials.

Material	Normal Range of Resistivity (Ω·m)		
Galena	0.000,03	to	300
Hematite (Iron Oxide)	0.0035	to	10,000,000
Clays	1	to	100
Silts	20	to	400
Sands	80	to	1050
Gravels	100	to	1400
Permafrost	1000	to	10,000
Consolidated Shales	20	to	2000
Sandstones	8	to	4000
Limestones	50	to	400
Glacier Ice	50,000	to	120,000,000

2 By comparing the ERT results with the available borehole log data, resistivity values shown to be in excess of 30 Ohm m appear to coincide with unconsolidated Quaternary sand, silt and clay deposits.

3 By comparing the ERT results with the available borehole log data, resistivity values shown to be less than 30 Ohm m appear to coincide with more consolidate Tertiary sand, silt and clay deposits.

4 The 30 Ohm m boundary highlighted within the ERT cross-sections may be associated with the depth zone a maximum ground movement as identified in slope indicators SI-3, SI-4 and SI-6A. Where the ERT data intersects slope indicator SI-5, the 30 Ohm m boundary is significantly higher in elevation than the zone of maximum ground movement.

5 Users of this information should be aware that the horizontal and vertical resolution of the modeled resistivity value distributions shown on the cross-section plots is +/- 5.0 m.

6 The vertical resolution of subsurface features diminishes with depth for all geophysical methodologies. Therefore users of this information should be cautioned to the possibility that relatively thin geologic sediment or rock sequence layers may not have been imaged, or detected at depth by the geophysical techniques used for this survey investigation.

SOURCES OF ERROR IN THE ERT DATA

Although every attempt has been made to obtain and provide accurate geophysical results for this investigation, sources for error must be taken into account by users of this information. Possible sources for ERT data measurement and subsequent inversion model errors for this project include:

i) Irregular electrode spacings associated with locations where significant curvatures in the ERT transects occur (ERT data measurements assume a constant distance interval spacing between electrodes).
ii) Inadequate smoothing/filtering of the data to infill absent electrode data (e.g. where concrete or asphalt was encountered and an electrode could not be pushed into the ground).
iii) 3-D side effects associated with volumetric measurements taken in 3-dimensionally complex sediment/rock environments.
iv) Problems associated with equivalence of geophysical measurements where two or more differing sets of geologic conditions produce similar geophysical responses.
v) Shadow effects in the ERT data which tend to exaggerate the base depth of relatively high resistivity value anomalies (e.g. in situations where modeled ERT values > 1000 Ohm m) occur.

5. CLOSING REMARKS

The geophysical interpretations outlined in this report are the result of our best effort analysis Electrical Resistivity Tomography collected within the West Quesnel survey area. Should additional geotechnical information become available for this project, these results may be subject to review and/or require further alteration.

The geologic information depicted in this report is intended to serve as an assessment of the subsurface conditions likely to be encountered within the geophysical survey investigation area(s).

We trust that these geophysical results contribute to the overall geotechnical assessment of the West Quesnel slope study. Please contact the undersigned at (403) 531-9721 should you require any additional information or clarifications regarding this report.

Respectfully submitted,

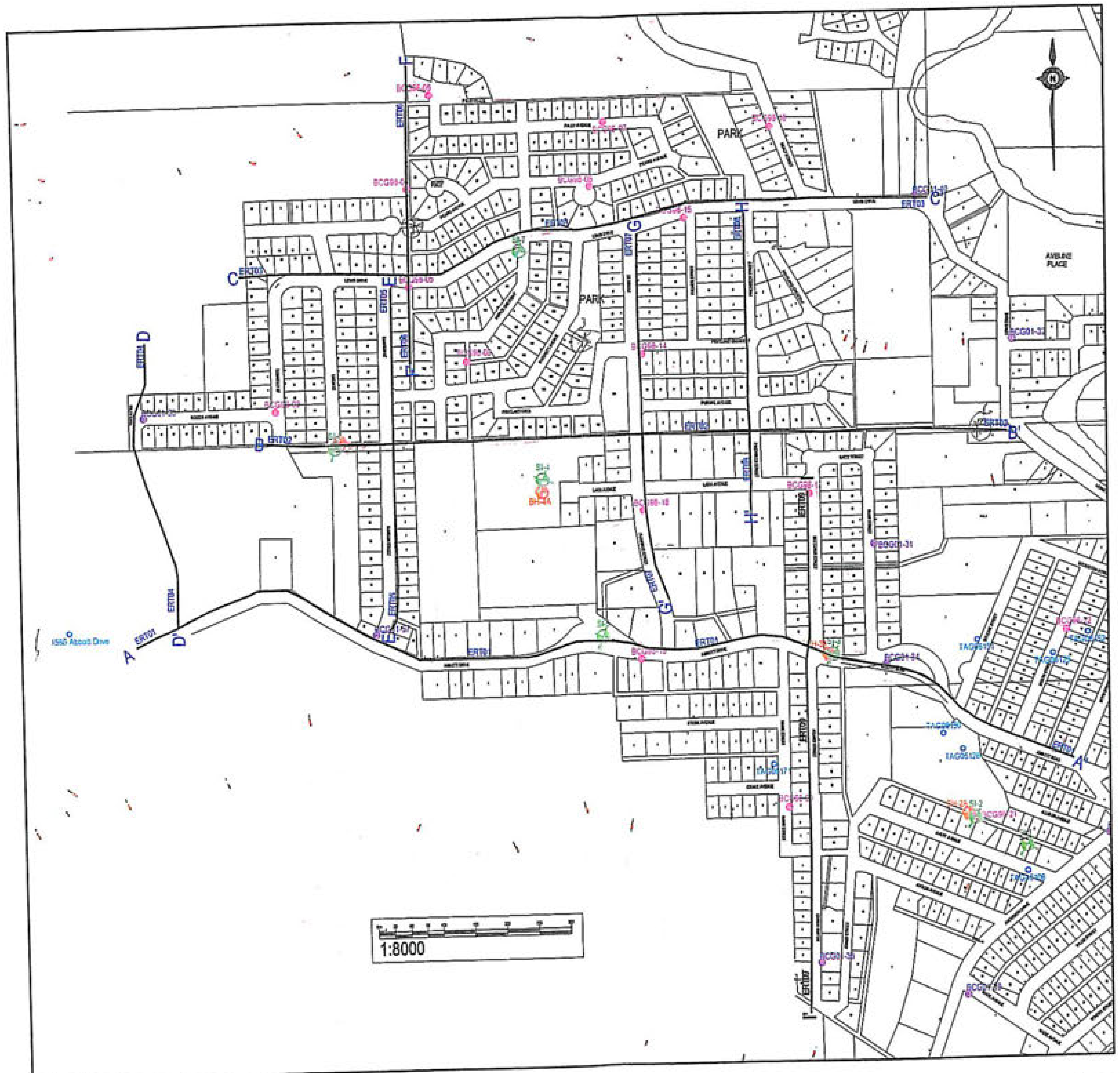
Paul Tarrant
President - Surface Search Inc.

ENCLOSED RESULTS

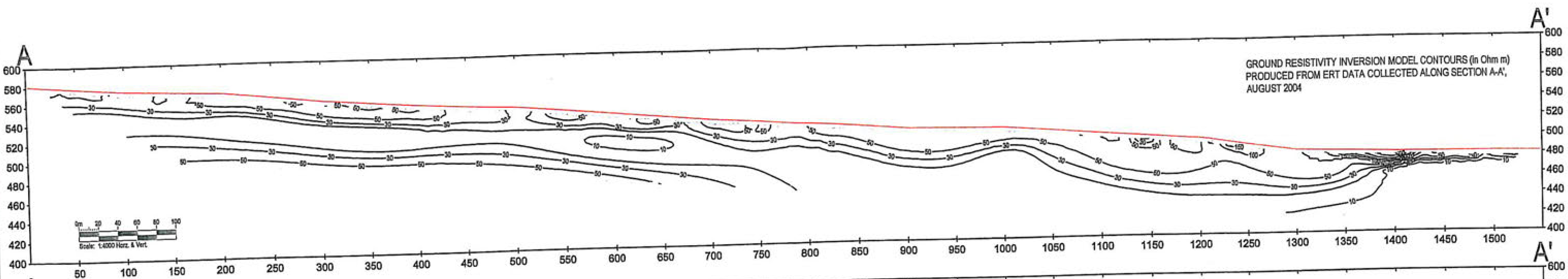
1. **ERT SURVEY LINE LOCATION MAP**, Drawing No. 04-860-00
2. **ERT INVERSION MODEL CROSS SECTION A-A'**, Drawing No. 04-860-01
3. **INTERPRETATION CROSS SECTION A-A'**, Drawing No. 04-860-01A
4. **ERT INVERSION MODEL CROSS SECTION B-B'**, Drawing No. 04-860-02
5. **INTERPRETATION CROSS SECTION B-B'**, Drawing No. 04-860-02A
6. **ERT INVERSION MODEL CROSS SECTION C-C'**, Drawing No. 04-860-03
7. **INTERPRETATION CROSS SECTION C-C'**, Drawing No. 04-860-03A
8. **ERT INVERSION MODEL CROSS SECTION D-D'**, Drawing No. 04-860-04
9. **INTERPRETATION CROSS SECTION D-D'**, Drawing No. 04-860-04A
10. **ERT INVERSION MODEL CROSS SECTION E-E'**, Drawing No. 04-860-05
11. **INTERPRETATION CROSS SECTION E-E'**, Drawing No. 04-860-05A
12. **ERT INVERSION MODEL CROSS SECTION F-F'**, Drawing No. 04-860-06
13. **INTERPRETATION CROSS SECTION F-F'**, Drawing No. 04-860-06A
14. **ERT INVERSION MODEL CROSS SECTION G-G'**, Drawing No. 04-860-07
15. **INTERPRETATION CROSS SECTION G-G'**, Drawing No. 04-860-07A
16. **ERT INVERSION MODEL CROSS SECTION H-H'**, Drawing No. 04-860-08
17. **INTERPRETATION CROSS SECTION H-H'**, Drawing No. 04-860-08A
18. **ERT INVERSION MODEL CROSS SECTION I-I'**, Drawing No. 04-860-09
19. **INTERPRETATION CROSS SECTION I-I'**, Drawing No. 04-860-09A
20. **10 m DEPTH LAYER ERT RESIDUALS MAP,** Drawing No. 04-860-R1
21. **20 m DEPTH LAYER ERT RESIDUALS MAP,** Drawing No. 04-860-R2
22. **40 m DEPTH LAYER ERT RESIDUALS MAP,** Drawing No. 04-860-R3
23. **60 m DEPTH LAYER ERT RESIDUALS MAP,** Drawing No. 04-860-R4

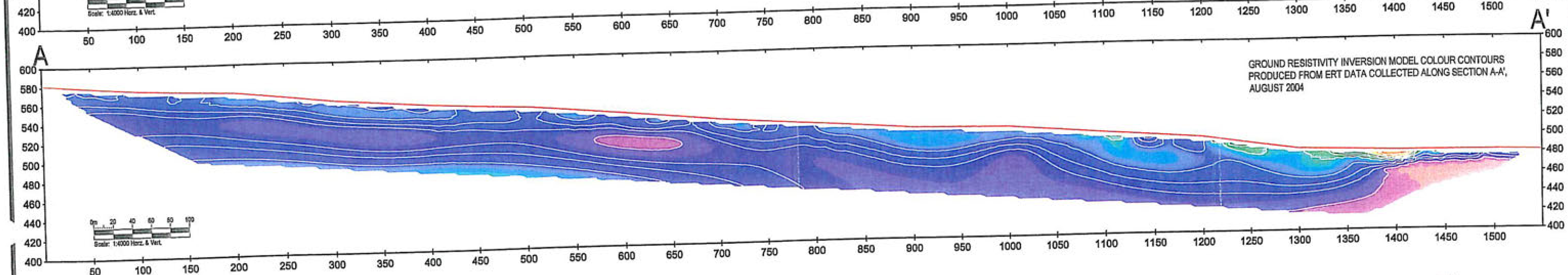
LEGEND:

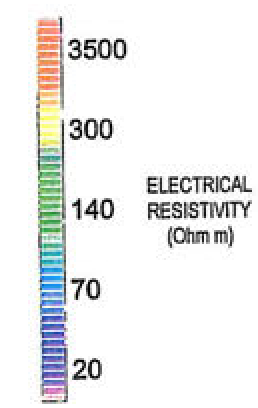
- BCG98-23 — 1998 BC GAS GPS SURVEY HUB
- BCG01-36 — 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A — AMEC BOREHOLES (2001)
- MOT-TH1 — MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 — WATERWELLS
- A—A' — ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

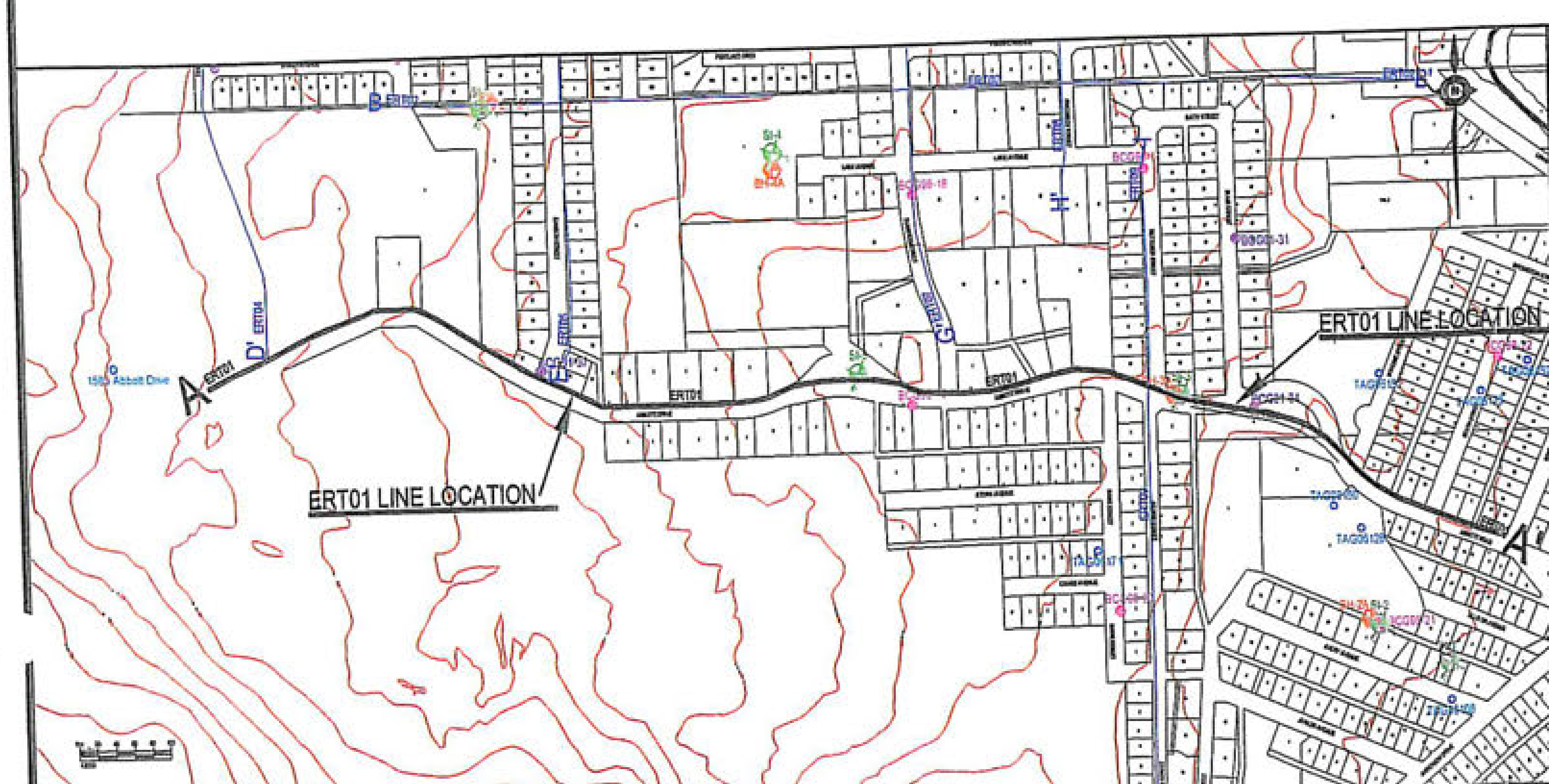


TITLE: ERT SURVEY LINE LOCATION MAP			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12036 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT MAP PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-00 REV. NO.: 01









LEGEND:

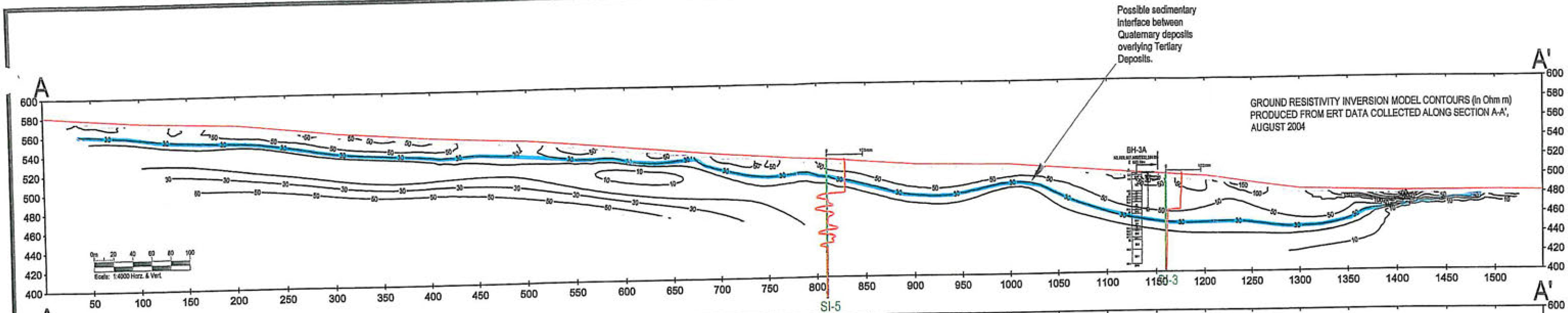
- BCG98-23 — 1998 BC GAS GPS SURVEY HUB
- BCG01-36 — 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A — AMEC BOREHOLES (2001)
- MOT-TH1 — MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 — WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

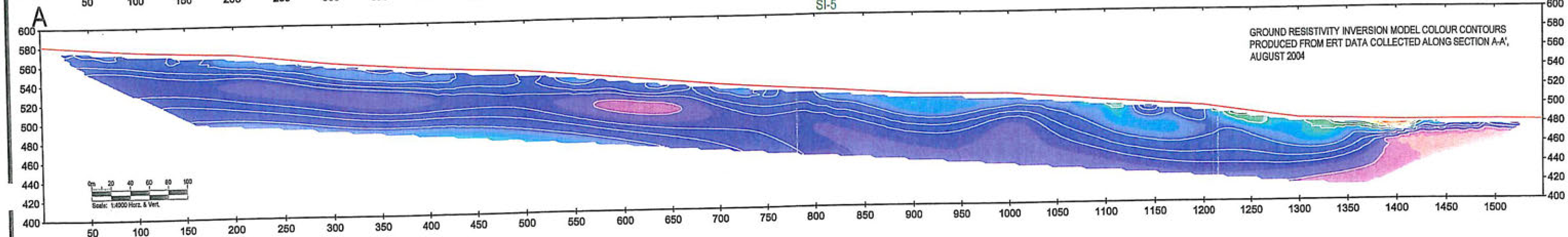
TITLE:
ERT INVERSION MODEL CROSS SECTION A-A' (ERT01)

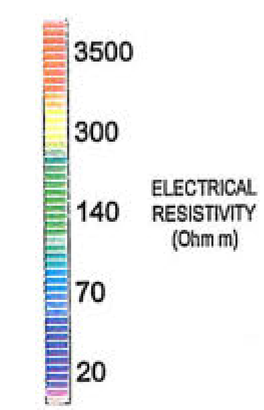
PROJECT:
WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY

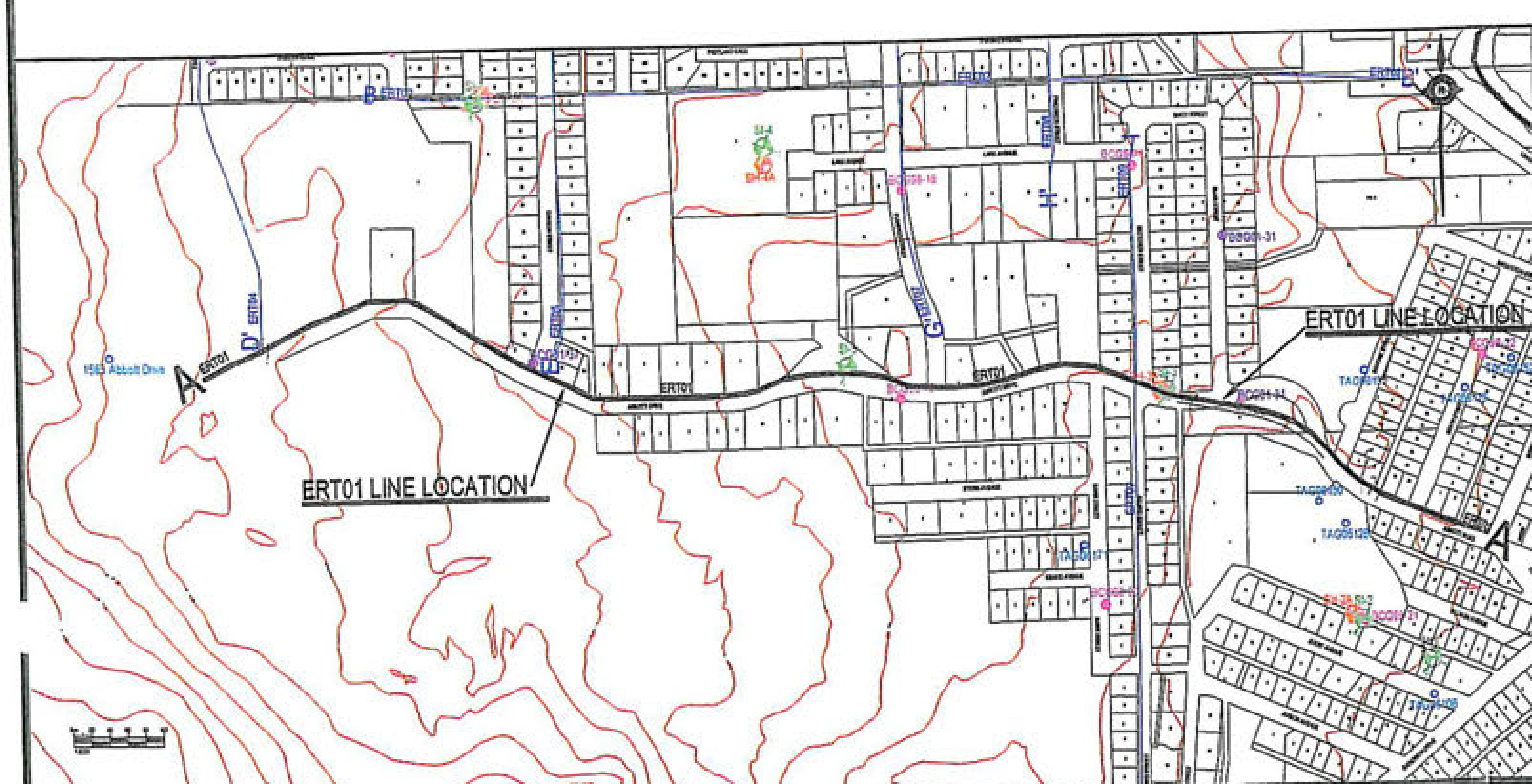
CLIENT:	CONSULTING ENGINEERS:
CITY OF QUESNEL	AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT01 DATA PLOT.DWG	
	DRAWN BY:	JOB NO.:	DRAWING NO.:	REV. NO.:
	PT	04-860	04-860-01	01





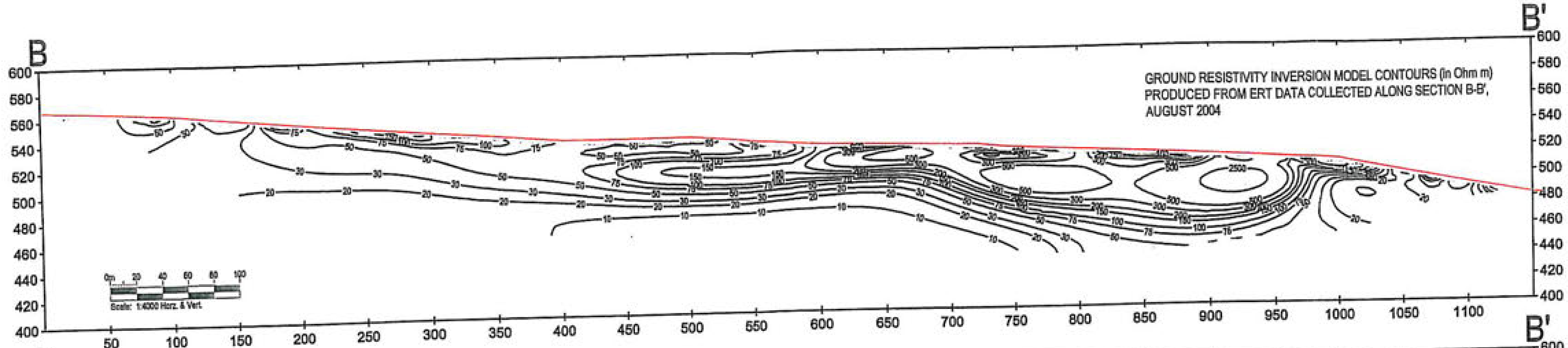


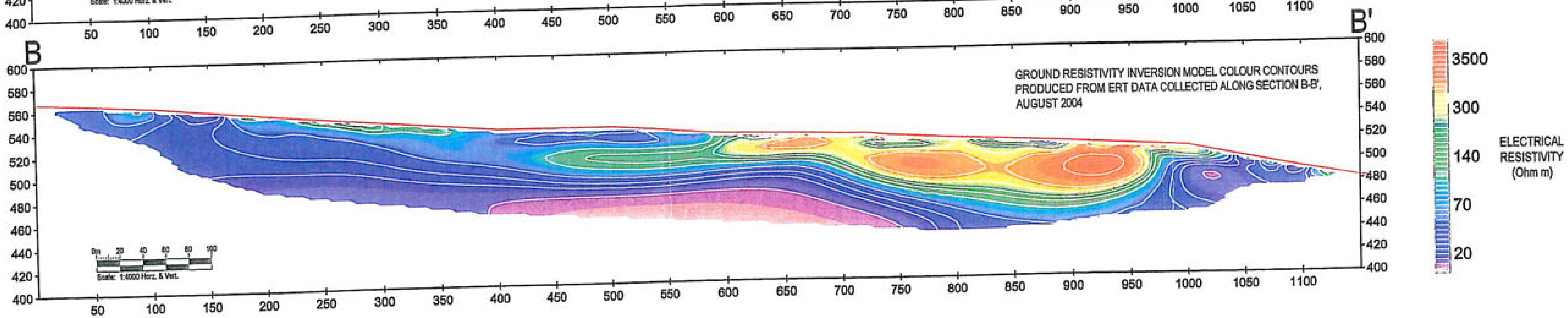


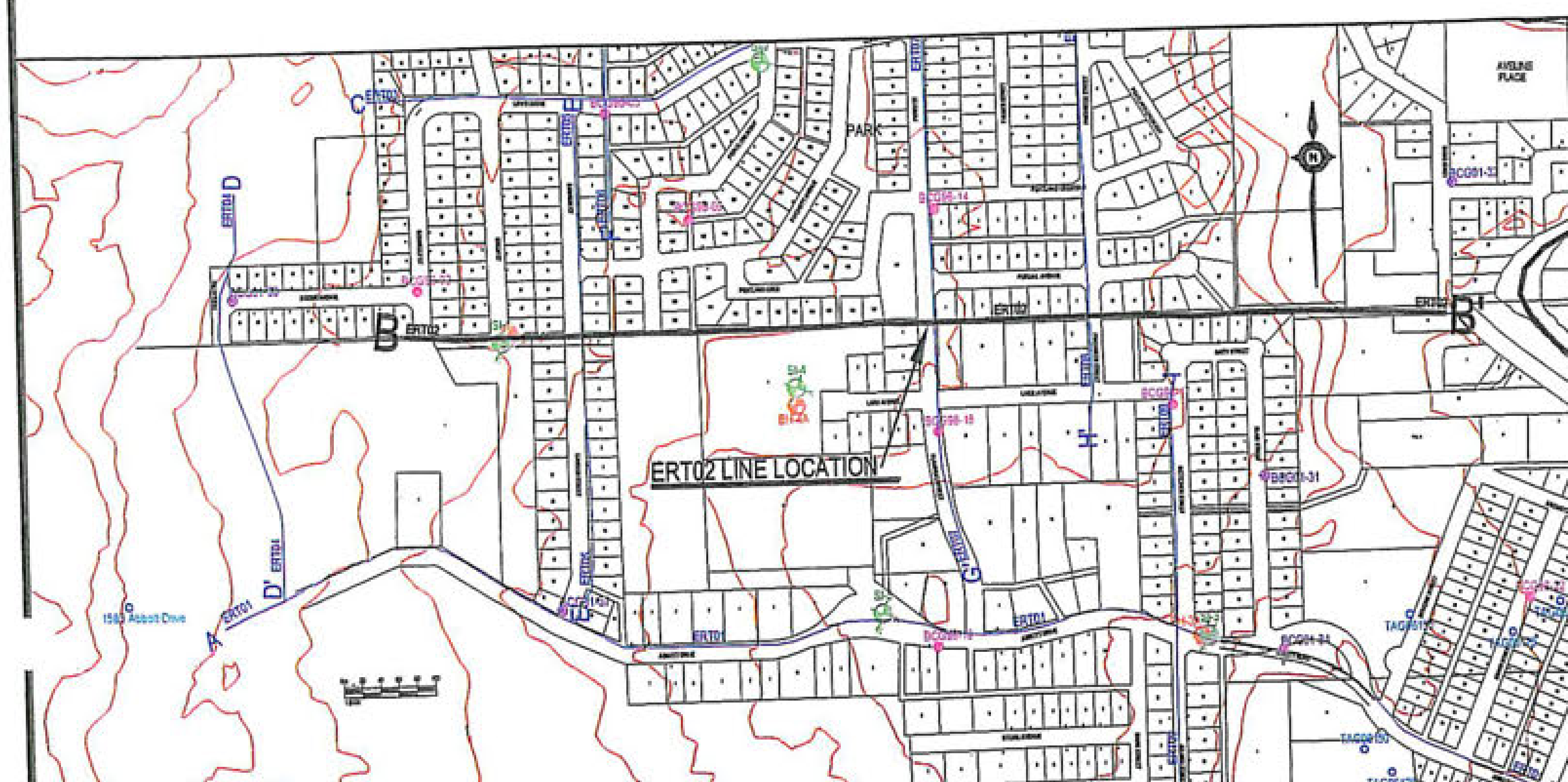
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: INTERPRETATION CROSS SECTION A-A' (ERT01)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12038 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5 Ph: (403) 531-9721 Fax: (403) 284-1240 Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT01 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-860	DRAWING NO.: 04-860-01A / REV. NO.: 01



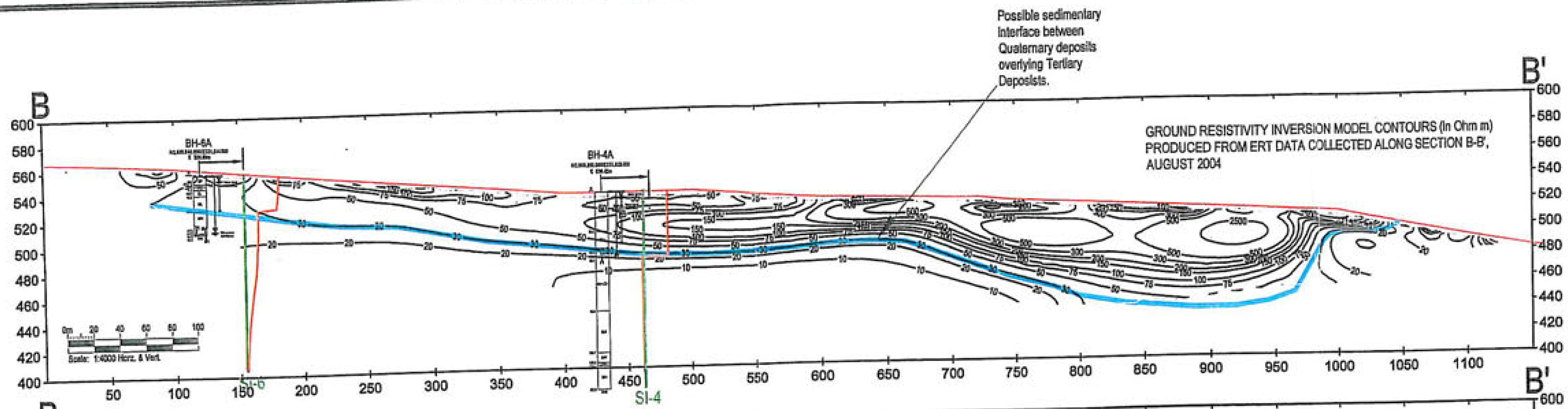


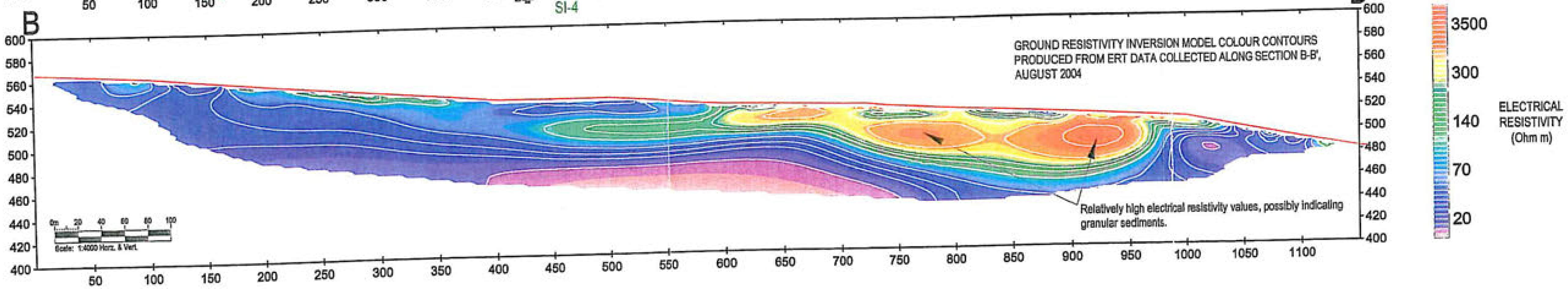


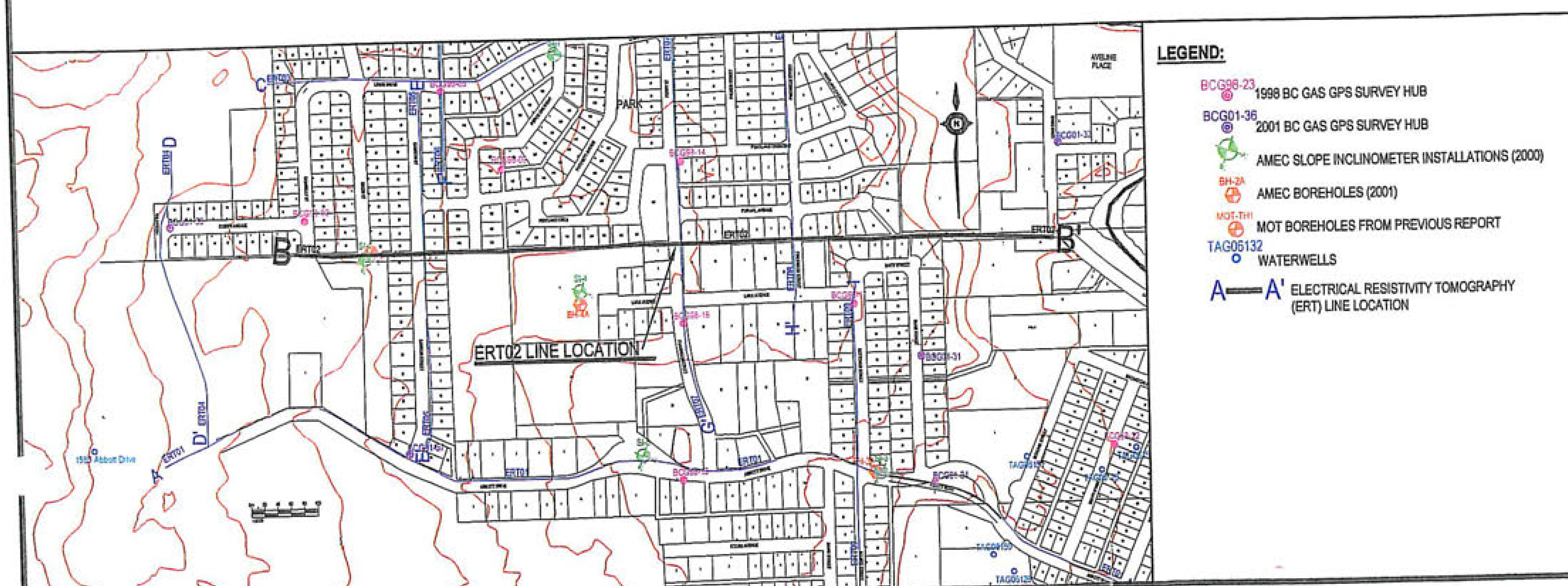
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: ERT INVERSION MODEL CROSS SECTION B-B' (ERT02)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT02 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-02 / REV. NO.: 01

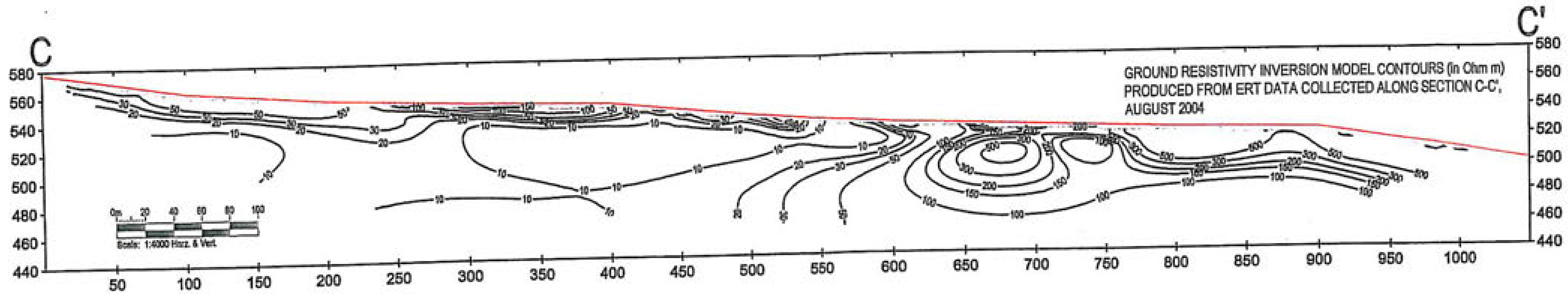


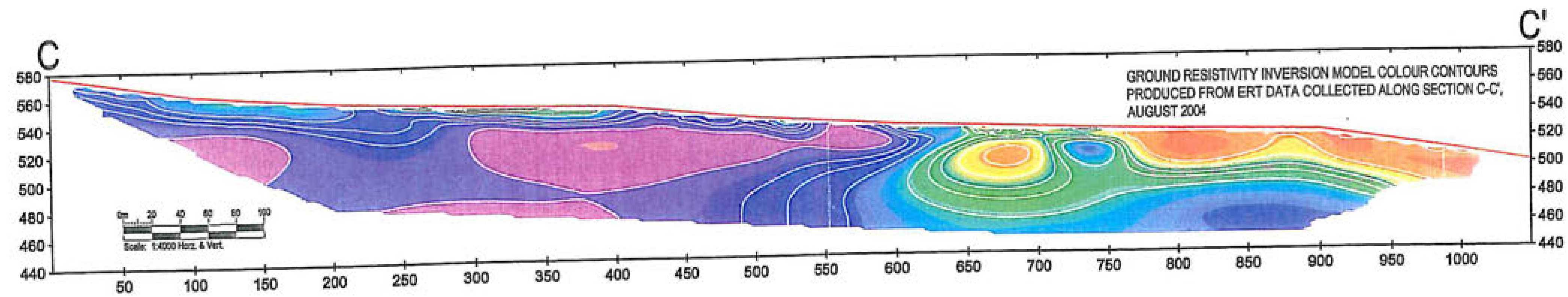


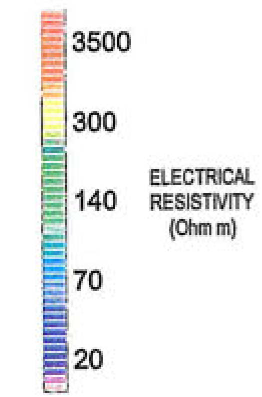


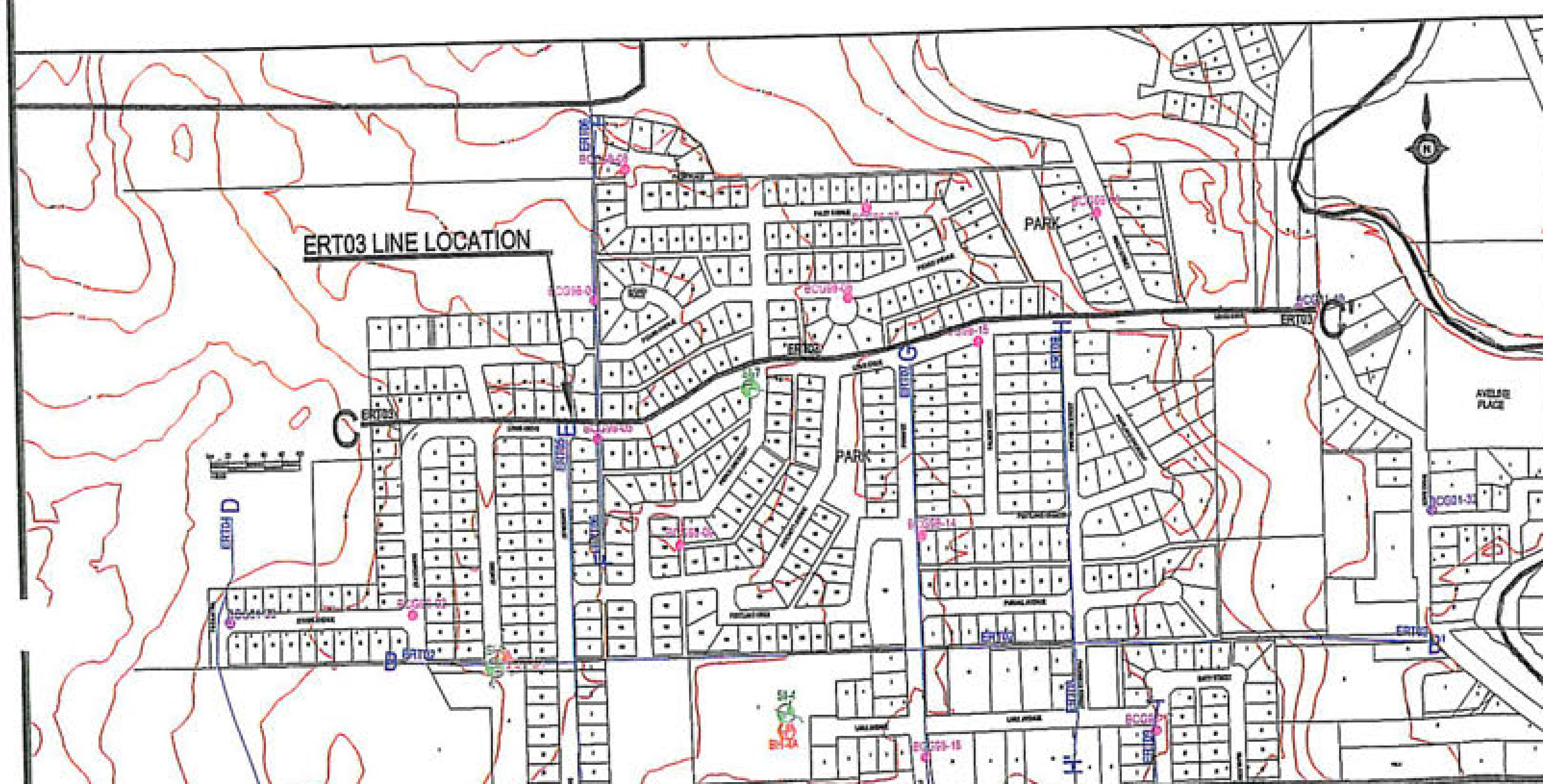
TITLE: INTERPRETATION CROSS SECTION B-B' (ERT02)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12038 Lake Emerald Cr. SW, Calgary, AB, T3J 2J6 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT02 INTERP.DWG	
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-02A	REV. NO.: 01





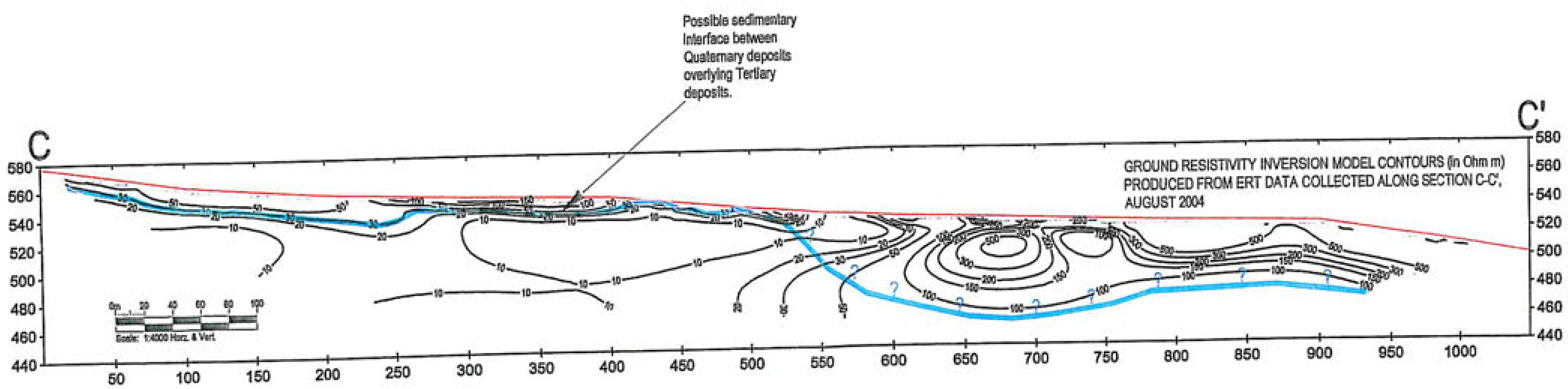


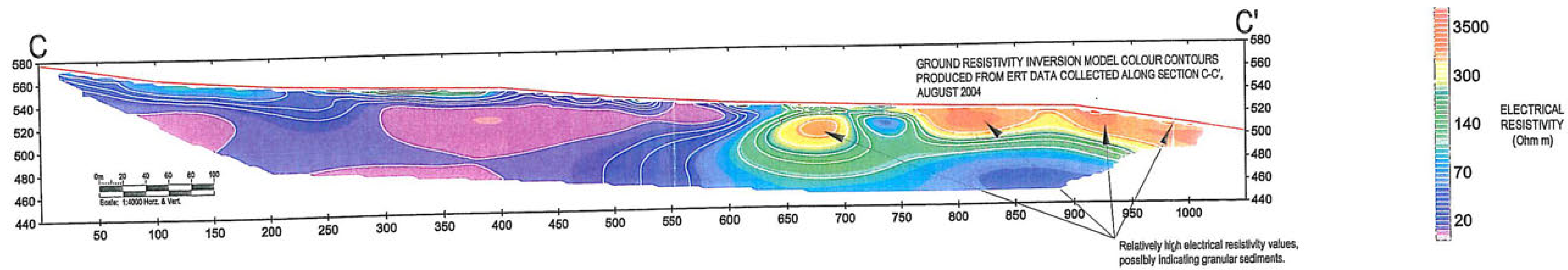


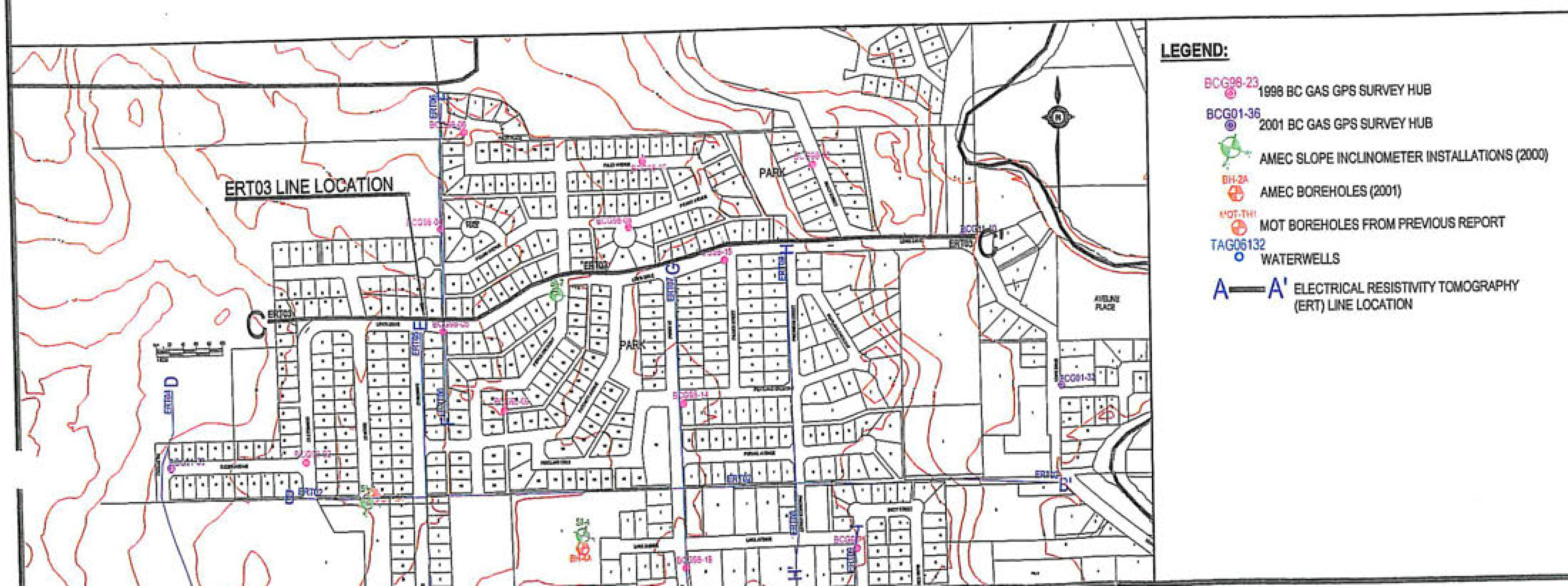
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: ERT INVERSION MODEL CROSS SECTION C-C' (ERT03)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 284-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT03 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-03 · REV. NO.: 01







TITLE:
INTERPRETATION CROSS SECTION C-C' (ERT03)

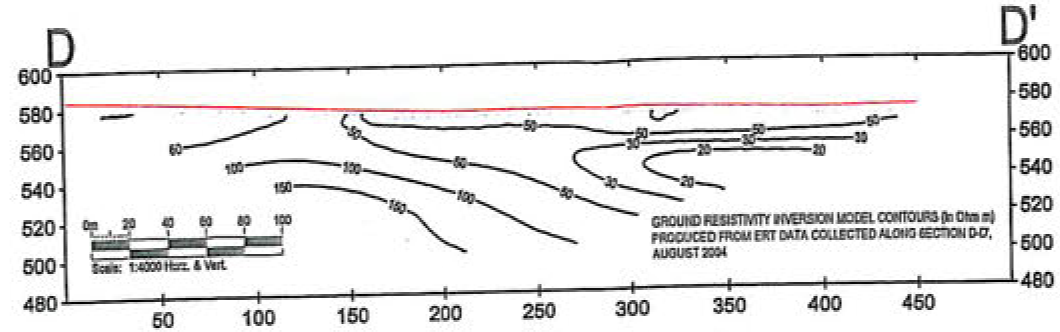
PROJECT:
WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY

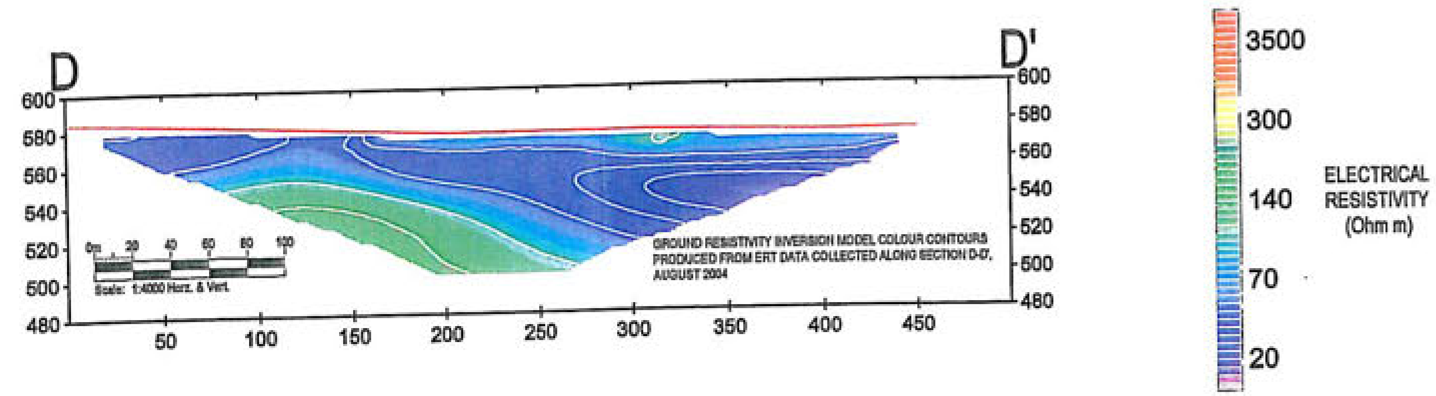
CLIENT:
CITY OF QUESNEL

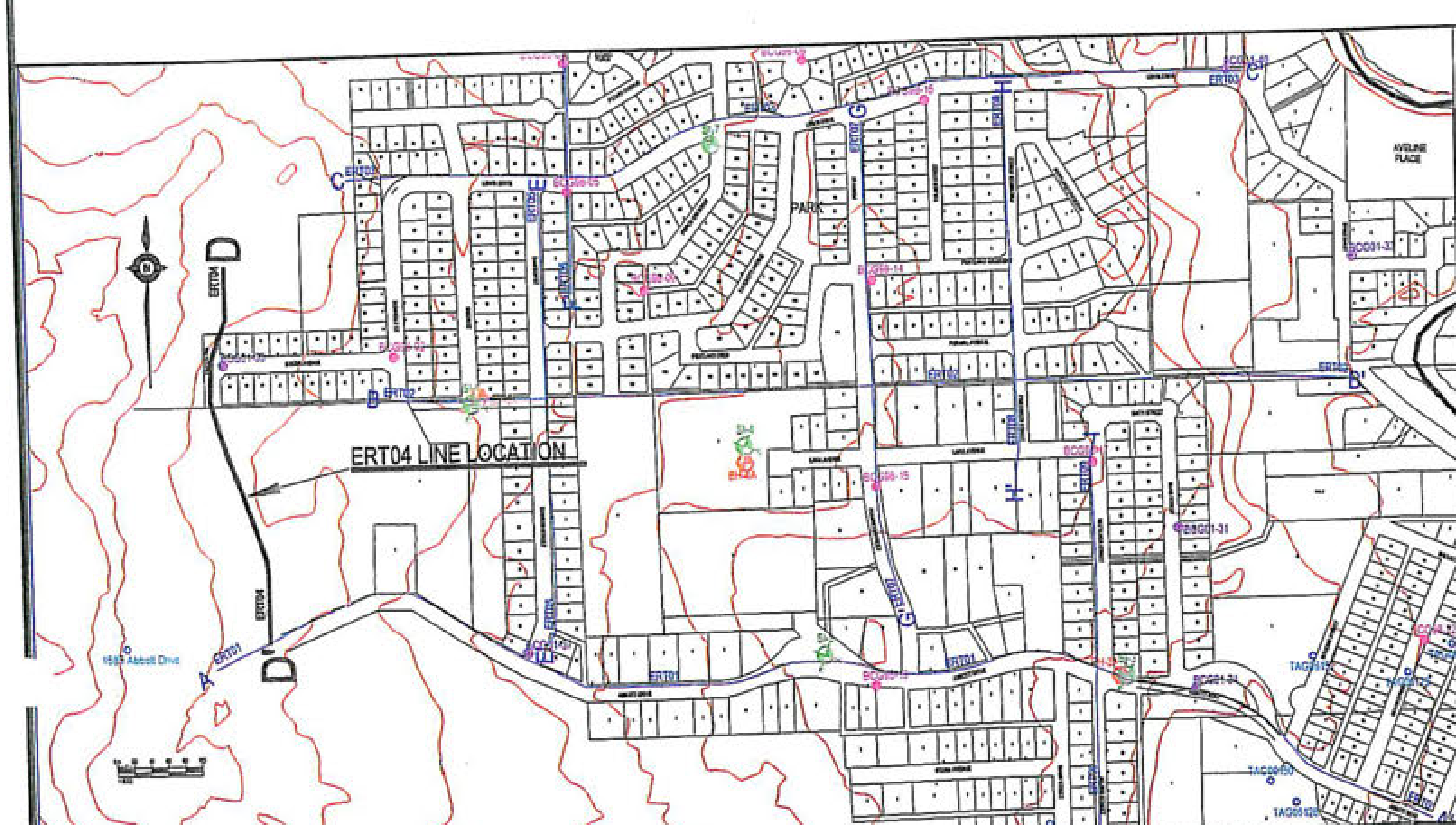
CONSULTING ENGINEERS:
AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:
SURFACE SEARCH INC.
ENGINEERING & ENVIRONMENTAL GEOPHYSICS
12038 Lake Emerald Cr. SW, Calgary, AB, T2J 2J5
Ph: (403) 531-9721 Fax: (403) 294-1240
Email: headoffice@surfacesearch.com

DRAWING SCALE:	DATE:	FILE NAME:	
AS SHOWN	October 2004	ERT03 INTERP.DWG	
DRAWN BY:	JOB NO.:	DRAWING NO.:	REV. NO.:
PT	04-863	04-860-03A	01



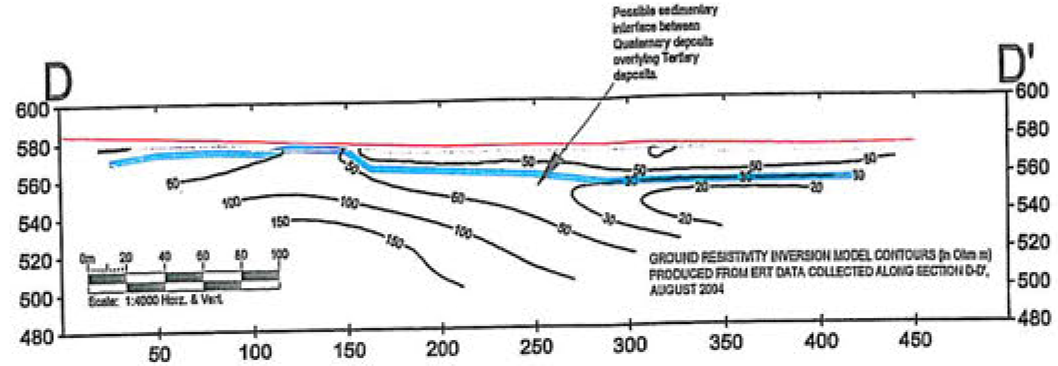


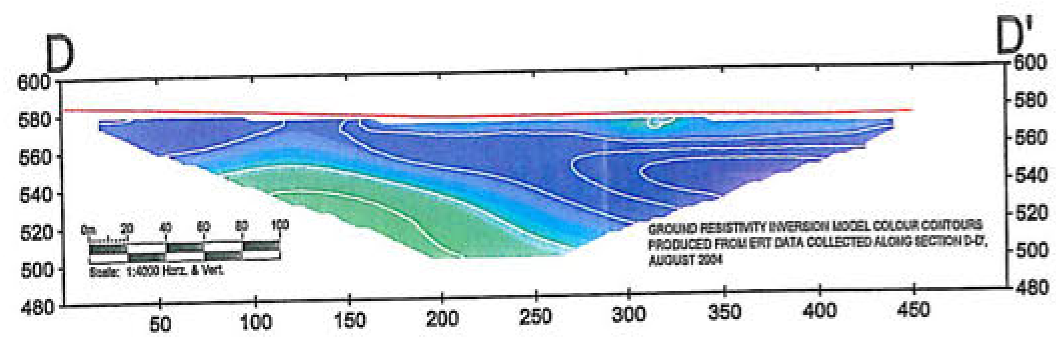


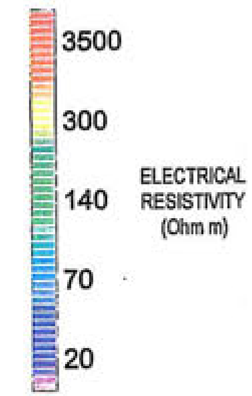
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG05132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: ERT INVERSION MODEL CROSS SECTION D-D' (ERT04)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT04 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-04 — REV. NO.: 01



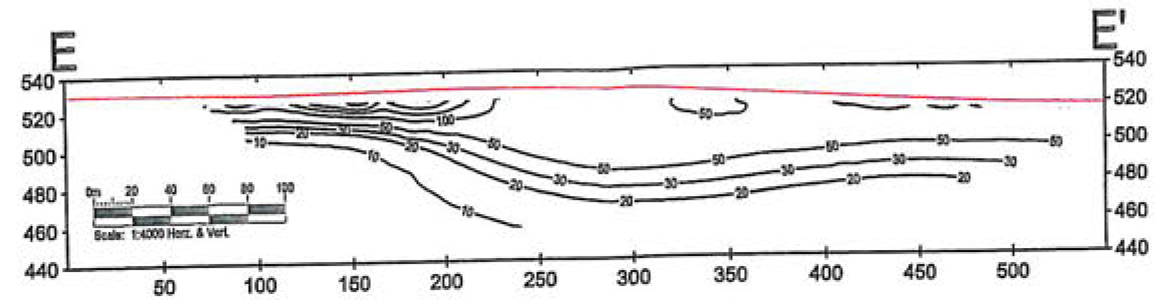




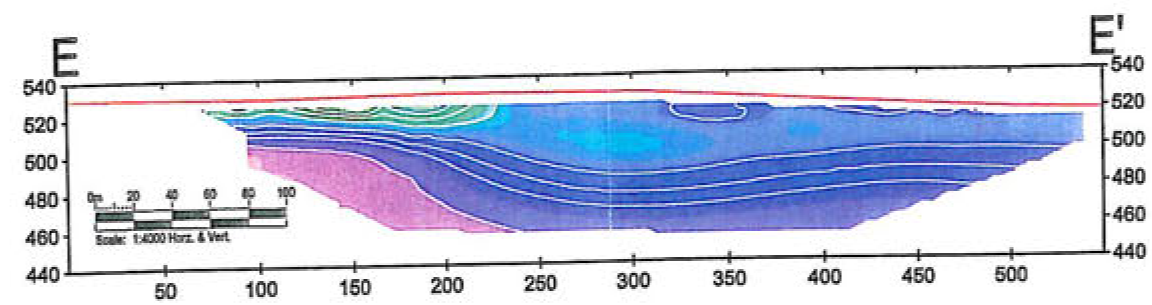
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG05132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

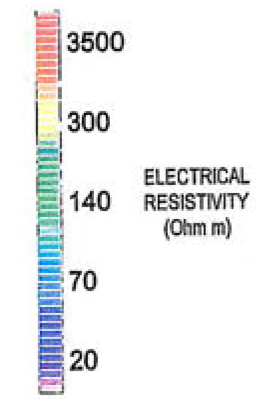
TITLE: INTERPRETATION CROSS SECTION D-D' (ERT04)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12035 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT04 INTERP.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-04A / REV. NO.: 01



GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION E-E', AUGUST 2004



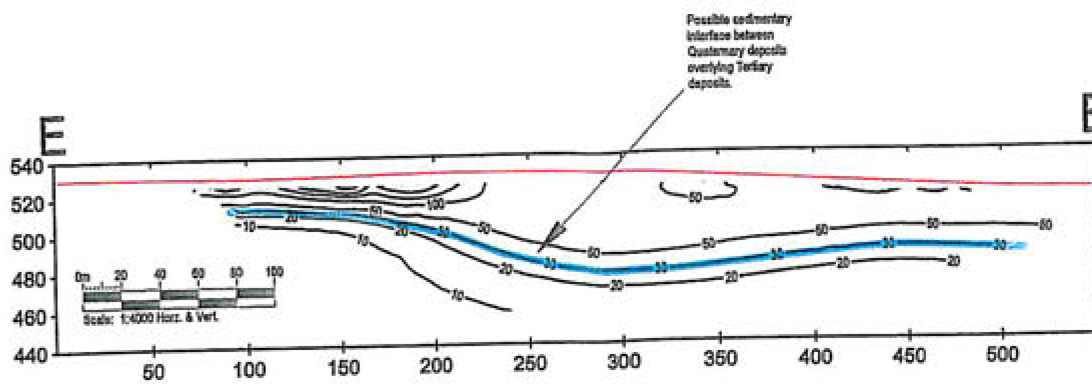
GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION E-E', AUGUST 2004



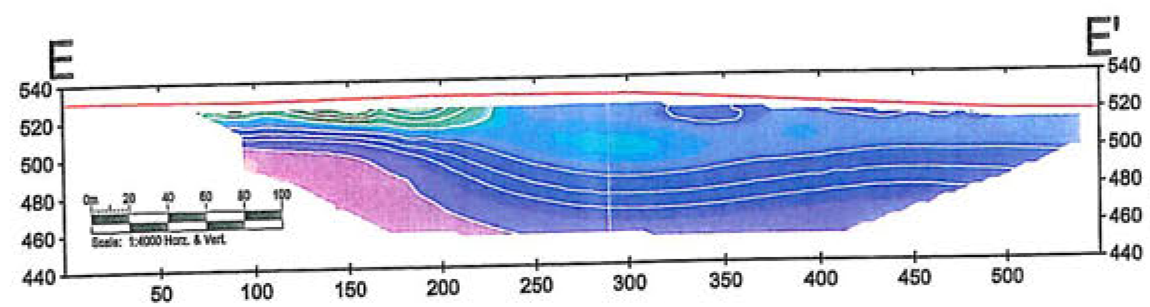
LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

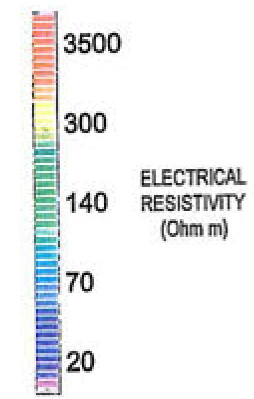
TITLE: ERT INVERSION MODEL CROSS SECTION E-E' (ERT05)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT05 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-05 / REV. NO.: 01

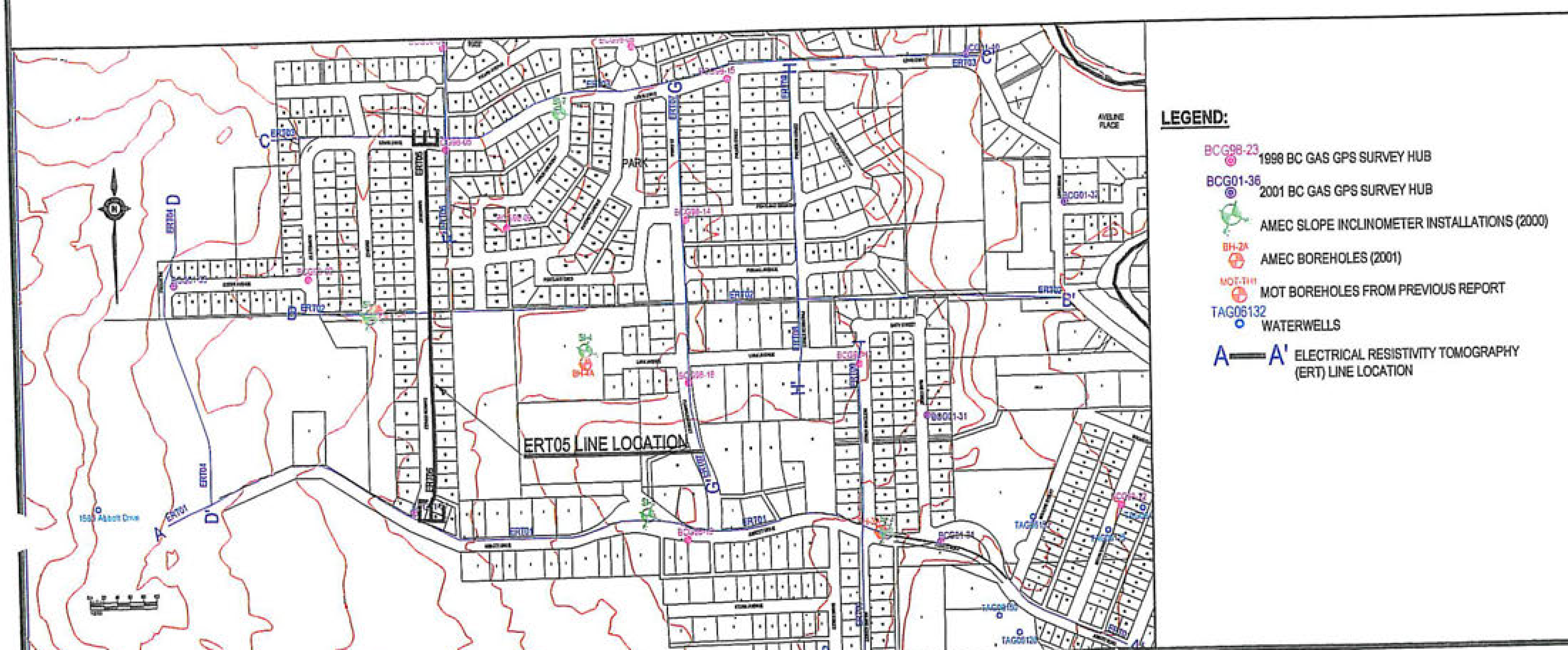


GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION E-E', AUGUST 2004



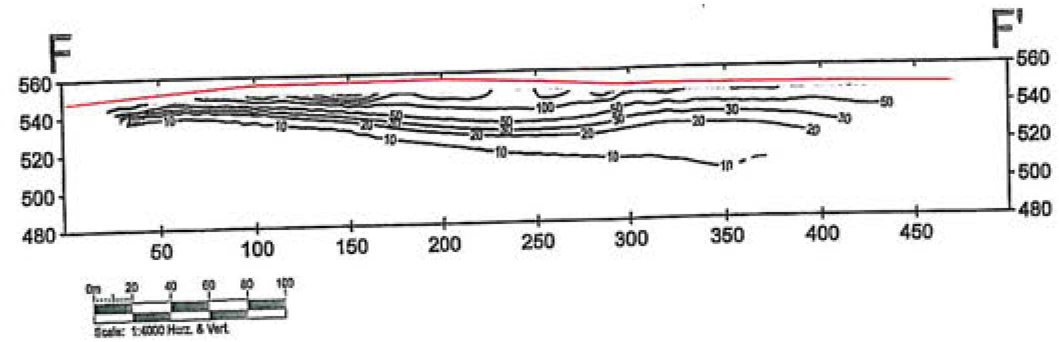
GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION E-E', AUGUST 2004



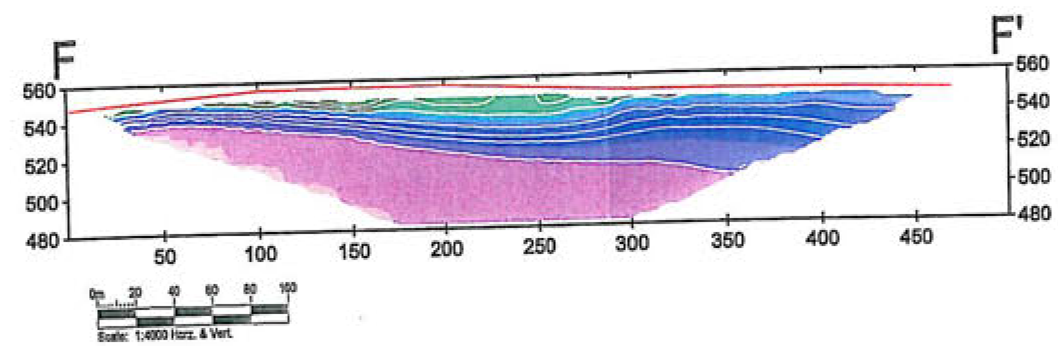


TITLE: INTERPRETATION CROSS SECTION E-E' (ERT05)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

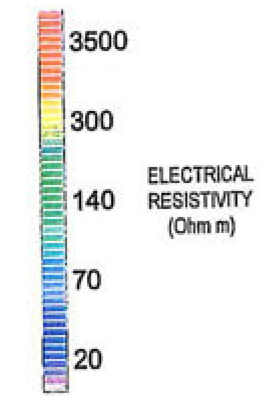
DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT05 INTERP.DWG	
	DRAWN BY: PT	JOB NO.: 04-853	DRAWING NO.: 04-860-05A	REV. NO.: 01

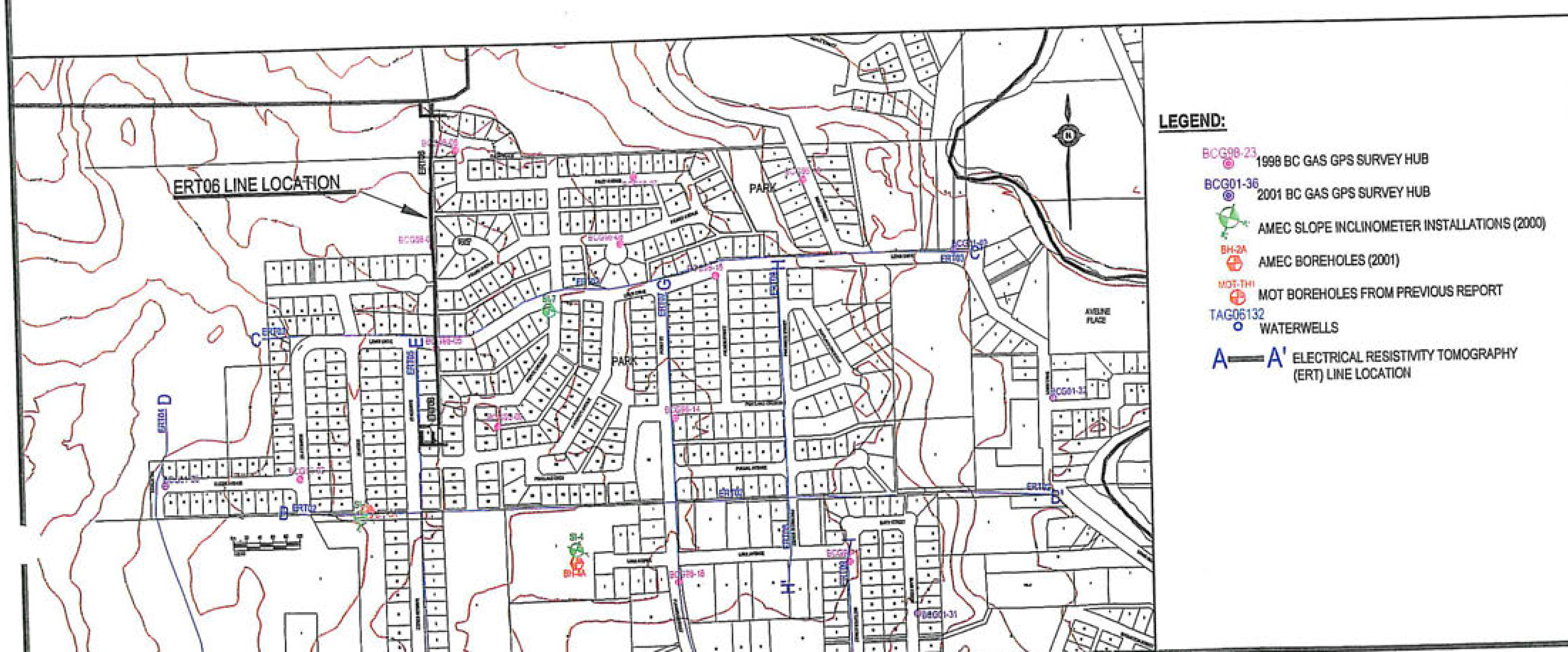


GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION F-F', AUGUST 2004

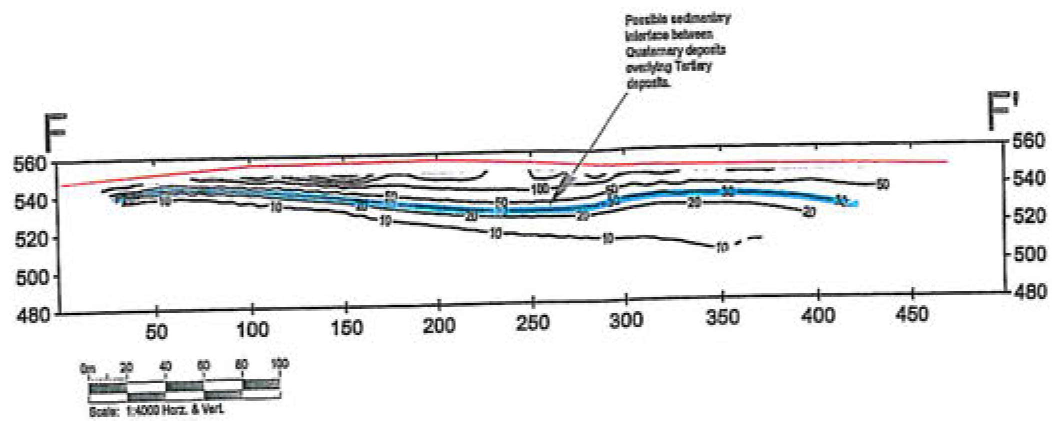


GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION F-F', AUGUST 2004

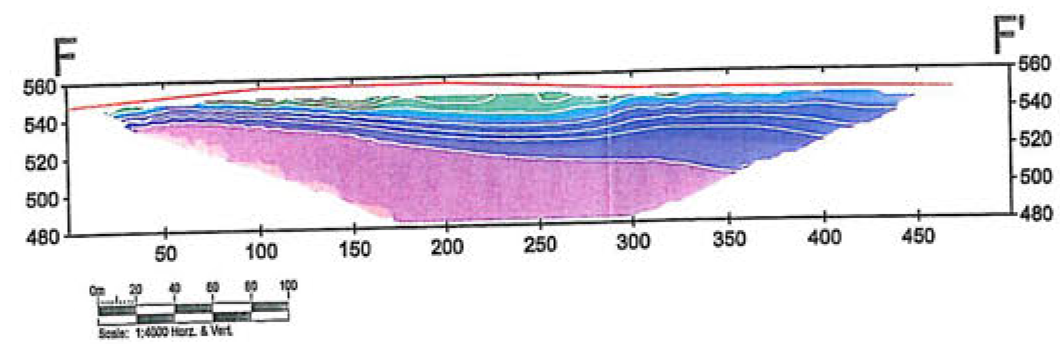




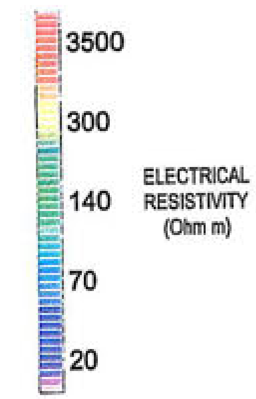
TITLE: ERT INVERSION MODEL CROSS SECTION F-F' (ERT06)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12035 Lake Emerald Dr. SW, Calgary, AB, T3J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN; DRAWN BY: PT	DATE: October 2004; JOB NO.: 04-863	FILE NAME: ERT06 DATA PLOT.DWG; DRAWING NO.: 04-860-06; REV. NO.: 01

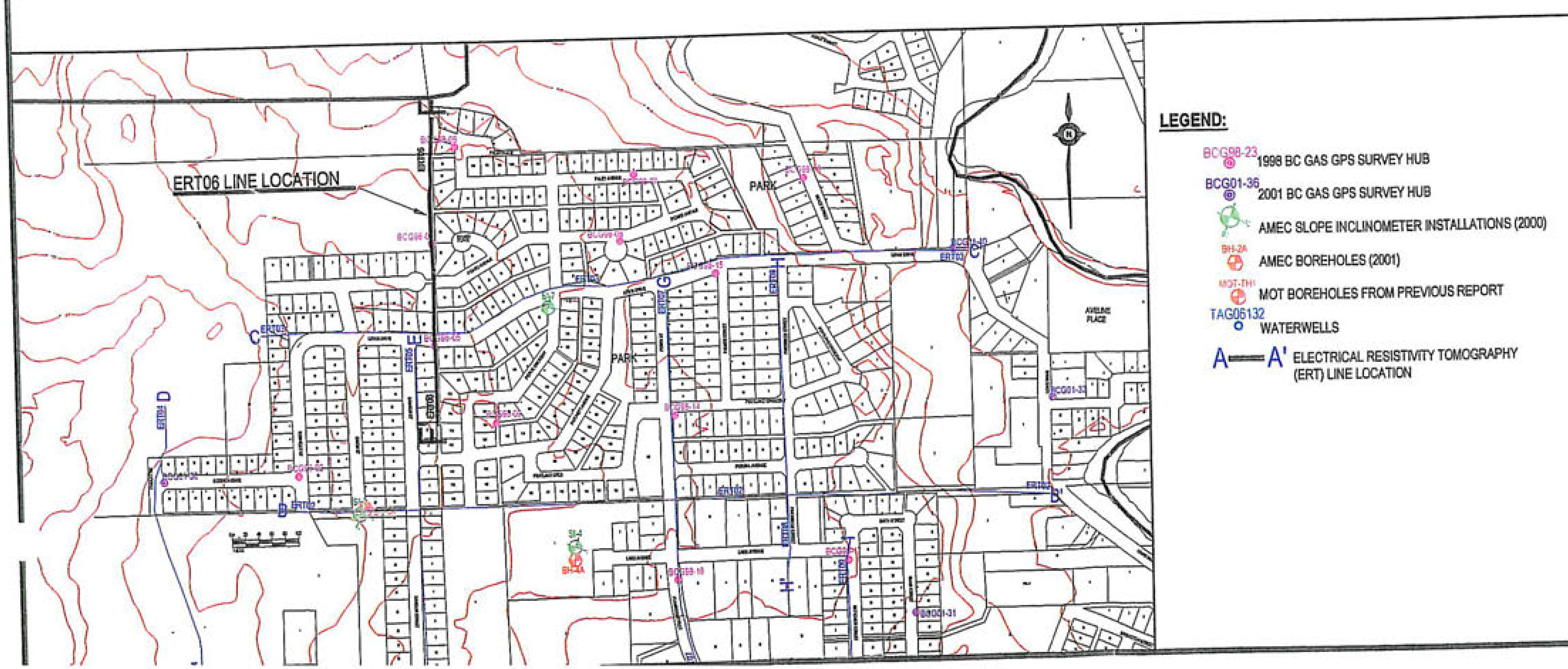


GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION F-F', AUGUST 2004



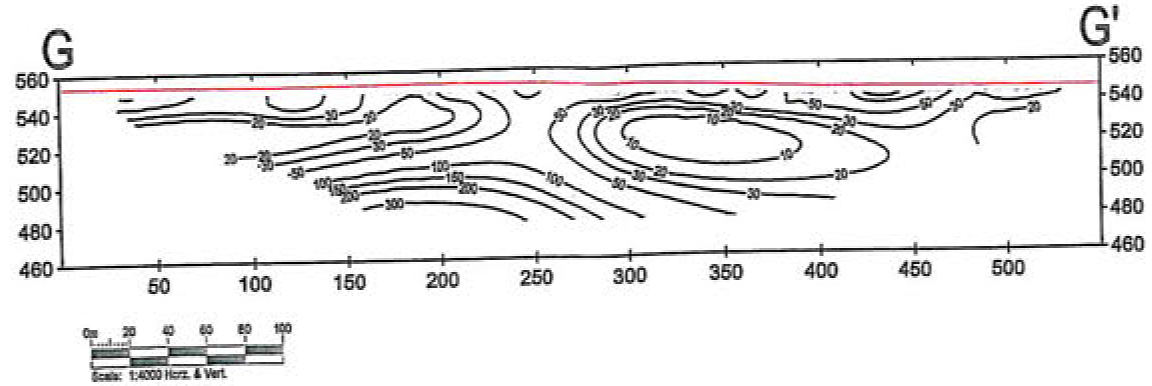
GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION F-F', AUGUST 2004





TITLE: INTERPRETATION CROSS SECTION F-F' (ERT06)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12038 Lake Emerald Cr. SW, Calgary, AB, T9J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT06 INTERP.DWG	
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-06A	REV. NO.: 01



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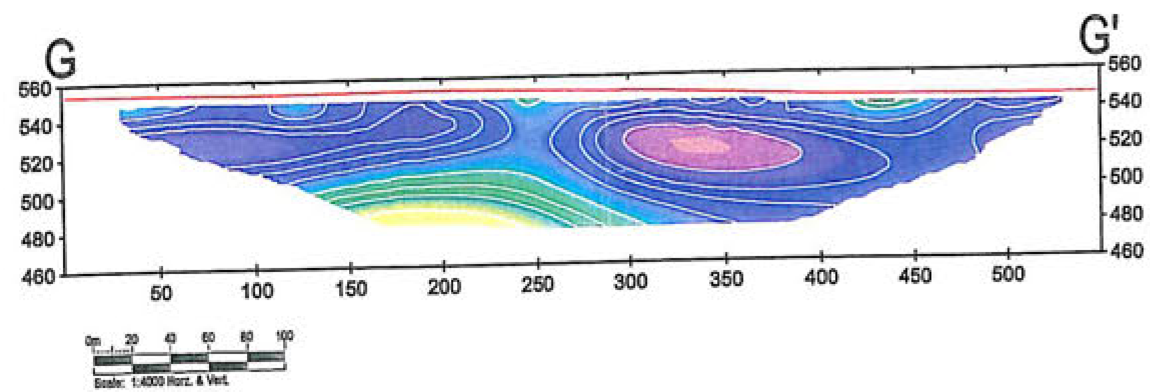

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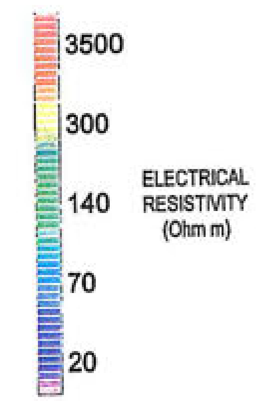
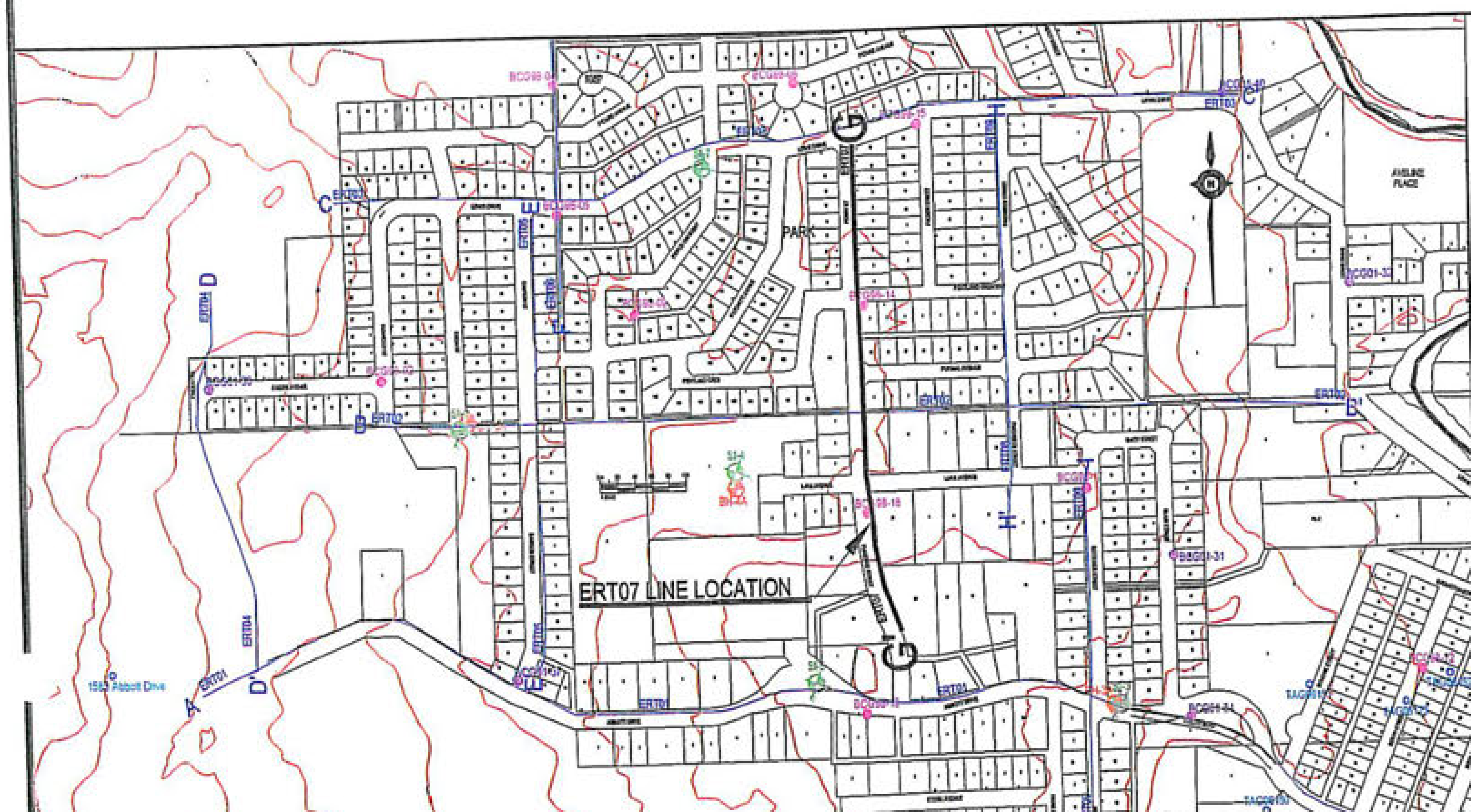
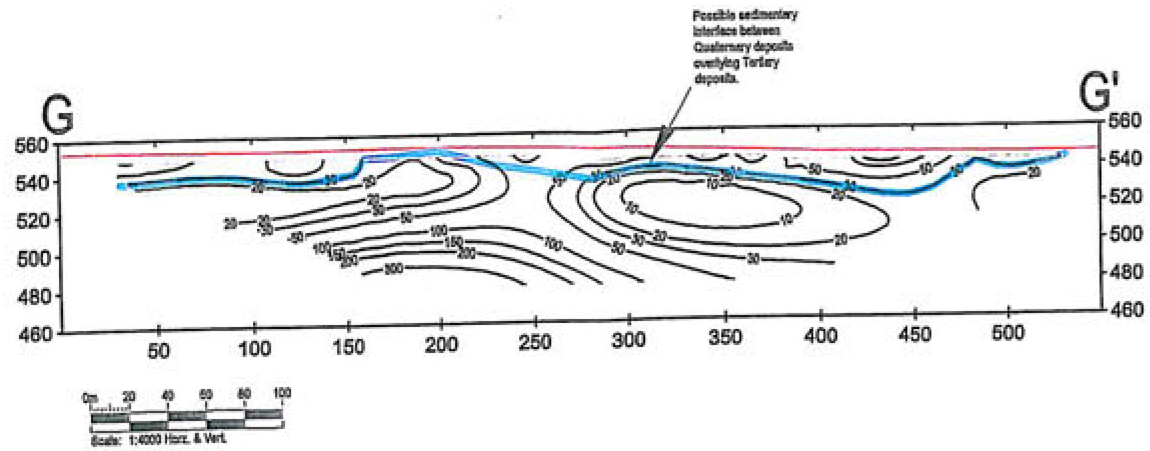




LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: ERT INVERSION MODEL CROSS SECTION G-G' (ERT07)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT07 DATA PLOT.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-07 / REV. NO.: 01



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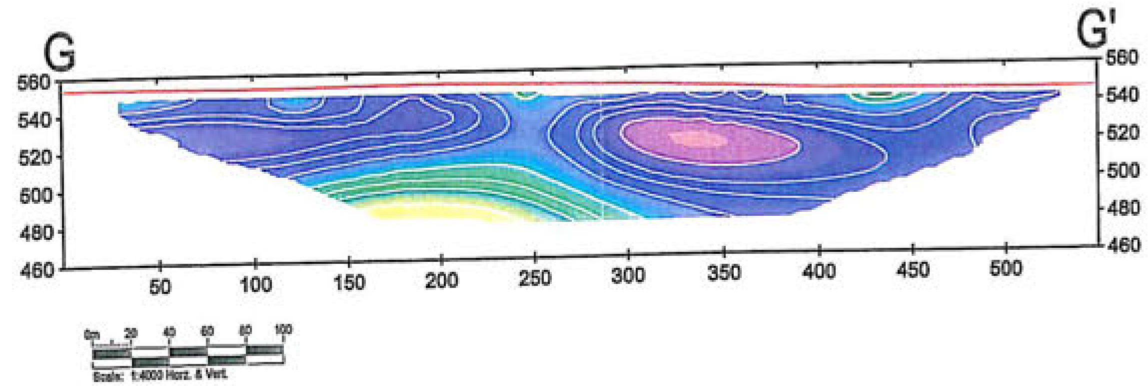

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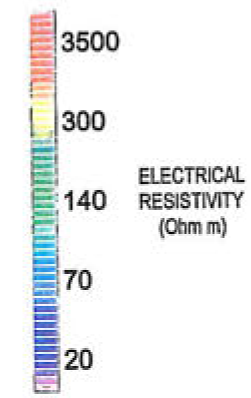
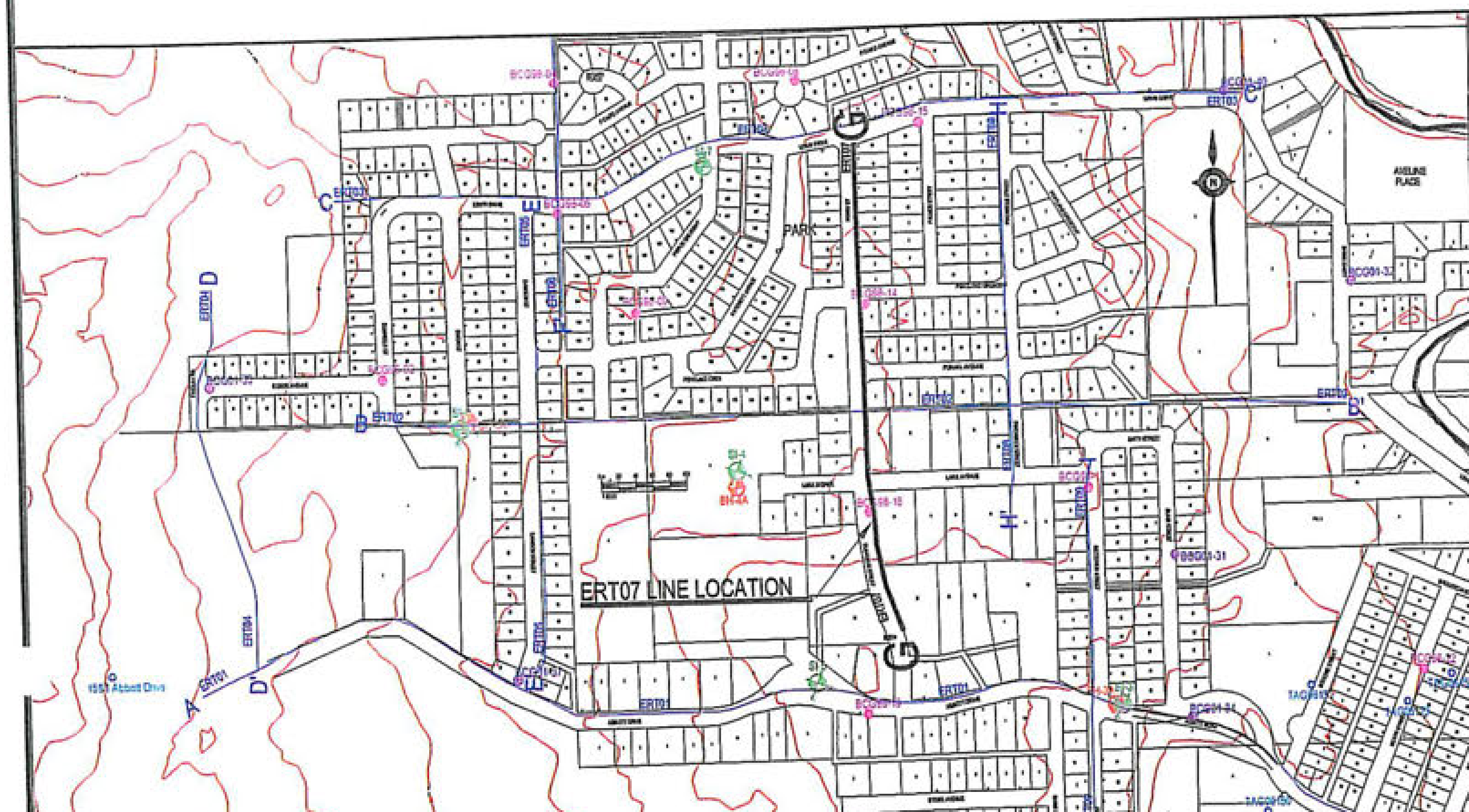


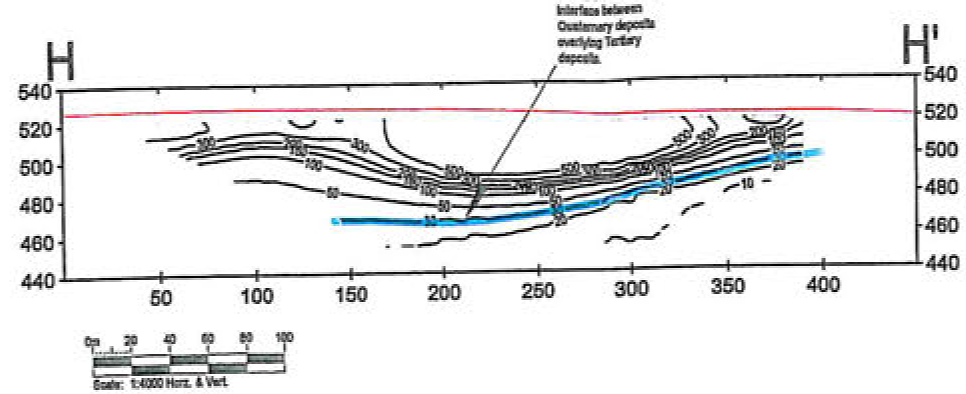


LEGEND:

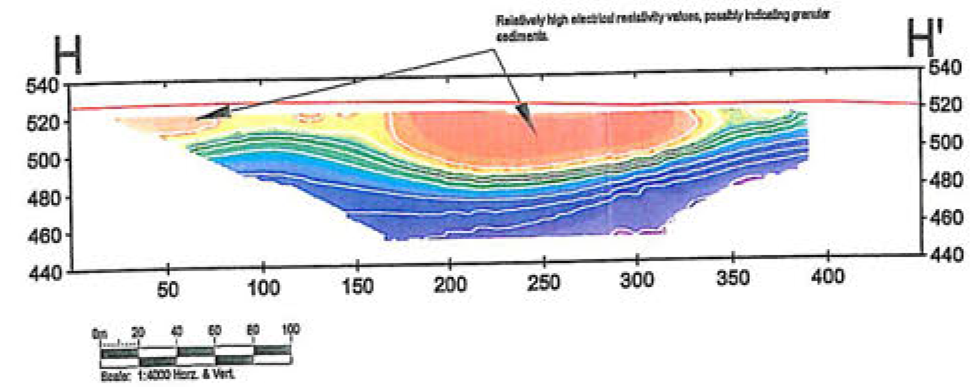
- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A—A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: INTERPRETATION CROSS SECTION G-G' (ERT07)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

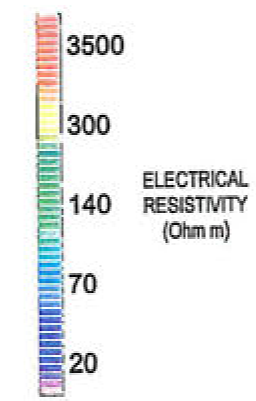
DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12035 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT07 INTERP.DWG	
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-07A	REV. NO.: 01

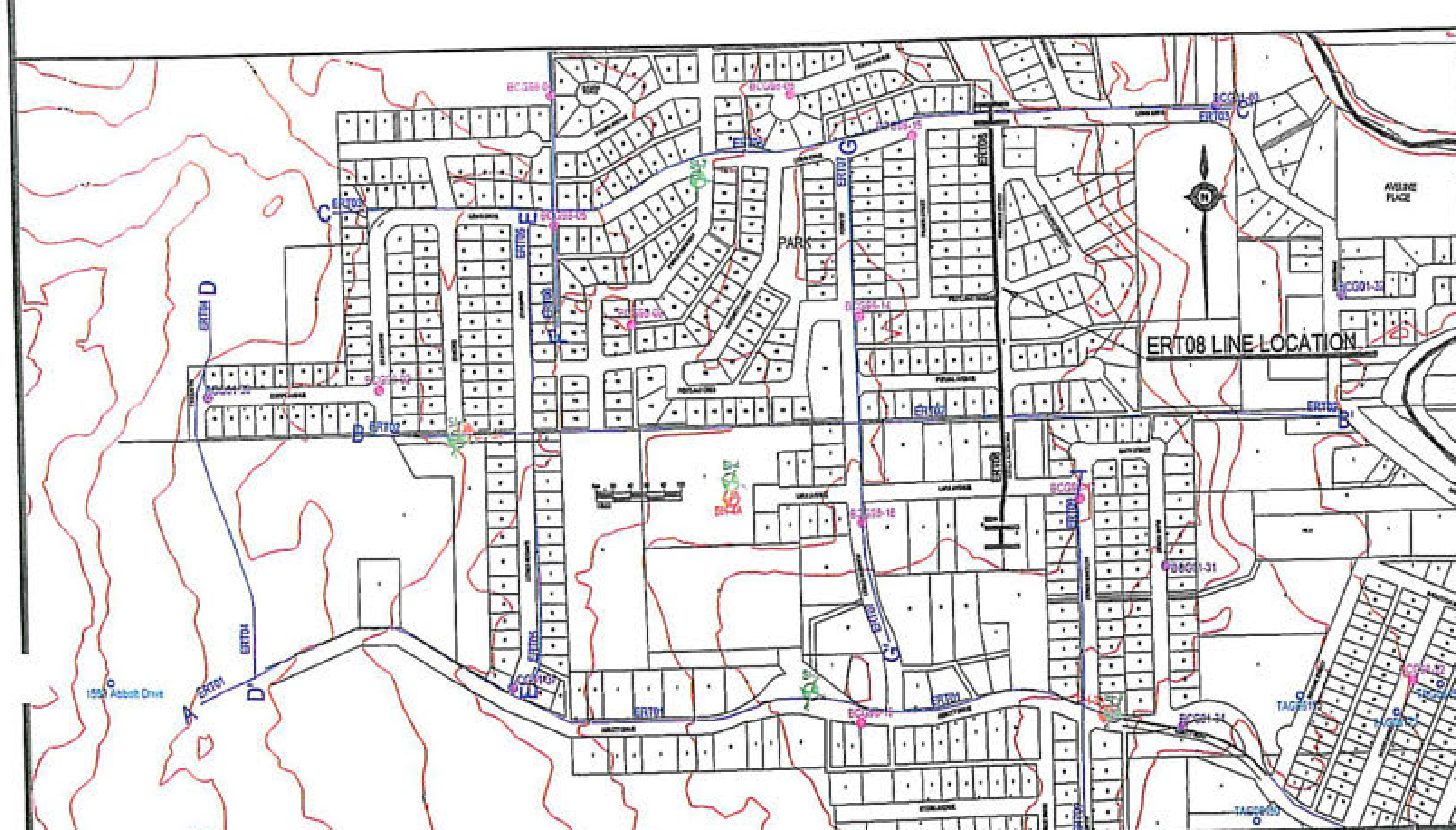


GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION H-H', AUGUST 2004



GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION H-H', AUGUST 2004



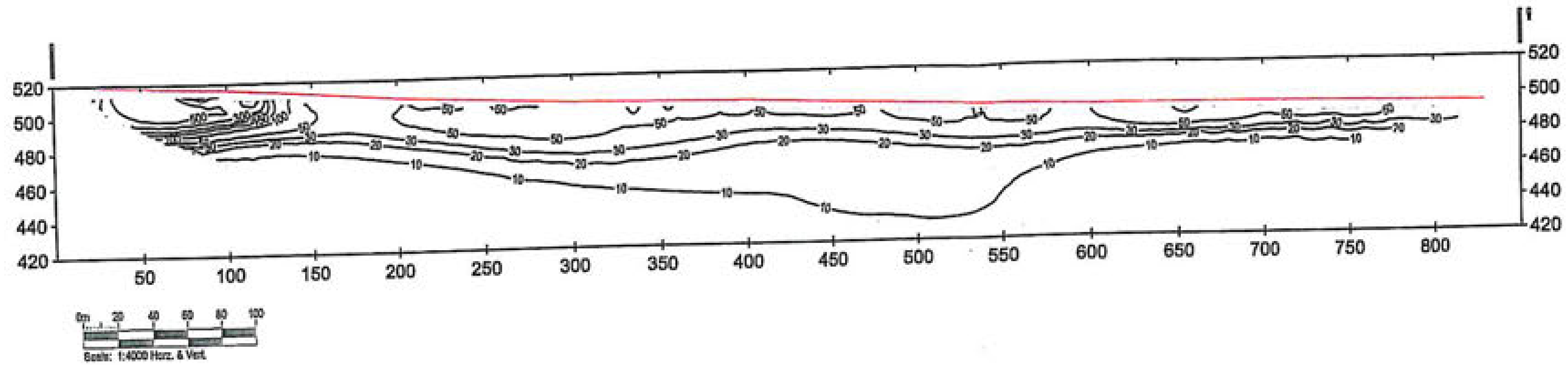


LEGEND:

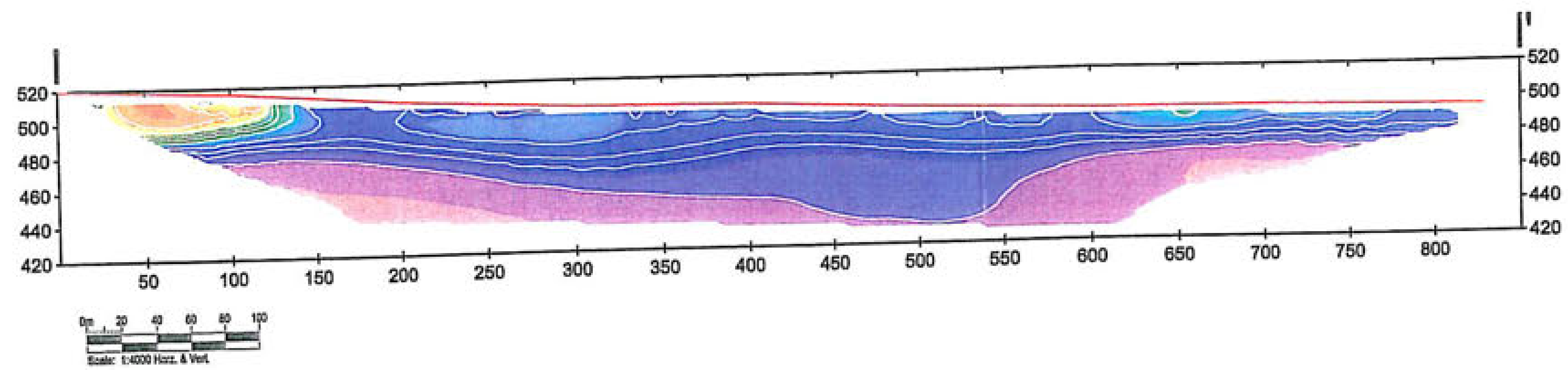
- BCG98-23 — 1998 BC GAS GPS SURVEY HUB
- BCG01-36 — 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A — AMEC BOREHOLES (2001)
- MOT-TH1 — MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 — WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: INTERPRETATION CROSS SECTION H-H' (ERT08)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

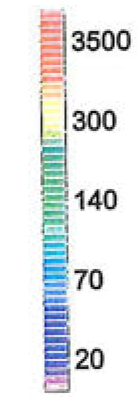
DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12035 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT08 INTERP.DWG	
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-08A	REV. NO.: 01

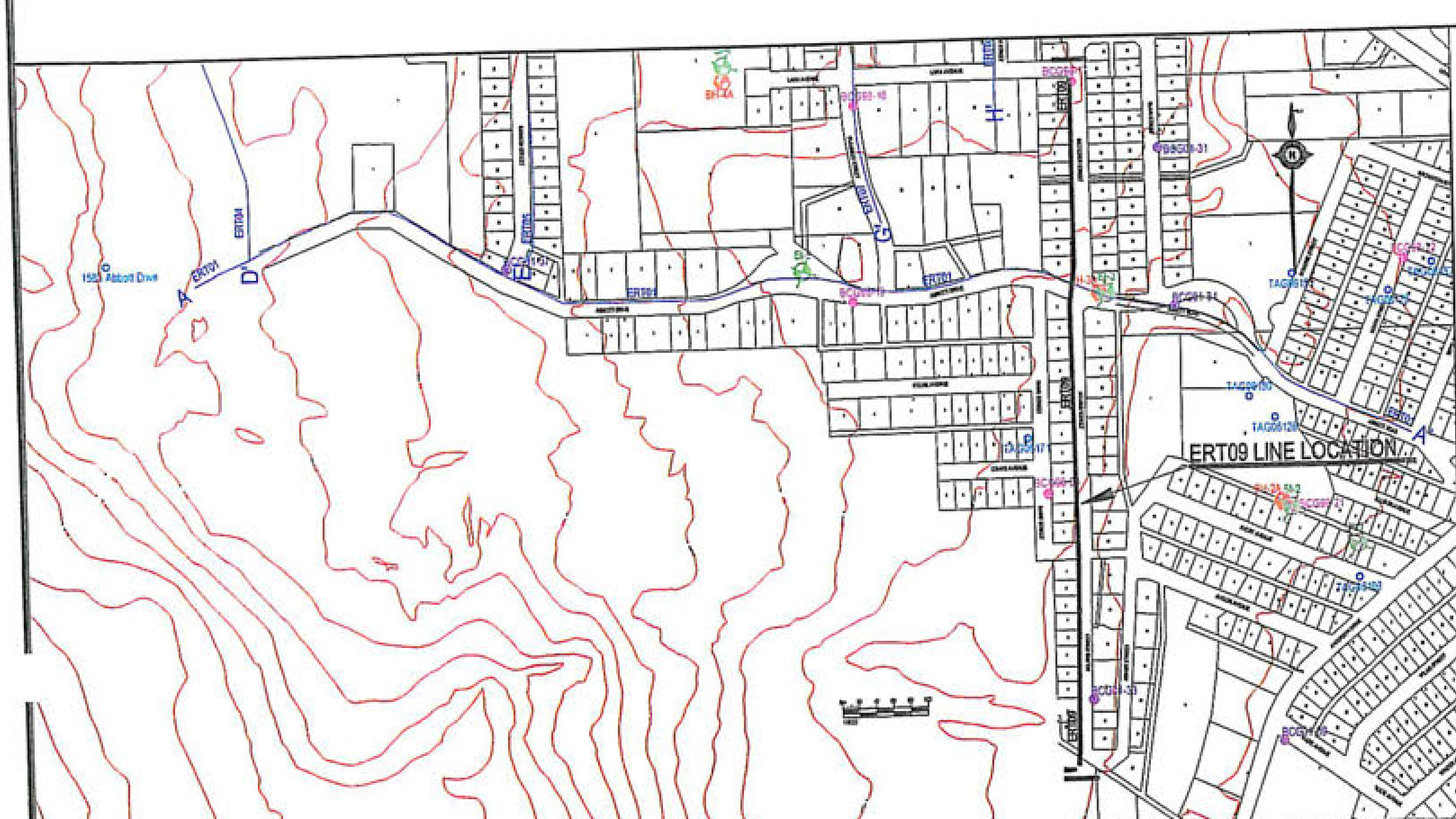


GROUND RESISTIVITY INVERSION MODEL CONTOURS (in Ohm m) PRODUCED FROM ERT DATA COLLECTED ALONG SECTION I-I', AUGUST 2004



GROUND RESISTIVITY INVERSION MODEL COLOUR CONTOURS PRODUCED FROM ERT DATA COLLECTED ALONG SECTION I-I', AUGUST 2004



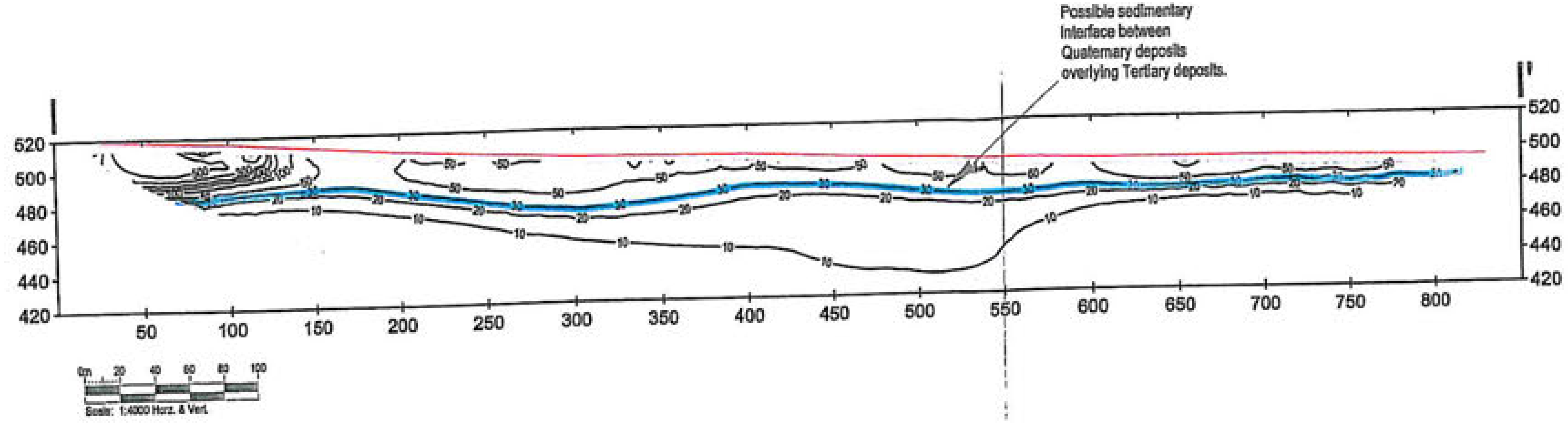


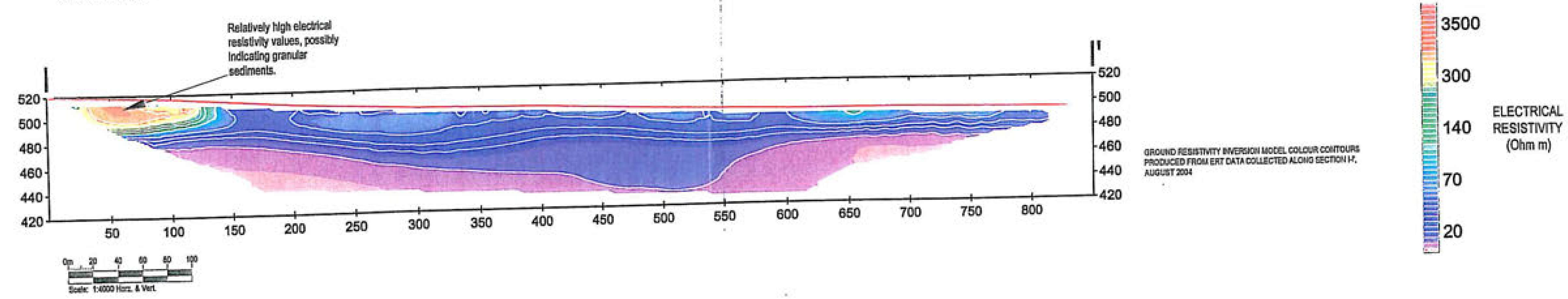
LEGEND:

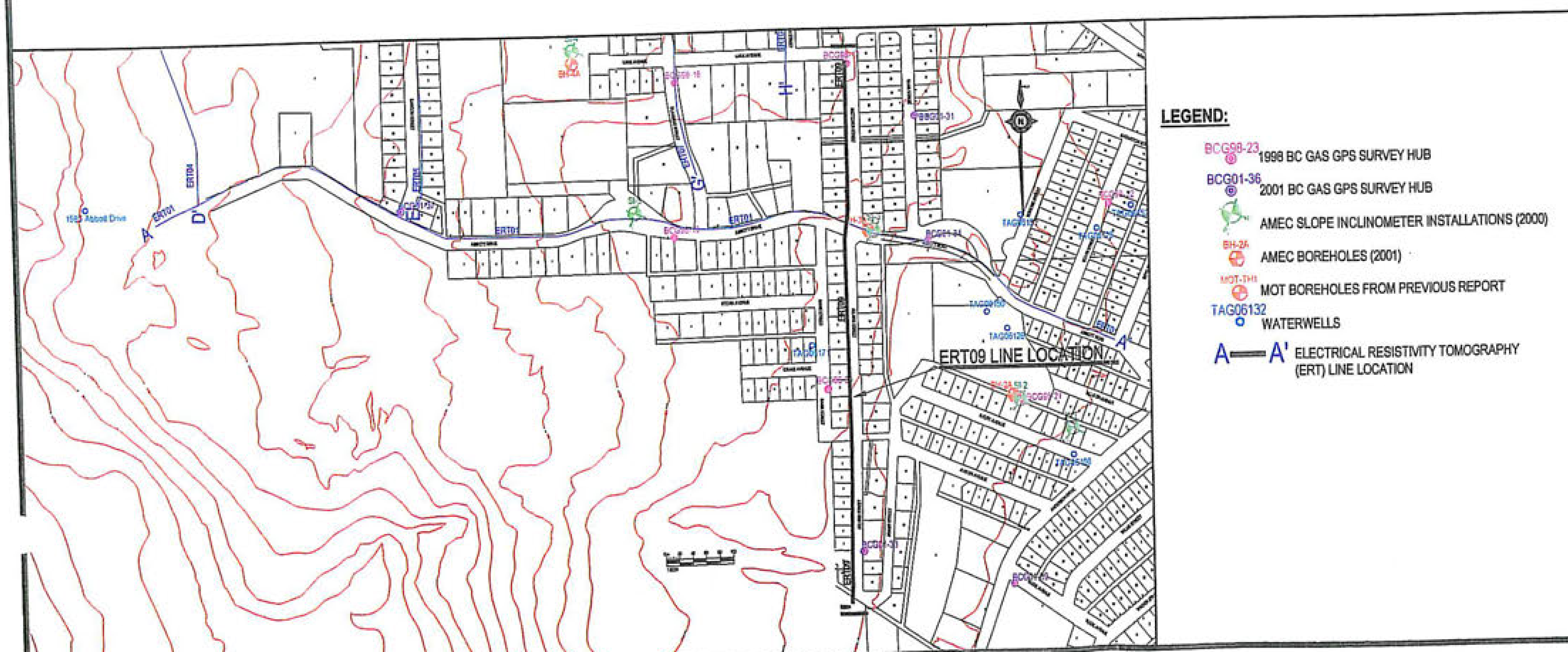
- BCG98-23 — 1998 BC GAS GPS SURVEY HUB
- BCG01-36 — 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A — AMEC BOREHOLES (2001)
- MOT-TH1 — MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 — WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

TITLE: ERT INVERSION MODEL CROSS SECTION I-I' (ERT09)	
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY	
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12035 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	AS SHOWN	October 2004	ERT09 DATA PLOT.DWG	
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-09	REV. NO.: 01



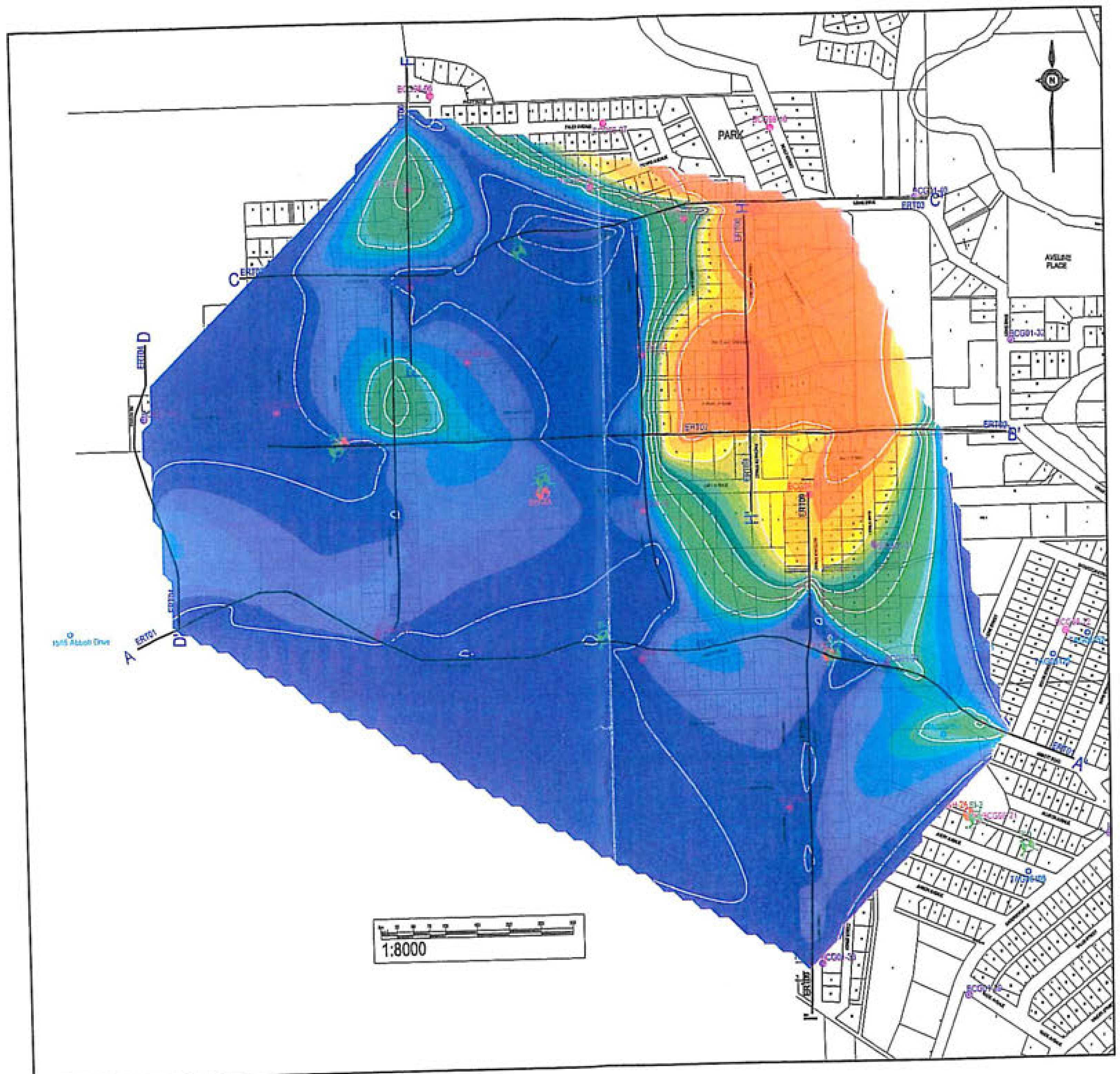


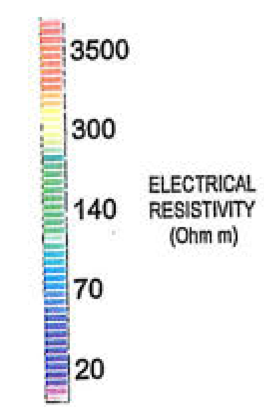


TITLE: INTERPRETATION CROSS SECTION I-I' (ERT09)			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: October 2004	FILE NAME: ERT09 INTERP.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-09A — REV. NO.: 01

LEGEND:

- BCG98-23 — 1998 BC GAS GPS SURVEY HUB
- BCG01-36 — 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A — AMEC BOREHOLES (2001)
- MOT-TH1 — MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 — WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION



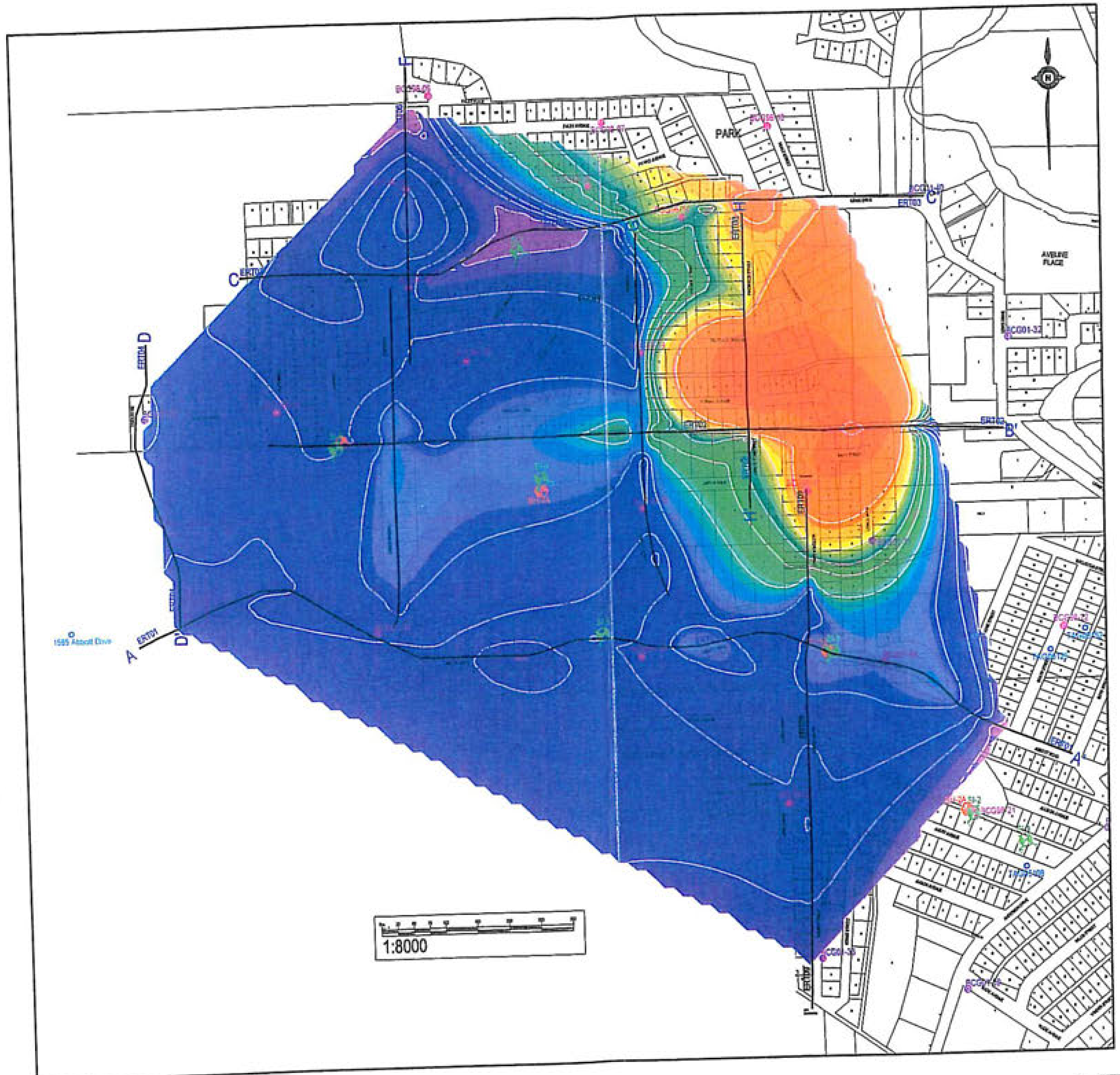


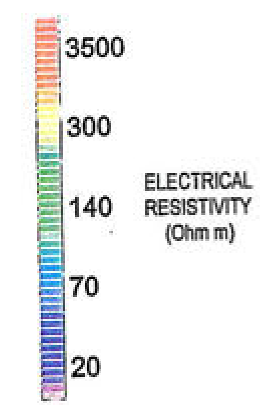
Map showing contoured pseudo-plan plot of the ERT data from residual electrical resistivity values taken at a 10 m subsurface depth level, as derived from the inverted ERT cross-section models.

TITLE: 10 m Depth Layer ERT Residuals Map			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. Engineering & Environmental Geophysics, 12038 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: January 2005	FILE NAME: 10 m ERT Residuals Map Plot.DWG
	DRAWN BY: PT	JOB NO: 04-863	DRAWING NO: 04-860-0R1 / REV NO: 01

LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION





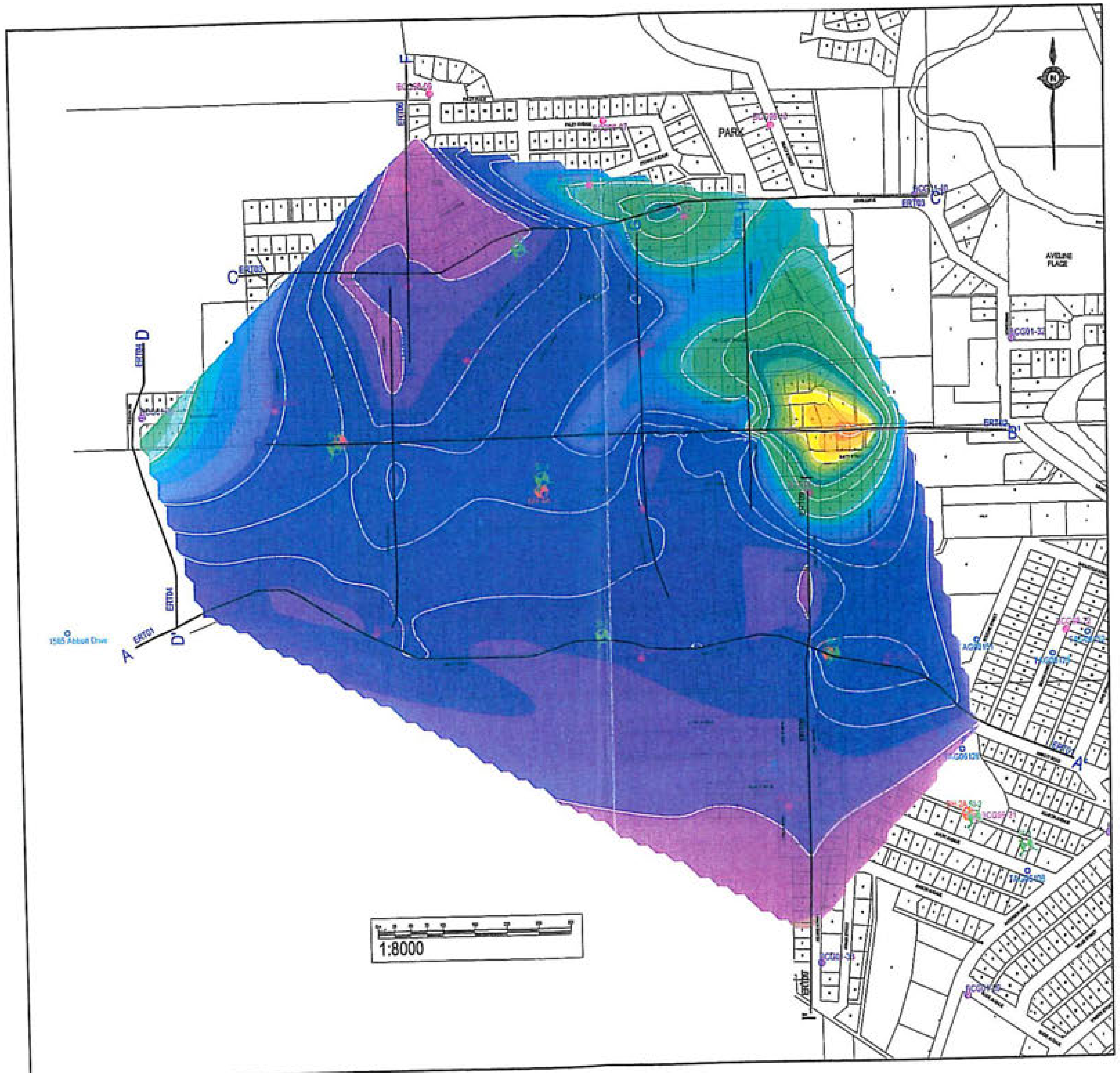
Map showing contoured pseudo-plan plot of the ERT data from residual electrical resistivity values taken at a 20 m subsurface depth level, as derived from the inverted ERT cross-section models.

TITLE:	20 m Depth Layer ERT Residuals Map
PROJECT:	WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.

DRAWING PRODUCED BY:	DRAWING SCALE:	DATE:	FILE NAME:	
SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS	AS SHOWN	January 2005	20 m ERT Residuals Map Plot.DWG	
12035 Lake Emerald Cr. SW, Calgary, AB, T5J 2J5 Ph: (403) 531-9721 Fax: (403) 294-1240 Email: headoffice@surfacesearch.com	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-0R2	REV. NO.: 01

LEGEND:

- BCG98-23 1998 BC GAS GPS SURVEY HUB
- BCG01-36 2001 BC GAS GPS SURVEY HUB
- AMEC SLOPE INCLINOMETER INSTALLATIONS (2000)
- BH-2A AMEC BOREHOLES (2001)
- MOT-TH1 MOT BOREHOLES FROM PREVIOUS REPORT
- TAG06132 WATERWELLS
- A — A' ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) LINE LOCATION

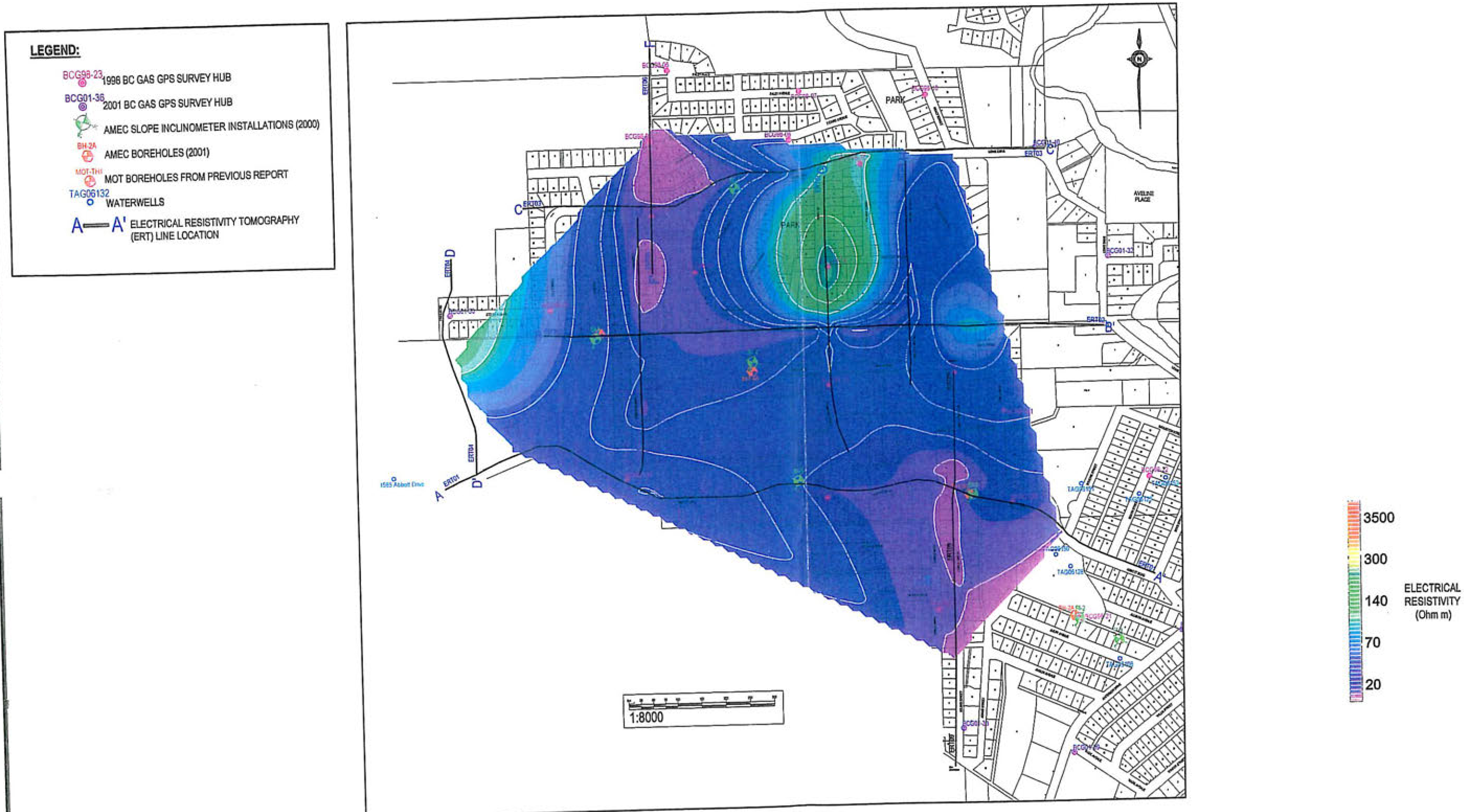


ELECTRICAL RESISTIVITY (Ohm m)

3500
300
140
70
20

Map showing contoured pseudo-plan plot of the ERT data from residual electrical resistivity values taken at a 40 m subsurface depth level, as derived from the inverted ERT cross-section models.

TITLE: 40 m Depth Layer ERT Residuals Map			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12035 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: January 2005	FILE NAME: 40 m ERT Residuals Map Plot.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-0R3 — REV. NO.: 01



Map showing contoured pseudo-plan plot of the ERT data from residual electrical resistivity values taken at a 60 m subsurface depth level, as derived from the inverted ERT cross-section models.

TITLE: 60 m Depth Layer ERT Residuals Map			
PROJECT: WEST QUESNEL ELECTRICAL RESISTIVITY TOMOGRAPHY SURVEY			
CLIENT: CITY OF QUESNEL	CONSULTING ENGINEERS: AMEC Earth & Environmental Ltd.		
DRAWING PRODUCED BY: SURFACE SEARCH INC. ENGINEERING & ENVIRONMENTAL GEOPHYSICS, 12035 Lake Emerald Cr. SW, Calgary, AB, T3J 2J5, Ph: (403) 531-9721 Fax: (403) 294-1240, Email: headoffice@surfacesearch.com	DRAWING SCALE: AS SHOWN	DATE: January 2005	FILE NAME: 60 m ERT Residuals Map Plot.DWG
	DRAWN BY: PT	JOB NO.: 04-863	DRAWING NO.: 04-860-0R4 / REV. NO.: 01

APPENDIX C

Table C1: GPS Movement Hub Data to November 2006

Movement Hub	Date Installed	Horizontal Displacement Since Installation	
		Magnitude (mm)	Vector* (°)
98-02	September 1998	350	100
98-04	September 1998	296	55
98-05	September 1998	307	89
98-06	September 1998	369	43
98-07	September 1998	313	63
98-08	September 1998	297	66
98-09	September 1998	389	91
98-14	September 1998	373	94
98-15	September 1998	275	77
98-16	September 1998	199	73
98-17	September 1998	421	97
98-18	September 1998	379	99
98-19	September 1998	340	14
98-20	September 1998	317	106
98-21	September 1998	191	115
98-22	September 1998	41	100
98-23	September 1998	21	106
01-30	December 2001	135	106
01-31	December 2001	221	92
01-32	December 2001	16	142
01-33	December 2001	120	106
01-34	December 2001	160	108
01-35	December 2001	16	135
01-36	December 2001	13	61
01-37	December 2001	185	102
01-38*	December 2001	13	122
01-39	December 2001	73	134
01-40	December 2001	85	84
06-01	November 2006	-	-
06-02	November 2006	-	-
06-03	November 2006	-	-
06-04	November 2006	-	-
06-05	November 2006	-	-
06-06	November 2006	-	-
06-07	November 2006	-	-
06-08	November 2006	-	-
06-09	November 2006	-	-
06-10	November 2006	-	-
06-11	November 2006	-	-
06-12	November 2006	-	-
06-13	November 2006	-	-
06-14	November 2006	-	-
06-15	November 2006	-	-
06-16	November 2006	-	-
06-17	November 2006	-	-
06-18	November 2006	-	-
06-19	November 2006	-	-
06-20	November 2006	-	-
06-21	November 2006	-	-

* Quesnel No.1 Station, GPS hub is located out of the study area

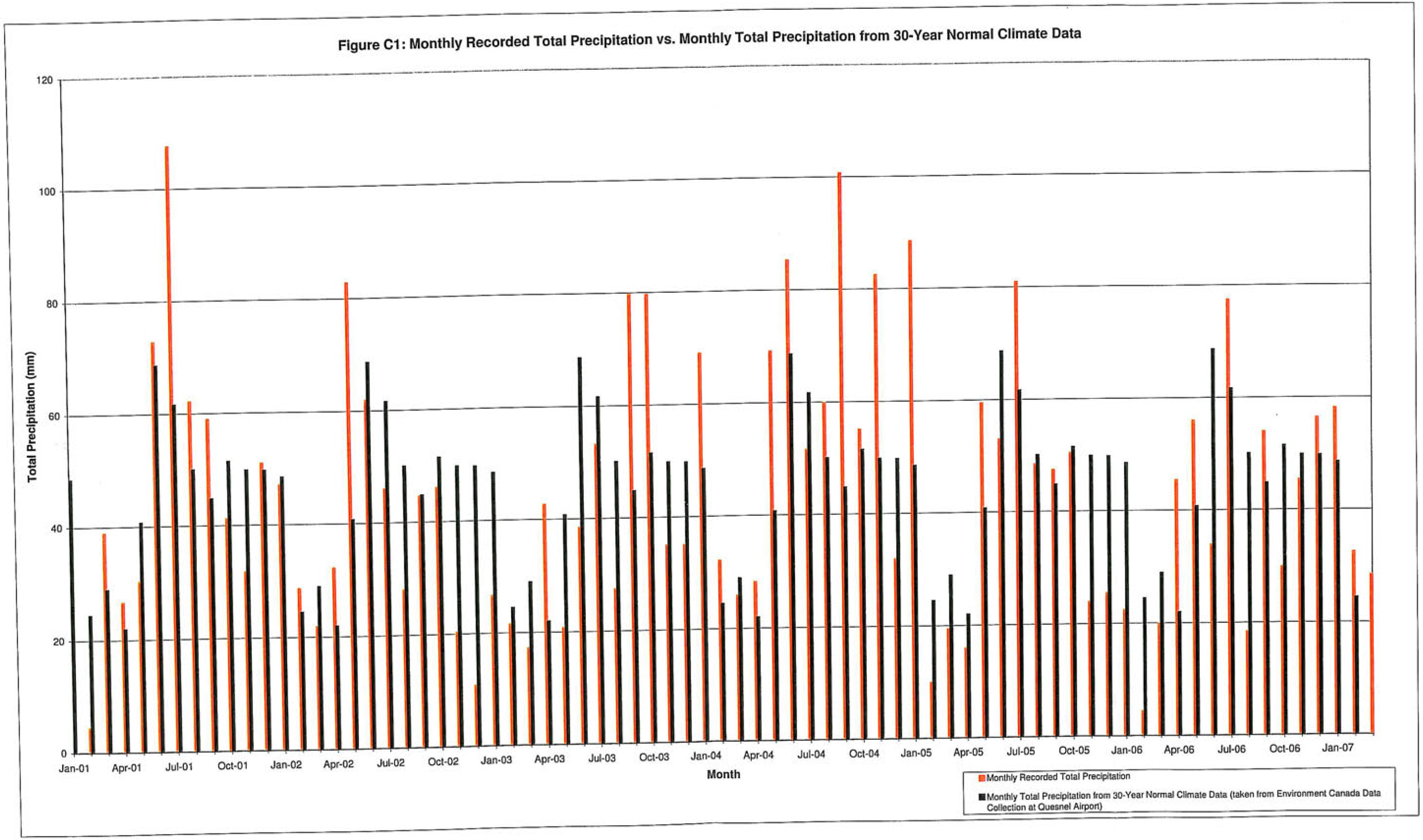


Figure C1: Monthly Recorded Total Precipitation vs. Monthly Total Precipitation from 30-Year Normal Climate Data
Total Precipitation (mm)
120
100
80
60
40
20
0
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Month
Monthly Recorded Total Precipitation
Monthly Total Precipitation from 30-Year Normal Climate Data (taken from Environment Canada Data Collection at Quesnel Airport)

Chart 1: Cumulative Net Lateral Displacement vs. Time (September 1998 to November 2006)

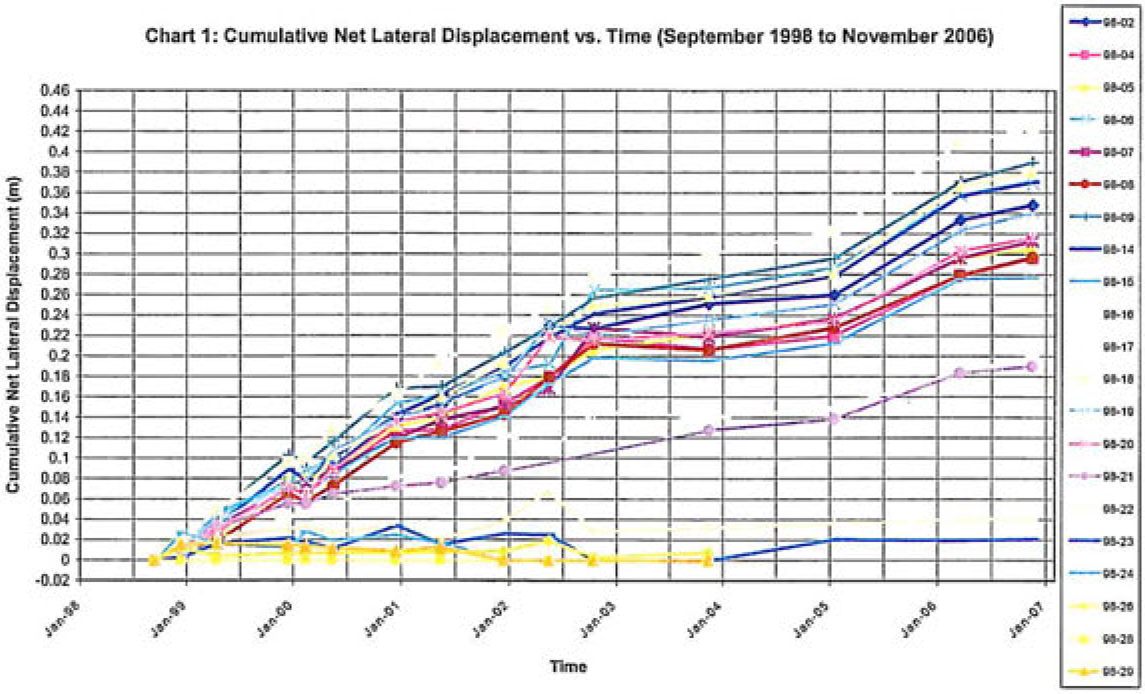
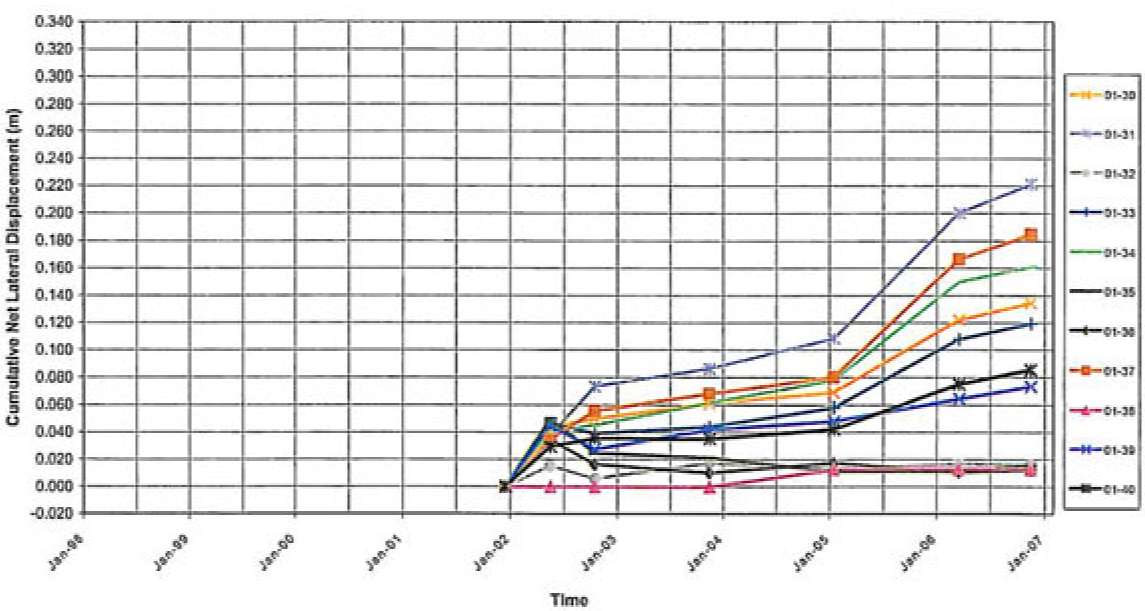


Chart 2: Cumulative Net Lateral Displacement vs. Time (December 2001 to November 2006)



amec

CITY OF QUESNEL

WEST QUESNEL LAND STABILITY STUDY
QUESNEL, BC

FIGURE C2	DATE: APR 2007	SCALE: NTS	DRAWN BY: SC/KB	PROJECT No: KX04397

APPENDIX D

Table D1: Drill Hole Locations and Log Comments

Hole ID	Location UTM (NAD 83)		Log Comments
	Northing	Easting	
SI1	5869298	532569	Drill logs not included as SIs were drilled close to BHs (corresponding BH logs include details for both holes)
SI2	5869343	532490	
SI3	5869598	531830	
SI4	5869878	531830	
SI5	5869633	531919	
SI6	5869933	531510	
SI7	5870232	531799	
SI8	5870035	532164	
SI9	5870114	531882	
SI10	5869649	531587	
SI11	5870355	532041	
SI12	5870278	532622	
SI13	5869938	532468	
SI14	5869683	531277	
SI15	5870278	531402	
BH2	5869340	532480	Drill log included
BH2A/B	5869742	532208	
BH2C	5869742	532210	
BH3	5869597	532264	
BH3A	5869771	532007	
BH3B/C	5869720	522005	
BH4	5869868	531829	
BH4A/B	5869783	532041	
BH4C	5869783	532043	
BH6	5869940	531514	
BH7	5870226	531799	
BH8	5870043	532161	
BH8A	5870043	532163	Drill log not included, BH8A combined with BH8 to make one drill log
BH9	5870120	531883	Drill log included, hole drilled twice in close proximity due to drilling difficulties
BH10	5869655	531592	Drill log included
BH11	5870360	532037	
BH12	5870272	531620	
BH13	5869938	532468	
BH14	5869693	531276	
BH15	5870278	531417	
BH16	5869544	530634	
BH16A	5869552	530634	Drill log not included, BH16A combined with BH16 to make one drill log
PW1	5869772	531993	Drill log included
PW2	5869595	532272	

Description of Rock Logging Terms

Core Recovery and Fracture Index		
Field	**Description**	**Example**
Run Length	The drilled length of the run as measured by the driller at the drill head. All depths are measured from the drill collar.	Drilled 1.0 m
Core Recovery	Total length of all recovered rock (including non-intact core), expressed as a percentage the run length. Reassemble the core to measure and bunch sections of non-intact core so they don't over-represent the recovery. Shouldn't be greater than 100% unless the barrel has picked up rock core from a previous run.	Recovered 0.90 m **Core recovery = 90%**
Rock Quality Designation **(RQD)**	Total length of SOLID CORE pieces in the run that are greater than 100 mm in length, expressed as a percentage the run length. Drilling induced fractures should be ignored, though if in doubt, assume a fracture is natural.	Pieces longer than 100 mm add up to 0.80 m **RQD = 80%**

Intact Rock Strength		
Estimated UCS (MPa)	**Description**	**Field Identification**
0.25-1.0	RO – Extremely Weak Rock	Indented by thumbnail, core crumbles in hand
1-5	R1 – Very Weak Rock	Crumbles under firm blows with the point of a geological hammer; can be peeled with a pocket knife
5-25	R2 – Weak Rock	Can be peeled with a pocket knife with difficulty; shallow indentations made by firm blow with point of geological hammer
25-50	R3 – Medium Strong Rock	Cannot be scraped or peeled with a pocket knife; specimen can be fractured with a single blow with point of geological hammer
50-100	R4 – Strong Rock	Specimen requires more than one blow with point of geological hammer to fracture it
100-250	R5 – Very Strong Rock	Specimen requires many blows with point of geological hammer to fracture it
>250	R6 – Extremely Strong Rock	Specimen can only be chipped with point of geological hammer and rings when struck

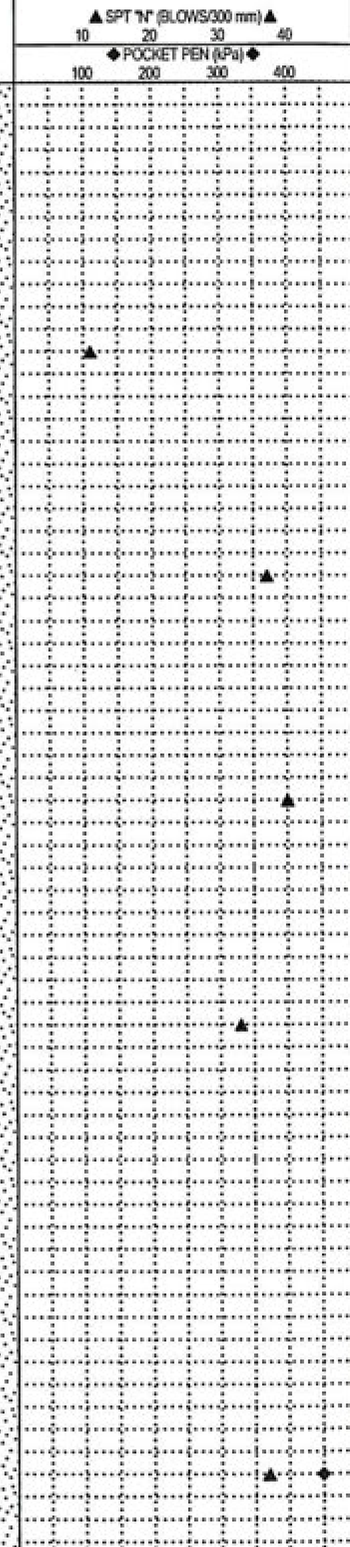
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
0							SAND (fine grained), some silt to silty, trace rootlets, compact to dense, poorly graded, brown, damp to moist (fluvial deposit) Water Level observed at -0.7m on August 17, 2002 water level observed at -0.7m on August 17, 2002
		484					
1		483	Split spoon	1			
2		482					
3		481	Split spoon	2			-soil has trace gravel
4		480	Split spoon	3			GRAVEL, sandy, dense, brown, damp (fluvial deposit)
5		479					
6		478	Split spoon	4			
7		477	Split spoon	5			
8		476					SILT, some clay to clayey, trace to some gravel, hard, low to medium plastic, grey, moist
9		475	Split spoon	6			
10							

WELL



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Prince George, BC V2N 2P9
(250) 564-3243

LOGGED BY: HA	COMPLETION DEPTH: 80.1 m
ENTERED BY: SR	COMPLETION DATE: 11/2/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
10							SILT, some clay to clayey, trace to some gravel, hard, low to medium plastic, grey, moist *(continued)*		
		474					SILT, sandy to some sand, trace to some clay, trace gravel, hard, low plastic, grey, moist		
11			Split spoon	7					>>▲
12		473							
		472	Split spoon	8					▲ ◆
13									
14		471							
15		470							
		469	Split spoon	9			SIEVE=G16%, S32%, F52% SIEVE=G16%, S32%, F52%		▲
16		468							
17			Split spoon	10			SILT, sandy (mainly fine grained), some cobbles to cobbly, trace to some gravel, hard, low plastic, grey, damp		>>▲
18		467							
			Split spoon	11					
		466	Core	11a	14		SPT Refusal End of SPT sampling Start Diamond coring		>>▲
19									
		465	Core	12	27		SPT Refusal End of SPT sampling Start Diamond coring		
20									

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
20				SILT, sandy (mainly fine grained), some cobbles to cobbly, trace to some gravel, hard, low plastic, grey, damp*(continued)*
				SILT, sandy, some clay, trace to some gravel, hard to stiff (PP = 240 to >450 kPa), medium to low plastic, grey, moist
	464	13	55	
21	463	14	37	
22	462	15		
23		16	11	
	461	17	59	
24	460	18	38	
25		19	43	
	459	20	68	
26	458			SIEVE=G15%, S29%, F56%
27				SIEVE=G15%, S29%, F56%
	457	21	27	
28	456			
29		22	20	
	455			-600mm layer of wet silty gravelly sand
30				

SPT "N" (BLOWS/300 mm) 10 20 30 40
POCKET PEN (kPa) 100 200 300 400

WELL

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STRATIGRAPHIC KX04397-2001-BH-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

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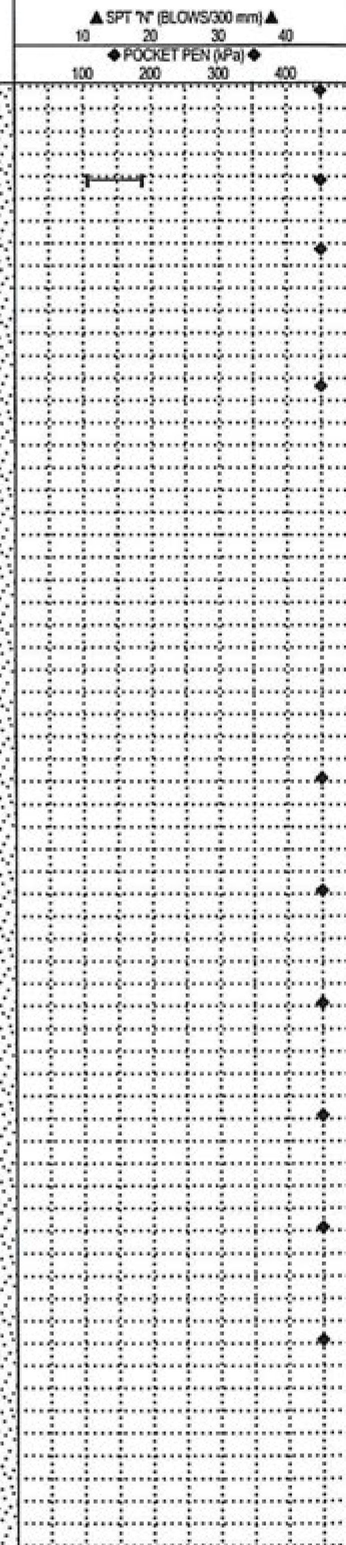
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		23	59		SILT, sandy, some clay, trace to some gravel, hard to stiff (PP = 240 to >450 kPa), medium to low plastic, grey, moist*(continued)*
	454	24	100		-cobble or boulder cored through, 750mm in diameter
31		25	99		-cobble or boulder cored through, 750mm in diameter
	453				
32		26	68		
	452				-very soft silt on top of sample (possibly varved)
33		27	10		
	451	28	33		
34					
	450	29	40		
35		30	77		
	449				
36		31	100		-cobble or boulder cored through 750mm in diameter
	448				
37		32	27		
	447	33	73		
38					
	446	34	23		
39					
	445	35	18		
40					

WELL



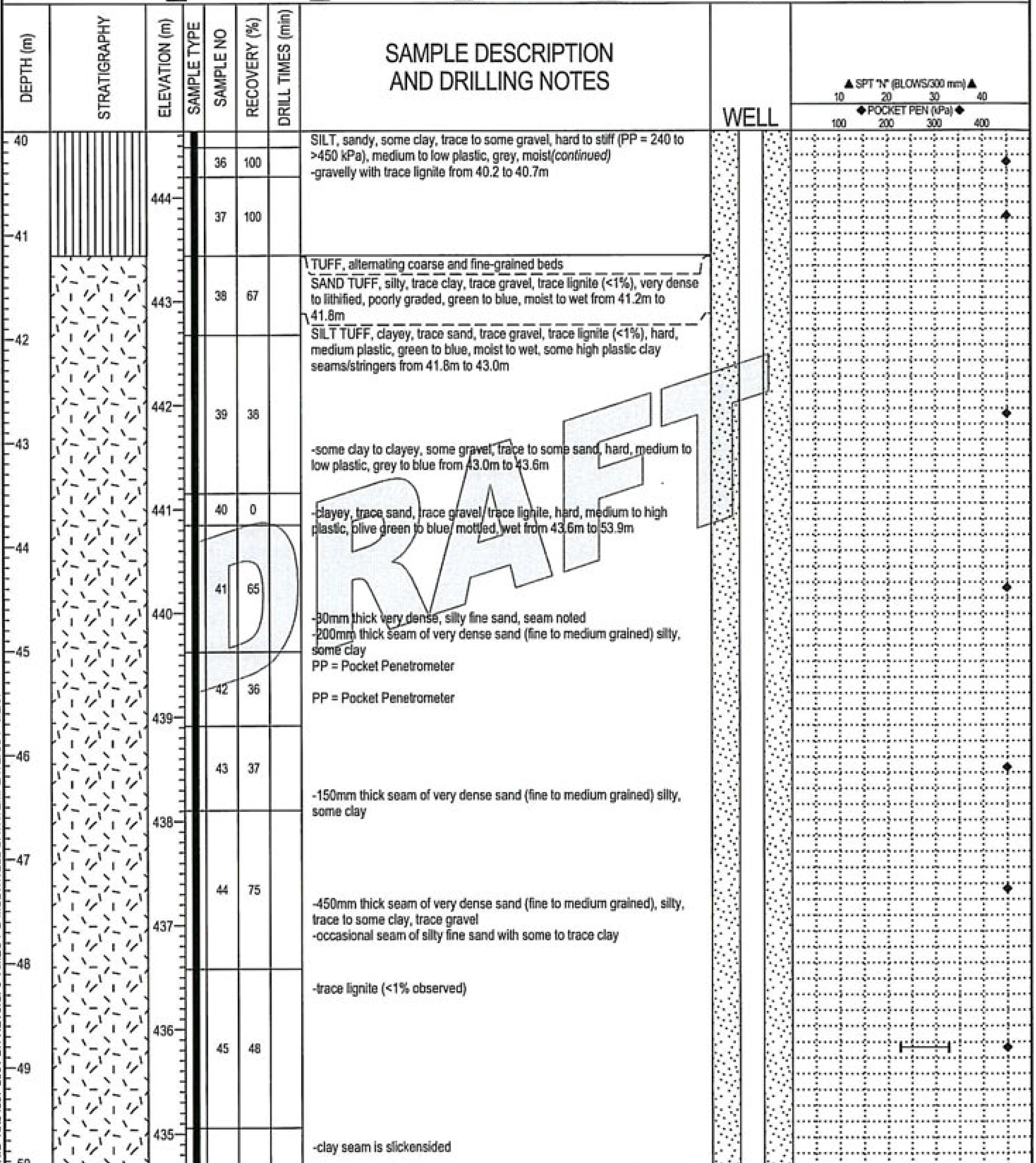
amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HA ENTERED BY: SR
		COMPLETION DEPTH: 80.1 m COMPLETION DATE: 11/2/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
40		36	100	SILT, sandy, some clay, trace to some gravel, hard to stiff (PP = 240 to >450 kPa), medium to low plastic, grey, moist*(continued)* -gravelly with trace lignite from 40.2 to 40.7m
	444	37	100	
41	443	38	67	TUFF, alternating coarse and fine-grained beds SAND TUFF, silty, trace clay, trace gravel, trace lignite (<1%), very dense to lithified, poorly graded, green to blue, moist to wet from 41.2m to 41.8m
42	442	39	36	SILT TUFF, clayey, trace sand, trace gravel, trace lignite (<1%), hard, medium plastic, green to blue, moist to wet, some high plastic clay seams/stringers from 41.8m to 43.0m
43				-some clay to clayey, some gravel, trace to some sand, hard, medium to low plastic, grey to blue from 43.0m to 43.6m
	441	40	0	-clayey, trace sand, trace gravel, trace lignite, hard, medium to high plastic, olive green to blue, mottled, wet from 43.6m to 53.9m
44	440	41	65	-30mm thick very dense, silty fine sand, seam noted -200mm thick seam of very dense sand (fine to medium grained) silty, some clay PP = Pocket Penetrometer
45	439	42	36	PP = Pocket Penetrometer
46	438	43	37	-150mm thick seam of very dense sand (fine to medium grained) silty, some clay
47	437	44	75	-450mm thick seam of very dense sand (fine to medium grained), silty, trace to some clay, trace gravel -occasional seam of silty fine sand with some to trace clay
48	436			-trace lignite (<1% observed)
49		45	48	
50	435			-clay seam is slickensided



CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE | NO RECOVERY | SPLIT SPOON | GRAB | MUD RETURN | CORE RETURN

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
50				46	83		TUFF, alternating coarse and fine-grained beds *(continued)*		
		434							
51							-250mm thick seam of silty fine sand with trace clay and trace gravel		
		433		47	55		-400mm seam of silty fine sand with trace to some clay and trace gravel		
52									
		432							
53				48	0				
		431					-70mm silty fine sand with trace clay seam		
54							SILT AND CLAY TUFF, trace sand, trace lignite (<1%), hard, high plastic (some low to non plastic zones), blue, wet, mottled, slickensides in some zones from 53.9m to 76.8m		
		430							
55				49	77				
		429					-very soft to soft zone (PP = 10 to 50kPa) of clay and silt, high plastic Atterberg - LL=108%		
56							Atterberg - LL=108% -some zones are hard to stiff (PP = 350 to 450kPa), soil is slickensides -trace lignite observed driller noted easy penetration from 56.4 to 56.8m, no recovery in zone		
		428		50	73		Driller noted easy penetration from 56.4 to 56.8m, no recovery in zone -thin sandy seam approximately 20mm thick		
57									
		427		51	73		-500mm thick seam of silt and clay, some sand, trace gravel above and below seam some zones of soft to firm clay and silt		
58							Hydrometer analysis=SAND 8%, SILT62%, CLAY30% -small zone at top of run clay is slickensides (PP = 150 to 300kPa)		
		426		52	109		Hydrometer Analysis=SAND 8%, SILT62%, CLAY30% -100mm thick seam of sand, silt, trace clay, very dense, grey, moist Direct shear test conducted		
59							Direct Shear Test conducted -50mm thick seam of sand, silt, trace clay, very dense, grey, moist		
		425							
60									

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE | NO RECOVERY | SPLIT SPOON | GRAB | MUD RETURN | CORE RETURN

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
60		53	100	-trace gravel (<2% observed in seam) TUFF, alternating coarse and fine-grained beds *(continued)*
	424			-150mm thick sandy silt, some clay, trace gravel observed -breccia, silt and clay matrix with sand and gravel sized angular to sub rounded clast, 100mm thick SIEVE=G28%, S53%, F19%
61	423	54	100	SIEVE=G28%, S53%, F19% -sand and silt, some clay, trace to some gravel, very dense, blue to grey, moist, 700mm thick
62				-slickensides in core break
	422	55	80	-thin seam with some gravel sized sub-angular clay clasts
63	421			
64		56	88	-slickensides in core break -seam of sandy silt or sand, some clay, silty, some rounded gravel (weathered, clay or silt clasts), dense, seam 800mm thick
	420			
65	419	57	20	
66				-seam of sandy silt or sand, some clay, silty, some rounded gravel (weathered, clay or silt clasts), very dense, seam is miminum 150mm thick (no recovery below)
	418			
67		58	60	-sand, silty, trace to some clay, trace gravel, very dense, seam 1.2m thick
	417			-seams of bedded sand and silt and clay with some gravel, 200mm thick
68				-four thin seams 100mm to 150mm thick of silty sand or silt and sand, gravelly (gravel is rounded to sub-rounded clay clasts), some clay between 68 to 69.2m -slickensides at 68.2m and 68.9m
	416	59	120	
69				
	415			-one 75mm seam of lignite observed
70				

STRATIGRAPHY | SAMPLE TYPE | DRILL TIMES (min) | WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40

◆POCKET PEN (kPa)◆ 100 200 300 400

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HA ENTERED BY: SR	COMPLETION DEPTH: 80.1 m COMPLETION DATE: 11/2/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
70		60	177	-slickensides evident in broken core, swelling clay (1.5m run) TUFF, alternating coarse and fine-grained beds *(continued)* -400mm thick seam of sand, gravelly (gravel is mainly clasts sub-rounded to rounded of clay), silty, some clay, brown to grey, moist
	414			
71				SIEVE=S46%, F54%
				SIEVE=S46%, F54% -700mm thick seam of silty fine sand with trace gravel, and trace clay, grey, very dense
	413	61	100	
72				-zone of breccia, sand and gravel in silt and clay matrix, harder towards base, at 72.1m has rounded gravel sized clay clasts
	412			
73		62	100	
	411			-50mm thick seam of silty sand with some gravel (gravel is angular basalt pieces with some rounded clay clasts)
74				-zone of breccia as per 71.8m, bedded with sand and gravel, zone is 1m thick
	410	63	100	
75				-occasional sandy or gravelly layer in slickensided clay, layers ranged from 70mm to 600mm thick
	409			
76		64	100	
	408			
77				SAND TUFF, (fine), silty, some gravel (mixture of rounded clay clasts and basalt clasts), trace to some clay, very dense, poorly graded, brown, moist to wet, layered with some seams of silt and clay from 76.8m to 80.1m SIEVE=S50%, F50%
	407	65	100	SIEVE=S50%, F50%
78				
	406			
79		66	103	
	405			
80				

Column headings: DEPTH (m), STRATIGRAPHY, ELEVATION (m), SAMPLE TYPE, SAMPLE NO, RECOVERY (%), DRILL TIMES (min), SAMPLE DESCRIPTION AND DRILLING NOTES, WELL, ▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40, ◆POCKET PEN (kPa)◆ 100 200 300 400

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LOGGED BY: HA	COMPLETION DEPTH: 80.1 m
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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869340 EASTING: 532480	ELEVATION: 484.6 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
80							End of Borehole at 80.1m, 25mm diameter standpipe was installed to approximately 60.4m below grade		
81		404							
82		403							
83		402							
84		401							
85		400							
86		399							
87		398							
88		397							
89		396							
90		395							

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH2AB
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869742.43 EASTING: 532207.57	ELEVATION: 516.5 m

SAMPLE TYPE: TUBE; NO RECOVERY; SPLIT SPOON; GRAB; MUD RETURN; CORE RETURN

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
0		516					SAND AND GRAVEL, fine to coarse grained sand, sub-rounded gravel, trace silt, loose, brown, moist	
3.7		513					SILT TUFF, some clay, trace sand, low plasticity, firm to dense, tan brown, moist from 3.7m to 16.8m	
13.7							-grey from 13.7m	
16.8		500					CLAY TUFF, some silt, high plasticity, multi-cloured reddish-brown to light green, firm to dense, moist from 16.8m to 18.9m	
18.9		498					SAND, fine to coarse grained sand, some silt, grey, compact to dense, moist	
20.1							-gravelly from 20.1m, gravel texture suggests it has been reheated	
25.9							-wet from 25.9m	
32.0		485					SILT AND CLAY TUFF, trace sand, firm to dense, high plasticity, light green from 32.0m to 44.8m	

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33

Elevation scale (m): 516, 515, 514, 513, 512, 511, 510, 509, 508, 507, 506, 505, 504, 503, 502, 501, 500, 499, 498, 497, 496, 495, 494, 493, 492, 491, 490, 489, 488, 487, 486, 485, 484

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2AB**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869742.43 EASTING: 532207.57	ELEVATION: 516.5 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
33	483	-drillers began adding water from 32.0m SILT AND CLAY TUFF, trace sand, firm to dense, high plasticity, light green from 32.0m to 44.8m*(continued)*
34	482	
35	481	
36	480	
37	479	-trace to some semi-consolidated clasts from 37.2m
38	478	
39	477	
40	476	
41	475	
42	474	
43	473	
44	472	
45	471	SILT AND CLAY TUFF, trace to some black sand, firm, high plasticity, dark brown from 44.8m to 46.5m
46	470	
47	469	LIGNITE, very weak, dark brown to black
48	468	-Piezometer B set between 47.4m and 48.2m, static water level recorded at 40.88m (October 8, 2003) TUFF, alternating coarse and fine-grained beds
49	467	SILT AND CLAY TUFF, firm to dense, high plasticity, green from 48.3m to 60.3m
50	466	
51	465	
52	464	-light green from 51.8m
53	463	
54	462	
55	461	
56	460	-hard drilling from 56.4m
57	459	
58	458	-trace sand from 57.9m
59	457	
60	456	SILT TUFF, clayey, trace to some sand, trace gravel, green from 60.3m to 62.2m
61	455	
62	454	SILT TUFF, sandy, trace semi-consolidated gravel clasts, dense, light grey from 62.2m to 65.5m -casing refusal at 62.4m, drilled open hole from 62.2m
63	453	
64	452	
65	451	
66		

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amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: SG ENTERED BY: CD	COMPLETION DEPTH: 90.4 m COMPLETION DATE: 8/7/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2AB**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869742.43 EASTING: 532207.57	ELEVATION: 516.5 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

SAMPLE DESCRIPTION AND DRILLING NOTES

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
66–67.1	450–449.4	SAND TUFF, silty, trace gravel, dense, light grey from 65.5m to 67.1m TUFF, alternating coarse and fine-grained beds*(continued)*
67.1–70.1		SILT TUFF, sandy, trace gravel, dense, light grey from 67.1m to 70.1m
70.1–73.1		SAND TUFF, silty, trace gravel, dense, light grey from 70.1m to 73.1m
73.1–79.2		SILT TUFF, clayey, some sand, trace gravel, dense, light grey from 73.1m to 79.2m
79.2–85.3		SILT AND CLAY TUFF, trace sand, trace semi-consolidated gravel sized clasts, dense, medium plasticity, light grey from 79.2m to 85.3m
85.3–90.4		SAND TUFF, silty, trace to some gravel, dense, grey from 85.3m to 90.4m -trace to some clay from 88.4m -Piezometer A set between 88.4m and 86.9m, static water level recorded at 80.84m (October 8, 2003)
90.4	426	End of Borehole 90.4m below grade

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amec Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: SG ENTERED BY: CD	COMPLETION DEPTH: 90.4 m COMPLETION DATE: 8/7/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH2C**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869742.28 EASTING: 532210.04	ELEVATION: 516.5 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
0 – 3	516.5 – 513.5	SAND AND GRAVEL, fine to coarse grained sand, subrounded gravel, trace silt, loose, brown, moist (fill)
3 – 5.5	513.5 – 511	SAND, fine to coarse grained sand, some gravel, trace to some silt, loose, brown, moist
5.5 – 15.5	511 – 501	SILT TUFF, some clay, trace gravel, low plasticity, firm to dense, tan brown, moist, gravel consists of semi-consolidated clasts from 5.5m to 15.5m Piezometer 2C Water level observed at 8.9m on October 8, 2003 -olive brown from 10.7m -localized oxidation along fractures in clasts from 12.2m -grey from 14.3m
15.5 – 18.3	501 – 498.2	CLAY TUFF, some silt, some gravel, firm to dense, high plasticity, multi-coloured to light green from 15.5m to 18.3m
18.3 – 22.2	498.2 – 494.3	SAND, fine to coarse grained, some silt, trace to some clay, some gravel, compact to dense, grey, moist note: gravel texture suggests it has been re-heated
22.2 – 26	494.3 – 490.5	GRAVEL, sub-rounded, some sand, some silt, compact to dense, grey, moist -no clay, trace silt, wet from 24.4m
26 – 30	490.5 – 486.5	SAND, fine to coarse grained, some sub-rounded gravel, trace to some silt, compact, grey, saturated -silty with some clay below 29.0m
30	486.5	End of Borehole 30.0m below grade

Column headings: DEPTH (m), STRATIGRAPHY, ELEVATION (m), SAMPLE TYPE, SAMPLE NO, RECOVERY (%), DRILL TIMES (min), SAMPLE DESCRIPTION AND DRILLING NOTES, WELL

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LOGGED BY: SG	COMPLETION DEPTH: 30.0 m
ENTERED BY: CD	COMPLETION DATE: 8/8/03

STRATIGRAPHIC KX04397-2003.PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | ▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400

Depth (m)	Elevation (m)	Sample No	Sample Description and Drilling Notes
0	503		SILT, some clay to clayey, stiff, low to medium plastic, brown, moist (glaciolacustrine deposit) PP = Pocket Pentrometer
1	502	1	
2	501		SAND (fine grained), silty, loose to compact, poorly graded, brown, moist to wet (glaciolacustrine deposit)
3	500	2	Water level observed at 3.3m on August 17, 2002
4	499	3	-gravelly below 4.9m
5	498		
6	497	4	
7	496		SILT, sandy to some sand, trace gravel, trace cobbles, trace clay, very stiff to hard (PP = 250 to >450kPa), low plastic, moist to wet
8	495	5	>>
9	494	6	
10			

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STRATIGRAPHIC KX04397-2001-BH-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

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LOGGED BY: HA
ENTERED BY: SR

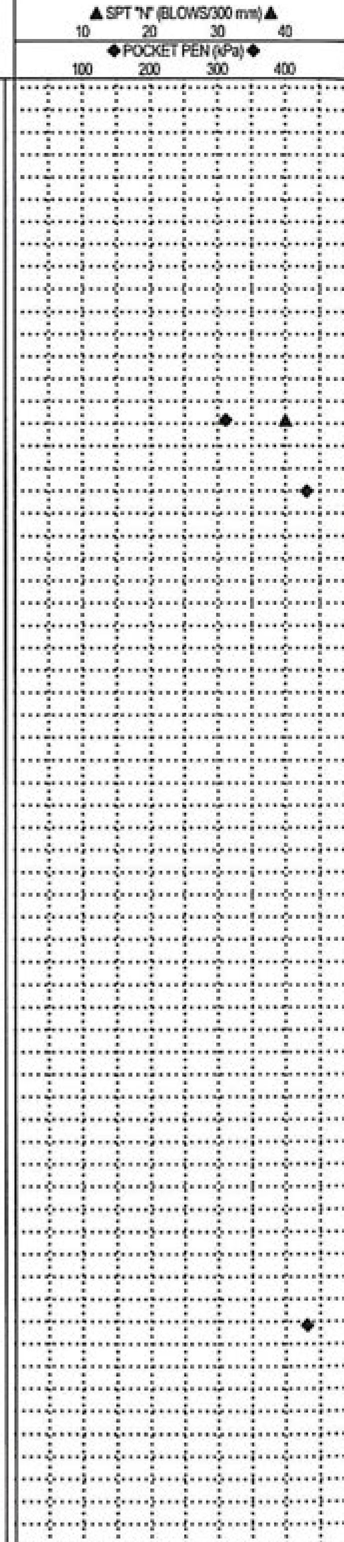
COMPLETION DEPTH: 95.3 m
COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10	493			SILT, sandy to some sand, trace gravel, trace cobbles, trace clay, very stiff to hard (PP = 250 to >450kPa), low plastic, moist to wet*(continued)*
11	492			
12	491	7, 8		
		9	79	
13	490	10		
				SIEVE=G7%, S21%, F72%
14	489	11	26	SIEVE=G7%, S21%, F72%
15	488	12	0	
16	487			
17	486	13	5	
18	485	14	8	
19	484			SILT, some clay, trace sand, trace gravel (<1%), stiff to hard (PP = 150 to 450 kPa), low to medium plastic, bedded to varved with some clay and silt or sand layers, brown, wet to moist (glaciolacustrine deposit)
20				



CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
20	483	15	43		SILT, some clay, trace sand, trace gravel (<1%), stiff to hard (PP = 150 to 450 kPa), low to medium plastic, bedded to varved with some clay and silt or sand layers, brown, wet to moist (glaciolacustrine deposit)*(continued)*
21	482	16			
		17	13		
22	481	18	10		SILT , clayey, some sand, trace gravel, stiff to hard (PP = 250 to >450 kPa), low to medium plastic, grey, moist to wet
23	480				
24	479	19	63		
25	478	20	37		SILT, some clay, trace sand, trace gravel, hard (PP = >400kPa), low to medium plastic, bedded to varved with some clay or fine sand layers, brown, moist to wet, some thin 600mm seams are gravelly (glaciolacustrine deposit) SIEVE=G22%, S56%, F22%
26	477	21	142		SIEVE=G22%, S56%, F22%
27	476	22	9		SILT, clayey, some sand, trace ot some gravel, hard (PP = >400kPa), low to medium plastic, bedded or varved with some clay and fine sand layers, brown, moist to wet, some thin seams up to 600mm thick are gravelly
28	475				
29	474	23	7		
30					

WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40

◆POCKET PEN (kPa)◆ 100 200 300 400

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LOGGED BY: HA
ENTERED BY: SR
COMPLETION DEPTH: 95.3 m
COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30	473	24	0	SILT, clayey, some sand, some gravel, hard to stiff (PP = 250 to >450 kPa), low to medium plastic, grey, wet, some layers of gravel and cobbles excavated (could not confirm depths due to poor recovery) brown to grey soil, gravelly to cobbly (based on drillers comments)
31	472			
32	471	25	0	
33	470			
		26	0	
34	469			
		27	30	
35	468			SIEVE=G22%, S30%, F48%
		28	41	SIEVE=G22%, S30%, F48%
36	467	29	14	-250mm thick seam of cemented (iron oxide), dense, gravelly sand (medium to fine grained)
37	466	30	0	**-Vibrating Wire Piezometer 3 at 37.5m**
				-possible slip surface - no recovery across slip surface
38	465	31	5	
				-possible lignite seam based on black drill water, no recovery
39	464			TUFF, alternating coarse and fine-grained beds
				CLAY AND SILT TUFF, hard, high to medium plastic, blue, wet from 39.0m to 42.7m
40		32	0	

WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40

◆POCKET PEN (kPa)◆ 100 200 300 400

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LOGGED BY: HA	COMPLETION DEPTH: 95.3 m
ENTERED BY: SR	COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

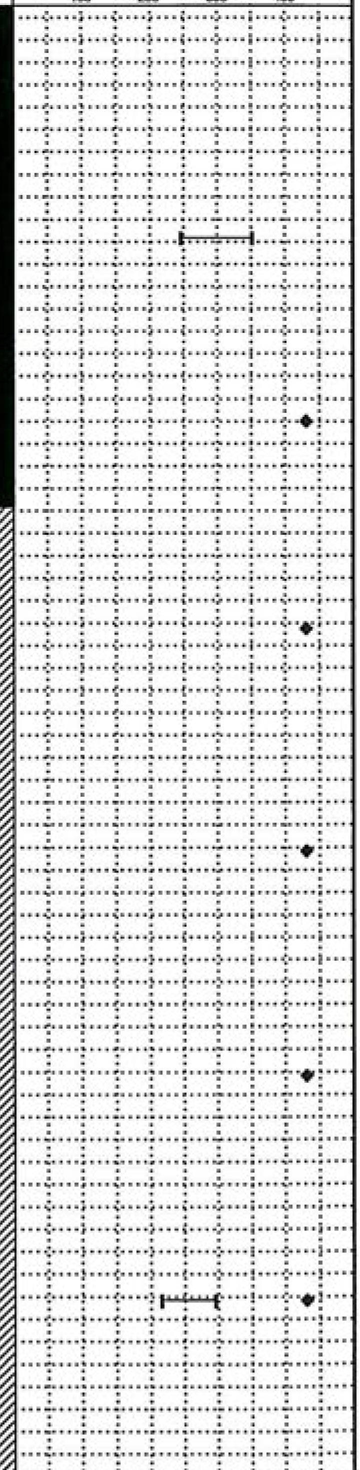
SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
40	463			TUFF, alternating coarse and fine-grained beds *(continued)*
41	462	33	5	
		34	41	
42	461			Hydrometer Analysis=SAND 3%, SILT 79%, CLAY 18%
				Hydrometer Analysis=SAND 3%, SILT 79%, CLAY 18%
43	460	35	92	SILT AND CLAY TUFF, trace sand and gravel (in some thin layers), trace lignite (<1%), hard (PP = >450kPa), medium plastic, green, mottled, moist to wet from 42.7m to 58.4m -230mm thick layer of bedded fine sand, silty with some gravel (in some thin layers), trace lignite (<1%), hard (pp >450kPa), medium plastic, green, mottled, moist to wet
44	459	36	100	-50mm layer of silty sand with trace gravel (clasts mainly rounded clay fragments) -75mm layer of silty sand with trace to some gravel (clasts mainly igneous rock with some clay fragments)
45	458			
46	457	37	80	-200mm thick seam of gravelly (angular, igneous fragments) silt with some sand and trace clay
47	456			-400mm seam of bedded silt and fine sand with some gravel -possible slickensides
48	455	38	100	-trace clay clasts (rounded and gravel size)
49	454	39	100	-300mm thick breccia seam -possible slickensides
50				SIEVE=S68%, F32% SIEVE=S68%, F32%

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400



amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HA ENTERED BY: SR	COMPLETION DEPTH: 95.3 m COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50	453	40	103	-600mm thick seam of trace to some sand, trace lignite (<1%) TUFF, alternating coarse and fine-grained beds *(continued)* -100mm thick sandy silt lense
51	452	41	100	-240mm thick silty sand lense -70mm thick silty sand lense -240mm thick silty sand lense
53	450	42	100	-sand and gravel (some silt to silty) 0.4m thick
		43	59	Artesian water pressure (greater than 5.5m of head) Artesian water pressure (greater than 5.5m of head above ground surface) -silt sand/sandy silt lense 1.5m thick
54–55	449–448	44	100	Artesian water pressure (greater than 5.5m of head above ground surface) Artesian water pressure (greater than 5.5m of head above ground surface) -150mm thick silty sand and gravel lense, trace gravel (rounded clay clasts) -trace lignite (<1%)
56	447	45	100	Artesian water pressure (flow was approx. 0.5L/min) Artesian water pressure (flow was approx. 0.5L/min) -possible slickensides -silty sand and gravel lense, trace gravel sized clay clasts, brown, 0.9m thick
57–58	446–445	46	100	-SANDSTONE, brown from 58.4m to 58.7m
59–60	444	47	100	SILT AND CLAY TUFF, trace to some sand, trace to some clay fragments (gravel size), trace lignite (<1%), hard, medium to high plastic, green from 58.7m to 60.2m -300mm thick lense of silty sand with clay clasts (rounded and gravel size)

WELL

SPT "N" (BLOWS/300 mm): 10 20 30 40
POCKET PEN (kPa): 100 200 300 400

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH3**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
60	443			TUFF, alternating coarse and fine-grained beds *(continued)*
				SAND TUFF, some gravel to gravelly, some silt to silty, some clay clasts (rounded and gravel size), very dense, green from 58.7m to 67.1m
				SIEVE=G25%, S52%, F23%
				SIEVE=G25%, S52%, F23%
61	442	48	80	-easier penetration from 60.7m to 61m
62	441	49	100	-silt and clay, trace lignite (<1%), hard, medium to high plastic, green, from 61.9m to 63.1m
63	440			
64	439	50	67	
65	438	51	52	-silt and clay, trace lignite (<1%), hard, medium to high plastic, green, from 64.8m to 65.4m
66	437			-silt and clay, trace lignite (<1%), hard, medium to high plastic, green, from 66.3m to 66.8m
67	436	52	114	SILT TUFF, some clay to clayey, trace to some sand with isolated sand and gravel lenses, trace to some clay fragments (rounded and gravel size), hard, low to high plastic, green from 67.1m to 70.0m
		53	58	
68	435	54	92	-600mm thick lense of sand with some gravel to gravelly, some silt, some clay clasts (rounded and gravel size), very dense, green
69	434			-450mm thick lense of silt and clay
70				

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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LOGGED BY: HA	COMPLETION DEPTH: 95.3 m
ENTERED BY: SR	COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH3**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
70		433		55	103		-gravelly, silty sand seam with clay clasts (rounded and gravel size) SAND TUFF, some gravel to gravelly, some silt to silty, trace to some clay, some clay clasts (rounded and gravel size), trace lignite (<1%), very dense, green from 70.0m to 80.2m TUFF, alternating coarse and fine-grained beds*(continued)* -silt and clay lenses interbedded within the stratum below 70.7m SIEVE=G3%, S72%, F25%		
71		432					SIEVE=G3%, S72%, F25%		
				56	93				
72		431							
73		430		57	97				
74		429					-150mm thick breccia seam		
				58	100				
75		428							
76		427		59	75				
77		426							
				60	78				
78		425							
79		424		61	87				
80									

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		ENTERED BY: SR	COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
80	423			TUFF, alternating coarse and fine-grained beds *(continued)* -300mm thick sandstone seam SILT AND CLAY TUFF, trace sand, trace gravel, hard, medium to high plastic, green from 80.2m to 95.1m
		62	107	
81	422			
82	421	63	92	
83	420			-trace lignite
				-silty sand and gravel lenses with clay fragments
		64	0	
84	419			
85	418	65	100	
86	417			
87	416	66	47	
88	415			-200mm thick silty sand and gravel lense
		67	100	-75mm thick silty sand sand gravel lense
89	414			-150mm thick silty sand and gravel lense, brownish
				SIEVE=G11%, S58%, F31%
				SIEVE=G11%, S58%, F31% -300mm thick silty sand and gravel lense
90				

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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(250) 564-3243

LOGGED BY: HA	COMPLETION DEPTH: 95.3 m
ENTERED BY: SR	COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869597 EASTING: 532264	ELEVATION: 503.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
90		413					TUFF, alternating coarse and fine-grained beds*(continued)* -130mm thick silty sand and gravel lense		
				68	88				
91		412		69	47				
92		411					-130mm thick silty sand and gravel lense -180mm thick seam of breccia		
93		410		70	0				
94		409		71	10				
95		408					End of Borehole at 95.1m, vibrating wire piezometer installed at 37.5m below grade		
96		407							
97		406							
98		405							
99		404							
100									

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LOGGED BY: HA	COMPLETION DEPTH: 95.3 m
ENTERED BY: SR	COMPLETION DATE: 11/15/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH3A**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869770.82 EASTING: 532006.53	ELEVATION: 519.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Columns: DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
0 – 3	519.1 – 516	SAND, fine to coarse grained, gravelly, some silt, campact, brown, moist (fill)
3 – 5	516 – 514	SAND, fine to coarse grained, some silt, trace clay, trace gravel, compact, grey, moist Piezometer 3A Water level observed at 3.85m on October 8, 2003
5 – 10.7	514 – 508.4	SILT, some sand, some gravel, trace to some clay, soft, brown, moist
10.7 – 12.2	508.4 – 506.9	SAND, fine to coarse grained, some angular gravel, trace silt, compact, brown, moist
12.2 – 14.3	506.9 – 504.8	SAND AND GRAVEL, fine to coarse grained, some silt, some clay, compact, grey, moist
14.3 – 19.8	504.8 – 499.3	SILT, some fine grained sand, trace to some clay, trace gravel, firm, grey, moist -some gravel from 18.3m
19.8 – 25.9	499.3 – 493.2	GRAVEL, sun-rounded, some sand, some silt, trace clay, compact to dense, grey, moist -silty from 24.4m
25.9 – 30	493.2 – 489.1	SILT, some fine grained sand, some gravel, trace to some clay, stiff, grey, moist

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LOGGED BY: SG	COMPLETION DEPTH: 53.9 m
ENTERED BY: CD	COMPLETION DATE: 7/24/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH3A
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869770.82 EASTING: 532006.53	ELEVATION: 519.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		SILT, some fine grained sand, some gravel, trace to some clay, stiff, grey, moist*(continued)*
31	488	
32	487	SAND, fine to coarse grained, some gravel, some silt, trace clay, compact, grey
33	486	CLAY, some silt, stiff to dense, medium plasticity, some lignite inclusions, dark brown to black, moist -trace fine sand from 32.6m to 32.9m
34	485	-trace lignite from 34.1m
35	484	
36	483	
37	482	LIGNITE, very weak, dark brown to black CLAY, trace to some silt, stiff, high plasticity, grey, moist
38	481	LIGNITE, very weak, dark brown to black
39	480	
40	479	CLAY, trace to some silt, stiff, high plasticity, grey and brown, moist -LIGNITE layer (0.5m thick) at 40.1m
41	478	LIGNITE, very weak, dark brown to black
42	477	CLAY, trace silt, trace gravel, stiff, high plasticity, brown and grey
43	476	-no gravel from 42.7m
44	475	-some silt from 43.6m
45	474	SAND, fine to coarse grained, some silt, compact to dense, grey SILT TUFF, some sand, some gravel, trace clay, stiff to dense, low plasticity, olive brown, moist note: gravel consists of semi-consolidated clasts
46	473	
47	472	
48	471	
49	470	
50	469	SAND TUFF, fine to coarse grained, some silt, some gravel, dense, light green from 49.4m to 50.4m
51	468	
52	467	-some clay from 51.8m
53	466	
54	465	End of Borehole 53.9m below grade
55	464	
56	463	
57	462	
58	461	
59	460	
60		

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LOGGED BY: SG	COMPLETION DEPTH: 53.9 m
ENTERED BY: CD	COMPLETION DATE: 7/24/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH3BC**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869720.44 EASTING: 522005.24	ELEVATION: 519.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
0		SAND AND GRAVEL, fine to coarse grained sand, trace silt, compact, brown, moist (fill)
2	517	SILT, some clay, some fine grained sand, trace to some gravel, soft, medium plasticity, brown, wet
7	512	-some sand to sandy, trace gravel, firm to stiff below 6.6m
10	509	-0.3m thick layer of weak, friable, rock at 9.8m
11	508	SAND AND GRAVEL, fine to coarse grained sand, some silt, trace clay, compact, brown, wet
13	506	SILT, clayey, trace to some fine grained sand, trace gravel, firm, medium plasticity, grey, wet
15	504	SAND, fine grained, silty, trace clay, compact to dense, grey, wet
19	500	SILT, clayey, trace gravel, firm, grey
21	498	SAND, fine grained, silty, some gravel, trace clay, dense, brown
22	497	SILT, clayey, sandy, some gravel, stiff to hard, high plasticity, trace lignite inclusions, brown
24	495	SAND AND GRAVEL, trace to some silt, dense, brown
25	494	SILT, clayey, some sand, trace gravel, dense, high plasticity, brown
30		

STRATIGRAPHIC KX04397-2003 PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

amec — Earth & Environmental, 3456 Opie Crescent, Prince George, BC V2N 2P9, (250) 564-3243	LOGGED BY: SG	COMPLETION DEPTH: 44.8 m
	ENTERED BY: CD	COMPLETION DATE: 7/22/03
		Page 1 of 2

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH3BC**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869720.44 EASTING: 522005.24	ELEVATION: 519.1 m

SAMPLE TYPE: TUBE | NO RECOVERY | SPLIT SPOON | GRAB | MUD RETURN | CORE RETURN

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
30								
31		488					GRAVEL, sub-rounded, some sand, trace silt, dense, grey	
32		487						
33		486					-Piezometer C set between 32.0m and 33.5m, static water level measured at 1.82m below grade (October 8, 2003)	
34		485					LIGNITE, very weak, dark brown to black	
35		484					CLAY, some silt, trace sand, hard, high plasticity, grey and black	
36		483					LIGNITE, very weak, dark brown to black	
37		482					CLAY, some silt, hard, high plasticity, grey to light brown	
38		481						
39		480					LIGNITE, very weak, dark brown to black	
40		479					-Piezometer B set between 38.7m and 40.2m, static water level measured at 1.14m below grade (October 8, 2003) -0.3m thick clay layer from 39.3m to 39.6m	
41		478					CLAY, some silt, hard, high plasticity, grey to light brown	
42		477					LIGNITE, very weak, dark brown to black	
43		476					CLAY, trace to some silt, hard, high plasticity, grey	
44		475					CLAY TUFF, some silt, trace sand, dense, high plasticity, grey	
45		474					End of Borehole 44.8m below grade	
46		473						
47		472						
48		471						
49		470						
50		469						
51		468						
52		467						
53		466						
54		465						
55		464						
56		463						
57		462						
58		461						
59		460						
60								

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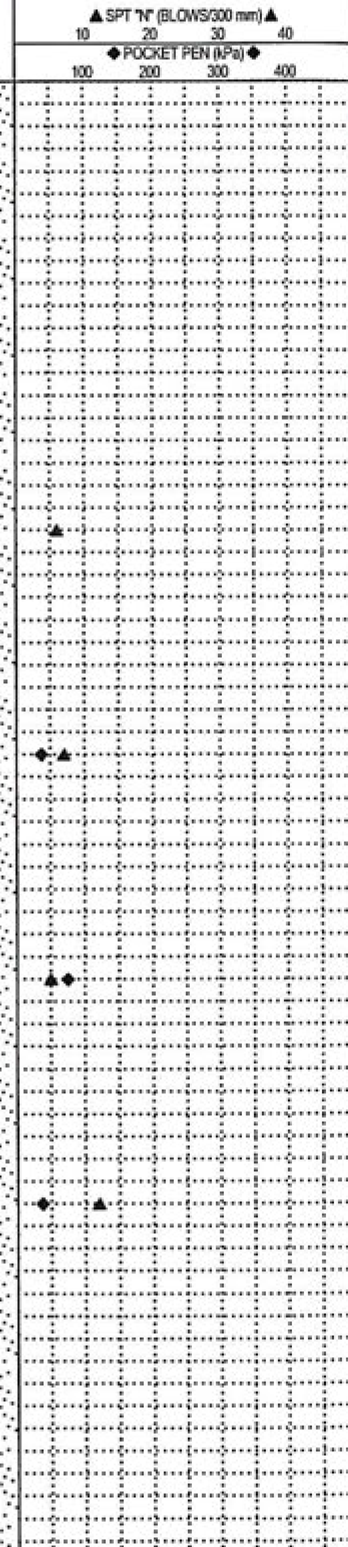
		ENTERED BY: CD	COMPLETION DATE: 7/22/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE; NO RECOVERY; SPLIT SPOON; GRAB; MUD RETURN; CORE RETURN

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
0							SILT, sandy to some sand (fine), trace gravel, trace cobbles, very stiff (at ground surface) to soft, non to low plastic, brown, damp to wet, (possible fill) PP = Pocket Pentrometer	
		536						
1								
		535						
2								
		534						
3			Split spoon	1				
		533					SILT, trace sand (fine), trace clay, soft (PP = 25 to 50kPa), low plastic, grey to brown, wet to saturated	
4								
		532	Split spoon	2				
5								
		531						
6			Split spoon	3				
		530						
7							-soft to firm (PP=25 to 125kPa), trace gravel and possible cobbles, gravel recovered was angular piece of plateau basalt	
		529	Split spoon	4				
8								
		528						
9			Split spoon	5				
		527						
10								



CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
10							SILT, trace sand (fine), trace clay, soft (PP = 25 to 50kPa), low plastic, grey to brown, wet to saturated *(continued)*		
		526		6					
11		525							
12				7					
		524							
13		523		8			-hard to very stiff, (PP=350 to >450kPa), with some firm lenses(PP=150kPa)		
14		522							
15				9			Water level observed at 15.1m below ground surface in Vibrating Wire Piezometer on August 17, 2002.		
		521					Water level observed at 15.1m below ground surface in Vibrating Wire Piezometer on August 17, 2002. -from 15.2m to 17.4m, 3 gravel lenses approximately 150 to 300mm thick encountered		
16		520		10					
17		519					SILT, some to trace clay, trace sand, trace gravel (mainly volcanics), hard, low to medium plastic, dark grey to brown, wet to saturated, silt contains some silty sand, and coarse sand layers		
18				11					>>
		518							
19		517							
20				12					

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
20							SILT, some to trace clay, trace sand, trace gravel (mainly volcanics), hard, low to medium plastic, dark grey to brown, wet to saturated, silt contains some silty sand, and coarse sand layers *(continued)*		
		516							
21		515		13					>>▲
22		514					-150mm thick gravel layer encountered		
23				14					
		513					-450mm thick gravel layer encountered		
24		512		15			-trace lignite in soil		>>▲
25		511		16	23				
26		510							
27		509		17	20		-trace cobbles		
28		508		18	18				
29		507							
30									

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		19	10	
	506			GRAVEL (angular to subrounded), some sand, some silt, trace to some cobbles, very dense, poorly graded, dark grey, saturated, some silt and clay seams in gravel
31	505			
32		20	15	
	504			
33	503	21	3	
34	502	22	24	
		23	50	
35		24	14	
	501	25	23	-driller reported cobbly ground from 35.7m to 38.7m
36	500			
37		26	26	
	499			
38	498	27	7	
39		28	0	
	497			
40		29	0	

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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LOGGED BY: HA
ENTERED BY: SR

COMPLETION DEPTH: 153.3 m
COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE	TUBE	NO RECOVERY	SPLIT SPOON	GRAB	MUD RETURN	CORE RETURN
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
40 – 43.6	GRAVEL	496 – 493	TUBE	30	12		GRAVEL (angular to subrounded), some sand, some silt, trace to some cobbles, very dense, poorly graded, dark grey, saturated, some silt and clay seams in gravel*(continued)*	BENTONITE
			TUBE	31	3			
43.6 – 45.4	SILT	492	SPLIT SPOON	32	67		SILT, trace sand, trace gravel, hard (PP=400 to >450kPa), low plastic, brown to steel grey, wet to moist, mottled (possible tuff) Stopped coring, used Macro Punch Sampler Stop coring, used Macro Punch Sampler	
45.4 – 50	SILT AND CLAY	491 – 487	SPLIT SPOON	33	98		SILT AND CLAY, gravelly, soft to stiff (PP=25 to 200kPa), medium to high plastic, steel grey to brown, saturated to wet (possible tuff)	
			SPLIT SPOON	34	61		Hydrometer analysis=SILT 64%, CLAY 36% Hydrometer Analysis=SILT 64%, CLAY 36%	SAND (from ~47.8)
			TUBE	35	17			
			SPLIT SPOON	36	0		Hydrometer anaylsis=SILT 48%, CLAY 35%	
			SPLIT SPOON	37	83		Hydrometer Analysis=SILT 48%, CLAY 35%	

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400

STRATIGRAPHIC KX04397-2001-BH-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE | NO RECOVERY | SPLIT SPOON | GRAB | MUD RETURN | CORE RETURN

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50				**-X-Ray Diffraction test at 49.68m**
	486	38	41	**X-Ray Diffraction Test at 49.68m** **-Vibrating Wire Piezometer 4 at 49.8m** Started coring
51		39	100	Start Coring PEAT, soft, fibrous*(continued)* TUFF, alternating coarse and fine-grained beds
	485			SILT AND CLAY TUFF, trace to some sand, trace gravel, hard, medium to high plastic, green from 50.1m to 92.6m -silty sand lenses with some gravel and some clay clasts (rounded and gravel size)
52		40	112	-possible slickensides -150mm thick silty sand and gravel lense, some clay clasts
	484			-250mm thick silty sand and gravel lense, some clay clasts SIEVE=G22%, S56%, F22% SIEVE=G22%, S56%, F22%
53		41	68	-150mm thick silty sand and gravel lense, some clay clasts
	483			-possible slickensides
54				
	482	42	107	-300mm thick silty sand and gravel lense
55				-150mm thick silty sand and gravel lense, some clay clasts
	481			-150mm thick silty sand and gravel lense, some clay clasts, trace lignite (<1%) -possible slickensides
56		43	58	
	480			
57				
	479	44	98	
58				-possible slickensides
	478			
59		45	40	
	477			
60				

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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LOGGED BY: HA
ENTERED BY: SR

COMPLETION DEPTH: 153.3 m
COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
60							TUFF, alternating coarse and fine-grained beds *(continued)* -possible slickensides		
		476		46	77				
61							-80mm thick silty sand and gravel lense, some clay clasts -800mm thick silty sand and gravel lense, some clay clasts		
		475							
62							-possible slickensides		
		474		47	90		-900mm thick silty sand and gravel lense, some clay clasts		
63		473							
64				48	100		-300mm thick silty sand and gravel lense, some clay clasts		
		472					-possible slickensides, possible lignite		
65							-black drill water return and soft drilling conditions were reported from 64.9m to 65.8m, may indicate lignite layer		
		471		49	103		-300mm thick silty sand and gravel lense, some clay clasts		
							-possible slickensides from 65.7m to 66.8m		
66				50	100				
		470					Up to 1.5m of Artesian head encountered during drilling from 66.4m to 71.0m depth.		
67				51	93		Up to 1.5m of Artesian head encountered during drilling from 66.4m to 71.0m depth. Atterberg - LL=105%		
		469					Atterberg - LL=105% -300mm thick silty sand and gravel lense, some clay clasts		
68							-300mm thick silty sand and gravel lense, some clay clasts		
		468		52	100				
69									
		467					-possible slickensides		
70									

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
70		53	73	TUFF, alternating coarse and fine-grained beds*(continued)*
	466			-300mm thick silty sand and gravel lense, some clay clasts
71	465	54	53	
72	464			-500mm thick silty sand and gravel lense, some clay clasts
73	463	55	92	-300mm thick silty sand and gravel lense, some clay clasts
74	462			-150mm thick sandy silt lense, tract to some gravel (some clay clasts)
				-possible slickensides
75	461	56	103	-100mm thick sandy silt lense, trace gravel, some clay clasts
				-possible slickensides
76	460	57	92	-2.7m silty sand and gravel lense, some clay clasts from 76 to 78.7m
77	459			
78	458	58	10	
79	457	59	107	
80				

WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40

◆POCKET PEN (kPa)◆ 100 200 300 400

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
80							-800mm thick silty sand and gravel lense, some clay clasts TUFF, alternating coarse and fine-grained beds*(continued)*		
		456							
81				60	102		-100mm thick silty sand and gravel lense, some clay clasts		
		455					-130mm thick silty sand and gravel lense, some clay clasts		
82		454		61	93		-220mm thick silty sand and gravel lense, some clay clasts		
83		453					-possible slickensides -800mm thick silty sand and gravel lense, some clay clasts		
84		452		62	102		-500mm thick silty sand and gravel lense, some clay clasts		
85		451		63	42		-300mm silty sand and gravel lense, some clay clasts SIEVE=G41%, S40%, F19%		
86		450					SIEVE=G41%, S40%, F19% -possible slickensides		
87		449		64	102				
88		448		65	93		-900mm thick silty sand and gravel lense, some clay clasts		
89		447					-80mm thick silty sand and gravel lense, some clay clasts		
90							-150mm thick silty sand and gravel lense, some clay clasts		

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
90		66	103	TUFF, alternating coarse and fine-grained beds *(continued)*
	446			-100mm thick silty sand and gravel lense, some clay clasts
91	445	67	105	-500mm thick silty sand and gravel lense, some clay clasts
92				-50mm sandstone piece encountered
	444			SAND AND GRAVEL TUFF, silty, some clay clasts (rounded and gravel size), poorly graded, brown from 92.6m to 124.7m
93	443			
94	442	68	100	
95	441			
96	440	69	53	
97				-300mm thick clayey silt lense, trace sand
	439	70	70	
98	438			
99	437	71	13	
100				

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

WELL

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
100							TUFF, alternating coarse and fine-grained beds *(continued)*		
		436		72	13				
101		435					-300mm thick clayey silt lense, trace sand		
102		434		73	98		-430mm thick clayey silt lense, trace sand		
103		433		74	12				
104		432							
105		431		75	13				
106		430					SIEVE=G22%, S66%, F12%		
							SIEVE=G22%, S66%, F12%		
107				76	63		-300mm thick clayey silt lense, trace sand		
108		429		77	46				
109		428							
110		427		78	23				

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
110							TUFF, alternating coarse and fine-grained beds *(continued)*		
		426							
111				79	43				
		425							
112									
		424							
							-200mm thick clayey silt lense, trace sand		
113				80	100		-450mm thick clayey silt lense, trace sand		
		423							
114									
		422		81	32				
115									
		421							
116				82	53				
		420							
117									
		419		83	15				
118									
		418							
119				84	64				
		417					-150mm thick possible sandstone encountered		
120									

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
120		85	54		TUFF, alternating coarse and fine-grained beds *(continued)*
	416				
121		86	47		-50mm diameter vesicular clast of tephra, brown on inside, weathered to white on outside
	415				
122		87	23		
	414				
123	413	88	100		-possible breccia layer (approx. 0.1m thick)
124	412				
125		89	103		SILT AND CLAY, fine size particles (silt and clay size), trace sand, trace gravel, medium to high plastic, white
	411				
126	410	90	100		-layers of chert below 126.2m depth
127	409				
128		91	88		
	408				
129	407	92	75		
130					

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
130				SILT AND CLAY, fine size particles (silt and clay size), trace sand, trace gravel, medium to high plastic, white *(continued)*
	406			-increased clay content, high plastic, brown below 130.6m
131	405	93	2	
132	404	94	37	CHERT with silicious sand seams
133				Atterberg - LL=113% PL=47%
	403	95	20	Atterberg - LL=113% PL=47%
134	402			SILTSTONE, silt and clay, trace sand, trace gravel, trace chert, well bedded, white
135	401	96	20	
136	400	97	43	
137	399			
138	398	98	95	
139	397			
140		99	23	

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40 / ◆ POCKET PEN (kPa) ◆ 100 200 300 400
140							SILTSTONE, silt and clay, trace sand, trace gravel, trace chert, well bedded, white *(continued)*		
		396							
141				100	8				
		395							
142				101	100				
		394							
143		393		102	52				
144		392							
145				103	53				
		391							
146		390		104	102				
147		389							
148				105	102				
		388							
149		387		106	60				
150									

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LOGGED BY: HA	COMPLETION DEPTH: 153.3 m
ENTERED BY: SR	COMPLETION DATE: 12/6/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH4
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869868 EASTING: 531829	ELEVATION: 536.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
150							SILTSTONE, silt and clay, trace sand, trace gravel, trace chert, well bedded, white *(continued)*		
		386							
151				107	97				
		385							
152									
		384		108	13				
153									
		383					End of Borehole at 153.3m, vibrating wire piezometer was installed at 49.8m below grade, 25mm diameter standpipe installed at 38.2m below grade		
154									
		382							
155									
		381							
156									
		380							
157									
		379							
158									
		378							
159									
		377							
160									

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4AB**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869782.79 EASTING: 532040.98	ELEVATION: 519.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE DESCRIPTION AND DRILLING NOTES
0		SILT, some fine grained sand, trace to some clay, trace to some gravel, soft, medium plasticity, olive brown, moist to wet
5	515	SAND AND GRAVEL, trace silt, brown, moist
5.4		SILT AND CLAY, trace sand, trace gravel, firm to stiff, medium plasticity, grey, mottled along fractured, moist -brown below 7.2m -silty sand layers (2mm-30mm thick) at 7.2m, 9.1m and 10.1m -stiff to dense below 9.1m
12		SAND, fine to medium grained, trace to some silt, trace gravel, compact, grey, saturated
13		SILT AND CLAY, firm to stiff, medium plasticity, grey, moist, texture along partings smooth and amorphous
17.5		SILT AND CLAY, some fine grained black sand, firm to stiff, medium plasticity, grey, moist -LIGNITE layer (0.3m thick) between 22.2m and 22.5m
23.5		LIGNITE, wery weak, dark brown to black
24.5		SILT AND CLAY, trace fine grained black sand, firm to stiff, medium plasticity, grey, moist -no sand from 25.9m

Depth scale: 0–30 m. Elevation scale: 519–490 m. Columns: DEPTH (m), STRATIGRAPHY, ELEVATION (m), SAMPLE TYPE, SAMPLE NO, RECOVERY (%), DRILL TIMES (min), SAMPLE DESCRIPTION AND DRILLING NOTES, WELL.

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LOGGED BY: SJ	COMPLETION DEPTH: 49.7 m
ENTERED BY: CD	COMPLETION DATE: 7/17/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4AB**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869782.79 EASTING: 532040.98	ELEVATION: 519.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
30–36.3		489–484					SILT AND CLAY, trace fine grained black sand, firm to stiff, medium plasticity, grey, moist*(continued)* -LIGNITE layer (0.3m thick) from 30.5m to 30.8m	
36.3		483					-driller began adding water below 36.3m	
36.6							LIGNITE, very weak, dark brown to black	
37–47.8		482–472					SILT AND CLAY, some fine grained black sand, firm to stiff, medium plasticity, grey, moist -Piezometer B set between 38.7m and 40.2m, static water level measured at 3.79m below grade (October 8, 2003) -LIGNITE layer (0.3m thick) between 39.0m and 39.3m -LIGNITE layer (0.3m thick) between 47.5m and 47.8m	
47.8–49.7		471–470					CLAY TUFF, trace to some sand, dense, high plasticity, light green, moist to wet -trace gravel from 48.8m	
49.7		469					-Piezometer A set between 48.8m and 49.4m, static water level measured at 32.38m below grade (October 8, 2003) End of Borehole at 49.7m below grade due to broken drive shoe	

Depth scale: 30–60 m; Elevation scale: 489–460 m

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STRATIGRAPHIC KX04397-2003.PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

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LOGGED BY: SJ	COMPLETION DEPTH: 49.7 m
ENTERED BY: CD	COMPLETION DATE: 7/17/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH4C**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Silverado/Air Rotary	NORTHING: 5869783.48 EASTING: 532042.93	ELEVATION: 519.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min)

SAMPLE DESCRIPTION AND DRILLING NOTES

WELL

Depth (m)	Sample Description and Drilling Notes
0	SILT, some fine grained sand, trace to some clay, trace to some gravel, soft, olive brown, moist to wet (fill)
5	SAND AND GRAVEL, trace silt, brown, moist Piezometer 4C Water level observed at 5.1m on October 8, 2003
5.5	SILT AND CLAY, trace sand, trace gravel, firm to stiff, medium plasticity, grey, mottled along fractures, moist -brown below 7.2m -silty sand layers (2mm-30mm thick) at 7.2m, 9.1m and 10.1m -stiff to dense below 9.1m
12	SAND, fine to medium grained, trace to some silt, trace gravel, compact, grey, saturated
13	SILT AND CLAY. firm to stiff, medium plasticity, grey, moist, texture along partings smooth and amorphous
17.8	-LIGNITE layer (0.3m thick) from 22.2m to 22.5m SILT AND CLAY, some fine grained black sand, firm to stiff, medium plasticity, grey, moist -LIGNITE layer (0.3m thick) from 22.2m and 22.5m
23.5	End of Borehole 23.5m below grade

Depth scale: 0–30 m; Elevation scale: 519–490 m.

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STRATIGRAPHIC KX04397-2003.PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

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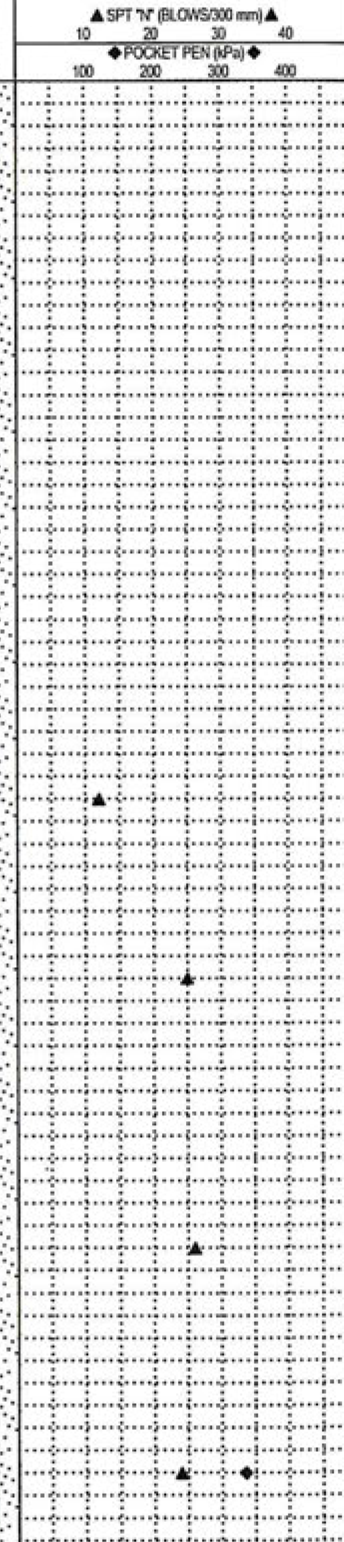
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH6
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869940 EASTING: 531514	ELEVATION: 556.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
0							ASPHALT PP = Pocket Pentrometer Water level observed at 0.05m depth in Piezometer 6B on August 18, 2002
		556					SAND AND GRAVEL, trace silt, compact, poorly graded, brown (road fill)
1							SILT, trace sand, trace gravel, trace to some clay, soft to stiff, low plastic, brown, moist to wet (glaciolacustrine deposits)
2		555					
3		554					
4		553					
5		552		1			
6		551		2			
							SAND, silty, some gravel, compact, poorly graded, brown
7		550					
8		549		3			
							CLAY, silty, trace sand, trace to some gravel, very stiff, medium to high plastic, brown, wet
9		548		4			SIEVE=G21%, S44%, F35%
10		547					SIEVE=G21%, S44%, F35%

WELL



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LOGGED BY: HA	COMPLETION DEPTH: 45.9 m
ENTERED BY: SR	COMPLETION DATE: 12/18/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH6**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869940 EASTING: 531514	ELEVATION: 556.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10				CLAY, silty, trace sand, trace to some gravel, very stiff, medium to high plastic, brown, wet *(continued)*
	546	5		SILT, clayey, very stiff (PP = 200 to 450kPa), low plastic, brown, wet (glaciolacustrine deposits)
11–12	545	6		
13	544			
14	543	7		
15	542	8		
	541	9	39	SILT AND CLAY, trace sand, trace gravel, very stiff (PP = 350 to 450kPa), medium plastic, brown SIEVE=S34%, F66% SIEVE=S34%, F66%
16–17	540	10	45	
18	539	11	44	
	538	12	13	-some gravel to gravelly from 18.6 to 21.6m
19–20	537	13	0	

SPT "N" (BLOWS/300 mm): 10, 20, 30, 40
POCKET PEN (kPa): 100, 200, 300, 400

WELL

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LOGGED BY: HA
ENTERED BY: SR

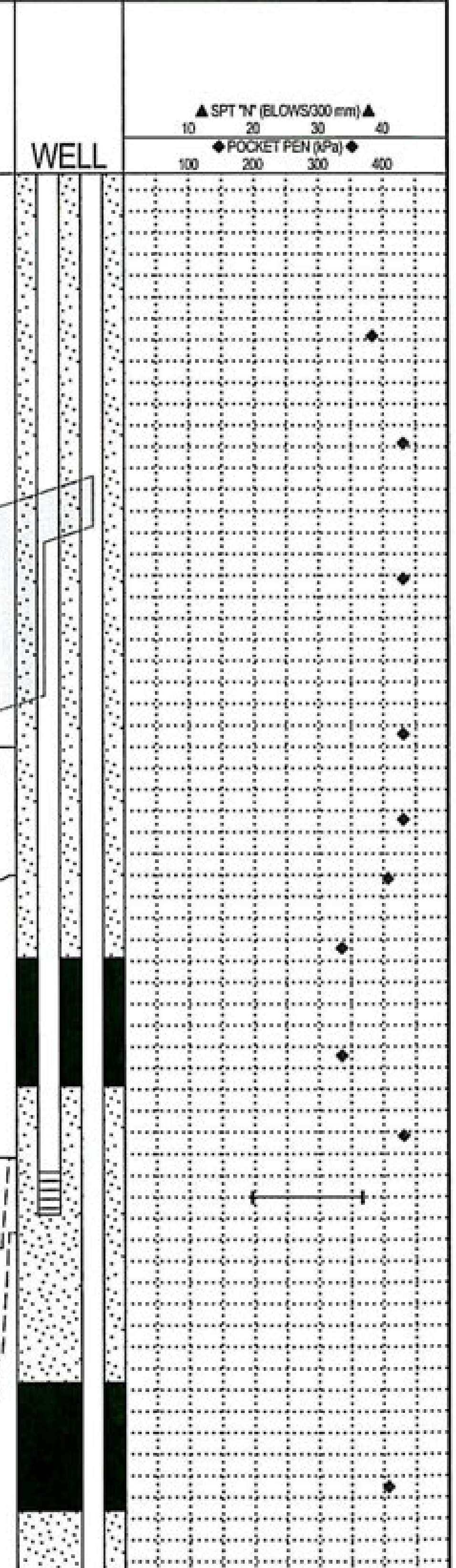
COMPLETION DEPTH: 45.9 m
COMPLETION DATE: 12/18/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH6**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869940 EASTING: 531514	ELEVATION: 556.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
20				SILT AND CLAY, trace sand, trace gravel, very stiff (PP = 350 to 450kPa), medium plastic, brown *(continued)*
21	536	14	7	
				-trace to some sand and trace to some gravel below 21.6m
22	535	15	32	
23	534	16	10	
24	533	17	11	-brown below 23.8m
				SILT, clayey, some sand, some gravel, hard, medium plastic, brown, wet
		18	171	SIEVE=G8%, S44%, F48%
25	532	19	200	SIEVE=G8%, S44%, F48%
				SILT AND CLAY, trace to some sand, trace gravel, hard (PP = 300 to 450kPa), medium to high plastic, brown, wet
		20	141	
26	531	21	170	
27	530	22	275	
		23	145	TUFF, alternating coarse and fine-grained beds Water level observed at 27 m below ground surface in Slotted Piezometer on August 17, 2002.
28	529	24	166	SILT AND CLAY TUFF, very stiff, medium to high plastic, slickensides throughout, brown and bluish green, wet from 27.0m to 27.5m **-X-ray diffraction test at 27.4m** **X-Ray Diffraction Test conducted**
		25	211	SILT TUFF, clayey, trace to some sand, trace to some gravel, very stiff to hard (PP = 300 to 450kPa), medium plastic, brown and bluish green, wet from 27.5m to 44.2m -harder drilling below 28.0m, silty sand and gravel lenses, some clay fragments below 28.3m
29	528	26	150	
30	527			



amec Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HA ENTERED BY: SR	COMPLETION DEPTH: 45.9 m COMPLETION DATE: 12/18/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH6
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869940 EASTING: 531514	ELEVATION: 556.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		27	143	TUFF, alternating coarse and fine-grained beds *(continued)*
31	526	28	122	
32	525	29	100	-piece of chert, marbly brown
33	524			
34	523	30	100	
35	522	31	12	
36	521	32	100	SIEVE=G25%, S68%, F7% SIEVE=G25%, S68%, F7%
37	520			SIEVE=S7%, F93% SIEVE=S7%, F93%
38	519	33	8	
39	518	34	12	
40	517	35	160	

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

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STRATIGRAPHIC KX04397-2001-BH-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

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LOGGED BY: HA	COMPLETION DEPTH: 45.9 m
ENTERED BY: SR	COMPLETION DATE: 12/18/01

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH6**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-53 MOBILE/HW CASING	NORTHING: 5869940 EASTING: 531514	ELEVATION: 556.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 / ◆POCKET PEN (kPa)◆ 100 200 300 400
40				36	25		TUFF, alternating coarse and fine-grained beds*(continued)*		
41		516		37	7				
42		515		38	42				
43		514		39	10				
44		513		40	67		Water level observed to be dry in Vibrating Wire Piezometer on August 17, 2002.		
							QUARTZ BRECCIA, white		
				41	90		SAND, trace to some gravel, trace to some silt, poorly graded, white, wet to saturated SIEVE=G1%, S78%, F21%		
45		512					SIEVE=G1%, S78%, F21%		
				42	100		QUARTZ BRECCIA, white		
				43	69				
46		511					End of Borehole at 45.9m, two standpipes installed at 27.1m and 44.9m below grade Water level observed to be dry in Piezometer 6A on August 19, 2002		
47		510							
48		509							
49		508							
50		507							

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amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HA ENTERED BY: SR	COMPLETION DEPTH: 45.9 m COMPLETION DATE: 12/18/01

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH7**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
0				SAND AND SILT, some clay, trace gravel, trace organics
	541			
1	540	1	21	
2	539			
				COBBLES AND CLAY, firm, tan, wet
3	538	2	12	
4				TUFF, alternating coarse and fine-grained beds
				CLAY TUFF, some silt, trace gravel, firm to stiff, light brown-grey from 3.9m to 12.4m
	537	3	105	
5	536			-trace sand, conchoidal fractures from 5.4 m to 5.6 m
6	535	4	78	
7	534	5	103	
8	533			
9	532	6	100	
10				

Column headings: DEPTH (m), STRATIGRAPHY, ELEVATION (m), SAMPLE TYPE, SAMPLE NO, RECOVERY (%), DRILL TIMES (min), SAMPLE DESCRIPTION AND DRILLING NOTES, WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID

20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH7
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆POCKET PEN (kPa)◆ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80
10		531		7	95		TUFF, alternating coarse and fine-grained beds*(continued)*		
11		530							
12		529		8	107		-trace fine gravel and coarse clasts, firm to stiff, whitish clasts and green/grey matrix, moist from 12.4m to 23.3m		
13		528		9	95		-some gravel and sand-sized clasts at 13.6 m		
14		527		10	110				
15		526		11	25				
16		525							
17		524		12	102				
18		523		13	86				
19		522							
20				14	105				

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH7**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
20				TUFF, alternating coarse and fine-grained beds*(continued)*
	521			
21	520	15	105	
22	519	16	102	
23	518	17	93	-trace fine sand and silt, firm, blue/grey, damp from 23.3m to 27.9m
24	517	18	93	
25	516	19	78	
26				-SI-7 indicates displacement at 25.9 m
	515			-trace sand-sized clasts from 26.4 m to 28.3 m
27	514	20	46	**-Vibrating Wire Piezometer 7A at 27.0m**
28				-slough, soft, wet from 27.9m to 28.3m
	513	21	122	-trace fine sand and silt, firm, blue/grey, damp from 28.3m to 31.8m
29	512	22	115	
30				

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH7
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		23	107	TUFF, alternating coarse and fine-grained beds *(continued)*
	511			
31				-some fine sand and silt from 30.9 m
	510	24	108	
				SAND AND SILT TUFF, fine to coarse sand-sized clasts, some fine and medium-grained gravel, cohesive, stiff from 31.8m to 32.1m
32				CLAY TUFF, trace fine sand and silt, stiff, green/grey, damp to moist from 32.1m to 40.7m
	509			
33		25	110	
	508			
34				
	507	26	108	-trace silt, poorly graded from 34.5 m to 35.6 m
35				
	506			
36		27	105	
	505			
37				
	504	28	105	
38				
	503			-moist at 38.4 m
39		29	105	
	502			
40				

WELL

POCKET PEN (kPa): 100 200 300 400

PLASTIC M.C. LIQUID: 20 40 60 80

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COMPLETION DEPTH: 78.9 m
COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH7
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
40		30	110	TUFF, alternating coarse and fine-grained beds *(continued)* -red brown, reacts with HCl, zone of localized calcite cementation from 40.3 m to 40.7 m
	501	31	102	SAND AND SILT TUFF, some clay, fine-grained sand-sized clasts, stiff, blue/grey from 40.7m to 41.0m
41				SAND AND GRAVEL TUFF, trace silt and clay, well-graded clasts, green/grey from 41.0m to 41.2m
	500	32	102	CLAY TUFF, trace fine sand and silt, stiff, grey/green from 41.2m to 49.2m
42	499	33	271	
43	498	34	108	
44	497			
45	496	35	108	
46	495	36	76	
47	494			
48	493	37	102	
49	492	38	108	SAND AND GRAVEL TUFF, fine to medium gravel-sized clasts from 49.2m to 49.4m
				CLAY TUFF, trace fine sand and silt, stiff, grey/green from 49.4m to 50.0m
50				

STRATIGRAPHY | SAMPLE TYPE | DRILL TIMES (min) | WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH7**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)
50		39	193
	491		
51		40	86
	490		
52		41	119
	489		
53		42	102
	488		
54	487	43	98
55	486	44	98
56	485		
57		45	105
	484		
58	483	46	108
59	482		
60			

SAMPLE DESCRIPTION AND DRILLING NOTES

-moist to wet at 49.7 m

SAND AND GRAVEL TUFF, some silt and clay, fine to coarse gravel-sized clasts, green/grey from 50.0m to 50.3m

TUFF, alternating coarse and fine-grained beds *(continued)*

CLAY TUFF, trace fine sand and silt, stiff, grey/green from 50.3m to 54.3m

-sand tuff interbed, some silt and clay, fine to coarse sand-sized clasts from 52.8m to 52.9m

-slough, soft, wet from 54.2m to 54.3m

CLAY TUFF, trace fine sand and silt, stiff, grey/green from 54.3m to 55.9m

SAND AND SILT TUFF, some clay, fine sand-sized clasts, stiff, blue/grey from 55.9m to 56.4m

-some fine gravel from 56.3m to 56.4m

CLAY TUFF, trace fine sand and silt, stiff, grey/green from 56.4m to 59.1m

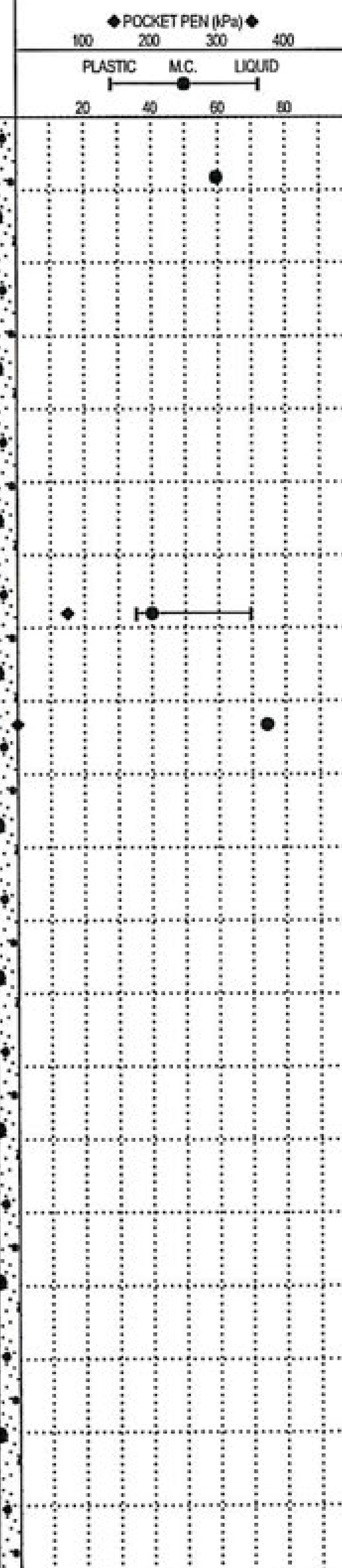
-some fine to coarse gravel-sized clasts from 56.7 m to 56.8 m

-some fine to coarse gravel-sized clasts from 57.9 m to 58.9 m

-some fine to medium sand and trace gravel-sized clasts from 58.9 m

SAND AND SILT TUFF, fine to medium sand-sized clasts, trace fine gravel from 59.1m to 60.4m

WELL



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LOGGED BY: HR
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COMPLETION DEPTH: 78.9 m
COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH7
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
60		47	106		TUFF, alternating coarse and fine-grained beds*(continued)*
	481				CLAY TUFF, trace fine sand and silt, stiff, grey/green from 60.4m to 76.3m
61		48	102		-some coarse gravel-sized clasts, trace sand from 60.9 m to 61.2 m
	480				-trace gravel and sand-sized clasts from 61.2 m to 62.2 m
62		49	121		-red, reacts with HCl, zone of localized calcite cementation from 61.8 m to 62.2 m
	479				
63	478	50	108		-some sand, coarsening downward to some gravel from 63.3 m to 63.9 m
64					-some sand, trace gravel-sized clasts from 63.9 m to 64.5 m
	477	51	108		-trace sand and gravel-sized clasts from 64.7 m to 65.8 m
65					**-Vibrating Wire Piezometer 7B at 64.9m**
	476				
66		52	108		-joint, smooth, non-planar, 60o from core axis at 65.8 m -sandy, trace organics from 65.8 m to 66.3 m
	475				
67					-SI-7 indicates displacement at 66.8 m -some sand and gravel-sized clasts, trace organics from 66.9 m to 67.2 m -sandy from 67.2 m to 67.8 m
	474	53	105		-gravelly, trace sand-sized clasts from 67.8 m to 68.7 m
68	473				
69		54	107		-trace to some sand-sized clasts from 68.7 m to 70.9 m
	472				
70					

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH7
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870225.57 EASTING: 531798.95	ELEVATION: 541.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
70				TUFF, alternating coarse and fine-grained beds *(continued)*
	471	55	109	
71				-some gravel and trace sand-sized clasts from 71.0 m to 71.2 m
	470			
72	469	56	105	
73	468	57	104	
74	467			
75	466	58	112	
76		59	72	
	465	60	112	SAND TUFF, some clay, very stiff from 76.3m to 76.4m
				CLAY TUFF, some sand, some organics, stiff from 76.4m to 76.6m
77				SAND TUFF, trace sand and gravel-sized clasts, stiff from 76.6m to 77.2m
	464			CLAY TUFF, trace sand and gravel-sized clasts, stiff from 77.2m to 78.9m
78	463	61		
79	462			End of Borehole at 78.9m Drilling method did not allow observation of water level
80				

Column headings also printed: STRATIGRAPHY, SAMPLE TYPE, DRILL TIMES (min), WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 78.9 m
ENTERED BY: CD	COMPLETION DATE: 7/2/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH8
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	PLASTIC / M.C. / LIQUID (20 40 60 80)
0		526					SAND AND GRAVEL note: from 0.0m to 14.4m, log based on air-lifted cuttings from ODEX drill rig		
1		525							
2		524							
3		523							
4		522							
5		521							
6		520					-large cobbles from 5.8m		
7		519					SAND, fine to medium grained, some gravel, clean		
8		518					SAND AND GRAVEL, some cobbles		
9		517					-no cobbles from 9.1 to 12.2m		
10									

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LOGGED BY: RT	COMPLETION DEPTH: 65.4 m
ENTERED BY: CD	COMPLETION DATE: 6/15/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH8**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

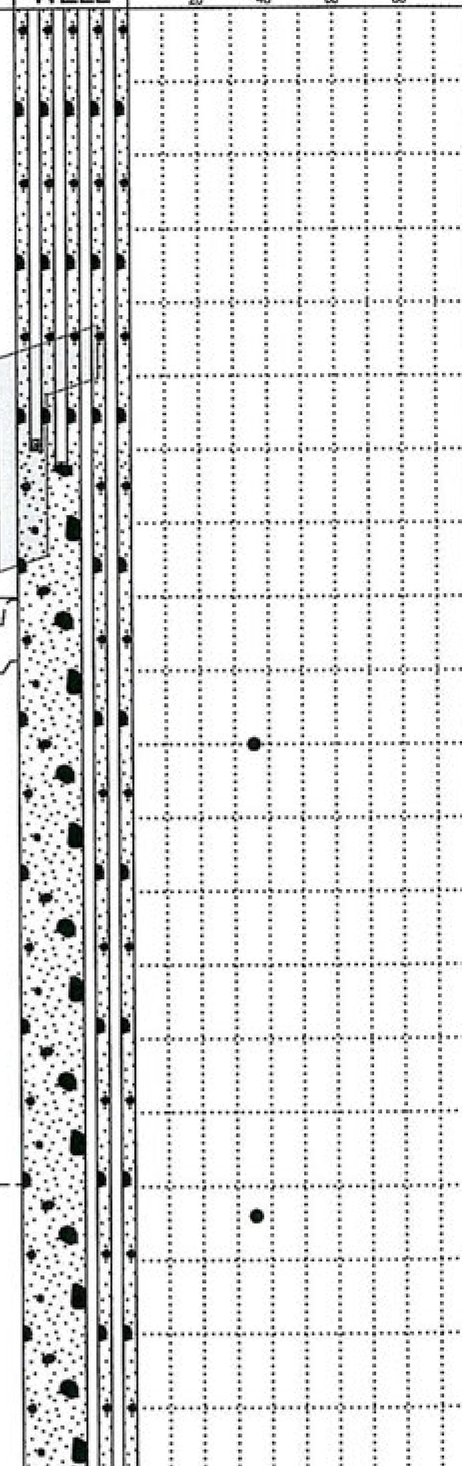
BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10	516			SAND AND GRAVEL, some cobbles *(continued)*
11	515			
12	514			
13	513			-Vibrating Wire Piezometer 8B at 13.0m -Vibrating Wire Piezometer 8A at 13.1m
14	512			SAND (fine grained) beds alternating with SILT AND SAND beds -SAND, fine grained, silty, dense, moist from 14.0m to 14.4m -drillers switched from ODEX air rotary to HQ coring SILT AND SAND, fine grained, dark blue-grey, saturated from 14.4m to 18.0m
		1	85	
15	511			-trace gravel, well rounded, cohesionless, non plastic, faint bedding, blueish grey to brownish grey from 15.0m to 17.9m
		2	31	
16	510	3	0	
17	509	4	0	
		5	25	
		6	130	-trace clay, stiff, low plastic, blue-grey from 17.9m to 18.0m
18	508	7	110	SAND AND SILT, fine grained, cohesionless, non plastic, bluish grey to dark grey from 18.0m to 25.0m
		8	34	
19	507	9	119	
20				

WELL

PLASTIC M.C. LIQUID

20 40 60 80



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amec Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: RT ENTERED BY: CD	COMPLETION DEPTH: 65.4 m COMPLETION DATE: 6/15/05

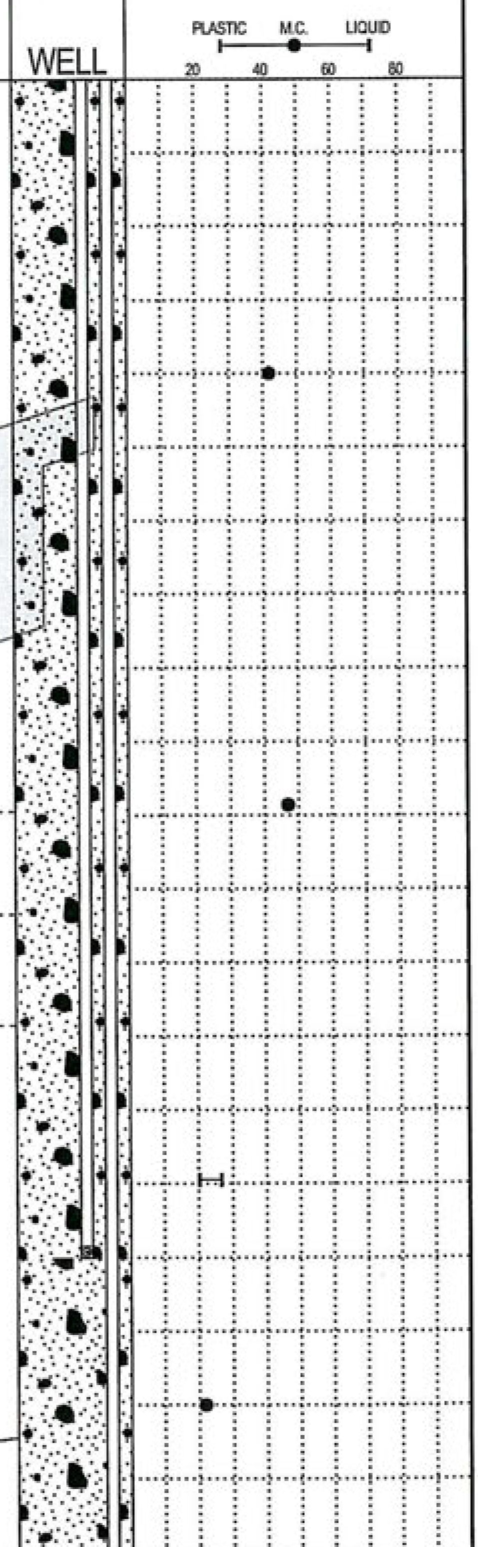
CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH8
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
20	506	10	64		SAND (fine grained) beds alternating with SILT AND SAND beds *(continued)*
		11	78		
21	505	12	44		
22	504	13	17		
23	503	14	34		
		15	102		
24	502	16	42		
25	501	17	68		SILT, trace to some fine sand, trace clay, soft, wet from 25.0m to 25.7m
26	500	18	64		SAND AND SILT, fine grained, blue-grey, wet from 25.7m to 26.4m
		19	93		SILT AND SAND, fine grained from 26.4m to 29.2m
27	499	20	93		-trace fine sand, trace clay, light grey from 27.0m to 29.2m
28	498	21	93		**-Vibrating Wire Piezometer 8C at 28.0m**
		22	77		
29	497				-grades into silt & clay, high plastic, dark grey from 29.1m to 29.2m
		23	54		SILT AND CLAY, high plastic, dark grey, gradational contact (>30cm) with weathered volcanic ash (CLAY TUFF) from 29.2m to 30.2m
30					

WELL



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CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH8
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30	496	24	113	TUFF, alternating coarse and fine-grained beds CLAY TUFF, some white sand-sized clasts, firm to stiff, grey from 30.2m to 31.2m -SI-8 indicates displacement at 30.5m to 36.6m -fractured from 30.9m to 31.2m
31	495	25	127	
		26	105	SAND AND SILT TUFF, fine grained, some light grey gravel and sand-sized clasts, mix of weak weathered clay rich and more resistant clasts from 31.2m to 31.4m -grades to clay tuff at 31.4m
32	494			CLAY TUFF, interbeds of fine sand and silt-sized clasts, firm to stiff, grey / light brown from 31.4m to 34.9m -joint, rough, stepped, 30o from core axis, at 32.2m -joint, rough, stepped, 45o from core axis, at 32.2m
33	493	27	100	
34	492			
		28	102	-grades to sand tuff at 34.9m SAND TUFF, light brown and white from 34.9m to 35.3m -grades to clay tuff at 35.3m
35	491			CLAY TUFF, clay matrix with some sand and gravel-sized clasts, clasts mix of weak weathered clay rich and more resistant lithologies from 35.3m to 36.7m -some white and rusty-coloured sand-sized clasts, firm to stiff, grey from 35.7m to 36.7m
36	490	29	98	
37	489			SAND TUFF, clay matrix, light brown from 36.7m to 37.2m
		30	105	CLAY TUFF, light brown from 37.2m to 41.7m -grades into some sand-sized clasts, blue-grey with rusty banding at 37.5m
38	488			
39	487	31	105	-firm to stiff, massive, light brown to blue-grey from 38.7m to 40.2m note: fractured into rough and jagged surfaces
40				

Moisture content plot (PLASTIC – M.C. – LIQUID; 20, 40, 60, 80)

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH8
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
40	486			TUFF, alternating coarse and fine-grained beds *(continued)*
				-some white sand-sized clasts, firm to stiff, light grey-brown with some rusty oxidation from 40.2m to 41.3m
41	485	32	105	
				-some oxidized rusty-coloured bands and clasts, well cemented, massive from 41.3m to 41.6m
				-some white sand-sized clasts, firm to stiff, light grey-brown with some rusty oxidation from 41.6m to 41.7m
42	484			SAND TUFF, medium grained, clay matrix, green brown, moist from 41.7m to 43.2m
		33	102	
43	483			-grades into clay tuff, some sand and gravel-sized clasts, green white at 43.2m
				CLAY TUFF, some coarse-grained white/black/red sand-sized clasts, firm to stiff, green brown, moist from 43.2m to 47.7m
				-joint, smooth, polished, 40° from core axis, at 43.3m
44	482	34	102	
45	481			-some sand and gravel-sized clasts, firm to stiff, white-grey to green, moist from 44.7m to 46.2m
		35	103	
46	480			-trace sand-sized clasts, firm to stiff, white-grey to blue-green, moist from 46.2m to 47.7m
47	479	36	61	-joint, irregular, polished, sub planar, 45° from core axis at 47.0m
48	478			CLAY TUFF, trace sand-sized clasts, firm to stiff, white-grey to blue-green, moist from 47.9m to 64.9m Note: fractured, slickensided (11 joints recorded), spaced 1.5m apart
		37	105	
49	477			
		38	98	
50				

WELL

PLASTIC M.C. LIQUID
20 40 60 80

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STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

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3456 Opie Crescent
Prince George, BC V2N 2P9
(250) 564-3243

LOGGED BY: RT	COMPLETION DEPTH: 65.4 m
ENTERED BY: CD	COMPLETION DATE: 6/15/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH8
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE	TUBE	NO RECOVERY	SPLIT SPOON	GRAB	MUD RETURN	CORE RETURN
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50	476	39	115	TUFF, alternating coarse and fine-grained beds *(continued)*
51	475	40	102	-some gravel-sized oxidized white/red clasts, firm to stiff, blue-grey, moist from 50.7m to 51.0m -some white/black sand-sized clasts, blue-grey from 51.0m to 52.0m
52	474			-firm to stiff, brown, moist from 52.0m to 52.2m -trace sand-sized clasts, firm to stiff, grey-brown, moist from 52.2m to 53.7m
53	473	41	103	
54	472	42	102	-some sand-sized clasts, firm to stiff, grey-brown, moist from 53.7m to 58.2m
55	471			-highly oxidized orange-brown color from 55.2m to 56.7m
56	470	43	107	-trace sand-sized clasts, very soft, high plastic, brown orange, wet (shear zone) **-Vibrating Wire Piezometer 8D at 56.2m**
57	469	44	86	
58	468			-firm to stiff, blue-grey, moist from 58.2m to 59.7m
59	467	45	102	
60				-some oxidized clasts and bands, firm to stiff, light brown to green grey from 59.7m to 61.2m

WELL

PLASTIC M.C. LIQUID

20 40 60 80

112.5

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LOGGED BY: RT	COMPLETION DEPTH: 65.4 m
ENTERED BY: CD	COMPLETION DATE: 6/15/05

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH8**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870042.69 EASTING: 532161.17	ELEVATION: 526.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	PLASTIC / M.C. / LIQUID (20 40 60 80)
60		466		46	100		TUFF, alternating coarse and fine-grained beds *(continued)* -core breaks into polished, irregular surfaces at 60.5m		
61		465					-SI-8 indicates displacement at 61.0m -firm to stiff, white-grey to blue-grey, moist from 61.2m to 62.5m		
62		464		47	102				
63		463		48	102		-trace to some white and black sand-sized clasts, firm to stiff, grey to brown from 62.5m to 64.9m		
64		462							
65		461		49	104		-grades to sand and gravel tuff at 64.9m SAND AND GRAVEL TUFF, fine to coarse grained, well graded, subangular, clasts mix of weak weathered clay rich and more resistant lithologies, clay matrix from 64.9m to 65.4m		
							End of Borehole at 65.4m Drilling method did not allow observation of water level		
66		460							
67		459							
68		458							
69		457							
70									

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES	SPT "N"
0				SAND AND GRAVEL, with SILT AND CLAY interbeds SAND, silty, fine to medium grained, some woody debris, trace to some rounded gravel, brown from 0.0m to 1.8m	
	534	1	15		
1	533				
2		2	13	GRAVEL, trace clay and sand, rounded, 1cm to 5cm clasts from 1.8m to 4.5m	
3	532	3	0		
4	531				
5	530	4	25	SAND AND SILT, fine grained, trace gravel and clay, light brown from 4.5m to 4.6m ORGANICS, woody, some clay, trace gravel, spongy, black from 4.6m to 4.7m SAND, silty, greyish brown, wet from 4.7m to 5.1m	36
	529	5	20	SILT, sandy, some fine to coarse gravel, subrounded, light grey-brown, trace organics from 5.1m to 6.0m	
6	528	6	31	SILT AND CLAY, gravelly, some sand, subrounded, coarsens with depth, some oxidation, cobble at end from 6.0m to 6.9m -field log indicated saturated soil (water table) at 6.2 m	
7	527	7	19	SAND, gravelly, some clay, trace cobbles, subangular, grey-brown from 6.9m to 11.4m	
8	526	8	0		
9	525	9	10		
10					

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LOGGED BY: HR	COMPLETION DEPTH: 69.3 m
ENTERED BY: CD	COMPLETION DATE: 6/27/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10				SAND AND GRAVEL, with SILT AND CLAY interbeds *(continued)*
	524	10	0	
11				
	523			SAND AND GRAVEL, trace silt, subrounded to subangular, grey-brown from 11.4m to 12.9m
12		11	8	
	522			
13				GRAVEL, some sand and silt, subangular, light grey-brown from 12.9m to 13.9m
	521			
14		12	14	SILT, gravelly, some sand, subangular to subrounded, grey-brown from 13.9m to 14.9m
	520			
15				CLAY, trace fine sand and white inclusions, trace rounded gravel, firm, blue and green from 14.9m to 16.1m **-Vibrating Wire Piezometer 9A at 15.1m**
	519	13	47	
16				-stiff, blue-green, moist from 15.9m to 16.1m
				SAND, some silt, some organics, compact from 16.1m to 17.2m
	518	14	53	
17				GRAVEL, some cobbles, some sand, trace silt, some organics, subrounded to subangular from 17.2m to 17.4m
				GRAVEL AND CLAY, some sand, subrounded from 17.4m to 18.0m
	517	15	25	
18				CLAY, some sandy zones, some subrounded gravel, stiff, grey from 18.0m to 18.9m
	516	16	48	
19				GRAVEL, clayey, some sand, subangular to subrounded, stiff, grey from 18.9m to 20.4m
	515	17	14	
20				

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CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE; NO RECOVERY; SPLIT SPOON; GRAB; MUD RETURN; CORE RETURN

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40; ◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
20							SAND AND GRAVEL, with SILT AND CLAY interbeds *(continued)*		
		514					SAND, fine to medium grained, trace silt, trace gravel from 20.4m to 20.5m		
21				18	105		CLAY, some sand, some fine to medium gravel, subrounded, very stiff, brown-grey		
		513					-joint: grooved, polished, wavy, 30° from core axis at 21.5m		
							TUFF, alternating coarse and fine-grained beds		
22							CLAY TUFF, firm, contorted bedding, blue-green, grey-brown and orange layers, sharp contact with lower unit along joint surface from 21.5m to 23.4m Note: fractured from 21.5m to 33.6m (27 joints recorded) spaced at 0.5m apart		
		512		19	105				
23							-some gravel-sized clasts, clasts mix of weak weathered clay rich and more resistant lithologies, contorted bedding, dark brown with oxidized spots from 23.2m to 23.3m		
		511					-contorted bedding, grey-blue and reddish orange from 23.3m to 23.4m		
24				20	102		SAND TUFF, fine grained, crystalline, compact, grey from 23.4m to 23.9m		
							CLAY TUFF grading down to crystalline SAND TUFF, firm from 23.9m to 24.5m		
		510					CLAY TUFF, firm, oxidized flecks, conchoidal fractures, grey from 24.5m to 24.9m		
25							SAND TUFF, lithic clasts, fine to medium grained, some silt-sized clasts, loose to compact, dark brown, moist from 24.9m to 25.1m		●
				21	107		CLAY AND SILT TUFF, crystalline, firm to stiff, contorted bedding, blue-grey from 25.1m to 25.6m		
		509					CLAY TUFF, regions of sand-sized clasts, firm, contorted bedding, dark grey from 25.6m to 28.2m		
26							-carbonaceous organic material, woody debris at 25.6m		
							-frequent interbeds of silt and sand tuff, firm, cross-laminated, light to dark grey from 26.3m to 27.0m sharp, angular contact with lower bed		
		508							
27				22	105		-firm, contorted bedding, golden brown from 27.0m to 28.2m		
		507							
28							SAND TUFF, crystalline, fine-grained sand-sized clasts, some clay, firm, contorted bedding, reddish brown to grey from 28.2m to 29.3m		
				23	99				
		506							
29							SILT TUFF with CLAY TUFF interbeds, trace fine sand-sized clasts, very stiff, contorted bedding, dark grey from 29.3m to 29.7m		
		505					sharp, angular contact with lower unit		
30									

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Column headings: DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | ▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40; ◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80

Sample No	Recovery (%)
24	97
25	108
26	93
27	95
28	108
29	108
30	108

Depth (m): 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

Elevation (m): 504, 503, 502, 501, 500, 499, 498, 497, 496, 495

CLAY TUFF, organics, stiff, contorted bedding, orange-brown from 29.7m to 30.1m

LIGNITE

TUFF, alternating coarse and fine-grained beds

CLAY TUFF, some fine sand tuff lenses, stiff, dark grey from 30.2m to 31.1m

-Vibrating Wire Piezometer 9B at 30.6m

-stiff, contorted bedding, dark grey from 30.8m to 31.1m

SAND TUFF, fine sand-sized clasts, stiff, contorted bedding, dark grey from 31.1m to 32.0m

CLAY TUFF, very stiff, contorted bedding, green-blue from 32.0m to 32.3m

-red-orange from 32.1m

SILT TUFF, interbeds of SANDY GRAVEL TUFF, firm, contorted bedding, orange-brown from 32.3m to 33.8m

SILT TUFF, lenses of CLAY TUFF, trace fine sand-sized clasts, stiff, contorted bedding, dark grey from 33.8m to 34.9m

-light grey from 34.3m

SAND TUFF, fine to medium sand-sized clasts, firm, contorted bedding, light grey from 34.9m to 35.4m

SILT TUFF from 35.4m to 36.1m

-firm, contorted bedding, light to dark grey from 35.9m to 36.1m

-joint smooth, grooved, polished, slightly wavy 30° from core axis at 35.9m

CLAY TUFF, firm, blue-green from 36.1m to 44.4m

Note: fractured (8 joints recorded) spaced 0.9m apart from 36.1m to 43.2m

-some white fragments of fine sand to gravel-sized clasts from 38.4m to 38.7m

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LOGGED BY: HR	COMPLETION DEPTH: 69.3 m
ENTERED BY: CD	COMPLETION DATE: 6/27/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH9**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE; NO RECOVERY; SPLIT SPOON; GRAB; MUD RETURN; CORE RETURN

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
40							TUFF, alternating coarse and fine-grained beds *(continued)*	
		494		31	97			
41							-trace to some sand-sized clasts from 41.1m to 43.2m	
		493						
42				32	106			
		492		33	110			
43							-slough from 43.2m to 43.5m	
		491		34	123			
44							-grades to SAND TUFF from 44.3m to 44.4m	
							SAND TUFF, clay matrix, trace gravel, coarsening down, hard, green with oxidized sections from 44.4m to 44.7m	
		490					CLAY TUFF, trace sand-sized clasts, firm to hard, green-blue from 44.7m to 53.3m	
45				35	103			
							-joint smooth, grooved, polished, wavy 70° from core axis at 45.5m	
		489						
46							-slough from 45.9m to 46.2m	
							note: fractured (10 joints recorded) spaced 0.7m apart from 46.2m to 53.3m	
		488		36	107			
47								
		487						
48				37	103			
		486						
49				38	93			
		485						
50								

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LOGGED BY: HR	COMPLETION DEPTH: 69.3 m
ENTERED BY: CD	COMPLETION DATE: 6/27/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50		39	104	TUFF, alternating coarse and fine-grained beds *(continued)* **-Vibrating Wire Piezometer 9C at 50.1m**
	484			
51	483	40	103	
52	482			
53		41	104	SAND TUFF, fine to medium sand-sized clasts, clay matrix, firm, grey-green with some orange-brown from 53.3m to 53.9m -joint slightly rough, grooved, polished, wavy, 35° from core axis at 53.4m -coarsens down to gravelly sand tuff, fine to medium gravel-sized clasts, clay matrix, hard, red-orange from 53.6m to 53.9m
54	481	42	131	CLAY TUFF, trace sand-sized clasts, firm to hard, green-blue from 53.9m to 58.3m -joint smooth, polished, wavy 80° from core axis at 54.4m
55	480			note: fractured (5 joints recorded) spaced 0.65m apart from 55.0m to 58.3m
56	479	43	80	-some sand and gravel-sized clasts from 56.4m to 56.7m
57	478	44	106	
58	477			
	476	45	107	GRAVEL AND SAND TUFF, fine gravel-sized clasts, subangular, clay matrix, stiff, brown and green-blue from 58.3m to 59.1m
59	475			CLAY TUFF, trace sand-sized clasts, firm to hard, green-blue from 59.1m to 61.8m note: fractured (4 joints recorded) spaced 0.8m apart -some sand to sandy, trace to some gravel-sized clasts from 59.5m to 61.2m
60				

SPT "N" (BLOWS/300 mm) 10 20 30 40; POCKET PEN (kPa) 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80

WELL

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LOGGED BY: HR	COMPLETION DEPTH: 69.3 m
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CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH9
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870120.36 EASTING: 531883.33	ELEVATION: 534.7 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN
BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
60		46	110	TUFF, alternating coarse and fine-grained beds *(continued)*
61	474	47	106	
62	473	48	107	SAND AND GRAVEL TUFF, fine to coarse gravel, subangular to subrounded, clay matrix, stiff, green-blue from 61.8m to 61.9m -joint smooth, planar 40° from core axis at 61.9m CLAY TUFF, trace sand-sized clasts, firm to hard, green-blue from 61.9m to 67.5m Note: highly fractured from 61.9m to 64.9m (11 joints recorded) spaced 0.3m apart (shear zone)
63	472	49	100	-some coarse gravel from 62.7m to 63.0m
64	471	50	136	
65	470	51	98	-grades to gravelly at 64.5m -sandy, trace organics from 64.5m to 65.2m -SI-9 indicates displacement at 64.9m
66	469	52	113	
67	468	53	85	-sandy, some gravel-sized clasts, stiff from 66.4m to 66.6m
68	467	54	96	SAND AND GRAVEL TUFF, fine to coarse gravel (2cm clasts), clay matrix, stiff from 67.5m to 68.3m
69	466	55	112	CLAY TUFF, trace sand-sized clasts, trace organics and woody debris, firm to hard, green-blue from 68.3m to 69.3m
		56	99	
70	465			End of Borehole at 69.3m Drilling method did not allow observation of water level

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40
◆POCKET PEN (kPa)◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

WELL

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3456 Opie Crescent
Prince George, BC V2N 2P9
(250) 564-3243

LOGGED BY: HR	COMPLETION DEPTH: 69.3 m
ENTERED BY: CD	COMPLETION DATE: 6/27/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH10**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
0							CLAY, some fine to coarse-grained gravel, trace sand, firm to stiff, medium plastic, massive, brown, trace organics, damp		
		544					-cobble, igneous mafic, black, fine grained crystals from 0.4m to 0.8m		
1				1	44				
2		543							
3		542					-soft, light orangish brown, mottled from 2.7m		
		541		2	27				
4				3	95		-some silt, very soft, high plastic, massive, brown, very moist from 4.2m to 4.3m -some silt, trace fine grained gravel, medium plastic, very stiff, massive, brown, damp from 4.3m to 5.2m		
5		540		4	39		-trace silt, trace fine grained gravel, nuggetted structure from 5.2m to 6.1m		
6		539					-slough, very soft, very moist at 6.0m depth -trace sand, trace fine grained gravel, soft to firm, high plastic, orange brown, damp from 6.1m to 7.2m -cobble, vesicular basalt, black from 6.3m to 6.5m		
7		538		5	71				
		537					-some silt, some medium to coarse-grained gravel, stiff, medium plastic, orange brown, damp from 7.2m to 10.2m		
8				6	71		-some silt, trace coarse-grained sand, medium plastic, firm, brown from 7.8m to 10.2m		
9		536					-cobble, vesicular basalt from 8.7m to 8.8m -cobble, vesicular basalt from 9.0m to 9.1m		
10		535		7	110		-cobble, vesicular basalt from 10.1m to 10.2m		
		534					SILT AND SAND (fine grained), trace clay, trace to no gravel, low to non plastic, stiff, massive, brown, damp		
11									

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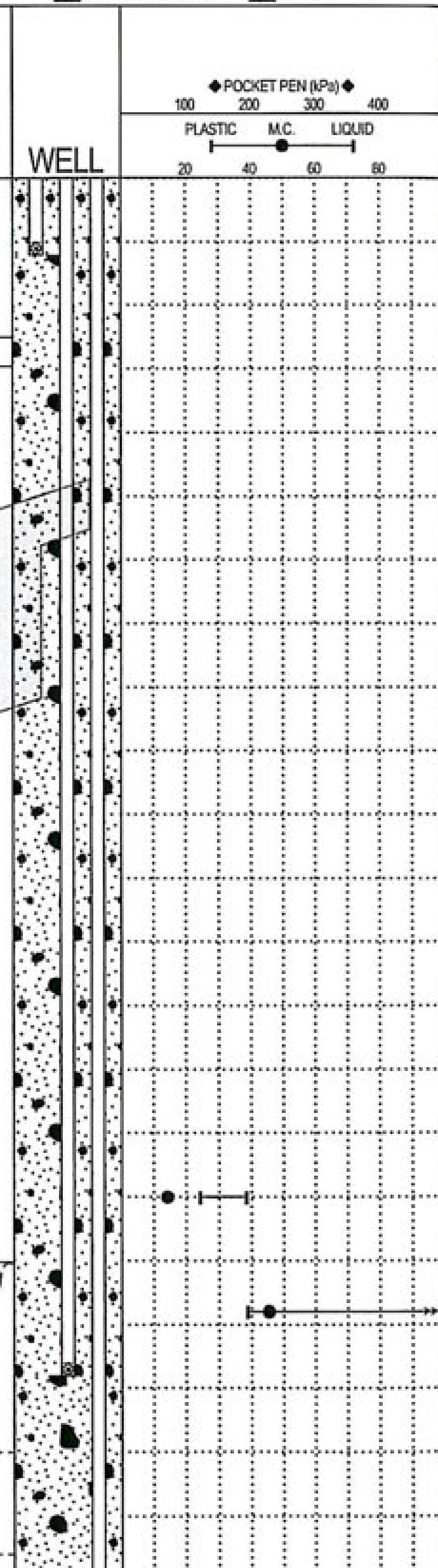
LOGGED BY: CD	COMPLETION DEPTH: 59.7 m
ENTERED BY: SR/CD	COMPLETION DATE: 8/4/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH10**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
11		8	56	SILT AND SAND (fine grained), trace clay, trace to no gravel, low to non plastic, stiff, massive, brown, damp*(continued)*
	533			**-Vibrating Wire Piezometer 10A at 11.6m**
12		9	112	
				SAND (fine grained), trace silt, loose, massive, brown
	532	10	92	CLAY AND SILT, trace to some fine gravel, very stiff, medium plastic, brown, damp
13	531			
14		11	46	
	530			
15		12	149	
	529	13	50	
16	528			
17		14	24	
	527			-trace coarse gravel from 17.7m to 18.1m
18		15	115	-some fine grained gravel from 18.1m to 18.4m
	526	16	81	-cobble, vesicular basalt at 18.7m depth
19				
		17	81	TUFF, alternating coarse and fine-grained beds
	525			CLAY TUFF, trace silt, trace sand, trace gravel, hard, high plastic, blue-grey, 1mm white inclusions of white and black grained material, damp from 19.5m to 21.0m
20		18	119	-some carbonaceous material **-Vibrating Wire Piezometer 10B at 20.4m** -SI-10 indicates displacement at 20.4m
	524			
21		19	114	GRAVEL TUFF, silt and clay matrix, trace sand, clasts mix of weak, subrounded, clay-rich gravel and resistant, subangular gravel, very dense to hard, blue-grey inner core, damp from 21.0m to 21.8m
22	523			



amec Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: CD ENTERED BY: SR/CD	COMPLETION DEPTH: 59.7 m COMPLETION DATE: 8/4/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH10**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80
22							CLAY TUFF, hard, high plastic, blue-grey inner core, damp from 21.8m to 22.2m		
							TUFF, alternating coarse and fine-grained beds *(continued)*		
							GRAVEL TUFF, fine grained clasts, some sand, clay and silt matrix, very dense to hard, blue-grey inner core, damp from 22.2m to 22.9m		
23		522		20	80		CLAY TUFF, hard to very stiff, high plastic, blue-grey inner core, damp, some sand size clasts from 22.9m to 26.7m		
24		521					-trace sand, some fine grained gravel from 23.7m to 23.8m -highly fractured from 23.8m to 24.8m		
				21	120				
25		520							
26		519		22	112		-highly fractured from 25.8m to 26.0m		
							-slickensided joint 20° from core axis at 26.4m depth		
27		518					GRAVEL TUFF (subrounded clasts, fine grained), and clay (matrix), trace sand, hard to very dense, blue-grey inner core, damp from 26.7m to 27.6m		
				23	100				
28		517					CLAY TUFF, trace sand size clasts, hard, high plastic, massive, blue-grey inner core, damp from 27.6m to 29.7m		
							-fractured into 50 mm blocks from 28.3m to 28.5m -dry, trace to no sand, brown from 28.5m to 28.9m		
29		516		24	94				
30		515					GRAVEL TUFF, (fine grained clasts, extremely weak, subrounded), some sand, some clay (matrix), trace sand-sized clasts, very dense to hard, blue-grey inner core, damp from 29.7m to 30.9m		
				25			-less gravel, more sand, darker color from 30.4m to 30.9m		
31		514					CLAY TUFF, trace sand-sized clasts, hard, high plastic, blue-grey inner core, damp from 30.9m to 31.7m -some sand, trace gravel from 31.2m to 31.7m		
32		513		26			SAND TUFF, medium grained, rounded to subrounded, some clay (matrix), stiff to hard, blue-grey, damp from 31.7m to 31.9m		
							CLAY TUFF, trace some sand clasts, hard, high plastic, blue-grey inner core, damp from 31.9m to 36.2m		
							-trace sand, very soft, high plastic, blue-grey, wet from 32.5m to 32.6m		
33		512							

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amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: CD	COMPLETION DEPTH: 59.7 m
		ENTERED BY: SR/CD	COMPLETION DATE: 8/4/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH10**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
33		27		-fracture 30° from core axis, slickensided 30° off of dip angle, polished, wavy at 32.7m depth TUFF, alternating coarse and fine-grained beds *(continued)*
34	511			-trace gravel-sized clasts, rounded, extremely weak at 34.1m depth
35	510	28		-fracture 30° from core axis, slickensided parallel to dip, no infill, polished, wavy at 34.6m depth
36	509			-trace sand and gravel-sized clasts from 35.6m to 35.7m -clay fractures into slickensided fractures, polished dip 20° from core axis, slickensides parallel in fracture, wavy
37	508	29		SAND AND GRAVEL TUFF, subrounded to subangular, some clay (matrix), massive, blue-grey, damp from 36.2m to 36.3m CLAY TUFF, some sand, some fine grained gravel-sized clasts, hard, high plastic, interbeds of gravelly/sandy material (5-30cm), blue-grey, damp from 36.3m to 37.9m
38	507	30		CLAY TUFF, trace to no sand clasts, hard, high plastic, massive, blue-grey inner core, damp from 37.9m to 38.3m -TUFF breaks into slickensided fractures (5mm spacing), polished, dip 20° from core axis, slickensides, parallel to dip, wavy, stepped, rough perpendicular dip, no infill from 38.2m to 38.4m
39	506	31		SAND AND GRAVEL TUFF (subrounded, weak clasts), coarsens (less clay with depth), hard to very dense, massive, grey, blue-brown, damp from 38.3m to 39.8m
40	505			CLAY TUFF, trace to no sand, hard, high plastic, massive, blue-grey, damp from 39.8m to 40.8m -TUFF breaks into fragments with faint slickensides from 40.0m to 40.2m -trace to no sand-sized clasts from 40.2m to 40.4m
41	504	32	97	SAND TUFF, (coarse, subrounded), and clay matrix, trace gravel, hard, dense, massive, blue-grey, damp from 40.8m to 40.9m CLAY TUFF, trace to no sand, trace to no gravel, alternating layers of clay and clay with trace to no sand and gravel, hard, medium to high plastic, blue-grey, damp, massive from 40.9m to 42.1m
42	503	33	102	SAND TUFF (medium subrounded), some clay matrix, trace gravel, hard to dense, massive, blue-grey, damp from 42.1m to 42.8m -coarse gravel, subrounded, extremely weak at 42.3m depth
43	502			CLAY TUFF, trace to no sand, hard, medium to high plastic, blue-grey, damp from 42.8m to 44.5m -trace sand, little coarse gravel from 42.9m to 43.3m
44	501			

Other column headings: STRATIGRAPHY, SAMPLE TYPE, DRILL TIMES (min), WELL, ◆ POCKET PEN (kPa) ◆ 100 200 300 400, PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH10**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
44		34	107	TUFF, alternating coarse and fine-grained beds *(continued)* -slickensided fractures, slickensided parallel to dip 80°, polished, wavy from 44.2m to 44.4m
	500			GRAVEL TUFF (coarse, subrounded), some sand and some clay (matrix), very dense to hard, massive, blue-grey, damp to dry from 44.5m to 46.6m -more clay, clay with some sand and trace gravel from 44.9m to 45.1m
45	499	35	105	
46		36	119	
	498			CLAY TUFF, trace silt, trace sand, hard, medium plastic, grey-blue, damp from 46.6m to 47.5m
47		37	106	-fracture, polished, undulating, wavy, at 47.1m
	497			SAND TUFF, trace fine grained gravel, little clay, some silt, compact (little to no cohesion), massive, blue-grey, moist from 47.5m to 48.7m
48		38	102	-5cm thick layer of clay, high plastic, moist to wet at 47.9m -no recovery from 48.0m to 48.7m, assumed SAND TUFF
	496	39	44	**-Vibrating Wire Piezometer 10C at 48.6m**
49				CLAY TUFF, some silt, hard, high plastic, grey blue, damp, massive from 48.7m to 49.8m -little fine grained gravel at 49.2m depth -high plastic, soft to firm, grey blue, moist to wet
	495			
50		40	92	SAND TUFF, some silt, some clay, trace fine grained gravel, hard, very dense, massive, blue-grey, damp from 49.8m to 50.8m -little to no cohesion, compact from 50.2m to 50.8m
	494			
51		41	89	CLAY TUFF, some silt, trace to no sand, hard, high plastic, massive, blue-grey, damp to dry from 50.8m to 51.1m
	493	42	122	SAND TUFF, some clay, some silt (matrix), trace fine grained gravel, subrounded, very dense to hard, massive, blue-grey, damp from 51.1m to 52.1m -some fine to medium-grained gravel, subrounded at 51.6m depth
52				-cobble, vesicular basalt from 52.1m to 52.3m
	492	43	92	SAND AND GRAVEL TUFF, (2mm to 30mm Ø) clasts in fine grained matrix, well lithified zone of localized calcite cementation, light brown matrix, ~35% matrix, becomes coarser down sequence, clasts are mix of subangular feldspar and weak, subrounded, volcanic tuff from 52.3m to 52.7m
53				SAND TUFF, trace fines, fine to medium-grained gravel, clasts rounded to subangular matrix is brown, clay sizes, becomes high plastic when ground and wetted, ~65% matrix, minimal to no acid reaction from 52.7m to 53.3m
	491			GRAVEL TUFF, some sand, trace clay, sand to coarse-grained gravel sizes clasts, clasts are subangular within weakly cemented matrix, minor acid reaction from 53.3m to 53.6m
54	490	44	93	CLAY TUFF, blue-grey to light brown, some sand, trace gravel, when ground up and wetted becomes high plastic, massive competent matrix from 53.6m to 54.7m
55				

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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Prince George, BC V2N 2P9
(250) 564-3243

LOGGED BY: CD
ENTERED BY: SR/CD
COMPLETION DEPTH: 59.7 m
COMPLETION DATE: 8/4/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH10
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869655.38 EASTING: 531591.83	ELEVATION: 544.8 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
55				CLAY TUFF, brown, some to sandy and gravelly, matrix varies, from competent to crumbly, poorly sorted, some to no acid reaction from 54.7m to 57.2m TUFF, alternating coarse and fine-grained beds *(continued)*
56	489	45	110	
57	488	46	105	CLAY TUFF, blue-grey, trace to some medium to fine grained sand, damp to dry from 57.2m to 58.1m -some sand, some gravel, clasts are rounded to subangular, 40% matrix from 57.6m to 57.8m
58	487	47	93	CLAY TUFF, blue-grey to brown, trace to some sand and gravel, clasts are rounded to subangular, high-plastic clay matrix, ~50-70% matrix, damp from 58.1m to 58.8m -material is wet from 58.5m to 58.6m, likely due to drilling
59	486			GRAVEL TUFF, little sand, trace clay, medium sand to coarse gravel-sized clasts, angular to subangular within fine grained matrix, clast hardness, weakly cemented, poorly sorted, damp, 25% matrix, gradational change from above unit from 58.8m to 59.4m CLAY TUFF, blue-grey to brown, some sand, trace gravel, subangular, matrix, 70% matrix, damp to dry from 59.4m to 59.7m
60	485			End of Borehole at 59.7m Drilling method did not allow observation of water level
61	484			
62	483			
63	482			
64	481			
65	480			
66	479			

WELL

POCKET PEN (kPa) 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	PLASTIC M.C. LIQUID 20 40 60 80
0							SAND AND GRAVEL, cobbley, trace silt, compact to dense, well graded, massive, brown, moist note: very poor recovery while drilling from 0m to 14.3m, log based on field observations by driller and the limited samples collected		
1		530							
2		529							
3		528							
4		527							
5		526							
6		525							
7		524		1	0				
8		523							
9		522							
10		521							

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STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH11
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10				SAND, fine to medium grained, some gravel, some fines, dense, brown, moist
11	520			
12	519			
13	518			
14	517			-Vibrating Wire Piezometer 11A at 14.3m
15	516	2	68	GRAVEL, sandy, some clay, rounded clasts up to 3cm, red orange
		3	40	GRAVEL, some clay, subrounded clasts up to 2cm, orange brown
				-no recovery, approximate contact
16	515	4	0	CLAY, some gravel, subangular clasts up to 1.5cm, moist -field log lists soil as saturated, (water table) near 16.0m
		5	27	TUFF, alternating coarse and fine-grained beds CLAY TUFF, trace sand, trace organics, very stiff, green-grey from 16.3m to 29.9m Note: fractured (12 joints recorded) spaced 1.1m apart
17	514	6	138	-very stiff to hard, green-blue from 16.9m to 28.0m
18	513	7	107	
19	512			
		8	113	-SI-11 indicates displacement at 19.2m
20	511			

WELL

PLASTIC M.C. LIQUID: 20 40 60 80

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
20				TUFF, alternating coarse and fine-grained beds*(continued)*
		9	114	
21	510			
		10	108	
22	509			
23	508	11	54	
24	507	12	122	
				-trace silt, trace organics, hard, grey from 24.3m to 24.5m
25	506	13	119	
26	505	14	108	
27	504	15	105	
28	503			-trace to some fine to medium white sand-sized clasts, very stiff to hard, green-blue and brown from 28.0m to 29.87m -SI-11 indicates displacement at 28.1m
29	502	16	86	
30	501	17	144	

WELL

PLASTIC M.C. LIQUID

20 40 60 80

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3456 Opie Crescent
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LOGGED BY: HR	COMPLETION DEPTH: 70.2 m
ENTERED BY: CD	COMPLETION DATE: 6/10/06

STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30				SAND TUFF, gravelly from 29.9m to 30.0m -joint: smooth to rough, wavy, 80o from core axis at 30.0m TUFF, alternating coarse and fine-grained beds*(continued)* CLAY TUFF, trace fine to medium white sand-sized clasts, very stiff to hard, green-blue and brown from 30.0m to 45.8m Note: fractured (7 joints recorded) spaced 2.3m apart
		18	97	
31	500			-no sand from 31.2m to 32.4m
		19	123	
32	499			**-Vibrating Wire Piezometer 11B at 32.0m**
				-trace sand-sized clasts from 32.4m to 36.8m
33	498	20	107	
34	497	21	130	
35	496	22	108	
36	495	23	102	
37	494			-some sand and gravel-sized clasts, hard, brown from 36.8m to 37.6m
				-no sand or gravel from 37.6m to 43.1m
38	493	24	83	
39	492	25	102	
		26	102	
40	491			

PLASTIC — M.C. — LIQUID: 20 40 60 80

WELL

DRAFT

STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE	TUBE	NO RECOVERY	SPLIT SPOON	GRAB	MUD RETURN	CORE RETURN
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | PLASTIC M.C. LIQUID 20 40 60 80

SAMPLE NO	RECOVERY (%)
27	105
28	100
29	96
30	119
31	102
32	96
33	99
34	119
35	96
36	110

Depth (m): 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Elevation (m): 490, 489, 488, 487, 486, 485, 484, 483, 482, 481

TUFF, alternating coarse and fine-grained beds *(continued)*

-some sand, trace fine gravel-sized clasts, hard, green-grey from 43.1m to 43.4m

-no sand from 43.4m to 44.1m

-trace fine sand-sized clasts from 44.1m to 45.0m

-sandy grading to gravelly, fine gravel-sized clasts, subangular to subrounded, hard, grey-green from 45.0m to 45.3m

-no sand or gravel from 45.3m to 45.8m

SAND AND GRAVEL TUFF, some clay matrix, fine subrounded gravel-sized clasts from 45.8m to 45.9m

CLAY TUFF, very stiff to hard, green-blue from 45.9m to 46.2m

SAND TUFF, clayey (matrix), fine sand-sized clasts, trace organics, hard, red-brown from 46.2m to 46.5m

CLAY TUFF, trace sand-sized clasts, very stiff to hard, green-blue from 46.5m to 58.9m Note: fractured (26 joints recorded) spaced 0.5m apart

-gravelly at 47.2m

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50				TUFF, alternating coarse and fine-grained beds*(continued)*
				-Vibrating Wire Piezometer 11C at 50.3m
51	480			-some white sand and fine gravel clasts, from 50.9m to 51.1m
		37	105	
52	479			
53	478	38	100	-SI-11 indicates displacement at 52.7m
				-some white sand clasts, from 53.3m to 53.7m
54	477			-sandy from 53.9m to 54.2m
		39	105	-some sand-sized clasts from 54.5m to 54.6m
55	476			
56	475	40	103	
57	474	41	100	
58	473			-some sand-sized clasts from 57.9m to 58.2m
		42	102	
59	472			SAND AND GRAVEL TUFF fine sand to fine subrounded gravel-sized clasts, clay matrix, hard, green- brown from 58.9m to 59.3m
		43	122	CLAY TUFF very stiff to hard, green-blue from 59.3m to 70.2m Note: fractured (15 joints recorded) spaced 0.7m apart
60	471			

WELL

PLASTIC M.C. LIQUID
20 40 60 80

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LOGGED BY: HR	COMPLETION DEPTH: 70.2 m
ENTERED BY: CD	COMPLETION DATE: 6/10/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH11**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
60				TUFF, alternating coarse and fine-grained beds*(continued)*
		44	100	
				-sandy interbed, trace subrounded gravel-sized clasts from 60.7m to 61.0m
61	470			
				-sandy interbed, trace subrounded gravel-sized clasts from 61.4m to 62.0m
62	469	45	98	-trace sand-sized clasts from 62.0m to 62.7m
63	468			
		46	102	-some gravel, trace sand-sized clasts from 63.4m to 63.7m
64	467			
				-sandy interbed from 64.3m to 64.6m
		47	119	
65	466			-trace sand-sized clasts, trace organics from 65.2m to 65.4m
		48	99	
66	465			-sandy interbed from 66.1m to 66.4m
		49	107	-sandy interbed from 66.8m to 66.9m
67	464			
68	463	50	95	
69	462			
		51	108	-sandy interbed at 69.7m
70	461			

WELL

PLASTIC M.C. LIQUID
20 40 60 80

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Prince George, BC V2N 2P9
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LOGGED BY: HR
ENTERED BY: CD
COMPLETION DEPTH: 70.2 m
COMPLETION DATE: 6/10/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH11
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870360.16 EASTING: 532036.58	ELEVATION: 530.9 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	PLASTIC / M.C. / LIQUID (20 40 60 80)
70							TUFF, alternating coarse and fine-grained beds *(continued)*		
							End of Borehole at 70.2m Drilling method did not allow observation of water level		
71		460							
72		459							
73		458							
74		457							
75		456							
76		455							
77		454							
78		453							
79		452							
80		451							

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HR ENTERED BY: CD	COMPLETION DEPTH: 70.2 m COMPLETION DATE: 6/10/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH12
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
0				SAND AND GRAVEL, silty, compact, well graded, subrounded particles, grades into SAND, silty, brown, moist to wet
	556			
1	555	1	11	
2	554	2	23	
3		3	58	SILT AND SAND, fine grained, trace gravel, dense to very dense, moist, brown
	553	4	0	
4	552	5	0	
5		6	81	SAND, fine grained, some silt, some interbeds of medium SAND, trace silt and SILT AND SAND, compact to dense, brown, moist to wet
	551	7	56	
6		8	76	
	550	9	68	
7	549	10	97	
8		11	59	-field log indicates saturated soil (possible water table) at 7.8 m
	548			
9		12	34	
	547	13	73	
10				

WELL

POCKET PEN (kPa) 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

DRAFT

STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

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(250) 564-3243

LOGGED BY: HR/CD
ENTERED BY: CD
COMPLETION DEPTH: 70.2 m
COMPLETION DATE: 6/22/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH12
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
10		546	Tube	14	0		SAND, fine grained, some silt, some interbeds of medium SAND, trace silt and SILT AND SAND, compact to dense, brown, moist to wet *(continued)*
			Tube	15	102		
11		545	Tube	16	47		-some gravel to gravelly from 11.1 m
			Tube	17	0		-no recovery from 11.7 to 12.0m
12		544	Tube	18	62		
			Tube	19	0		-no recovery from 12.5m to 14.0m
13		543	Tube	20	0		
14		542	Tube	21	64		
			Tube	22	85		GRAVEL, silt and sand matrix, subrounded to subangular, well graded up to 70 mm sized clasts, dense, damp
15		541	Tube	23	62		
			Tube	24	7		
16		540	Tube	25	68		SAND, medium grained, some silt, some gravel, dense to compact, brown, moist to wet
			Tube	26	0		SAND AND GRAVEL, well graded, rounded to angular, trace to some silt, brown, wet -no recovery from 16.5m to 18.0m
17		539	Tube	27	0		
			Tube	28	0		
18			Split spoon	1	203		**-Vibrating Wire Piezometer 12A at 18.0m**
		538	Tube	29	0		-no recovery from 18.2m to 20.7m
19		537	Tube				
20							

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

DRAFT

STRATIGRAPHIC KX04397-2005.SIMP.BH05-7-8-9-11-12-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HR/CD ENTERED BY: CD	COMPLETION DEPTH: 70.2 m COMPLETION DATE: 6/22/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH12**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
20		30	0	SAND AND GRAVEL, well graded, rounded to angular, trace to some silt, brown, wet*(continued)*
	536			
21		31	79	GRAVEL AND SAND, some silt, rounded to subangular, well graded up to 70 mm clasts, compact to dense, with some interbeds of GRAVEL, loose, washed and interbeds of SAND trace to some silt, dense, moist to wet, brown
	535	32	48	
22	534			-SAND, some gravel, some clay grading to SAND, clayey, stiff/dense, moist, greyish brown at 22.4 m
23	533	33	27	**-Vibrating Wire Piezometer 12B at 22.9m**
24				-no recovery from 23.7m to 25.2m
	532	34	0	
25	531			GRAVEL AND CLAY, medium sized gravel, subangular clasts TUFF, alternating coarse and fine-grained beds CLAY TUFF, trace sand-sized clasts, very stiff, high plastic, green/blue from 25.3 to 45.2m Note: fractured between 25.3m and 51.3m with average joints (51 recorded) spaced 0.35m to 0.40m apart
26	530	35	108	**-Vibrating Wire Piezometer 12C at 26.5m**
27	529	36	103	
28	528	37	106	-sandy, hard from 28.2m to 28.5m
29	527	38	107	
30				

WELL

POCKET PEN (kPa) 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

DRAFT

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH12**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
30				TUFF, alternating coarse and fine-grained beds *(continued)*
	526	39	102	
31	525			
32		40	107	-slightly oxidized, orange colour from 31.8m to 32.7m
33	524			
	523	41	105	-sandy from 33.5m to 33.8 m
34	522			-sandy from 34.5m to 34.6 m
35		42	114	
	521			-sandy from 35.2m to 35.6 m
36	520	43	95	
37	519	44	99	-sandy from 37.7m to 38.0m
38				-sandy, some fine gravel-sized clasts from 38.0m to 38.0m
	518	45	106	-trace organics from 38.6m to 40.2m
39	517	46	106	
40				

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH12**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min)

SAMPLE DESCRIPTION AND DRILLING NOTES

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

Sample No	Recovery (%)
47	102
48	93
49	123
50	130
51	97
52	102
53	130
54	102
55	108

Depth (m): 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Elevation (m): 516, 515, 514, 513, 512, 511, 510, 509, 508, 507

-sandy from 39.8m to 40.0m
TUFF, alternating coarse and fine-grained beds *(continued)*

-some sand to sandy from 41.9m to 42.2m

-sandy from 43.4m to 43.8m

-some fine whitish gravel-sized clasts from 43.7m to 43.8m

-slough from 44.7m to 44.8m

CLAY TUFF, trace sand-sized clasts, very stiff, high plastic, green-blue from 44.8m to 45.7m

-sandy from 45.2 m to 45.3 m

SAND AND GRAVEL TUFF, fine gravel-sized clasts, subrounded, mix of weak weathered clay rich and more resistant clasts, clay matrix, hard, blue/green from 45.7m to 45.8m

CLAY TUFF, trace sand-sized clasts, very stiff, high plastic, green-blue from 45.8m to 46.6m

-soft, damp from 46.0 m to 46.1 m

SAND AND GRAVEL TUFF, fine gravel-sized clasts, subrounded, mix of weak weathered clay rich and more resistant clasts, clay matrix, hard, blue/green from 46.6m to 46.7m

CLAY TUFF, trace sand-sized clasts, very stiff, high plastic, green/blue from 46.7m to 48.0m

CLAY AND SAND TUFF, very stiff, medium plastic, blue-green from 48.0m to 49.0m

GRAVEL AND SAND TUFF, clay matrix, clasts well graded up to medium-sized gravel, mix of weak weathered clay-rich and more resistant clasts, very stiff/dense, green/blue from 49.0m to 49.3m

CLAY AND SAND TUFF, very stiff, medium plastic, green-blue, whitish sand-sized inclusions from 49.3m to 49.7m

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LOGGED BY: HR/CD	COMPLETION DEPTH: 70.2 m
ENTERED BY: CD	COMPLETION DATE: 6/22/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH12**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
50	506			CLAY TUFF, trace to no sand-sized clasts, very stiff to hard, high plastic, blue-green from 49.7m to 50.1m TUFF, alternating coarse and fine-grained beds *(continued)* SAND TUFF, coarse grained, some fine gravel-sized clasts, clay matrix, very stiff to dense, blue-green from 50.1m to 50.4m CLAY TUFF, trace to some sand-sized clasts, very stiff, medium plastic, damp from 50.4m to 53.5m
51	505	56	91	
52	504	57	100	
53	503			CLAY AND SAND TUFF, trace fine gravel-sized clasts, very stiff, high plastic, whitish sand-sized inclusions from 53.5m to 56.6m
54	502	58	100	note: highly fractured between 54.0m and 54.5m with slickensided joints, 15-40° from core axis (10 recorded) spaced 0.1m apart (shear zone)
55	501			-Vibrating Wire Piezometer 12D at 54.9m
56	500	59	93	
57	499	60	102	CLAY TUFF, trace sand-sized clasts, very stiff, medium plastic, blue-green from 56.6m to 57.9m note: highly fractured between 57.3m and 59.0m with joints, 45-50° from core axis (6 recorded) spaced 0.3m apart
58	498			SAND TUFF, medium to coarse-grained clasts, trace gravel-sized clasts, clay matrix, very stiff to hard, blue-green, damp from 57.9m to 58.1m CLAY TUFF, zones of some sand-sized clasts, hard, high plastic, blue-green, damp from 58.1m to 60.0m
59	497	61	117	
60				

STRATIGRAPHY | SAMPLE TYPE | DRILL TIMES (min) | WELL | ◆POCKET PEN (kPa)◆ 100 200 300 400 | PLASTIC M.C. LIQUID 20 40 60 80

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(250) 564-3243

LOGGED BY: HR/CD
ENTERED BY: CD
COMPLETION DEPTH: 70.2 m
COMPLETION DATE: 6/22/06

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH12
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
60				TUFF, alternating coarse and fine-grained beds *(continued)*
	496	62	98	GRAVEL AND SAND TUFF, well graded from fine sand to medium gravel-sized clasts, mix of weak weathered clay-rich and more resistant clasts, clay matrix and clast supported, hard from 60.0m to 60.2m
61				CLAY TUFF, zones of fine sand-sized clasts, hard, high plastic, blue-green, damp, core breaks into slickensided fractures from 60.2m to 61.5m note: highly fractured between 60.4m and 62.3m with slickensided joints, 65-70° from core axis (10 recorded) spaced 0.2m apart (shear zone)
	495			SAND AND CLAY TUFF, fine to medium-grained sand-sized clasts, clay matrix, hard, medium plastic, blue-green from 61.5m to 62.0m
62		63	108	CLAY TUFF, trace to no sand-sized clasts, hard, high plastic, blue/green, damp, core breaks into slickensided fractures, from 62.0m to 62.4m
	494			GRAVEL AND SAND TUFF, clast and matrix (clay) supported, subrounded clasts of clays and lithic fragments, very hard, blue/green matrix from 62.4m to 63.7m note: no joints
63	493	64	103	-SI-12 indicates displacement at 63.4m
64	492			
65	491	65	93	
66	490	66	15	
67	489			
68	488	67	110	
69	487	68	89	
70				

WELL

POCKET PEN (kPa): 100, 200, 300, 400
PLASTIC, M.C., LIQUID: 20, 40, 60, 80

DRAFT

CLIENT: City Of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH12
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC 2000 Coring	NORTHING: 5870271.58 EASTING: 531620.09	ELEVATION: 556.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆POCKET PEN (kPa)◆ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80
70							TUFF, alternating coarse and fine-grained beds*(continued)* SAND TUFF interbed, fine grained, some clay, trace to some gravel-sized clasts, supported by clay and sand matrix, blue-green from 63.7m to 70.2m note: no joints -coarse sand and fine gravel-sized clasts from 64.8 m to 65.5 m -coarse sand and fine gravel-sized clasts from 66.3 m to 66.4 m -coarse sand and fine gravel-sized clasts from 67.0 m to 67.2 m -coarse sand and fine gravel-sized clasts from 68.7 m to 68.9 m End of Borehole at 70.2m Drilling method did not allow observation of water level		
		486							
71									
		485							
72									
		484							
73									
		483							
74									
		482							
75									
		481							
76									
		480							
77									
		479							
78									
		478							
79									
		477							
80									

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: HR/CD ENTERED BY: CD	COMPLETION DEPTH: 70.2 m COMPLETION DATE: 6/22/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH13
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869937.72 EASTING: 532468.2	ELEVATION: 482.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
0	482			COBBLES, some silt, some clay, trace sand, loose, cobbles are volcanic andesite
1	481	1	17	
2	480	2	7	COBBLES AND CLAY, firm to stiff, high plastic
3	479	3	100	TUFF, alternating coarse and fine-grained beds CLAY TUFF, very stiff, high plastic, massive, greyish brown, damp from 2.8m to 6.4m -grey-brown clay grades to dark brown clay from 3.5m to 3.8m
4	478			-stiff, very high plastic from 43.1m to 4.7m, trace organics -blue-green colour from 4.2m
5	477	4	103	-trace to some sized clasts from 5.1m to 5.3m **-Vibrating Wire Piezometer 13A at 5.1m**
6	476	5	107	SAND TUFF, fine to coarse sand-sized clasts, some clay, very stiff, green-blue, damp from 6.4m to 6.53m CLAY TUFF, very stiff, high plastic, massive, greenish blue, damp, trace organics from 6.5m to 9.9m
7	475			-alternating beds (3cm thick) of clay and clay with trace sand from 7.4m to 7.6m
8	474	6	98	-alternating beds (5cm thick) of clay tuff and sandy clay tuff with white medium-grained sand-sized clasts, sandy zones become finer, less sand with depth from 7.6m to 8.3m note: clay tuff zones represent areas which have been spun while drilling
9	473	7	87	
10				

WELL

PLASTIC M.C. LIQUID
20 40 60 80

DRAFT

STRATIGRAPHIC KX04397-2005-BH05-10 AND 13-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

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LOGGED BY: CD	COMPLETION DEPTH: 30.5 m
ENTERED BY: SR/CD	COMPLETION DATE: 10/20/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH13**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869937.72 EASTING: 532468.2	ELEVATION: 482.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	SAMPLE DESCRIPTION AND DRILLING NOTES
10	472			SAND TUFF, medium sand-sized clasts, some clay to clayey, poorly graded, hard, blue-green, clay whitish sand-sized clasts, damp from 9.8m to 10.1m TUFF, alternating coarse and fine-grained beds *(continued)*
		8	99	CLAY TUFF, trace to no sand-sized clasts, very stiff, high plastic, massive, damp from 10.1m to 14.6m -organic inclusions up to 1.5cm in length from 10.0m to 10.5m depth -alternating beds of sandy clay tuff (2-10cm thick), and CLAY, stiff (1-3cm thick), 15 sequences in total. note: clay tuff zones represent zones that have been spun while drilling from 10.5m to 11.6m depth
11	471			
12	470	9	107	
13	469			-trace to some organic inclusions, color ranges from green-blue to carbonaceous dark brown clay, from 12.8m to 14.3m, organic odor noted while drilling -possible joint, smooth planar, 85-90° from core axis at 12.8m depth
14	468	10	101	**-Vibrating Wire Piezometer 13B at 14.4m** -SI-13 indicates displacement at 14.6m
				CARBONACEOUS SHALE interbed, black, very weak, possible coal seam or petrified wood fragment, sharp contact
15	467	11	105	TUFF, alternating coarse and fine-grained beds CLAY TUFF, trace medium-grained sand-sized clasts, very stiff, high plastic, massive, damp from 14.7m to 17.0m -alternating sandy clay beds (fine-grained clasts) at 15.2m to 15.4m and 15.5m to 15.6m and 15.7m to 15.8m depth, clay tuff zones represent zones that have been spun while drilling -trace to no sand-sized clasts at 15.8m depth -joint slightly rough, polished, planer 10° from core axis at 16.2m depth
16	466			
17	465	12	91	SAND TUFF, some clay, very stiff, massive, blue-green clay and whitish sand, grades from fine to medium sand at the base of the sequence, damp from 17.0m to 17.1m
				CLAY TUFF, trace to no sand-sized clasts, very stiff, high plastic, massive, damp from 17.1m to 18.3m -alternating beds of clay (1-8cm thick), with clay and trace medium sand clasts (2-6cm thick), clay tuff represent zones that have been spun and remolded during drilling from 17.1m to 17.7m -field log noted soft/saturated zones at 17.8m, 17.9m and 18.1m depths
18	464	13	63	SAND TUFF, fine grained, some clay, poorly graded, dense, damp to dry, appears like weak fine sandstone, area of local cementation from 18.3m to 19.2m
19	463			CLAY TUFF, trace to no sand-sized clasts, very stiff, high plastic, massive, blue-green, grades into trace sand with depth from 19.2m to 20.2m
20				

WELL

PLASTIC M.C. LIQUID

20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 30.5 m
ENTERED BY: SR/CD	COMPLETION DATE: 10/20/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH13**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869937.72 EASTING: 532468.2	ELEVATION: 482.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)
20	462	14	107
21	461	15	100
22	460		
23	459	16	87
24	458	17	87
25	457		
26	456	18	67
27	455	19	63
28	454		
29	453	20	110
30			

SAMPLE DESCRIPTION AND DRILLING NOTES

TUFF, alternating coarse and fine-grained beds *(continued)*

SAND AND CLAY TUFF, medium-grained whitish sand clasts, clay matrix, well graded, very stiff, massive, damp from 20.2m to 20.4m

CLAY TUFF, trace to no sand-sized clasts, very stiff, high plastic, massive, blue-green, damp from 20.4m to 23.4m

-alternating layers of moist, stiff, clay tuff from 20.4m to 21.9m depth, possibly spun/remolded during drilling

-clay has blocky structure (fractured at 10 mm spacing) at 22.5m to 22.9m depth

CARBONACEOUS SHALE interbed, black, weak, some possible petrified wood fragments/coal seams

TUFF, alternating coarse and fine-grained beds

CLAY TUFF, trace to no sand-sized clasts, very stiff, high plastic, massive, blue/green, damp from 23.6m to 29.5m

-stiff, moist clay from 23.8m to 23.9m depth

-trace whitish medium sand-sized clasts from 25.2m to 26.4m depth

-stiff, moist clay from 26.2m to 26.3m depth

-sandy clay, fine to medium-grained sand-sized clasts from 26.4m to 26.7m, joint, planar rough, 85° from core axis at 26.4m depth

-stiff and moist from 26.7m to 28.0m depth

-blocky structure, 1cm spacing between fractures from 28m to 28.2m depth

-zone of firm to stiff moist clay from 28.3m to 28.4m depth

CLAY TUFF, sandy, fine to medium sand-sized clasts, well graded, clay matrix from 28.6m to 28.9m depth

SAND TUFF, fine to medium coarse sand-sized clasts, subrounded, some clay, well graded, blue-green clay matrix, very stiff, massive, damp from 29.5m to 29.7m

WELL

PLASTIC M.C. LIQUID

20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 30.5 m
ENTERED BY: SR/CD	COMPLETION DATE: 10/20/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH13**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000 Coring	NORTHING: 5869937.72 EASTING: 532468.2	ELEVATION: 482.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	PLASTIC / M.C. / LIQUID (20 40 60 80)
30		452		21	109		CLAY TUFF, high plastic, stiff to firm, massive, blue-green, moist from 29.7m to 30.5m TUFF, alternating coarse and fine-grained beds*(continued)*		
							End of Borehole at 30.5m Drilling method did not allow observation of water level		
31		451							
32		450							
33		449							
34		448							
35		447							
36		446							
37		445							
38		444							
39		443							
40									

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LOGGED BY: CD	COMPLETION DEPTH: 30.5 m
ENTERED BY: SR/CD	COMPLETION DATE: 10/20/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

SAMPLE DESCRIPTION AND DRILLING NOTES

DEPTH (m)	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)
~2.6		Split spoon	1	0	0
~3.3		Core	1	45	10
~4.5		Core	2	30	11
~5.6		Core	3	68	6
~6.6		Core	4	34	2
~8.2		Core	5	26	5
~9.7		Core	6	15	7

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 m; Elevation: 571, 570, 569, 568, 567, 566, 565, 564, 563 m

ORGANICS/TOPSOIL

SILT, clayey, trace to some sand, stiff, low plastic, massive structure, dark brown, thin sand seams (~1mm thick), moist

CLAY, silty, trace gravel, trace sand, very stiff (PP=270kPa), medium to high plastic, massive/reworked structure, light brown-tan, trace organics, moist to wet

-switched to HQ3 coring at 2.7m

SILT, some clay, trace sand, stiff, low to medium plasticity, massive to parallel laminations/bedding, brown, moist (glaciolacustrine)

-clay or silty fine sand interbeds/laminations 2 to 20mm thick from 5.3m to 12.0m

-gravelly at 7.5m

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

>>18

DRAFT

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH14
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
10					SILT, some clay, trace sand, stiff, low to medium plasticity, massive to parallel laminations/bedding, brown, moist (glaciolacustrine)*(continued)*
11	561	7	0	11	
12	560				GRAVEL AND COBBLES, some clay to clayey, some silt to silty, subrounded clasts of vesicular basalt and diorite, loose to hard, massive, wet Note: potential aquifer although poor recovery and lack of fines suggest washed core sample while drilling
		8	3	4	
13	559				
14	558	9	7	11	
15	557				
16	556	10	15	13	
17	555	11	23	19	
18	554				
19	553	12	10	15	
20					TUFF, alternating coarse and fine-grained beds

WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40
◆POCKET PEN (kPa)◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
20		13	85	25	SAND TUFF, fine sand clasts in clay matrix, most clasts weak, clay-rich with some resistant subangular, smoky coloured clasts (chert), dense, massive, blue-green, moist from 19.7m to 21.2m TUFF, alternating coarse and fine-grained beds*(continued)* **-Vibrating Wire Piezometer 14A Installed at 20.1m** -gravel tuff interbed, sand and clay matrix supported from 20.4m to 20.5m
21	551	14	77	12	SAND AND GRAVEL TUFF, subrounded, up to 30mm Ø from 21.2m to 25.8m -clean gravel (fines washed) from 21.6m to 22.7
22	550	15	21	13	
23	549	16	61	14	-grades from sand tuff to coarse gravel tuff from 23.0m to 24.4m
24–25	548–547	17	18	11	
26	546	18	98	21	SAND TUFF, clay matrix, medium grained, gravelly sand interbeds, bluish green, moist from 25.8m to 32.3m
27	545	19	98	27	-clay tuff interbed, breaks into slickensided joints 25° from core axis from 27.0m to 27.3m (shear zone) -joint: 45° from core axis, planar, grooved, slickensided -trace to some gravel, medium to coarse grained from 27.3m to 27.8m -gravelly from 27.8m to 28.0m
28	544	20	13	47	
29–30	543	21	89	20	-clay tuff interbed from 29.6m to 30.2m

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

SPT "N" (BLOWS/300 mm): 10, 20, 30, 40
POCKET PEN (kPa): 100, 200, 300, 400
PLASTIC — M.C. — LIQUID: 20, 40, 60, 80

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
30					-breaks into slickensided joints 40° from core axis, moist from 29.6m to 29.7m (shear zone) TUFF, alternating coarse and fine-grained beds*(continued)* -fractured into coarse gravel-sized clasts from 30.0m to 30.2m
31	541	22	92	36	-coarsening downward sequence from medium SAND TUFF, clay matrix to SAND TUFF, gravelly, sand matrix from 31.4m to 31.9m and 31.9m to 32.3m
32	540				
		23	100	57	CLAY TUFF, medium plasticity, very stiff, massive, some slickensided fractures, interbeds (50% of total length) of GRAVEL AND SAND TUFF, clasts mix of subrounded, weak, clay gravel and subangular, resistant, smoky gravel (chert), bluish grey, damp from 32.3m to 33.4m -fractured with slickensided joints, 30° from core axis from 32.6m to 32.9m (shear zone) **-X-Ray Diffraction Test at 32.8m** -fractured with slickensided joints, 35° from core axis at 33.2m
33	539				SAND AND GRAVEL TUFF, clay matrix, some sand interbeds, very stiff from 33.4m to 36.4m note: core small diameter, field log listed water loss and possible washing
34	538	24	33	19	-slickensided joint at 25° from core axis at 33.7m
35	537				-woody lignite fragment (40mm by 20mm) at 35.0m
		25	31	17	
36	536				CLAY TUFF trace medium-grained sand clasts, massive, trace organics from 36.4m to 36.8m
					SAND AND GRAVEL TUFF grades into GRAVEL & SAND near middle and fines at base and top of unit, bluish grey from 36.8m to 38.3m
37	535	26	69	27	
38	534				CLAY TUFF some medium-grained sand-sized clasts, trace weak gravel-sized clasts, trace organics 5mm Ø, very stiff from 38.3m to 39.3m
		27	97	31	
39	533				SAND AND GRAVEL TUFF from 39.3m to 41.5m
40					

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | ▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40 ◆POCKET PEN (kPa)◆ 100 200 300 400 PLASTIC M.C. LIQUID 20 40 60 80

Sample No	Recovery (%)	Drill Times (min)
28	39	36
29	49	21
30	0	14
31		
32	98	12
33	96	23
34	94	21
35	102	25
36	23	17
37	42	12
38	26	36

Depth 40 to 50 m; Elevation 531 to 523 m.

TUFF, alternating coarse and fine-grained beds*(continued)*

-clay rich, firm from 40.8 to 40.9m

-gravel, loose (washed) from 41.0m to 41.2m

CLAY TUFF, some weathered sand and gravel-sized clasts, trace organics 5mm Ø, bluish grey, damp from 41.5m to 42.5m

GRAVEL AND SAND TUFF, abrupt upper contact with evident fining downward grading to SAND TUFF in clay matrix, blue-grey, moist from 42.5m to 43.2m

CLAY TUFF, trace to some sand-sized clasts, medium plasticity, very stiff, massive, blue-grey from 43.2m to 45.7m

-core fractures into slickensided joints, 5-10° from core axis at 43.6m (shear zone?)

-coarse sand tuff interbed 200mm thick at 44.7m

-joint 20° from core axis, wavy, grooved, polished, slickensided

GRAVEL AND SAND TUFF, sand and some clay matrix, clast to matrix supported, clasts mix of subrounded, weak, clay rich gravel and subangular, pearly to black, resistant, lithic clasts, dense/hard, interbeds (15% of total length) of fine to medium-grained SAND TUFF, bluish grey, damp from 45.7m to 68.4m

-GRAVEL, coarse, loose from 48.9m to 50.7m
note: fines washed while drilling

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
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DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
50					TUFF, alternating coarse and fine-grained beds*(continued)*
					-field log noted loss of circulation at 50.5m
					-sand tuff interbed, massive from 50.7m to 52.1m abrupt contact at base of unit
51	521	39	62	25	
52	520	40	57	36	
53	519				
					-sand tuff interbed, masssive, abrupt contact at top and base of unit from 53.7 to 53.9m
54	518	41	43	17	
					-note: depth confirmed with sounder and adjusted while drilling (overlapping runs 41 and 42)
55	517	42	29	8	-GRAVEL, coarse, loose, subrounded to subangular from 54.8m to 57.1m note: fines washed while drilling
		43	45	24	
56	516	44	10	18	
57	515				SAND TUFF, fine to medium grained, massive, sharp contact at top and base of unit from 57.1m to 60.0m
		45	41	40	
58	514				
59	513	46	123	28	-from 59m to 63m, high pressure while drilling, breaking rods caused intense pressure release -high water pressure and dirty return when not drilling
60					

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
60					-some coarse, rounded, gravel-sized clasts, highly cemented zone, strong reaction to HCl, calcite cementation from 59.8m to 60.0m GRAVEL, medium to coarse grained, loose from 60.0m to 68.4m note: fines washed while drilling
		47	19	13	
61	511				
62	510	48	20	25	
63	509	49	46	22	
64	508	50	33	9	
		51	66	14	
65	507	52	21	9	
66	506				-Vibrating Wire Piezometer 14B installed at 65.8m
		53	25	24	
67	505				
68	504	54	30	26	
					TUFF, alternating coarse and fine-grained beds SAND TUFF, fine to medium grained, trace gravel, dense, grades from fine sand to medium sand trace fine gravel at base of unit, bluish grey, damp from 68.4m to 70.4m note: core smaller diameter than adjacent core, may have been washed while drilling
69	503	55	42	13	
70					

WELL

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
70					TUFF, alternating coarse and fine-grained beds *(continued)*
					GRAVEL, loose, subangular, smoky color, vitreous fine-grained igneous clasts, hardness 6-7 from 70.4m to 71.0m note: fines may have washed while drilling
71	501	56	31	22	GRAVEL AND SAND TUFF, sand and clay matrix, subangular chert clasts and some weak, clay-rich gravel-sized clasts, greenish grey, damp from 71.0m to 81.7m
72	500	57	91	22	
73	499				-zone of calcite cementation from 72.8m to 73.0m -broken and fractured from 73.2m to 74.5m
		58	38	24	
74	498				
		59	115	31	
75	497				-broken and fractured from 75.0m to 75.2m -gravel-sized lignite inclusion at 75.1m
		60	95	43	
76	496				-CLAY TUFF interbed, sandy, breaks into slickensided joints parallel to core axis from 76.5 to 76.7m
77	495	61	34	25	
78	494				-GRAVEL, some clay, loose from 77.8m to 79m note: fines washed while drilling
		62	43	20	
79	493				
80		63	86	28	

WELL

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40
◆POCKET PEN (kPa)◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: CD ENTERED BY: CD	COMPLETION DEPTH: 100.7 m COMPLETION DATE: 6/1/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH14
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
80					TUFF, alternating coarse and fine-grained beds *(continued)*
81	491	64	52	28	SAND AND CLAY TUFF, fine grained, dense/very stiff, massive, bluish grey, frequent organic stringers and whitish clasts from 81.7m to 82.0m
82	490	65	33	18	GRAVEL, clasts composed of subangular granite (90% rose quartz), granodiorite and vesicular basalt from 82.0m to 85.2m
		66	13	23	
83	489				-some clay from 83.0m to 85.2m
		67	23	12	
84	488	68	0	14	
85	487	69	38	37	TUFF, alternating coarse and fine-grained beds GRAVEL AND SAND TUFF, sand and clay matrix, subangular chert clasts and some weak subrouded, clay-rich gravel-sized clasts, bluish grey, damp from 85.2m to 90.4m -zone of calcite cementation, strong HCl reaction from 85.2m to 86.1m
86	486	70	104	24	-mostly weak, clay rich, gravel-sized clasts from 86.1m to 88.0m
87	485	71	82	20	-stiff/compact and broken, some planar, smooth joint surfaces from 87.5m to 88.0m **-X-Ray Diffraction Test at 87.5m**
88	484	72	126	16	-gravel tuff interbed, sand and clay matrix from 88.2m to 88.3m, gradational contact
89	483	73	66	20	-core fractured in 70mm fragments with polished joint surfaces 45° from core axis from 88.9m to 90.4m
90					

▲ SPT "N" (BLOWS/300 mm) ▲ 10 20 30 40
◆ POCKET PEN (kPa) ◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

WELL

DRAFT

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH14
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40
◆POCKET PEN (kPa)◆ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

WELL

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
90		74	62	31	TUFF, alternating coarse and fine-grained beds *(continued)*
					GRAVEL, coarse grained, subangular, loose from 90.4m to 94.7m note: fines washed while drilling
91	481	75	45	47	
92	480	76	25	13	
93	479	77	25	24	
94	478	78	23	16	
					GRAVEL AND SAND TUFF from 94.7m to 97.7m
95	477	79	38	28	
96	476				
97	475	80	25	28	
					GRAVEL, coarse grained, subangular, loose from 97.7m to 100.7m note: fines washed while drilling
98	474	81	48	15	-Vibrating Wire Piezometer 14C installed at 98.7m
99	473				
100					

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH14**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5869692.84 EASTING: 531276.55	ELEVATION: 572 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	▲SPT "N" (BLOWS/300 mm)▲ 10 20 30 40; ◆POCKET PEN (kPa)◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
100				82	16	45	GRAVEL, coarse grained, subangular, loose from 97.7m to 100.7m note: fines washed while drilling*(continued)*		
							End of Borehole at 100.7m Drilling method did not allow observation of water level		
101		471							
102		470							
103		469							
104		468							
105		467							
106		466							
107		465							
108		464							
109		463							
110									

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LOGGED BY: CD	COMPLETION DEPTH: 100.7 m
ENTERED BY: CD	COMPLETION DATE: 6/1/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH15
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
0	565				GRAVEL (fill)
					SILT, trace gravel, subrounded vesicular basalt and other lithic clasts, stiff to very stiff, non plastic, brown, moist
1	564				
2	563				
3	562				-sand interbed, fine grained, some silt, compact, massive, tan, moist from 3.4m to 3.6m
4	561	1	120	16	-gravelly from 4.2m to 9.8m
5	560	2	0	9	
6	559	3	0	11	
7	558	4	11	9	
8	557				
9	556	5	20	8	-Vibrating Wire Piezometer 15A installed at 8.8m
10					-soft to firm, wet from 9.8m to 11.3m

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

WELL

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LOGGED BY: CD	COMPLETION DEPTH: 100.6 m
ENTERED BY: CD	COMPLETION DATE: 6/27/06

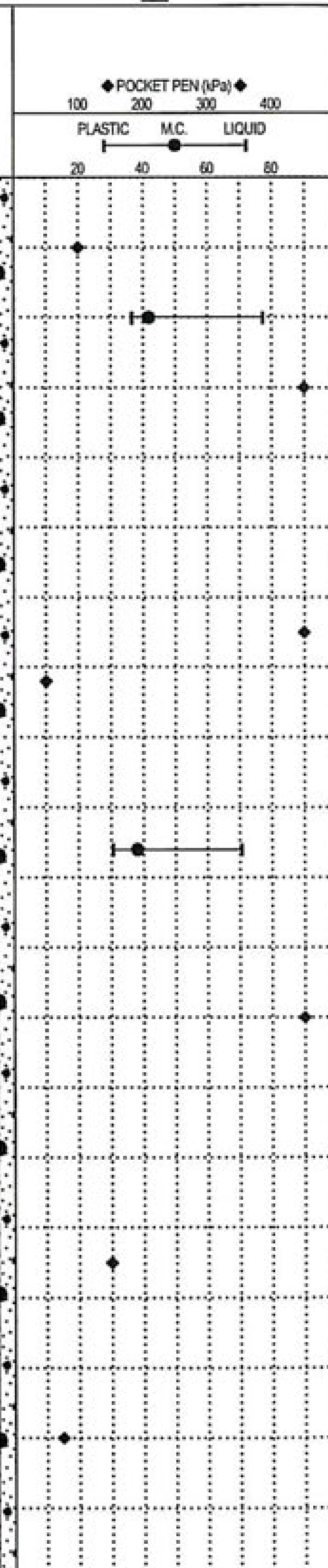
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
10	555				TUFF, alternating coarse and fine-grained beds
		6	64	14	CLAY TUFF, trace to some sand, fine and medium, weak, black and white weak clay-rich sand-sized clasts, massive, bluish grey, moist from 10.1m to 34.0m
11	554				
12	553	7	84	9	
13	552				-some subangular fine gravel, frequent organic inclusions from 13.0m to 13.4m
		8	97	22	-soft, wet interbed from 13.5m to 13.8m
					-sandy from 13.8m to 14.3m
14	551				
15	550	9	90	25	-joint: smooth, polished, planar, 55° from core axis at 14.9m -joint: smooth, polished, planar, 55° from core axis at 15.0m
16	549	10	72	28	
17	548				
					-firm, wet from 17.6m to 18.1m
18	547	11	71	32	
19	546				-firm, wet from 18.9m to 19.1m
20		12	97	17	

WELL



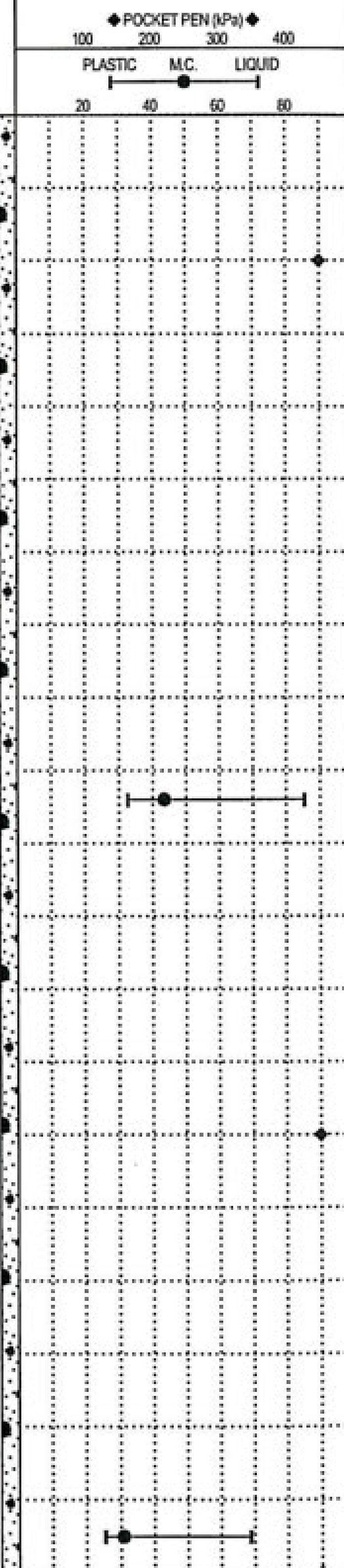
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
20	545				TUFF, alternating coarse and fine-grained beds *(continued)*
					-some sand to sandy interbed, medium sand-sized clasts, abrupt contact (within 10mm) from 20.4m to 20.6m
21	544	13	64	18	
22	543	14	96	37	-sandy interbed, medium to coarse sand-sized clasts, abrupt contact (within 10mm) from 22.4m to 22.8m
23	542				
24	541	15	80	35	
25	540	16	103	10	-some sand to sandy interbed, medium sand-sized clasts, abrupt contact (within 10mm) from 25.6m to 26.0m
26	539				-gravelly clay lens 50mm thick at 26.5m
27	538	17	94	16	
28	537				
29	536	18	98	21	
30					

WELL



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STRATIGRAPHIC KX04397-2006.BH14,15,16-LOGGED-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
30		535		19	98	10	-joint: wavy, slightly rough, faint slickensides, 30° from core axis at 29.9m TUFF, alternating coarse and fine-grained beds*(continued)*
31–32		534, 533		20	0	18	
33		532		21	59	25	
34–35		531, 530		22	69	15	CLAY TUFF, some sand to sandy, very stiff with interbeds up to 250mm thick of GRAVEL TUFF, clay matrix, gravel clasts up to 30mm Ø and mix of subrounded, weak clay-rich clasts and subangular resistant clasts mostly of smoky/pearly black, vitreous, H=6-7, aphanitic igneous lithology (chert), interbeds 40% of total length, bluish grey, moist from 34.0m to 36.0m
36–37		529, 528		23	82	16	CLAY TUFF, some sand, hard, medium plasticity, some interbeds 20-100mm thick of SAND/GRAVEL & CLAY, 5%-10% of total length, bluish grey, damp from 36.0m to 42.8m -joint: smooth, polished, planar, slickensided 45° from core axis at 36.4m
38		527		24	103	22	-core breaks into slickensided joints at 37.7m -joint: smooth, polished, planar, slickensided 30° from core axis at 38.0m -some organic inclusions from 38.1m to 39.0m
39–40		526		25	52	18	-carbonaceous clay lignite seam (50mm thick) at 38.7m

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
40	525				TUFF, alternating coarse and fine-grained beds *(continued)* -gravelly interbed from 40.0m to 40.2m
41	524	26	95	21	
42	523				-joint: smooth, polished, planar, slickensided 25° from core axis at 42.0m
		27	96	25	-joint: smooth, polished, planar, slickensided 30° from core axis at 42.6m
43	522				CLAY TUFF, some sand, very stiff, interbeds up to 250mm thick of SAND AND GRAVEL, clay matrix, gravel clasts up to 20mm Ø, interbeds 40% of total length, bluish grey, moist from 42.8m to 51.0m
44	521	28	52	22	
45	520	29	105	15	
46	519				
47	518	30	16	43	
48	517	31	102	14	
49	516				
50					-coarse sandy clay tuff interbed, firm to stiff from 49.7m to 50.0m

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 100.6 m
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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

◆ POCKET PEN (kPa) ◆ 100 200 300 400 — PLASTIC M.C. LIQUID — 20 40 60 80

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
50	515	32	94	20	TUFF, alternating coarse and fine-grained beds*(continued)*
51	514	33	90	19	CLAY TUFF, firm, medium plasticity, massive, fractured or fractures into slickensided joints, abrupt contact with above unit, brown, some organic inclusions, organics throughout likely give brownish colour, moist from 51.0m to 55.2m (potential shear zone) -sandy from 51.0m to 51.2m -firm from 51.2m to 51.3m
52	513				
53	512	34	98	41	-fractured or core breaks into fractures with polished slickensides or smooth, planar, polished surfaces, fractures randomly oriented between 20° and 70°, sheared in multiple directions from 52.5m to 55.2m (shear zone)
54	511	35	102	35	
55	510				CLAY TUFF, trace sand-sized clasts, very stiff, medium to high plastic, massive and fractured into polished slickensided joints, bluish grey, moist from 55.2m to 58.0m (potential shear zone) -series of slickensided joints, 50mm spacing at 65° from core axis
56	509	36	98	28	
57	508	37	100	29	-multiple joints, smooth, polished, planar, slickensided 0°, 15° and 45° from core axis at 57.2m **-X-Ray Diffraction Test at 57.2m** -interbed of clayey sand tuff, 40mm thick, 90° from core axis at 57.8m and 57.9m
58	507				CLAY TUFF with interbeds of SILT TUFF and rare SAND TUFF, very stiff, medium plasticity, parallel bedding, 10mm to 60+mm thick oriented within 20° of core axis, fractured into joints with dark brown staining or slickensided lineations, 100 to 200mm spacing, random orientations, bluish grey, damp from 58.0m to 66.2m note: appears origonally horizontal bedding has been rotated 70° to 90° -bedding 25° from core axis, fractured parallel to bedding at 58.3m
59	506	38	102	22	-bedding 20° from core axis at 59.3m **-X-Ray Diffraction Test at 59.7m**
60					

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH15
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
60	505				TUFF, alternating coarse and fine-grained beds *(continued)*
					-vertical contact between sand and silt tuff beds from 60.5m to 61.0m
61	504	39	97	25	
					-moist and fractured into gravel-sized clasts from 61.6m to 61.8m (slough)
62	503	40	145	15	
63	502				-bedding 20° from core axis at 63.0m
		41	92	16	**-Vibrating Wire Piezometer 15B Installed at 63.3m**
					-bedding 25° from core axis at 63.5m
64	501				
65	500	42	98	16	
66	499				CLAY TUFF, trace to some sand-sized clasts, medium plastic, very stiff, massive, some fractures to fractured, some areas where core breaks into polished, planar surfaces, bluish green, damp from 66.2m to 76.5m note: appears as welded tuff and has not been reworked by water or other processes -dark brown staining on joint surfaces from 66.2m to 66.6m -sandy, fine grained, dry from 66.6m to 66.9m -dark brown staining on joint surfaces from 66.9m to 67.3m
		43	97	14	
67	498				
					-sandy, fine to medium grained from 67.8m to 68.5m
68	497	44	95	14	
69	496				-potential bedding contact 10° from core axis
		45	98	26	-sandy, fine-grained interbed from 69.5m to 70.6m
70					

STRATIGRAPHY | SAMPLE TYPE | WELL

POCKET PEN (kPa): 100 200 300 400

PLASTIC M.C. LIQUID: 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
70	495				TUFF, alternating coarse and fine-grained beds *(continued)*
71	494	46	97	39	-brown from 71.1m to 71.6m
72	493	47	98	17	-brown from 72.5m to 73.0m
73	492				-some sand, massive, less fractured from 73.6m to 76.5m
74	491	48	103	26	
75	490				
76	489	49	54	33	
77	488	50	5	14	GRAVEL, some clay to clayey, loose to dense, clasts subangular 10-30mm Ø primarily pearly to smoky-coloured quartz, greenish white clay matrix in some areas, moist Note: poor recovery and absence of fine-grained matrix suggests washing while drilling
78	487	51	14	17	
79	486	52	41	32	
80					

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID

20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
80	485	53	16	30	GRAVEL, some clay to clayey, loose to dense, clasts subangular 10-30mm Ø primarily pearly to smoky-coloured quartz, greenish white clay matrix in some areas, moist Note: poor recovery and absence of fine-grained matrix suggests washing while drilling *(continued)*
81	484				
82	483	54	15	21	
83	482	55	94	22	GRAVEL in firm clay matrix, angular clasts of highly weathered quartz, 10 to 60mm Ø, some weathered clasts break into angular cubic fragments with light pressure, clasts light grey to smoky, vitreous, hardness 7 (chert), matrix is light greenish white, laminated clay, bedding evident 90° from core axis, interbeds 5mm of white weathered clayey gravel 10mm thick, moist -soft to firm, light green interbed from 83.0m to 83.5m **-Vibrating Wire Piezometer 15C installed at 83.2m** -highly weathered, very weak coarse gravel from 83.5m to 84m
84	481	56	59	22	
85	480				-white clay and sand interbed at 85.2m
86	479	57	49	22	
87	478				
88	477	58	30	23	
89	476				
90		59	34	24	

STRATIGRAPHY | WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Column headings: DEPTH (m), STRATIGRAPHY, ELEVATION (m), SAMPLE TYPE, SAMPLE NO, RECOVERY (%), DRILL TIMES (min), SAMPLE DESCRIPTION AND DRILLING NOTES, WELL, ◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	Elevation (m)	Sample No	Recovery (%)	Drill Times (min)	Sample Description and Drilling Notes
90–92	475–473	60	46	26	GRAVEL in firm clay matrix, angular clasts of highly weathered quartz, 10 to 60mm Ø, some weathered clasts break into angular cubic fragments with light pressure, clasts light grey to smoky, vitreous, hardness 7 (chert), matrix is light greenish white, laminated clay, bedding evident 90° from core axis, interbeds 5mm of white weathered clayey gravel 10mm thick, moist*(continued)* -grades into consolidated white SHALE from 90.5m to 92.0m
92–94.2	473–471	61	0	40	WHITE SHALE, R0 to R1, highly weathered, laminated and fissile with fine interbeds of silt and clay shale, trace sand and fine gravel, some quartz nodules, planar cross bedding dipping between 20° and 70° from core axis, white, some rusty colored sand-sized inclusions (possible secondary mineralization), dry to damp -abrupt lower contact over 30mm at base of unit
94.2–	471–	62	98	29	PHYLLITE, R0 to R2, weathered, laminated/foliated, greasy/graphitic feel, carbonaceous in areas, some quartz veining, dark grey to black -frequent quartz inclusions, 10mm wide, weathered to gravel-like consistency from 94.3m to 94.5m
					-brown-tan smooth, polished, planar, greasy feel 0° from core axis at 95.2m
		63	102	32	-orientation of laminations between 30° and 70° of core axis
					-carbonaceous shaley interbed from 96.5m to 91.1 (coal)
		64	95	32	-quartz nodule (30mm thick) at 97.1m, 97.3m, 97.5m and 97.8m -wavy foliations, phyllitic texture, foliations 75° from core axis
		65	55	36	
–100	–466	66	86	24	-quartz nodule (30mm thick) at 99.4m

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COMPLETION DEPTH: 100.6 m
COMPLETION DATE: 6/27/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH15**
DRILLER: Geotech Drilling	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: B-80/ODEX/Coring	NORTHING: 5870278.18 EASTING: 531417.2	ELEVATION: 565.2 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆POCKET PEN (kPa)◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
100		465		67	101	15	PHYLLITE, R0 to R2, weathered, laminated/foliated, greasy/graphitic feel, carbonaceous in areas, some quartz veining, dark grey to black*(continued)* -foliations at 45° from core axis -quartz inclusion at 100.6m		
							End of Borehole at 100.6m Drilling method did not allow observation of water level		
101		464							
102		463							
103		462							
104		461							
105		460							
106		459							
107		458							
108		457							
109		456							
110									

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STRATIGRAPHIC KX04397-2006.BH14,15,16-LOGGED-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
0					SILT, clayey, firm, medium plasticity, brown, wet
	660				
1	659				
2	658	1	46	20	
3	657				-stiff, moist from 3.0 to 4.6m -sand lense at 3.2 m and 3.6m
4	656	2	86	22	
5	655	3	40	10	-some angular gravel from 4.6m to 6.1m, firm -Core shot onto ground into mud, may be wrong order/direction from 4.6m-6.1m
6	654				SAND, silty, trace clay, trace coarse, subrounded volcanic gravel, cohesive, soft, massive, brown, wet
					SILT, trace clay to clayey, firm to very stiff, massive, brown, moist
7	653	4	37	8	
8	652	5	100	13	-trace gravel from 7.6 to 7.65m -Helper lost core from 7.5m-7.6m -20mm thick fine sand lense at 7.9m, 8.0m, 8.1m, and 8.2m
9	651				-medium sandstone cobble 20mm thick
10		6	100	16	

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06

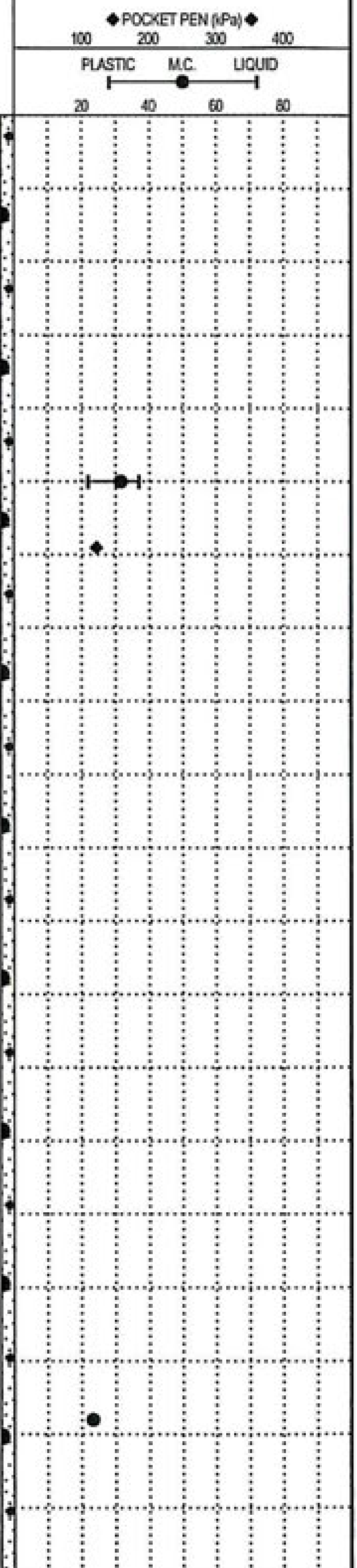
CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
10	650				SILT, trace clay to clayey, firm to very stiff, massive, brown, moist*(continued)*
11	649	7	100	15	
12	648				-interbedded with low angle fine sand cross-laminae from 12.0m to 12.2m -soft to firm, wet from 12.2m to 12.7m
13	647	8	82	14	
14	646	9	100	30	SILT AND SAND (fine grained), very stiff, non-plastic, massive, dark brown, damp
15	645				SAND, trace to some silt, compact, with alternating beds of SILT, stiff, non-plastic, beds between 10 and 200mm thick, trace organics and trace-fossils, faint bedding, brown to dark brown, moist
16	644	10	100	20	-trace gravel from 15.7m to 16.2m
17	643	11	53	35	
18	642				
19	641	12	90	40	-very loose fine-grained sand from 18.7m to 19.2m
20					

WELL



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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

SAMPLE DESCRIPTION AND DRILLING NOTES

SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)
13	33	30
14	33	35
15	88	30
16	100	20
17	100	20
18	100	35
19	100	25

Depth (m): 20–30; Elevation (m): 640–631

- 20 m: SAND, trace to some silt, compact, with alternating beds of SILT, stiff, non-plastic, beds between 10 and 200mm thick, trace organics and trace-fossils, faint bedding, brown to dark brown, moist*(continued)*
- ~22.8 m: SILT, trace fine sand, firm to very stiff, low to non plastic, massive, dark brown, moist
- ~23.8 m: SILT, some fine sand, soft to very stiff, with alternating beds of SAND (fine), trace silt, beds between 20 and 100mm thick, dark brown, moist
- ~24.8 m: SILT AND SAND (fine grained), some fine gravel, trace clay, very stiff, non plastic, massive, brown, moist
- ~26.3 m: SAND, trace silt, fine grained, loose, massive, brown, moist
- ~26.8 m: SILT, some fine sand, some subrounded gravel (various lithologies), trace cobbles of vesicular basalt, very stiff, non-plastic, massive, brownish grey, moist
  - -vesicular basalt cobble from 28.8m to 28.9m
  - -vesicular basalt cobble 29.6m to 29.8m

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
30	630				SILT, some fine sand, some subrounded gravel (various lithologies), trace cobbles of vesicular basalt, very stiff, non-plastic, massive, brownish grey, moist *(continued)*
31	629	20	87	15	-joint: 70° from core axis, smooth, polished, planar
32–33	628–627	21	100	15	-joint: 45° from core axis, smooth, polished, planar
34	626	22	0	20	
35–36	625–624	23		30	
37	623	24	92	34	CLAY, some silt, trace sand, trace gravel, firm to stiff, medium plasticity, massive, brown, moist
38–39	622–621	25	63	15	
40					

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
40	620	26	28	18	CLAY, some silt, trace sand, trace gravel, firm to stiff, medium plasticity, massive, brown, moist*(continued)*
41	619				
42	618	27	78	9	
					-Vibrating Wire Piezometer 16A installed at 42.7m
43	617				CLAY, some silt, trace gravel with interbeds of fine SAND, firm to stiff, brownish grey, moist
		28	73	15	SILT, clayey, some fine to coarse subrounded gravel to gravelly, trace coarse sand, very stiff, medium plasticity, massive, brownish grey
44	616				
45	615	29	100	17	-vesicular basalt cobble from 44.9m to 45.2m
46	614	30	103	16	
47	613				
48	612	31	55	10	
49	611				
50		32	62	15	

WELL

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BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
50 – 55.4	610 – 605	33	75	11	SILT, clayey, some fine to coarse subrounded gravel to gravelly, trace coarse sand, very stiff, medium plasticity, massive, brownish grey*(continued)*
		34	80	12	
		35	0	8	
55.4 – 56.4		36	37	12	GRAVEL AND COBBLE lens, loose, subrounded, metamorphic lithology, foliated schist
56.4 – 57.5	604 – 603	37	73	30	SILT, clayey, some sand, very soft, low to medium plasticity, massive, dark brown, very wet note: possible slough
57.5 – 57.7					CLAY, silty, soft, medium plasticity, massive, dark brown, moist to wet
57.7 – 60	602 – 601	38	92	20	SILT AND COBBLES, some gravel, subangular to subrounded, composed of vesicular basalt and various lithologies, some sand, trace clay, very stiff to hard, low plasticity, massive, dark brown, damp -basalt cobble from 57.8m to 57.9m -basalt cobble from 57.9m to 58.0m -basalt cobble from 58.9m to 59.3m

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

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BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
60	600	39	100	15	SILT AND COBBLES, some gravel, subangular to subrounded, composed of vesicular basalt and various lithologies, some sand, trace clay, very stiff to hard, low plasticity, massive, dark brown, damp*(continued)* -basalt cobble from 60.0m to 60.4m
61	599	40	93	20	-basalt cobble from 61.0m to 61.2m -basalt cobble from 61.3m to 61.4m -basalt cobble from 61.7m to 62.1m
62–64	598, 597	41	100	20	TUFF, alternating coarse and fine-grained beds SAND TUFF, clay matrix, some gravel-sized clasts
64–65	596, 595	42	100	19	CLAY TUFF, trace sand-sized clasts, very stiff, massive, trace orgainic inclusions, blue-green, moist from 64.3m to 64.7m CLAY AND SAND TUFF (coarse grained), clay matrix, trace to some gravel-sized clasts, crumbles with moderate pressure, massive, blue-green, moist from 64.7m to 66.1m
66	594	43	100	25	SAND TUFF, fine to medium-grained clasts, clast supported, clay matrix supported, compact, blue-green, moist from 66.1m to 66.2m SAND AND GRAVEL TUFF, clay matrix, clast supported, non cohesive, blue-green, moist from 66.2m to 68.3m
67–68	593, 592	44	100	33	SAND TUFF, fine-grained, compact, curved-parallel laminations with organic material, dark grey-blue from 68.3m to 68.5m SAND AND GRAVEL TUFF, clay matrix and clast supported, generally non-cohesive, massive, blue-green, moist from 68.5m to 70.0m
69–70	591	45	100	20	

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
70	590				TUFF, alternating coarse and fine-grained beds *(continued)* GRAVEL TUFF, coarse-grained in clay matrix, dense, grey-blue, moist from 70.0m to 71.0m
		46	100	25	
71	589				SAND TUFF, fine to coarse-grained, trace to some gravel, clay matrix, hard to dense, massive, blue-green, moist from 71.0m to 73.9m -bedding evident with some organics and pebble stringers from 71.0m to 71.6m
72	588	47	100	20	
73	587				
74	586	48	100	25	CLAY TUFF, trace to some sand-sized clasts, very stiff from 73.9m to 77.9m **-X-Ray Diffraction Test at 74.5m** -some coarse gravel to gravelly, sub-angular, vitreous clasts from 74.6m to 77.9m
75	585	49	100	20	
76	584				
77	583	50	100	30	
78	582	51	100	30	GRAVEL TUFF, some sand-sized clasts, clay matrix, dense, massive, grey from 77.9m to 78.6m SAND TUFF, coarse grained in clay matrix, subrounded clasts, dense from 78.6m to 79.4m
79	581				CLAY TUFF, trace sand and gravel-sized clasts, hard, massive, dark brownish grey, damp from 79.4m to 80.8m -woody fragment 50mm long at 79.8m
80					

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
80		580		52	100	30	TUFF, alternating coarse and fine-grained beds *(continued)* -fractured zone at 80.1m, slickensided joints 15° from core axis, purplish color
81		579		53	100	30	GRAVEL AND SAND TUFF, clay and sand matrix, clasts to 75mm Ø, weak, subrounded and clay-rich, coarse gravel clasts at base of unit, dense, grey, damp from 80.8m to 82.3m
82–83		578–577		54	100	20	-grades into sandy clay tuff at 82.3m CLAY TUFF, sandy, fine to medium-grained clasts, trace gravel-sized clasts, hard, blue-green from 82.3m to 84.8m -joint 45° from core axis, smooth, planar at 82.5m -gravelly, weathered clay clasts 83.1 to 83.4m
84		576		55	100	40	-joint: 20° from core axis, wavy, planar, slickensided at 83.7m -yellow veining at 84.1m, reacts with HCl -gravelly, weathered clay clasts 84.6m to 84.8m
85–86		575–574		56	100	35	SAND TUFF, medium grained, dense, massive, organic inclusions, blue-grey, moist from 84.8m to 86.6m -gravel tuff interbed 84.8m to 85.2m **-Vibrating Wire Piezometer 16B installed at 85.6m** -gravel tuff interbed 85.6m to 85.8m -carbonaceous interbed (5mm) at 86.3m
87		573		57	35	16	GRAVEL TUFF, sand matrix, some sand tuff interbeds, fine to coarse grained, well graded, subangular to subrounded, weak clays, dense, trace organic inclusions, blue-grey moist from 86.6m to 93.0m -fractured zone 86.9 to 89.9m
88–89		572–571		58	100	17	-highly weathered weak zone from 88.4 to 88.8m (possible slough)
90							

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

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20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | ◆ POCKET PEN (kPa) ◆ 100 200 300 400 | PLASTIC M.C. LIQUID 20 40 60 80

SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)
59	100	26
60	97	23
61	100	19
62	98	15
63	100	25
64	100	23
65	87	28

Depth (m): 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

Elevation (m): 570, 569, 568, 567, 566, 565, 564, 563, 562, 561

-sand tuff interbed with low angle cross stratification from 88.8m to 89.9m abrupt lower and upper contact
-multiple coarsening downward sequences from 89.9m to 90.8m, 5 sequences total, medium sand tuff coarsening to gravel tuff
TUFF, alternating coarse and fine-grained beds *(continued)*

-fractured zone 92.6m to 93.0m

SILT TUFF, some whitish sand-sized inclusions, hard, massive, blue-grey, damp from 93.0m to 95.4m

-gravel tuff interbed from 93.5m to 93.8m, sharp contact

GRAVEL TUFF in sand and silt matrix, clast and matrix supported, fine to coarse grained, well graded, up to 50 mm Ø, mix of subrounded weak clay clasts and subangular resistant clasts, dense, some sand interbeds, bluish grey, trace organic inclusions, moist from 95.4m to 107m
-fractured zone from 95.4m to 96.4m

-clast of highly weathered vesicular basalt, secondary mafic mineralization within vesicles at 97.5m

-fining downward sequences from 99.1 to 99.5m, 2 sequences total, coarse gravel tuff grading to fine sand tuff

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
100	560				-clay with some whitish sand-sized clast interbeds 99.9m to 100.1m TUFF, alternating coarse and fine-grained beds *(continued)*
101	559	66	100	29	
102	558	67	97	25	-organic interlaminations (2mm) at 102.6m
103	557				
104	556	68	100	30	-coarse-grained gravel, subangular, in sand and silt matrix, 30-60mm Ø
105	555				
106	554	69	100	20	-note: volcanics entrained in tuff unit
107	553	70	100	25	VOLCANICS, subangular white phenocrysts up to 5mm, dark blue to dark grey matrix, very weak to weak, highly weathered, massive, fractures into joints with plumose structure, damp (Andesite)
108	552				
109	551	71	100	25	
110					GRAVEL TUFF, clay and sand matrix, clasts 20mm Ø, composed of weak clay-rich and more resistant clasts from 109.7m to 111.5m

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

DRAFT

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
110	550	72	100	20	GRAVEL TUFF, clay and sand matrix, clasts 20mm Ø, composed of weak clay-rich and more resistant clasts from 109.7m to 111.5m*(continued)* -organic lignite inclusions at 110.0m, 30mm X 3mm
111	549				
112	548	73	37	25	SAND TUFF, fine grained, trace coarse sand and gravel-sized clasts, trace organic inclusions, compact to dense, light to dark grey from 111.5m to 113.9m
113	547	74	98	20	-fracture at 113.1m through clay zone, planar, smooth, polished, slickensided at 45° from core axis
114	546				GRAVEL TUFF, some cobbles in sand matrix, matrix and clast supported, fine to coarse-grained gravel clasts, subangular to subrounded, weak clay and more resistant clasts, hard, massive, bluish grey, moist from 113.9m to 115.9m
115	545	75		20	-coarse gravel and cobble sized clasts, clast edges polished and shiny from 115.1m to 115.8m
116	544	76	83		-Casing lost in original hole at 115.8m, new hole started 8.5m south at ~0.3m higher elevation (log continued from 115.8m) -highly fractured phyllite with some gravel tuff from 115.9m to 117.4m
117	543	77	100		PHYLLITE, weak to moderate strength (R1-R3), some faint bedding, black, some white veining, moist, some polished grooved, planar surfaces represents foliation of low grade meta-shale or preferential fractures along laminated shale surfaces -highly weathered and soft interbeds from 117.4m to 117.8m -joint: smooth, planar, 45° from core axis at 117.8m
118	542	78	83		
119	541	79	100		-joint: rough, planar, 60° from core axis at 119.0m -weathered interbed, some fine black sand from 119.4m to 122.0m
120					

WELL

POCKET PEN (kPa) 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

DRAFT

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
120					PHYLLITE, weak to moderate strength (R1-R3), some faint bedding, black, some white veining, moist, some polished grooved, planar surfaces represents foliation of low grade meta-shale or preferential fractures along laminated shale surfaces*(continued)*
	540	80	15		
121	539				
122	538	81	112		
123	537				-wavy foliations, greasy feel at 123.0m
124	536	82	88	25	
125	535				-weathered interbed, trace sand, hard from 125.0m to 125.6m
					-some coarse sand and fine gravel-sized clasts, clasts same composition as phyllite, possible brittle shearing from 125.6m to 126.1m -highly fractured in 20mm-100mm fragments from 125.6m to 129.0m
126	534				
127	533	83	33	18	
128	532	84	77	18	
129					-joint: smooth, planar, polished, 65° from core axis at 128.8m
	531	85	40	23	
130					

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80
130		530					CLAY with PHYLLITE interbeds, some black sand, firm to stiff, PP=200-400Kg/cm2, fissile/platy structure, non-plastic to high plasticity, some quartz veins, light grey to black, moist *(continued)*		
131		529		86	95	21			
132		528		87	0	24			
133		527		88	22	20			
134		526		89	100	22			
135		525		90	46	17			
136		524		91	52	27			
137		523		92	43	26	-lithified interbed with white veining parallel to core axis at 137.4m		
138		522							
139		521		93	15	32	**-Vibrating Wire Piezometer 16C installed at 139.1m**		
140									

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Columns: DEPTH (m) | STRATIGRAPHY | ELEVATION (m) | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | DRILL TIMES (min) | SAMPLE DESCRIPTION AND DRILLING NOTES | WELL | ◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80

SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)
94	35	24
95	30	22
96	26	27
97	35	25
98	72	31
99	81	28
100	63	29
101	34	14

Depth 140 m – 150 m; Elevation 520 m – 511 m

140.0 m: CLAY with PHYLLITE interbeds, some black sand, firm to stiff, PP=200-400Kg/cm2, fissile/platy structure, non-plastic to high plasticity, some quartz veins, light grey to black, moist*(continued)*
-lithified interbed with white veining parallel to core axis at 140.0m

-lithified interbed with white veining parallel to core axis at 141.6m

147.9 m: CLAY, firm, non to high plastic, fissile/platy structure where preserved, quartz veins up to 30mm thick common in areas, light grey to black from 147.9m to 154.4m
-quartz veins 20mm thick spaced 100mm from 147.9m to 150.0m

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
150	510	102	58	23	CLAY, firm, non to high plastic, fissile/platy structure where preserved, quartz veins up to 30mm thick common in areas, light grey to black from 147.9m to 154.4m*(continued)* -clay and weathered phyllite, soft to firm, fissile structure gives broken samples gravel-like consistency from 150.0m to 152.2m
151	509	103	83	24	
152	508	104	0	25	-some quartz veins 20mm thick, light grey colour from 152.2m to 154.4m
153	507				
154	506	105	65	24	PHYLLITE (weathered), extremely weak (R0), non-plastic to low plasticity, soft, foliated structure, gravel-like consistency, moist, black
155	505	106	52	24	
156	504				
157	503	107	12	21	
158	502				
159	501	108	40	20	
160					

WELL

◆ POCKET PEN (kPa) ◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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STRATIGRAPHIC KX04397-2006.BH14,15,16-LOGGED-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
160	500	109	73	21	PHYLLITE (weathered), extremely weak (R0), non-plastic to low plasticity, soft, foliated structure, gravel-like consistency, moist, black*(continued)*
161–162	499, 498	110	38	27	
163	497	111	80		PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black -parallel joints at 38° between 163.0m and 166.0m
164	496	112	17		-from 164.4m to 164.5m highly factured to sand-like consistency -very weak R1, highly fractured and foliated at 38°, greasy feel from 164.4m to 165.2m
165	495	113	100		-green mineralization along some joint surfaces from 165.5m to 166.4m
166	494	114	88		-foliation/lamination evident, parallel (0° to 10°) to core axis, wavy, planar, greasy feel (graphitic), core fractured at 15° cross-cutting laminations from 166.0m to 167.4m
		115	121	24	
167	493	116	69	59	-parallel quartz veins, 4mm thick, oriented 45° from core axis from 167.5m to 167.6m -weathered shale interbed, black, moist from 167.7m to 168.3m
168	492	117	40	7	-Reduced to NQ at 167.9m -fractured into angular coarse gravel-sized clasts from 168.3m to 177.0m
169–170	491	118	46	30	

WELL

POCKET PEN (kPa) 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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LOGGED BY: CD
ENTERED BY: CD/BP

COMPLETION DEPTH: 222.3 m
COMPLETION DATE: 10/23/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
170	490				PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black*(continued)*
171	489	119	65	65	
172	488	120	92	45	
173	487	121	153	35	
174	486	122	45	35	
175	485	123	117	23	
176	484	124	131	18	
177	483	125	100	23	-interbedded/foliated 30° from core axis, fractured along planes (grooved, polished, greasy feel), 50mm spacing, lineations on fractured plane trending perpendicular to dip direction (parallel to strike) -some pyrite mineralization at 177.2m
178	482				-convolute/deformation bedding at 178.3m
179	481	126	53	24	
180		127	58	19	

WELL

POCKET PEN (kPa): 100, 200, 300, 400

PLASTIC, M.C., LIQUID: 20, 40, 60, 80

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: BH16
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
180	480				PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black*(continued)* -fractured angular gravel-size clasts from 180.0m to 180.8m
181	479	128	120	25	-phyllite with siltstone interbeds, laminated/foliated at 35° from core axis, fractured along planes (grooved, polished, planar, greasy feel), 100mm spacing, lineations on fractured plane trending perpendicular to dip direction (parallel to strike) from 180.8m to 187.5m
182	478	129	100	23	
183	477				
184	476	130	100	12	
185	475				
186	474	131	114	16	
187	473				-phyllite, trace silty shale interbeds 10mm thick, fractured, laminated at 34° from core axis, some quartz veins, 5mm thick, black from 187.5m to 188.4m
188	472	132	76	23	-crumbles with moderate pressure into gravel-like consistency from 188.4m to 189.2m
189	471				
190					

WELL

◆POCKET PEN (kPa)◆ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	ELEVATION (m)	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES
190	470	133	63	18	PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black*(continued)*
191	469				-fractured (50mm-100mm spacing), laminated, bedding evident (planar and deformation), dark grey, trace quartz vein inclusions from 191.0m to 222.3m
192	468	134	92	18	
193	467				-fracture at 33° from core axis, grooved and polished lineations parallel to dip direction at 193.4m
194	466	135	100	18	-fracture 20° from core axis, grooved and polished lineations parallel to dip direction from 194.0m
					-highly fractured into angular coarse gravel from 194.6m to 196.8m
195	465	136	100	13	
196	464				
197	463	137	121	17	-highly fractured into angular coarse gravel parallel to core axis and parallel to laminations, polished, grooved, wavy greasy-feeling lineations trending perpendicular to dip direction from 197.4m to 199.7m
198	462	138	50		
199	461				
200					

POCKET PEN (kPa): 100, 200, 300, 400

PLASTIC, M.C., LIQUID: 20, 40, 60, 80

WELL

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
200							-highly fractured into angular gravel-sized clasts, laminated from 199.8m to 207.6m PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black*(continued)*		
		460							
201									
		459							
202									
		458					-less fractured zone, convolute/deformation bedding from 202.7m to 203.1m		
203									
		457							
204									
		456							
205									
		455							
206							-bedding dips 30° from core axis, fractured parallel to bedding at 206.0m		
		454							
207									
		453					-core fractured into disks with 20mm-70mm spacing at 65° from core axis, smooth, polished bedding/laminations parallel to fractures from 207.6m to 215.7m		
208									
		452							
209									
		451							
210									

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LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400; PLASTIC M.C. LIQUID 20 40 60 80
210		450					PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black *(continued)*		
211		449							
212		448							
213		447							
214		446							
215		445					**-Vibrating Wire Piezometer 16D installed at 214.9m**		
216		444					-highly fractured into angular gravel-sized clasts from 215.7m to 222.3m		
217		443							
218		442							
219		441							
220									

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CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **BH16**
DRILLER: Radius	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: HC2000/ODEX/Coring	NORTHING: 5869544.24 EASTING: 530634.61	ELEVATION: 660.3 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL	◆ POCKET PEN (kPa) ◆ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80
220–222.3		440, 439, 438					PHYLLITE, weak (R1-R2), highly fractured (spaced <100mm), shale parent rock, laminated/foliated, faint bedding, silty shale interbeds, trace quartz vein inclusions, dark grey to black *(continued)*		
222.3							End of Borehole at 222.3m Drilling method did not allow observation of water level		

Depth scale: 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230

Elevation scale: 440, 439, 438, 437, 436, 435, 434, 433, 432, 431

STRATIGRAPHIC KX04397-2006.BH14,15,16-LOGGED-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/3/07

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: CD	COMPLETION DEPTH: 222.3 m
		ENTERED BY: CD/BP	COMPLETION DATE: 10/23/06
			Page 23 of 23

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **PW-1**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869772.5 EASTING: 531993.42	ELEVATION: 520.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
0							SAND, fine to coarse grained, trace silt, some gravel, loose, brown, dry (fill)	
1		519					SAND, fine to medium grained, trace silt, loose, tan brown, dry	
2		518					Pumping well PW-1 (150mm diameter)	
3		517					SILT, some sand, trace to some clay, trace gravel, medium plasticity, soft, grey, moist to wet	
4		516					Water level observed at 1.8m on October 8, 2003	
5		515					SAND, fine to medium grained, trace silt, some gravel, compact, dark grey	
6		514					note: some groundwater seepage at 5.5m below grade	
							SILT, some clay, trace to some sand, trace gravel, medium plasticity, soft, olive brown	
7		513					note: driller began adding water from 5.8m below grade	
8		512						
9		511						
10		510						
11		509						
12		508					-grey from 11.6m	
13		507						
14		506						
15		505					-some clay, some gravel, trace fine sand, interbeds of clay 0.25m to 0.30m thick, firm, grey from 15.2m to 29.9m	
16		504						
17		503						
18		502						
19		501						
20		500						
21		499						
22		498						
23		497						
24		496						
25		495						
26		494						
27		493						
28		492						
29		491						
30								

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: SG ENTERED BY: CD	COMPLETION DEPTH: 54.9 m COMPLETION DATE: 9/16/03

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **PW-1**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869772.5 EASTING: 531993.42	ELEVATION: 520.1 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
30–32		489–488					GRAVEL, subrounded, trace silt, some fine to coarse grained sand, grey *(continued)* -dark brown with some lignite below 31.4m	
32–33		488–487					LIGNITE, wery weak, dark brown to black	
33–35.8		487–484					CLAY, trace to some silt, firm to stiff, high plasticity, light grey	
35.8–36.6		484					LIGNITE, wery weak, dark brown to black	
36.6–41.6		483–479					CLAY, trace silt, trace black coarse grained sand, firm to stiff, high plasticity, blue grey -trace silt, some lignite, high plasticity, dark brown to black from 39.3m to 40.8m -trace silt, firm, high plasticity, dark brown from 40.8m to 41.6m	
41.6–43.6		478–477					LIGNITE, clay interbeds <0.10m, very weak, dark brown to black -drilled open hole from 42.7m	
43.6–46		476–474					CLAY, trace silt, trace to some black sand, firm, high plasticity, light brown	
46–54.9		474–466					CLAY TUFF, trace silt, trace to some black and green sand, very stiff to dense -LIGNITE interbeds, thin (<20mm), with 1.5m spacing at 46.5m -light brown from 47.5m to 47.7m	
54.9		465					End of Borehole 54.9m below grade	

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: SG ENTERED BY: CD	COMPLETION DEPTH: 54.9 m COMPLETION DATE: 9/16/03

STRATIGRAPHIC KX04397-2003.PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **PW-2**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869595.41 EASTING: 532272.27	ELEVATION: 503.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
0		503					SAND, fine to medium grained, trace silt, brown, loose, moist (fill)	
1		502					-drak brown to black below 1.5m	
2		501					SAND, fine to medium grained, trace silt, trace gravel, loose to compact, brown, moist	
3		500						
4		499					-fine to medium grained, silty, trace clay, loose, brown, wet from 4.0m to 6.2m	
5		498					Water level observed at 4.1m on October 8, 2003	
6		497					SILT, trace to some sand, some gravel, trace to some clay, dense, brown, wet, isolated cobbles	
7		496						
8		495						
9		494						
10		493					-some clay below 10.4m	
11		492						
12		491						
13		490					-grey below 13.1m	
14		489					-driller began adding water to borehole at 14.0m	
15		488						
16		487						
17		486						
18		485						
19		484						
20		483						
21		482						
22		481						
23		480						
24		479						
25		478						
26		477						
27		476					-clayey below 27.4m	
28		475						
29		474						
30		473						
31		472						
32		471						
33								

amec	Earth & Environmental 3456 Opie Crescent Prince George, BC V2N 2P9 (250) 564-3243	LOGGED BY: SG ENTERED BY: CD	COMPLETION DEPTH: 61.0 m COMPLETION DATE: 9/18/03

STRATIGRAPHIC KX04397-2003.PUMPING WELLS-REV3.GPJ AMEC-PG-MULTIWELL-DATATEMPLATE.GDT 5/2/07

CLIENT: City of Quesnel	PROJECT: West Quesnel Land Stability Study	BOREHOLE NO: **PW-2**
DRILLER: Cariboo Water Wells	Quesnel, BC	PROJECT NO: KX04397
DRILL TYPE/METHOD: Ingersoll-Rand TH-60/Air Rotary	NORTHING: 5869595.41 EASTING: 532272.27	ELEVATION: 503.4 m

SAMPLE TYPE: TUBE, NO RECOVERY, SPLIT SPOON, GRAB, MUD RETURN, CORE RETURN

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

DEPTH (m)	STRATIGRAPHY	ELEVATION (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	DRILL TIMES (min)	SAMPLE DESCRIPTION AND DRILLING NOTES	WELL
33–38		470–465					SILT, trace to some sand, some gravel, trace to some clay, dense, brown, wet, isolated cobbles*(continued)* -GRAVEL layer, 15cm thick, at 37.5m	
38–61		465–442					CLAY TUFF, trace silt, some sand, very dense, green, moist -no sand from 41.1m to 43.3m -driller drilled open hole below 42.7m below grade with casing drive shoe at 42.7m no groundwater seepage was observed in borehole after being left undisturbed overnight -LIGNITE layers, thin (<15cm), at 46.6m and 48.5m -sandy between 47.2m and 48.2m -less weathered from 56.4m	
61		442					End of Borehole 61.0m below grade	

Depth scale: 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66

Elevation scale: 470 469 468 467 466 465 464 463 462 461 460 459 458 457 456 455 454 453 452 451 450 449 448 447 446 445 444 443 442 441 440 439 438

WELL

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Prince George, BC V2N 2P9
(250) 564-3243

LOGGED BY: SG	COMPLETION DEPTH: 61.0 m
ENTERED BY: CD	COMPLETION DATE: 9/18/03

BH15 (65.8m to 100.6m)

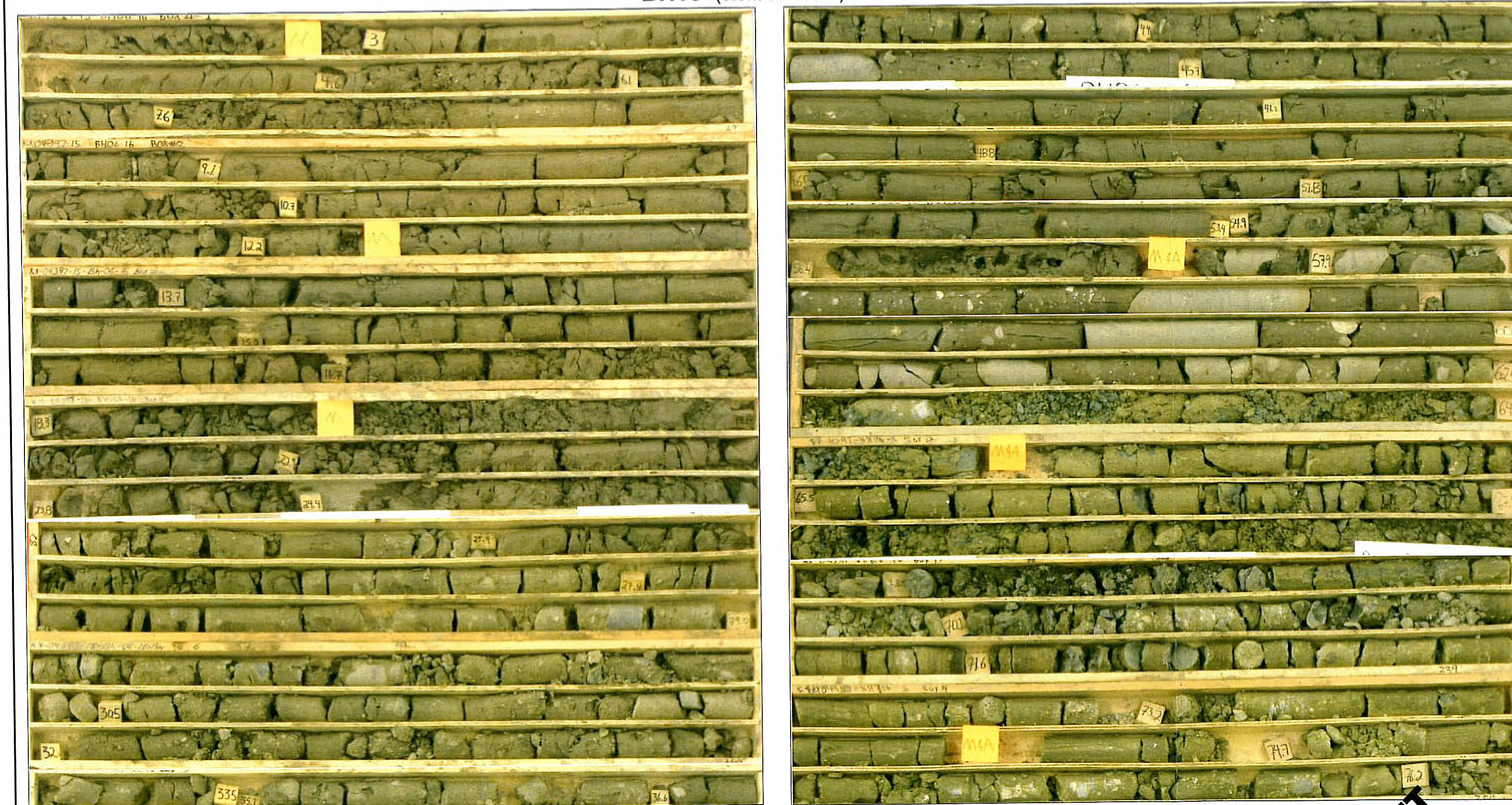
West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz CHK'D BY: S.Kelly	TITLE: DRILL CORE PHOTOS BH15 (2 of 2)	DATE: APRIL 2007 PROJECT NO: KX04397
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	DATUM: NAD83 PROJECTION: UTM Zone 10 SCALE: NOT TO SCALE	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A FIGURE No. BH15

DRAFT

This drawing was originally produced in colour.

C:\ Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2006 Drill Core Photos\WQ-BH15-Corephoto.dwg – 06-15-2 – May. 03, 2007 8:56am – shelley.ruiz

BH16 (0.0m to 76.5m)



CLIENT:	CITY OF QUESNEL	
West Quesnel Land Stability Program	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	amec

DWN BY:	S.Ruiz
CHK'D BY:	S.Kelly
DATUM:	NAD83
PROJECTION:	UTM Zone 10
SCALE:	NOT TO SCALE

TITLE: DRILL CORE PHOTOS BH16 (1 of 3)

DRAFT

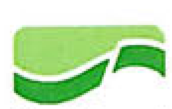
PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC

DATE:	APRIL 2007
PROJECT NO:	KX04397
REV. NO.:	A
FIGURE No.	BH16

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2006 Drill Core Photos\WQ-BH16-Corephoto.dwg - 06-16-1 - May. 03, 2007 8:57am - shelley.ruiz

This drawing was originally produced in colour.

BH16 (76.5m to 143.3m)



CLIENT: **CITY OF QUESNEL**	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH16 (2 of 3) DRAFT	DATE: APRIL 2007
AMEC Earth & Environmental, 3456 Opie Crescent, Prince George, BC, CANADA V2N 2P9, Tel. (250) 564-3243, Fax (250) 562-7045	CHK'D BY: S.Kelly		PROJECT NO: KX04397
	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
	PROJECTION: UTM Zone 10		FIGURE No. BH16
	SCALE: NOT TO SCALE		

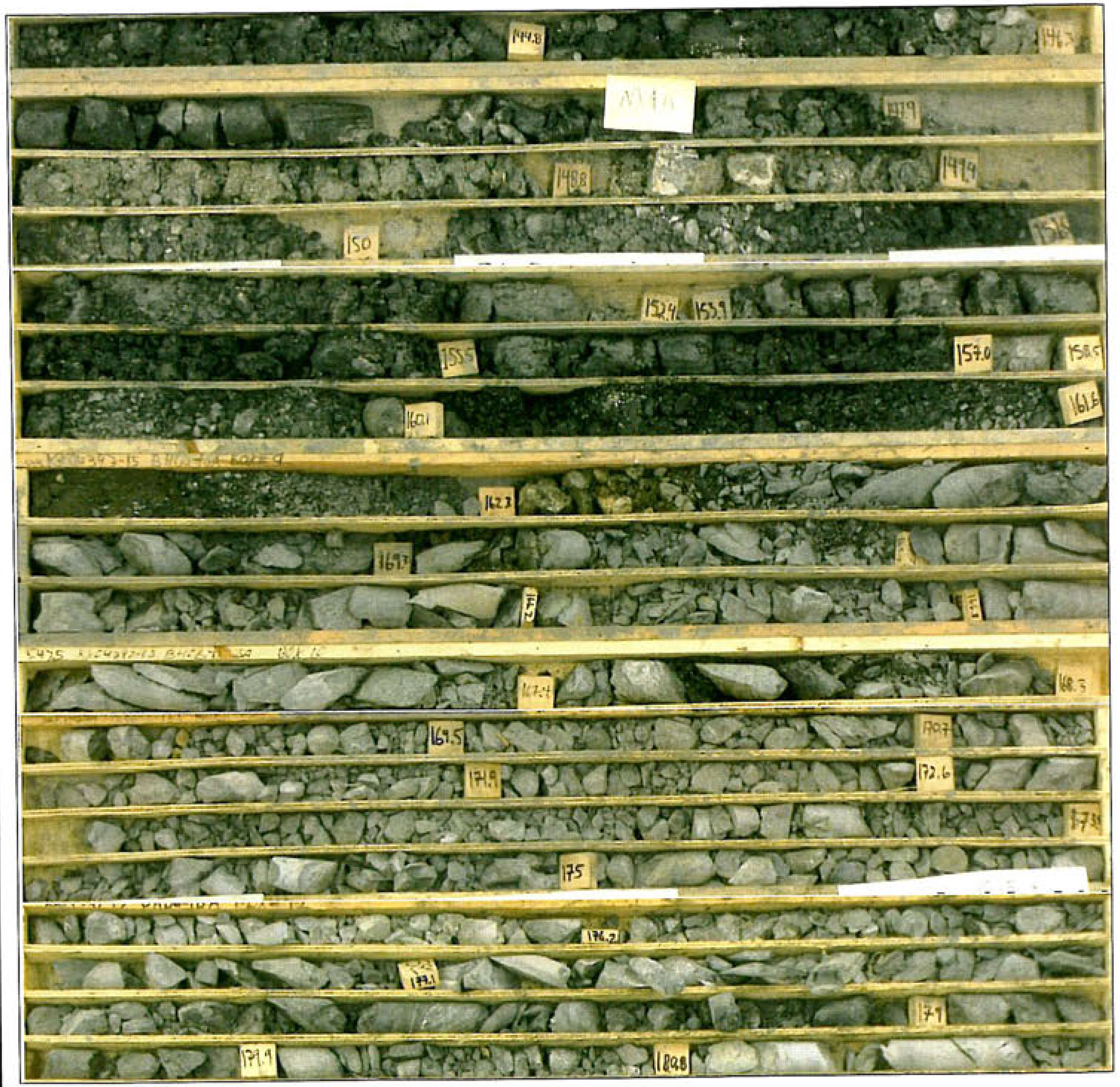
West Quesnel Land Stability Program

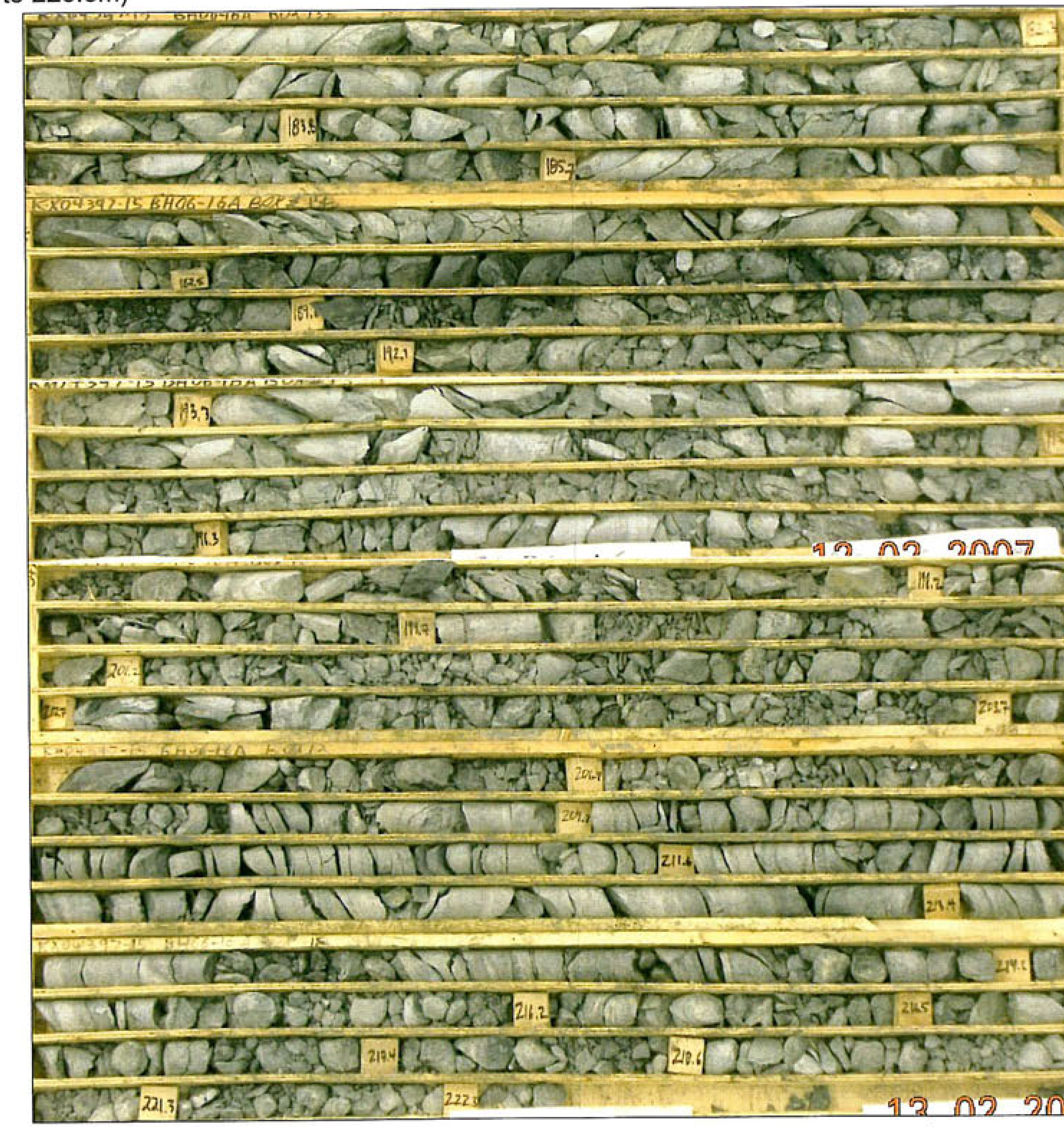
amec

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15–Core Photos\2006 Drill Core Photos\WQ–BH16–Corephoto.dwg – 06–16–2 – May. 03, 2007 8:57am – shelley.ruiz

BH16 (143.3m to 223.3m)





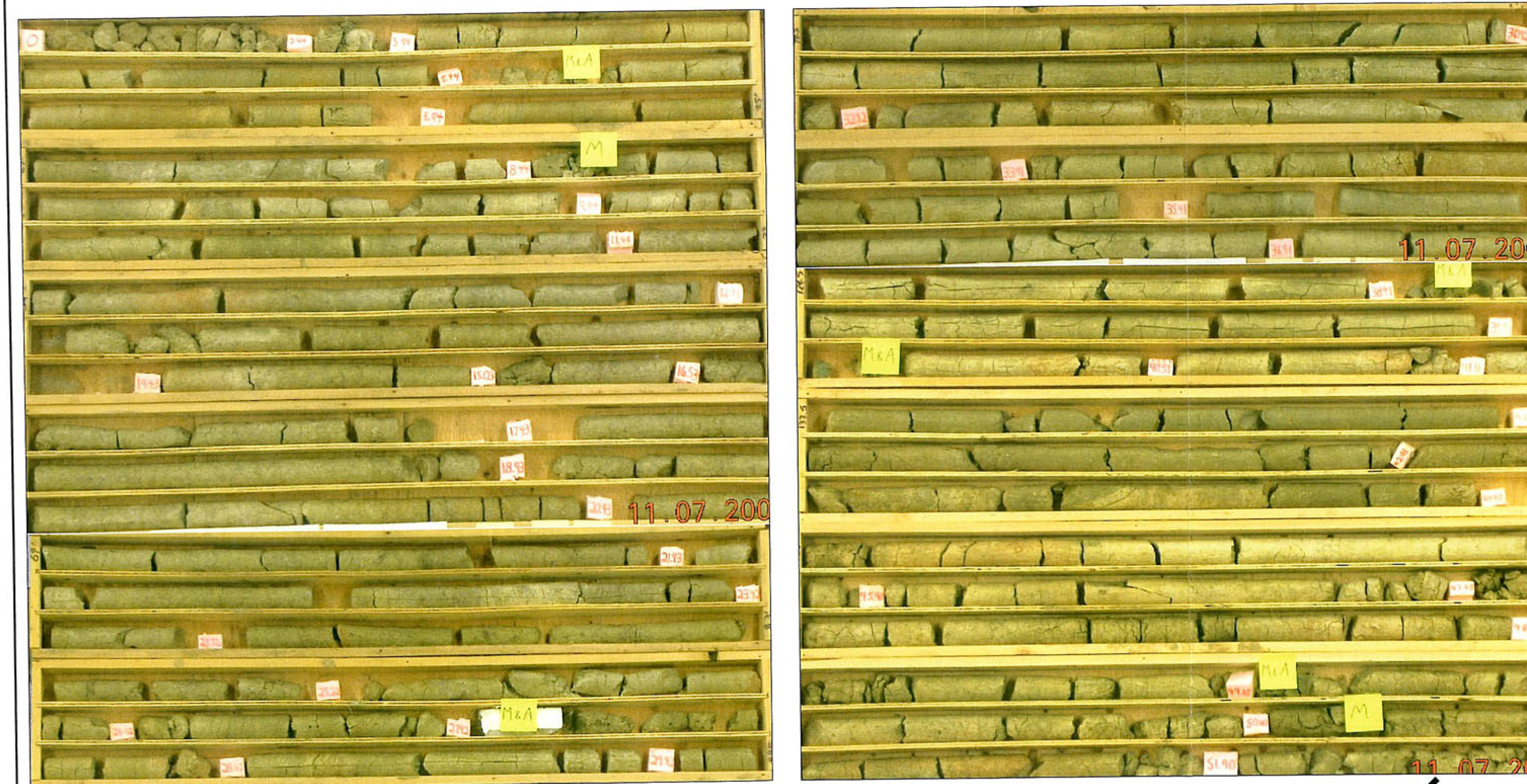
West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH16 (3 of 3)
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly	DATE: APRIL 2007
		DATUM: NAD83	PROJECT NO: KX04397
		PROJECTION: UTM Zone 10	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC
		SCALE: NOT TO SCALE	REV. NO.: A
			FIGURE No. BH16

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2006 Drill Core Photos\WQ-BH16-Corephoto.dwg – 06-16-3 – May. 03, 2007 8:58am – shelley.ruiz

BH7 (0.0m to 52.3m)



West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly
	amec	DATUM: NAD83
		PROJECTION: UTM Zone 10
		SCALE: NOT TO SCALE

TITLE: DRILL CORE PHOTOS BH7 (1 of 2)

DRAFT

PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC

DATE: APRIL 2007

PROJECT NO: KX04397

REV. NO.: A

FIGURE No. BH7

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C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH7-Corephoto.dwg – 05-07A-1 – May. 03, 2007 8:46am – shelley.ruiz

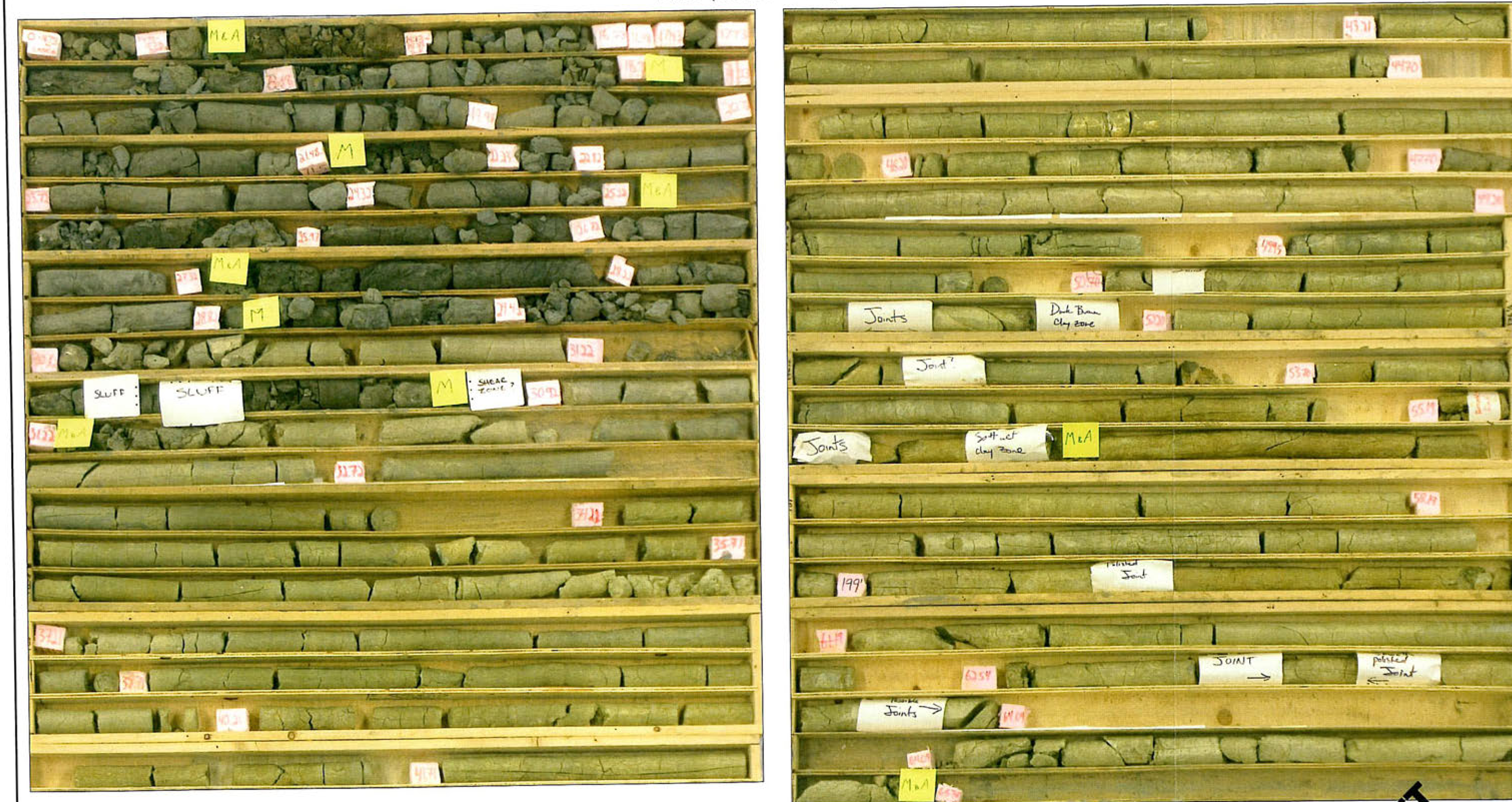
BH7 (52.3m to 78.9m)

West Quesnel Land Stability Program	CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE DRILL CORE PHOTOS BH7 (2 of 2)	DRAFT	DATE: APRIL 2007
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly			PROJECT NO: KX04397
	amec	DATUM: NAD83	PROJECT WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC		REV. NO.: A
		PROJECTION: UTM Zone 10			FIGURE No. BH7
		SCALE: NOT TO SCALE			

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH7-Corephoto.dwg – 05-07A-2 – May. 03, 2007 8:47am – shelley.ruiz

BH8 (0.0m to 65.4m)



CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH8 (1 of 1)	DATE: APRIL 2007
	CHK'D BY: S.Kelly		PROJECT NO: KX04397
	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
	PROJECTION: UTM Zone 10		FIGURE No. BH8
	SCALE: NOT TO SCALE		

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C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH8-Corephoto.dwg – 05-08A-1 – May. 03, 2007 8:50am – shelley.ruiz

BH9 (0.0m to 47.4m)

West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH9 (1 of 2)
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly	DATE: APRIL 2007
	amec	DATUM: NAD83	PROJECT NO: KX04397
		PROJECTION: UTM Zone 10	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC
		SCALE: NOT TO SCALE	REV. NO.: A
			FIGURE No. BH9

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15—Core Photos\2005 Drill Core Photos\WQ—BH9—Corephoto.dwg — 05—09A—1 — May. 03, 2007 8:52am — shelley.ruiz

BH9 (47.4m to 69.3m)

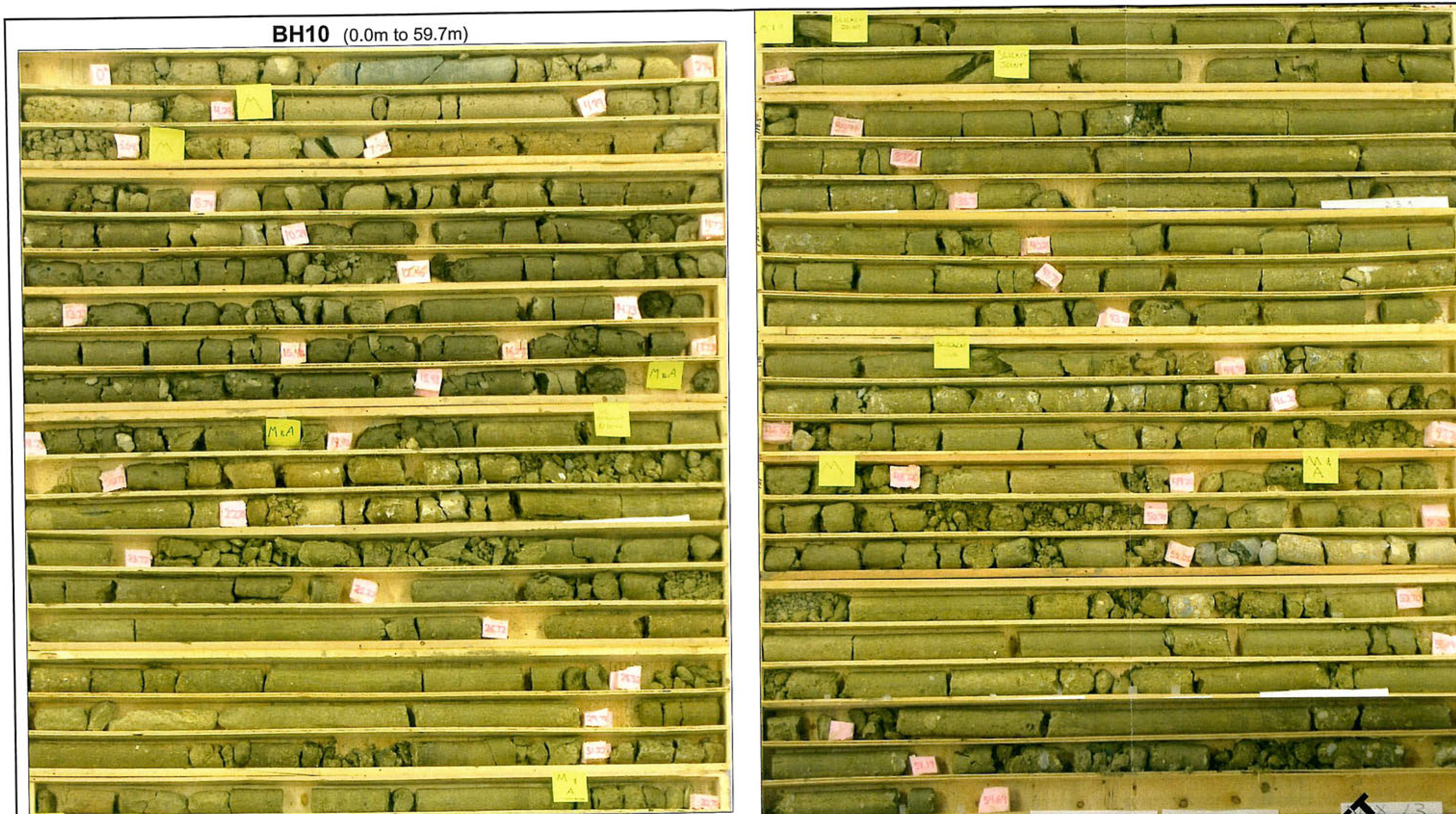
West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH9 (2 of 2)	DATE: APRIL 2007
	AMEC Earth & Environmental, 3456 Opie Crescent, Prince George, BC, CANADA V2N 2P9, Tel. (250) 564-3243, Fax (250) 562-7045	CHK'D BY: S.Kelly		PROJECT NO: KX04397
		DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
		PROJECTION: UTM Zone 10		FIGURE No. BH9
		SCALE: NOT TO SCALE		

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH9-Corephoto.dwg - 05-09A-2 - May. 03, 2007 8:52am - shelley.ruiz

BH10 (0.0m to 59.7m)



West Quesnel
Land Stability Program

CLIENT:
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amec

DWN BY:	S.Ruiz
CHK'D BY:	S.Kelly
DATUM:	NAD83
PROJECTION:	UTM Zone 10
SCALE:	NOT TO SCALE

TITLE
DRILL CORE PHOTOS
BH10 (1 of 1)

DRAFT

PROJECT
WEST QUESNEL LAND STABILITY STUDY
QUESNEL, BC

DATE:	APRIL 2007
PROJECT NO:	KX04397
REV. NO.:	A
FIGURE No.	BH10

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH10-Corephoto.dwg - 05-10A-1 - May. 03, 2007 8:52am - shelley.ruiz

BH11 (0.0m to 45.3m)

West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL		DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH11 (1 of 2)		DATE: APRIL 2007
			CHK'D BY: S.Kelly			PROJECT NO: KX04397
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	amec	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC		REV. NO.: A
			PROJECTION: UTM Zone 10			FIGURE No. BH11
			SCALE: NOT TO SCALE			

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH11-Corephoto.dwg - 05-11A-1 - May. 03, 2007 8:53am - shelley.ruiz

BH11 (45.3m to 70.2m)

CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH11 (2 of 2)	DATE: APRIL 2007
	CHK'D BY: S.Kelly		PROJECT NO: KX04397
	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
AMEC Earth & Environmental, 3456 Opie Crescent, Prince George, BC, CANADA V2N 2P9, Tel. (250) 564-3243, Fax (250) 562-7045	PROJECTION: UTM Zone 10		FIGURE No. BH11
	SCALE: NOT TO SCALE		

West Quesnel Land Stability Program

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C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2005 Drill Core Photos\WQ-BH11-Corephoto.dwg - 05-11A-2 - May. 03, 2007 8:53am - shelley.ruiz

BH12 (0.0m to 70.2m)

CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH12 (1 of 1)
	CHK'D BY: S.Kelly	DATE: APRIL 2007
	DATUM: NAD83	PROJECT NO: KX04397
	PROJECTION: UTM Zone 10	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC
	SCALE: NOT TO SCALE	REV. NO.: A
		FIGURE No. BH12

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West Quesnel Land Stability Program

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This drawing was originally produced in colour.

BH13 (0.0m to 30.5m)

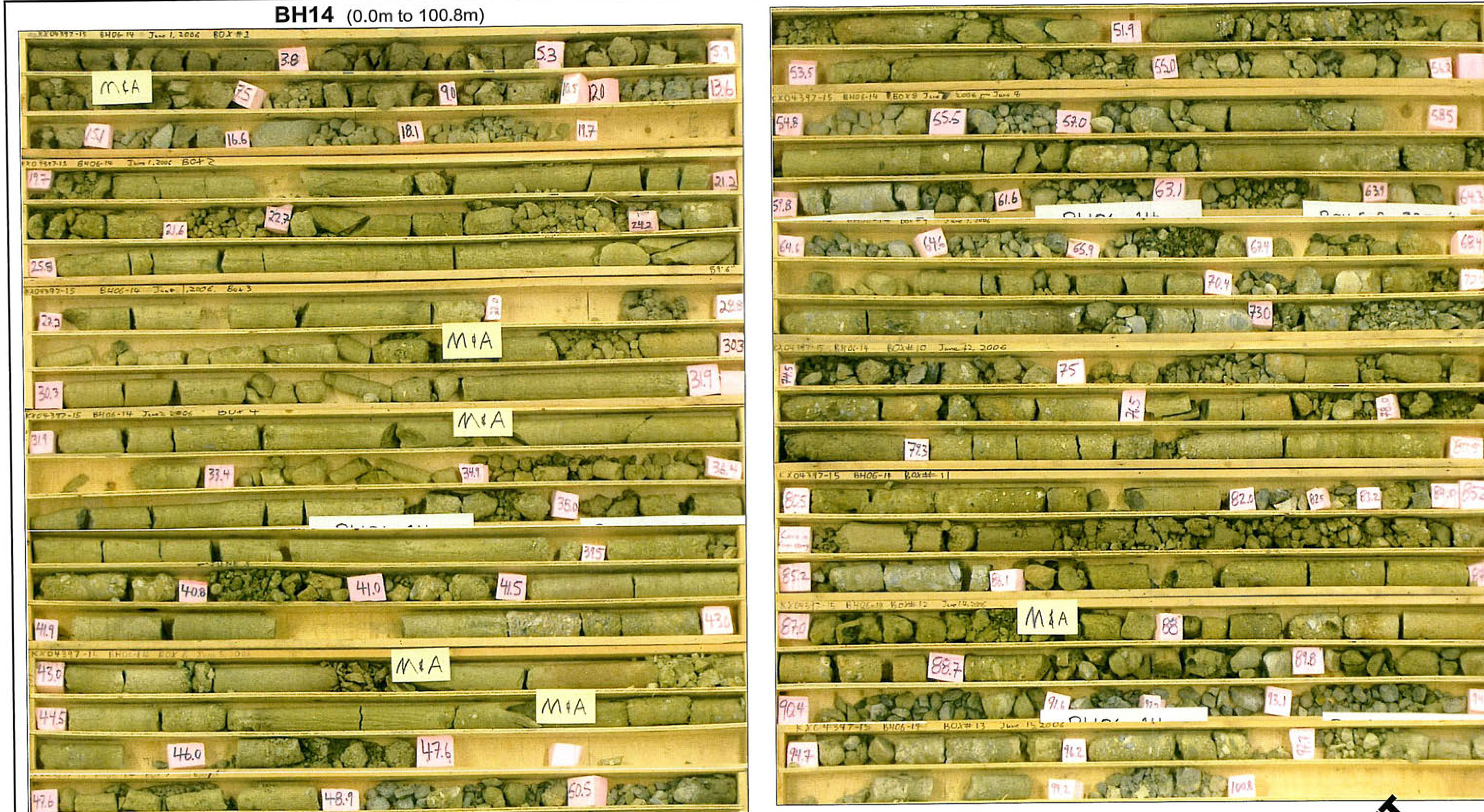
West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH13 (1 of 1)	DATE: APRIL 2007
		CHK'D BY: S.Kelly		PROJECT NO: KX04397
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
		PROJECTION: UTM Zone 10		FIGURE No. BH13
		SCALE: NOT TO SCALE		

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15–Core Photos\2005 Drill Core Photos\WQ–BH13–Corephoto.dwg – 05–13A–1 – May. 03, 2007 8:54am – shelley.ruiz

BH14 (0.0m to 100.8m)



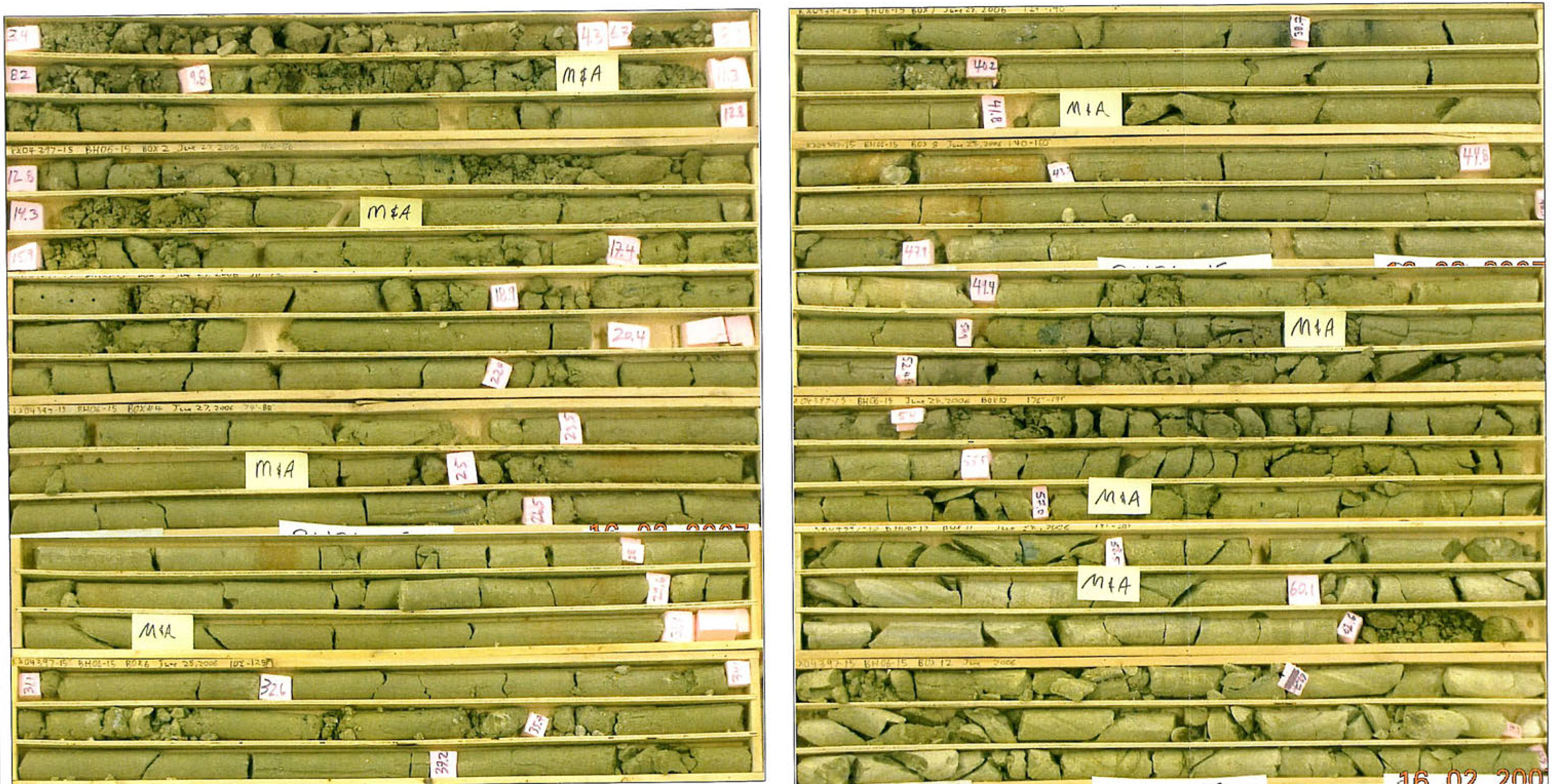
West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH14 (1 of 1)	DATE: APRIL 2007
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly		PROJECT NO: KX04397
	amec	DATUM: NAD83	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC	REV. NO.: A
		PROJECTION: UTM Zone 10		FIGURE No. BH14
		SCALE: NOT TO SCALE		

DRAFT

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2006 Drill Core Photos\WQ-BH14-Corephoto.dwg - 06-14-1 - May. 03, 2007 8:55am - shelley.ruiz

This drawing was originally produced in colour.

BH15 (3.4m to 65.8m)



West Quesnel Land Stability Program	CLIENT: CITY OF QUESNEL	DWN BY: S.Ruiz	TITLE: DRILL CORE PHOTOS BH15 (1 of 2)
	AMEC Earth & Environmental 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	CHK'D BY: S.Kelly	DATE: APRIL 2007
	amec	DATUM: NAD83	PROJECT NO: KX04397
		PROJECTION: UTM Zone 10	PROJECT: WEST QUESNEL LAND STABILITY STUDY QUESNEL, BC
		SCALE: NOT TO SCALE	REV. NO.: A
			FIGURE No. BH15

DRAFT

This drawing was originally produced in colour.

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-Core Photos\2006 Drill Core Photos\WQ-BH15-Corephoto.dwg - 06-15-1 - May. 03, 2007 9:35am - shelley.ruiz

APPENDIX E

TABLE E1 – Atterberg Limit Index Testing Results

STRATIGRAPHIC UNIT	SAMPLING JUSTIFICATION	BOREHOLE ID	DEPTH (m)	ELEVATION (masl)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	MOISTURE CONTENT	USC DESIGNATION
Glaciolacustrine Silts and Clays	Soil/rock type	BH8	27.3	498.8	27	20	7	-	CL
	Soil/rock type	BH10	19.0	525.8	38	15	23	14	CI
	Soil/rock type	BH14	7.0	565.3	31	22	10	28	CI
	Soil/rock type	BH16	12.5	648.2	37	22	15	32	CI
	Soil/rock type	BH16	37.0	623.7	47	20	27	29	CI
	Soil/rock type	BH16	42.2	618.5	61	23	38	36	CH
	Soil/rock type	BH16	56.6	604.1	38	14	24	28	CI
Clay Tuff	Proximate to SI	BH8	31.2	494.9	38	14	24	49	CI
	Proximate to SI	BH10	19.9	524.9	109	39	70	46	CH
	Proximate to SI	BH11	19.1	511.8	98	35	63	33	CH
	Proximate to SI	BH11	27.7	503.2	93	38	55	32	CH
	Proximate to SI	BH11	51.9	479	87	33	54	31	CH
	Proximate to SI	BH12	62.3	494.1	73	23	50	39	CH
	Proximate to SI	BH13	11.0	471.0	97	31	66	27	CH
	Proximate to SI	BH13	17.3	464.7	77	24	52	23	CH
	Soft zone, Proximate to SI	BH8	56.0	470.1	117	41	76	112	CH
	Soft zone	BH7	53.4	488.0	69	35	34	40	MH
	Soft zone	BH10	32.5	512.3	115	38	77	58	CH
	Soft zone	BH10	49.4	495.4	61	16	45	25	CH
	Soft zone	BH15	11.0	554.2	77	36	41	42	MH
	Slickensided	BH14	32.8	539.5	94	35	59	40	CH
	Slickensided	BH14	43.5	528.8	65	31	34	28	CH
	Slickensided	BH14	45.5	526.8	83	37	46	39	CH
	Slickensided	BH15	14.8	550.4	70	30	40	38	CH
	Slickensided	BH15	42.0	523.2	70	28	42	32	CH
	Slickensided	BH15	57.2	508.0	89	40	50	46	MH
	Slickensided	BH16	64.5	596.2	67	27	41	28	CH
	Slickensided	BH16	80.1	580.6	67	25	42	23	CH
	Soil/rock type	BH2	48.1	436.5	65	45	20	35	MH
	Soil/rock type	BH2	55.7	428.9	108	51	57	36	MH
	Soil/rock type	BH2	58.8	425.8	98	33	65	37	CH
	Soil/rock type	BH2	69.4	415.2	83	49	34	31	MH
	Soil/rock type	BH2	77.0	407.6	76	49	27	33	MH
	Soil/rock type	BH3	35.2	468.0	35	20	15	13	CI
	Soil/rock type	BH3	41.0	462.2	70	49	21	43	MH
	Soil/rock type	BH3	48.0	455.2	59	43	16	31	MH
	Soil/rock type	BH3	55.7	447.5	66	48	18	35	MH
	Soil/rock type	BH3	67.8	435.4	75	49	26	34	MH
	Soil/rock type	BH3	81.4	521.8	85	45	40	38	MH
	Soil/rock type	BH3	89.2	414.0	93	52	41	31	MH
	Soil/rock type	BH4	46.8	489.6	54	29	25	27	CH
	Soil/rock type	BH4	49.4	487.0	58	29	29	33	CH
	Soil/rock type	BH4	66.4	470.0	105	49	56	14	MH
	Soil/rock type	BH4	84.7	451.7	92	42	50	12	MH
	Soil/rock type	BH4	107.6	428.8	68	41	27	16	MH
	Soil/rock type	BH6	27.0	529.9	73	39	34	31	MH
	Soil/rock type	BH6	32.8	524.1	60	39	21	27	MH
	Soil/rock type	BH9	51.3	483.4	76	34	42	48	CH
	Soil/rock type	BH9	54.9	479.8	70	30	39	65	CH
	Soil/rock type	BH12	33.0	523.4	77	34	44	31	CH
	Soil/rock type	BH13	23.8	458.2	78	31	48	34	CH
	Soil/rock type	BH14	29.7	542.6	95	46	48	48	MH
	Soil/rock type	BH15	24.7	540.5	85	33	53	44	CH
	Soil/rock type	BH15	29.8	535.4	69	25	43	31	CH
	Soil/rock type	BH15	51.4	513.8	66	37	30	36	MH
	Soil/rock type	BH15	59.7	505.5	90	41	50	41	MH
	Soil/rock type	BH15	72.5	492.7	89	48	41	58	MH
	Soil/rock type	BH16	74.5	586.2	100	40	60	36	CH
Sand and gravel tuff	Soil/rock type	BH8	65.4	460.7	70	27	43	43	CH
	Soil/rock type	BH14	87.5	484.8	109	54	54	55	MH
	Soil/rock type	BH16	113.1	547.6	60	23	36	23	CH
Siliceous White Clay Shale	Soil/rock type	BH15	83.0	482.2	23	16	7	13	CL
Phyllite	Soil/rock type	BH16	147.5	513.2	22	14	8	12	CL
Siltstone	Soil/rock type	BH4	130.5	405.9	113	47	66	14	MH
	Soil/rock type	BH4	137.4	399.0	26	21	5	14	CL

Figure E1: Plasticity Chart for Soils Passing No. 40 Sieve
City of Quesnel, West Quesnel Slide
(by Borehole Location)

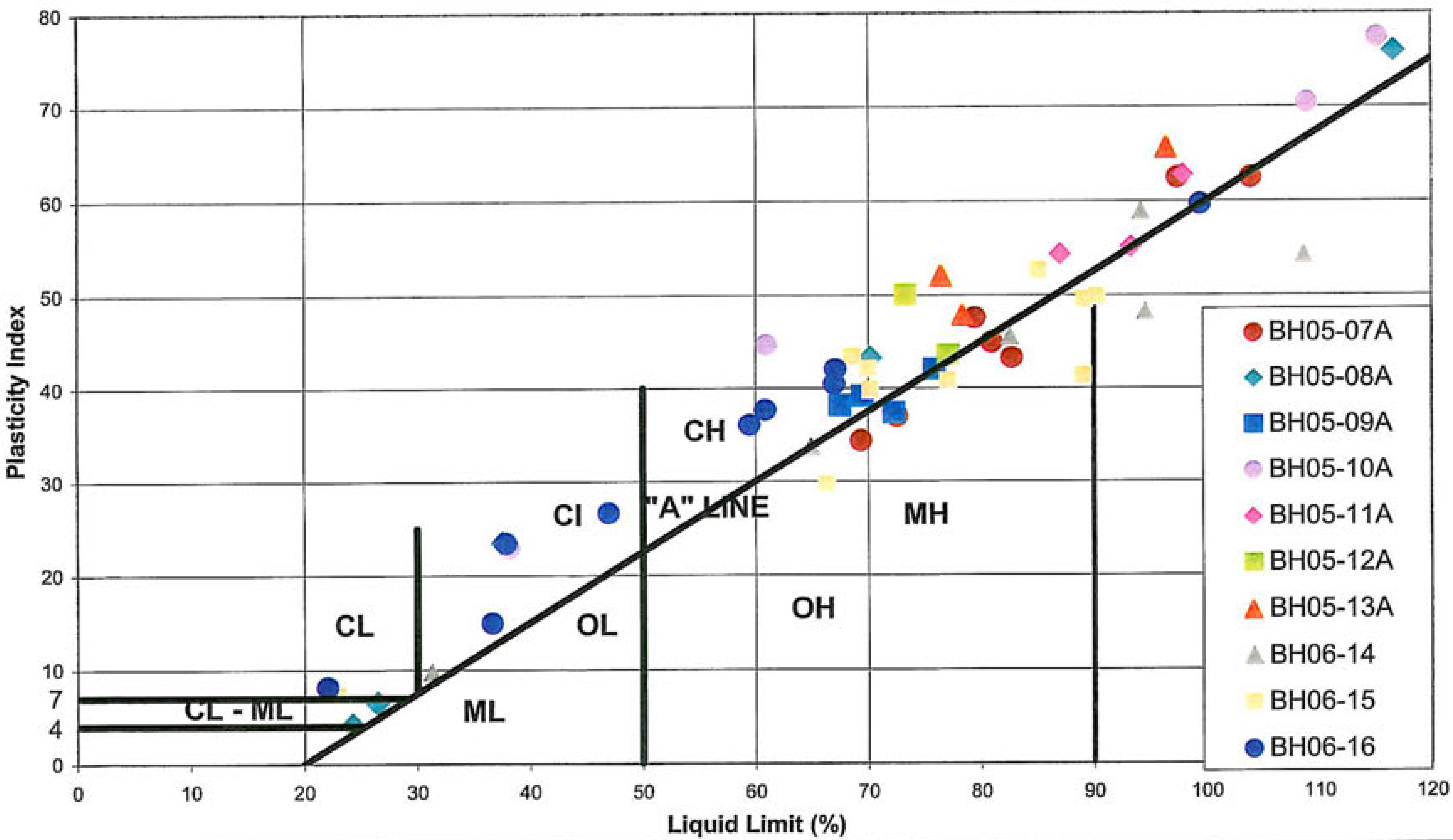


Figure E2: Plasticity Chart for Soils Passing No. 40 Sieve
City of Quesnel, West Quesnel Slide
(by Soil Type)

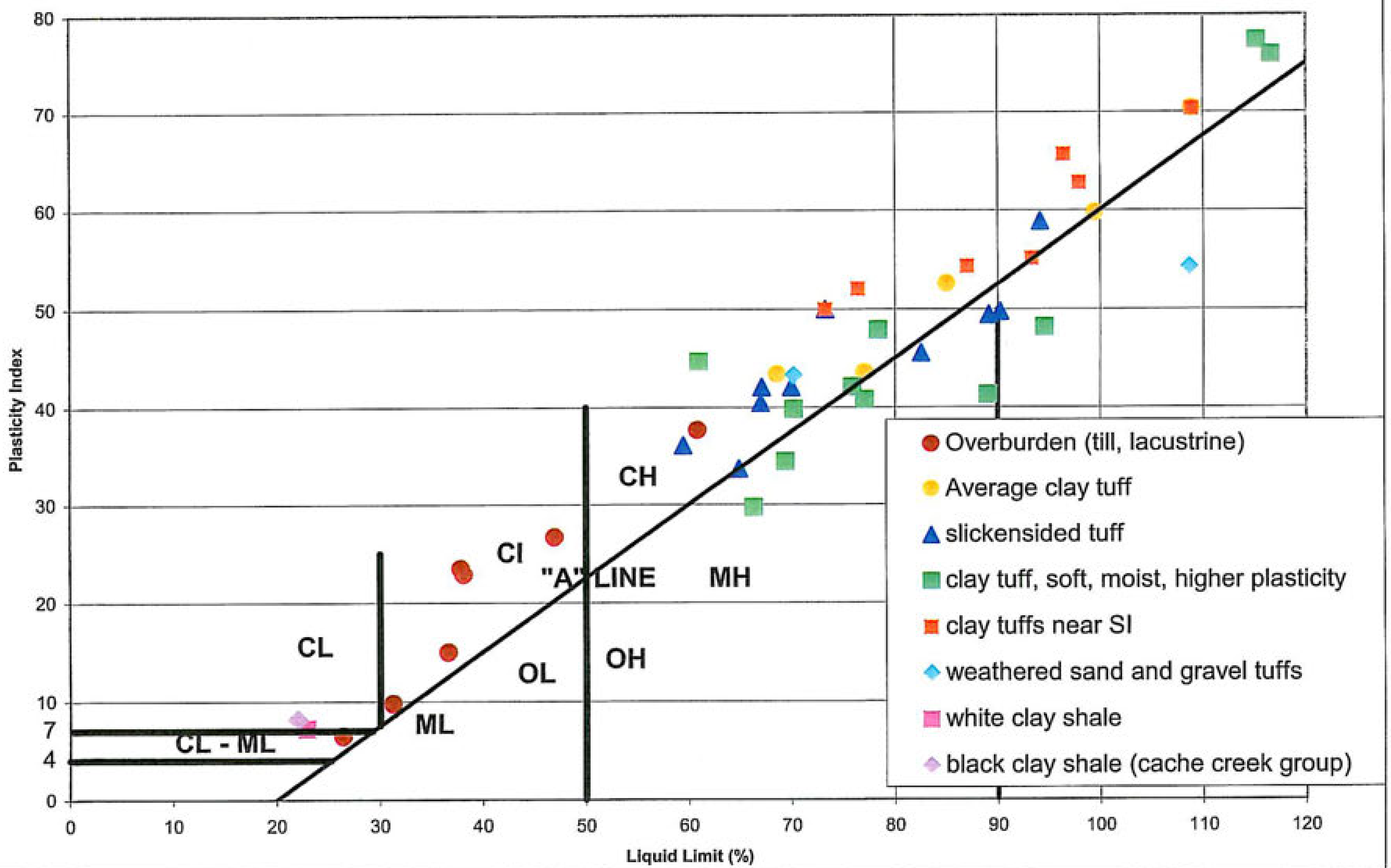
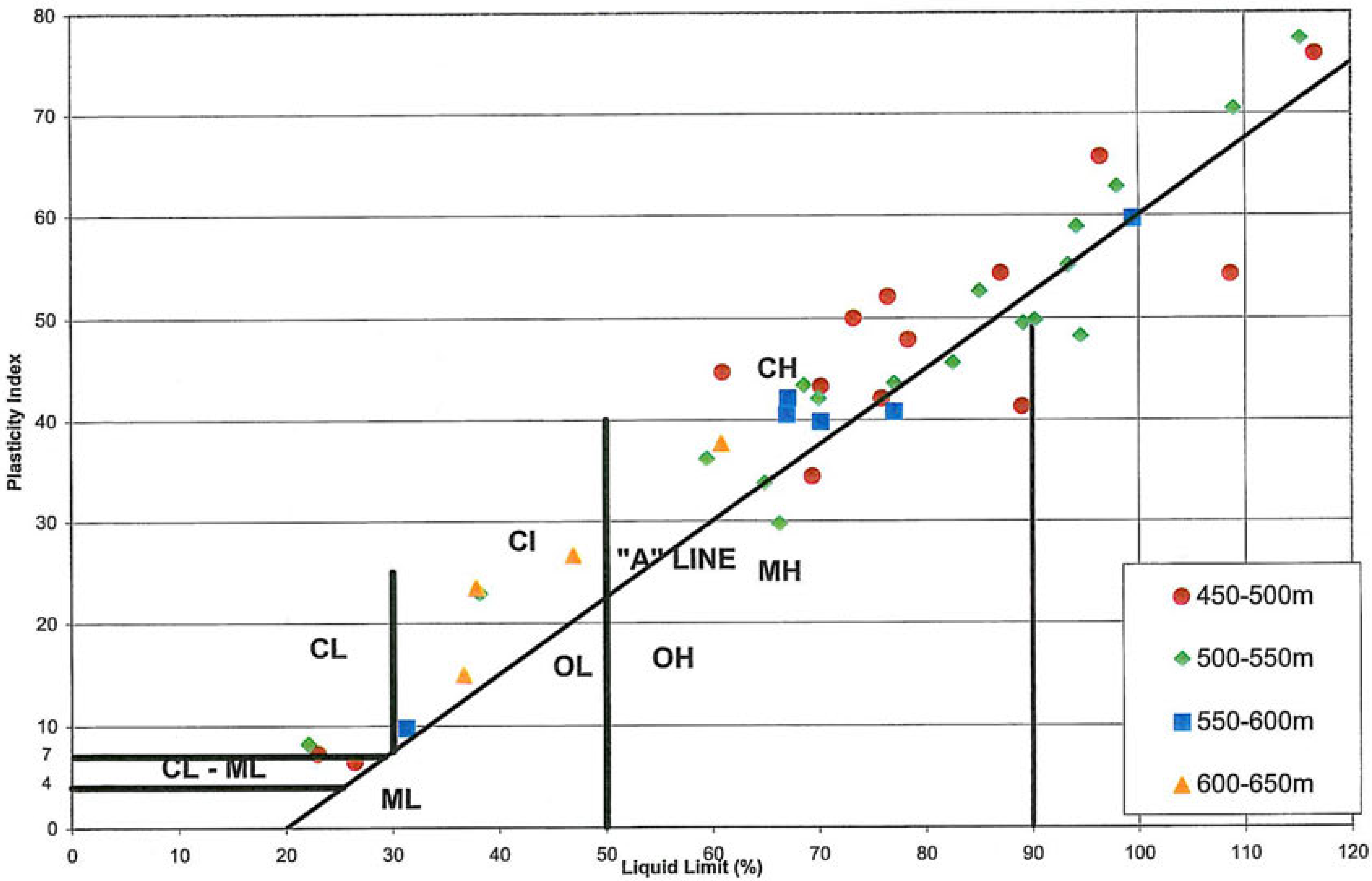


Figure E3: Plasticity Chart for Soils Passing No. 40 Sieve
City of Quesnel, West Quesnel Slide
(by Elevation)



APPENDIX F

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 7 AUGUST 2003

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: BH2AB

Install Method / Driller: TH-60 - CARIBOO WATER WELLS

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 25mm

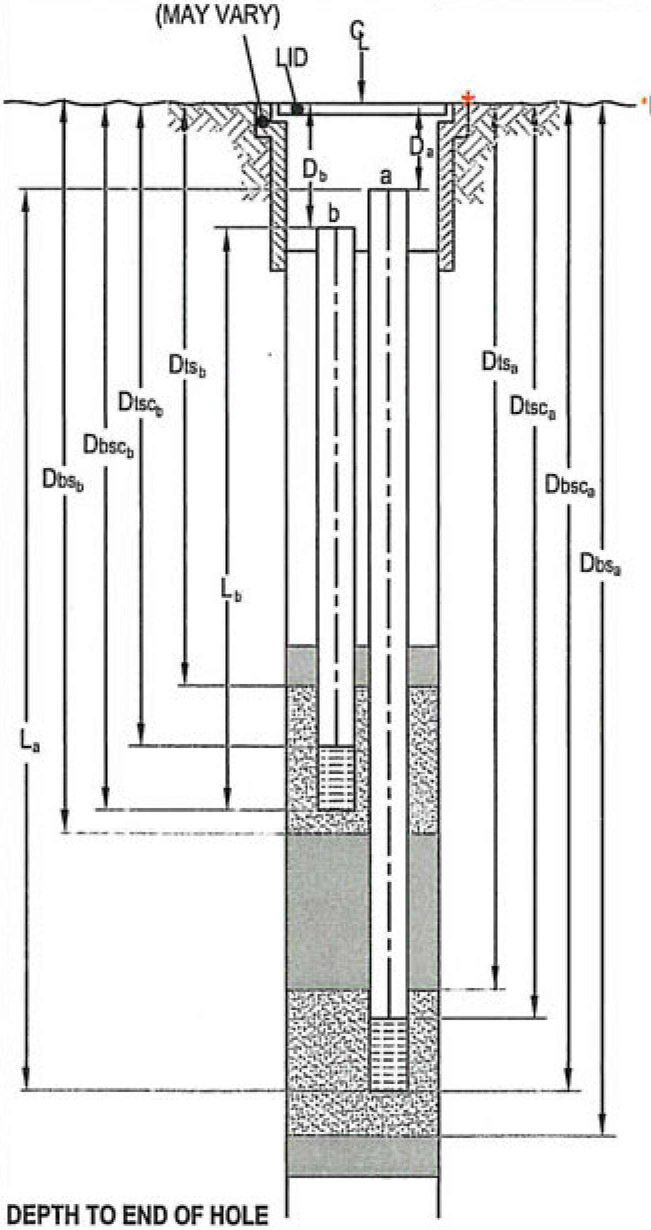
Seal Mixture:

ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869742.41

EASTING: 532207.57



INSTRUMENT No (i=a, b, c..)	a		b	
INSTALL LENGTH (m) L_i	88.3		48.1	
	DEPTH (m)	ELEVATION (m)	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.11	516.39	0.13	516.37
TOP SEAL (Dts_i)	85.0	431.4	46.5	470.0
TOP SCREEN ($Dtsc_i$)	86.9	429.5	47.4	469.1
BOTTOM SCREEN ($Dbsc_i$)	88.4	428.0	48.2	468.3
BOTTOM SEAL (Dbs_i)	SAND to end of hole at 90.4m		77.5	439.0

DEPTH TO END OF HOLE

90.4 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

G:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 Installation forms .dwg - BH2AB - Apr. 17, 2007 1:58pm - shelley.rulz

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 8 AUGUST 2003

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: BH2C

Install Method / Driller: TH-60 - CARIBOO WATER WELLS

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 25mm

Seal Mixture:

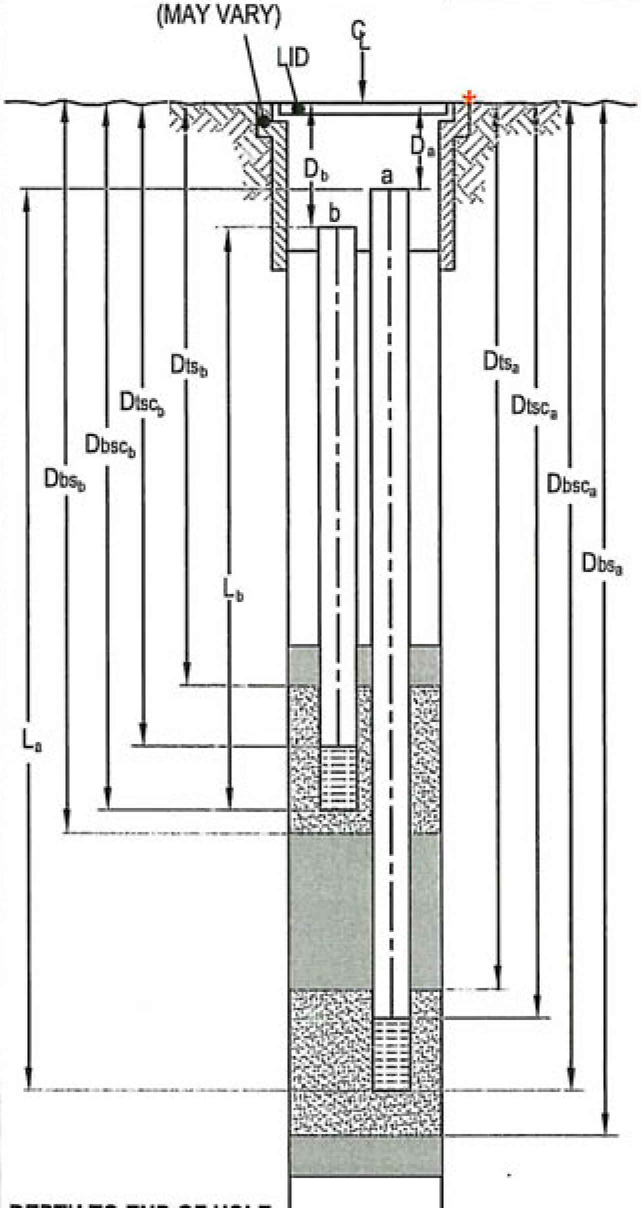
ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869742.28

STEEL PROTECTIVE BOX (MAY VARY)

EASTING: 532210.04



*ELEVATION OF GROUND SURFACE 516.5 m

INSTRUMENT No (i=a, b, c..)	c	
INSTALL LENGTH (m) L_i	25.8	
	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.08	516.42
TOP SEAL (Dts_i)	25.0	491.5
TOP SCREEN ($Dtsc_i$)	25.3	491.2
BOTTOM SCREEN ($Dbsc_i$)	25.7	490.8
BOTTOM SEAL (Dbs_i)	27.0	489.5

DEPTH TO END OF HOLE

30.0 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 24 JULY 2003 Project No: KX04397

Supervised by AMEC: S.GREEN Install'n No: BH3A

Install Method / Driller: SILVERADO - GEOTECH DRILLING Lock/Key No:

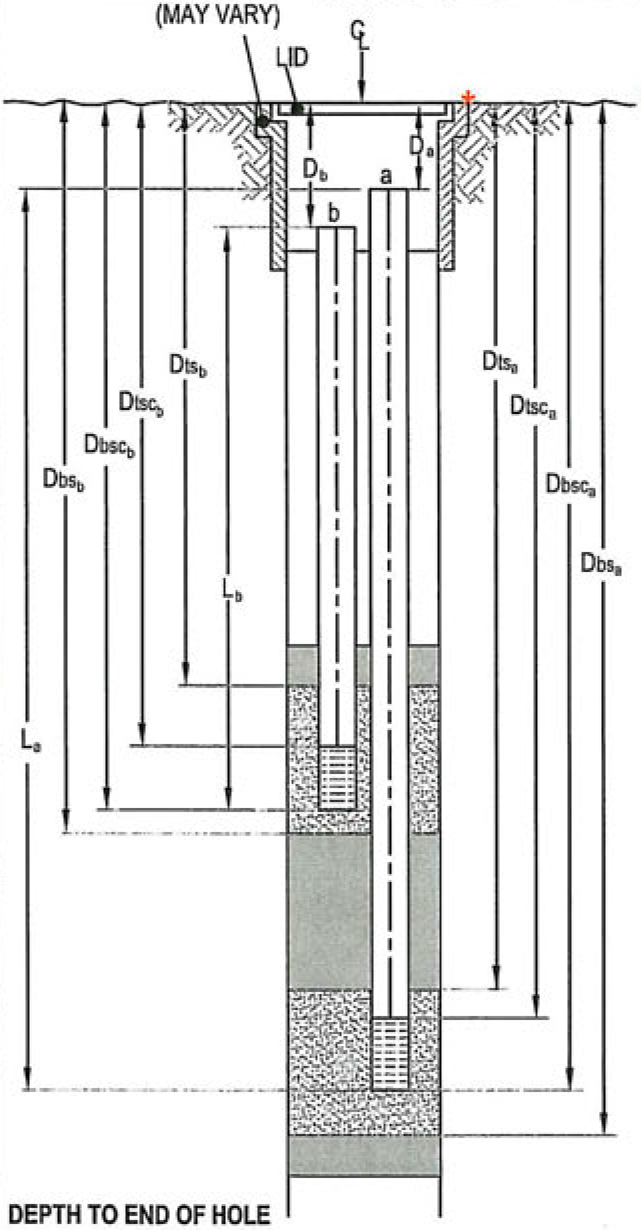
Screen / Tip Type: SLOTTED Pipe Diameter: 25mm Seal Mixture:

ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869770.82

EASTING: 532006.53



INSTRUMENT No (i=a, b, c..)	a	
INSTALL LENGTH (m) L_i	50.52	
	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.08	519.02
TOP SEAL (Dts_i)	49.0	470.1
TOP SCREEN ($Dtsc_i$)	50.0	469.1
BOTTOM SCREEN ($Dbsc_i$)	50.6	468.5
BOTTOM SEAL (Dbs_i)	50.8	468.3

DEPTH TO END OF HOLE

53.9 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

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STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 22 AUGUST 2003

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: BH3BC

Install Method / Driller: SILVERADO - GEOTECH DRILLING

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 25mm

Seal Mixture:

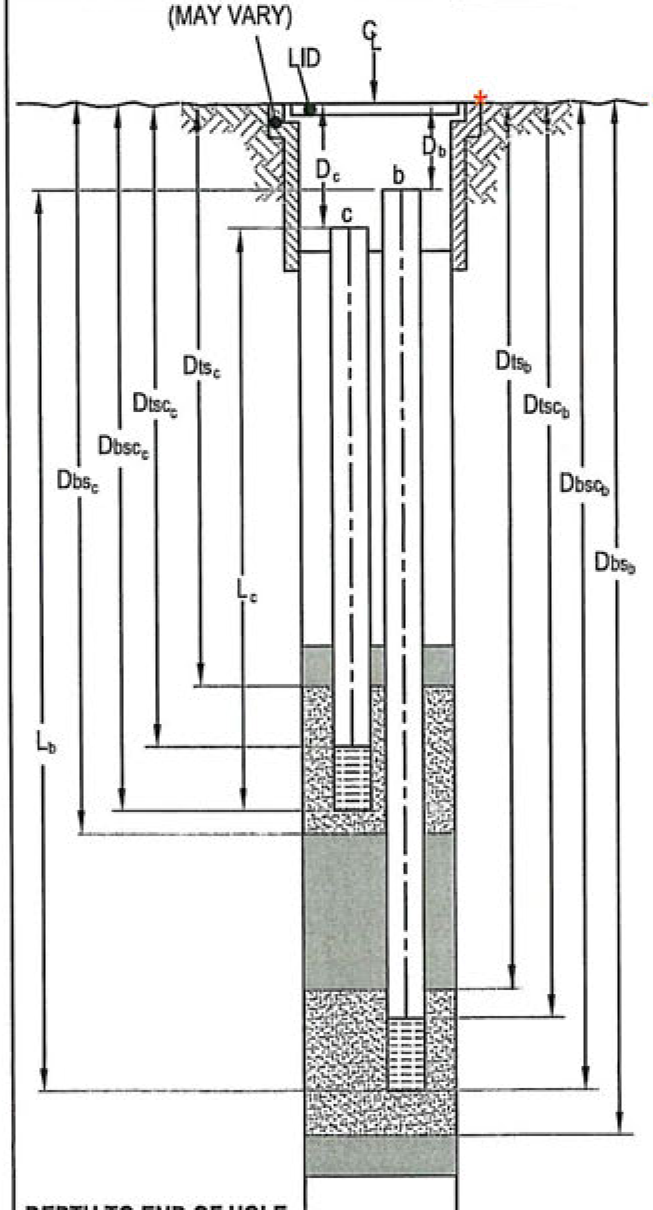
ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869770.43

EASTING: 532005.22

STEEL PROTECTIVE BOX (MAY VARY)



*ELEVATION OF GROUND SURFACE 519.1 m

INSTRUMENT No (i=a, b, c..)	b		c	
INSTALL LENGTH (m) L_i	40.17		33.5	
	DEPTH (m)	ELEVATION (m)	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.03	519.07	0.0	519.1
TOP SEAL (Dts_i)	38.3	480.8	31.5	487.6
TOP SCREEN ($Dtsc_i$)	38.7	480.4	32.0	487.1
BOTTOM SCREEN ($Dbsc_i$)	40.1	479.0	33.5	485.6
BOTTOM SEAL (Dbs_i)	SLOUGH to end of hole at 44.8m		33.5	485.6

DEPTH TO END OF HOLE

44.8 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 17 JULY 2003

Project No: KX04397

Supervised by AMEC: S.JORGENSON

Install'n No: BH4AB

Install Method / Driller: SILVERADO - GEOTECH DRILLING

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 25mm

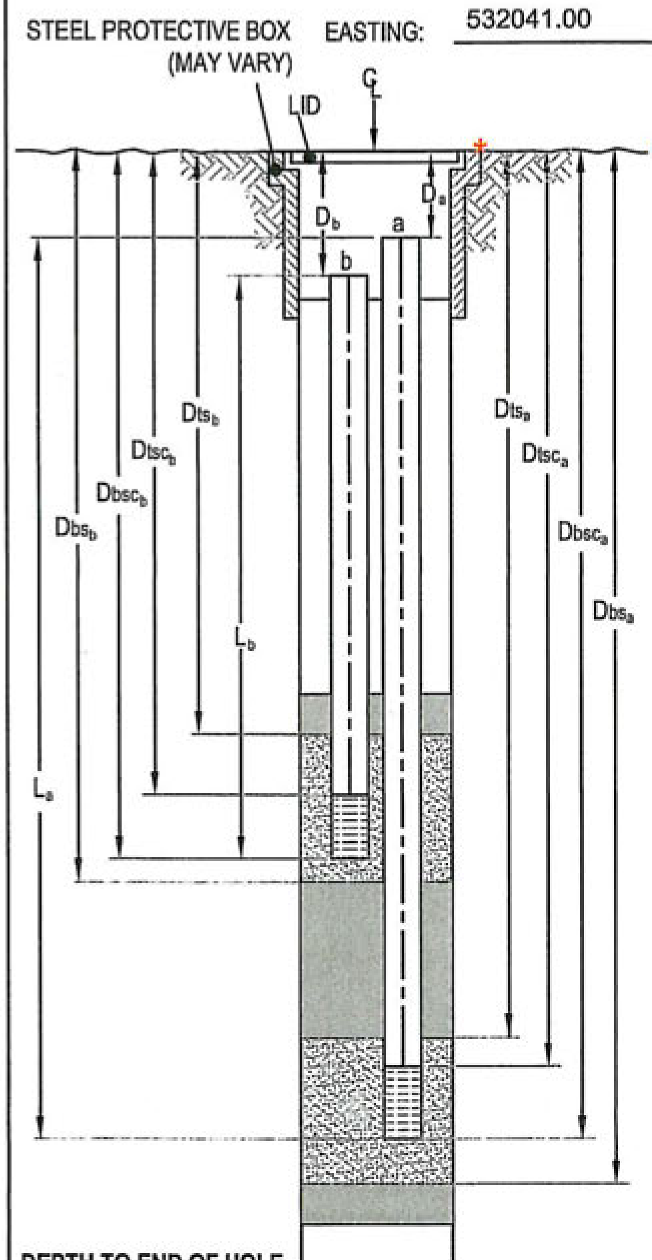
Seal Mixture:

ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869782.81

EASTING: 532041.00



*ELEVATION OF GROUND SURFACE 519.8 m

INSTRUMENT No (i=a, b, c..)	a		b	
INSTALL LENGTH (m) L_i	49.3		48.2	
	DEPTH (m)	ELEVATION (m)	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.08	519.72	0.08	519.72
TOP SEAL (Dts_i)	48.0	471.8	38.1	481.7
TOP SCREEN ($Dtsc_i$)	48.8	471.0	38.7	481.1
BOTTOM SCREEN ($Dbsc_i$)	49.4	470.4	40.2	480.4
BOTTOM SEAL (Dbs_i)	SAND to end of hole at 49.7m		40.0	479.8

DEPTH TO END OF HOLE

49.7 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg – BH4AB – Apr. 17, 2007 1:59pm – shelley.ruiz

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 18 JULY 2003

Project No: KX04397

Supervised by AMEC: S.JORGENSON

Install'n No: BH4C

Install Method / Driller: SILVERADO - GEOTECH DRILLING

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 25mm

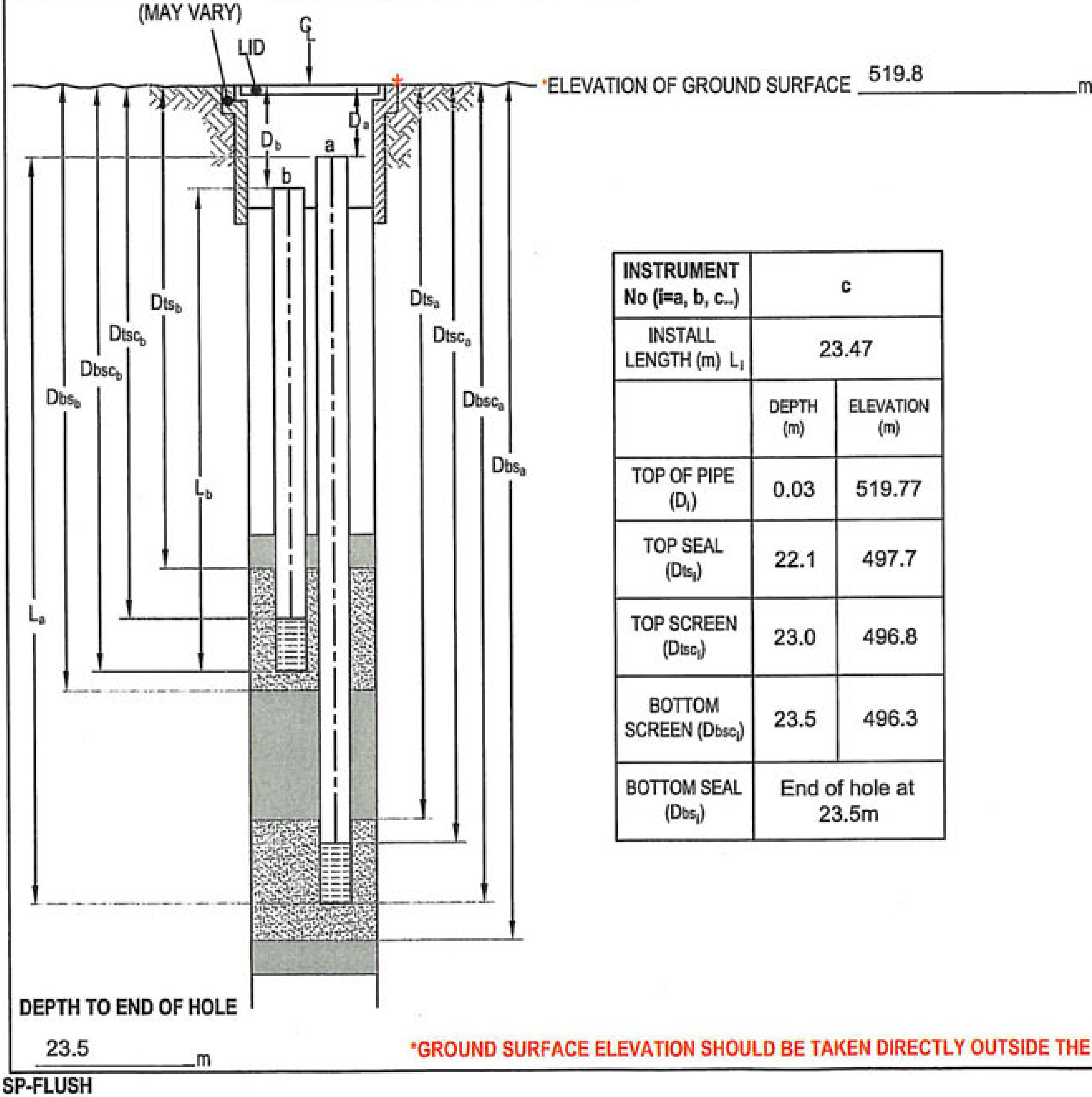
Seal Mixture:

ROAD BOX / FLUSH MOUNT COVER

Tip Backfill:

NORTHING: 5869783.48

EASTING: 532042.93



INSTRUMENT No (i=a, b, c..)	c	
INSTALL LENGTH (m) L_i	23.47	
	DEPTH (m)	ELEVATION (m)
TOP OF PIPE (D_i)	0.03	519.77
TOP SEAL (Dts_i)	22.1	497.7
TOP SCREEN ($Dtsc_i$)	23.0	496.8
BOTTOM SCREEN ($Dbsc_i$)	23.5	496.3
BOTTOM SEAL (Dbs_i)	End of hole at 23.5m	

DEPTH TO END OF HOLE

23.5 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg -- BH4C -- Apr. 17, 2007 1:59pm -- shelley.ruiz

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 2 NOVEMBER 2001

Project No: KX04397

Supervised by AMEC:

Install'n No: BH2

Install Method / Driller: B53 MOBILE - GEOTECH DRILLING

Lock/Key No:

Screen / Tip Type:

Pipe Diameter: 25mm

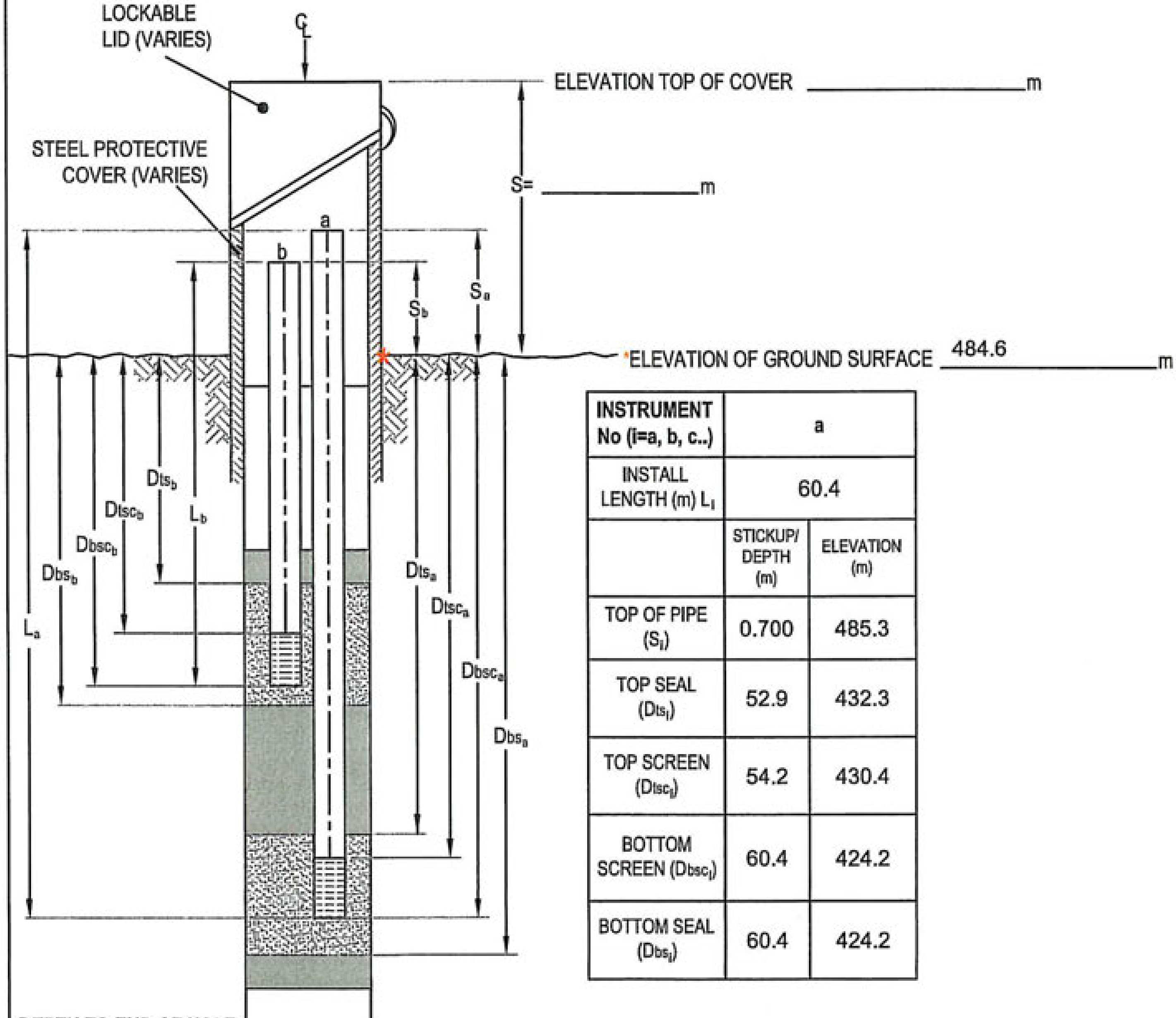
Seal Mixture:

STICK-UP CASING PROTECTOR:

Tip Backfill: PEA GRAVEL

NORTHING: 5869340

EASTING: 532480



INSTRUMENT No (i=a, b, c..)	a	
INSTALL LENGTH (m) L_i	60.4	
	STICKUP/ DEPTH (m)	ELEVATION (m)
TOP OF PIPE (S_i)	0.700	485.3
TOP SEAL (Dts_i)	52.9	432.3
TOP SCREEN ($Dtsc_i$)	54.2	430.4
BOTTOM SCREEN ($Dbsc_i$)	60.4	424.2
BOTTOM SEAL (Dbs_i)	60.4	424.2

DEPTH TO END OF HOLE

80.1 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-STICKUP

G:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg - BH2 - Apr. 13, 2007 11:31am - shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 15 NOVEMBER 2001

Project No: KX04397

Supervised by AMEC: H.ARABSHAHI

Install'n No: BH3

Install Method / Driller: HQ/B-53 - GEOTECH DRILLING

Lock/Key No:

VW Make/Model: SINCO

Data Logger:

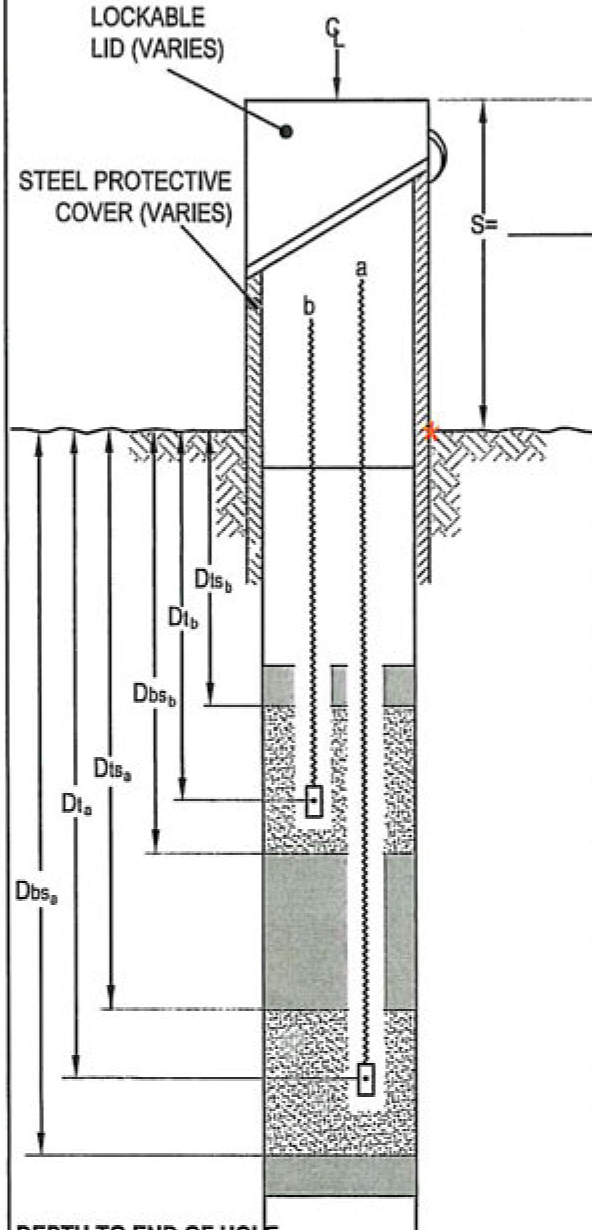
Seal Mixture:

STICK-UP CASING PROTECTOR:

Tip Backfill: SAND

NORTHING: 5869597

EASTING: 532264



ELEVATION TOP OF COVER 503.186 m

S= m

*ELEVATION OF GROUND SURFACE 503.0 m

INSTRUMENT No (i=a, b, c, d)	a	
SERIAL NO.	73153	
MANUAL FACTOR A (m H_2O)	-0.000018148	
MANUAL FACTOR B (m H_2O)	0.0090068	
MANUAL FACTOR C (m H_2O)	143.89	
	DEPTH (m)	ELEVATION (m)
TOP SEAL (D_{ts_i})	36.9	466.3
TIP (D_{t_i})	37.5	465.7
BOTTOM SEAL (D_{bs_i})	40	463.0

DEPTH TO END OF HOLE

95.1 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VW-STICKUP

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 15 NOVEMBER 2001

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: BH4

Install Method / Driller: B-53 - GEOTECH DRILLING

Lock/Key No:

VW Make/Model:

Data Logger: MINILOGGER

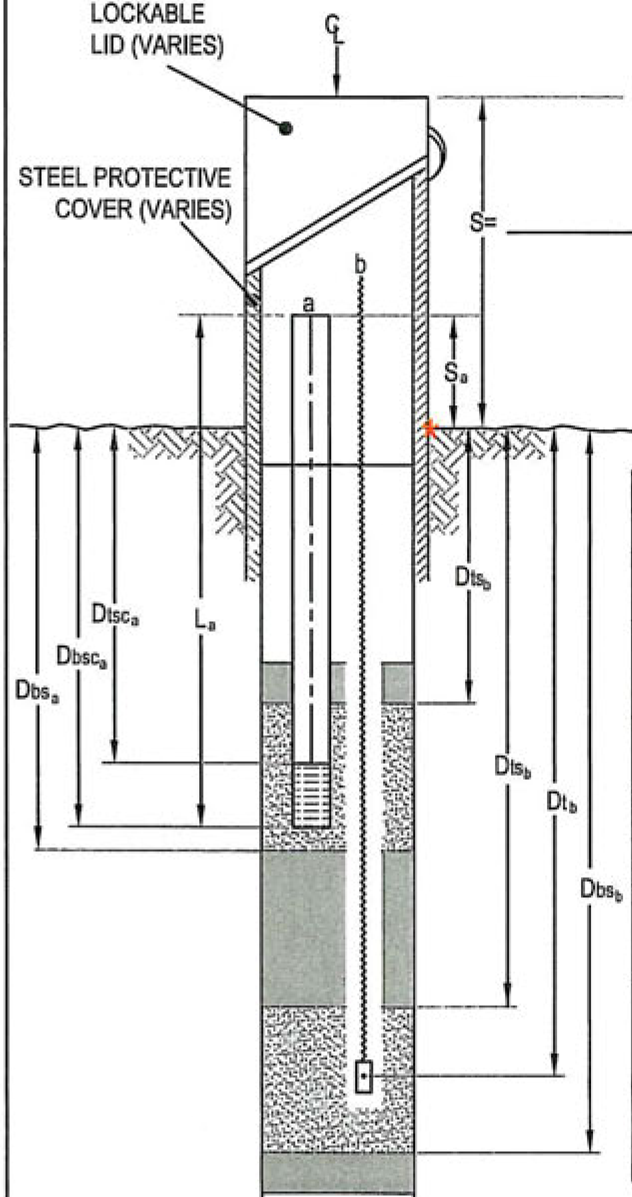
Seal Mixture:

STICK-UP CASING PROTECTOR:

Tip Backfill: PEA GRAVEL

NORTHING: 5869868

EASTING: 531829



ELEVATION TOP OF COVER ______ m

S= ______ m

*ELEVATION OF GROUND SURFACE 536.4 m

INSTRUMENT No (i=a, b, c..)	a	
INSTALL LENGTH (m) L_i	38.2	
	STICKUP/ DEPTH (m)	ELEVATION (m)
TOP OF PIPE (S_i)	0.89	537.8
TOP SEAL (Dts_i)	36.7	499.7
TOP SCREEN ($Dtsc_i$)	37.9	499.0
BOTTOM SCREEN ($Dbsc_i$)	38.2	498.7
BOTTOM SEAL (Dbs_i)	39.6	497.3

INSTRUMENT No (i=a, b, c, d)	b	
SERIAL NO.	73154	
MANUAL FACTOR A (m H2O)	-0.000019183	
MANUAL FACTOR B (m H2O)	0.0067254	
MANUAL FACTOR C (m H2O)	161.74	
	DEPTH (m)	ELEVATION (m)
TOP SEAL (Dts_i)	47.8	488.6
TIP (Dt_i)	49.8	486.6
BOTTOM SEAL (Dbs_i)	50.9	485.5

DEPTH TO END OF HOLE

153.3 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VW-STICKUP

STANDPIPE PIEZOMETER / OBSERVATION WELL INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 18 DECEMBER 2001

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: BH6

Install Method / Driller: B53 MOBILE - GEOTECH DRILLING

Lock/Key No:

Screen / Tip Type: SLOTTED

Pipe Diameter: 30mm

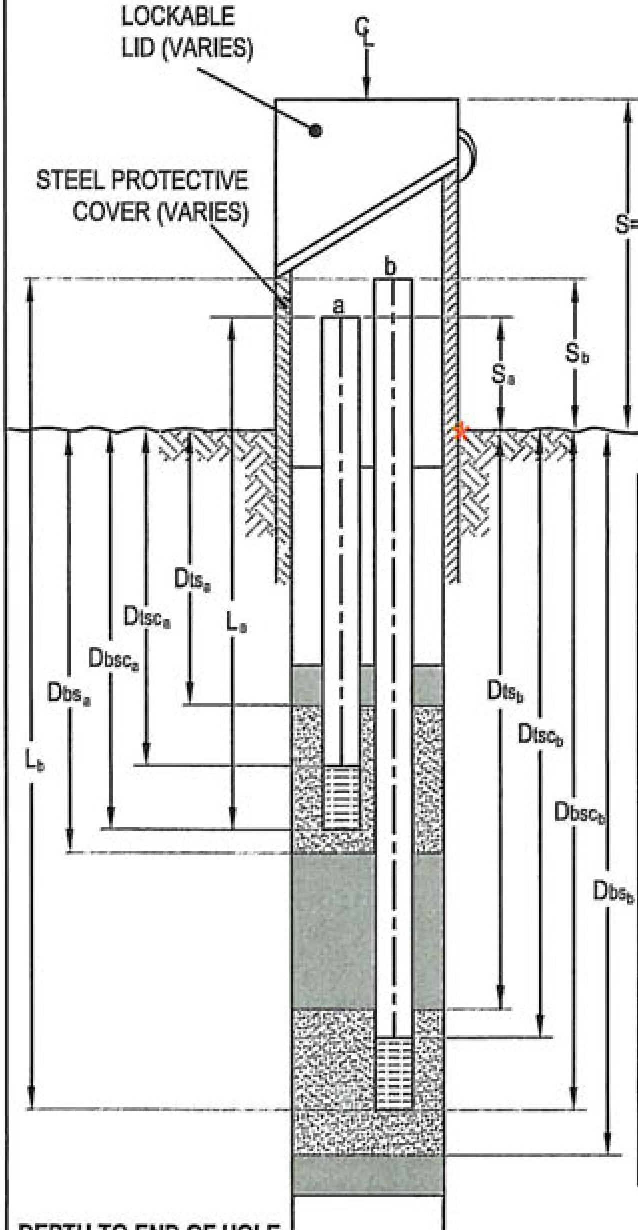
Seal Mixture: BENTONITE

STICK-UP CASING PROTECTOR:

Tip Backfill:

NORTHING: 5869940

EASTING: 531514



ELEVATION TOP OF COVER ______ m

S= ______ m

*ELEVATION OF GROUND SURFACE 556.9 m

INSTRUMENT No (i=a, b, c..)	a		b	
INSTALL LENGTH (m) L_i	27.4		44.9	
	STICKUP/ DEPTH (m)	ELEVATION (m)	STICKUP/ DEPTH (m)	ELEVATION (m)
TOP OF PIPE (S_i)				
TOP SEAL (Dts_i)	26.5	530.4	44.1	512.8
TOP SCREEN ($Dtsc_i$)	27.1	529.8	44.6	512.3
BOTTOM SCREEN ($Dbsc_i$)	27.4	529.5	44.9	512.0
BOTTOM SEAL (Dbs_i)	28.6	528.3	45.4	511.5

DEPTH TO END OF HOLE

45.9 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SP-STICKUP

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 Installation forms .dwg - BH6 - Apr. 13, 2007 11:36am - shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 2 JULY 2005

Project No: KX04397

Supervised by AMEC: S.CARLSON / B.GAUSS

Install'n No: BH7

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

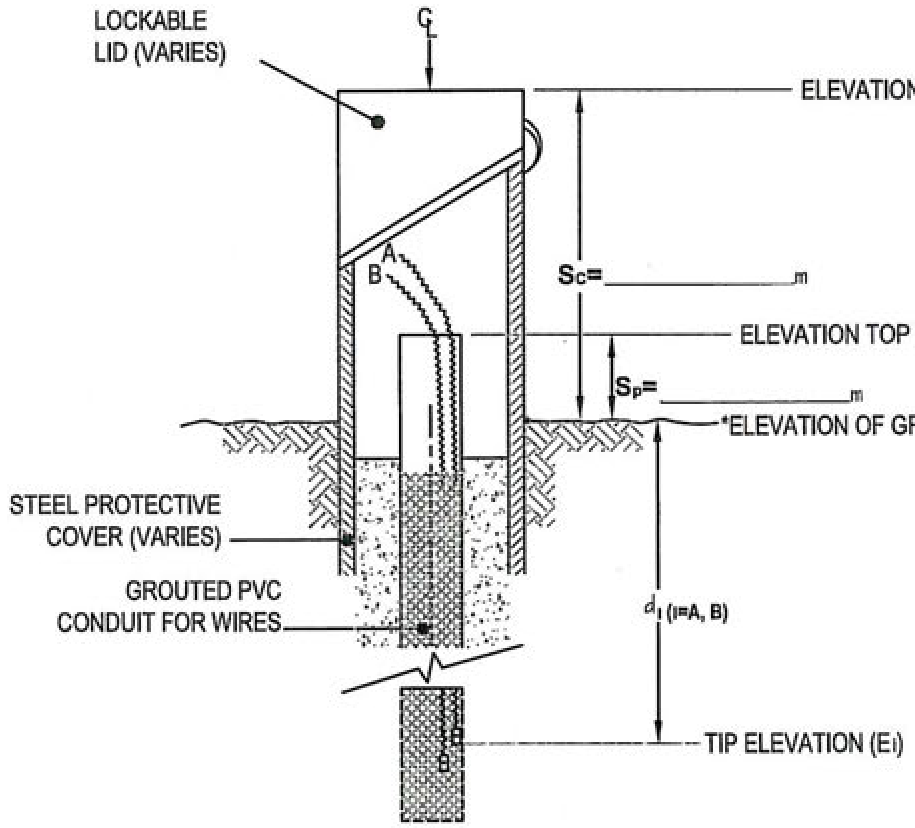
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5870225.57

EASTING: 531798.95



ELEVATION TOP OF COVER ____________ m

ELEVATION TOP OF PLASTIC PIPE ____________ m

*ELEVATION OF GROUND SURFACE 541.4 m

TIP ELEVATION (E_i)

INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_i	TIP ELEVATION (m) E_i	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	27.0	514.4	82515	-0.000011997	-0.00071701	114.14
B	64.9	476.5	82505	-0.000010485	-0.0020117	107.11

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH7-BH16-installation forms.dwg – BH7 – Apr. 03, 2007 3:03pm – shelley.nutz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 15 JUNE 2005

Project No: KX04397

Supervised by AMEC: S.CARLSON / N.EKMAN

Install'n No: BH8

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No: ______

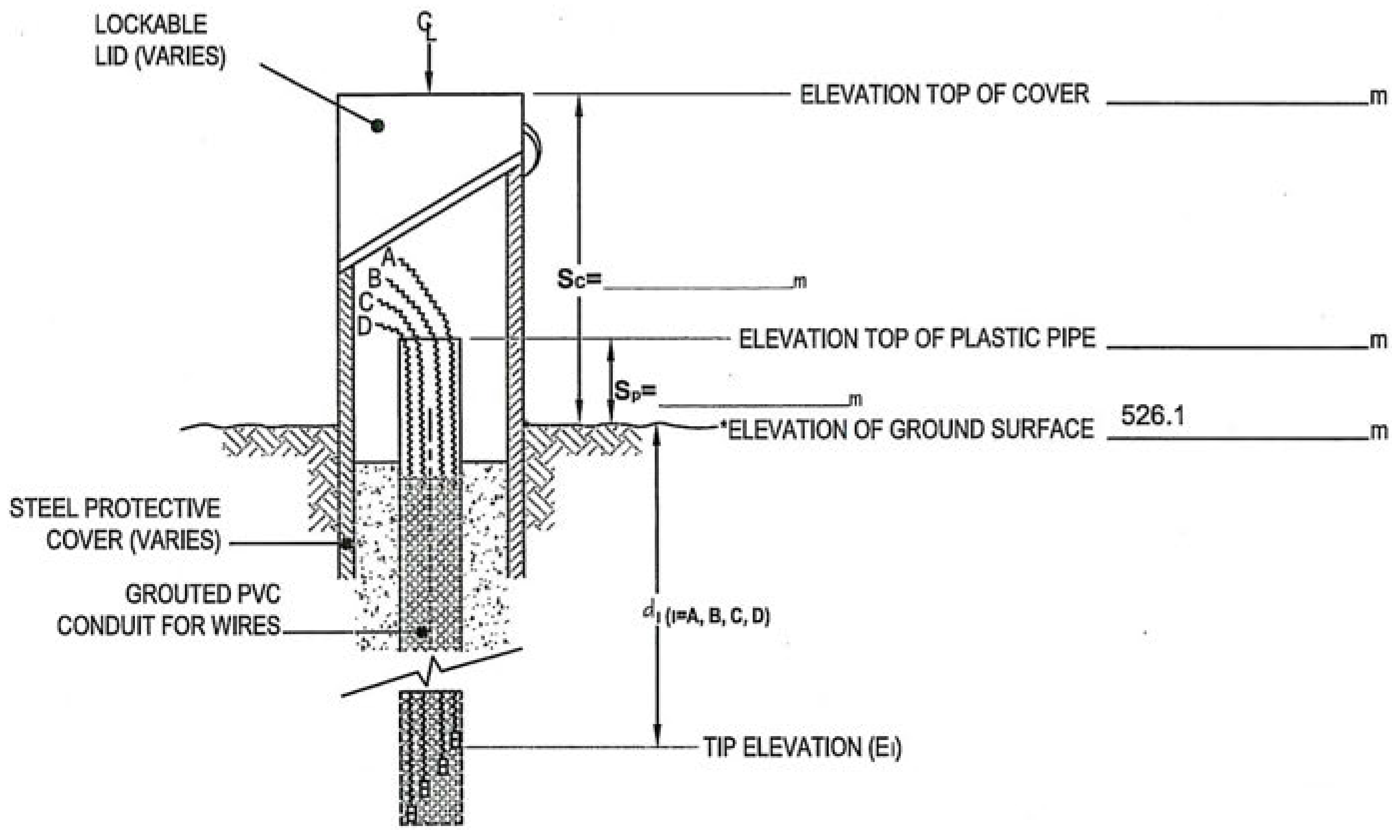
VW Make / Type: SINCO

Grout Mixture: ______

STICK-UP CASING PROTECTOR:

NORTHING: 5870042.20

EASTING: 532161.22



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	13.1	513.0	86207	-0.0000092187	-0.000086190	74.336
B	13.0	513.1	82508	-0.000010436	-0.0037525	102.54
C	28.0	498.1	82507	-0.0000094174	-0.0068098	105.80
D	56.2	469.9	82501	-0.000012001	-0.0034358	102.03

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 29 MAY 2006

Project No: KX04397

Supervised by AMEC: S.CARLSON / R.GUSTAFSON

Install'n No: BH9

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

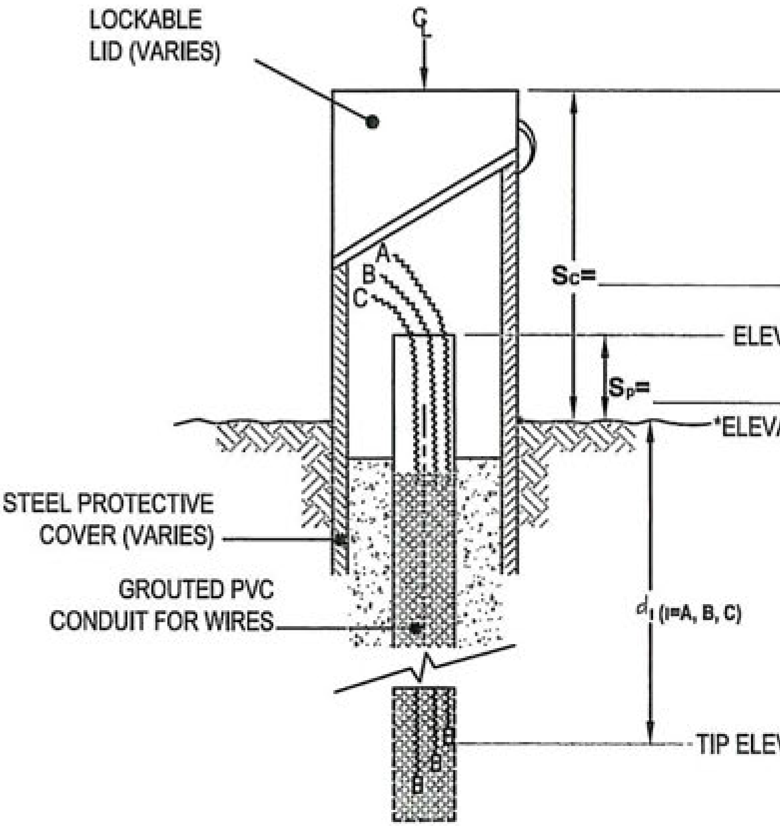
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5870120.36

EASTING: 531883.33



ELEVATION TOP OF COVER m

ELEVATION TOP OF PLASTIC PIPE m

*ELEVATION OF GROUND SURFACE 534.7 m

TIP ELEVATION (E_I)

INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_20)	MANUAL FACTOR B (m H_20)	MANUAL FACTOR C (m H_20)
A	15.1	519.6	86206	-0.0000089271	-0.0031765	91.884
B	30.6	504.1	82510	-0.000012535	0.00089219	111.86
C	50.1	484.6	86210	-0.000015490	-0.0064010	149.72

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH7-BH16-Installation forms.dwg – BH9 – Apr. 03, 2007 3:04pm – shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 5 JULY 2005

Project No: KX04397

Supervised by AMEC: N.EKMAN

Install'n No: BH10

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

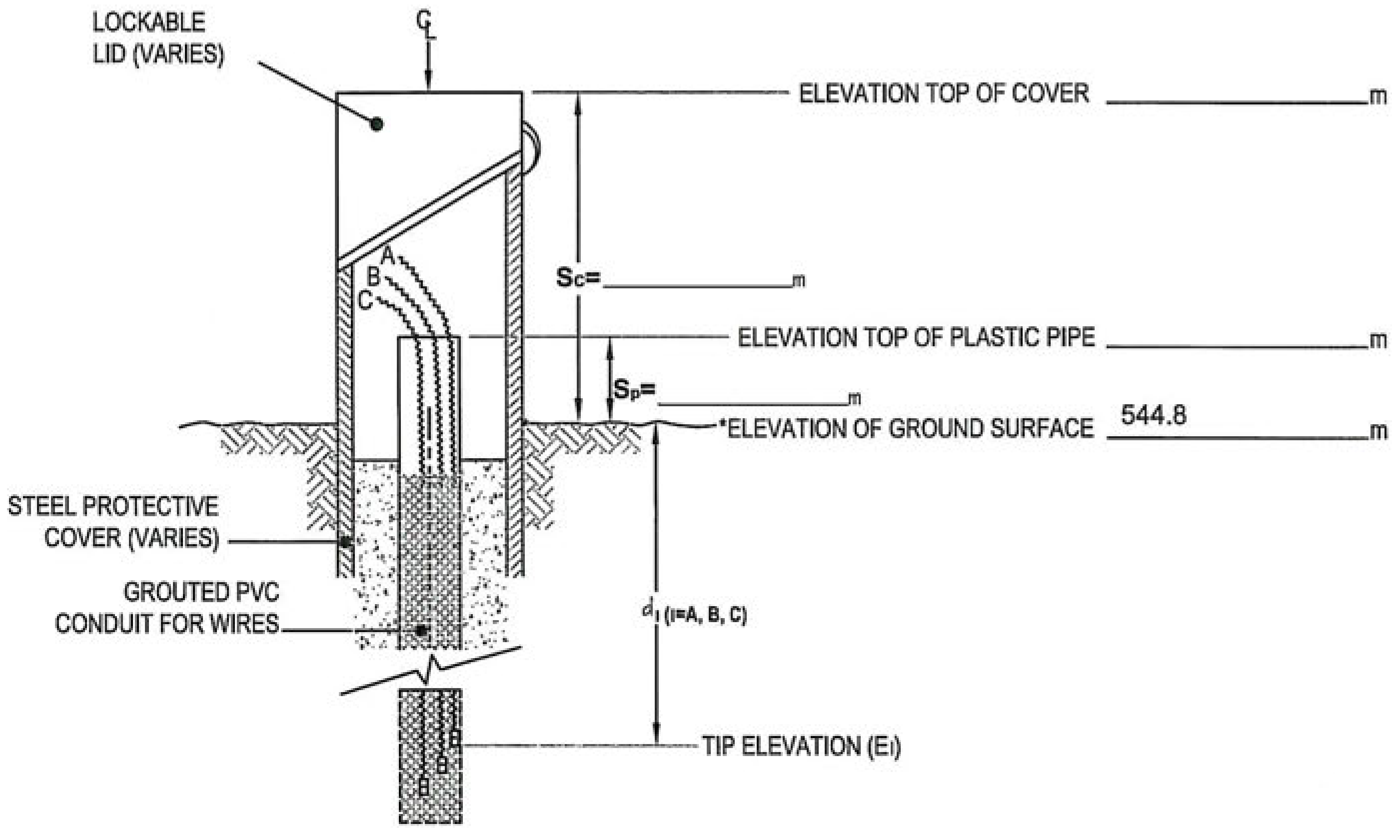
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5869655.38

EASTING: 531591.83



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	11.6	533.2	82758	-0.000012935	0.0018914	115.81
B	20.4	524.4	82511	-0.000010929	-0.0021866	105.81
C	48.6	496.2	82504	-0.000012802	0.000056544	122.96

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH7-BH16-installation forms.dwg - BH10 - Apr. 03, 2007 3:04pm - shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 10 JUNE 2005

Project No: KX04397

Supervised by AMEC: S.CARLSON / N.EKMAN

Install'n No: BH11

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

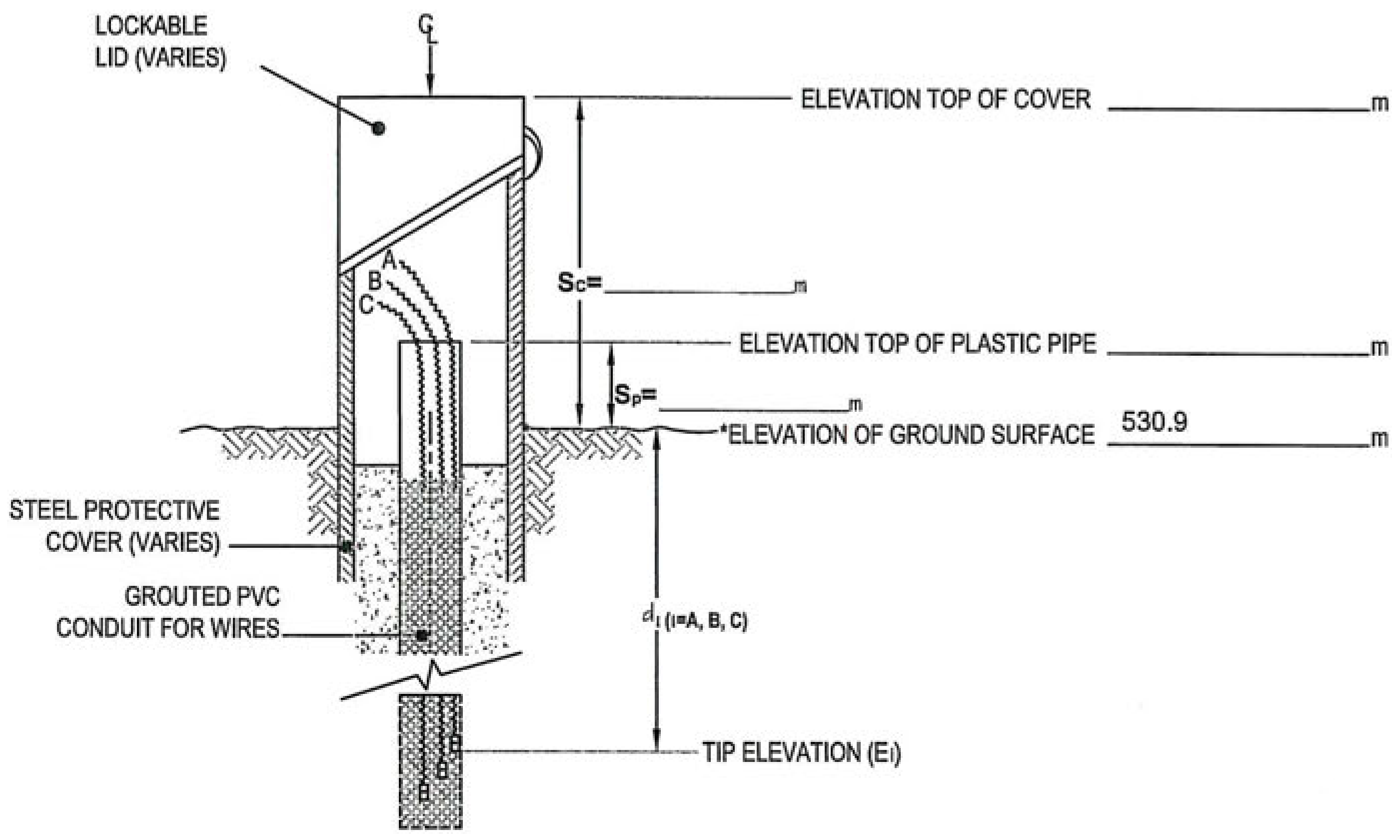
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5870360.16

EASTING: 532036.58



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_20)	MANUAL FACTOR B (m H_20)	MANUAL FACTOR C (m H_20)
A	14.3	516.6	82513	-0.000010701	0.0023936	80.96
B	32.0	498.9	82514	-0.000012057	0.0025357	111.36
C	50.3	480.6	82502	-0.000012722	0.0038803	111.73

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 21 JUNE 2005

Project No: KX04397

Supervised by AMEC: S.CARLSON / N.EKMAN

Install'n No: BH12

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

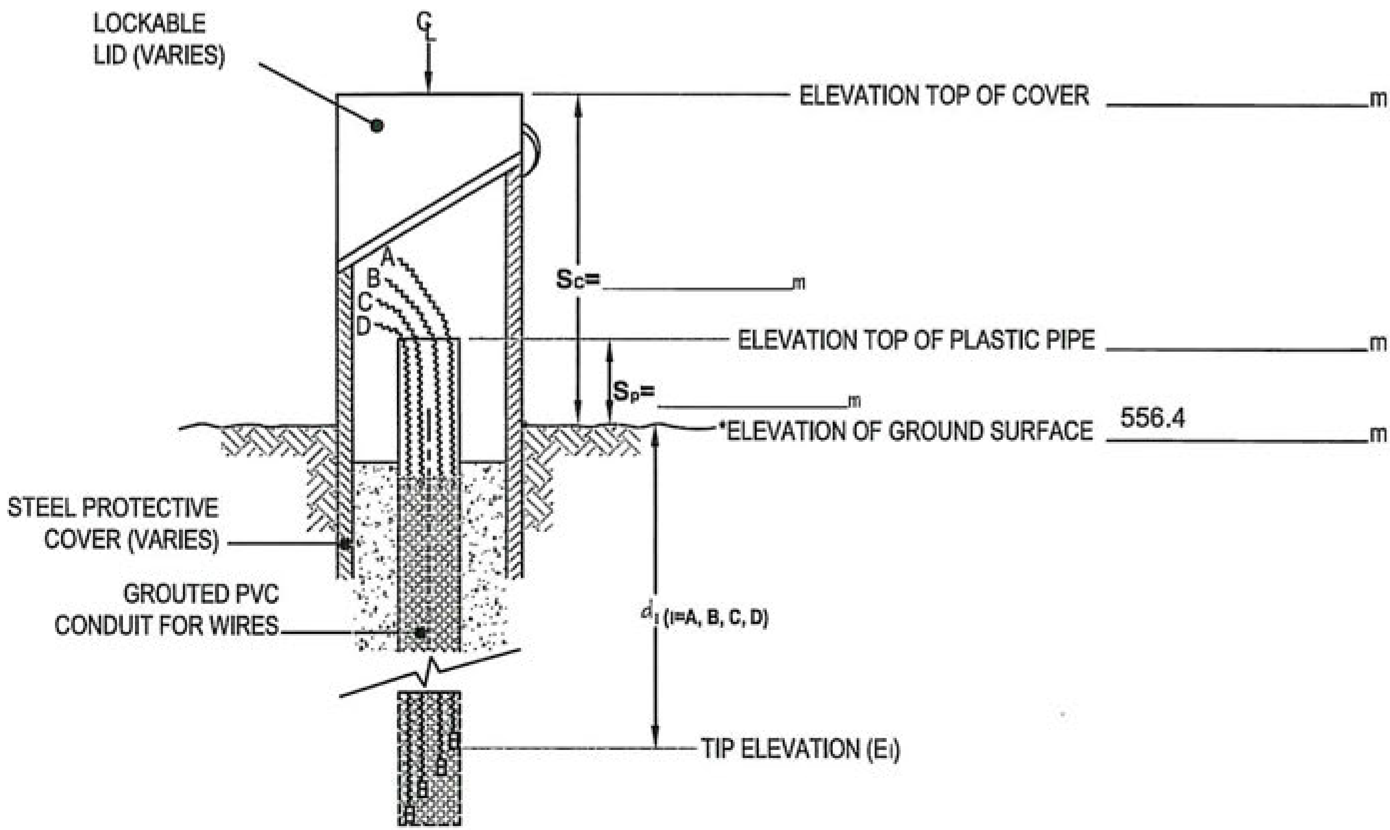
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5870271.58

EASTING: 531620.09



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	18.0	538.4	82760	-0.000012275	-0.0012922	118.28
B	22.9	533.5	82517	-0.000012605	-0.0028334	135.80
C	26.5	529.9	82516	-0.000012238	0.00036981	115.34
D	54.9	501.5	82506	-0.000012076	0.00035765	117.45

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 8 JULY 2005

Project No: KX04397

Supervised by AMEC: N.EKMAN

Install'n No: BH13

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

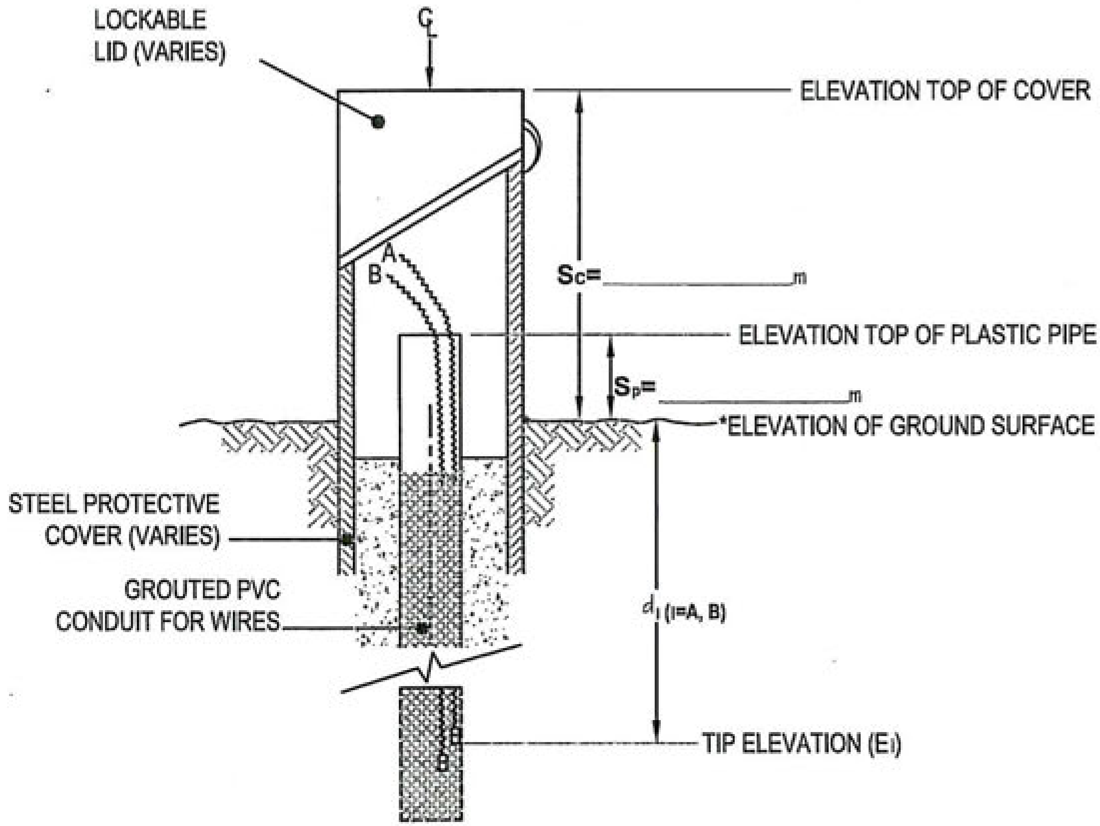
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5869941.11

EASTING: 532460.93



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_I	TIP ELEVATION (m) E_I	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	5.1	476.9	82759	-0.000011740	-0.0049154	128.58
B	14.4	467.6	82512	-0.000013035	0.0021625	100.42

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 23 JUNE 2006

Project No: KX04397

Supervised by AMEC: R.GUSTAFSON

Install'n No: BH14

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

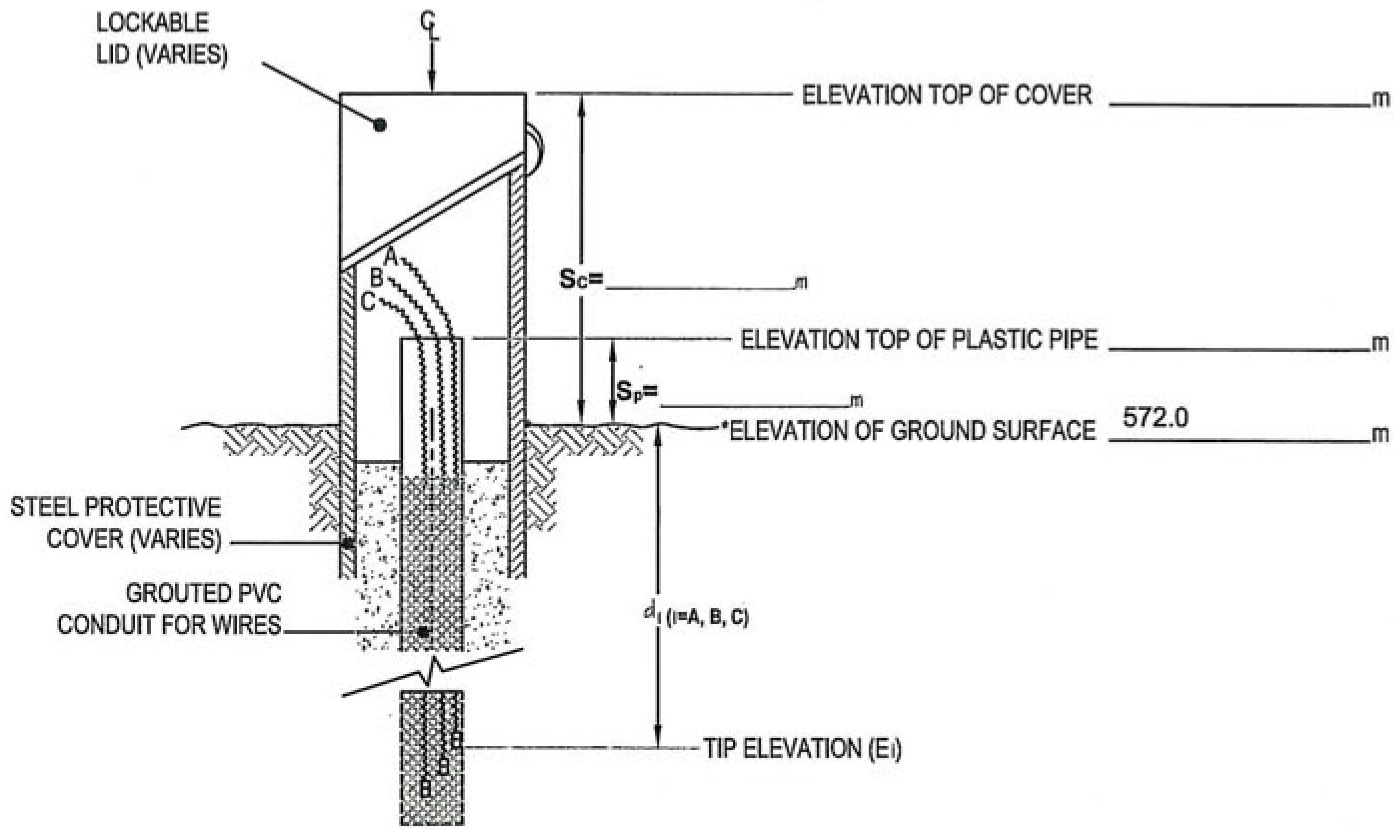
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5869692.84

EASTING: 531276.21



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_i	TIP ELEVATION (m) E_i	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	20.1	551.9	86208	-0.0000083033	-0.0050388	84.487
B	65.9	506.1	86211	-0.000016544	-0.0019229	159.14
C	98.7	473.3	86213	-0.000027912	-0.026608	356.17

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH7-BH16-Installation forms.dwg - BH14 - Apr. 03, 2007 3:06pm - shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 19 JULY 2006

Project No: KX04397

Supervised by AMEC: R.GUSTAFSON

Install'n No: BH15

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

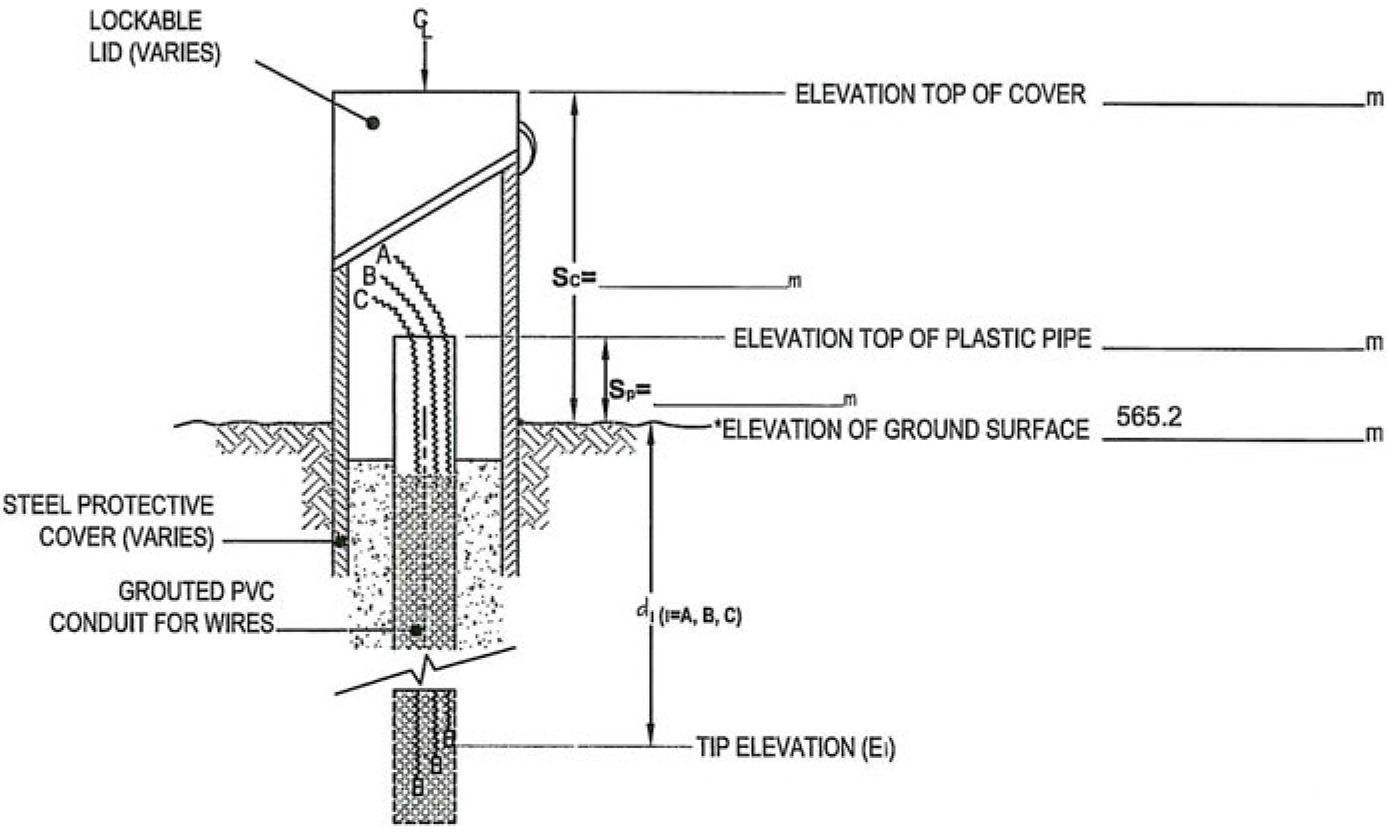
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5870278.18

EASTING: 531417.20



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_i	TIP ELEVATION (m) E_i	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	8.8	556.4	86209	-0.0000097174	0.0010648	80.114
B	63.3	501.9	86212	0.000017528	-0.00046492	161.27
C	83.2	482.0	86214	-0.000029246	-0.012026	297.22

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH7-BH16-Installation forms.dwg - BH15 - Apr. 03, 2007 3:06pm - shelley.ruiz

VIBRATING WIRE PIEZOMETER INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 23 OCTOBER 2006

Project No: KX04397

Supervised by AMEC: S.CARLSON / N.EKMAN

Install'n No: BH16

Install Method / Driller: GEOTECH DRILLING SERVICES

Lock/Key No:

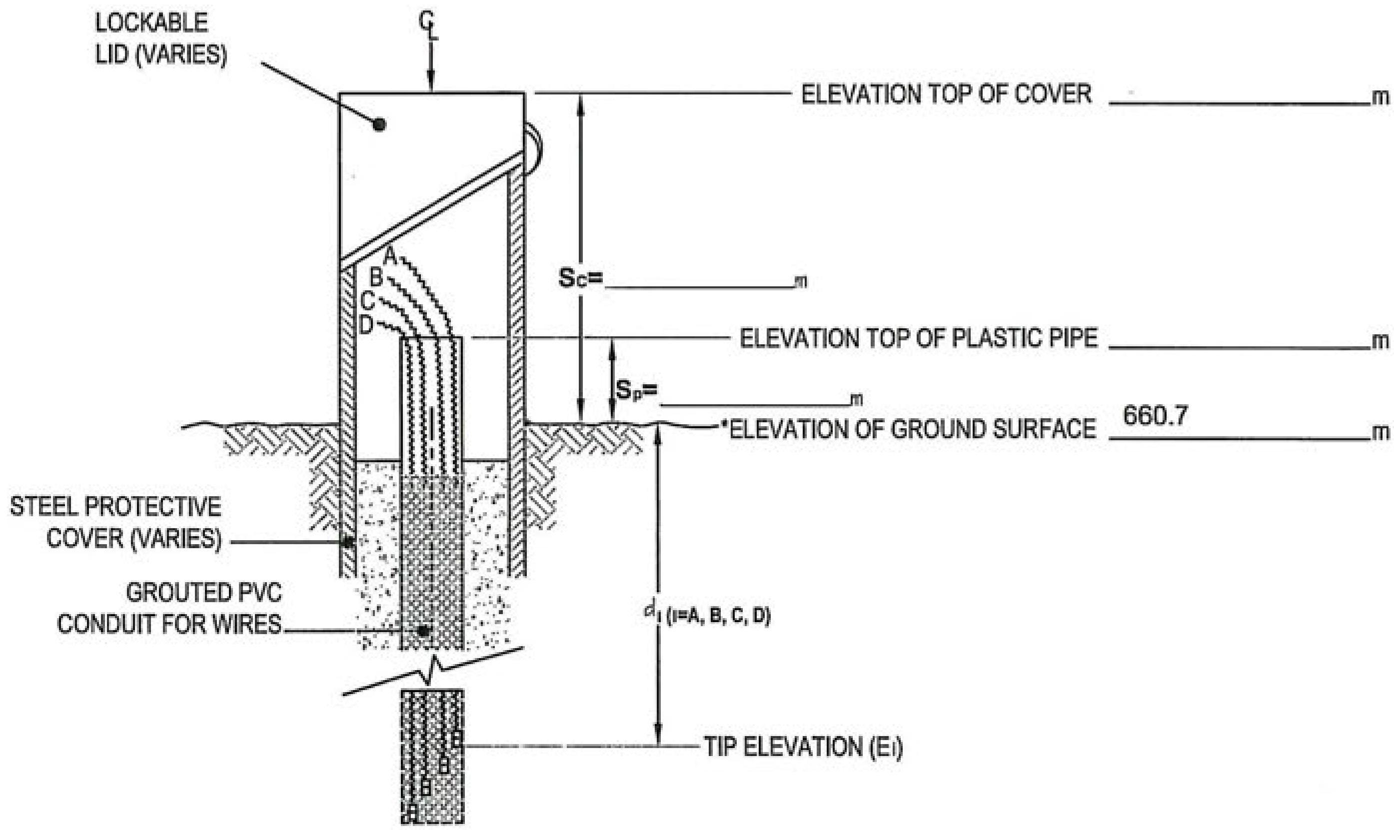
VW Make / Type: SINCO

Grout Mixture:

STICK-UP CASING PROTECTOR:

NORTHING: 5869544.24

EASTING: 530634.61



INSTRUMENT NO.	INSTALLED TIP DEPTH (m) d_i	TIP ELEVATION (m) E_i	SERIAL NO.	MANUAL FACTOR A (m H_2O)	MANUAL FACTOR B (m H_2O)	MANUAL FACTOR C (m H_2O)
A	42.7	618.0	82509	-0.000010267	-0.000085463	97.557
B	85.5	575.2	86215	-0.000029148	-0.026148	332.81
C	139.1	521.6	86216	-0.000029390	-0.028715	340.86
D	214.9	445.8	86217	-0.000092198	0.032651	671.88

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 25 OCTOBER 2000

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: SI1

Install Method / Driller: CARIBOU WATER WELLS

Lock/Key No: ______

SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 128 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869298.11

EASTING: 532568.71

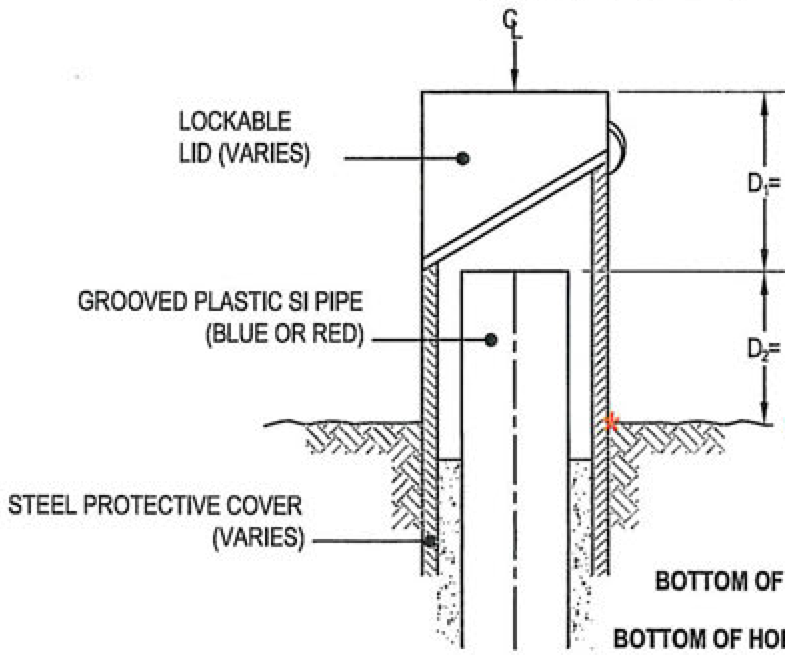
Anchor/Grout/backfill details:

______

______

______

______



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 480.27 m

D_2= 0.72 m

*ELEVATION OF GROUND SURFACE 479.55 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	43.6 m	435.95 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 Installation forms .dwg - SI1 - Apr. 13, 2007 11:38am - shelley.ruiz

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name:	WEST QUESNEL SLOPE STABILITY		
Date (s) Installed:	23 OCTOBER 2000	Project No:	KX04397
Supervised by AMEC:	D.DEWAR	Install'n No:	SI2
Install Method / Driller:	CARIBOU WATER WELLS	Lock/Key No:	

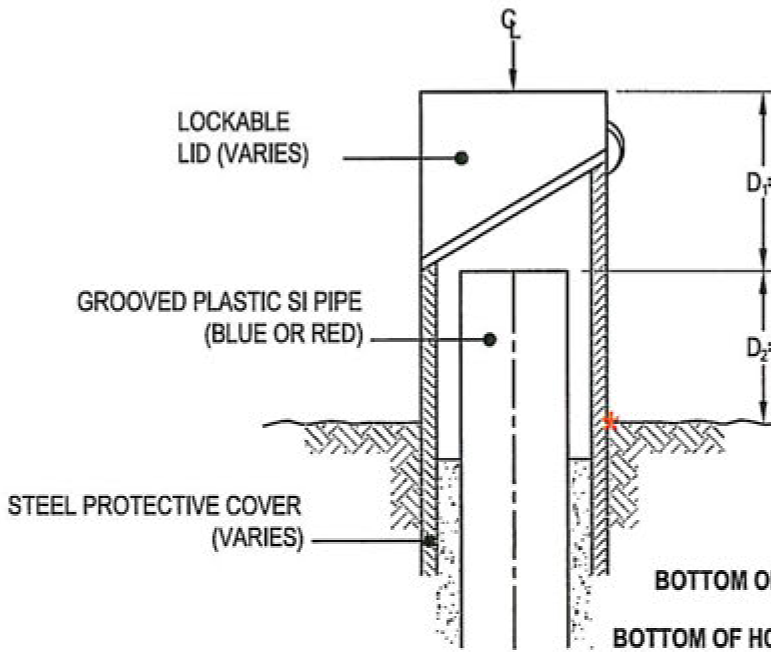
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 138 °mag ______ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

NORTHING: 5869342.66

EASTING: 532489.83



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 485.86 m

D_2= 0.80 m

*ELEVATION OF GROUND SURFACE 485.06 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	74.6 m	410.46 m
BOTTOM OF HOLE AT	74.7 m	410.36 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 27 OCTOBER 2000 — Project No: KX04397

Supervised by AMEC: D.DEWAR — Install'n No: SI3

Install Method / Driller: CARIBOU WATER WELLS — Lock/Key No: ____

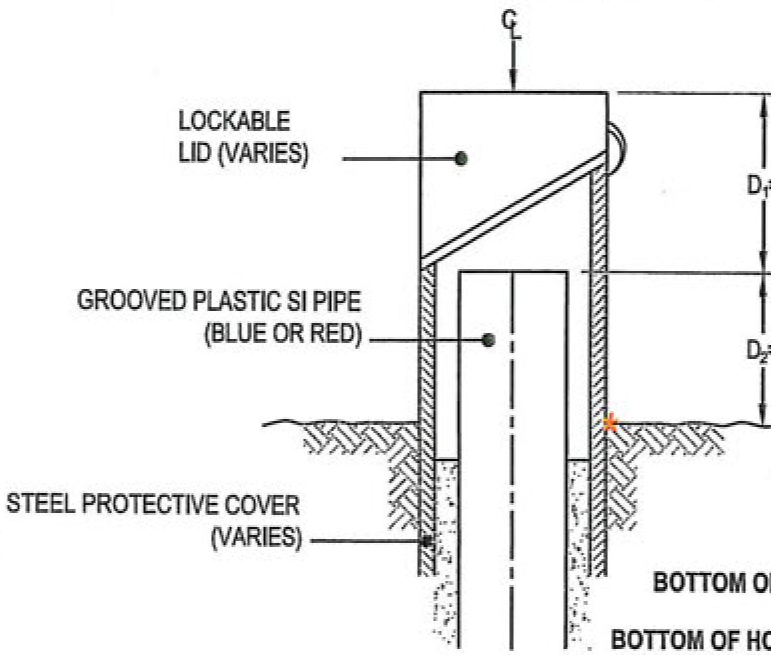
SI Casing Make / Type: ____ Dia: ____ Length: ____ Az of A0: 108 °mag ____ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869598.07

EASTING: 532273.05

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ____ m

D_1= ____ m

ELEVATION TOP OF SI PIPE 503.43 m

D_2= 0.82 m

*ELEVATION OF GROUND SURFACE 502.61 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	102.4 m	400.21 m
BOTTOM OF HOLE AT	109.8 m	392.81 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 13 OCTOBER 2000

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: SI4

Install Method / Driller: CARIBOU WATER WELLS

Lock/Key No:

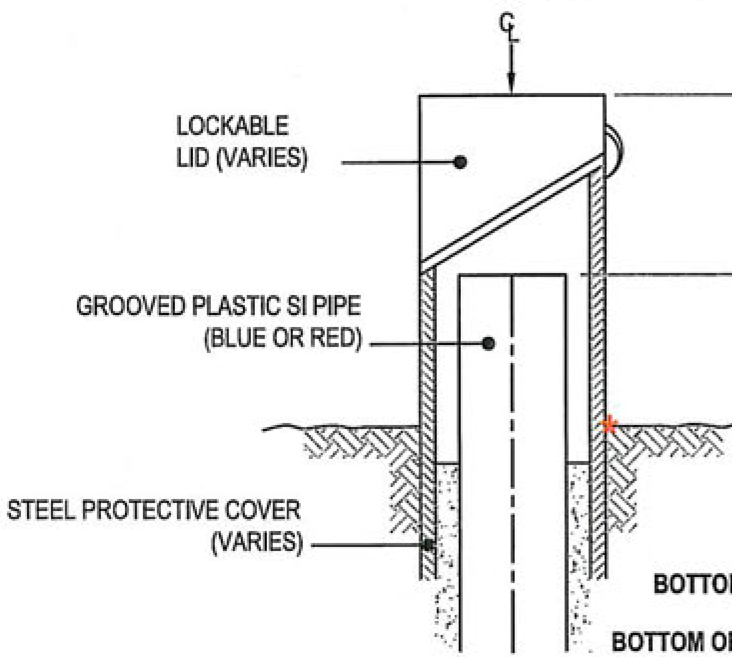
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 128 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869878.16

EASTING: 531829.52

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 537.58 m

D_2= 0.73 m

*ELEVATION OF GROUND SURFACE 536.86 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	158.0 m	378.86 m
BOTTOM OF HOLE AT	158.5 m	378.36 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg - SI4 - Apr. 13, 2007 11:42am - shelley.ruiz

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 5 OCTOBER 2000

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: SI5

Install Method / Driller: CARIBOU WATER WELLS

Lock/Key No:

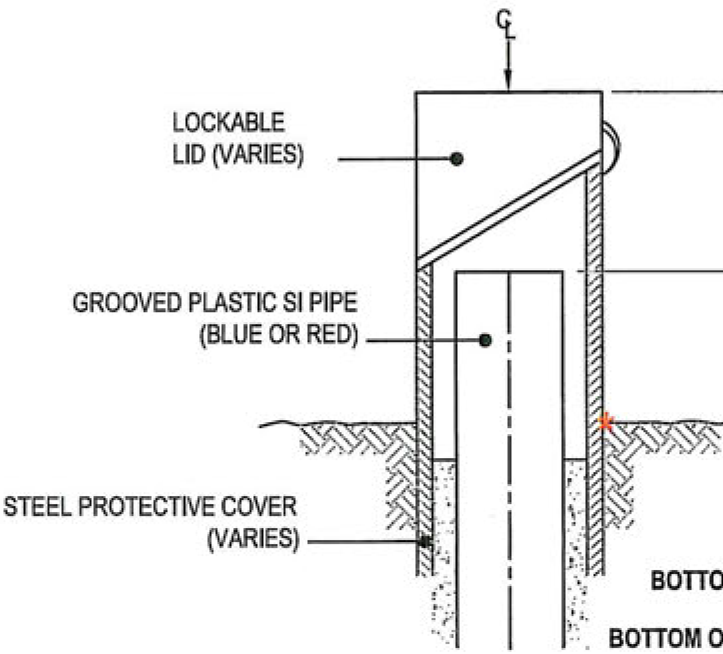
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 110 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869633.24

EASTING: 531919.02

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 517.67 m

D_2= 0.78 m

*ELEVATION OF GROUND SURFACE 516.89 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	144.8 m	372.09 m
BOTTOM OF HOLE AT	152.4 m	364.49 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg - SI5 - Apr. 13, 2007 11:43am - shelley.nuiz

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 16 OCTOBER 2000

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: SI6

Install Method / Driller: CARIBOU WATER WELLS

Lock/Key No:

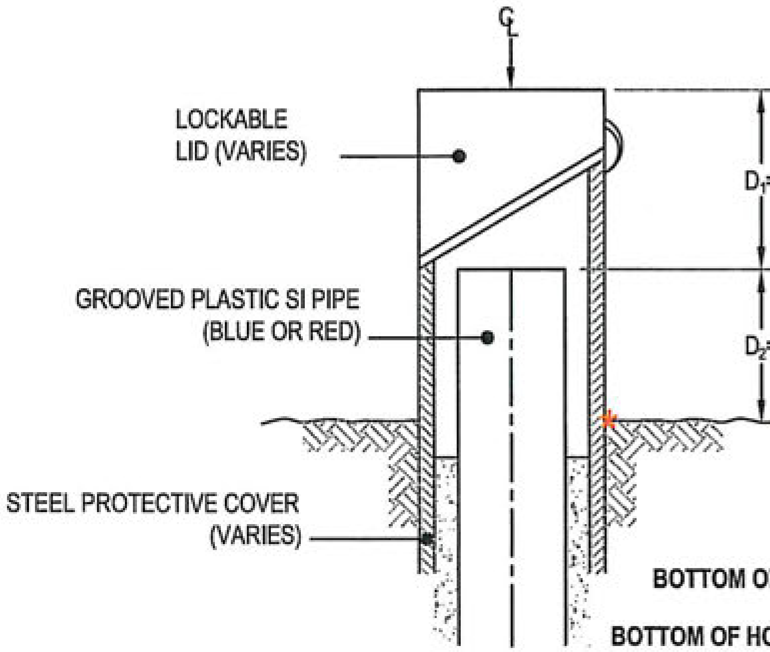
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 105 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869933.44

EASTING: 531509.91

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 557.72 m

D_2= 0.84 m

*ELEVATION OF GROUND SURFACE 556.88 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	154.5 m	402.38 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 installation forms .dwg - SI6 - Apr. 13, 2007 11:44am - shelley.nelz

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 19 OCTOBER 2000

Project No: KX04397

Supervised by AMEC: D.DEWAR

Install'n No: SI7

Install Method / Driller: CARIBOU WATER WELLS

Lock/Key No:

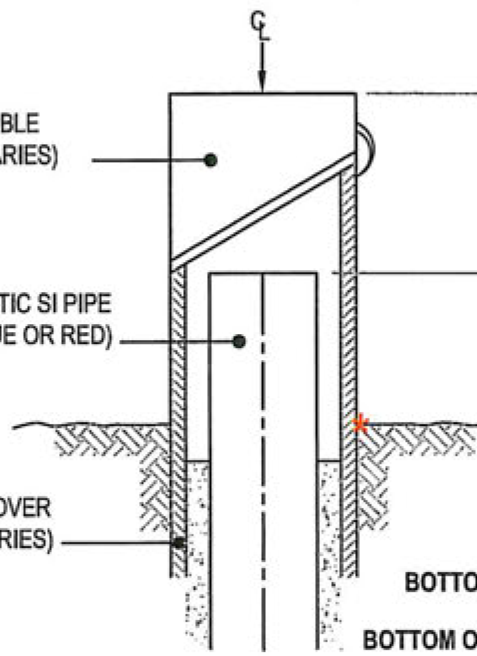
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 84 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5870231.73

EASTING: 531798.61

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 542.22 m

D_2= 0.66 m

*ELEVATION OF GROUND SURFACE 541.56 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	125.6 m	415.96 m
BOTTOM OF HOLE AT	128.0 m	413.56 m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

C:_Drafting Working\West Quesnel Slope Stability\KX04397.15-2007 Report-April 2007\BH2-BH6 and SI1-SI15 Installation forms .dwg - SI7 - Apr. 13, 2007 11:47am - shelley.ruiz

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name:	WEST QUESNEL SLOPE STABILITY		
Date (s) Installed:	30 MARCH 2005	Project No:	KX04397
Supervised by AMEC:	S.GREEN	Install'n No:	SI8
Install Method / Driller:	INGERSOLL RAND TH-60 CARIBOU WATER WELLS	Lock/Key No:	

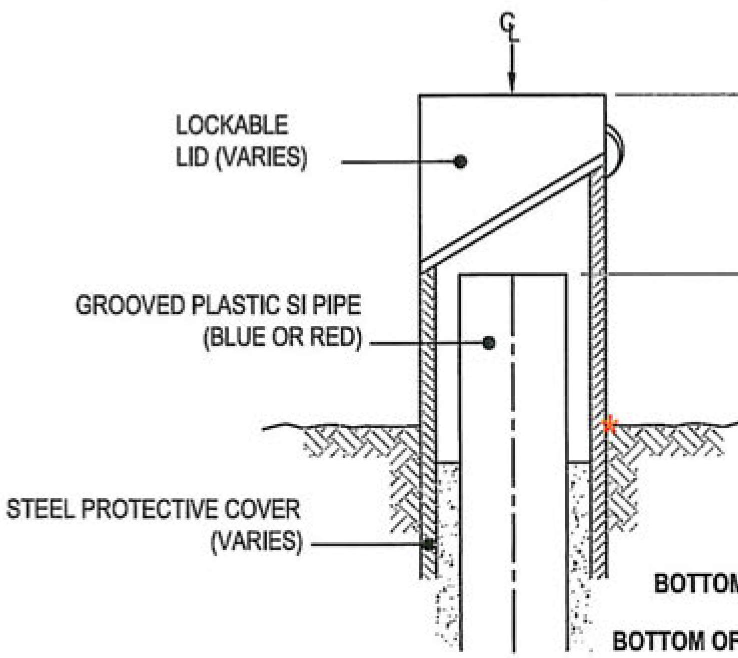
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 82 °mag ______ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

NORTHING: 5870035.94

EASTING: 532164.87



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 526.7 m

D_2= 0.8 m

*ELEVATION OF GROUND SURFACE 525.9 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	71.3 m	454.6 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name:	WEST QUESNEL SLOPE STABILITY		
Date (s) Installed:	1 APRIL 2005	Project No:	KX04397
Supervised by AMEC:	S.GREEN	Install'n No:	SI9
Install Method / Driller:	INGERSOLL RAND TH-60 CARIBOU WATER WELLS	Lock/Key No:	

SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 146 °mag ______ °true

A). STICK-UP CASING PROTECTOR

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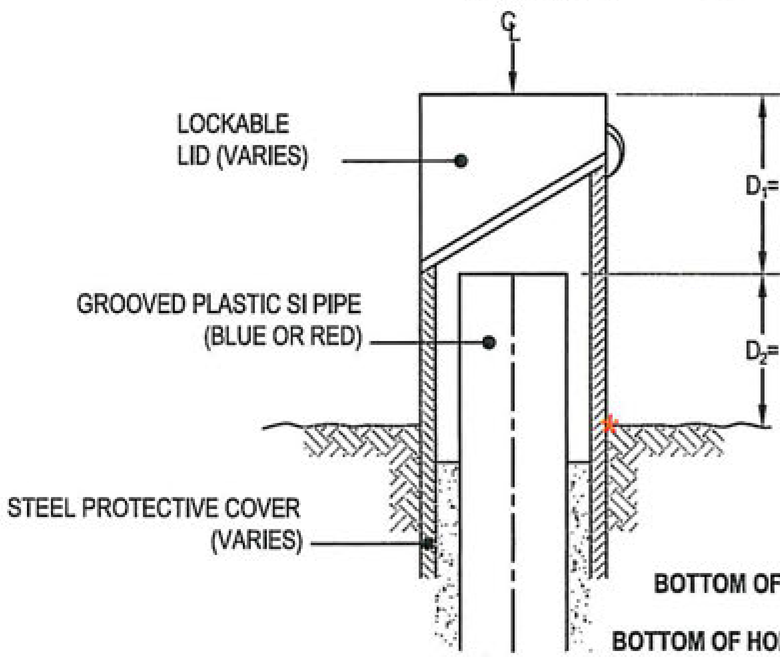
EASTING: 531881.71

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 535.9 m

D_2= 1.0 m

*ELEVATION OF GROUND SURFACE 534.9 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	79.2 m	455.7 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 3 APRIL 2005

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: SI10

Install Method / Driller: INGERSOLL RAND TH-60 CARIBOU WATER WELLS

Lock/Key No:

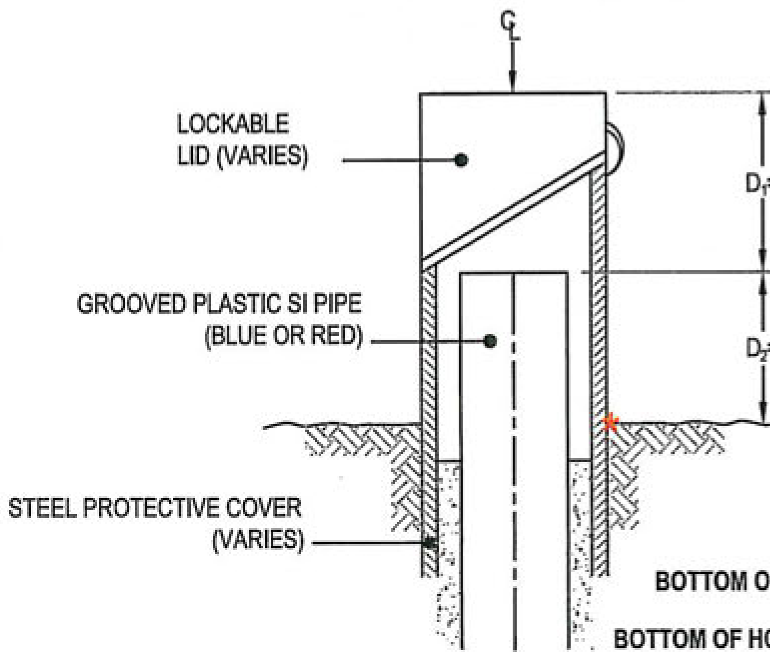
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 112 °mag ______ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

NORTHING: 5869648.52

EASTING: 531587.49



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 546.1 m

D_2= 1.0 m

*ELEVATION OF GROUND SURFACE 545.1 m

BOTTOM OF SI AT 79.9 m 465.2 m

BOTTOM OF HOLE AT ______ m ______ m

DEPTH (bgs) ELEVATION

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 4 APRIL 2005

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: SI11

Install Method / Driller: INGERSOLL RAND TH-60 CARIBOU WATER WELLS

Lock/Key No: ____

SI Casing Make / Type: ____ Dia: ____ Length: ____ Az of A0: 80 °mag ____ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

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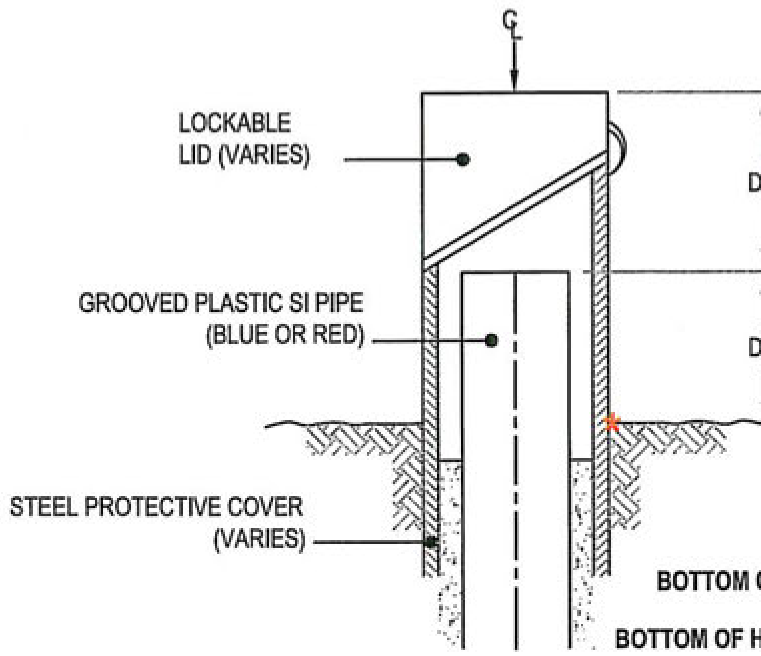
EASTING: 532040.67



ELEVATION TOP OF COVER ____ m

D_1= ____ m

ELEVATION TOP OF SI PIPE 531.8 m

D_2= 0.9 m

*ELEVATION OF GROUND SURFACE 530.9 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	70.7 m	460.2 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 4 APRIL 2005

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: SI12

Install Method / Driller: INGERSOLL RAND TH-60 CARIBOU WATER WELLS

Lock/Key No:

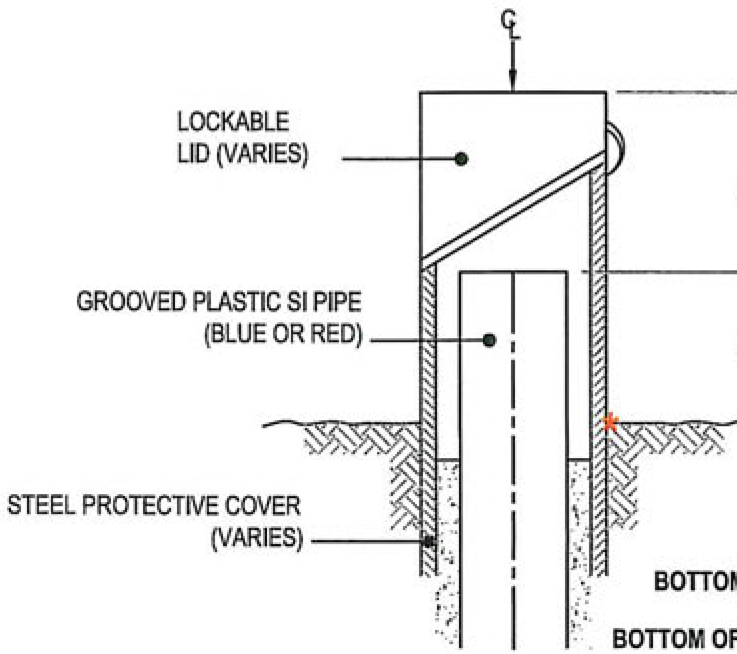
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 110 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5870278.21

EASTING: 531621.51

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1 = ______ m

ELEVATION TOP OF SI PIPE 557.1 m

D_2 = 0.9 m

*ELEVATION OF GROUND SURFACE 556.2 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	73.2 m	483.0 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 7 APRIL 2005

Project No: KX04397

Supervised by AMEC: S.GREEN

Install'n No: SI13

Install Method / Driller: INGERSOLL RAND TH-60 CARIBOU WATER WELLS

Lock/Key No: ______

SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 54 °mag ______ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

______

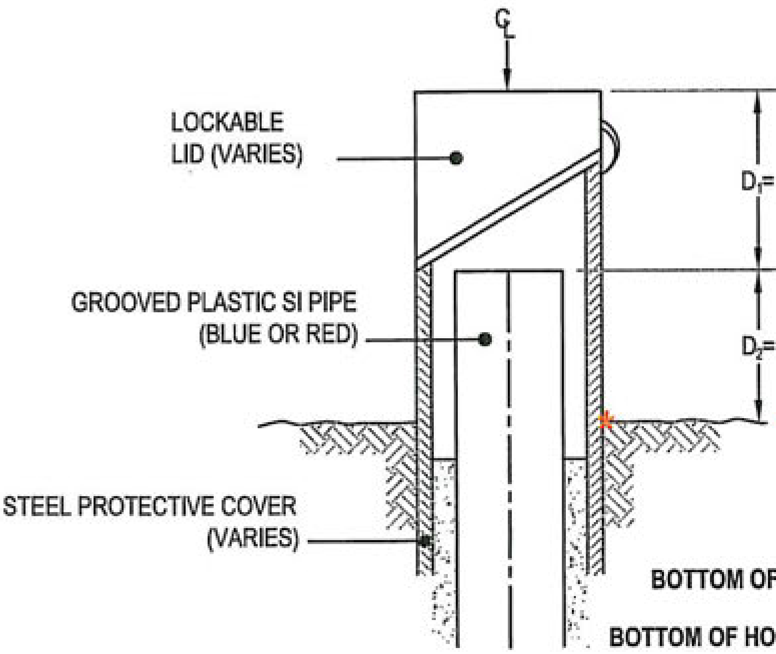
______

______

______

NORTHING: 5869937.72

EASTING: 532468.20



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 482.9 m

D_2= 0.8 m

*ELEVATION OF GROUND SURFACE 482.1 m

BOTTOM OF SI AT 39.6 m 442.5 m

BOTTOM OF HOLE AT ______ m ______ m

DEPTH (bgs) ELEVATION

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 20 JUNE 2005 | Project No: KX04397

Supervised by AMEC: R.GUSTAFSON | Install'n No: SI14

Install Method / Driller: B-80 GEOTECH DRILLING | Lock/Key No:

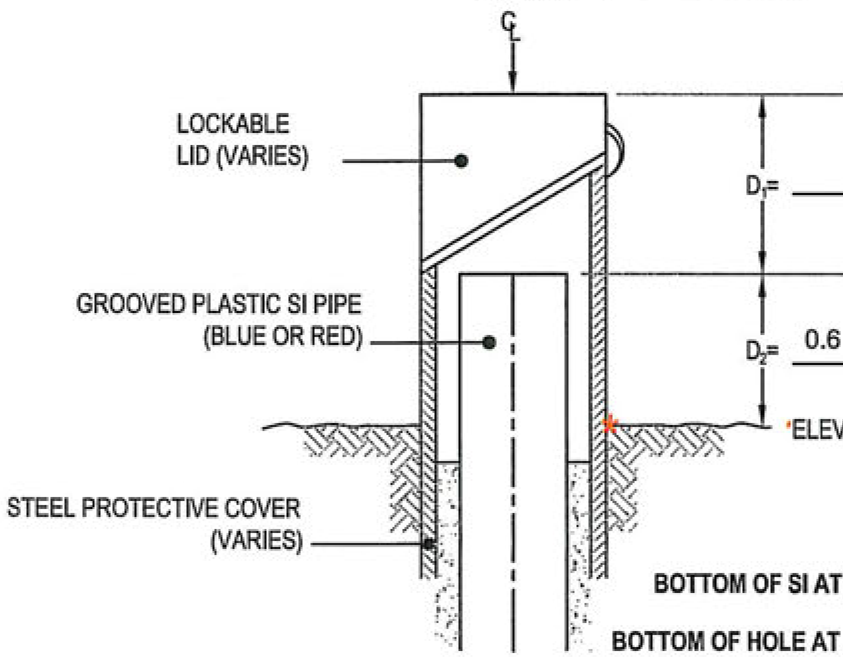
SI Casing Make / Type: ______ Dia: ______ Length: ______ Az of A0: 148 °mag ______ °true

A). STICK-UP CASING PROTECTOR

NORTHING: 5869683.61

EASTING: 531276.55

Anchor/Grout/backfill details:



ELEVATION TOP OF COVER ______ m

D_1= ______ m

ELEVATION TOP OF SI PIPE 572.9 m

D_2= 0.6 m

*ELEVATION OF GROUND SURFACE 572.3 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	99.4 m	472.9 m
BOTTOM OF HOLE AT	m	m

GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

SI-STICKUP&FLUSH

SLOPE INCLINOMETER (SI) INSTALLATION DETAIL

amec

Project Name: WEST QUESNEL SLOPE STABILITY

Date (s) Installed: 25 JULY 2005

Project No: KX04397

Supervised by AMEC: R.GUSTAFSON

Install'n No: SI15

Install Method / Driller: GEOPROBE GEOTECH DRILLING

Lock/Key No:

SI Casing Make / Type: ____ Dia: ____ Length: ____ Az of A0: 92 °mag ____ °true

A). STICK-UP CASING PROTECTOR

Anchor/Grout/backfill details:

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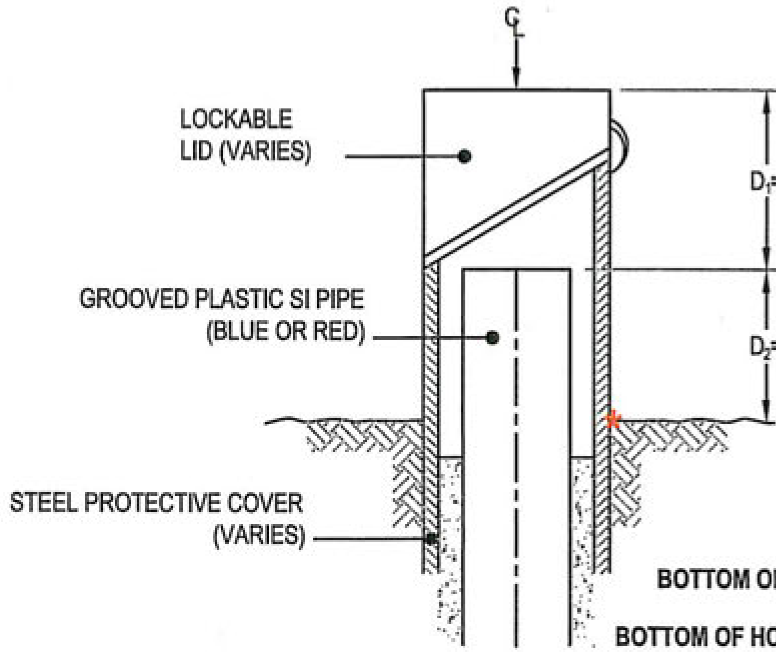
EASTING: 532163.15



ELEVATION TOP OF COVER ____ m

D_1= ____ m

ELEVATION TOP OF SI PIPE 567.1 m

D_2= 0.6 m

*ELEVATION OF GROUND SURFACE 566.5 m

	DEPTH (bgs)	ELEVATION
BOTTOM OF SI AT	90.8 m	475.7 m
BOTTOM OF HOLE AT	m	m

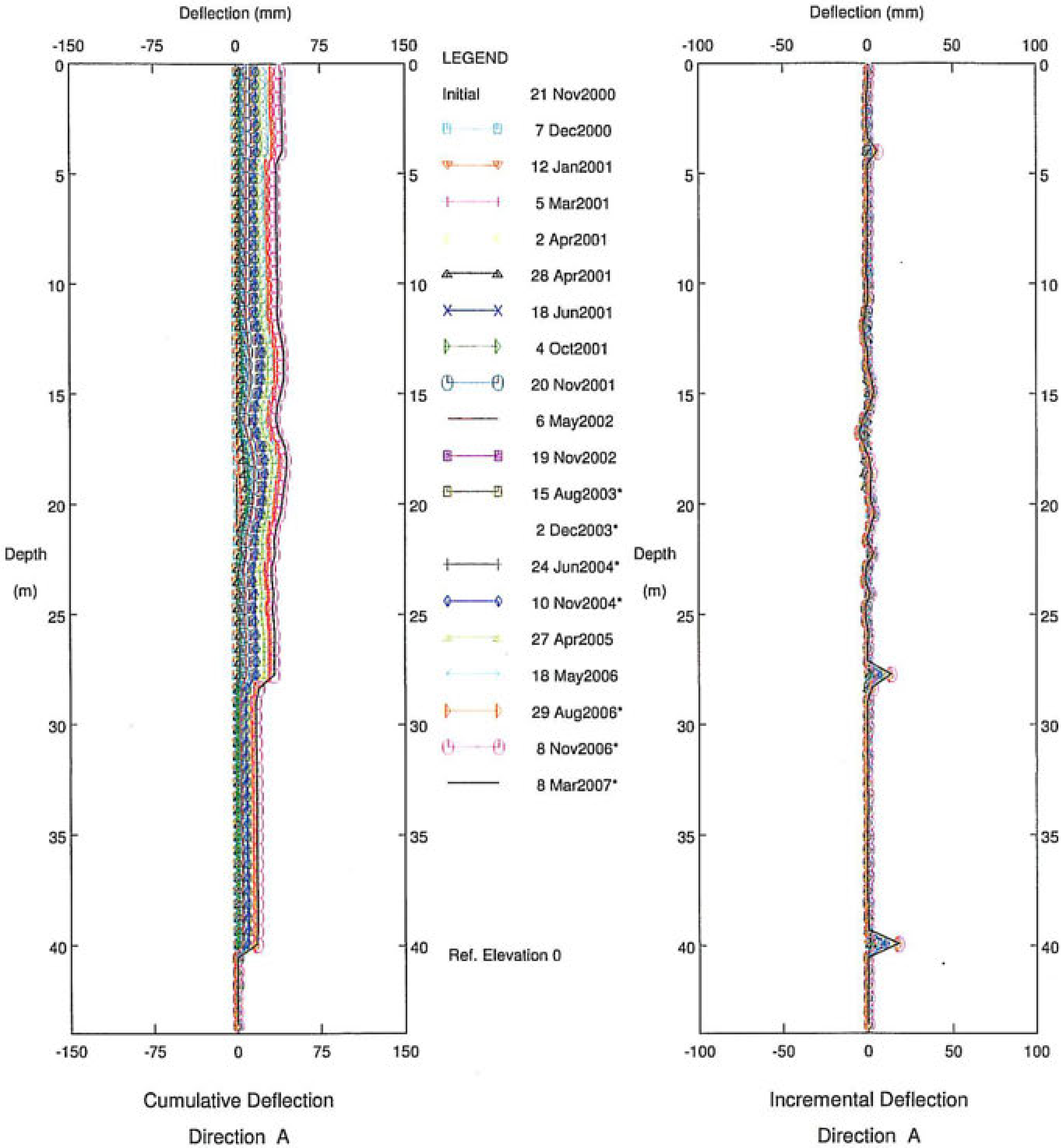
GROUND SURFACE ELEVATION SHOULD BE TAKEN DIRECTLY OUTSIDE THE INSTALLATION

APPENDIX G

Table G1: Slope Inclinometer Instrumentation Installation Details

Installation No.	Location	Ground Elevation (m)	Top of SI Elevation (m)	Install Depth (m) (from top of SI)	Ao Azimuth (º)
SI-1	Avery Lane	479.5	480.2	43.3	128
SI-2	Avery Lane	485.1	485.9	74.4	138
SI-3	Abbott & Bettcher	502.6	503.5	101.8	108
SI-4	Voyageur School	536.9	537.6	153.6	128
SI-5	Abbott Drive	516.9	517.6	144.5	-
SI-6	Dixon Street	556.9	557.7	153.0	150
SI-7	Lewis Drive & Pierce Street	541.6	542.3	124.9	84
SI-8	Pinchbeck St	525.9	526.7	71.3	82
SI-9	Patchett Ave	534.9	535.9	79.2	146
SI-10	Dawson Street	545.1	546.1	79.8	112
SI-11	Picard Ave	530.9	531.8	70.7	78
SI-12	East end of Panagrot Ave	556.2	557.1	73.2	110
SI-13	Lewis Drive	482.1	482.9	39.6	54
SI-14	Findlay Road	572.3	572.9	99.4	148
SI-15	West end of Panagrot Ave	566.5	567.1	90.8	92

AMEC Earth & Environmental - Pr. George

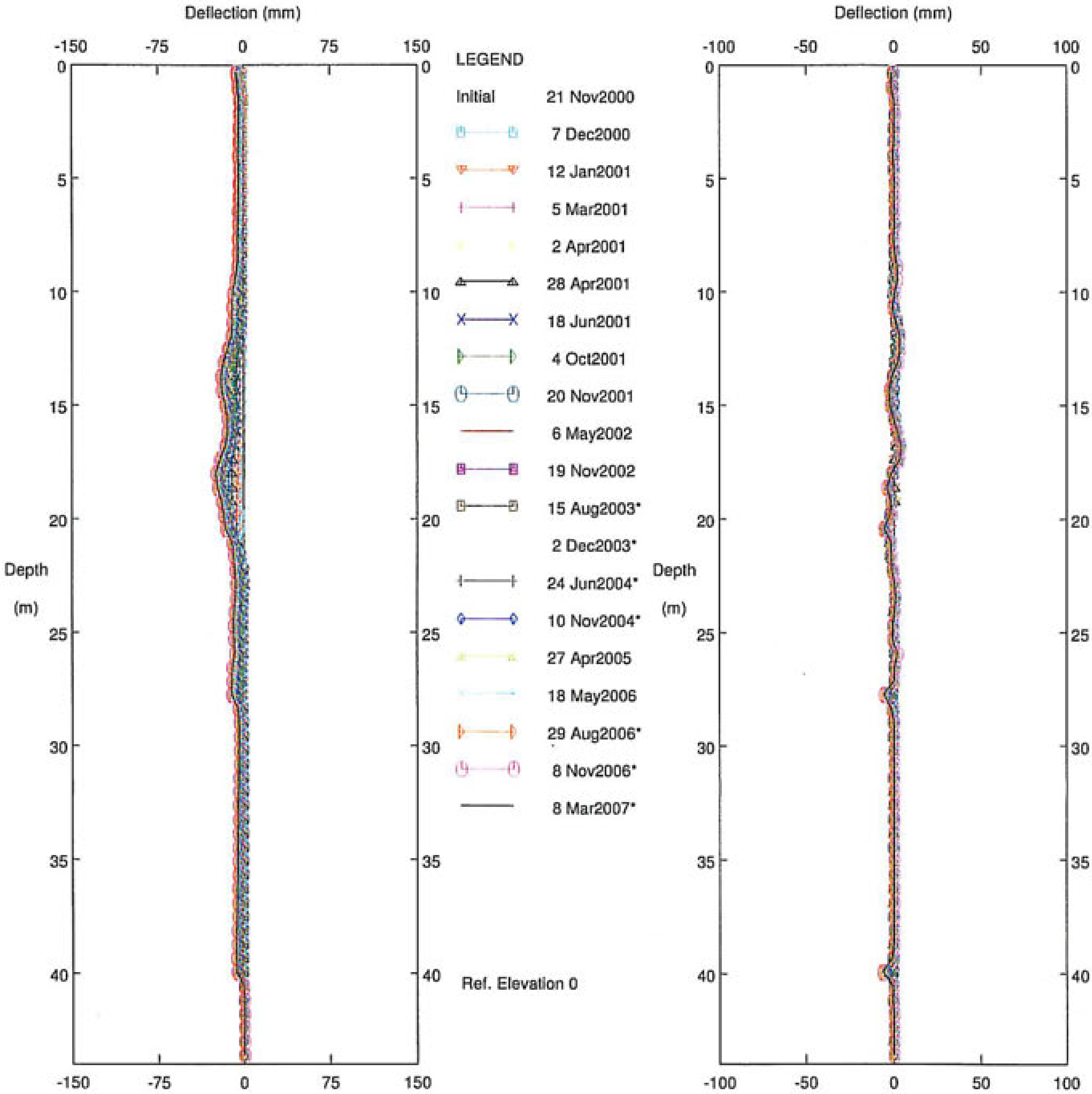


KX04397 W. Quesnel Stability Study, Inclinometer SI1

Lower Avery Lane

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

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction B

Incremental Deflection

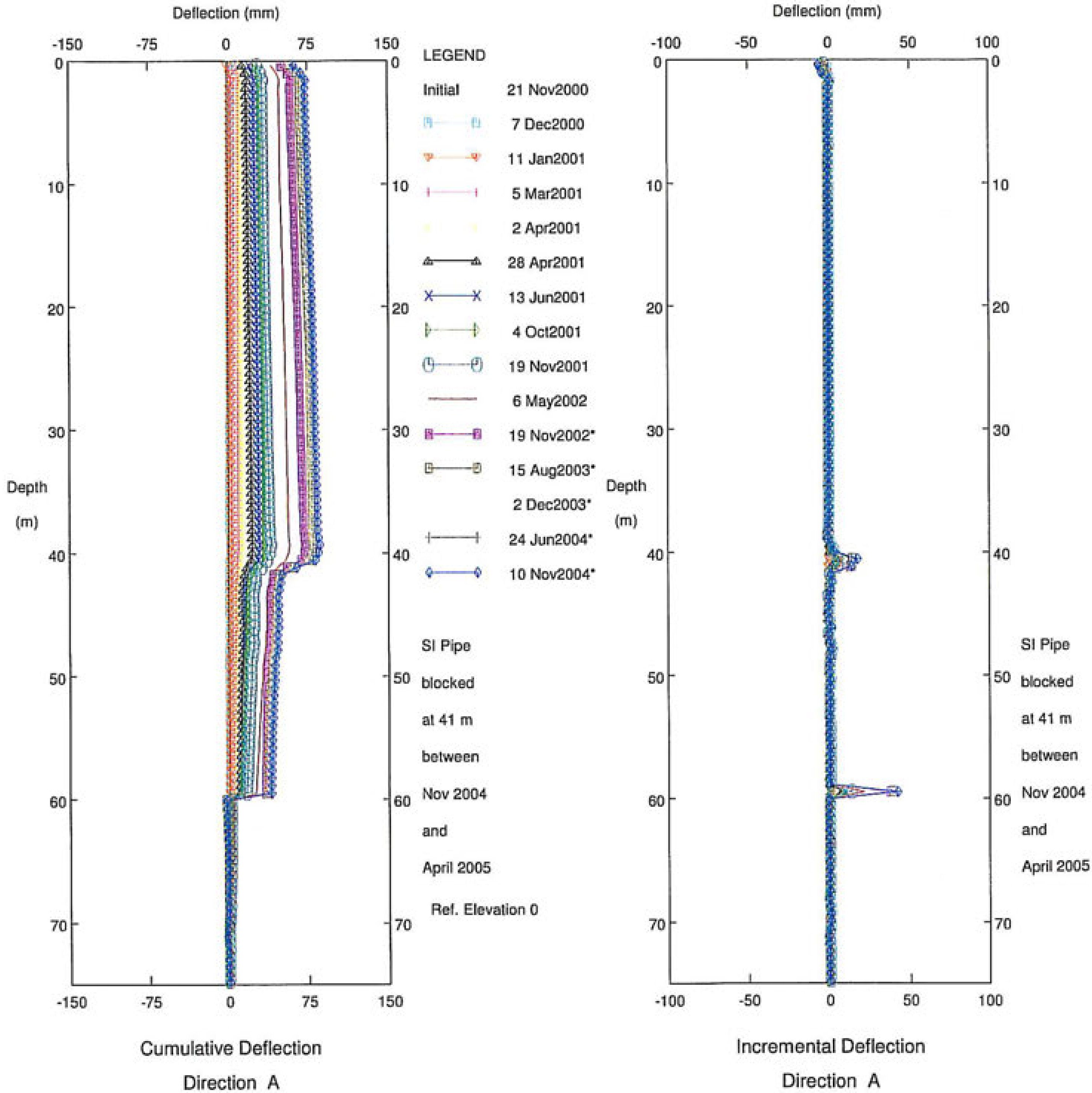
Direction B

KX04397 W. Quesnel Stability Study, Inclinometer SI1

Lower Avery Lane

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

AMEC Earth & Environmental - Pr. George

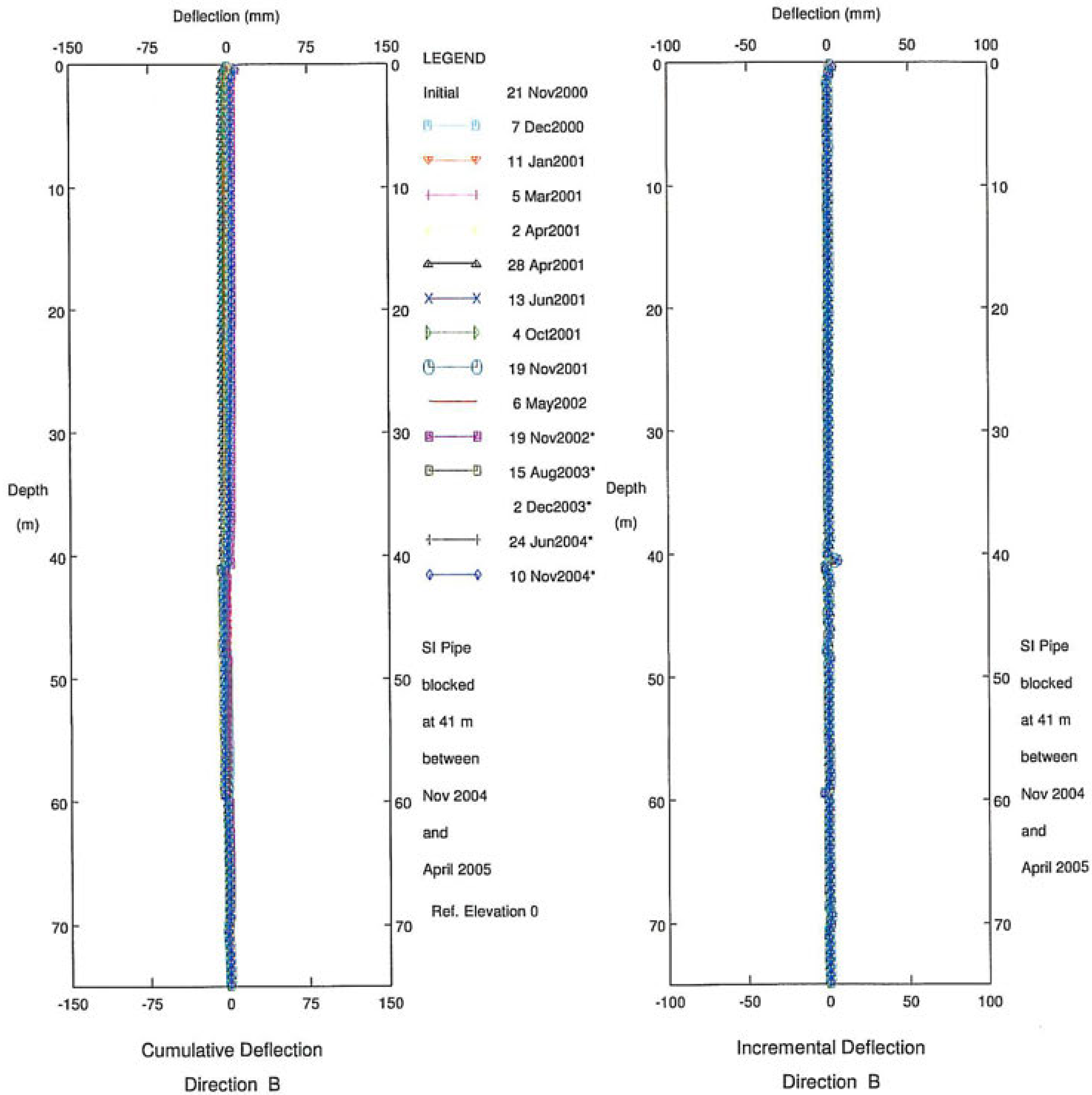


KX04397 W. Quesnel Stability Study, Inclinometer SI2

Upper Avery Lane

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

AMEC Earth & Environmental - Pr. George

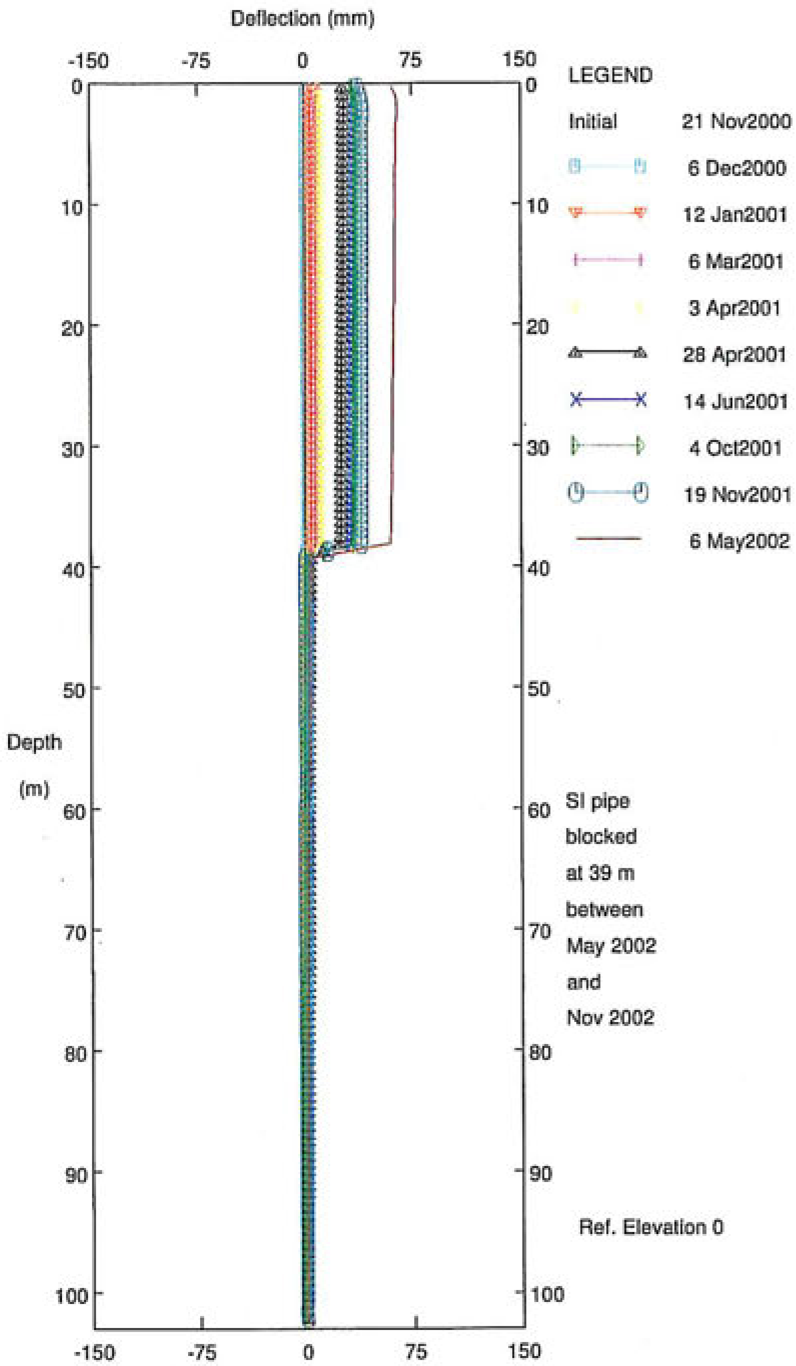


KX04397 W. Quesnel Stability Study, Inclinometer SI2

Upper Avery Lane

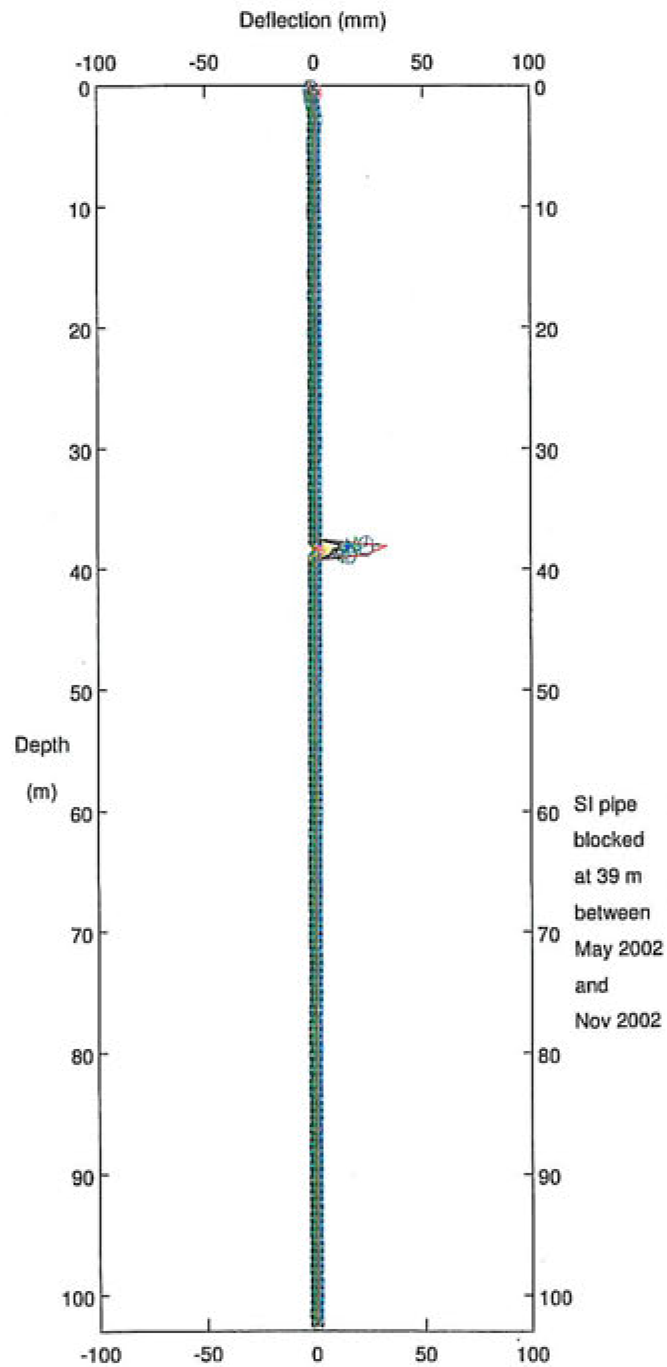
Sets marked * include zero shift and/or rotation corrections.

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction A



Incremental Deflection

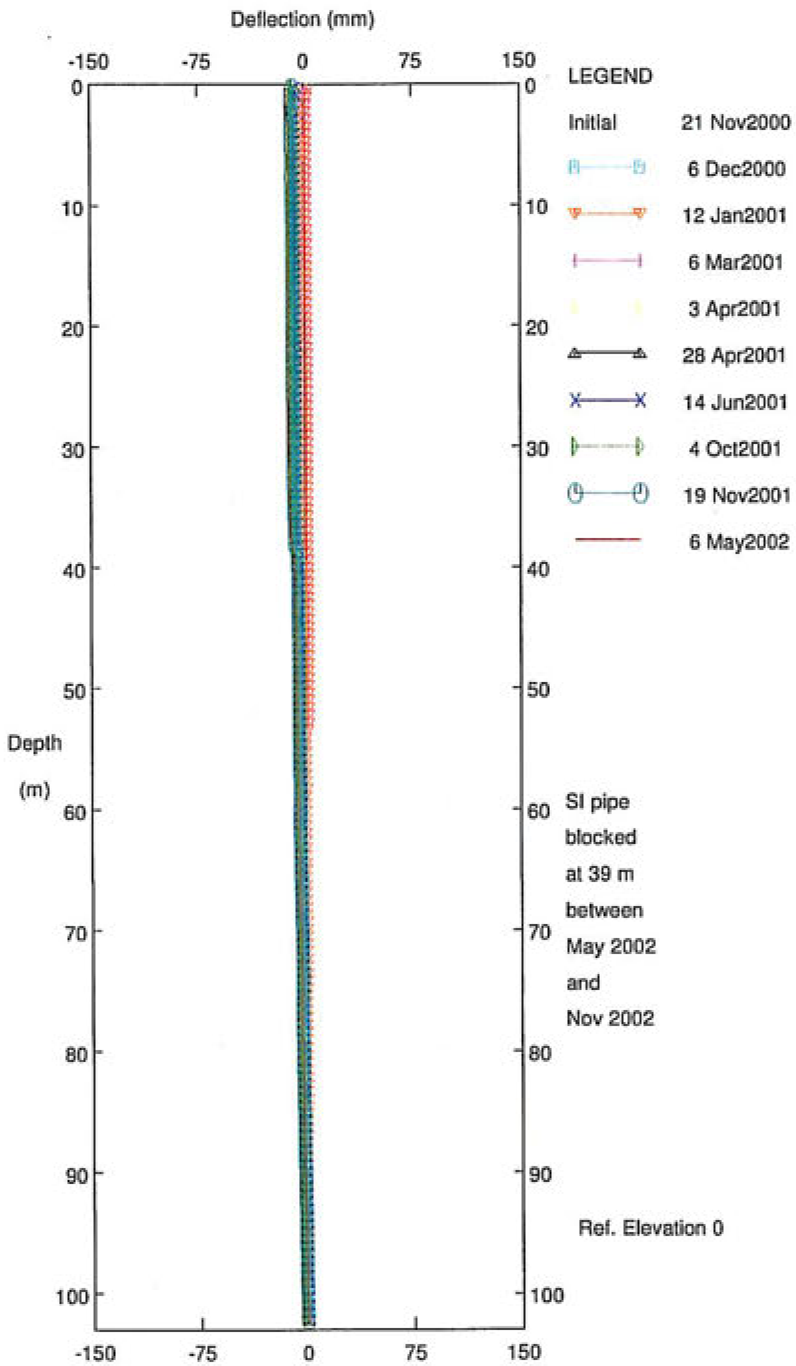
Direction A

KX04397 W. Quesnel Stability Study, Inclinometer SI3

Abbott Drive near Bettcher

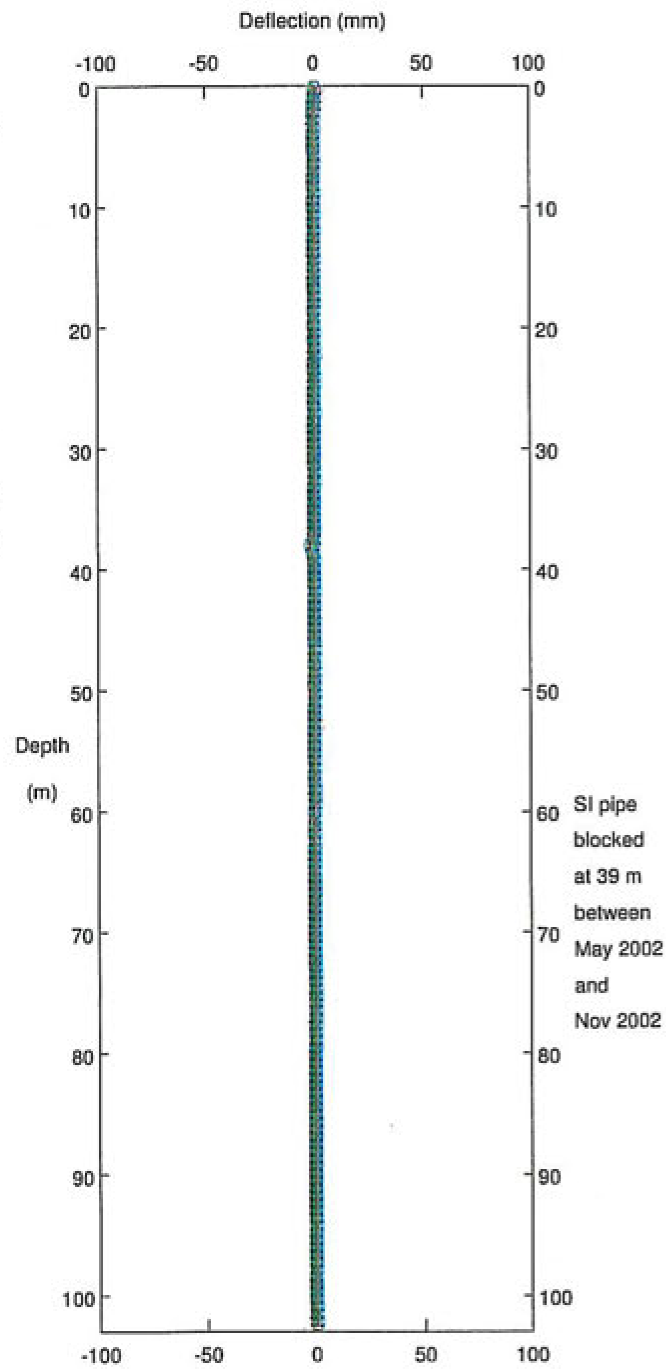
Sets marked * include zero shift and/or rotation corrections.

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction B



Incremental Deflection

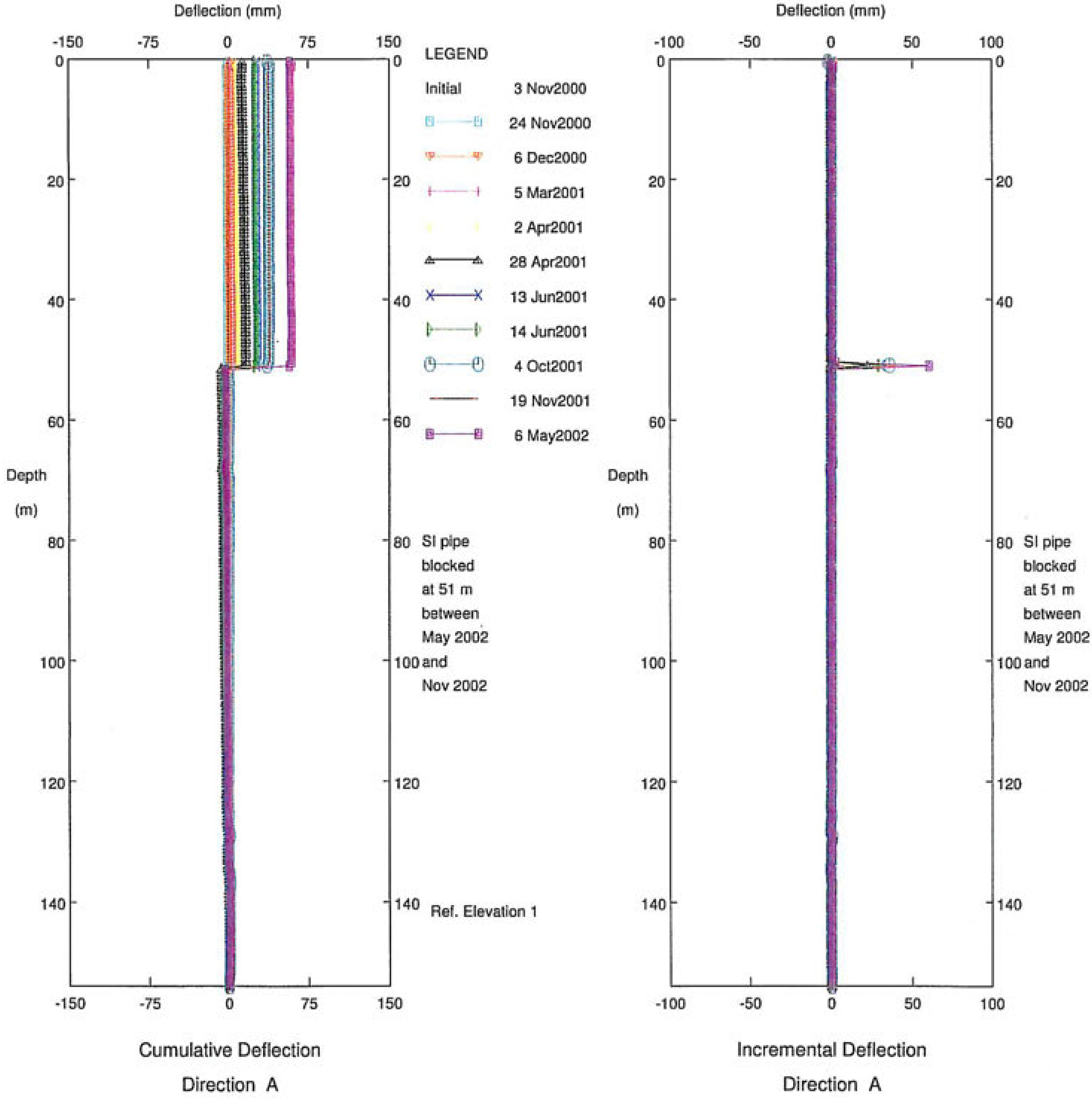
Direction B

KX04397 W. Quesnel Stability Study, Inclinometer SI3

Abbott Drive near Bettcher

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

AMEC Earth & Environmental - Pr. George

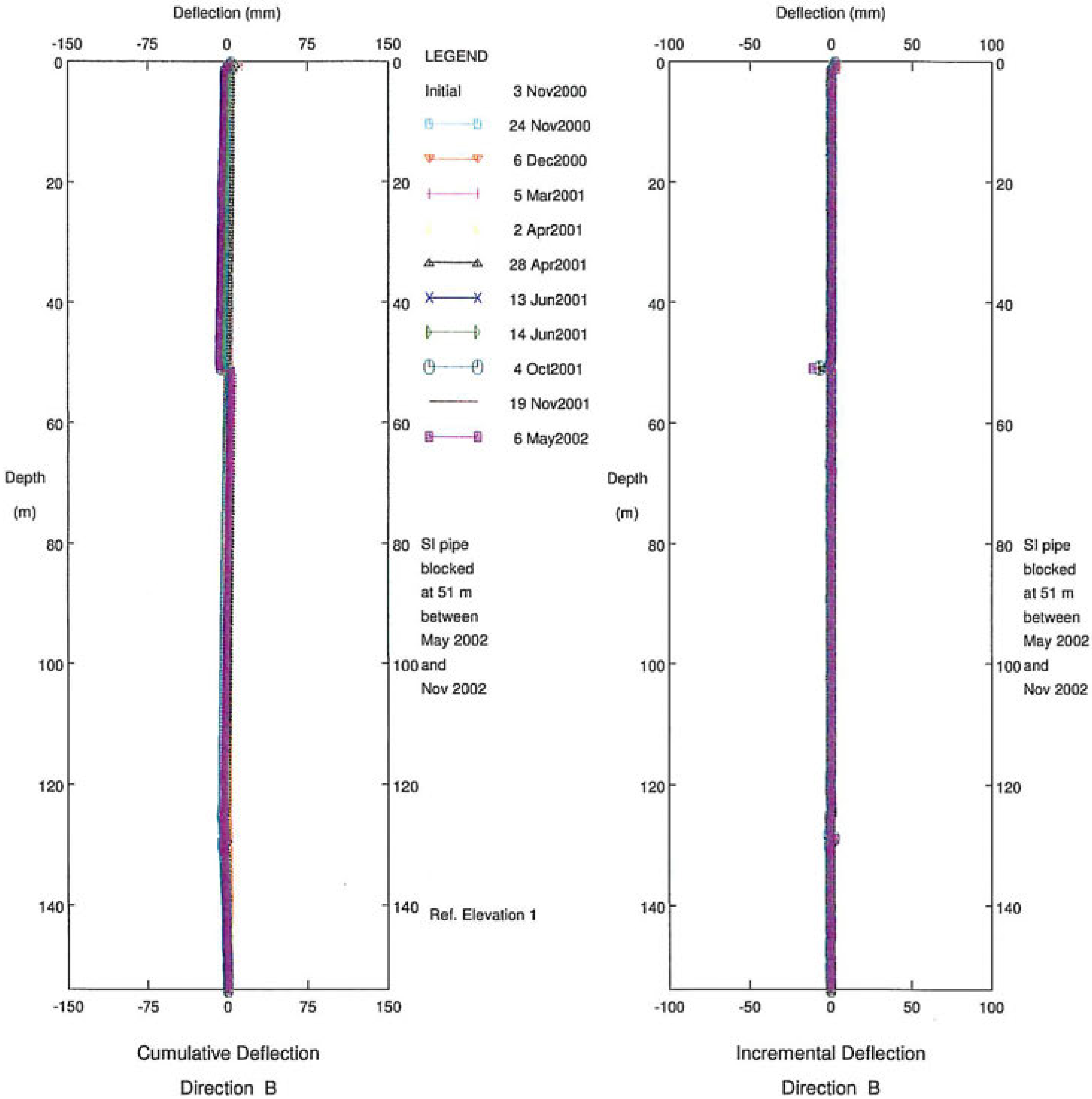


KX04397 W.Quesnel Stability Study, Inclinometer SI4

Voyageur School

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

AMEC Earth & Environmental - Pr. George

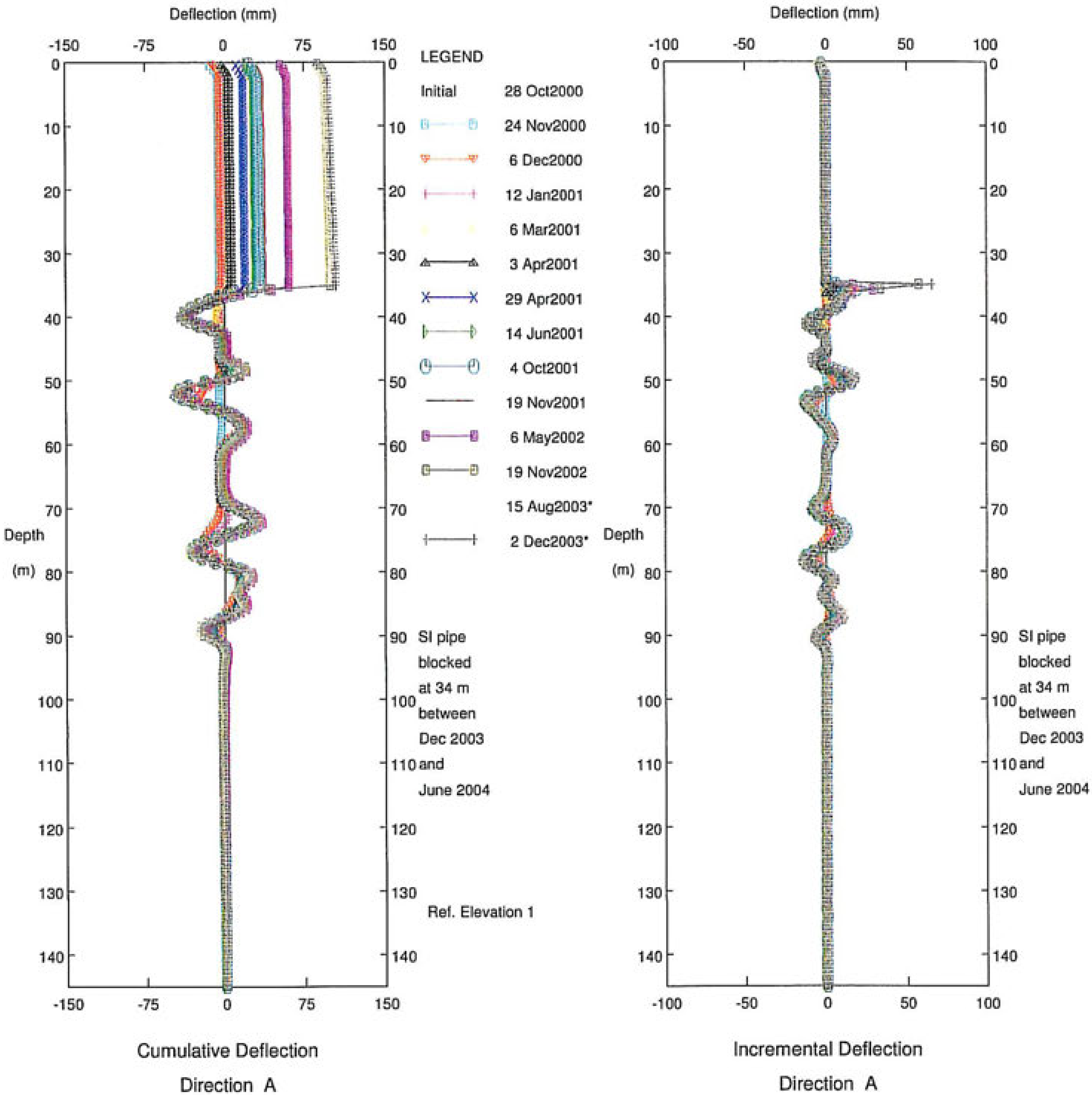


KX04397 W.Quesnel Stability Study, Inclinometer SI4

Voyageur School

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

AMEC Earth & Environmental - Pr. George

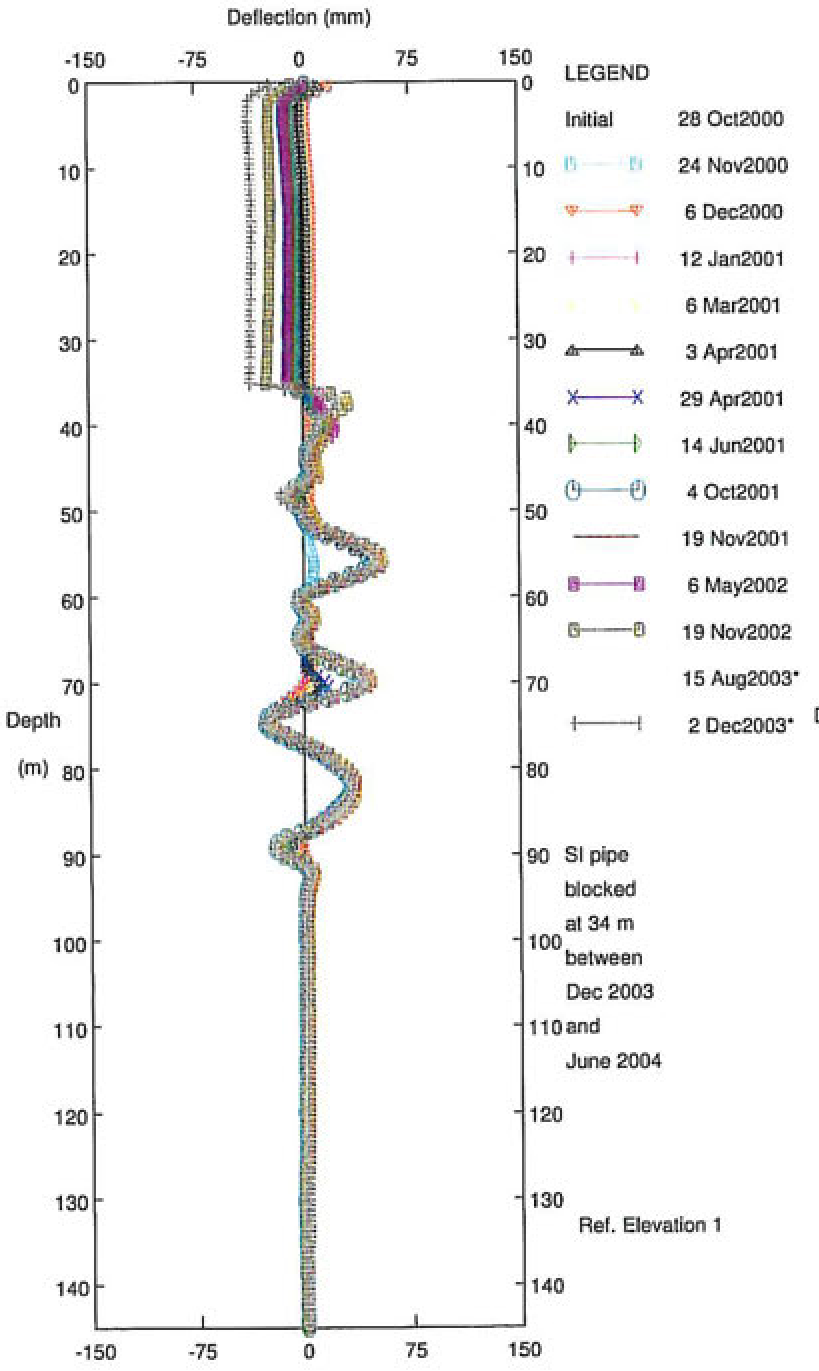


KX04397 W. Quesnel Stability Study, Inclinometer SI5

Abbott Drive

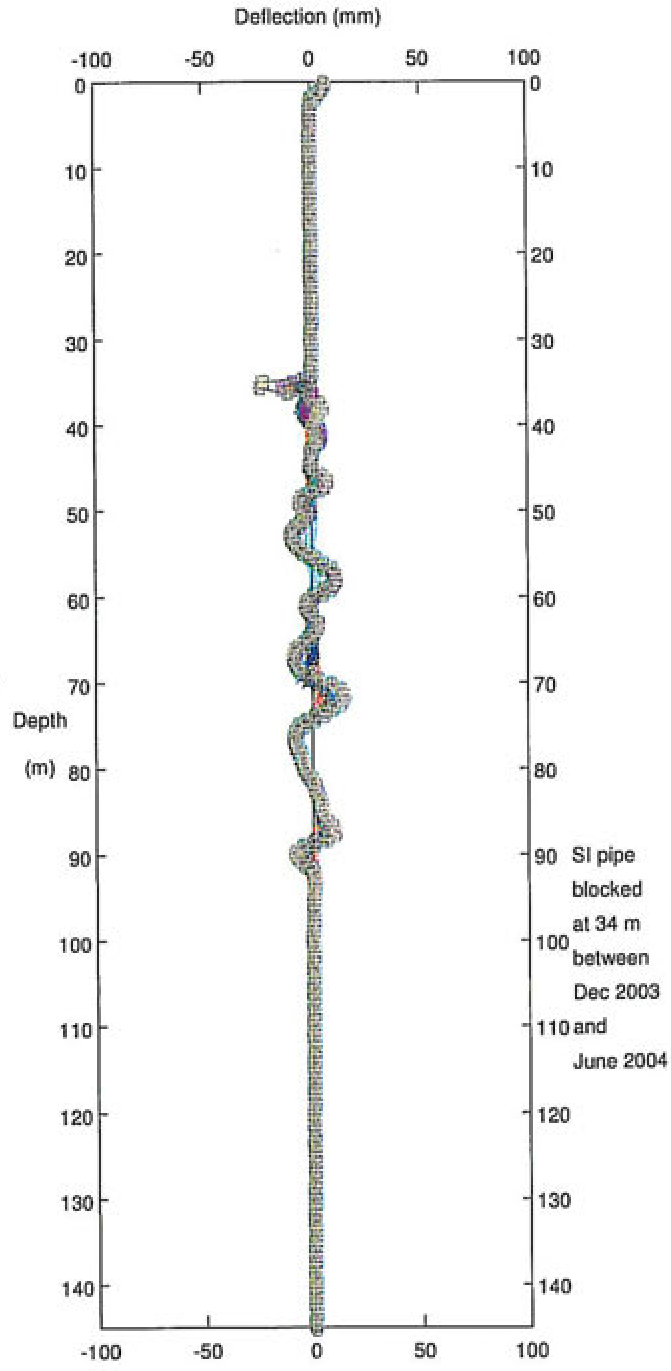
Sets marked * include zero shift and/or rotation corrections.

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction B



Incremental Deflection

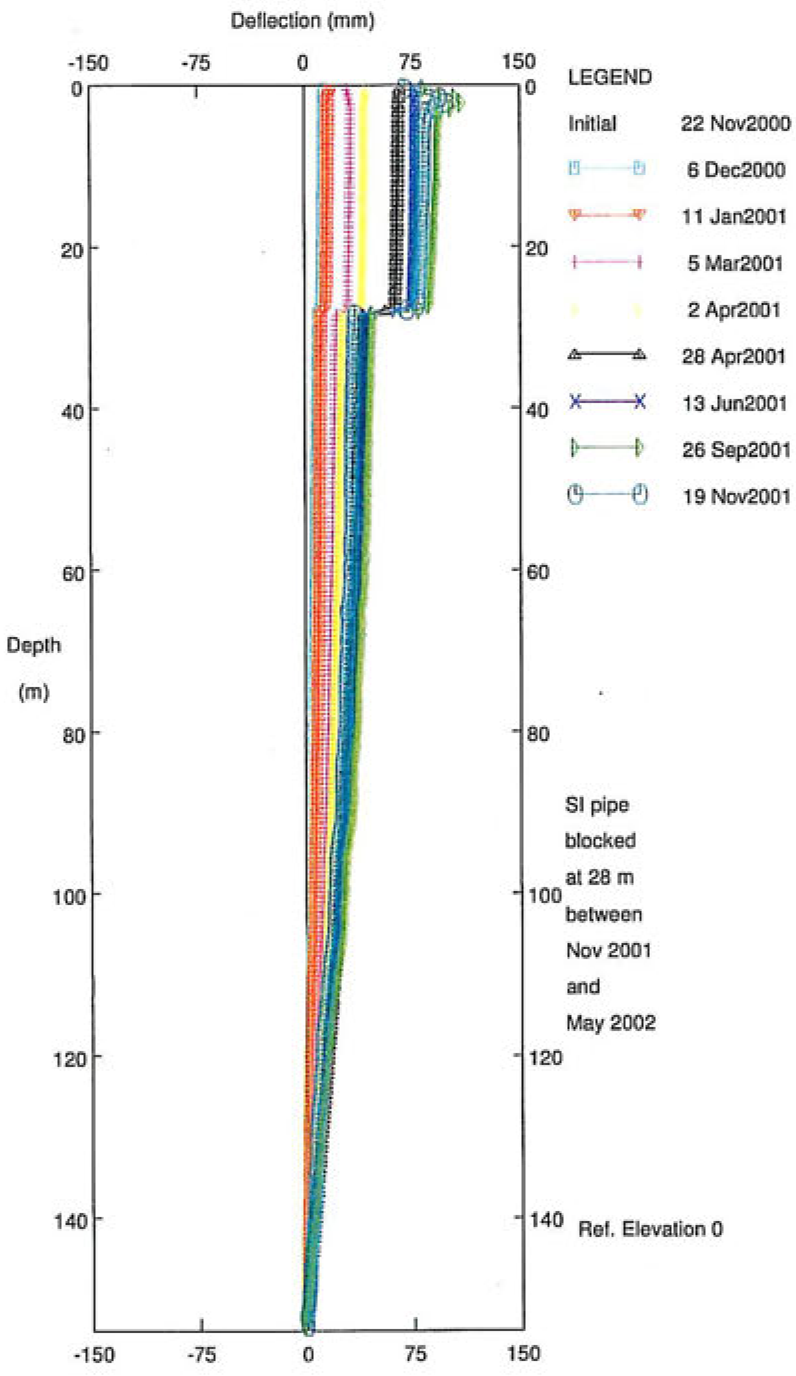
Direction B

KX04397 W. Quesnel Stability Study, Inclinometer SI5

Abbott Drive

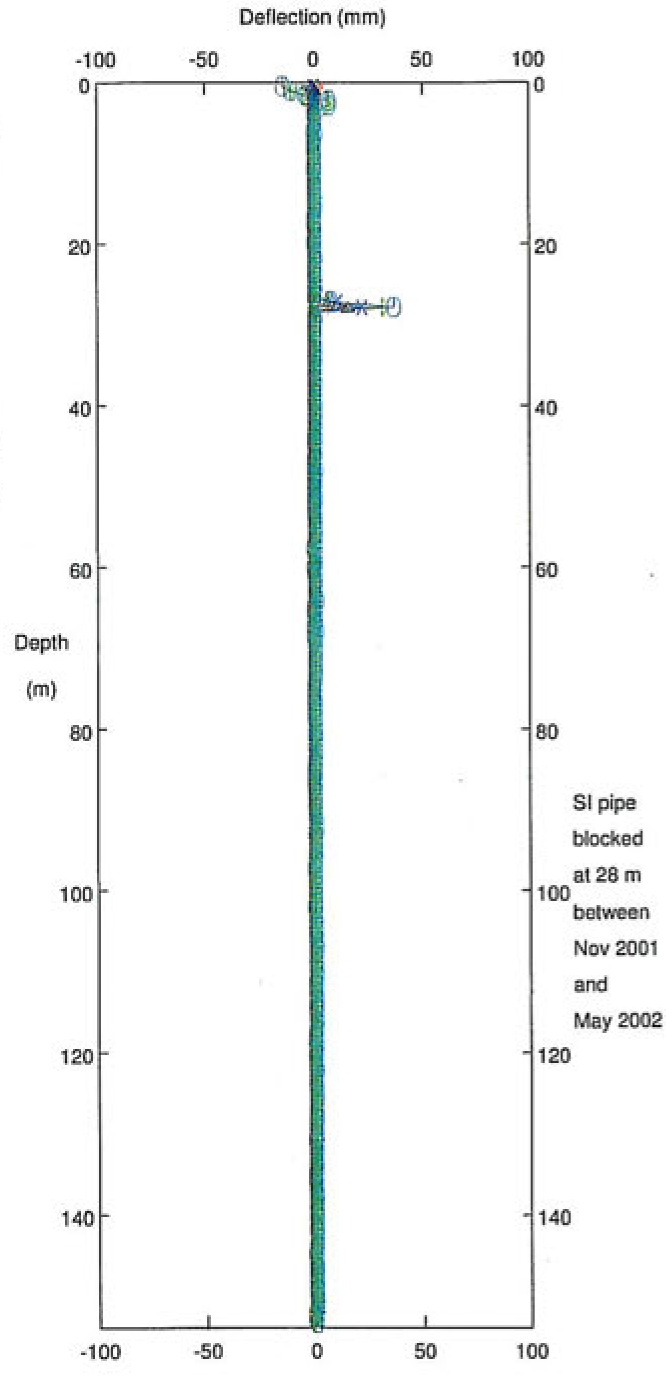
Sets marked * include zero shift and/or rotation corrections.

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction A



Incremental Deflection

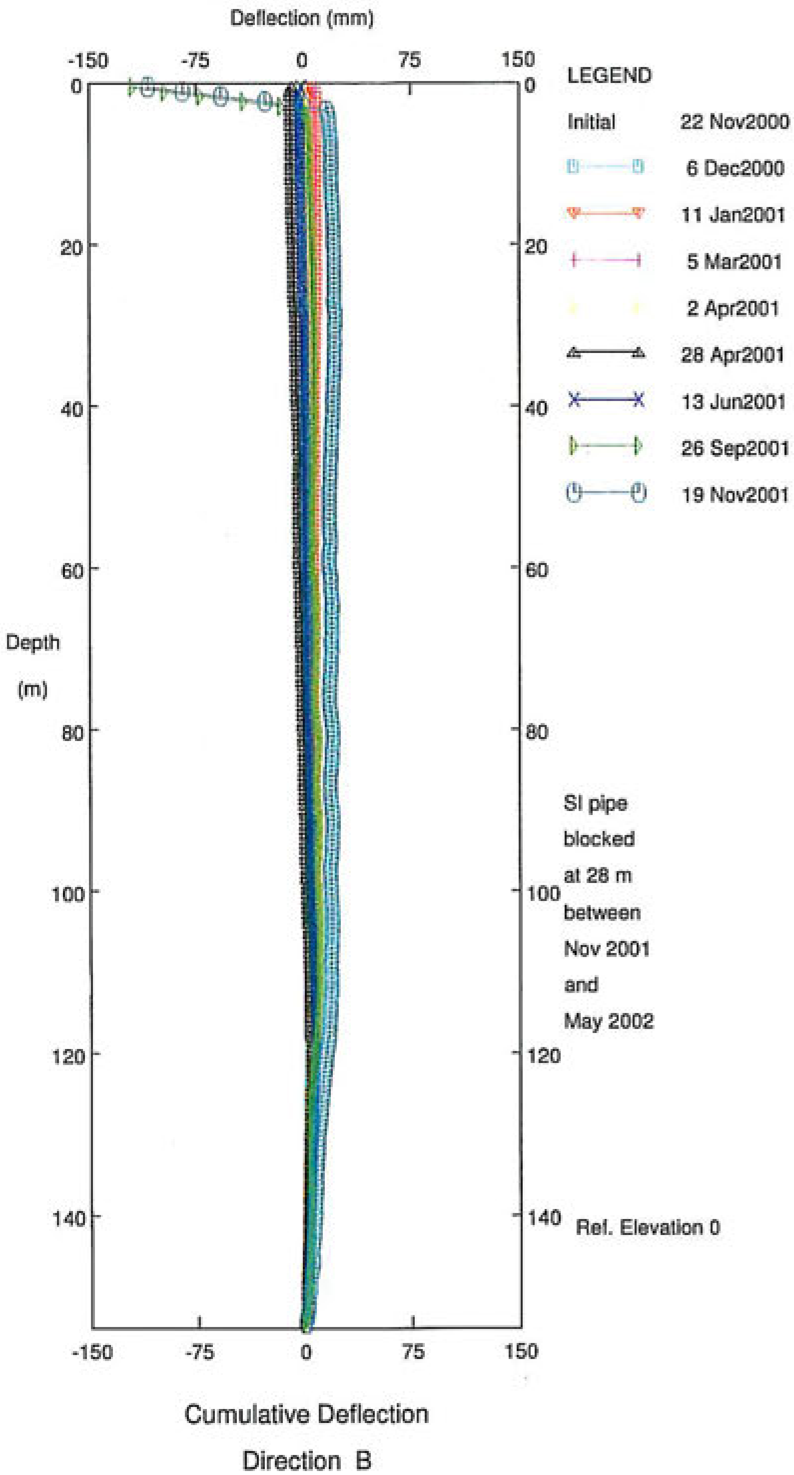
Direction A

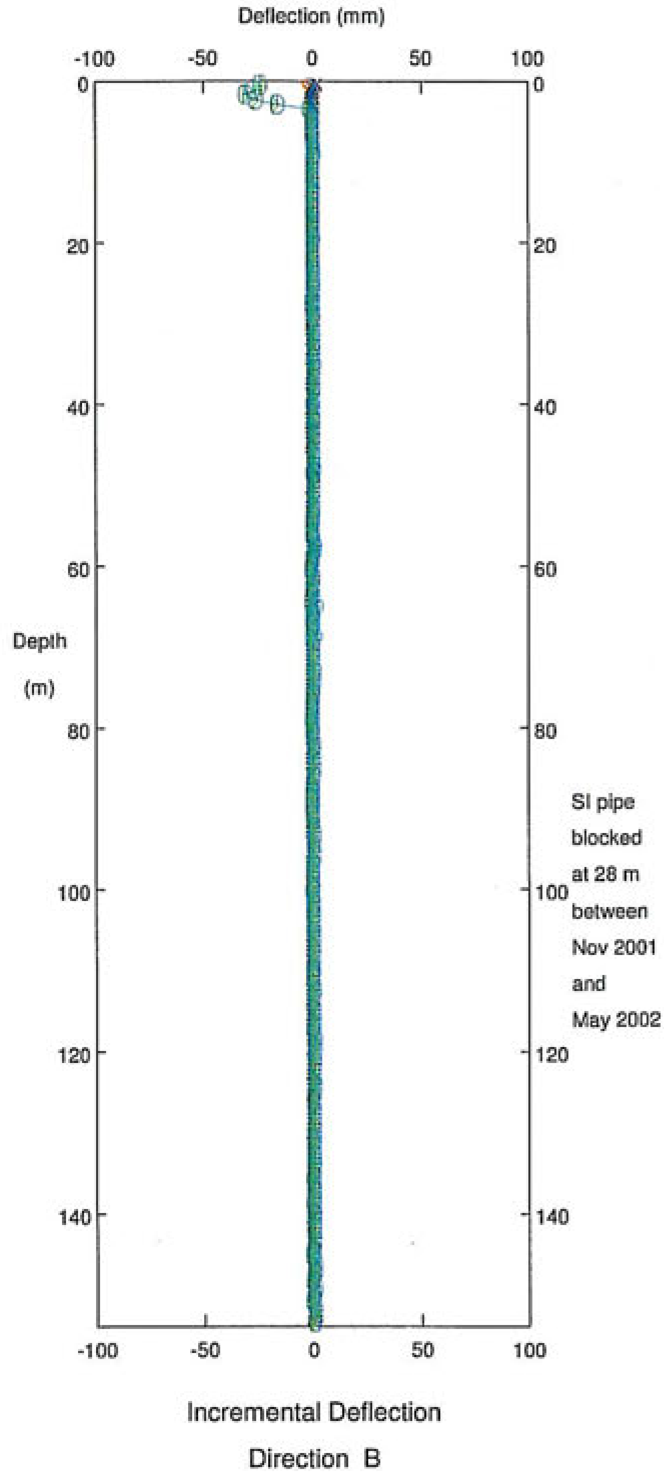
KX04397 W.Quesnel Stability Study, Inclinometer SI6

End of Dixon Street

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

AMEC Earth & Environmental - Pr. George



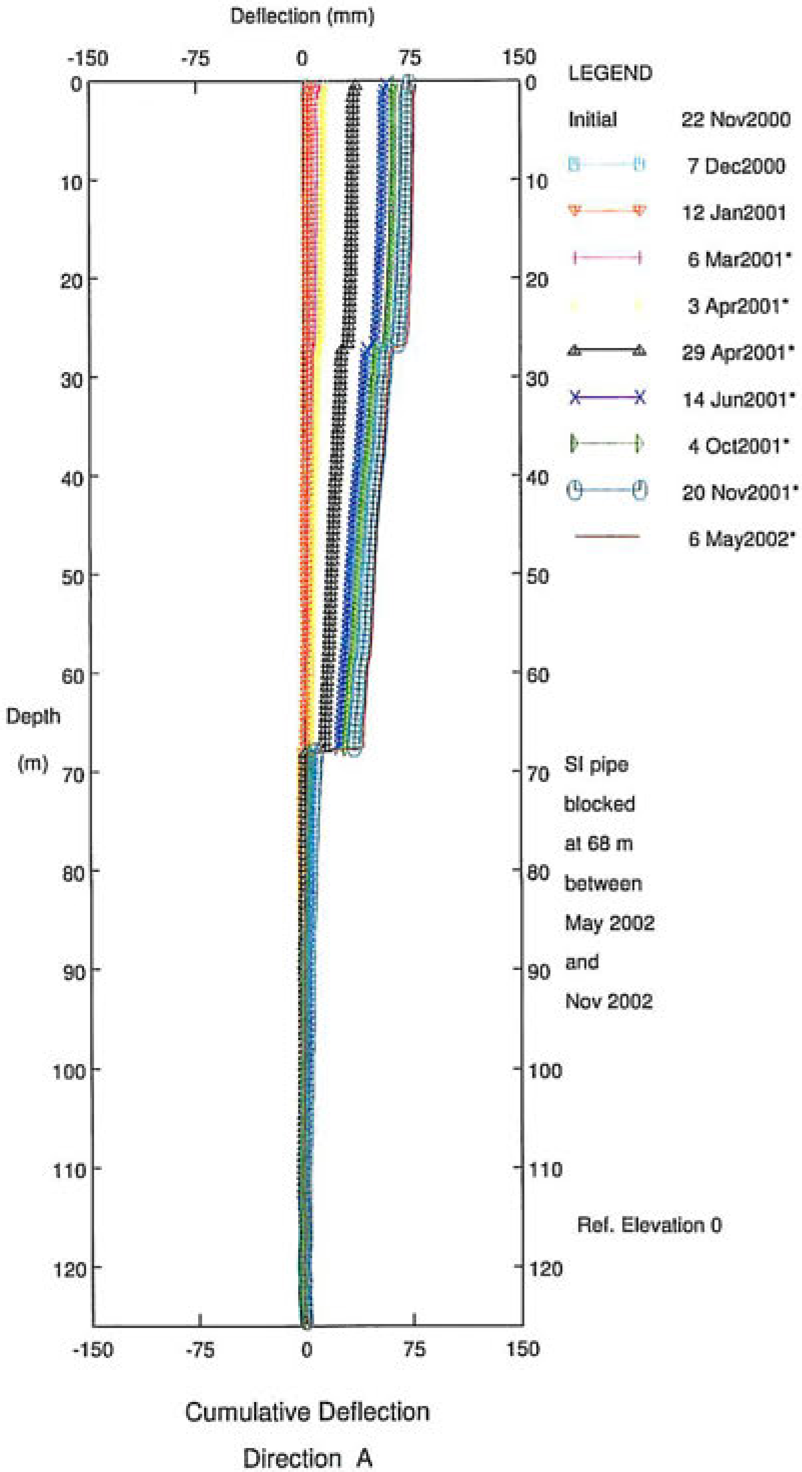


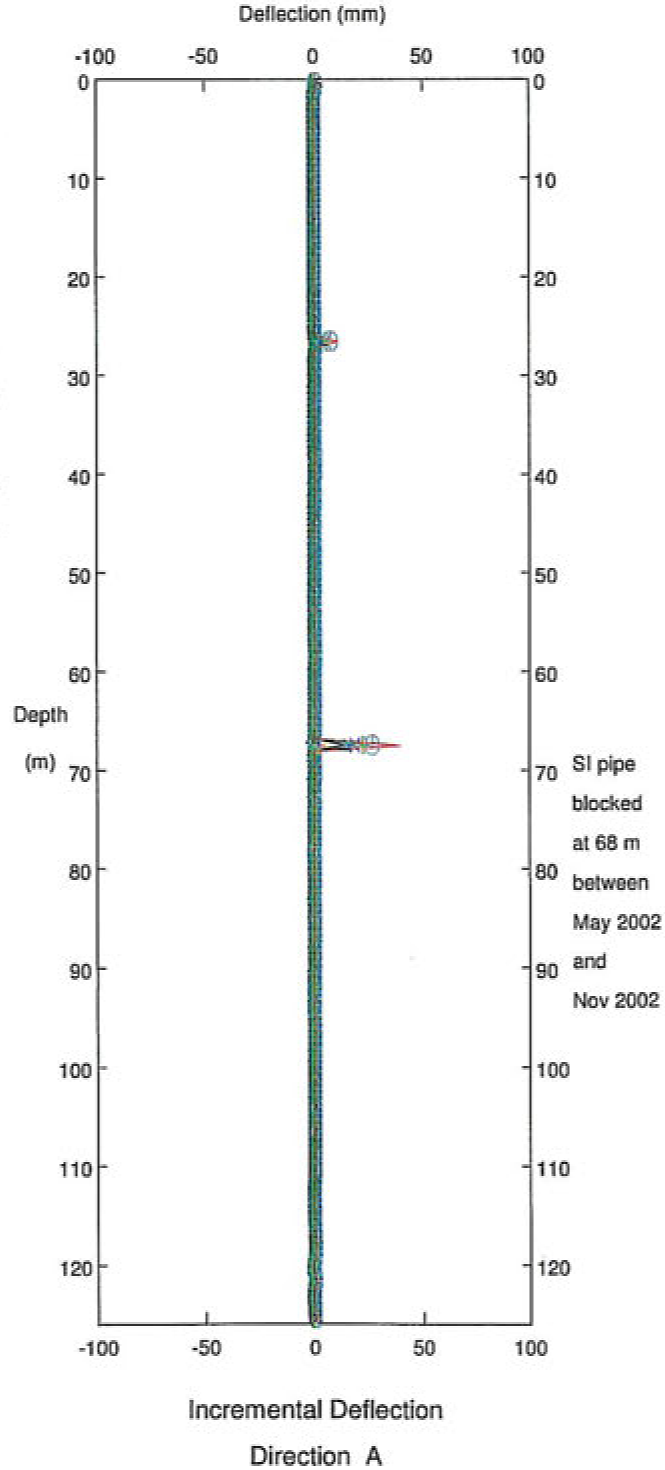
KX04397 W.Quesnel Stability Study, Inclinometer SI6

End of Dixon Street

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

AMEC Earth & Environmental - Pr. George



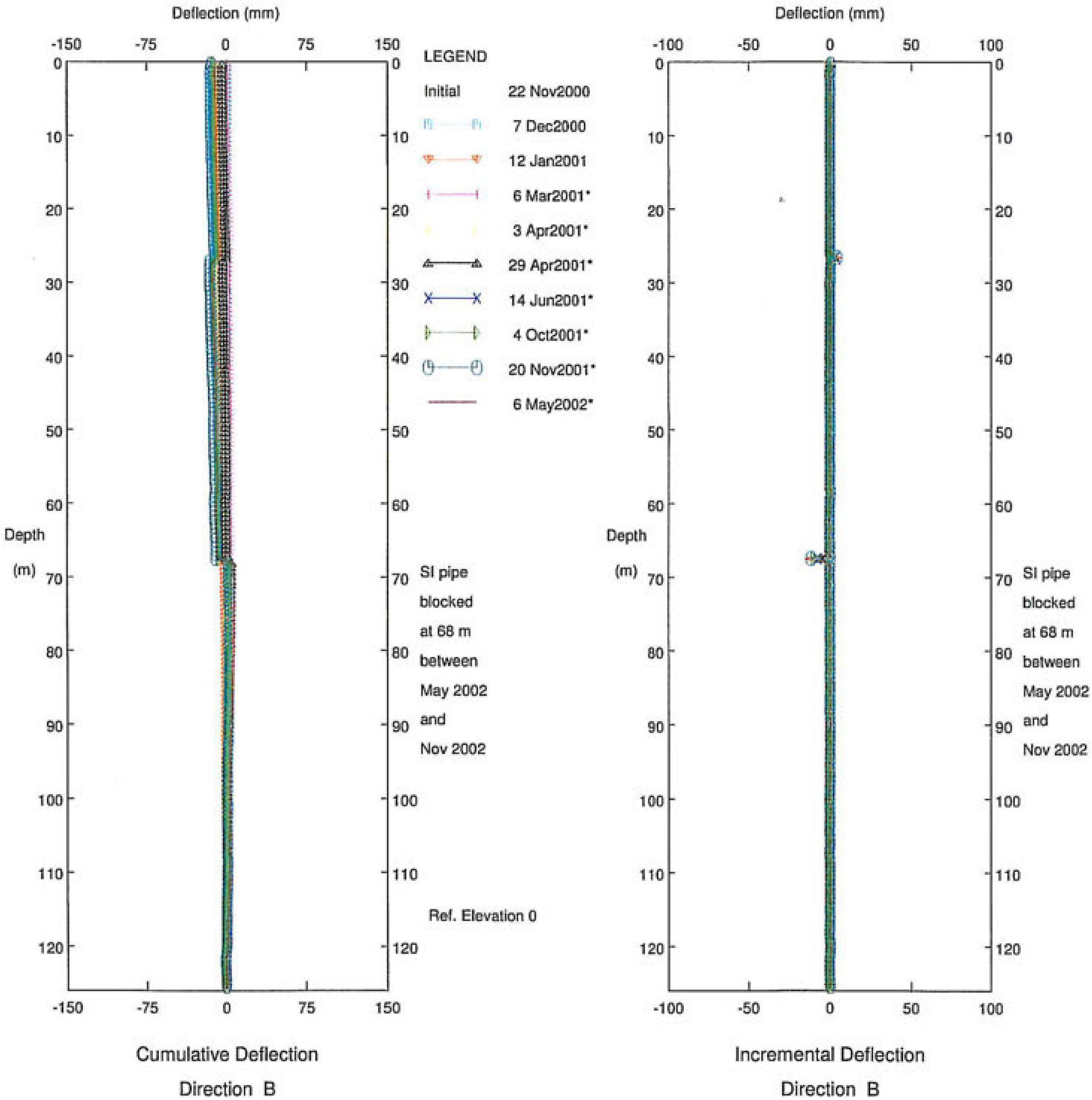


KX04397 W. Quesnel Stability Study, Inclinometer SI7

Pierce Crescent & Lewis Drive

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

AMEC Earth & Environmental - Pr. George

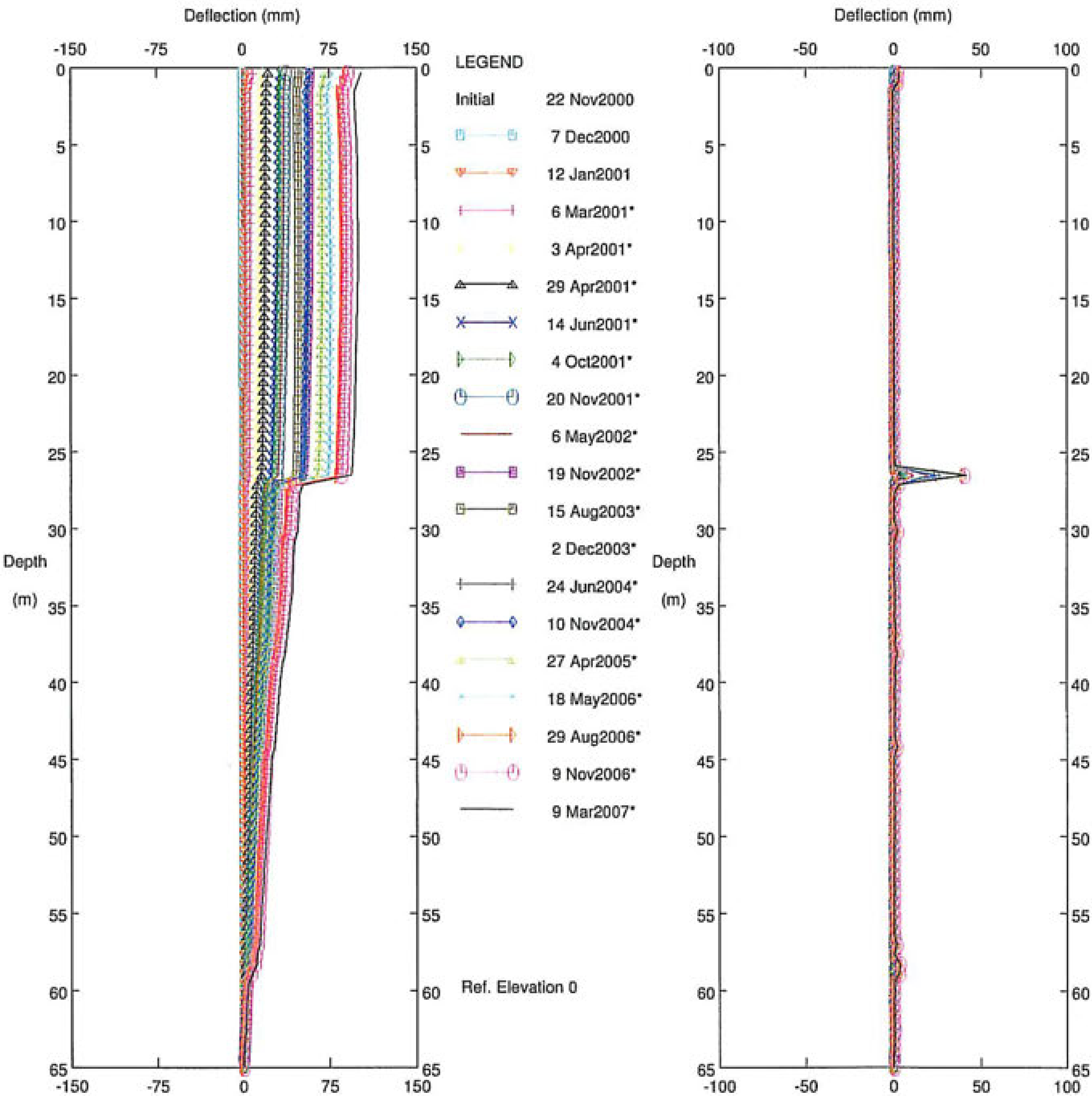


KX04397 W. Quesnel Stability Study, Inclinometer SI7

Pierce Crescent & Lewis Drive

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

AMEC Earth & Environmental - Pr. George



Cumulative Deflection
Direction A

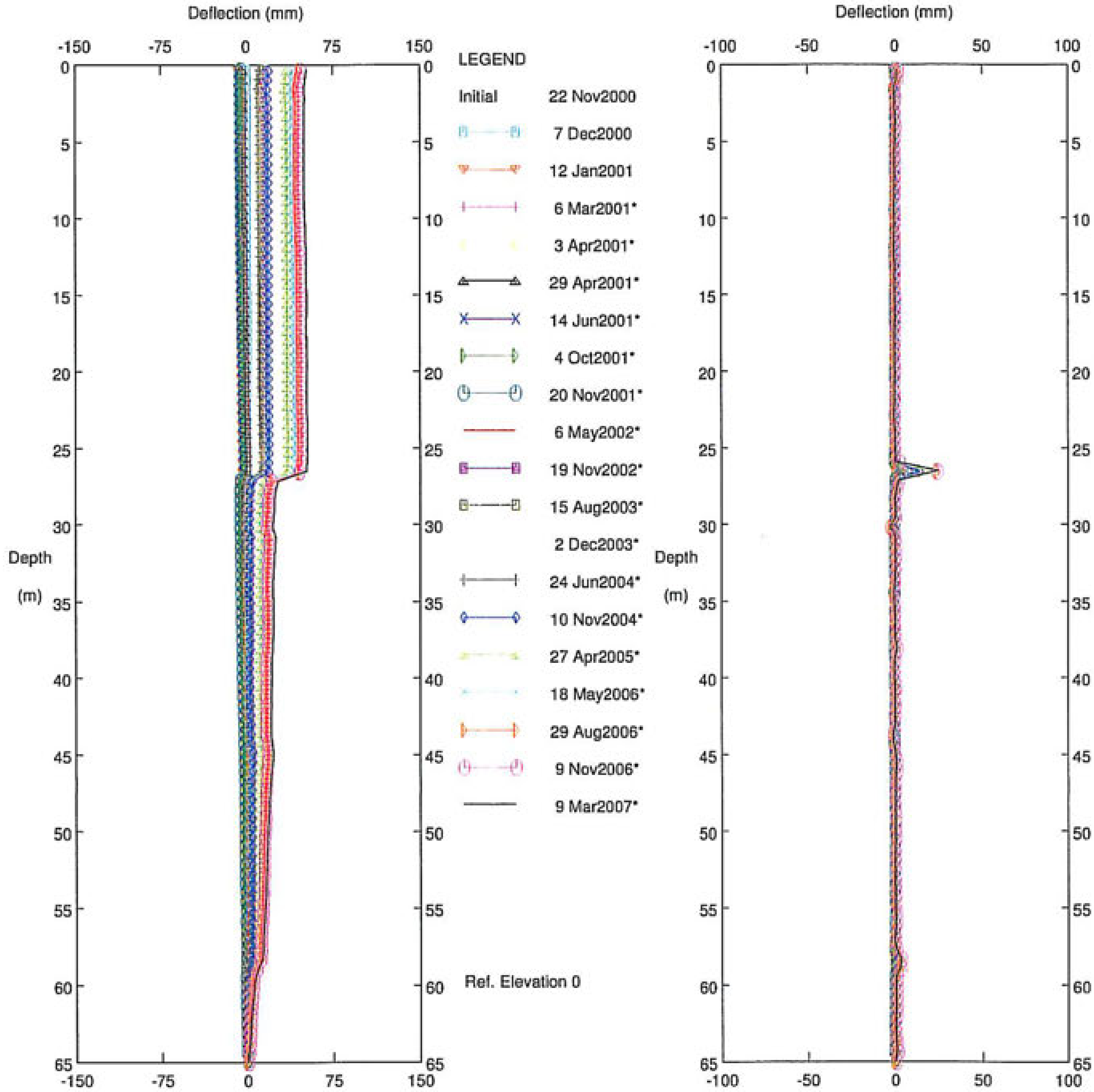
Incremental Deflection
Direction A

KX04397 W. Quesnel Stability Study, Inclinometer SI7

Pierce Crescent & Lewis Drive

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

AMEC Earth & Environmental - Pr. George



Cumulative Deflection

Direction B

Incremental Deflection

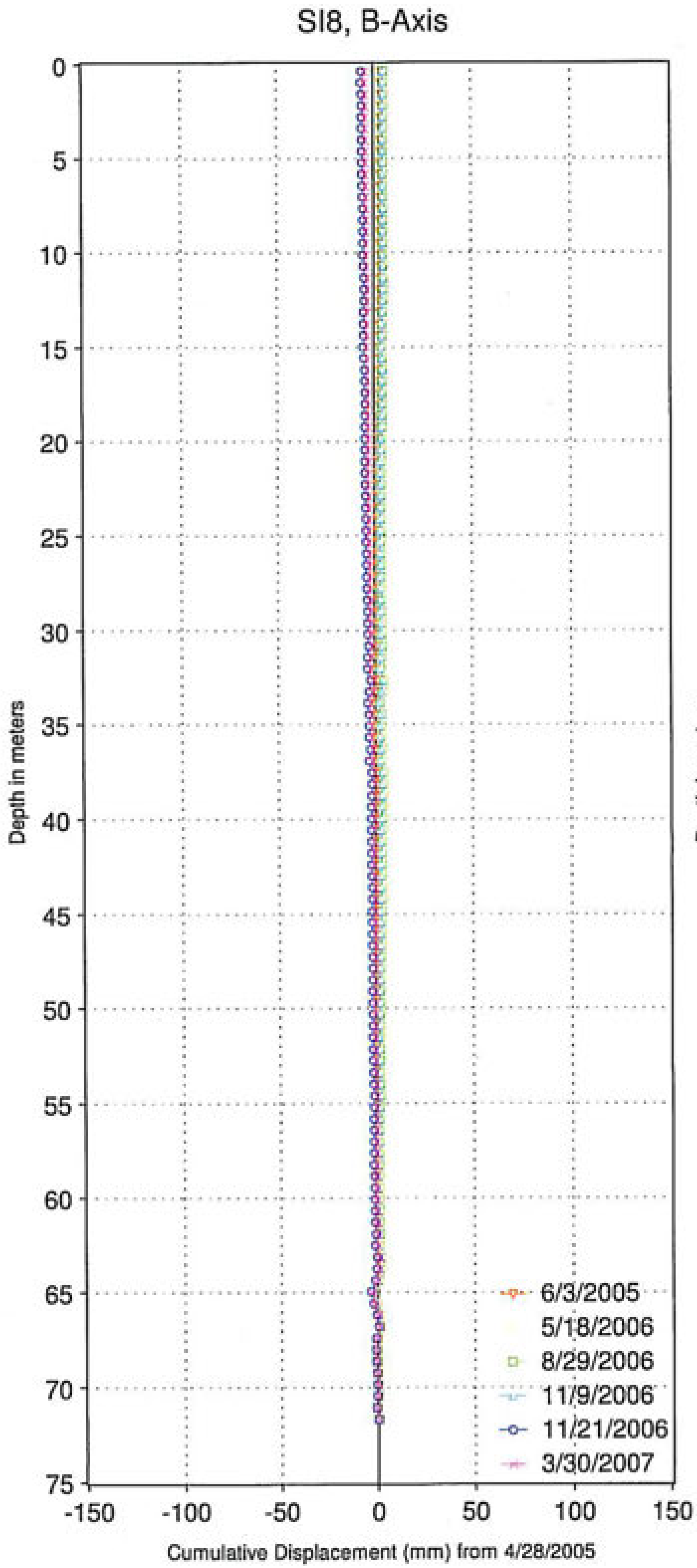
Direction B

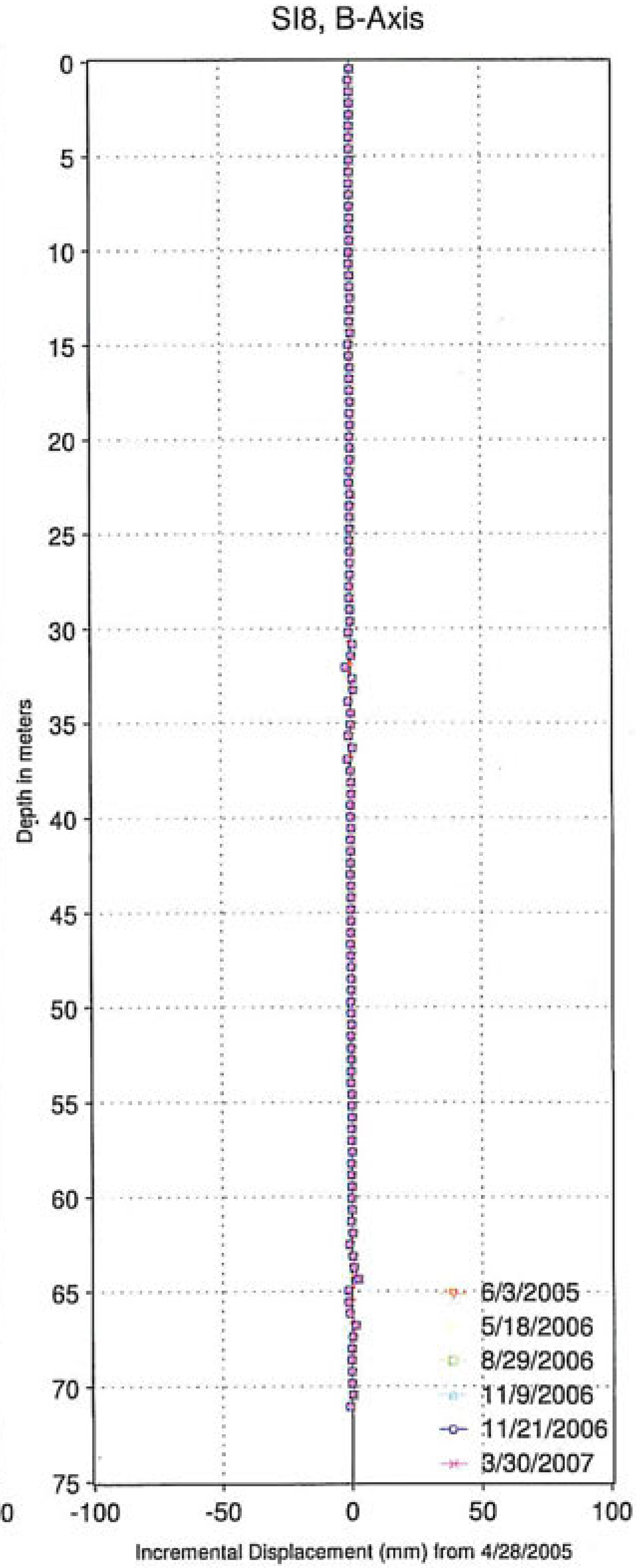
KX04397 W. Quesnel Stability Study, Inclinometer SI7

Pierce Crescent & Lewis Drive

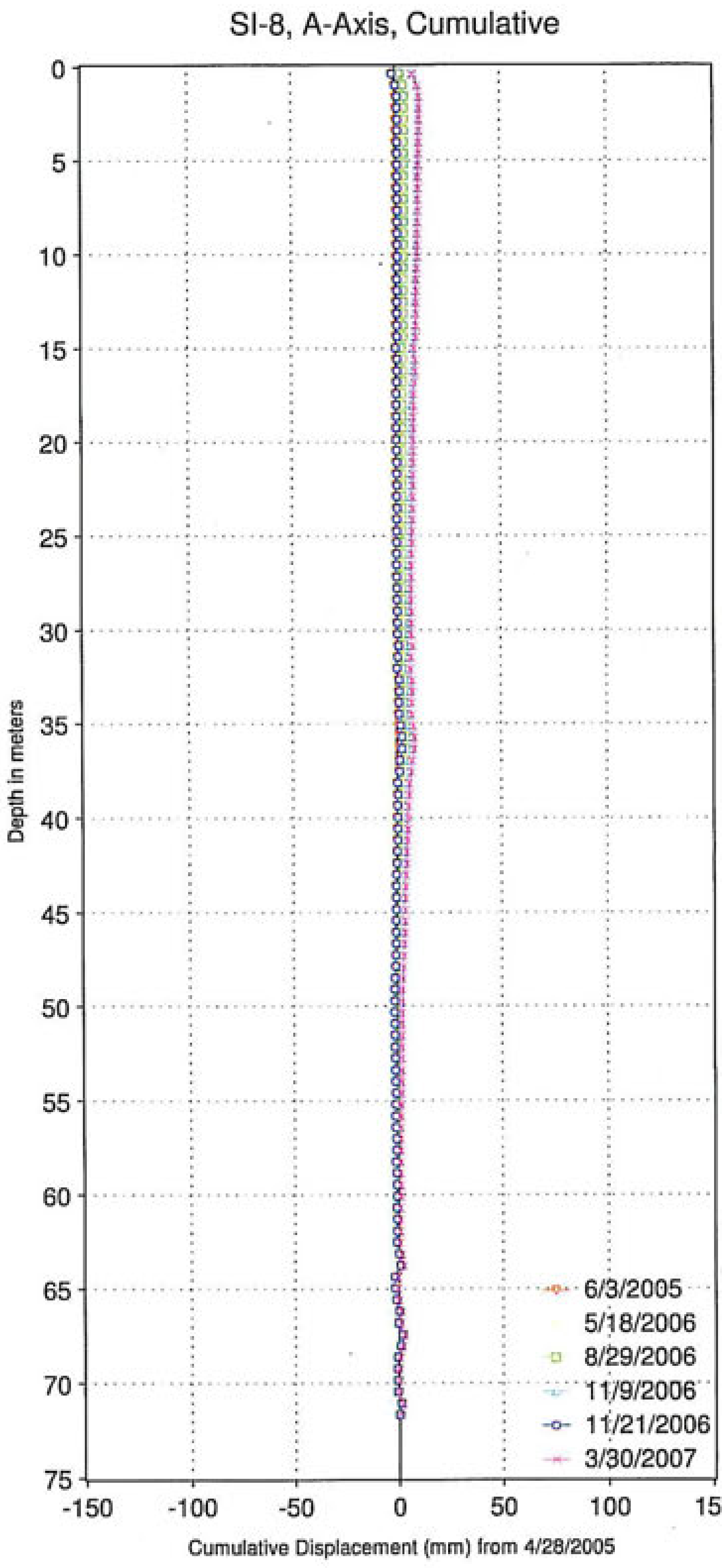
Sets marked * include zero shift and/or rotation corrections.

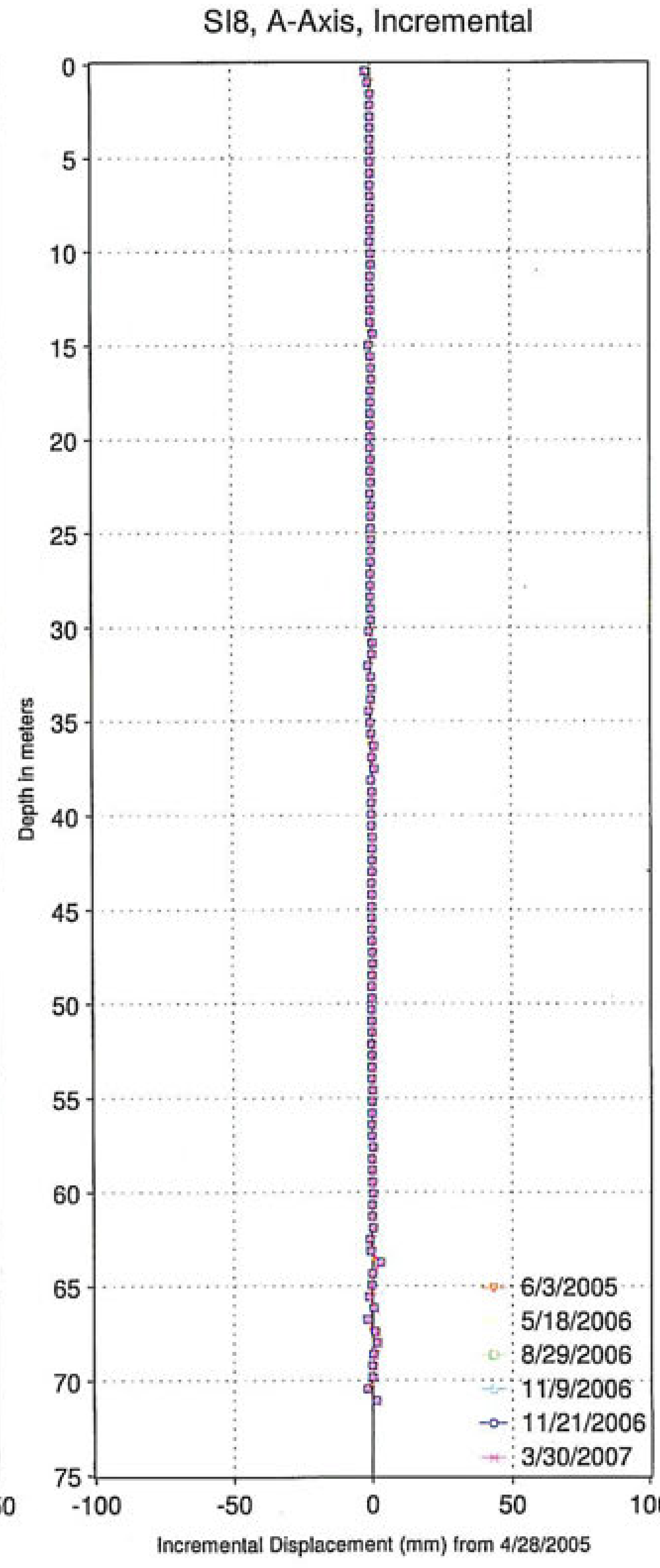
KX04397
WEST QUESNEL LAND STABILTY Study
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI8



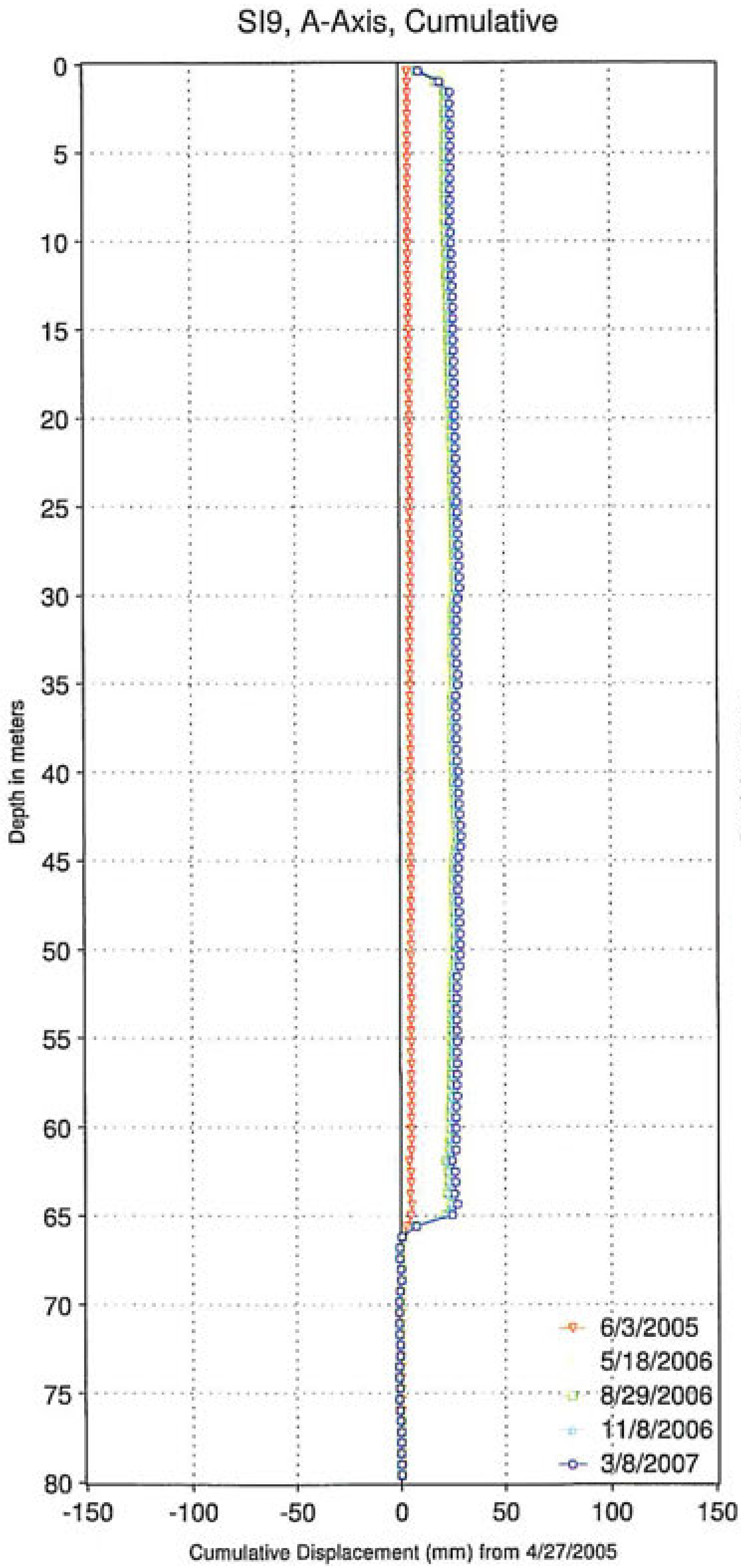


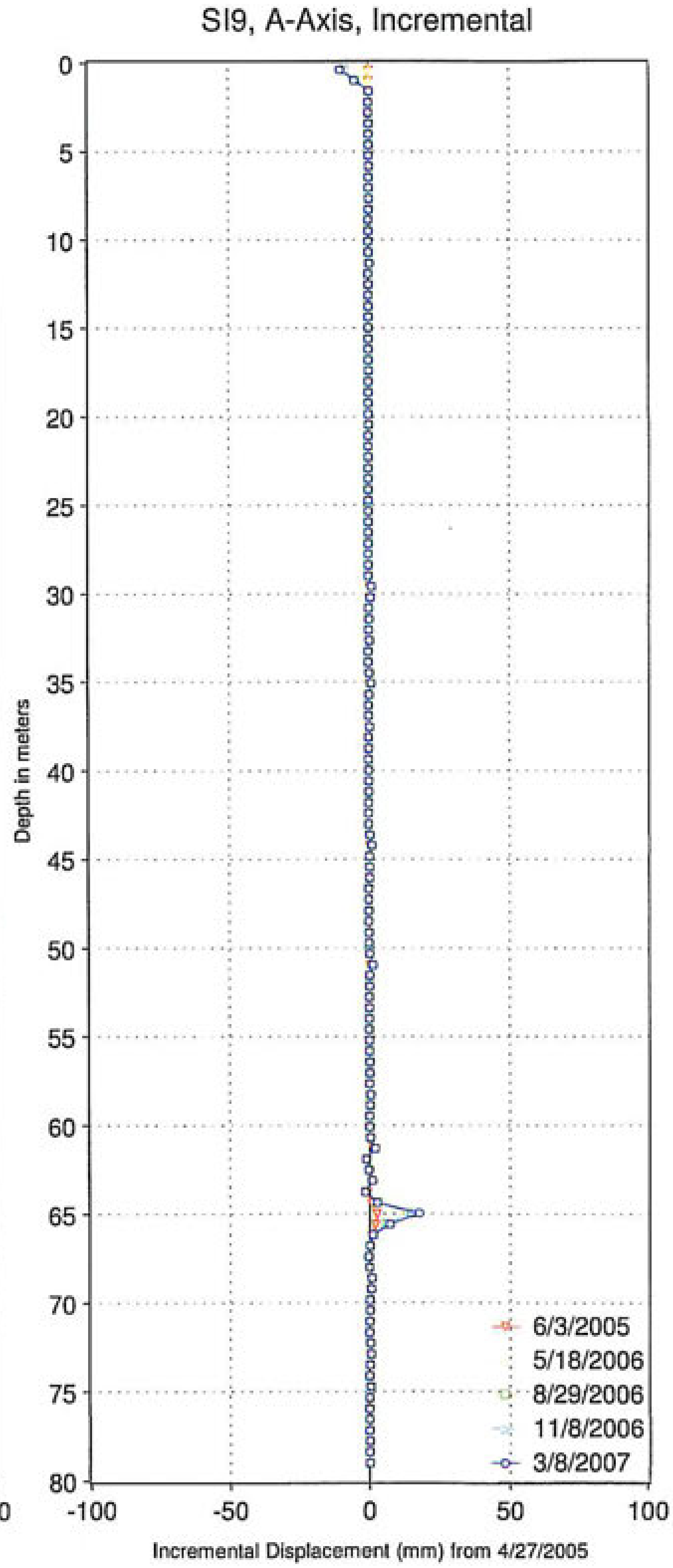
KX04397
WEST QUESNEL LAND STABILITY MONITORING
CUMMULATIVE & INCREMENTAL DISPLACEMENTS
SI-8



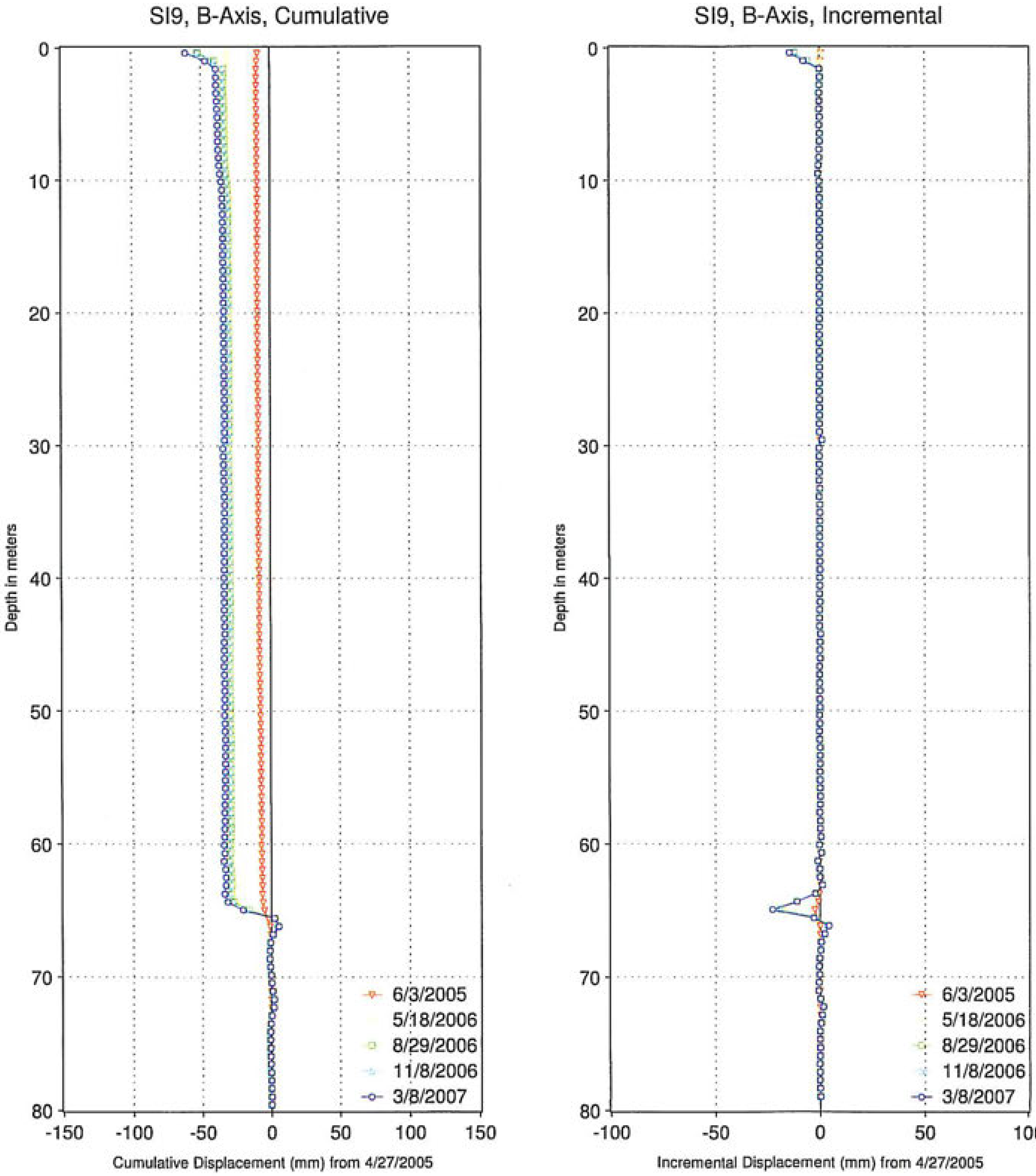


KX09397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI9

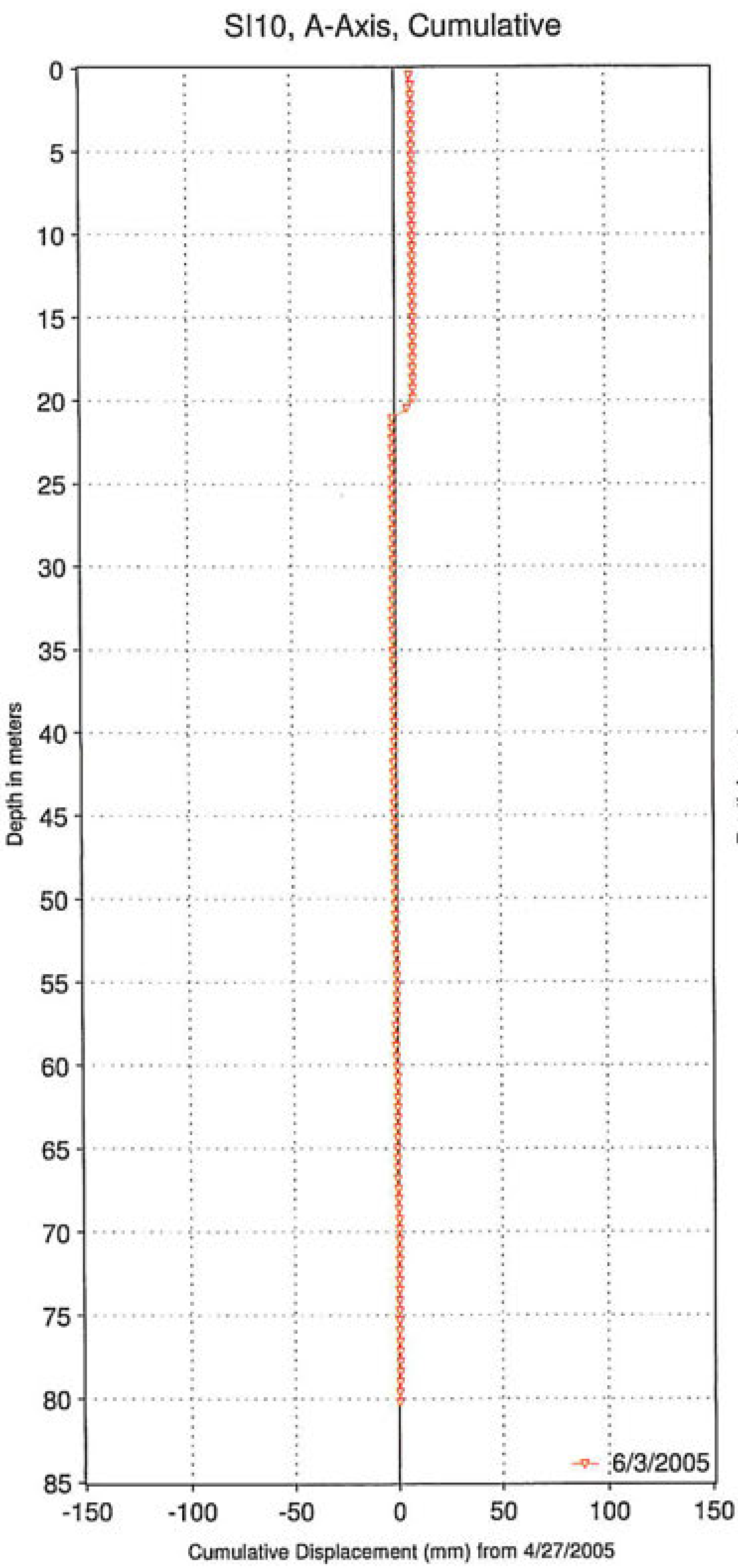


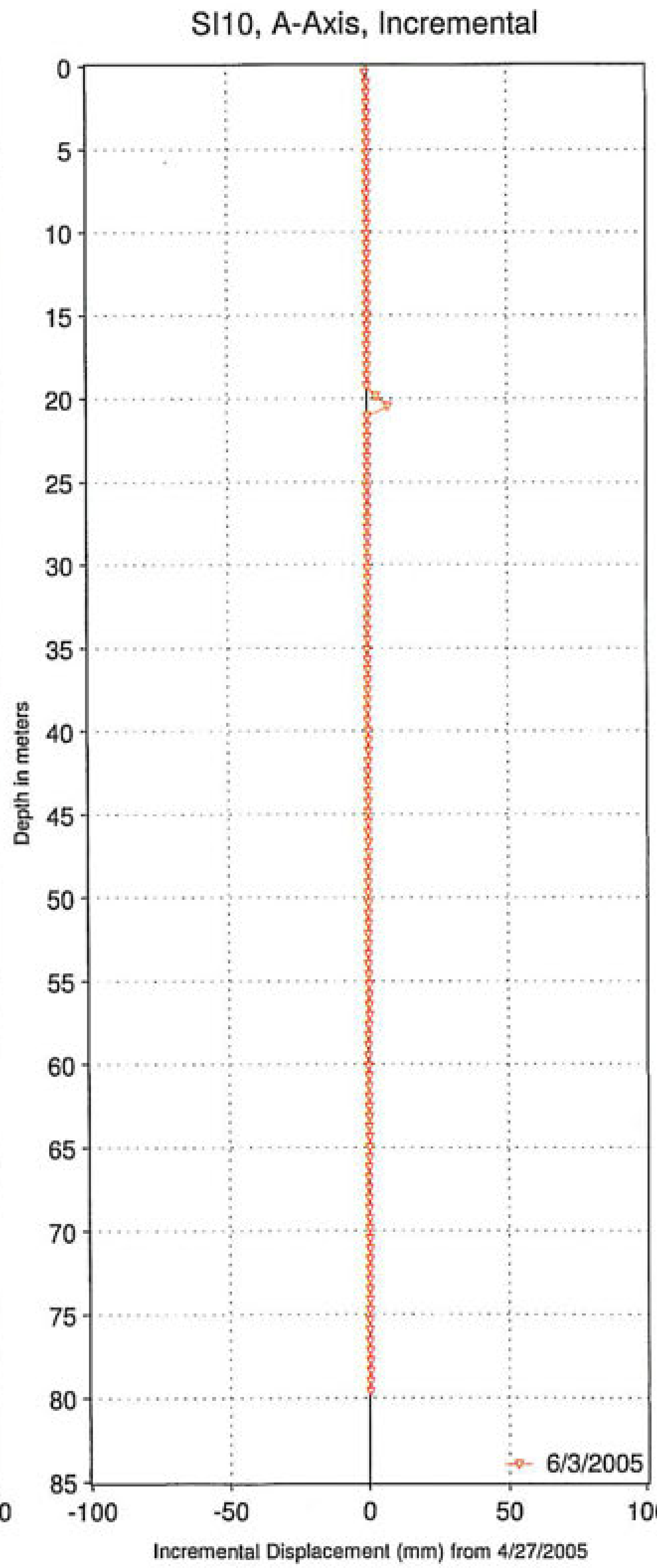


KX09397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI9

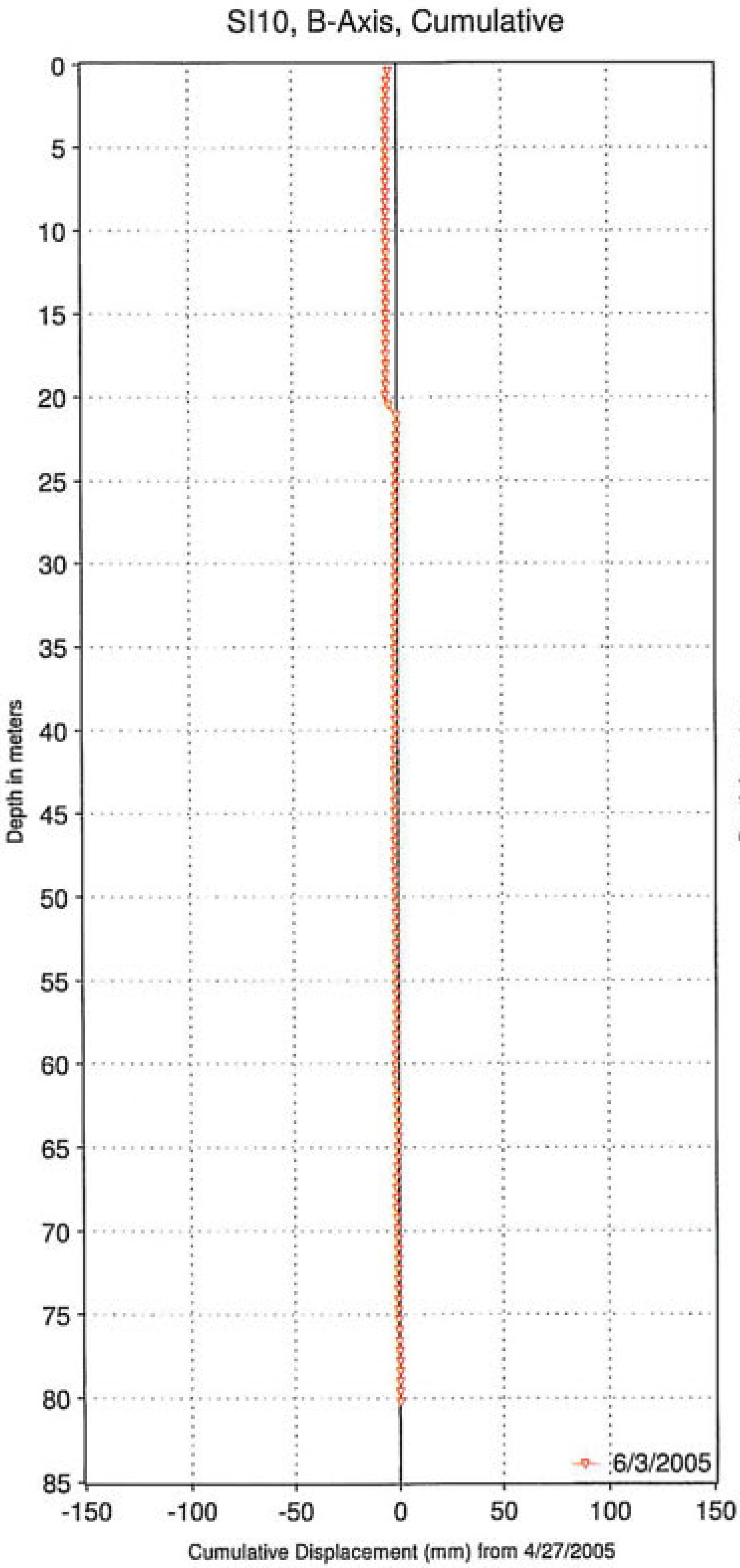


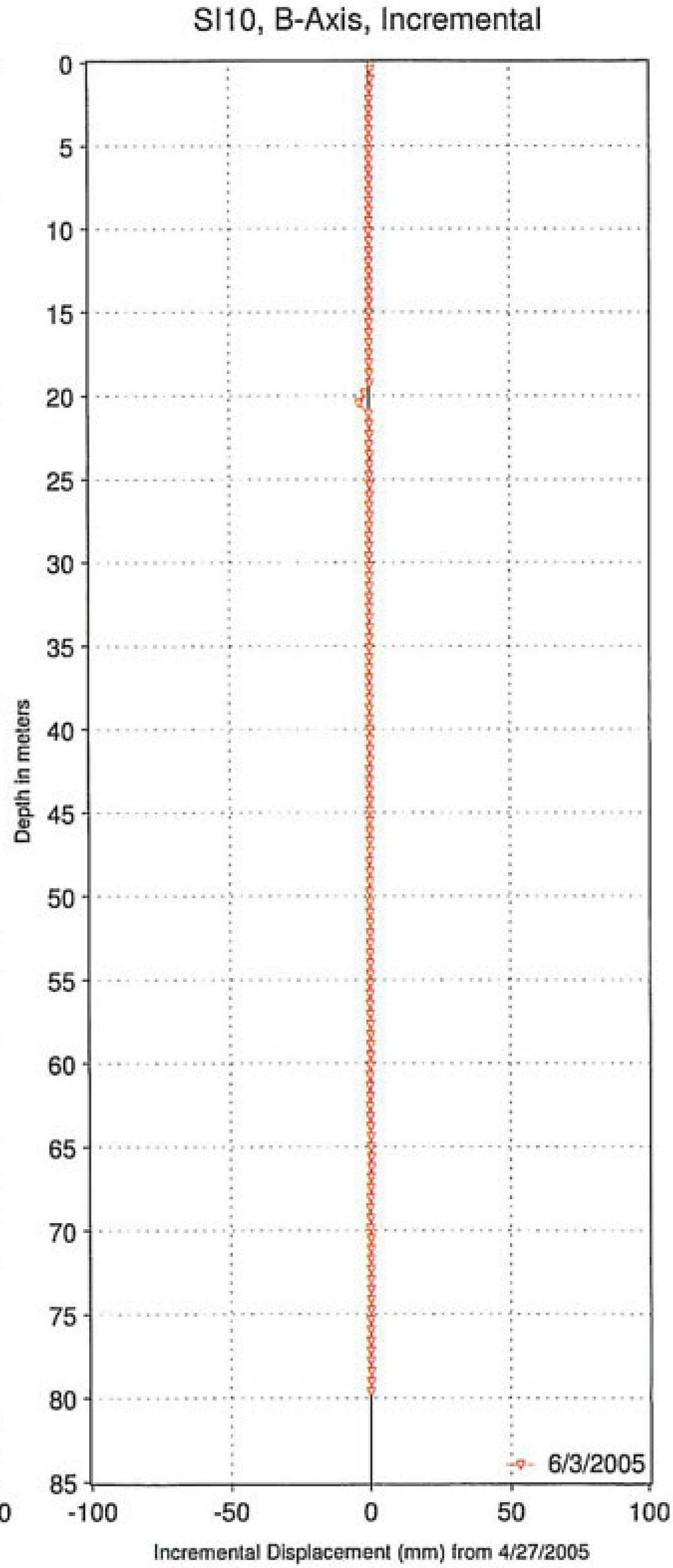
KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI10 SI sheared at 69' between 06/03/2005 and 05/19/2006





KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI10 SI blocked at 21.0 m between 06/03/2005 and 05/19/2006





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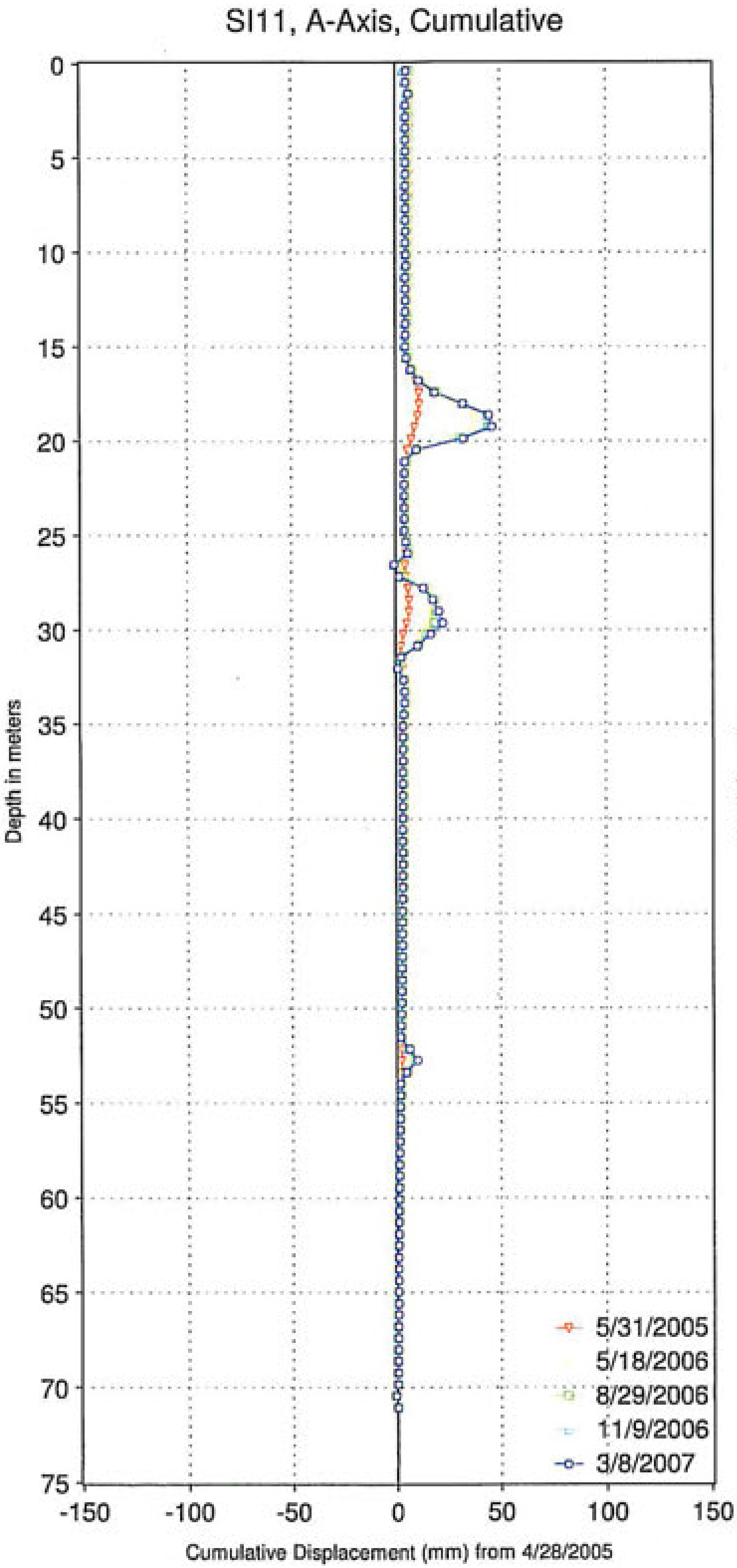
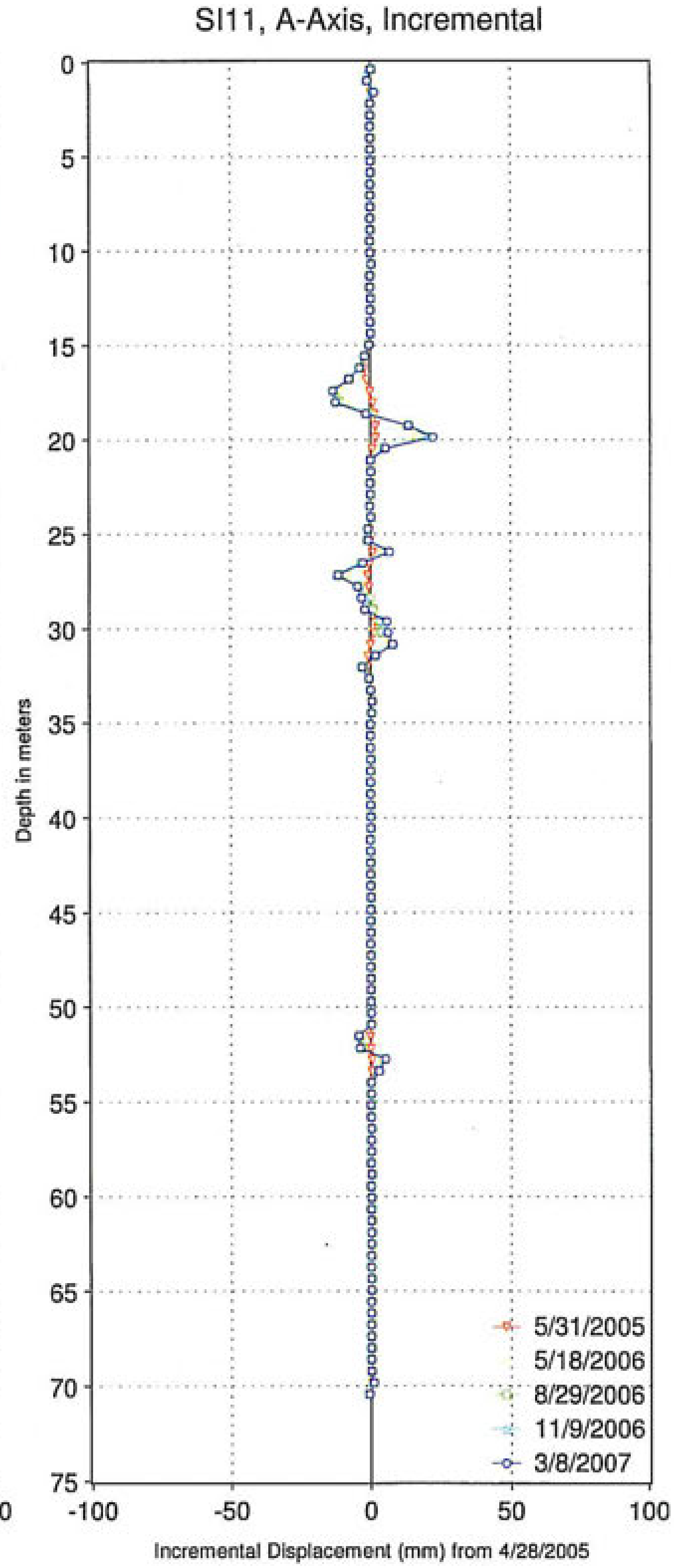
WEST QUESNEL LAND STABILITY STABILITY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI11





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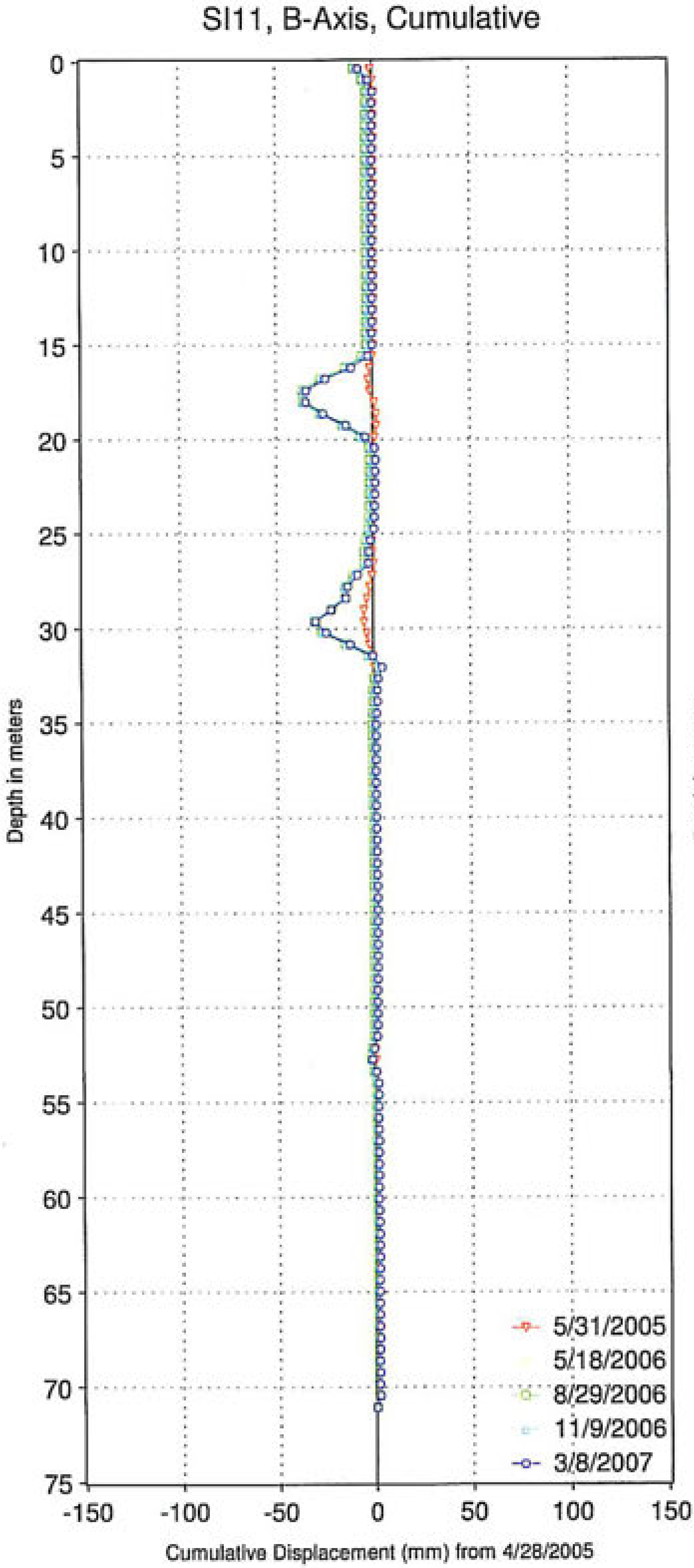
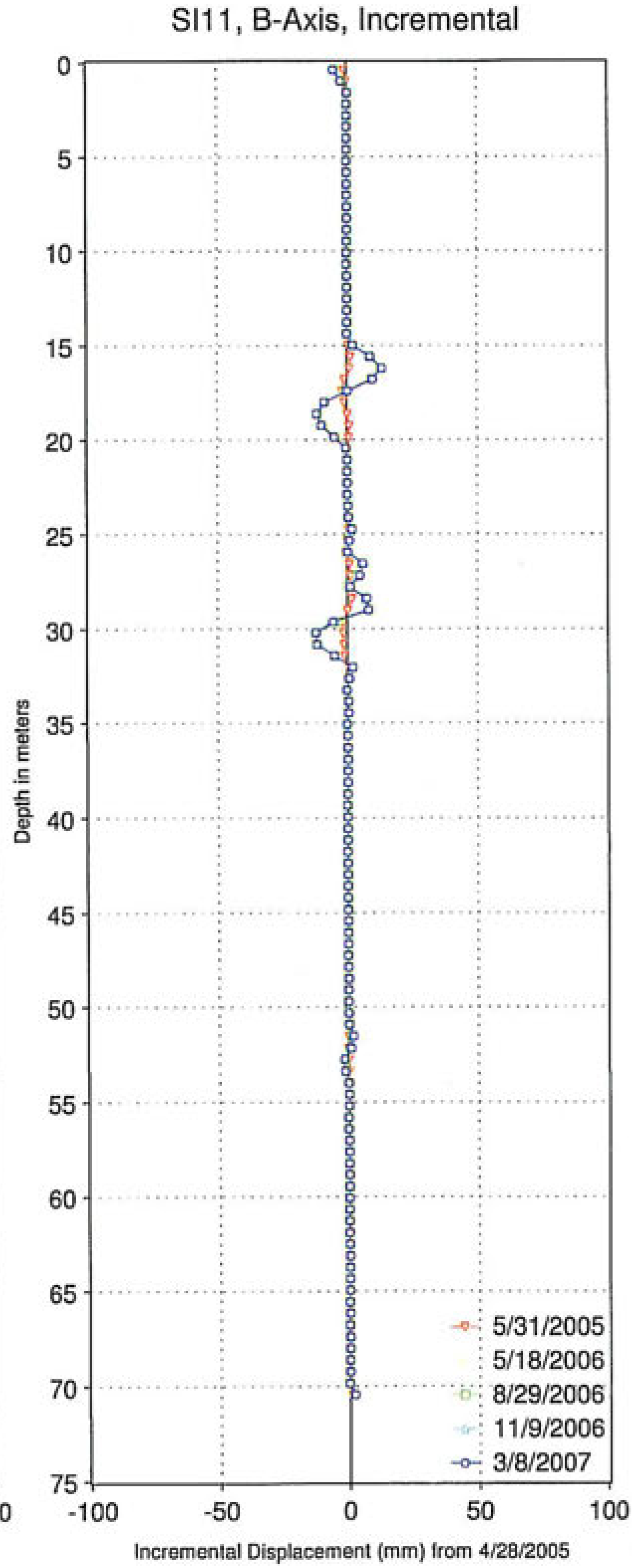
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI11





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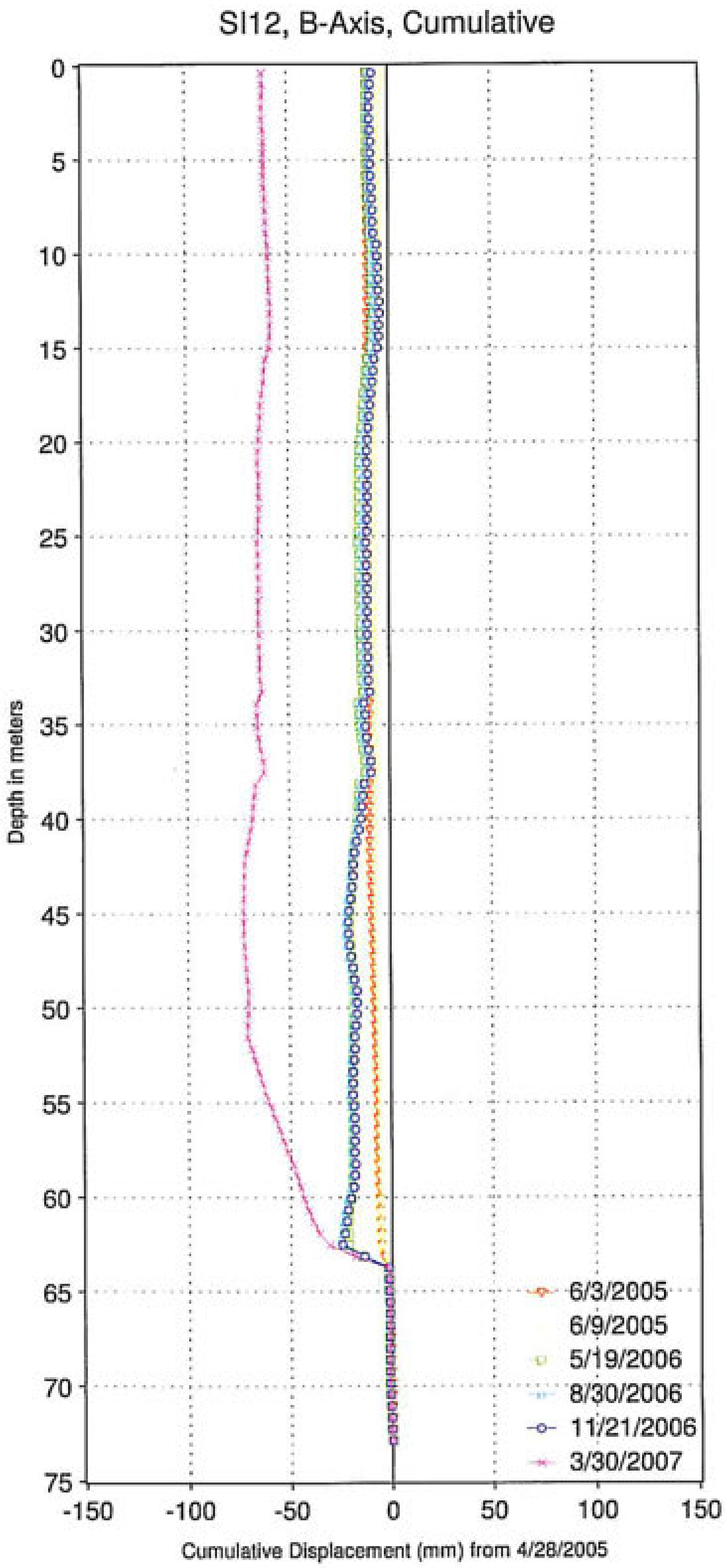
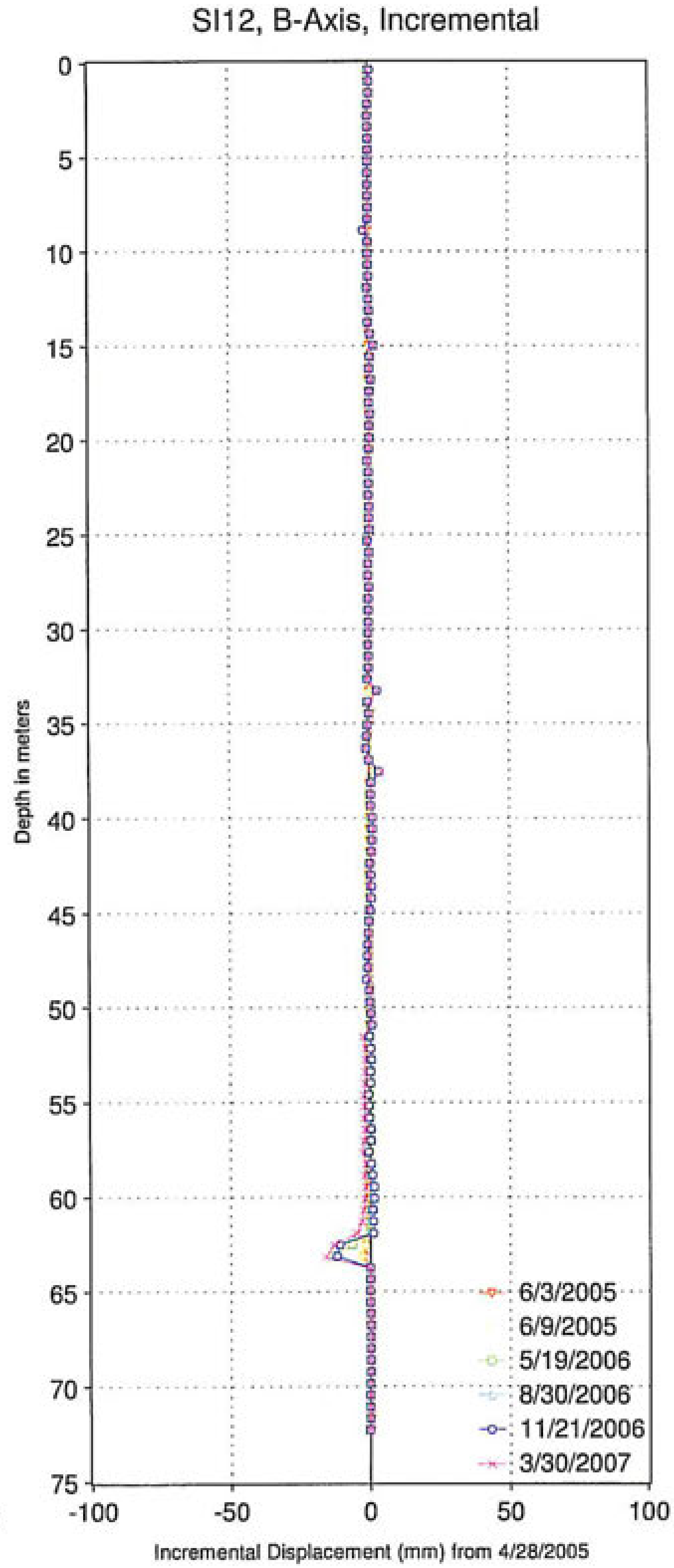
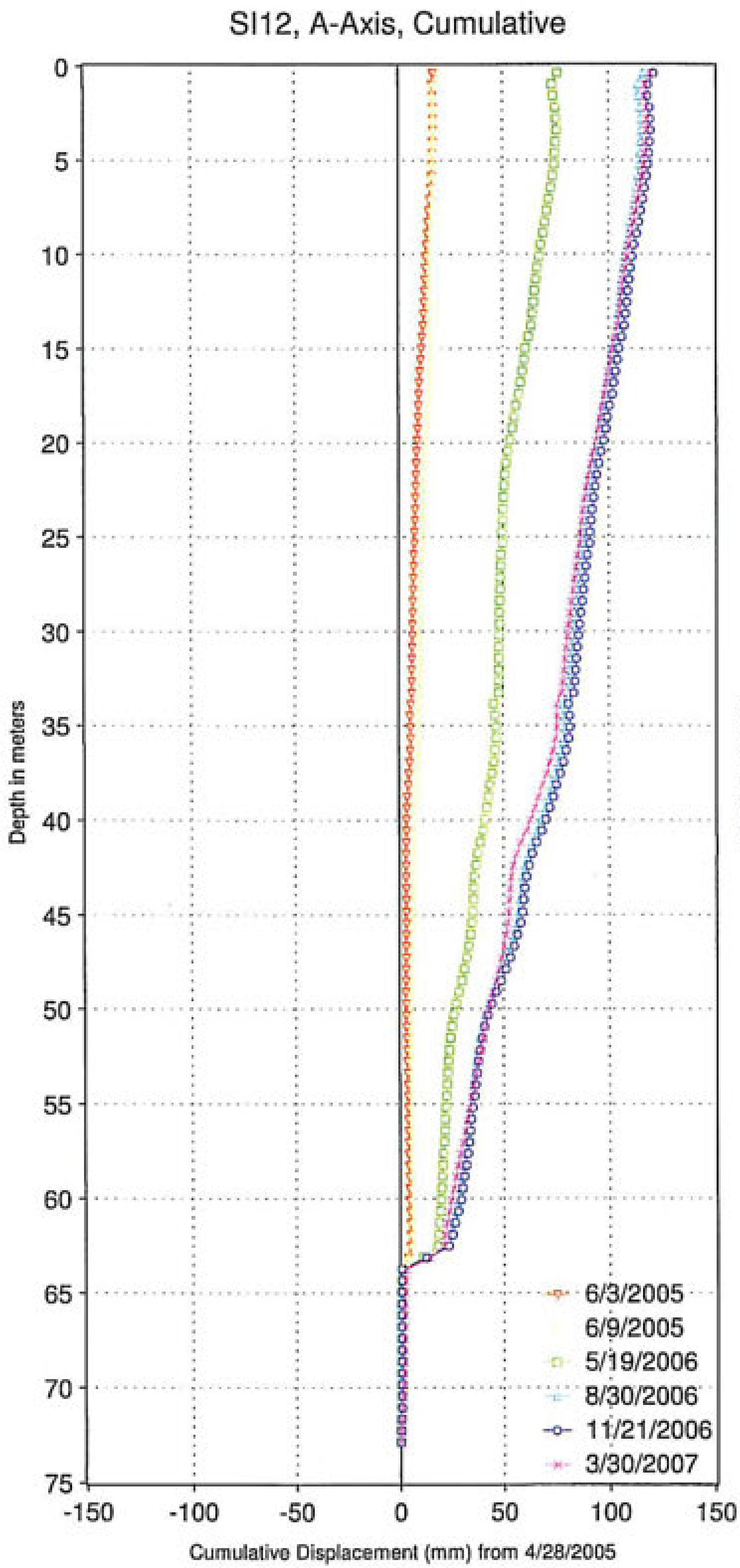
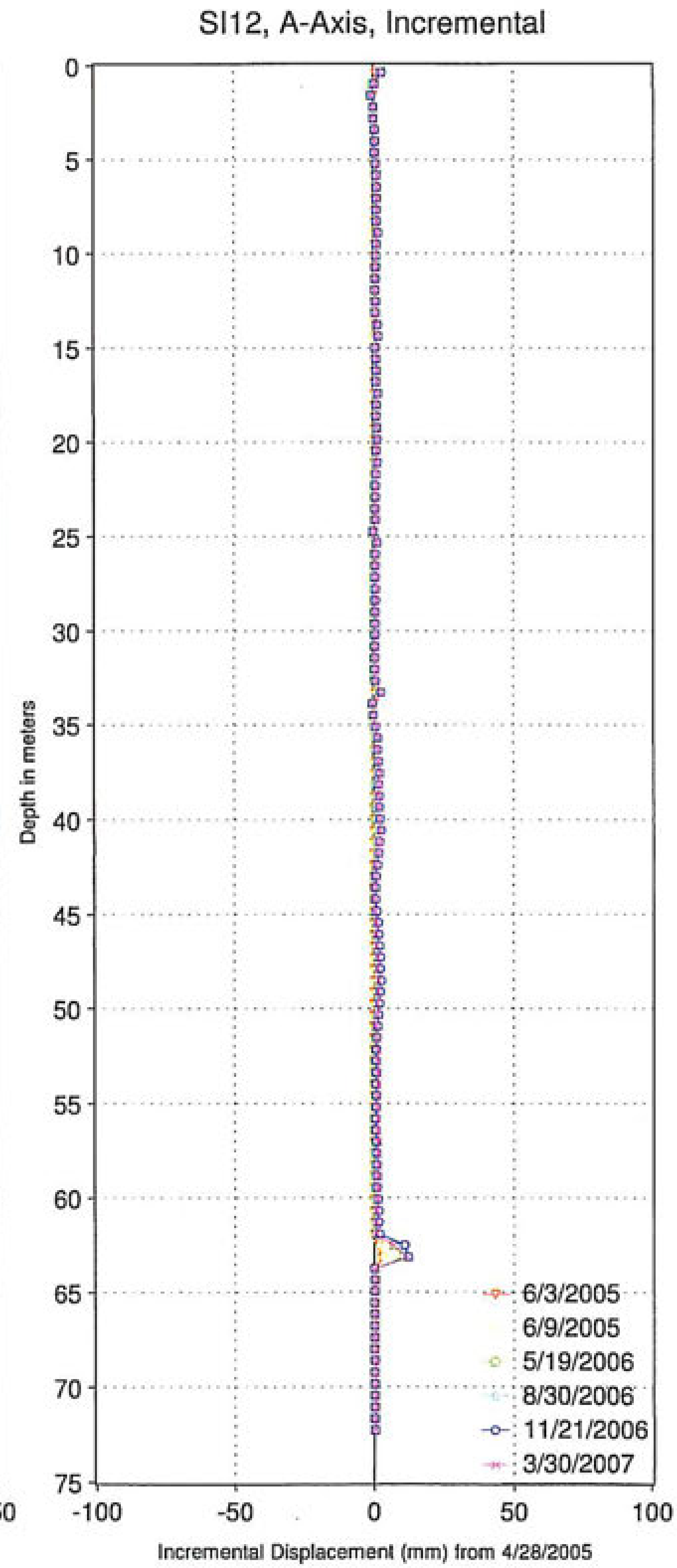
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI12



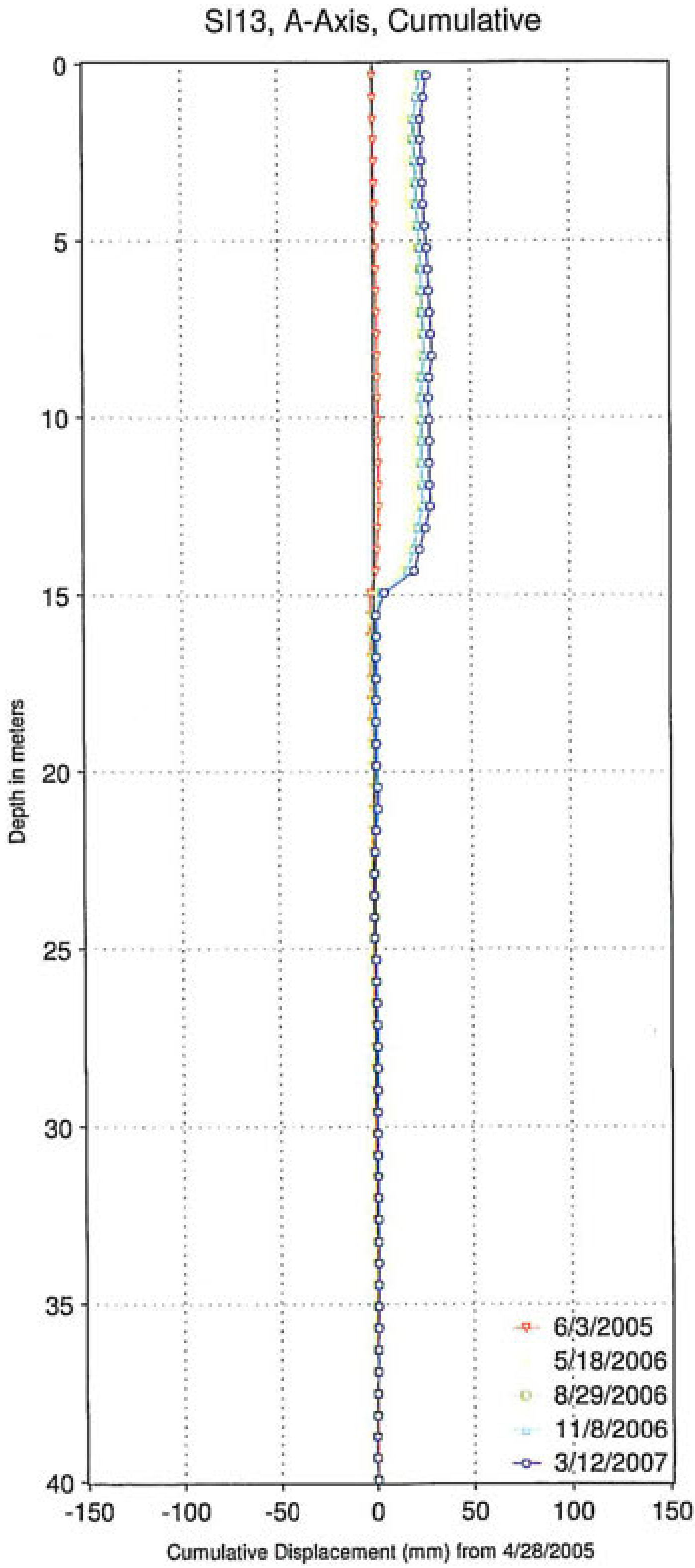


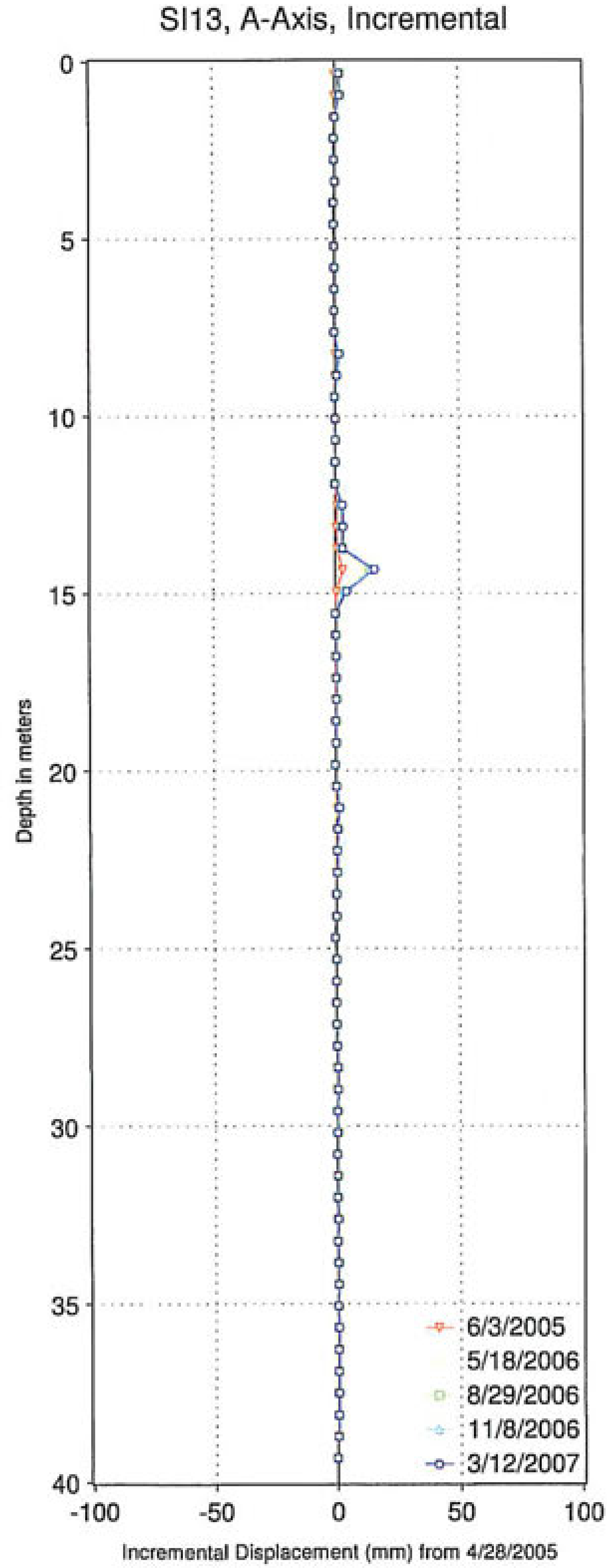
KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI12





KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI13





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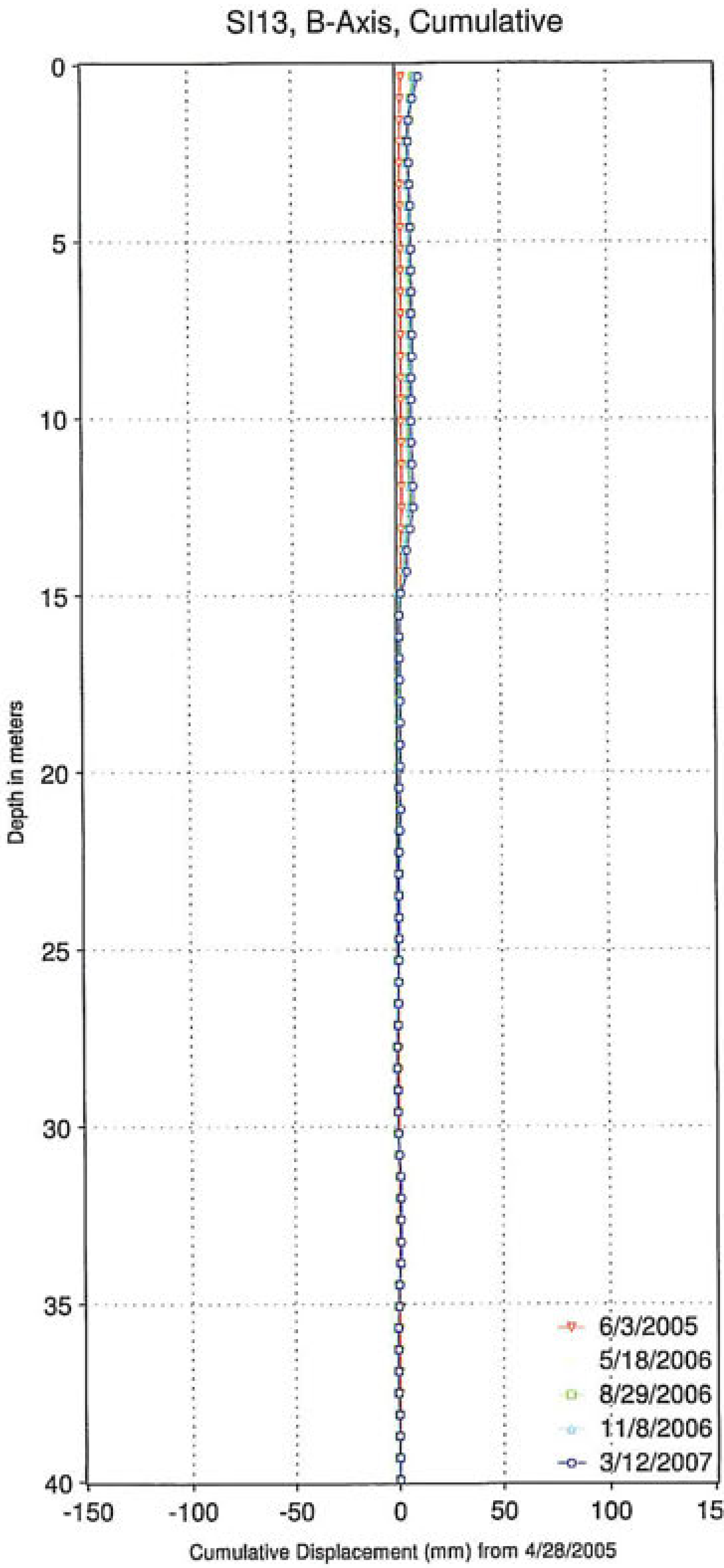
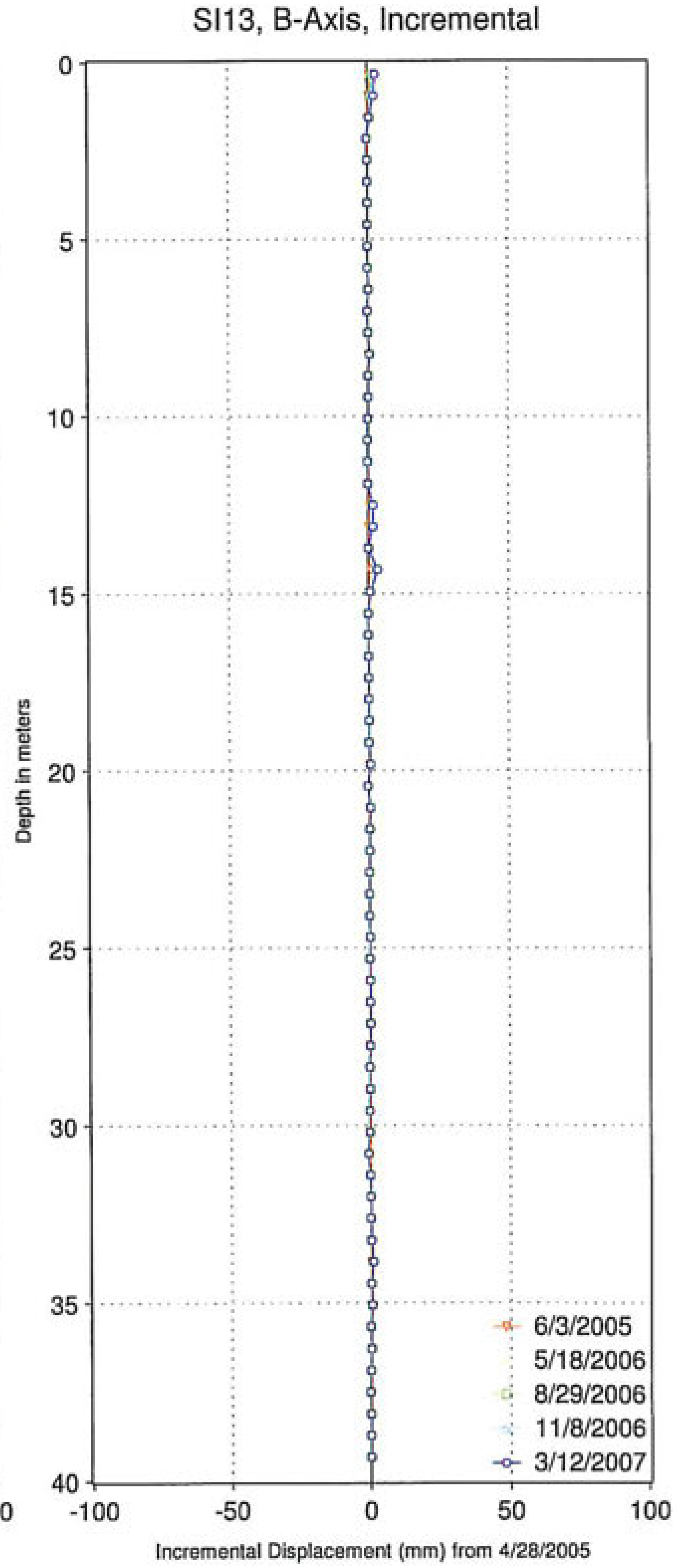
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI13

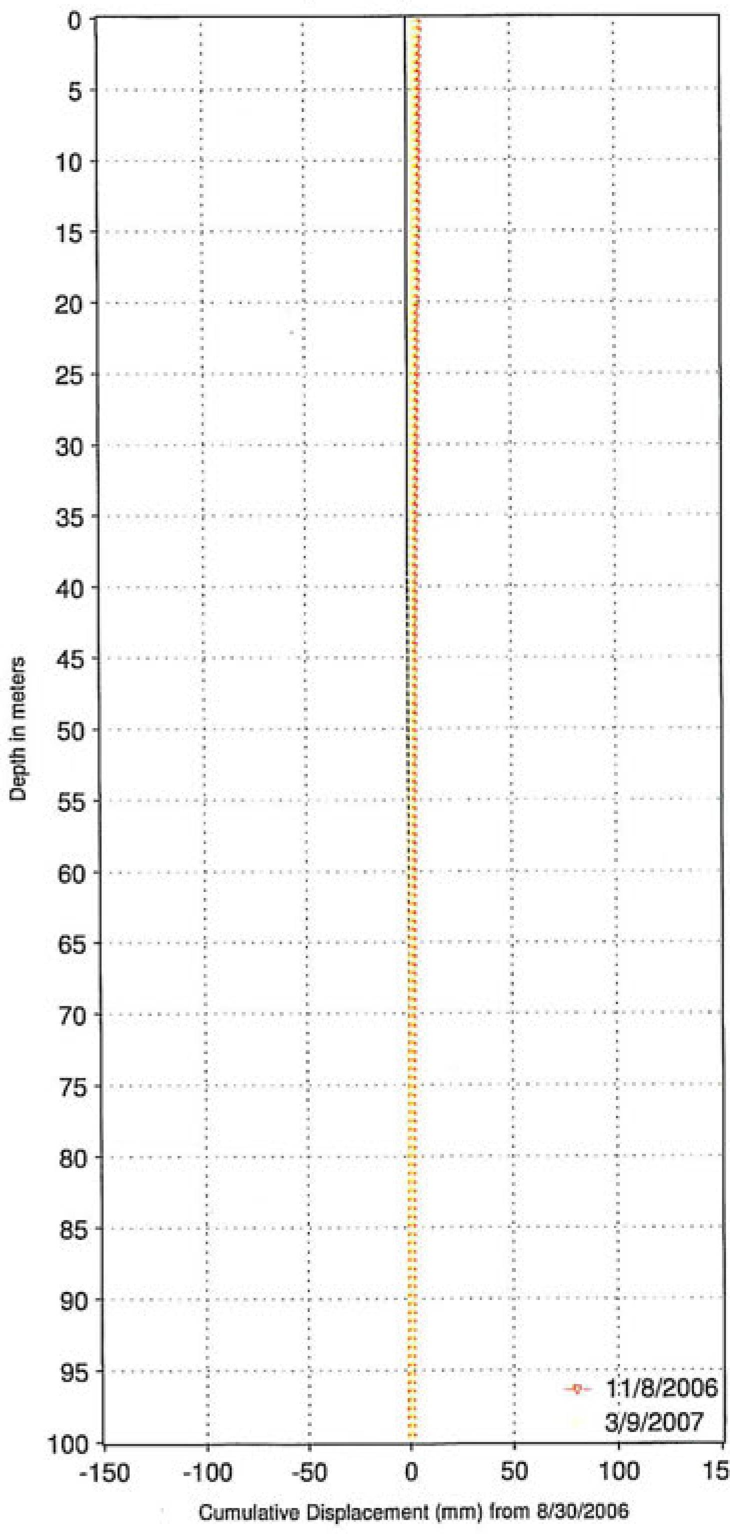




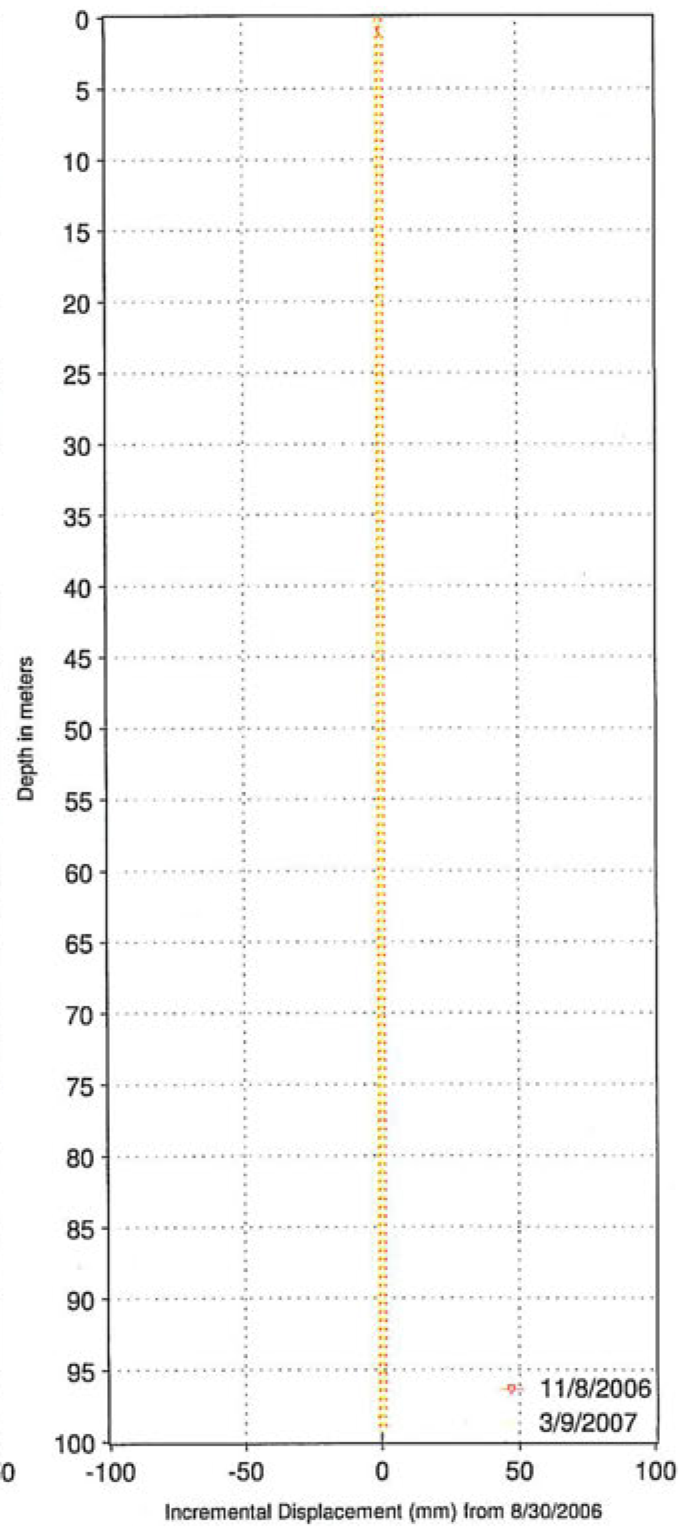
KX04397
WEST QUESNEL STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI14

INITIAL READINGS

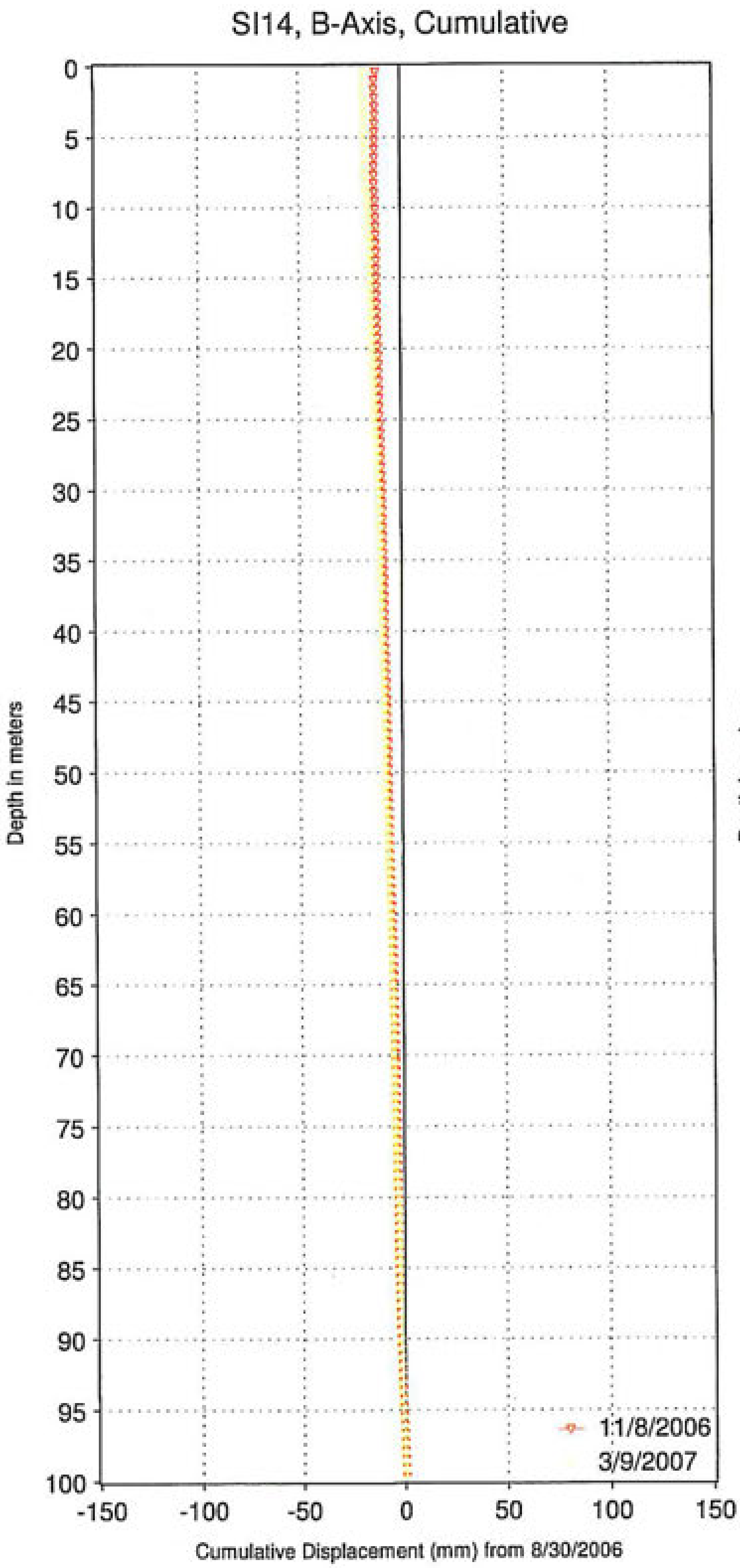
SI14, A-Axis, Cumulative

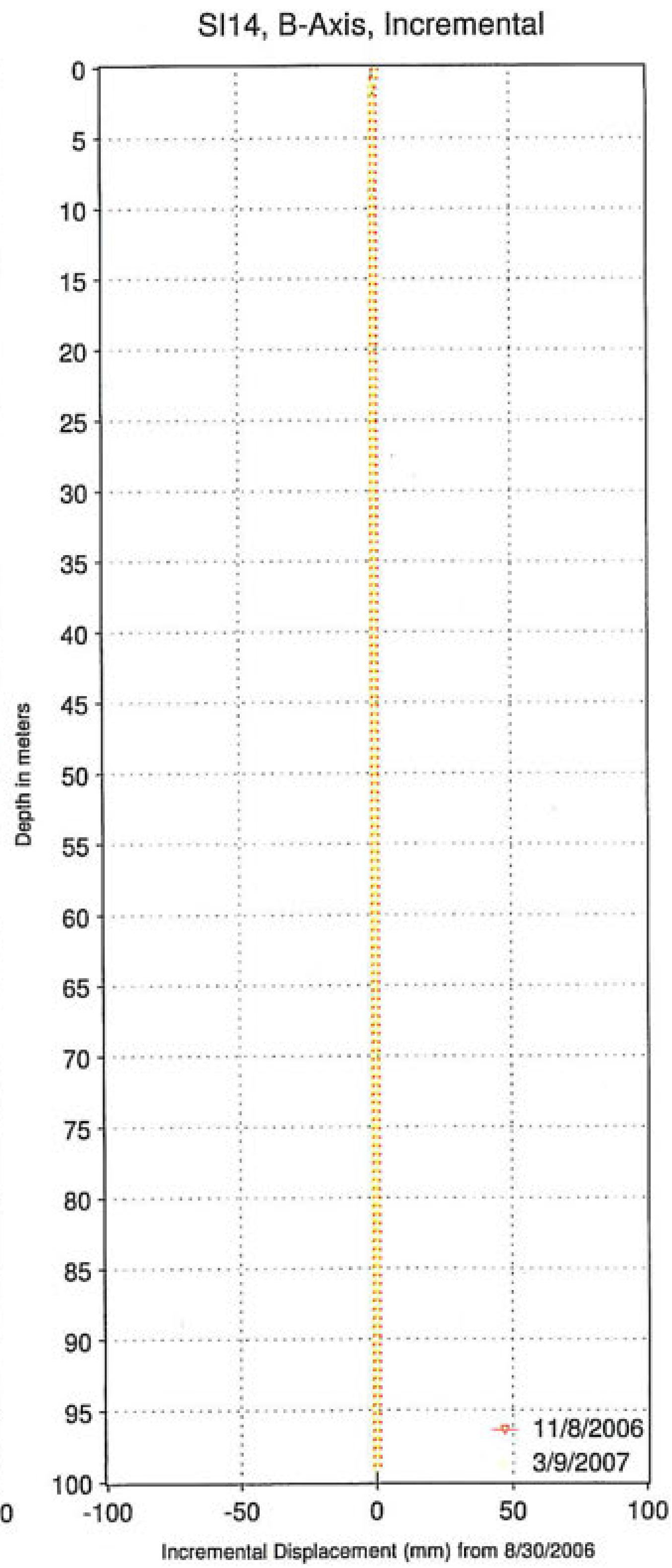


SI14, A-Axis, Incremental



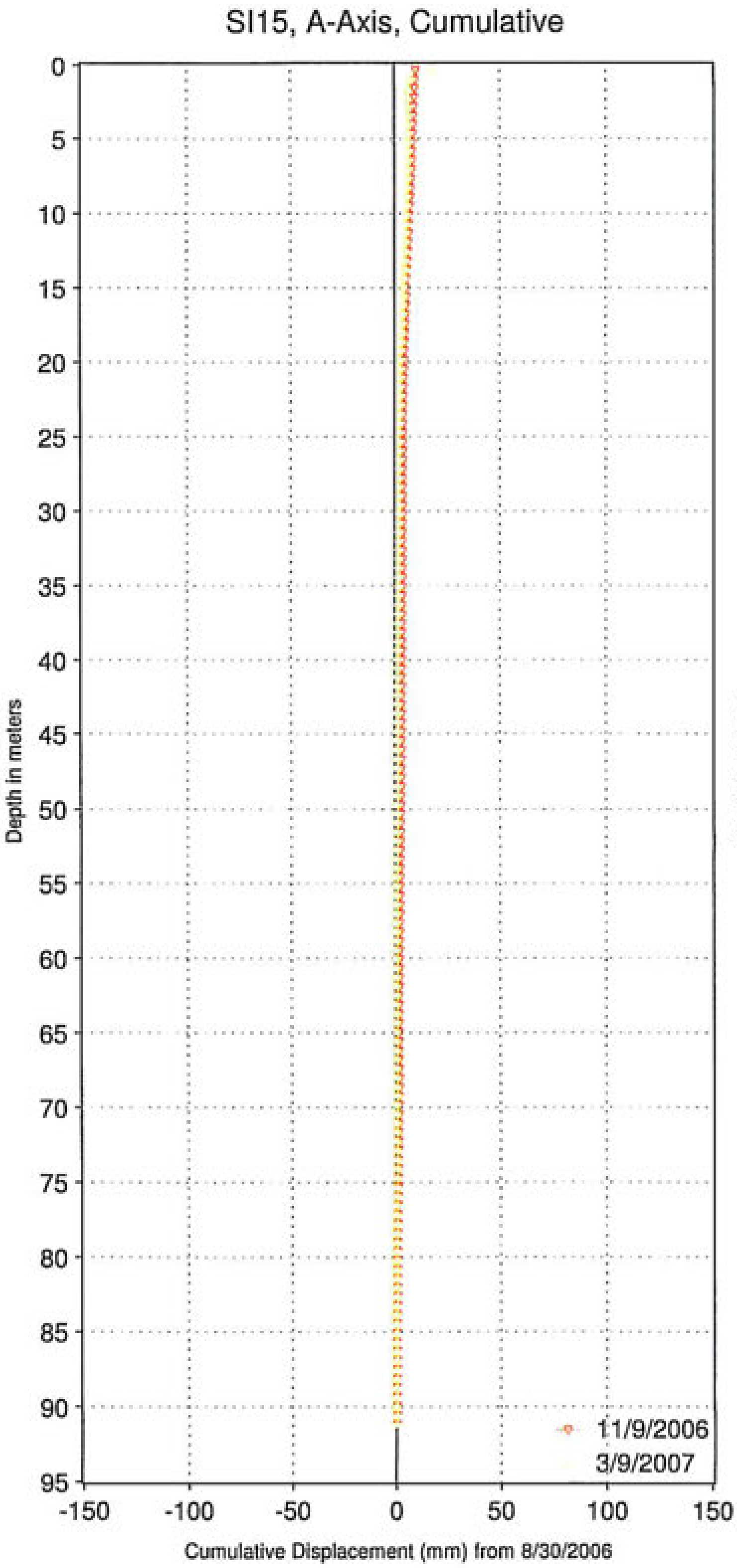
KX04397
WEST QUESNEL STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACEMENTS
SI14 INITIAL READINGS

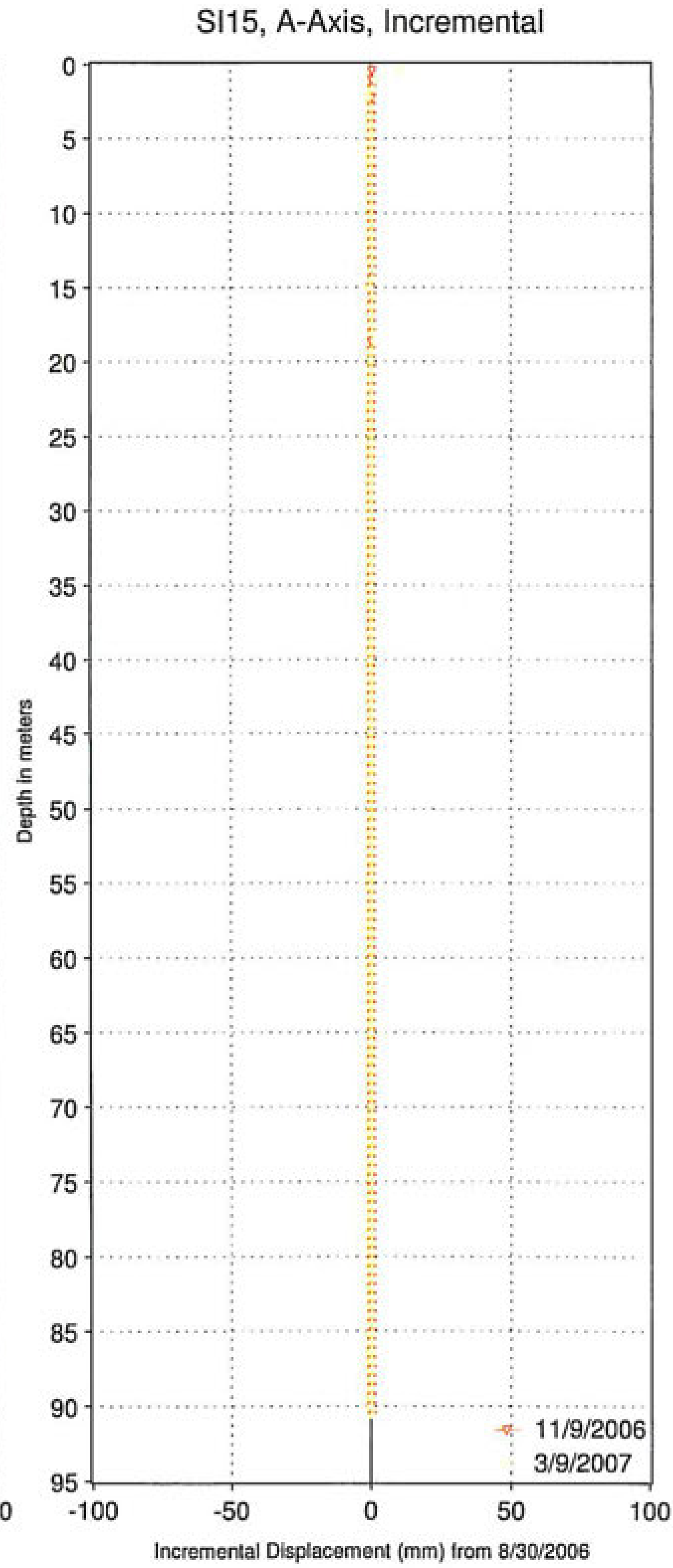




KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACMENTS
SI15

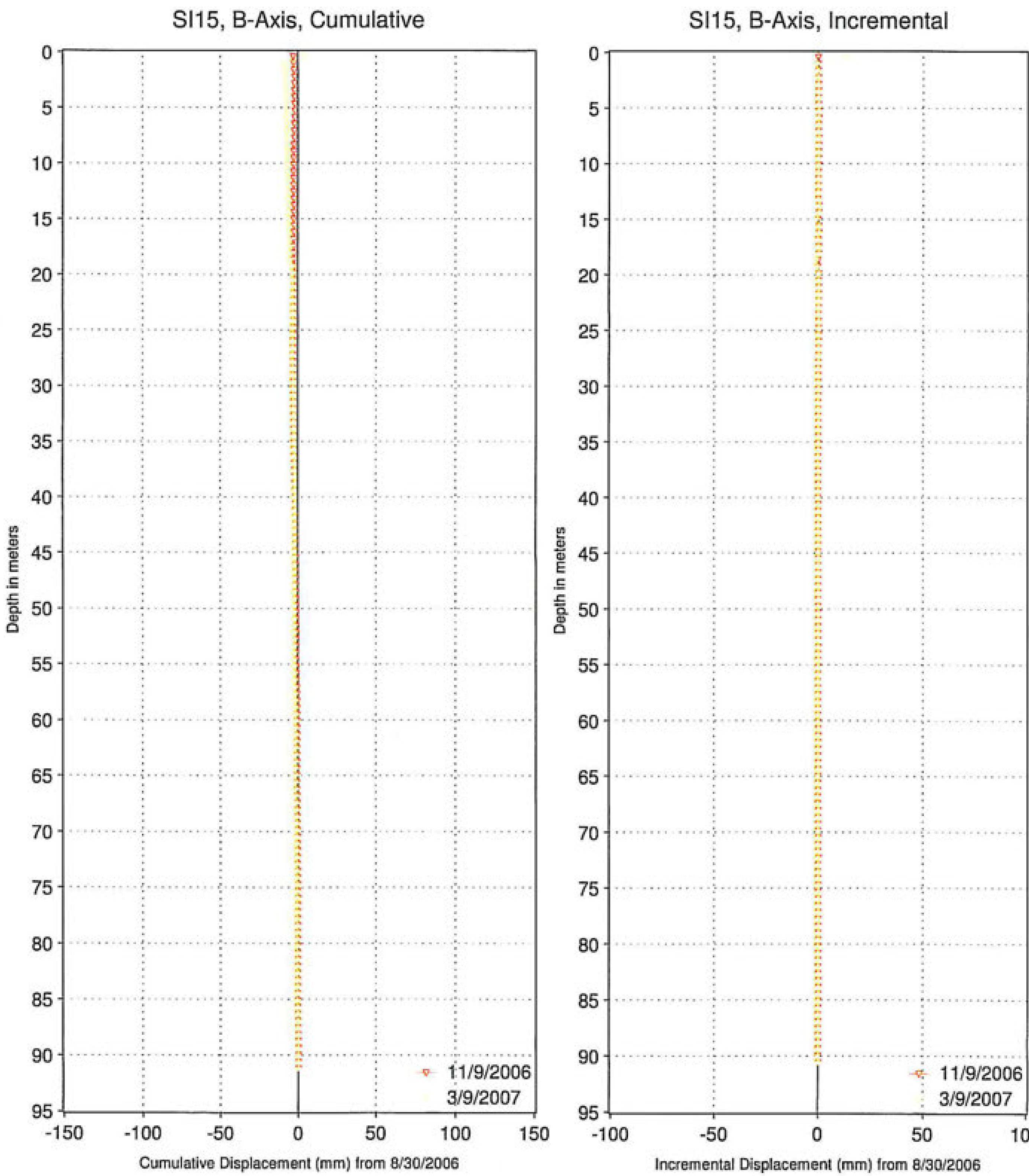
INITIAL READINGS





KX04397
WEST QUESNEL LAND STABILITY STUDY
CUMULATIVE & INCREMENTAL DISPLACMENTS
SI15

INITIAL READINGS



APPENDIX H

Table H1: Standpipe and Vibrating Wire Piezometer Installation Details

Installation No.	Location	Installation Type	Date Completed	Screen or Tip Depth (m)[1]	Type of Casing Protector
BH-2	Avery Lane	Standpipe	02 Nov. 2001	54.2-60.2	Stick-up
VWP-3	Abbott Drive	Vibrating Wire Piezometer (VWP)	15 Nov. 2001	38.0	Stick-up
BH-4	Voyager School	Standpipe	06 Dec. 2001	39.6-39.9	Stick-up
VWP-4	Voyager School	VWP	06 Dec. 2001	49.0	Stick-up
BH-6A1	Dixon Street	Standpipe	18 Dec. 2001	44.0-45.2	Flush-Mount
BH-6A2	Dixon Street	Standpipe	18 Dec. 2001	26.4-27.8	Flush-Mount
PW-01	Flamingo Street	Standpipe	16 Sep. 2003	29.9-48.2	Stick-up
PW-02	Abbott Drive & Bettcher Street	Standpipe	18 Sep. 2003	29.8-55.0	Stick-up
BH-2A	Bettcher Street	Standpipe	07 Aug. 2003	86.9-88.4	Flush-Mount
BH-2B	Bettcher Street	Standpipe	07 Aug. 2003	47.7-48.2	Flush-Mount
BH-2C	Bettcher Street	Standpipe	08 Aug. 2003	25.3-25.9	Flush-Mount
BH-3A	Flamingo Street	Standpipe	24 Jul. 2003	49.9-50.5	Flush-Mount
BH-3B	Flamingo Street	Standpipe	22 Jul. 2004	38.7-40.2	Flush-Mount
BH-3C	Flamingo Street	Standpipe	22 Jul. 2004	32.0-33.5	Flush-Mount
BH-4A	Flamingo Street	Standpipe	17 Jul. 2003	48.8-49.4	Flush-Mount
BH-4B	Flamingo Street	Standpipe	17 Jul. 2003	38.7-40.2	Flush-Mount
BH-4C	Flamingo Street	Standpipe	18 Jul. 2003	22.8-23.4	Flush-Mount
VWP-7A	Lewis Drive & Pierce Street	VWP	21 Jul. 2005	27.0	Stick-up
VWP-7B	Lewis Drive & Pierce Street	VWP	21 Jul. 2005	64.9	Stick-up
VWP-8A	Pinchbeck Street	VWP	15 Jun. 2005	13.1	Stick-up
VWP-8B	Pinchbeck Street	VWP	15 Jun. 2005	13.0	Stick-up
VWP-8C	Pinchbeck Street	VWP	15 Jun. 2005	28.0	Stick-up
VWP-8D	Pinchbeck Street	VWP	29 May 2006	56.2	Stick-up
VWP-9A	Patchett Ave	VWP	27 Jun. 2005	15.1	Stick-up
VWP-9B	Patchett Ave	VWP	31 May 2006	30.6	Stick-up
VWP-9C	Patchett Ave	VWP	31 May 2006	50.1	Stick-up
VWP-10A	Dawson Street	VWP	05 Jul. 2005	11.6	Stick-up
VWP-10B	Dawson Street	VWP	05 Jul. 2005	20.4	Stick-up
VWP-10C	Dawson Street	VWP	05 Jul. 2005	48.6	Stick-up
VWP-11A	Picard Ave	VWP	10 Jun. 2005	14.3	Stick-up
VWP-11B	Picard Ave	VWP	10 Jun. 2005	32.0	Stick-up
VWP-11C	Picard Ave	VWP	10 Jun. 2005	50.3	Stick-up
VWP-12A	East end of Panagrot Ave	VWP	22 Jun. 2005	18.0	Stick-up
VWP-12B	East end of Panagrot Ave	VWP	22 Jun. 2005	22.9	Stick-up
VWP-12C	East end of Panagrot Ave	VWP	22 Jun. 2005	26.5	Stick-up

Table H1: Standpipe and Vibrating Wire Piezometer Installation Details

Installation No.	Location	Installation Type	Date Completed	Screen or Tip Depth (m)[1]	Type of Casing Protector
VWP-12D	East end of Panagrot Ave	VWP	22 Jun. 2005	54.9	Stick-up
VWP-13A	Lewis Drive	VWP	08 Jul. 2005	5.1	Stick-up
VWP-13B	Lewis Drive	VWP	08 Jul. 2005	14.4	Stick-up
VWP-14A	Findlay Road	VWP	06 Jun. 2006	20.1	Stick-up
VWP-14B	Findlay Road	VWP	06 Jun. 2006	65.8	Stick-up
VWP-14C	Findlay Road	VWP	06 Jun. 2006	98.8	Stick-up
VWP-15A	West end of Panagrot Ave	VWP	27 Jun. 2006	8.8	Stick-up
VWP-15B	West end of Panagrot Ave	VWP	27 Jun. 2006	63.4	Stick-up
VWP-15C	West end of Panagrot Ave	VWP	27 Jun. 2006	83.2	Stick-up
VWP-16A	North of Diatomite Mine	VWP	23 Oct. 2006	42.7	Stick-up
VWP-16B	North of Diatomite Mine	VWP	23 Oct. 2006	85.6	Stick-up
VWP-16C	North of Diatomite Mine	VWP	23 Oct. 2006	139.0	Stick-up
VWP-16D	North of Diatomite Mine	VWP	23 Oct. 2006	214.9	Stick-up

Notes:
1 Depths are measured from ground surface. Screen depth is for standpipes, tip depth is for vibrating wire piezometers.

Appendix H: Legend for Stick Logs Shown in Figures H1 – H19

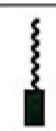
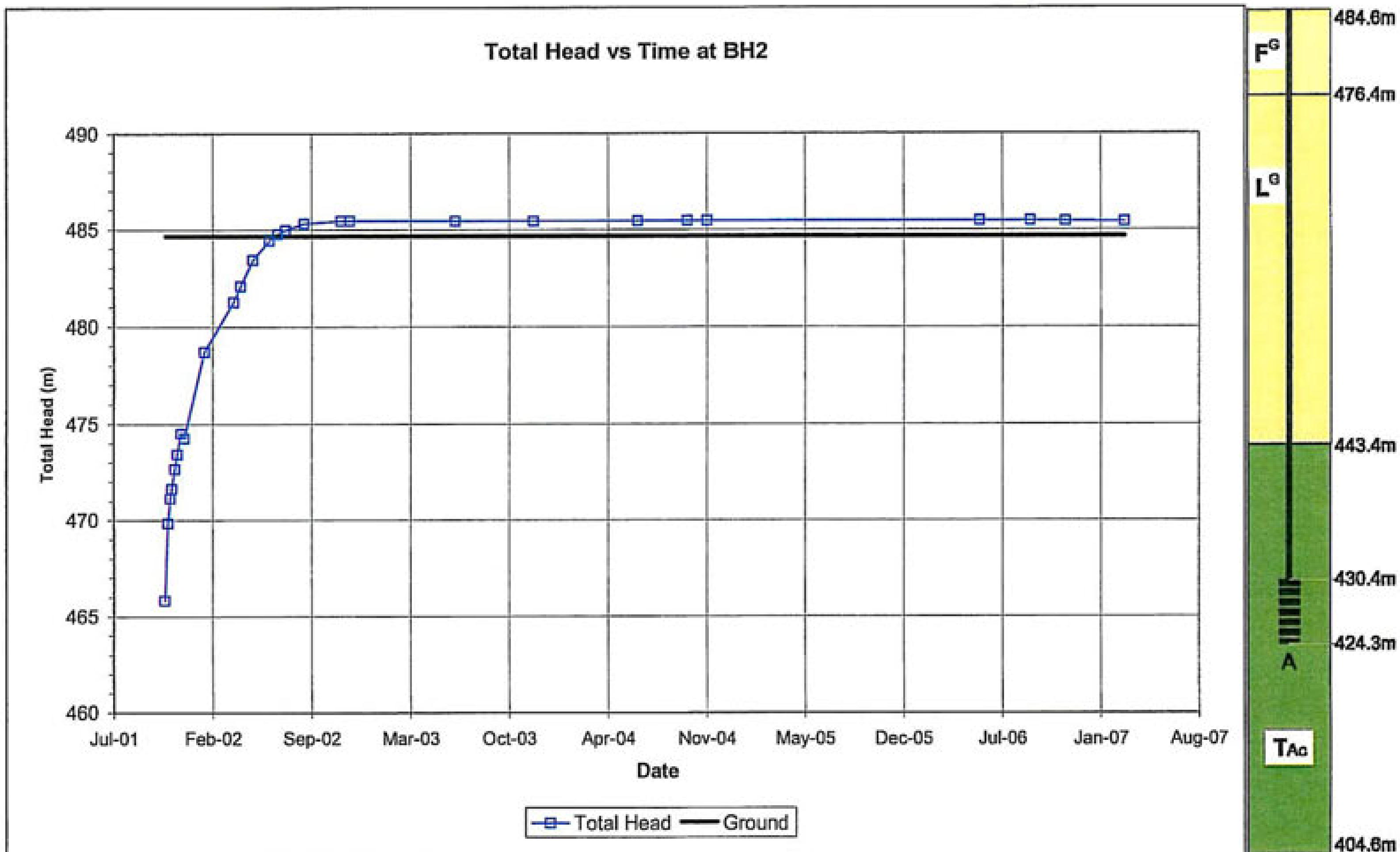
	F^G	Glaciofluvial material. This unit may contain smaller discontinuous layers of silt, sand, gravel, till, and various near surface fill. Due to high variability of soils, the unit is modeled as isotropic.
	L^G	Glaciolacustrine material. This unit generally contains layered silt, clay and fine sand.
	T_{AC}	T_{AC}–Australian Creek Tertiary sediments, comprised of sediments of volcanic origin.
	MT_{CC}	MT_{CC} – Mississippian to Triassic Cache Creek Sedimentary to Metamorphic bedrock. Highly fractured.
	Vibrating Wire Piezometer	Denotes the location of a vibrating wire piezomter in the stick log (tip and wire).
	Standpipe Piezometer	This symbol is used to denote the location of a standpipe piezomter in a stick log. The dashed section is the screened portion of the standpipe and is relative to the actual length of screen used.

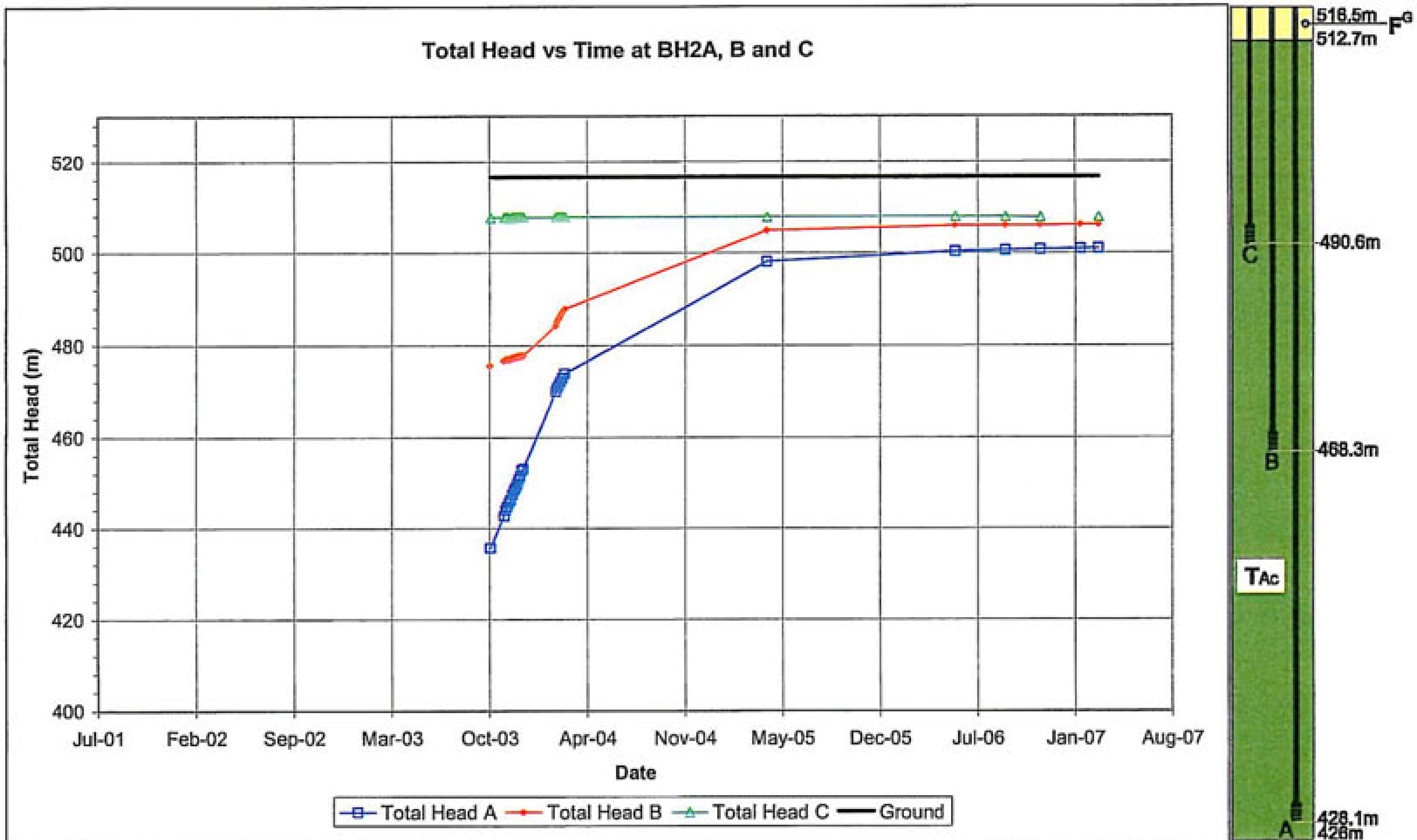
Figure H1



Total Head Datum = Om asl

Initial reading taken on 11/9/2001

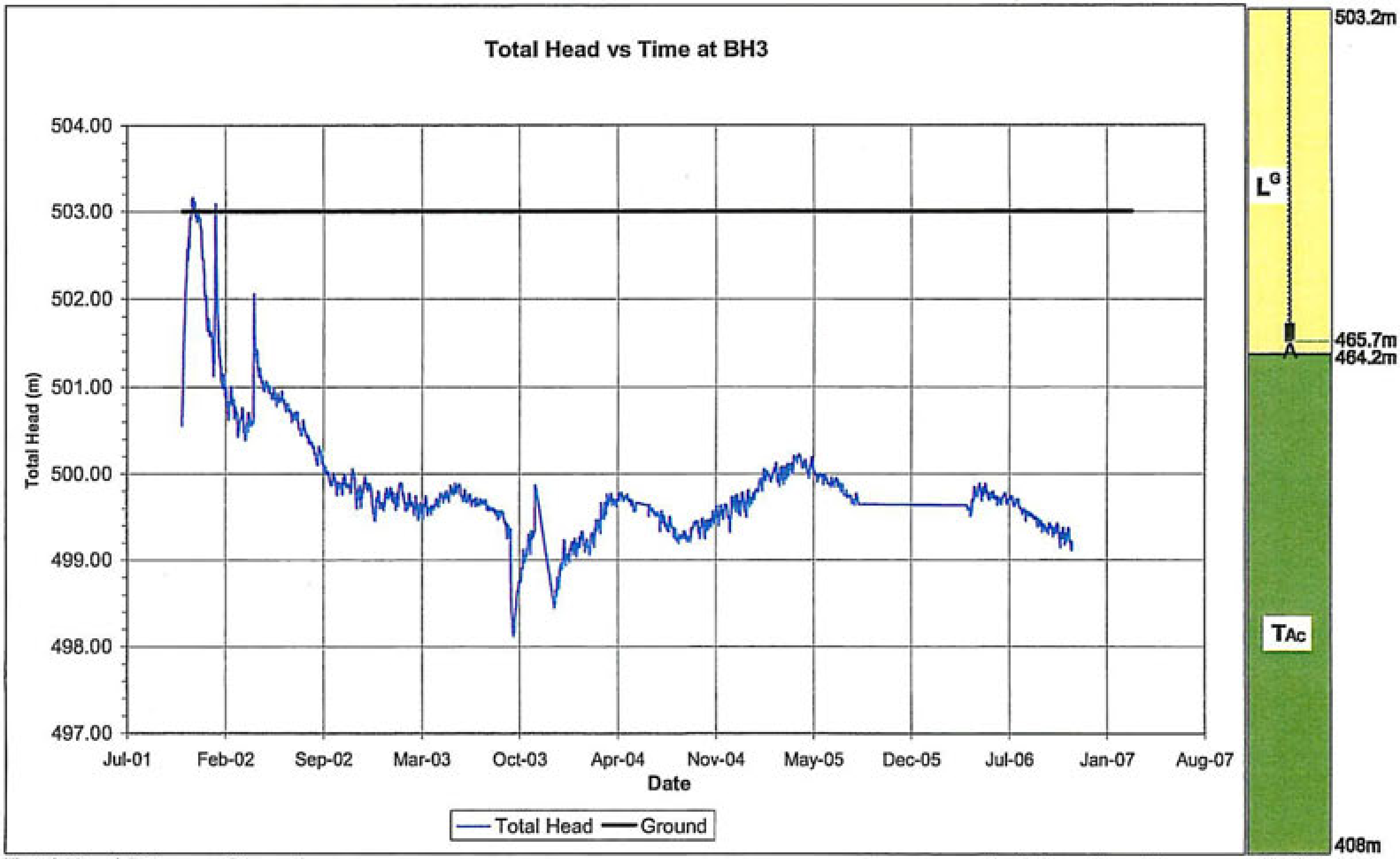
Figure H2



Total Head Datum = Om asl

Initial reading taken on 10/8/2003

Figure H3



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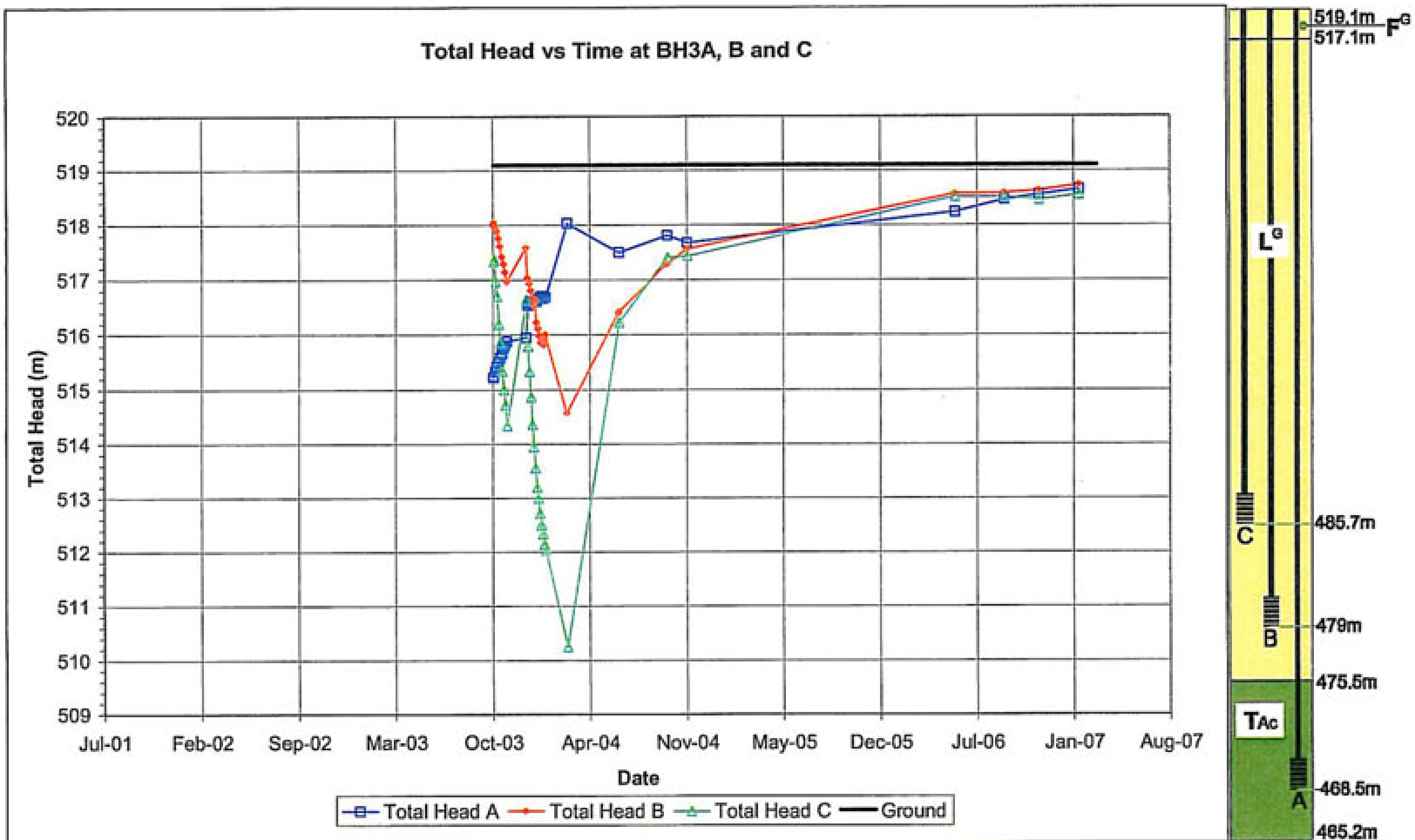
Initial reading taken on 11/16/2001

Figure H4



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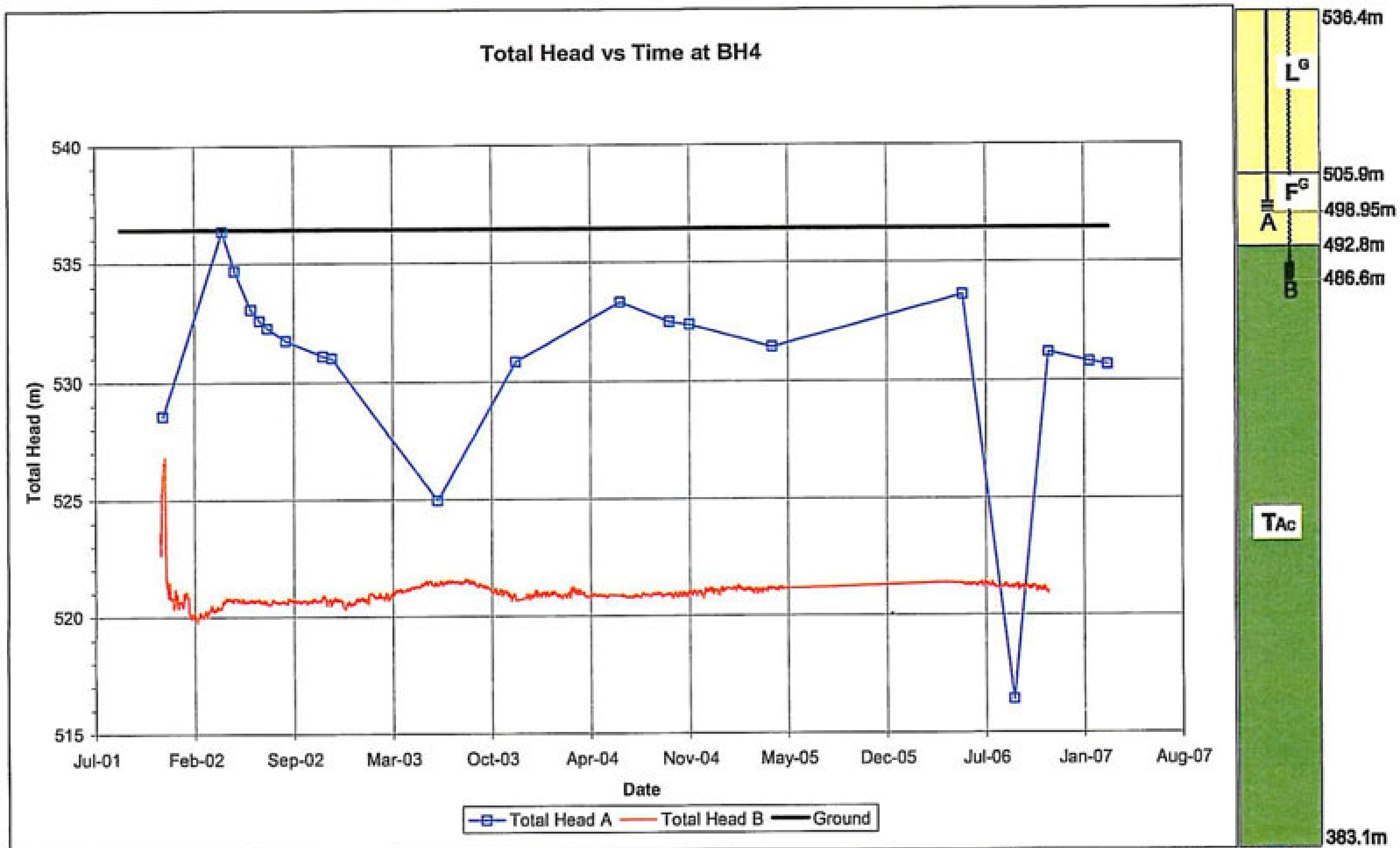
Initial reading taken on 10/8/2003

Figure H5



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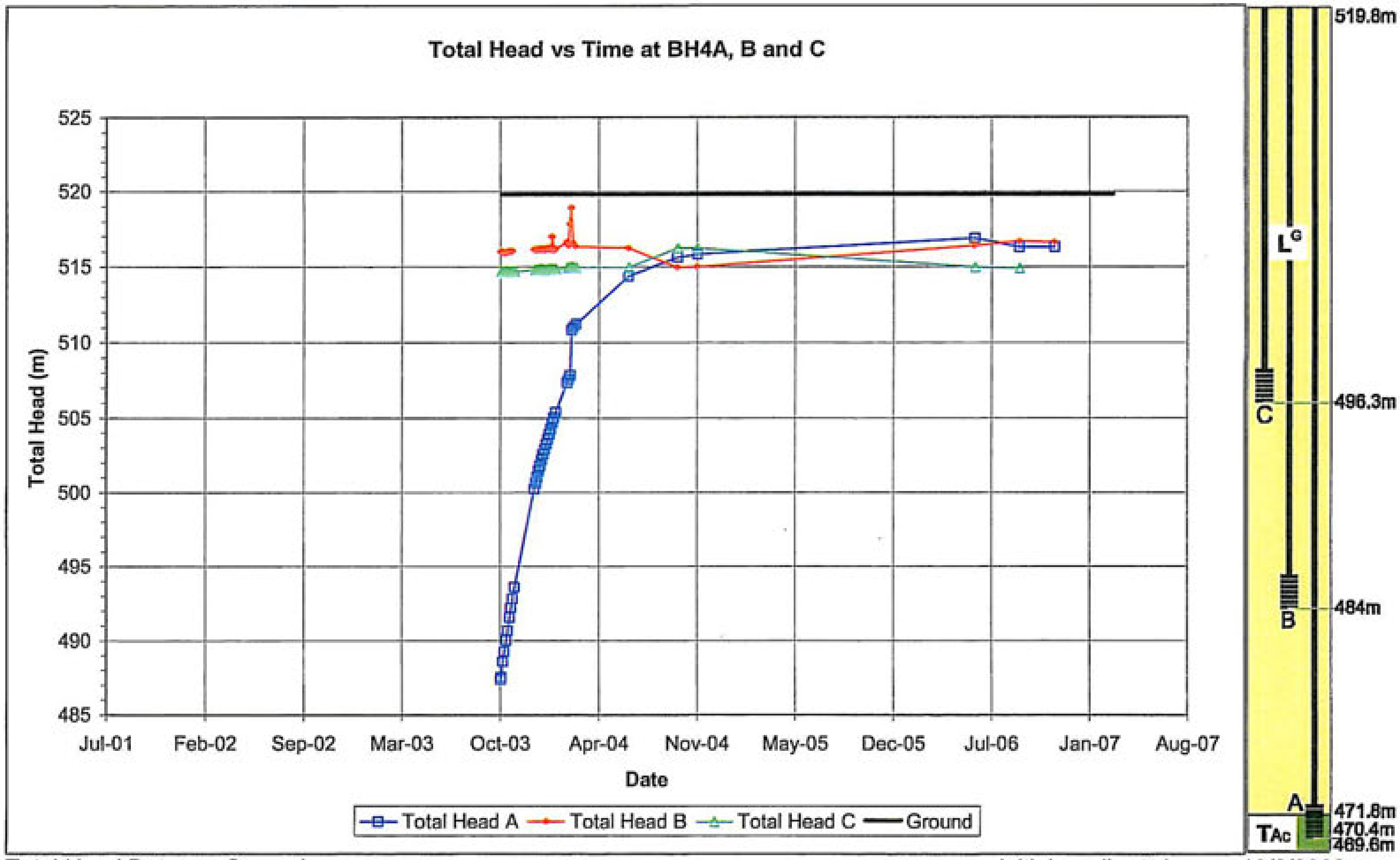
Initial reading taken on 12/7/2001

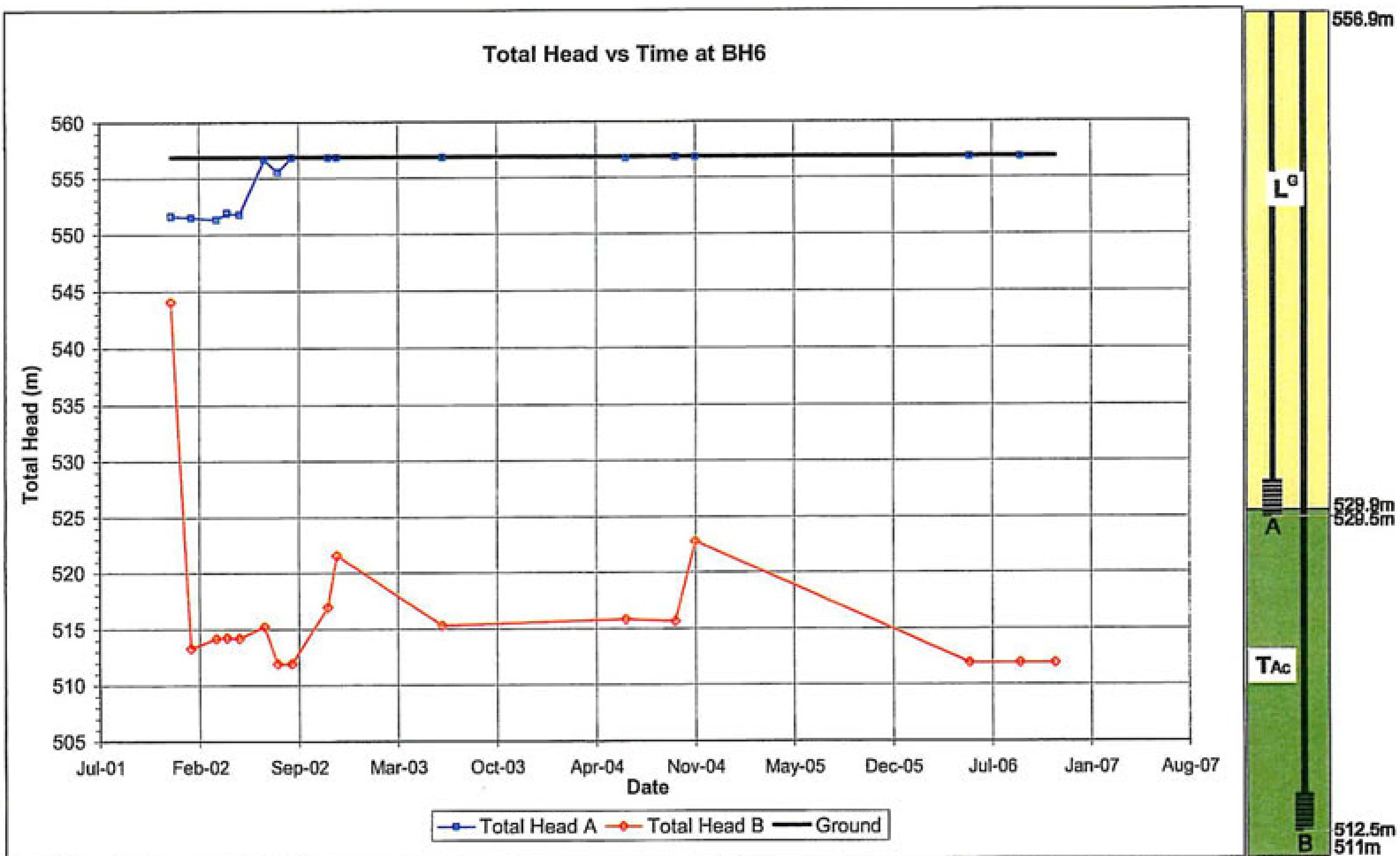
Figure H6



Total Head Datum = Om asl

Initial reading taken on 10/8/2003

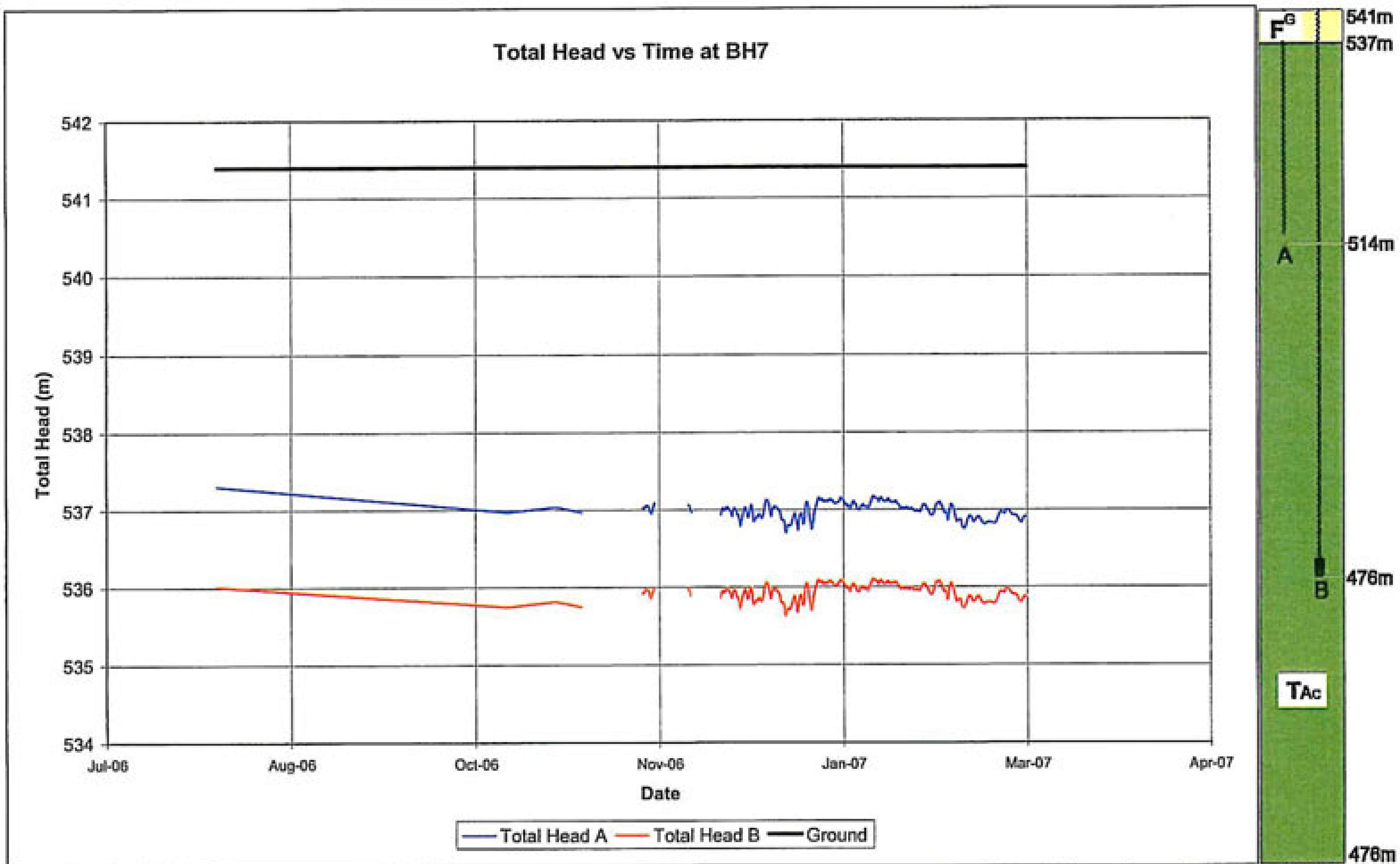
Figure H7



Total Head Datum = Om asl

Initial reading taken on 12/19/2001

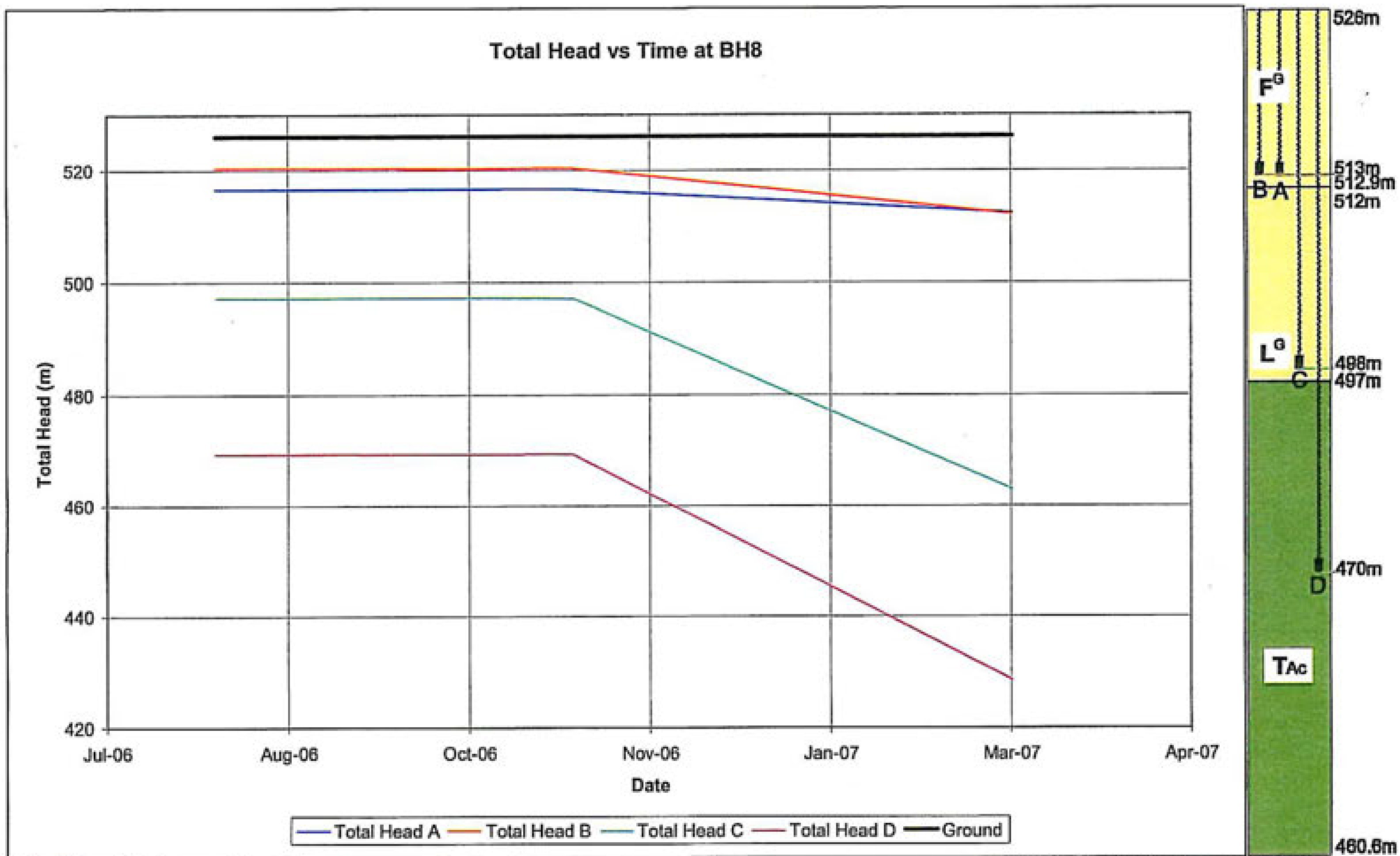
Figure H8



Total Head Datum = Om asl

Initial reading taken on 8/1/2006

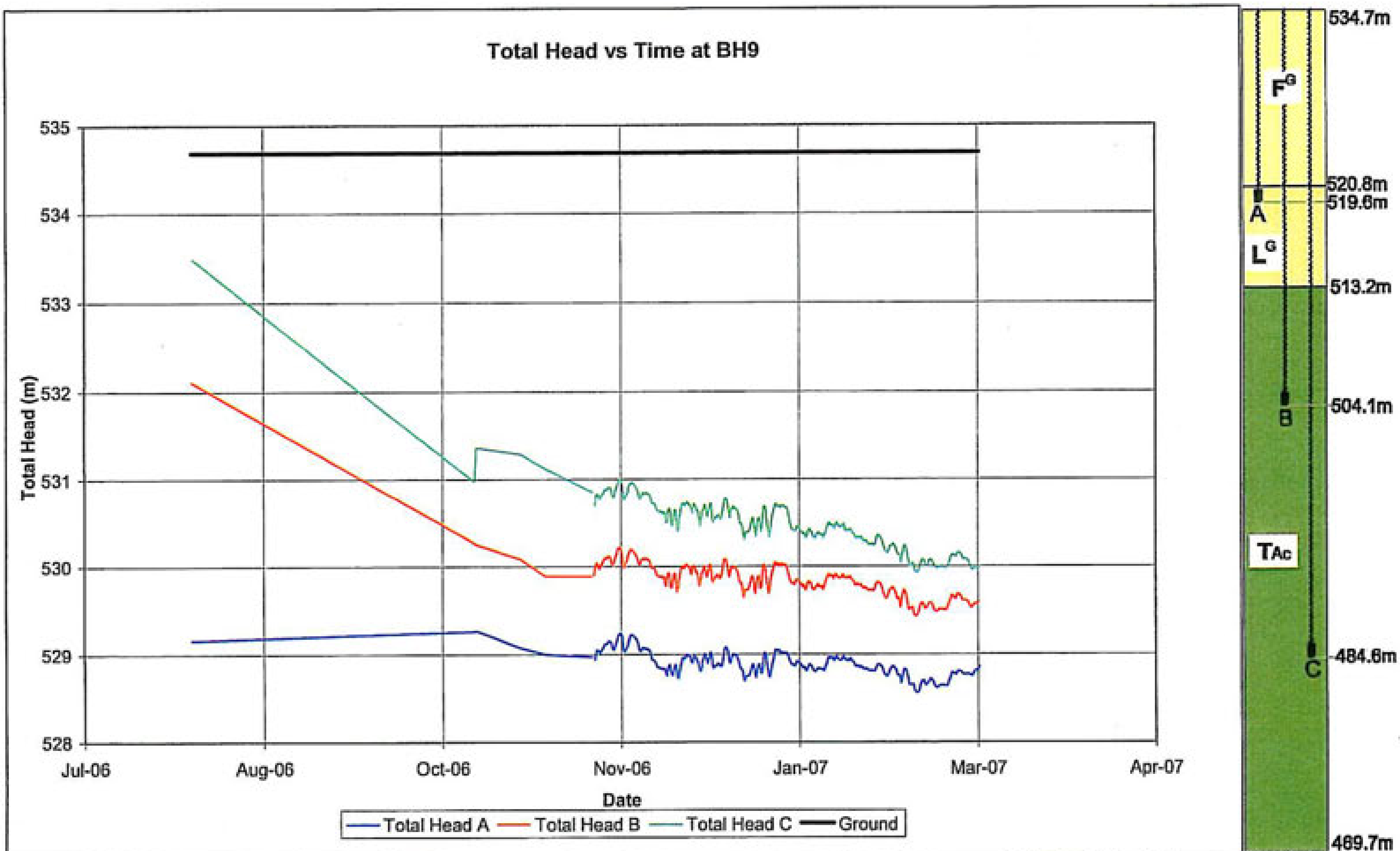
Figure H9



Total Head Datum = Om asl

Initial reading taken on 8/1/2006

Figure 10



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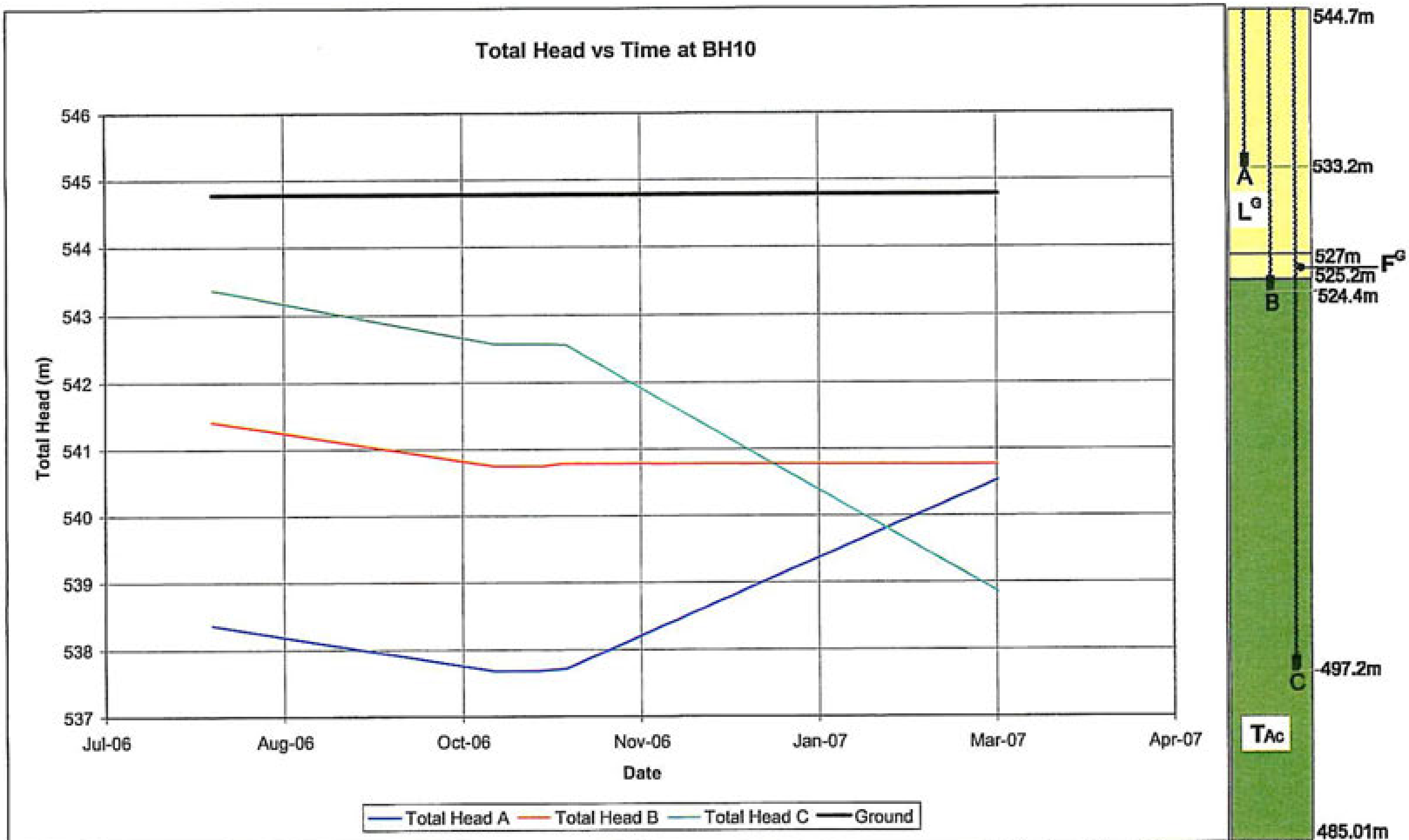
Initial reading taken on 8/1/2006

Figure H11



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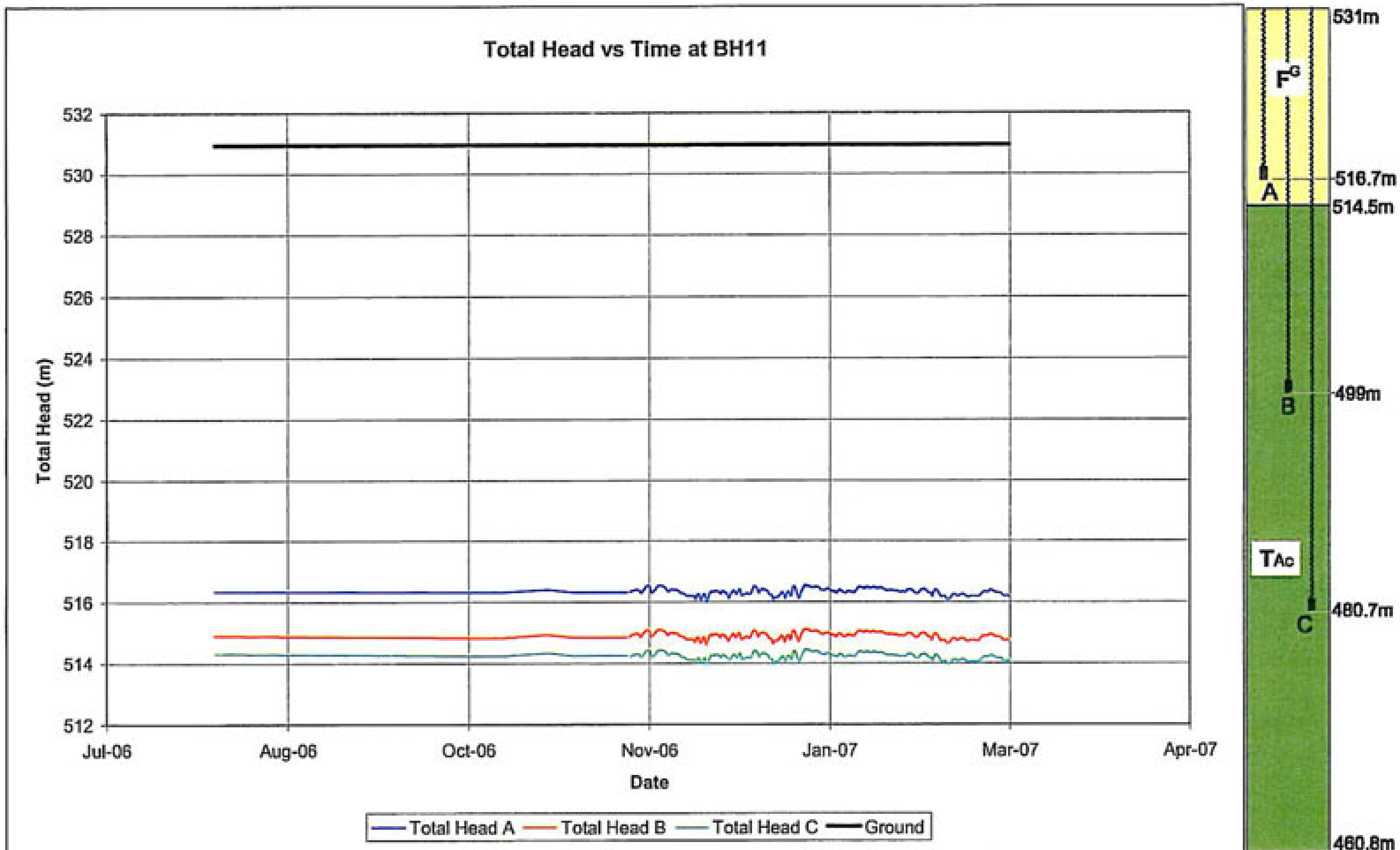
Initial reading taken on 8/1/2006

Figure H12



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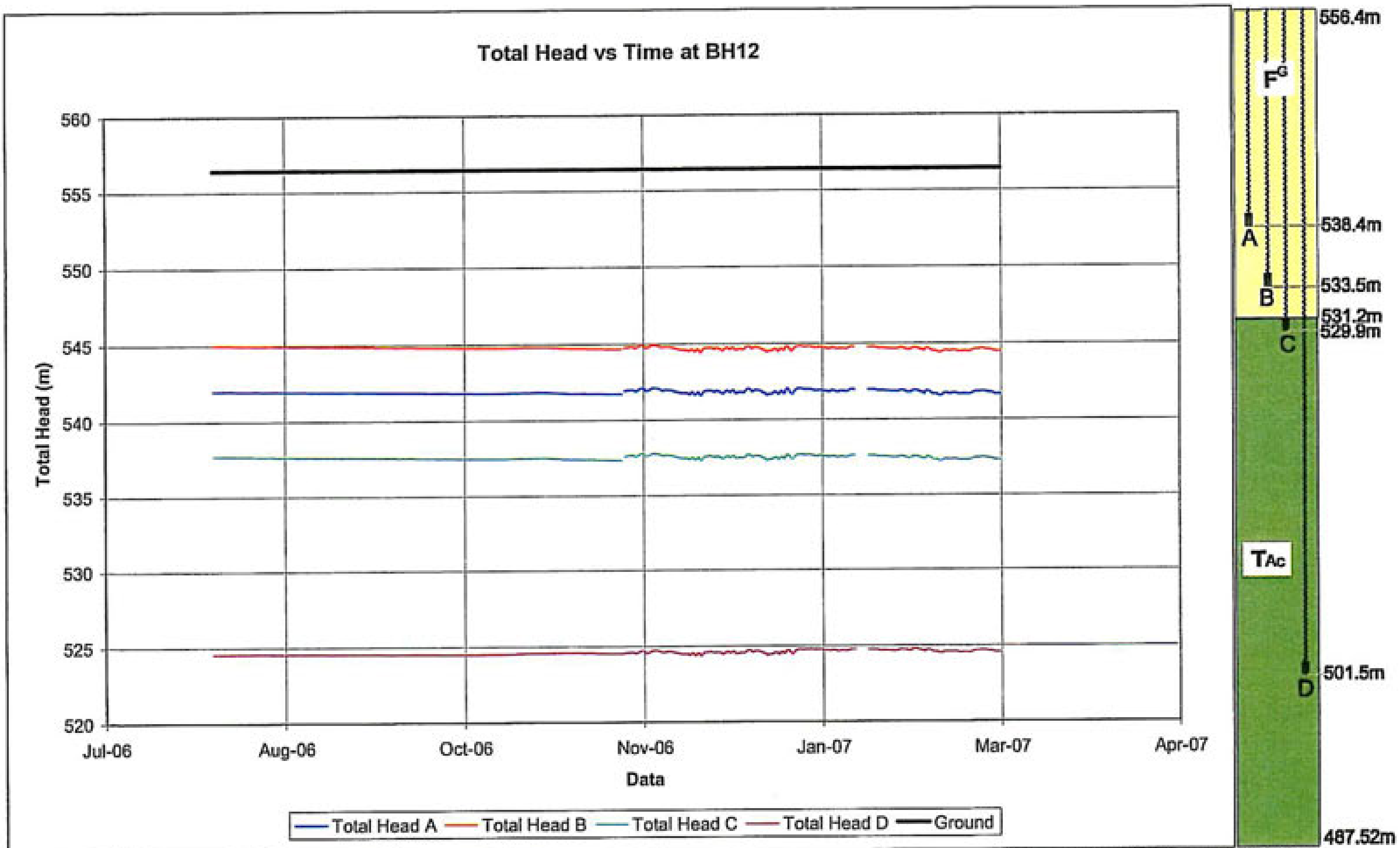
Initial reading taken on 8/1/2006

Figure H13



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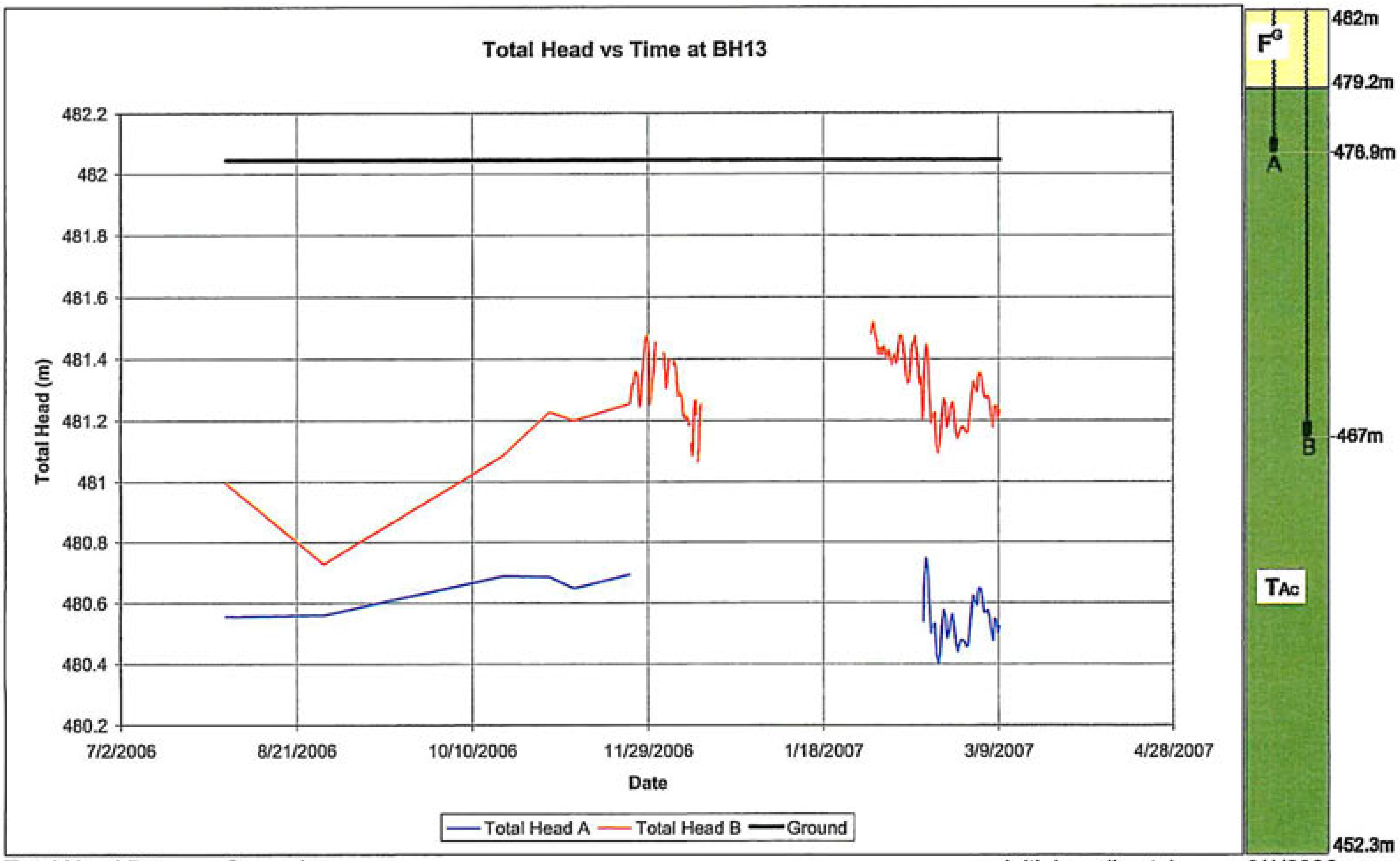
Initial reading taken on 8/1/2006

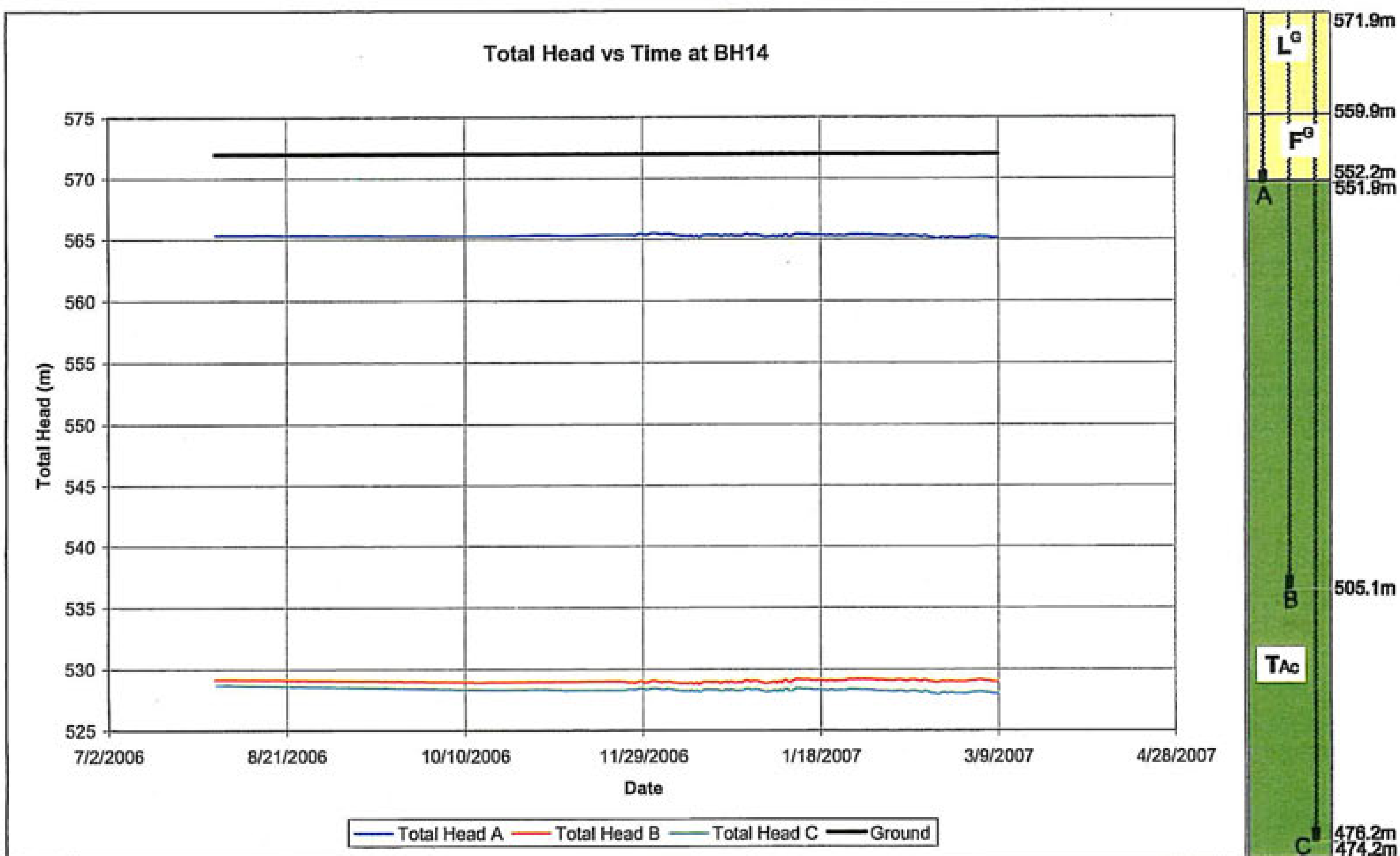
Figure H14



Total Head Datum = Om asl

Initial reading taken on 8/1/2006

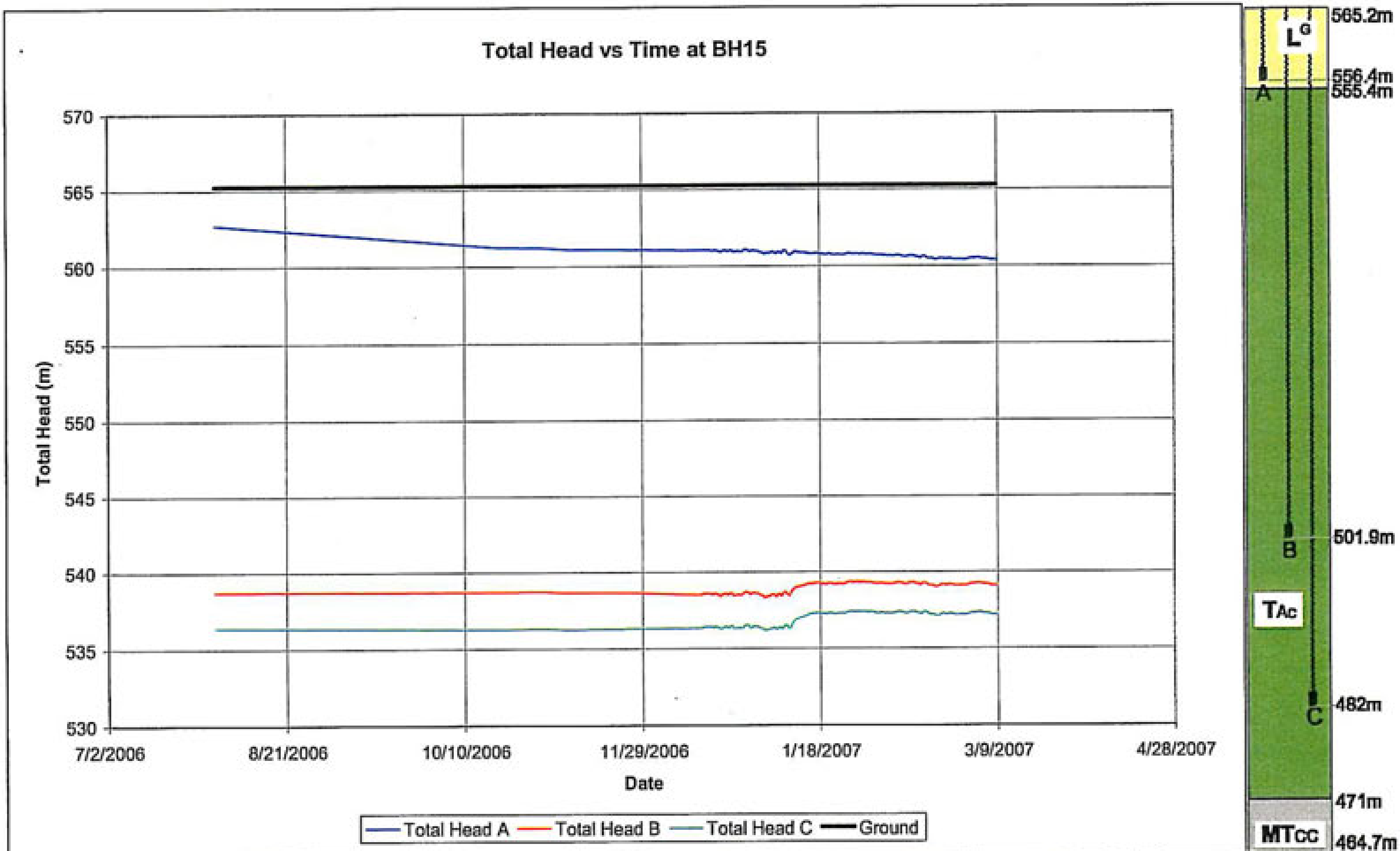
Figure H15



Total Head Datum = Om asl

Initial reading taken on 8/1/2006

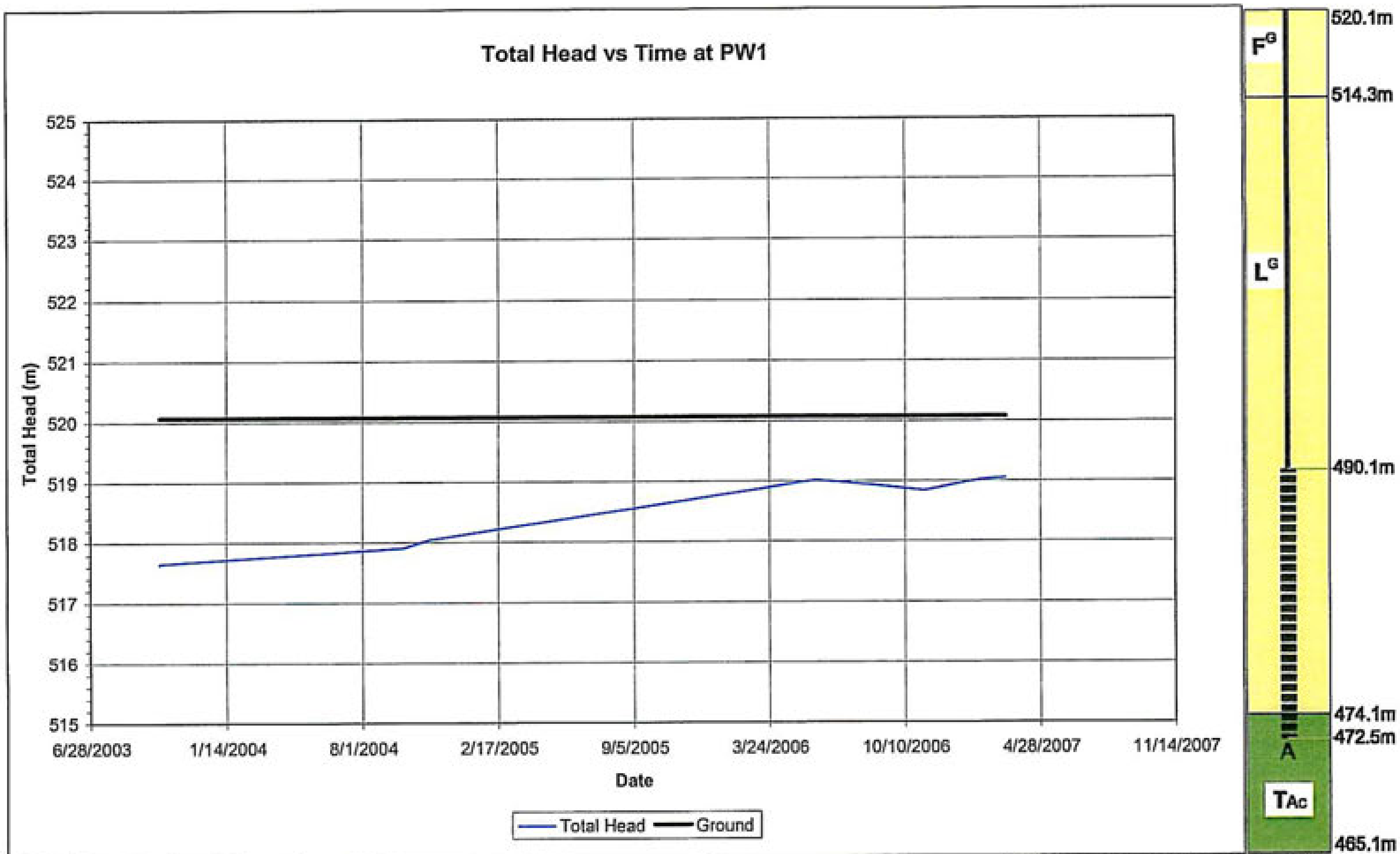
Figure H16



Total Head Datum = Om asl

Initial reading taken on 8/1/2006

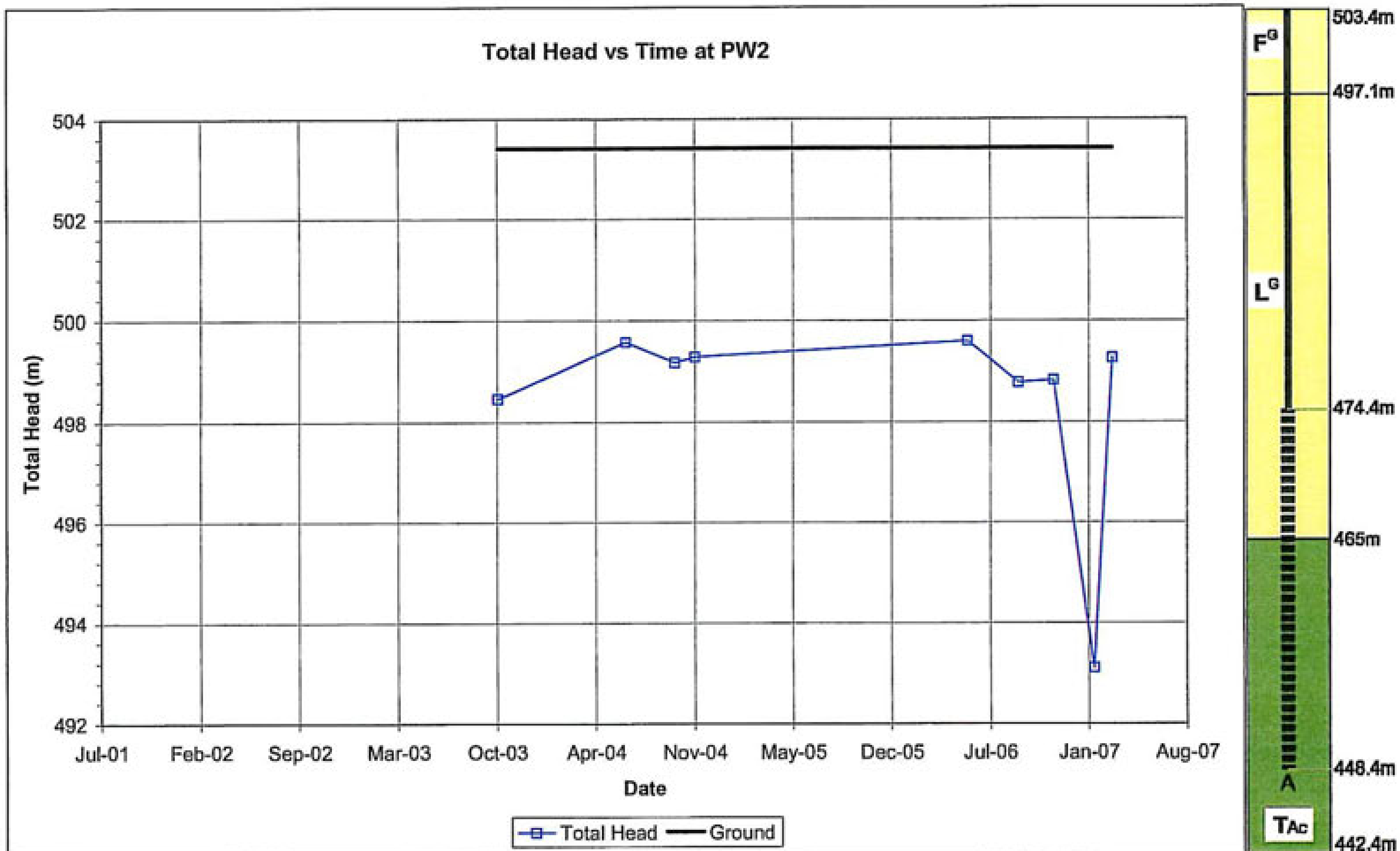
Figure H18



Total Head Datum = Om asl

Initial reading taken on 10/8/2003

Figure H19



Total Head Datum = Om asl

Initial reading taken on 10/8/2003

Figure H20

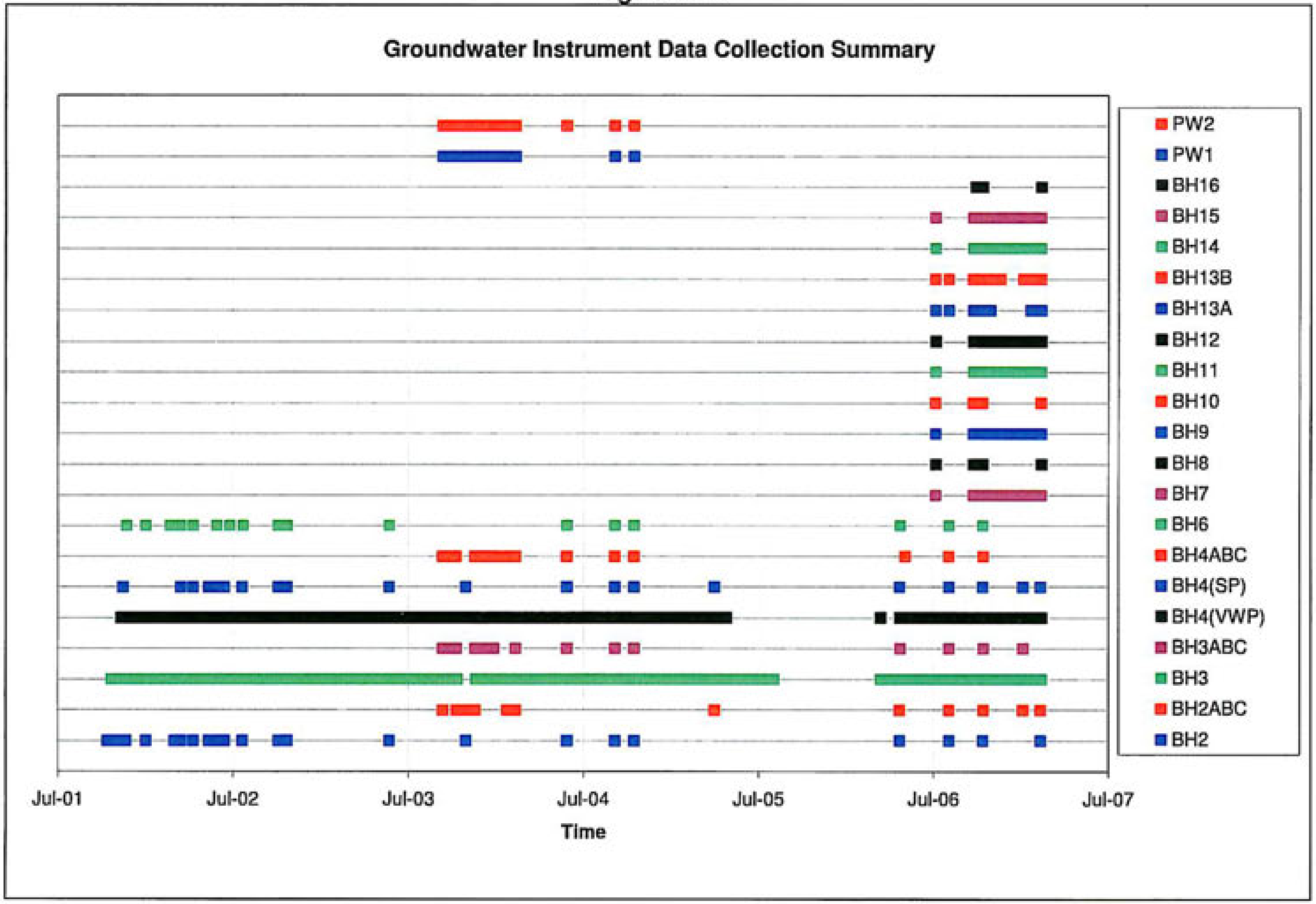

Groundwater Instrument Data Collection Summary
PW2
PW1
BH16
BH15
BH14
BH13B
BH13A
BH12
BH11
BH10
BH9
BH8
BH7
BH6
BH4ABC
BH4(SP)
BH4(VWP)
BH3ABC
BH3
BH2ABC
BH2
Jul-01
Jul-02
Jul-03
Jul-04
Jul-05
Jul-06
Jul-07
Time

Photo 1: Drilling borehole for installation of vibrating wire piezometer 8A.

Photo 2: View of vibrating wire piezometer prior to installation in borehole.

Photo 3: Trenching between vibrating wire piezometer locations prior to installation of datalogger system at BH8.

Photo 4: Re-routing of vibrating wire piezometer cable during datalogger installation at BH16.

Photo 5: Interior view of datalogger system showing battery, datalogger and vibrating wire interface.

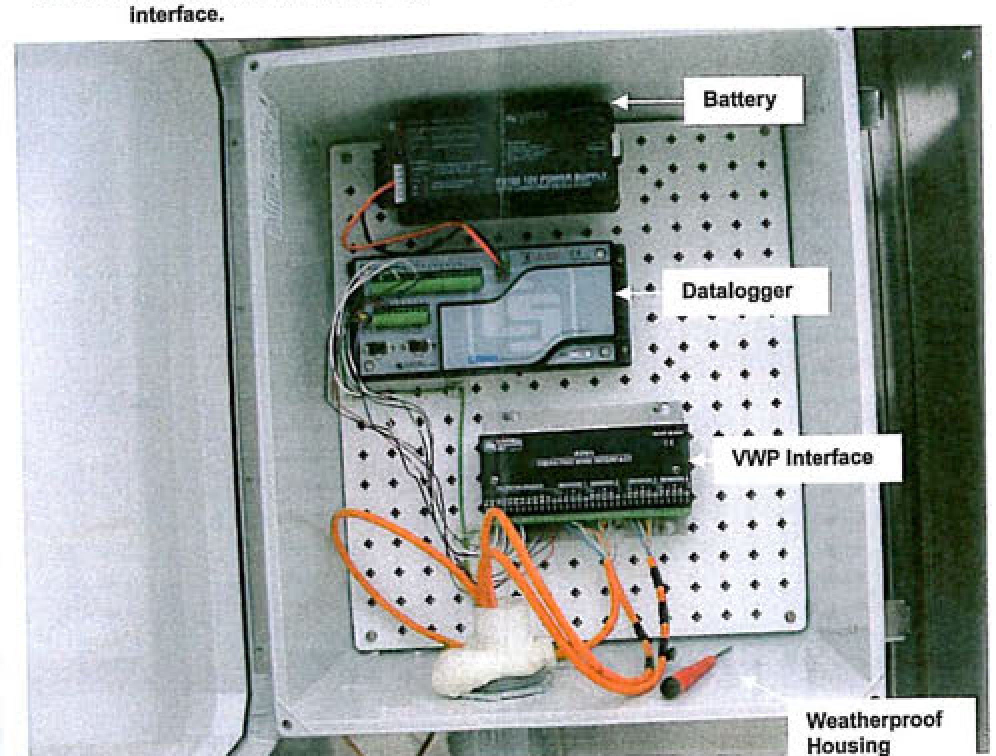


Photo 6: Completed installation of vibrating wire piezometer and datalogger system at BH16.

amec

CITY OF QUESNEL

WEST QUESNEL LAND STABILITY STUDY
QUESNEL, BC

DATE PREPARED: APRIL 2007

SCALE: NTS

PREPARED BY: NE

PROJECT : KX04397

Photos 1 though 6

Taken: June 2005 to January 2007

APPENDIX I

X-RAY POWDER DIFFRACTION ANALYSIS OF FIVE SAMPLES.

(Project KX04397-15)

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EXPERIMENTAL METHODS

The five samples were reduced to the optimum grain-size range (<5 μm) by grinding under ethanol in a vibratory McCrone Micronising Mill for 7 minutes. Fine grain-size is an important factor in reducing micro-absorption contrast between phases. Step-scan X-ray powder-diffraction data were collected over a range 3-80°2θ with CoKα radiation on a standard Siemens (Bruker) D5000 Bragg-Brentano diffractometer equipped with an Fe monochromator foil, 0.6 mm (0.3°) divergence slit, incident- and diffracted-beam Soller slits and a Vantec-1 strip detector. The long fine-focus Co X-ray tube was operated at 35 kV and 40 mA, using a take-off angle of 6°

RESULTS

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4 using Search-Match software by Siemens (Bruker). Although quantitative phase analysis using the Rietveld method was requested, the abundance of clay minerals with severe stacking disorder, mainly smectite-group (probably montmorillonite-saponite) precludes this. The results of qualitative phase analysis are given in Table 1. Although the abundance of each phase is approximately proportional to peak heights, caution should be used in using this property. The X-ray diffractograms are shown in Figures 1-5.

Table 1. Results of qualitative phase analysis

Mineral	Ideal Formula	BH06-14 at 32.75m	BH06-15 at 57.2m	BH06-15 at 59.7m	BH06-16 at 74.5m	BH06-14 at 87.5m
Quartz	SiO_2	X	X	X	X	X
Kaolinite	$Al_2Si_2O_5(OH)_4$	X	X	X	X	X
Phlogopite/biotite	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	X	X	X	X	
Smectite group (montmorillonite?)	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$	X	X	X	X	X
Lizardite?	$Mg_3Si_2O_5(OH)_4$	X	X		X	
Plagioclase	$NaAlSi_3O_8 - CaAl_2Si_2O_8$	X	X	X	X	X
K-feldspar	$KAlSi_3O_8$	X	X	X	X	X
Alunite ?	$K_2Al_6(SO_4)_4(OH)_{12}$	X	X		X	

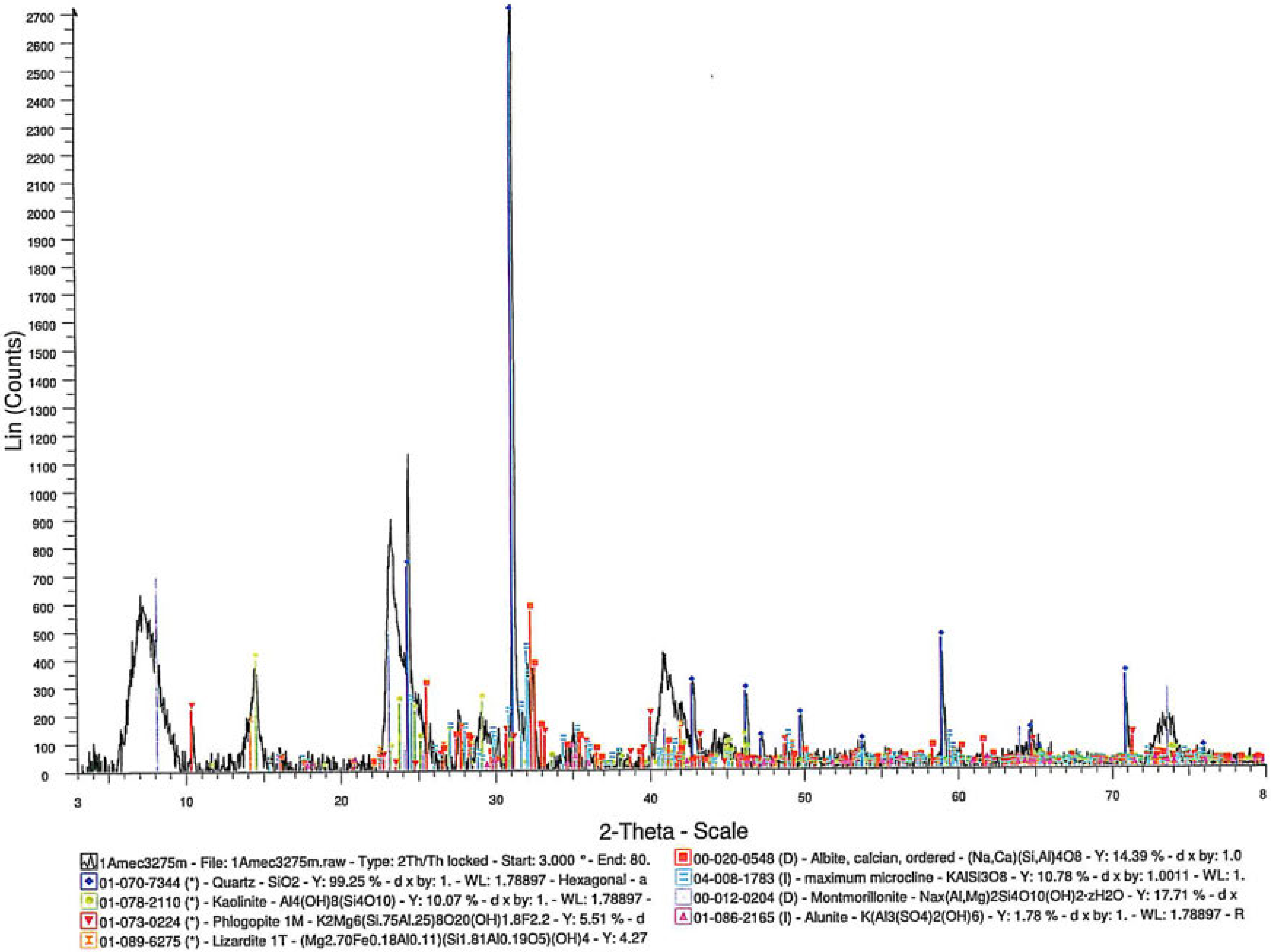

Figure 1. X-ray diffractogram of sample **Amec BH06-14 at 32.75m**

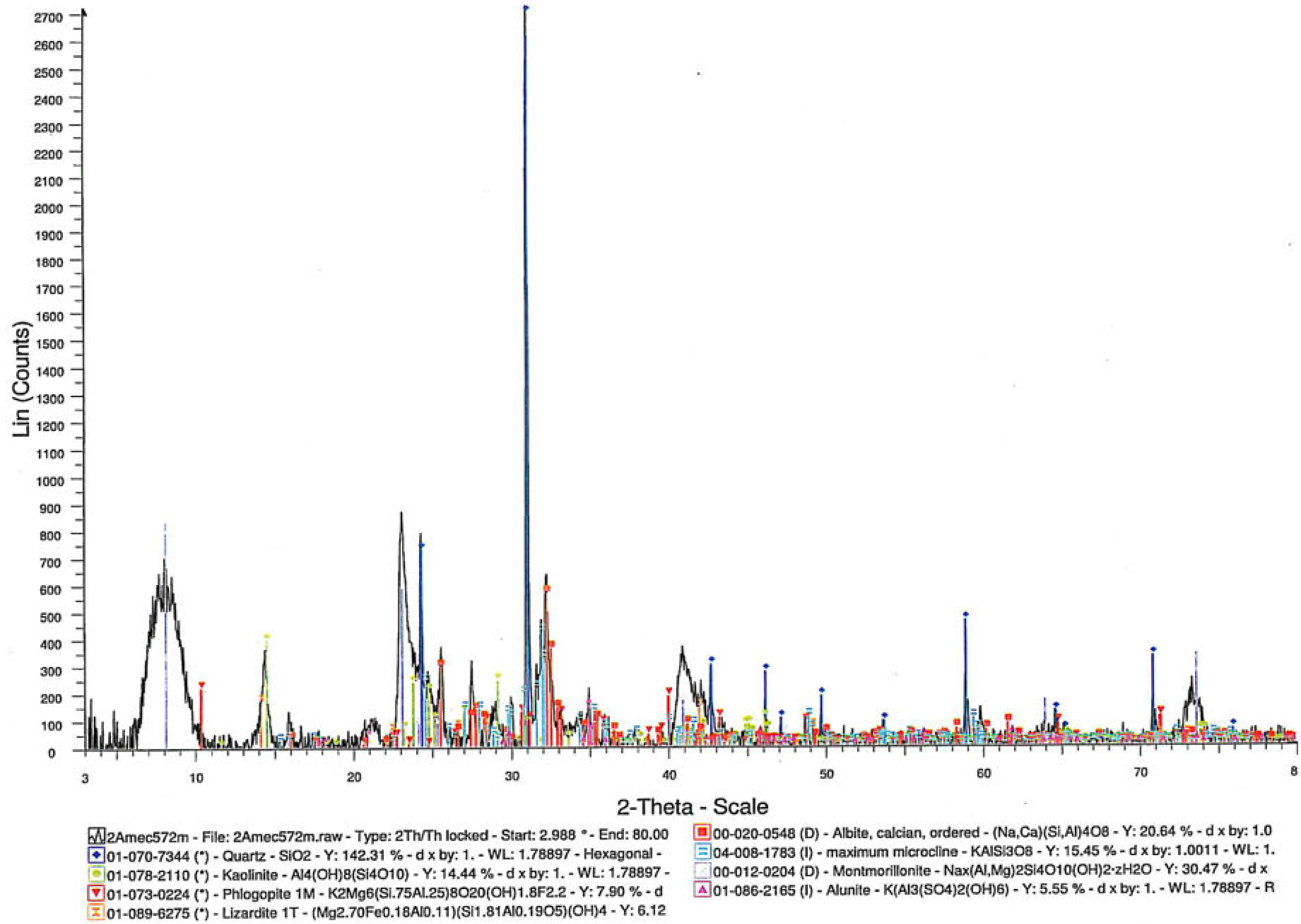

Figure 2. X-ray diffractogram of sample **Amec BH06-15 at 57.2m**

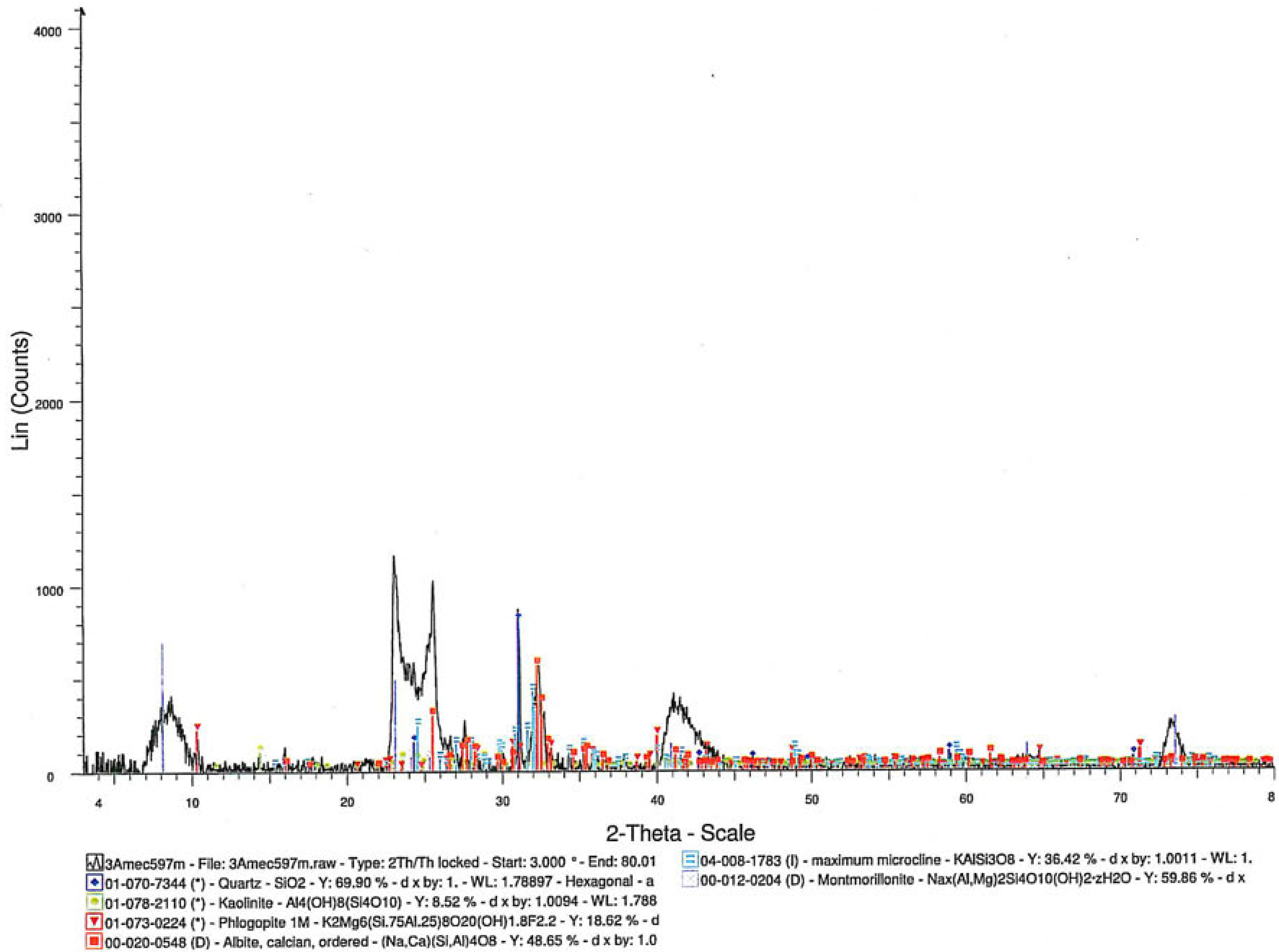

Figure 3. X-ray diffractogram of sample **Amec BH06-15 at 59.7m.**

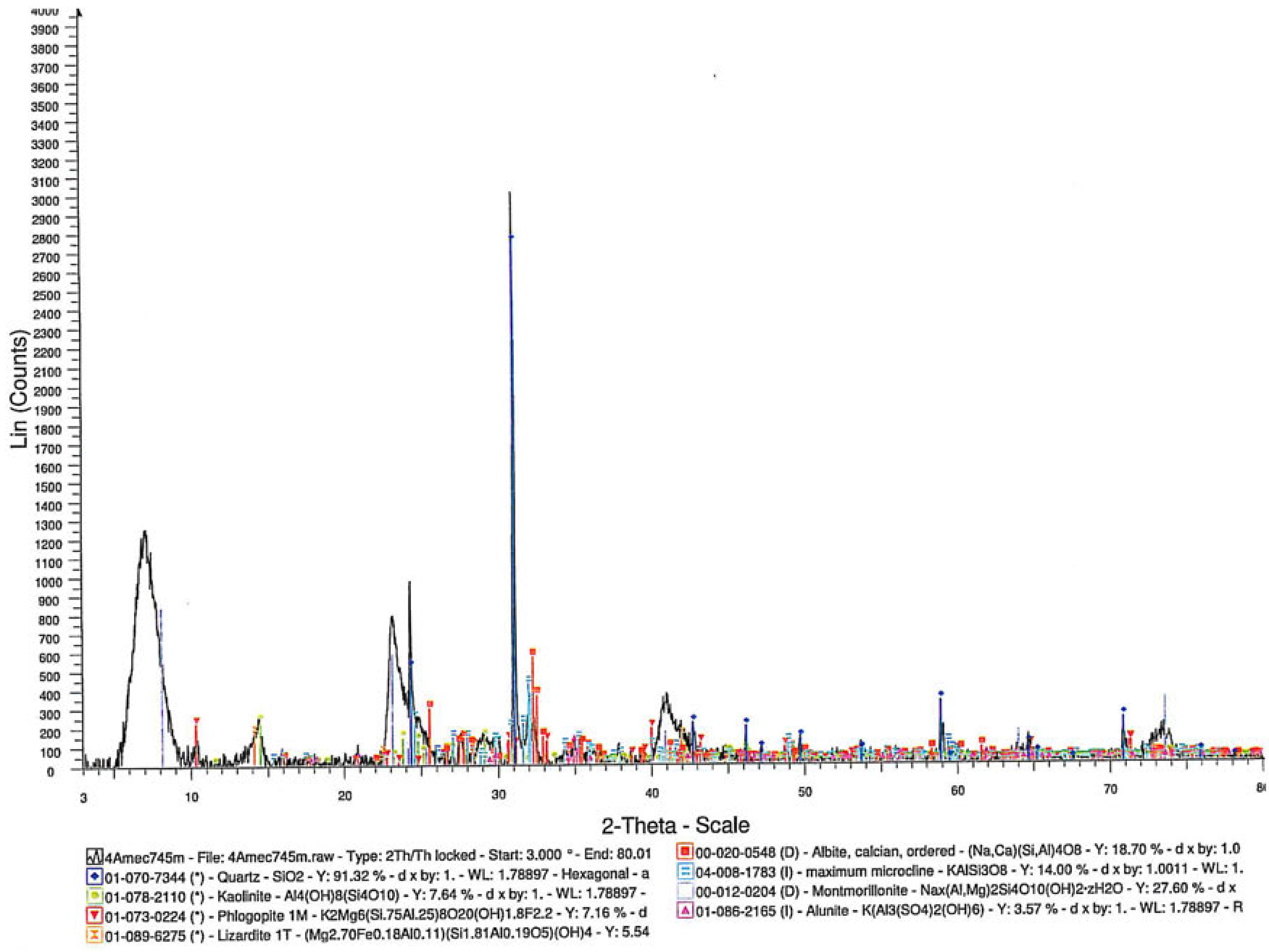

Figure 4. X-ray diffractogram of sample **Amec BH06-16 at 74.5m**

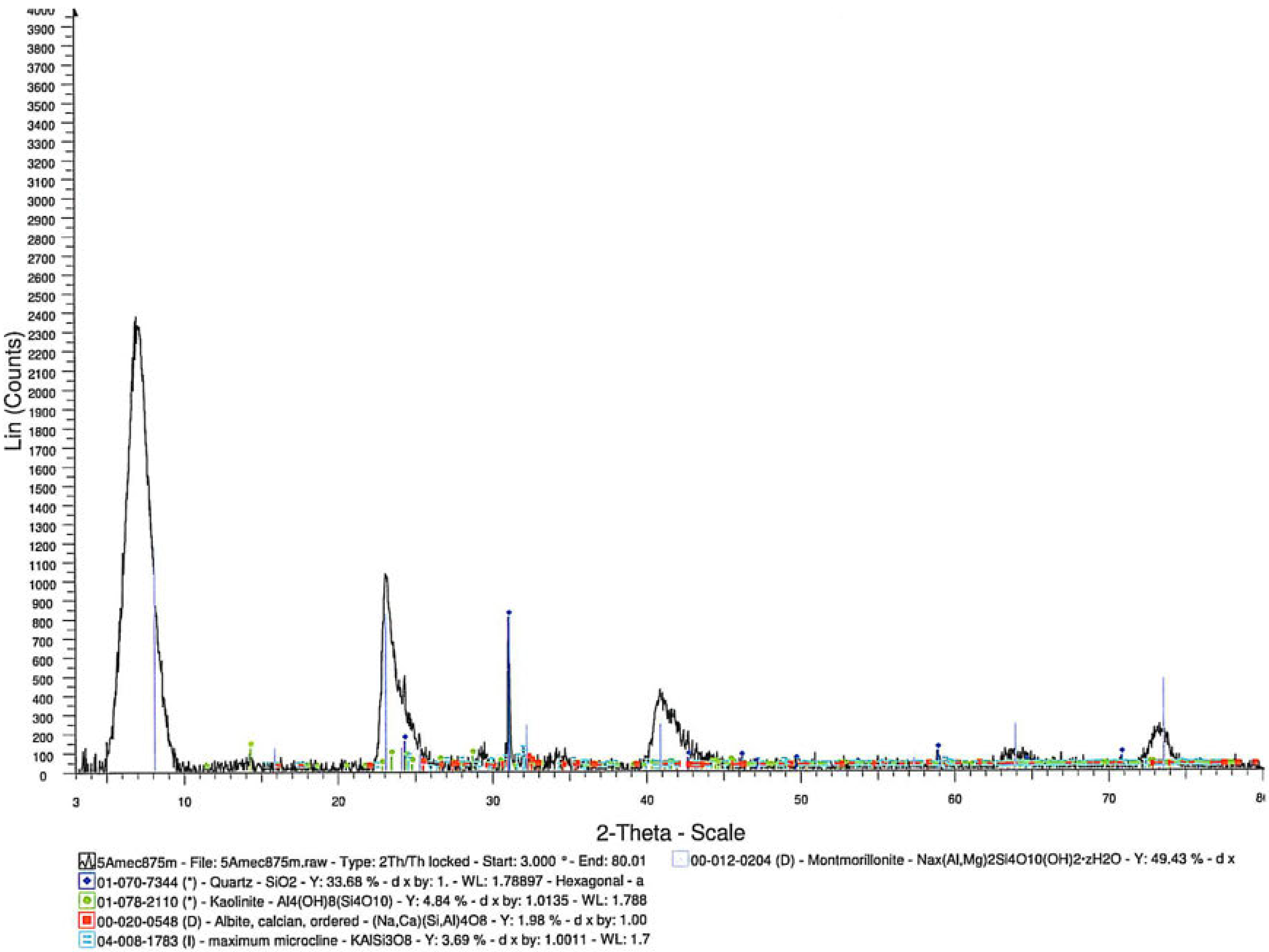

Figure 5. X-ray diffractogram of sample **Amec BH06-14 at 87.5m**