PRIVILEGED AND CONFIDENTIAL
16TAN North Saskatchewan River Crossing - Geotechnical Investigation Report (Final)

Prepared for:
Husky Energy

Prepared by:
Stantec Consulting Ltd.

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Sign-off Sheet

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Executive Summary

The **south slope of the North Saskatchewan River** surrounding the NPS 16 and NPS 8 pipelines is a complex rotational rock slide in weak Cretaceous clay shales. The landslide contains rotational, translational and flow components and movement occurs episodically within the body of the landslide, and through time. In the region of the pipeline, the landslide is currently active as evidenced by open ground cracks, slope inclinometer movements and the distress that occurred to the NPS16 and NPS8 pipelines in July 2016. Given the available data to date, the most recent movement affecting the pipelines was likely triggered by a high precipitation event, surface topography that impedes drainage and the weak pre-sheared foundation of Cretaceous clay shales.

The overall south slope of the North Saskatchewan River at the pipeline crossing is at a shallow 5.5-degree slope inclination, which corresponds to approximately 10 Horizontal to 1 Vertical (10H:1V). The overall slope is approximately 104 m high over a horizontal length of about 1080 m from the river to the top of the slope.

A shear zone was identified in the upper part of the Lea Park Formation clay shale at about 512 m elevation and a potentially deeper shear zone correlating to the buried river alluvium at about 486 m elevation. The upper shear zone was confirmed by slope inclinometer movements within Boreholes NSR-BH-01 and Stantec 1. The current rate of movement in these inclinometers is annualized to about 35 mm/year, as of October 12, 2016. This active landslide is functioning upon residual strengths and is sensitive to small disturbances/alterations and significant rainfall events and rapid snowmelt. The estimated movement rate is likely not uniform during the year but is episodic, with slower and faster rates depending on site conditions, such as precipitation.

To manage pipeline integrity, engineering approaches to design can include active remediation and slope stabilization measures or passive measures through monitoring and allowing slope movements to occur and the implementation of early warning systems to trigger mitigating actions.

Remedial stabilization measures were considered infeasible given the large size and complexity of the landslide and for the following additional reasons:

Given that high permeability zones were not encountered during the geotechnical drilling investigation, stabilization measures such as dewatering through horizontal drains would not likely be feasible given the low permeability clay shale with closed discontinuities.

Slope modifications such as slope re-grading or removal of soil loads at/near the top of the slope are not recommended given the scale of the slope and considering that small disturbances to the slope may initiate further movement.

Buttressing the toe of the slope with a toe berm or retaining structure is not practical, as such measures would require multiple tiers and would need to extend some distance to both the west and east of the pipeline corridor at a very significant cost.

Monitoring slope movements to manage pipeline integrity risks is a necessary requirement for the life of the pipelines. Monitoring the south slope with established thresholds considering reasonable risk tolerances supported by a decision tree matrix will be necessary to assess the risk to the pipelines. An iterative approach is required to: monitor and record future measurements; assess the risk to pipeline integrity through model updates and to implement mitigating design measures as necessary. Section 8 provides details regarding the geotechnical recommendations of the proposed monitoring program.

The **north slope of the North Saskatchewan River** surrounding the NPS 16 and NPS 8 pipelines contains a presently inactive, rotational earth flow (slump-flow), based on the information available to date. Near the top of the slope, an active rotational landslide is failing into the gully and the retrogressing headscarp is currently within 70 m of the current pipeline right of way. No observations of open ground cracks were made along the pipeline alignment. An open ground crack was observed parallel to the crest of the landslide gully located 100 m to 300 m east of the pipeline alignment. It is understood that no pipeline integrity issues have been reported along the north slope over the lifetime of the pipelines. It is recommended that future monitoring be undertaken in conjunction with the south slope as indicated in **Section 8.0**.

1.0 INTRODUCTION

Husky Oil Operations Limited (Husky) operates the Saskatchewan Gathering System (SGS) in west central Saskatchewan. The 16TAN portion of the SGS pipeline system comprises a NPS16 heavy oil pipeline commencing at the East Hill Junction at SE1 50-28-W3M and terminating at Celtic Junction at NW32 51-24-W3M as indicated in the overview map on **Figure 1 in Appendix B**. The 16TAN alignment also includes an NPS8 condensate pipeline running from Husky Tangleflags to Celtic Junction. The two pipelines cross the North Saskatchewan River in a north-south oriented right-of-way along Sections SW17 51-24-W3M north to NW19 51-24-W3M. The North Saskatchewan River crossing is approximately 50 km northeast of Lloydminster, Saskatchewan.

The NPS16 and NPS8 pipelines share the same trench down the valley slopes of the North Saskatchewan River and cross the river as a bundle, which were installed by Horizontal Directional Drill (HDD) methods across the river from the valley lowlands.

2.0 BACKGROUND AND SCOPE OF WORK

On July 21, 2016, a leak was discovered along the NPS 16 right of way. The leak was caused by distress on the 16TAN line. The distress was noted on the south slope of the North Saskatchewan River (south slope) at the Horizontal Directional Drill (HDD) overbend. Both the NPS 16 and NPS 8 pipes buckled at approximately 6 m upslope from the HDD installed pipe. Only the NPS 16 suffered loss of containment.

Following the shut in of the 16Tan pipeline system, Husky requested Stantec to undertake a geotechnical assessment of the North Saskatchewan River crossing, including as assessment of the risk of a similar incident in the future for the full route. This report provides the geotechnical assessment and recommendations supporting the North Saskatchewan River crossing.

3.0 GEOLOGICAL SETTING

Physiography, bedrock geology, Quaternary history, and surficial geology of the North Saskatchewan River crossing from the top of the south slope starting, up the north slope, and to Celtic Junction are described herein.

3.1 PHYSIOGRAPHY

The North Saskatchewan River crossing is situated within the Prairie Ecozone-Aspen Parkland Ecoregion (south slope) and the Boreal Plain Ecozone-Boreal Transition Ecoregion (north slope) (Acton et al. 1998). The Aspen Parkland Ecoregion is a transitional area between the open grasslands of the south and the continuous forests of the north. It is a broad plain, with deep,

wide valleys, and subdued hilly uplands. Elevations range from approximately 488 m at the North Saskatchewan River to approximately 592 m near the top of the south slope and approximately 620 m near the top of the north slope. The overall slope at the south side is about 1,080 m from crest to river, with an average slope angle of 5.5 degrees. The north slope is about 1,400 m from crest to river with shallow slope angles of about 3 to 4 degrees on the lower and upper portions of the slope and about 8 degrees through the mid slope from about elevations 510 to 600 m. The Boreal Transition Ecoregion is a transitional area between boreal forest to the north and grasslands to the south. It is a large area of undulating to gently sloping plains.

3.2 STRATIGRAPHY

3.2.1 Upper Cretaceous Bedrock

The North Saskatchewan River crossing is underlain by Upper Cretaceous sedimentary sequences of marine clay shale, minor siltstone, and muddy sandstone with some local coal beds and bentonite seams (Lea Park Formation) (Macdonald and Slimmon 1999). The bedrock surface generally slopes downward to the north and east; covered by thick glacial sediments, obscuring the underlying bedrock topography (Acton et al. 1998).

Over-consolidation of the Cretaceous clay shales is interrupted by shear zones between 30 and 143 m below ground surface (Sauer, Garequ, & Christiansen, 1990). These zones are characterized by fractures, slickensides and clay gouge interpreted as a result of glacial shear (Sauer, Garequ, & Christiansen, 1990). Large blocks of intact, over-consolidated clay shale, are therefore susceptible to failures along weak layers in the rock.

3.2.2 Quaternary Deposits

There is evidence of at least eight glacial advances in southern Saskatchewan during the Quaternary Period (2.59 million years). The most recent advance was from the Laurentide Ice Sheet, which advanced westward over Saskatchewan from the Canadian Shield, reaching its glacial maximum approximately 18, 000 years before present (BP) and depositing over-consolidated till and other glacial sediments.

Lloydminster and the surrounding area did not become ice-free until after 12,500 years BP (Christiansen 1979) as the North Saskatchewan River valley formed a major meltwater spillway (North Saskatchewan Spillway) between the retreating Cordilleran and Continental ice sheets at the end of glaciation. The meltwater was impounded by the retreating Continental ice front occupying the Saskatoon area around 12,500-12,000 years BP to form Glacial Lake Saskatchewan. Glacial Lake Saskatchewan occupied the North Saskatchewan River valley between Saskatoon and Lloydminster until the ice front retreated northeastward (Christiansen 1979).

During post-glacial time (the last 12,000 years) the North Saskatchewan River has downcut into the glacial deposits and underlying bedrock early on after deglaciation. Fluvial terraces and over-bank deposits of sand and silt underlies much of the North Saskatchewan River floodplain. Lateral erosion by the river continues to form over-steepened valley walls by undercutting the toe slopes along the valley sides. Valley widening commonly results in landslides (colluvial deposits) particularly along the outsides of meander bends where toe erosion reduces the stability of slopes. The presence of weak (bentonite clay beds) and pre-sheared (slickensides and clay gouge zones) bedrock, stress relief due to glacial unloading, and human activities (Soe Moe et al. 2009) further contribute to slope instability in the river valleys. Slope movement typically occurs along weak pre-sheared zones, horizontally bedded clay shales or bentonite seams.

Several incidences of landslides are recognized in the Cretaceous bedrock along the North Saskatchewan River valley from Edmonton, Alberta to Maymont, Saskatchewan (Soe Moe, 2008; Christiansen, 1993; Sauer 1984; Christensen 1983; Sauer, 1983). In addition, the south valley slope surrounding the 16TAN corridor was reported to contain retrogressive translational failures with potentially multiple shear surfaces on horizontal surfaces at depth (J.D. Mollard, 2016). Mollard's report highlighted evidence of ground movements along the south slope of the North Saskatchewan River at Husky's lease sites A16-18 and A15-18, located west of the pipeline alignment about three-quarters of the way up the valley slope as well as at the water intake pond located east of the pipeline corridor near the edge of the river.

3.2.3 Groundwater

Regional groundwater resource mapping for the St. Walburg area (73F) (Millard 1990) does not show groundwater aquifers of flowing wells within the vicinity of the North Saskatchewan River crossing.

Boreholes drilled in late-August 2016 (south slope) and mid-September 2016 (north slope) have vibrating wire piezometers installed which provides on-going monitoring of water levels. The preliminary results show water levels generally follow the valley profile ranging from about 2 m to 16 m below ground surface. Further details are provided in the subsequent Sections.

3.2.4 Seismic Hazard

Deep-seated softening of Cretaceous shale layers described in section 3.2.1 may have co-seismic origins related to tectonic deformation during the Rocky Mountain uplift. Current seismic activity is, however, low.

The potential for seismically generated slope instability at the North Saskatchewan River crossing was calculated using the 5th Generation Seismic Hazard Model developed by the Geological Survey of Canada that indicated the Peak Ground Accelerations (PGA) for earthquakes with 100-, 475-, 1,000- and 2,475-year return periods indicated in **Table 3-1** (Halchuck et al. 2014).

Table 3-1 PGA(1) and MMI(2) for Corresponding Return Periods

Return Period	PGA	MMI	Landslide Threshold Exceeded?
100 years (39% chance of exceedance in 50 years)	0.0025 g	N/A	No
475 years (10% chance of exceedance in 50 years)	0.010 g	~ II	No
1,000 years (5% chance of exceedance in 50 years)	0.017 g	< III	No
2,475 years (2% chance of exceedance in 50 years)	0.033 g	< IV	No

Notes:
1. Peak ground acceleration
2. Modified Mercalli Intensity

The strength of ground shaking is commonly described by the PGA or the Modified Mercalli Intensity (MMI) scale. PGA is defined as the maximum amplitude of a ground acceleration trace recorded at a site (in units of gravitational force) while MMI is a descriptive scale based on how severely the shaking was felt and how much damage certain structures suffered at a given location. Landslide thresholds for ground motion have long been associated with the MMI scale (Keefer, 1984). Landslides in coherent material (such as those at the North Saskatchewan River) are normally triggered by MMI ≥ VII with the lower threshold at V.

For this site we convert the PGA to MMI using the formula developed by Wald et al. (1999) (Eqn 3.1; PGA in cm/s^2).

$$MMI = 3.66 \log(PGA) - 1.66 \qquad \text{(Eqn 3.1)}$$

In the study area, seismically generated ground accelerations with a 2% chance of exceedance in 50 years (1:2,475) have a PGA of 0.033 g, or slightly less than MMI IV (note that the chance of a seismic event of comparable magnitude occurring in the 3 year expected life of the pipeline is 0.1%). This is below the minimum threshold for initiation of landslides of this type. Notwithstanding the potential impacts from nearby oilfield development (hydraulic fracturing, etc.), seismic activity is not considered a potential cause of landslides at this location.

3.3 TERRAIN ASSESSMENT

3.3.1 LiDAR and Air Photo Interpretation

Desktop terrain mapping was completed for the study area, using 2016 LiDAR data, a 2015 colour orthophoto and 2012 digital stereo air photos.

The LiDAR data for the North Saskatchewan River crossing was processed to produce a hillshade image, a slope map, and 1 m, 2 m, and 5 m contours. Interpretation of the processed LiDAR data and an orthophoto image of the area using ArcGIS facilitated accurate delineation of

slope breaks and identification of landslides and other terrain map units at the North Saskatchewan River crossing.

PurVIEW™, a software application for ArcGIS was also used to view the digital air photos in stereo. The colour, 1:30,000 scale air photos were geo-referenced and viewed in PurVIEW™, allowing the mapper to view the stereo imagery at scales of up to about 1:1,000. The digital air photos were used primarily to review the LiDAR and orthophoto based terrain mapping.

3.3.2 Field Validation

Walking traverses were undertaken on the north and south valley sides at the North Saskatchewan River crossing on September 12-13, 2016. Ten hours were spent on these traverses, not including the time to travel to and from the site and from the north to the south slopes. Waypoints were recorded on a GPS and site photographs taken. The waypoints shown on **Figure 2** in **Appendix B** give a general indication of the routes of the field traverses. Selected site photos are included in **Appendix C** and are referenced in the text below. Observations were made of the surface morphology and surficial materials present on the two valley sides; as well as of visible evidence of recent slope movement, for example, fresh ground cracks and fresh and partially revegetated soil scarps.

Following the fieldwork, the preliminary terrain mapping was reviewed and compared to our field observations and borehole data. Changes were made to terrain map units and classifications where appropriate to reflect the field observations and borehole data.
The final mapping was reviewed by a senior terrain mapper according to our quality control and review processes.

3.3.3 Landslide and Terrain Map Unit Characteristics

Error! Reference source not found. and **Figures 3 and 4 in Appendix B** describe and list the terrain map units and the extent and morphology of the large landslide complex on the south slope of the crossing as well as landslides and a landslide complex on the northern valley side. The full extent of the landslides and landslide complexes near the pipeline corridor are not illustrated in these figures as they extend such a significant distance away from the pipeline that their influence is thought to be negligible or non-existent.

Table 3-2 Terrain Map Unit Descriptions

Map Unit #	Terrain Map Unit Descriptions
	South Slope: Figure 3
1	This map unit comprises the upper slope of the South Slope landslide to the east of the pipeline corridor. The surficial materials are dominated by well- to moderately well-drained, silty clayey colluvium (landslide debris); well-drained, silty clay till is present locally near the crest of the slope. Depths for these materials recorded in nearby boreholes range from 6.5 m (Stantec-2) to 15 m (NL-BH-40) above clay shale bedrock. The borehole logs suggest that the top few metres of the underlying shales are weathered, plastic and extremely

Map Unit #	Terrain Map Unit Descriptions
	weak. Since till (morainal material) is present on nearby slopes that have not been subject to landslide activity and in Borehole NSR-BH-40, it seems likely that the colluvial materials on this slope are a complex mix of the original morainal mantle and weathered materials derived from the underlying clay shale. The surface morphology of the slope consists of a series of transverse ridges and troughs, the upslope side of the troughs often being steeper (at times forming a distinct scarp) and higher than the lower sides. These scarps appear to be of varying ages. The top of the landslide is bounded by a 5 m to10 m high main scarp. A sequence, of recent moss-covered, near-vertical, transverse scarps **(Photo 1, Appendix C)** are present within the map unit (at or near waypoints 021 through 025). The moss cover is ≤ 0.5 cm and we interpret these scarps to be approximately < 20 years and perhaps < 10 years old. These recent scarps often form the lower slope of older, higher scarps, which are generally not as steeply sloping. *Note: The boundary line drawn between map units 1 and 2 is a subjective interpretation. It may be further west or not exist at all.
2/2a	This map unit comprises the upper slope of the South Slope landslide generally west of the pipeline corridor. This slope is similar to the slope east of the pipeline, however there are a number of fresh (≤1-2-year-old) ground cracks (**Photo 2, Appendix C**) and, transverse, near-vertical to steeply sloping scarps (**Photos 3 and 4, Appendix C**) at or near waypoint 005 and waypoints 008 through 014. Some of the fresh scarps form the lower slopes of older, higher scarps. These fresh scarps and/or cracks do not appear to reach or extend east to the pipeline. Map unit 2a is similar to map unit 2 and may or may not form a separate part of the landslide complex. The transverse ridge and trough surface morphology of Map units 1, 2 and 2a may represent a downslope sequence of transverse, back-rotated blocks and possible grabens. Movement of these blocks appears to be episodic, with movement in different parts of the landslide occurring at different times. The upper slopes of the landslide appear to have been enlarging by regressing slowly upward to and through the ridge crest at the top of the south slope of the valley.
3	This map unit outlines a moderate to moderately steep slope that runs east to west across the toe of the upper slope of the landslide to the east of the pipeline. The slope comprises well- to moderately well-drained, silty clayey colluvium. The slope morphology is weakly terraced with small, low scarps. What appear to be slump-flow deposits in map unit 6 (downslope) suggest that this slope has been subject to recurrent, retrogressive, slump-flow[1] landslides in the past.
4	This map unit outlines a steep, well-drained, silty clayey, colluvial slope that runs across the toe of the upper slope of the landslide complex generally to the west of the pipeline. This slope may have been subject to recurrent, retrogressive slump-flow or debris avalanche style landslides such as the two small landslides delineated as map unit 5, and the apparent slump-flow deposits of map unit 6 and possible slump-flow deposits within map unit 9. There is evidence of relatively fresh rotational and/or translational movement on this slope at and near waypoint 014.
5	These map units outline two small slump-flow landslides that have occurred off the steep slopes of map unit 4.

[1] Rotational failure, in cohesive soil or weak, easily disaggregated bedrock. There is a steep back-scarp and defined lateral shear zones in the upper portion of the landslide. There is undulating, lobate morphology in the lower portion of the landslide. Shear zones are generally preserved in the rotational portion; however, few internal structures are preserved in the lower landslide body subject to flow.

Map Unit #	Terrain Map Unit Descriptions
6	This map unit outlines the extent of apparent deposits of slump-flow landslides from map units 3 and 4. The slope is composed of well- to moderately well-drained, silty clayey colluvium. The slope morphology is undulating with low terraces (possibly relict flow lobes), small, subdued ridges occur locally. These deposits are likely younger than and have buried parts of the original surface of map unit 8.
7	These map units define the extent of sag ponds and wetlands within the landslide mass. Some of these wetlands appear to be flooded seasonally, so may indicate seasonal fluctuations in the groundwater table. There is no visible field, air photo or LiDAR evidence of surface streams entering these wetlands. Some of the wetlands occur in the transverse linear depressions created by back-rotated slump blocks (Photo 5), others occur in depressions along the leading edge of the slump flow deposits of map units 6, 9 and 11 (Photo 6).
8	This map unit outlines a level to gently sloping, mid-slope bench within the landslide complex. The surficial materials consist of a well- to moderately well-drained silty clay colluvium. Borehole data from this area suggests that the colluvial materials range from 12 m (NSR-BH-01) to 17m (Stantec-1) deep over clay shale bedrock. The surface morphology of the map unit ranges from almost planar to gently undulating to low ridges. The planar and gently undulating areas are grass covered (Photo 7) whereas the ridged areas tend to be forested or sparsely forested. There is some evidence (e.g., windrows, straight forest edges) of earlier forest clearing and limited leveling on the grassy portions of the bench, so some of the level and gently undulating areas may be an artifact of that activity.
9	Ridged areas that may be part of the mid-slope bench portion of landslide or part of the upper slope portion of the landslide (map unit 6). On the LiDAR hillshade image the flow deposits of map unit 6 appear to have pushed out or up against these ridged areas or alternately map unit 9 is an older part of the flow deposits that form map unit 6. The log from Borehole NSR-BH-01 records colluvial depths of 12 m at the northern limit of this map unit. This deposit may be younger than and deposited on top of the mid-slope bench to the immediate north (i.e., map unit 8).
10	This map unit outlines a short, moderate to moderately steep slope immediately below the mid-slope bench (map unit 8). This slope is composed of well-drained, silty clayey colluvium; the surface morphology is gently undulating with low ridges or terraces. As noted below (map unit 11), this slope has likely been subject to repeated, retrogressive slump-flow landslides.
11	This map unit outlines the extent of apparent colluvial deposits of what are thought to be slump-flow landslides originating upslope in map unit 10. The area is gently sloping and undulating with low ridges. The surficial materials are well- to moderately well drained, silty clayey colluvium. At the northern edge of this map unit the colluvium is about 34 m deep over clay shale bedrock (Borehole NSR-BH-02). This deposit/surface may be younger than and deposited on top of the bench to the immediate north (i.e., map unit 12)
12	This map unit comprises a lower slope bench, which may be a relatively intact block within the landslide complex. The bench is level to gently sloping. The surface morphology of the bench is nearly planar to undulating and locally ridged. The surficial materials comprise well- to moderately well-drained, silty clayey colluvium. The log from Borehole NSR-BH-02 at the intersection of maps unit 11 and 12 suggests a significantly deeper zone of colluvium in this area (about 34 m deep). The borehole records colluvium, sands, silts and gravel as well as traces of till and organic debris; suggesting incorporation of pre-existing glaciofluvial and morainal materials into the landslide mass in this area. The bench is grass covered and like map unit 8 there is evidence of forest clearing and limited leveling.

Map Unit #	Terrain Map Unit Descriptions
13	This map unit outlines an active, moderate size, secondary slump-flow landslide (or a series of smaller retrogressive slump-flows) developed in the toe of the larger landslide complex at the edge of the North Saskatchewan River. A fresh ground crack and scarp is present within this landslide near waypoint 007. This landslide is likely younger than the main landslide mass and may have extended out into the river. The material that extended out into the river would have been subsequently eroded by the river. The surficial materials at and near the surface of this landslide comprise well-moderately well-drained, clayey colluvium with trace sand and clay shale rock fragments. The log from Borehole NSR-BH-03 located on the toe of the accumulation (deposition) zone of this smaller landslide shows 7.8 m of colluvium overlying compact silty sandy fluvial sediments that extend a further 6.5 m down to bedrock at14.3 m. Extremely weak, weathered, grey clay shale is present at and immediately below the sand-bedrock contact. The borehole location is about 6 m above the river level at the time the LiDAR data was collected. Before this secondary landslide occurred, the landslide debris (colluvium) at the toe of the landslide complex would likely have been 10 to 15 m deeper; that is, comparable to the colluvial thickness at Borehole NSR-BH-02.
14	This map unit delineates a narrow band of sandy silty, fluvial (alluvial) terraces/floodplains (Photo 8) along the river's edge at the toe of the south slope landslide. This area is subject to seasonal flooding as well as limited deposition and/or erosion of fluvial sediments.
	North Slope: Figure 4
15	This map unit comprises a narrow zone of sandy silty, fluvial (alluvial) terraces/floodplains along the river's edge at the toe of the north slope. At Borehole NSR-BH-04, just above the northern limit of this map unit, the fluvial materials are 4.4 m thick over 1 m of silty clay over weathered shale bedrock. Some or all of this area is subject to seasonal flooding as well as deposition and/or erosion of fluvial sediments.
16	This map unit is thought to comprise relatively thick, silty sandy to gravelly fluvial deposits of the North Saskatchewan River, which overly till at depth. The terraces on the slope have a subdued appearance suggesting that there may have been some later deposition of fluvial materials from small, upslope, seasonal or ephemeral streams as the slope above (map unit 17) is locally gullied and appears to consist of a complex of fluvial and colluvial fans and localized exposures of morainal materials.
17	This map unit appears to comprise a complex of deep, well-drained, coalescing, fluvial and /or colluvial fans (i.e., debris flow/flood fans), which overlie relatively thick till. As noted below these fan materials were encountered in Borehole NL-BH-41 and were 8.7 m thick. They range from clayey sandy silts to fine sands with minor gravels and overlie a 4 m thick layer of till. In some parts of the map unit the fluvial or colluvial materials may be quite thin or absent. Where these materials are absent the surface will likely be composed of till.
19	This map unit comprises a well-drained, undulating colluvial deposit, most likely the accumulation zone a slump-flow landslide (Photo 9) that initiated in map unit 20. The surface material in this map unit appears to be colluvium (landslide debris) derived from till. At Borehole NL-BH-41 the landslide materials comprise a silty sandy clay colluvium layer 2.4 m thick. These materials bury an 8.7 m deep sequence of colluvial and/or fluvial fan materials ranging from clayey sandy silts to sands with minor gravel which in turn overlie 4m of till. The underlying bedrock is clay shale. At Borehole NSR-BH-06 the landslide derived colluvium consists of a layer of clayey sandy silt overlying sandy silty clay to a depth of 6.2 m and then a brown, silty clay to clay till to a depth of 16 m.

Map Unit #	Terrain Map Unit Descriptions
20	A well-drained, undulating to weakly hummocky colluvial (landslide) deposit that forms the depletion zone of a slump-flow landslide that began in deep morainal materials (Photo 10). The surficial materials likely comprise a mix of clayey sandy silt and sandy silty clay similar to the colluvial materials found in Borehole NSR-BH-06.
21	This map unit forms the headscarp of the landslide that started in map unit 20. The headscarp (Photo 10) is about 10 m high with a slope angle range of 25 to 30 degrees The surficial materials forming the headscarp are likely well-drained till, however, the stratigraphy logged at Borehole NSR-BH-07 suggests that some sandy glaciofluvial materials may also be present.
22	Map unit 22 comprises an active landslide complex to the east of the pipeline corridor. The landslide surface consists of a series of curvilinear scarps, narrow benches, ridges and troughs. Portions of the southern part of the landslide (east of and below waypoints 017-019) appear to be more active as the surface features described above are more distinct and the surface slopes steeper. A ground crack 20-50 mm wide and several metres long was observed at waypoint 017, immediately west of the headscarp of the landslide suggesting that retrogressive retreat of this part of the landslide is ongoing. The headscarp slopes in this area are steeper (35 to 45 degrees) than further north where they are generally range from 20 to 30 degrees. Glaciofluvial sands are exposed locally in the lower portion of the headscarp and on the bench at the base of the headscarp between waypoints 018 and 019. Similar materials occur in NSR-BH-07 between 3 m and 6.5 m below ground level. The curvilinear, stepped scarp and bench sequence found on the surface of the landslide, often with the outer edge of the benches slightly higher than the back edge, suggests ongoing retrogressive, rotational (slumping) and translational (downslope) movement.
23	This map unit consists of well-drained, silty clay till overlying glaciofluvial sands and gravels overlying till to a depth of at least 20 m. At Borehole NSR-BH-07 the upper till is about 3 m thick overlying 3.3 m of sands and gravels with minor clay, which overlie silty clay till to a depth of 20.3 m at refusal.
24	This map unit appears to be a small, well-drained, moderately to gently sloping, inactive landslide, likely developed in silty clayey morainal materials.
25	This map unit outlines a gently to moderately sloping, weakly undulating, well-drained morainal slope.

3.3.4 Toe Erosion Assessment

A desktop assessment of bank erosion at the toe of the south slope was undertaken by analyzing historical air photos of the North Saskatchewan River crossing (Error! Reference source not found.). The 1963 air photos were georeferenced in ArcGIS and compared to the 2012 orthophotos. There was no noticeable change to the channel in this 49-year time span. Bank erosion at the toe of the south slope is either not occurring or is occurring at a similar rate to downslope movement resulting in no net change. Given the available data, the results for the period of record (50 years) are inconclusive. The borehole record from Borehole NSR-BH3 and the terrain interpretation described above support a model where downslope movement has overtaken river deposits and been subsequently removed.

Table 3-3 Historical Air Photos

Air Photo Date/Year	Flight Line Series/Frame Number(s)	Comments
June 22, 1963	A18087 Nos. 183 – 184	1:35,000
1980	N/A	1:20,000
2012		Colour orthophoto
March 12, 2015		Google Earth aerial imagery

4.0 METEOROLOGICAL DATA

Slope movements tend to occur or accelerate following spring thaw or significant rainfall events as infiltration into the slope occurs through water accumulation in sag ponds, open ground cracks and pervious soils. The infiltration increases the water pressure and reduces the shear strength, which can lead to displacements along the shear surface of a pre-existing failure plane.

Published climate data (Environment Canada 1997 to 2016) for the Hillmond and Frenchman Butte censors, located about 20 km from the North Saskatchewan River crossing, show that the region experiences an average of about 370 mm/year total annual precipitation. The recorded daily maximum rainfalls were 45 mm and 65 mm in July 2000 and June 2007, respectively. The 20-year average monthly precipitation through June and July was about 60 mm/month, whereas the average monthly precipitation from August to May was about 24 mm/month.

The precipitation news link records (www.CBC.ca and www.meridianbooster.com for July 12, 2016) for Lloydminster area indicates that a significant storm event yielding in excess of 95 mm rain occurred on July 11, 2016, nine days prior to the pipeline leak. Anecdotal reports provided by local Lloydminster Husky personnel indicated that several large rainstorms occurred in the Lloydminster area throughout June and July 2016. The Environment Canada weather station does not record this value at either the Hillmond or Frenchman Butte censors and the Lloydminster Airport is missing records for several days in July, including July 11, 2016.

5.0 SITE INVESTIGATION

5.1 GEOTECHNICAL INVESTIGATION SUMMARY

A geotechnical investigation was undertaken from August 12 to September 21, 2016 for the purpose of assessing the subsurface conditions within the 16TAN pipeline corridor along the valley slopes of the North Saskatchewan River crossing. The geotechnical investigation included drilling boreholes using solid stem augers and wet rotary coring methods. Instrumentation

comprising slope inclinometers (SI) and vibrating wire piezometers (VW) were installed within the south slope boreholes and select north slope boreholes. Table 5-1 below provides a summary of the borehole locations and instrumentation installation details.

Table 5-1 Borehole Location and Instrumentation Summary

Borehole No.	Surveyed UTM Coordinates (m)		Surface Elevation (m)	Total Depth (m)		Slope Inclinometers		Vibrating Wire Piezometers	
	Northing	Easting		Depth (m)	Completion Elevation (m)	Depth (m)	Tip Elevation (m)	Depth (m)	Elevation (m)
South Slope									
NL-BH40	5918289	598509	592.4	92.9	499.5	89.9	502.5	I 26.5 II 53.9	566.0 538.5
STANTEC 2	5918590	598503	563.2	89.9	473.3	89.9	473.3	I 19.8 II 39.6	543.4 523.6
NSR-BH-01	5918759	598502	538.0	70.4	467.6	70.1	467.9	I 19.8 II 53.9	517.5 483.1
STANTEC 1	5918890	598508	530.8	50.3	480.5	50.3	480.5	I 19.0 II 31.3	511.7 499.5
NSR-BH-02	5919009	598505	513.6	44.1	469.5	42.7	470.9	I 21.6	492.0
NSR-BH-03	5919177	598538	494.1	91.4	399.1	62.7	431.4	I 20.7 II 39.3	473.3 454.8
North Slope									
NSR-BH-04	5919565	598489	494.1	80.8	413.3	80.8	413.3	13.4	480.7
NL-BH-41	5919954	598480	520.0	80.3	439.7	80.3	439.7	32.0	488.0
NSR-BH-06	5920124	598456	534.7	68.6	466.1	N/A	N/A	N/A	N/A
NSR-BH-07	5920871	598445	618.23	20.3	597.9	N/A	N/A	N/A	N/A

5.1.1 Drilling Investigation

Boreholes previously proposed by Husky to support the proposed NPS20 pipeline expansion were drilled along with an additional two boreholes on the south slope and two boreholes on the north slope. Six boreholes were drilled on the south slope and four boreholes were drilled on the north slope. These borehole locations were required to be located on the Husky pipeline right of way so were selected based on a preliminary site visit with Husky personnel on August 3, 2016, permitting requirements, landowner permissions and equipment accessibility.

Prior to commencing the field program, Husky personnel completed utility clearances through Sask 1st Call, arranged for McElhanney Land Surveys (McElhanney) to provide a secondary utility sweep within the vicinity of the borehole locations. McElhanney also provided the borehole location staking and as-built survey. Husky also arranged for Ministry of Environment consent with the Saskatchewan Government, environmental monitoring provisions, water withdrawal permitting and subcontractor support for water transport and hydrovac cleanup.

Given the urgency for initiating the drilling program, the availability of drilling subcontractors capable of undertaking a deep coring program using drilling equipment capable of augering and wet rotary coring methods was limited. On August 12, 2016, a Morooka MST 1500 track-mounted drill rig owned and operated by Paddock Drilling Ltd. (Paddock) of Saskatoon, Saskatchewan was used to complete Borehole NSR-BH-02, then was demobilized from site. A second Morooka MST 1500 track-mounted drill rig, owned and operated by Val's Drilling Ltd. (Val's Drilling) of Balzac, Alberta was mobilized to site on August 22, 2016 to expedite the drilling program. Val's Drilling completed Boreholes NSR-BH-01, Stantec 2 and NL-BH-40 and demobilized from the site. Upon availability, an HT 300 NL track-mounted drill rig was mobilized to site on August 26, 2016, owned and operated by Garritty & Baker Drilling Ltd. (Garritty) of Edmonton, Alberta, who completed drilling Boreholes Stantec 1, NSR-BH-03 and the four boreholes on the north slope. The drilling investigation was completed on September 21, 2016 and Garritty and Stantec demobilized from site.

Boreholes were completed using a combination of 150 mm diameter solid stem auger and NQ size wet rotary rock coring of from Paddock and Val's drilling rig and HQ rock core size from Garritty drilling rig. One Stantec geotechnical site representative was on-site for each drill rig to visually log the subsurface conditions encountered at each borehole location.

Drill cuttings generated during auguring were contained in 1 m^3 environmental soil bags. During bedrock coring, circulation fluid consisted of both water and soil cuttings with or without bentonite gel. The drilling fluid was controlled using a mud tank or mud pit to maintain circulation and to control mud spills. The drill cuttings and higher density circulating fluid was collected in storage tanks using: large plastic cubic tanks; large environmental bulk bags and a support track unit which discharged the waste into a larger steel storage tank. Husky coordinated the removal of heavy drilling fluid and excess cuttings from the site.

Soil sampling was carried out at regular intervals using conventional split spoon samplers while performing Standard Penetration Testing as described in ASTM D1586 (Standard Penetration Test and Split –Barrel Sampling of Soils). The Standard Penetration Test (SPT) "N-value" is the number of blows required to advance a split spoon sampler (50-mm outer diameter) 300 mm into the soil using a standardized drop height and weight. N-values generally provide an indication of soil consistency/compactness and may also be used to aid in estimation of other soil parameters. Uncorrected N-values are presented on the borehole logs.

Relatively undisturbed soil sampling was performed at select locations using thin-walled Shelby tubes, as described in ASTM D1587 (Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes). Bulk samples were obtained from the augers, when solid stem auger drilling techniques were used. Field strength testing was carried out on cohesive materials using a pocket penetrometer. Rock cores collected and were logged on site and stored in core boxes. Rock cores were plastic wrapped and placed in wooden core boxes to keep the in situ water content and allow for laboratory testing. Samples were transported to Stantec's Edmonton laboratory for detailed core logging and laboratory testing.

5.1.2 Instrumentation Installation

Following drilling completion, SI and VW piezometer instrumentation was installed in select boreholes and grouted to surface. The instrumentation summary has been provided in Table 5-1 and has been included on Borehole Records attached in **Appendix D.** VW piezometer groundwater elevations and discreet displacement zones measured by the SI's have been included on **Figures 5 and 6 in Appendix B**.

The SI's were measured using a RST MEMS digital inclinometer probe with 0.5 m increments and handheld personal computers. Readings were taken based on cable markings relative to the top of the SI casing. The VW piezometers were read with a Slope Indicator readout box.

Further details regarding the instrumentation monitoring has been provided in **Section 5.6**. The SI instrumentation plots and VW piezometer summary table and plot are provided in **Appendix F**.

5.2 SOIL AND GROUNDWATER CONDITIONS

Detailed descriptions of the subsurface conditions encountered are provided in the Borehole Records attached in **Appendix D** along with the Explanation of Terms and Symbols and the rock core photo log. The borehole locations are indicated on **Figure 2 in Appendix B** and have been plotted on the cross sections on **Figures 5 and 6 in Appendix B**.

5.2.1 South Slope

In general, the subsurface stratigraphy of the south slope of the North Saskatchewan River comprised of a layer of colluvium (displaced soil) over clay shale bedrock. The borehole near the crest of the south slope (NL-BH40) encountered clay till over clay shale bedrock and the borehole at the toe of the slope near the river (NSR-BH3) contained colluvium over river alluvium over clay shale bedrock. The stratigraphic cross section of the south slope of the North Saskatchewan River has been included in **Figure 5, Appendix B**.

Topsoil was encountered on the surface of all boreholes. The topsoil was brown silty clay, with rootlets, and moist in nature. Topsoil thickness ranged between 150 mm to 350 mm with an outlier of 1.2 m near the North Saskatchewan River in Borehole NSR-BH03.

5.2.1.1 Clay Till

Clay till was encountered below the topsoil (520 m elevation) to about 15 m below ground surface (509 m elevation) at the crest of the south slope (NL-BH40). The clay till was brown, fragmented, sandy, with silt, and high plastic. Trace of rootlets, some clay shale fragments, and some oxidation was found in upper half of the clay till layer. The lower half was grey in colour, silty, blocky, and high plastic.

Natural water contents ranged between 22 to 30 percent with an outlier of 15 percent near the ground surface. Results of two Atterberg Limits indicated high plastic clay with a Plastic Limit of 21 and 22 and a Liquid Limit of 53 and 58. Further test results are provided **Section 5.3** and included in **Appendix E**.

5.2.1.2 Colluvium

The colluvium generally comprised disturbed and mottled, medium to high plastic clay till and clay shale. It also contained buried organics and wood debris at many depths. The colluvium ranged in thickness from about 6.5 m in the upper reaches of the slope in Borehole Stantec 2 to about 34 m at Borehole NSR-BH-2, immediately upslope of the affected pipeline. Seepage was inferred during drilling at 4.6 m below ground level in NSR-BH-03.

The natural water content of the colluvium material ranged between 15 to 35%. Occasional outliers of 39 to 45% moisture contents were observed in Borehole Stantec 1. Atterberg Limit tests were carried out with Plastic Limits ranging from 19 to 32 and Liquid Limit ranged from 49 to 92. Grain size analysis comprising hydrometer tests were conducted on multiple locations within colluvium zone. In general, the colluvium layer contained 99% fine grained particles (about 54% silt and 44% clay) and less than 1.5 percent sand particles. Further test results can be found in **Section 5.3** and **Appendix E.**

5.2.1.3 Alluvium

Alluvium was observed near the river bank at Borehole NSR-BH-03. The alluvium mainly contained fine grained sand, which was brown and silty. The alluvium underlies the colluvium and overlies the clay shale. Occasional coal fragments were found in the lower zone while seepage was encountered during drilling in this unit.

5.2.1.4 Clay Shale

The colluvium and alluvium was underlain by clay shale belonging to the Lea Park Formation. The clay shale was grey, silty, high plastic and extremely weak to very weak. It contained occasional slickensides, multiple bentonite seams (about 512 m and ranged between 485 m to 490 m elevation), and blocky zones. The upper clay shale was weathered with oxidized staining and was fragmented and highly disturbed. The clay shale layer extended to the total depths investigated.

No water bearing layers, such as fractured siltstone/sandstone or coal layers were identified during the drilling investigation.

The natural water content of clay shale layer ranged between 15 to 25%; occasional outliers were found above 25% in the upper clay shale sequence. A moisture content nearing 40 percent was observed at a bentonite seam within Borehole NSR-BH-01. Atterberg limit tests identified the clay shale as high plastic with an average Plastic Limit and Liquid Limit of 25 and 93, respectively. Liquid limits were as high as 151.

Soil strengths were obtained using Unconfined Compressive Shear and Direct Shear tests. The unconfined compressive strength (UCS) ranged from approximately 235 kPa to 1250 kPa and undrained shear strengths (Cu) ranged from approximately 120 kPa to 630 kPa. The UCS and Cu generally increased with respect to depth. An outlier UCS and Cu of 2230 kPa and 1115 kPa, respectively was observed in Borehole Stantec 2 at 506 m elevation. Direct shear tests were completed on four samples; three clay shale samples and one bentonitic clay shale sample. The clay shale effective cohesion values of 74, 123 and 250 kPa and peak friction angles of 32, 22 and 13 degrees with residual friction angles of 12, 11 and 20 degrees. The outlier sample with the peak and residual friction of 13 and 20 degrees, respectively may have resulted from pre-existing fissures/flaws or disturbance during sampling/handling/testing. The bentonitic clay shale sample yielded a cohesion of 170 kPa with peak and residual friction angles of 13 and 11 degrees, respectively. Further test results can be found in **Section 5.3** and **Appendix E**.

5.2.2 North Slope

In general, the subsurface stratigraphy of the north slope of the North Saskatchewan River is comprised of till in the upper slope overlain by glaciofluvial sands and gravel over till. The mid to lower slope generally comprised layers of colluvium (displaced soil) over clay till over clay shale bedrock. The borehole near river bank (NSR-BH4) contained colluvium overlying alluvium over clay shale bedrock. The stratigraphic cross section of the north slope of the North Saskatchewan River has been included in **Figure 6 in Appendix B.**

5.2.2.1 Topsoil

Topsoil was encountered at the surface of all boreholes with consistent thickness around 200 mm throughout all boreholes. The topsoil was light brown silty clay, with rootlets, and moist in nature.

5.2.2.2 Glacial Deposits

Clay till was encountered at the surface in Borehole NSR-BH-07 and extended beyond the depth investigated at 598 m elevation. The clay till was encountered underlying the colluvium in the mid slope area and overlies the clay shale. It is absent in Borehole NSR-BH-04 near the toe of the slope. The clay till was brown, with trace fine grained sand and gravel, medium to high plastic and moist. Sand and gravel interlayers were encountered in Borehole NSR-BH-07. Trace oxidation and coal fragments were observed within Borehole NSR-BH3. The till within Borehole NSR-BH-06

contained occasional grey mottling and white mineral deposits within the upper layer and trace coal was observed below this. Seepage was inferred during drilling at 14.5 m below ground surface in Borehole NL-BH41 (about 507 m elevation).

The water contents in the clay till ranged from 5 to 15 percent in Boreholes NSR-BH-07 and NSR-BH-06 with outliers of around 25 percent in Borehole NSR-BH-06 in the lower clay till zone at 522.3m elevation. Water contents for NL-BH41 ranged from 10 to 30 percent. Atterberg limit test resulted in Liquid Limits of 48 and 57 and Plastic Limits of 18 and 26. Further test results can be found in **Section 5.3** and **Appendix E.**

5.2.2.3 Colluvium

A clay layer was encountered below the topsoil within the boreholes on the lower slope and near the river bank. Based on the terrain assessment, the clay was classified as colluvium. The clay is brown, silty, some sand, low to high plastic and moist. The colluvium clay was generally underlain by clay shale bedrock.

The natural water contents of the colluvium ranged from15 to 25% with occasional outliers of 5 to 10%. Two Atterberg Limit tests resulted in Plastic Limits of 26 to 13 and Liquid Limits ranging from 32 to 57. Hydrometer test results yielded 1% gravel, 9.5 and 14.9% sand, 60.2 and 65.8% silt and 30.2 and 19.3% clay sizes. Further test results can be found in **Section 5.3** and **Appendix E**.

5.2.2.4 Alluvium

Alluvium was observed near the river bank at Borehole NSR-BH-04. The alluvium was moist and contained poorly graded, fine grained sand, with gravel, trace silt. The alluvium underlies the colluvium and overlies the clay shale. The sand was encountered from 3.0 to 4.5 m below ground surface (491 to 489.5 m elevation). The natural moisture content of the sand ranged from 5 to 10%. Test results can be found in **Section 5.3** and **Appendix E**.

5.2.2.5 Clay Shale

The clay shale belonging to the Lea Park Formation was encountered within all boreholes except Borehole NSR-BH-07 near the top of the slope. The clay shale was silty, grey, blocky, high plastic, and extremely weak to very weak. It contained occasional slickensides, multiple bentonite seams and blocky zones. The upper clay shale was weathered with trace of oxidation. The clay shale layer extended to the total borehole depths investigated.

No water bearing layers, such as fractured siltstone/sandstone or coal layers were identified during the drilling investigation.

The natural water content of clay shale layer ranged between 15 to 25%; with occasional 30 percent moisture content in NL-BH41. Atterberg Limit tests identified the clay shale layer as high plastic with Plastic Limits ranging from 22 to 50 and Liquid Limits ranging from 61 to 165.

The UCS test results were 202 kPa and 1320 kPa and Cu of 101 kPa to 660 kPa for tests completed within Boreholes NSR-BH-06 and NSR-BH-04, respectively.

5.2.3 Groundwater Conditions

The initial groundwater observation was completed during the site investigation. Eleven vibrating wire piezometer were installed on the south slope and two on the north slope to accommodate future monitoring. The details of the piezometer installation depths have been provided in **Table 5-1** and monitoring results are included in **Appendix F.**

Based on the latest measurements taken on October 12, 2016, assuming hydrostatic pressure was reached, the groundwater elevation results ranged from 582.2 m to 487.4 m at the south slope and 507.3 m to 487.9 m at the north slope. The groundwater elevation for the two boreholes near the North Saskatchewan River (NSR-BH-03 and 04) generally coincide with the river level elevation (about 487 m). The summary table and chart for the VW piezometers are provided in **Appendix F**.

5.3 LABORATORY TEST RESULTS

Laboratory testing was completed on selected soil and rock core samples delivered to the Edmonton laboratory following review by the engineering team. Laboratory testing completed consisted of: Atterberg limits; grain size distribution (sieve and hydrometer); unit weight; unconfined compressive strength and direct shear on selected samples in accordance with the ASTM standards. The results of the laboratory testing are presented in summary tables below and included in **Appendix E** along with the individual laboratory test reports. Laboratory test results are also included on the Borehole Records included in **Appendix D**.

5.3.1 Atterberg Limit

Atterberg limit testing was completed on select samples of both overburden material and clay shale bedrock. Results of the Atterberg limit tests are presented in the summary table and laboratory test results included **Appendix E.** Test results are also summarized in the Borehole Records included in **Appendix D**.

5.3.2 Grain Size Distribution

Grain size distribution testing was competed on select samples consisting of both overburden material and clay shale bedrock. The grain size distribution testing was completed using wet sieve method and hydrometer analysis in accordance with testing guidelines provided in ASTM C136 and ASTM C117. Results of the grain size distribution testing are presented in the summary table and laboratory test results included **Appendix E.** Test results are also summarized in the Borehole Records included in **Appendix D.** Unconfined Compressive Strength

The unconfined compressive strength (UCS) testing was completed on three (3) Shelby tube samples collected within the overburden material and, twelve (12) bedrock core specimens from the clay shale bedrock. The soil samples and rock core specimen were subjected to an UCS test in accordance with ASTM D2166 to determine the strength of the material. The UCS test results are presented in the summary table and laboratory test results included **Appendix E.**

5.3.3 Direct Shear

Direct shear testing was completed on four (4) selected clay shale samples, one of which was bentonitic (Borehole Stantec 1 - RC45), to determine the bedrock characteristics including the peak strength and residual strength parameters at failure conditions. The tests were completed at three normal load conditions considering the sample location depth. The direct shear testing was completed in Stantec's Calgary laboratory using ASTM D3080 test methodology. The summary of the laboratory tests is presented Error! Reference source not found. below and individual test results are included in **Appendix E**.

Table 5-2 Direct Shear Test Results

Borehole ID	Sample ID	Sample depth (m)	Sample Elevation (m)	Wc (%)	Total Unit Weight (KN/m³)	Dry Unit Weight (kN/m³)	Effective Cohesion (kPa)	Friction Angle (Degree)	Residual Friction Angle (kPa)
NSR-BH01	RC27	25.3 - 25.5	512.7-512.5	21.8	20.4	16.7	123	21.8	11.3
STANTEC1	RC29	22.9 - 23.2	507.9-507.6	18.9	19.0	15.9	74	31.6	11.7
NSR-BH-02	RC39	40.8 – 41.0	472.8-472.6	18.6	20.8	17.5	250	12.9	19.9
Stantec 1	RC45	46.4-46.6	484.4-484.2	35.9	17.8	13.1	170	13.4	11.3

5.3.4 Chemical Analysis

Water soluble chloride content, sulphate content, pH and resistivity tests were conducted on selected soil samples from the boreholes. This testing was completed by Maxxam Analytics International of Edmonton, Alberta. The test results are presented in the summary table and laboratory test results included **Appendix E**.

5.4 FIELD RESISTIVITY TESTING

Field resistivity testing was conducted by Stantec personnel on September 27-28, 2016, using the Four-pin Wenner resistivity testing method (ASTM G57). The resistivity testing was completed on the north and south slopes of the North Saskatchewan River on the east of the existing right of way. Location and coordinates of the test sites are summarized in Table 5-3 below. Stantec's Pipeline Integrity group provided the location of the test sites. The coordinates of the field test points were collected using a hand-held GPS device having an accuracy of ±3 m.

Table 5-3 Resistivity Test Site Coordinates (UTM 12U)

Test location ID	Northings (m)	Eastings (m)	Comments
CP - 12-17-051-24W3 (NSR Valve Station South/BH40)	5919954	598484	Approximately 28 m east of existing block valve site
CP - 12-20-051-24W3 (NSR Valve Station North/BH41)	5918290	598518	North-east of existing block valve site

Field testing was completed at specified electrode spacing intervals of 0.75, 1.5, 3.0, 6.0, 9.0, 12.0 and 15 m. The results of the field resistivity test in the east-west and north south direction are presented in **Table 5-4** and **Table 5-5**. The results include the measured apparent resistivity, current and voltage.

Table 5-4 Summary of Wenner Four-Pin Results for North Slope of North Saskatchewan River

Electrode Spacing (m)	Field Electrode Penetration Depth (cm)	Apparent Resistivity (ohm-m)		Current (mA)		Voltage (mV)	
0.75	4	20.47	23.62	6.35	7.92	27.14	39.06
1.5	7.5	14.02	13.02	0.33	17.56	0.48	25.35
3.0	15.0	13.34	14.79	6.68	28.99	4.68	22.39
6.0	15.0	14.47	14.72	46.69	49.71	17.63	18.45
9.0	15.0	12.10	10.96	84.91	88.00	17.88	16.72
12.0	15.0	11.92	11.39	112.49	116.32	17.51	17.30
15.0	15.0	12.74	10.56	123.82	155.76	16.47	17.18

Notes:
1) Air temperatures were 17°C and 18°C for the north-south and east-west orientations, respectively.
2) Weather: partly cloudy and windy
3) Ground surface: grass and topsoil within a cultivated canola field.
4) Soil conditions: dry clay till underlying topsoil/root mat.

Table 5-5 Summary of Wenner Four-Pin Results for South Slope of North Saskatchewan River

Electrode Spacing (m)	Field Electrode Penetration Depth (cm)	Apparent Resistivity (ohm-m)		Current (mA)		Voltage (mV)	
0.75	4.0	119.62	101.20	1.03	1.13	25.77	23.86
1.5	7.5	39.03	33.59	4.02	4.98	16.39	17.47
3.0	15.0	18.04	19.24	17.42	16.69	16.23	16.76

6.0	15.0	14.95	13.85	40.75	44.85	15.91	16.22
9.0	15.0	14.04	12.54	64.29	71.98	15.71	15.71
12.0	15.0	11.58	0	107.46	9999.00	16.24	0.01
15.0	15.0	0	0	9999.00	9999.00	0	0.00

Notes:
1) Air temperatures were 13°C and 11°C, for the north-south and east-west orientations, respectively.
2) Weather: partly cloudy
3) Ground surface: grass and topsoil with trees downslope in the north direction and approximately 10m north of the center of test location.
4) Soil conditions: dry clay till underlying topsoil/ root mat.

On the south slope, high current output readings resulting to 9999.0 mA was noted for electrode probes spaced at 12 and 15 m in the east-west direction. It was observed that these measurements were collected along Husky's existing pipeline right of way.

Similarly, in the north-south direction, high current measurement readings at 9999.0 mA were noted at electrode spacing intervals of 15 m. Resistivity measurement at the 15 m interval mark located on the north side was completed at the toe of the existing slope.

5.5 GEOTECHNICAL INVESTIGATION BY OTHERS

Several geotechnical drilling investigations have been undertaken at or near the pipeline corridor. The following highlights the general findings from these investigations.

Geo-Engineering (M.S.T.) Ltd. completed a geotechnical investigation in 1997 to support the NPS16 and NPS pipeline bundle crossing of the North Saskatchewan River. Excerpts of the report text and the cross section were available for review from the SGS Expansion River crossing of the North Saskatchewan River and Monnery River - July 1997, prepared by Concise Design Engineering Services. The geotechnical investigation comprised Ground Penetrating Radar across the river, which indicated a sand-gravel deposit ranging in thickness from about 8 to19 m. One borehole was drilled on each side of the river near the base of the slopes. The borehole records and survey coordinates for the boreholes were not available. The south slope Borehole, NS-1, was drilled to 24 m and comprised 10 m of stiff to very stiff, high plastic, clay, with slickenslides in the upper portion, which was underlain by 8 m of fine compact wet sand, underlain by extremely weak, high plastic mudstone. The north slope Borehole, NS-2, was drilled to 13 m and comprised sand underlain by gravel, clay and mudstone.

Clifton Associates Ltd. completed a borehole drilling investigation in 2009 at the Pikes Peak Water Intake site at the bottom of the south slope and immediately east of the pipeline corridor. Two boreholes were drilled adjacent to the existing inlet to a depth of about 6 m below ground surface. The borehole stratigraphy generally comprised alluvial sandy silt to a depth around 2 m underlain by clay shale. The alluvium was described as clayey near the surface.

Solid Earth Geotechnical Inc. completed an auger borehole drilling investigation in May 2016 for a proposed Husky water intake located referred to as Site B, which is proposed to be located about 1 km west of the pipeline alignment on the south slope of the North Saskatchewan River. The draft borehole records were reviewed, which were generally drilled on the lower half of the slope with one borehole at the crest. The subsurface conditions generally comprised colluvium over clay shale. The boreholes drilled at the valley bottom generally comprised colluvium underlain by sand and underlain by clay shale. Borehole depths were generally terminated at auger refusal ranging from about 15 to 30 m below ground surface. The top of bank borehole generally comprised a thin sand layer over till over clay shale. The reported borehole results are similar to the results from boreholes drilled at the pipeline corridor in this study. Slope inclinometers were installed in several boreholes and the readings from June through to mid-September 2016 have not reflected significant movements or zones of movements.

5.6 INSTRUMENTATION INTERPRETATION

The boreholes drilled on the south slope were completed with slope inclinometers (SI) and vibrating wire piezometers (VW) to monitor lateral subsurface movements and groundwater levels at discreet locations. Monitoring this instrumentation provides indications of shear planes, their depth, rates of movement and ground water level changes. Currently, the instrumentation requires manual measurements and is not fitted with real-time monitoring sensors.

5.6.1 Slope Inclinometers

Slope Inclinometers comprise PVC casing with four precisely incised grooves in the inside of the casing. A wheeled probe with accelerometers installed at 90 degrees to one another is then run along two of these grooves and readings of the verticality of the casing are taken at 0.5 m increments from the base of the casing to the surface. The system is very effective in finding a spike in the data corresponding to shear displacement in the ground.

5.6.1.1 Sources of Error in Slope Inclinometers

Where relatively small movements are being monitored, such as this site, minor systematic errors in the process of obtaining readings can lead to challenges in interpreting the data if not corrected, particularly in deep installations. The individual sets of readings of each of the instruments have been assessed against two potential systematic errors:

1. Accelerometer Rotation Errors – a combination of casing tilt (i.e. being installed non-vertical) and a sensor axis alignment shift can lead to this error. If the installed profile of the casing is non-vertical, even out of alignment by about a half a degree, slight sensor axis rotation can lead to shifting of the cumulative displacement plot. This divergence of the cumulative displacement plot takes the shape as the absolute profile of the casing at 90 degrees to the measured direction (i.e. the A direction cumulative displacement plot is impacted by the profile of the casing in the B direction).

2. Bias Shift Error – the accelerometers are calibrated to read as close to zero as possible in a vertical orientation. Slight variations from this routinely occur, but the reading process addresses this for a consistent offset from zero. However, if the probe is jarred between reading sets a change in the mean checksum can show up. This error is very uncommon.

None of the reading sets showed any significant Bias Shift Error, so no corrections for this were undertaken. However, most of the casing installations showed evidence of a non-vertical profile and warranted correction for Accelerometer Rotation Errors as the cumulative displacement plots tended to mirror the absolute profile in the 90 degree orientation. Where this correction was undertaken for a given data set, it is noted on the output.

Cumulative and incremental SI plots for the A and B directions as well as the displacement versus time plots for those sites with distinct movements are provided in **Appendix F** and summarized in the following sections. In addition, SI movement elevations have been provided on **Figure 5 in Appendix B**. The instruments have only been monitored for a short period through September and early October 2016, which may not be representative of all the locations of shear movement in the slope, annual movement rates or the maximum rate of movement.

The latest SI readings were taken on October 12, 2016 and the following observations were made from the toe of the slope to the top of the south slope:

NSR-BH-03: There have been three sets of readings since initialization. To date there is no distinct indication of movement in this slope indicator. However, there is a suggestion of potential bulging of the material above elevation 480 m, at and above the level of the clay shale. This plot has been adjusted for rotational correction due to the tilt of the installation which can impact the readings.

NSR-BH-02: There have been four sets of readings since initialization. There is a distinct movement zone with about 1 mm displacement in the A direction (downslope) at 476 m elevation. There is also indication of movement at 504 m elevation. Both movement zones are confined within the colluvium deposit above the bedrock contact.

Stantec 1: There have been four sets of readings since initialization. One distinct movement zone has been identified at 512 m elevation. A total of about 3.5 mm movement in the A direction (downslope) and -0.5 mm in the B direction (movement to the west) has occurred over 36 days since initialization. The current rate of movement is about 35 mm/year in the resultant X-direction. This movement rate is an annualized average, and should not be expected to uniform. Most landslide movements are episodic, moving faster or slower depending on site conditions, such as precipitation. The movement zone corresponds to the upper, weathered, high plastic clay shale surface and just below the colluvium/clay-shale contact.

NSR-BH-01: There have been two sets of readings since initialization. One distinct movement zone has been identified at about 511 m elevation. A total of about 2 mm of movement in the A direction (downslope) has occurred over 26 days. The current annualized rate of movement is

about 35 mm/year in the A direction (downslope). This elevation corresponds to the upper clay shale and in particular, a 50 mm thick bentonite seam was identified at about 510.8 m elevation (about 15 m below the colluvium-clay shale contact).

Stantec 2: There have been three sets of readings since initialization. There is no indication of movement with the readings obtained to date. This SI is installed slightly downslope from the location of tension cracks at the well pad about 100 m to the west.

NL-BH40: There have been two sets of readings since initialization. There is no indication of movement with the readings to date. This inclinometer has significant noise below 560 m elevation.

The latest SI readings were taken on October 12, 2016 and the following observations were made from the toe of the slope to the top of the north slope:

NSR-BH-04: There has been one set of readings since initialization. There is no discernable movement to date within this inclinometer.

NL-BH41: There has been one set of readings since initialization. There is no discernable movement to date within this inclinometer. The B orientation data for the initial reading on this instrument has been adjusted over a depth range of 30 to 33 m, using the mean check sum difference between the opposite readings. The data obtained suggests a 3 mm movement to the west at this depth, but it is considered that this is in error. Both sets of data plots have been provided in **Appendix F**. This needs to be verified during the subsequent readings.

Resultant Direction of Movement

The following table summarizes the A direction azimuths of the slope inclinometers with respect to true north. Should lateral displacements be measured in the B direction, the resultant slope movement magnitude and azimuth direction will be determined with respect to true north to report potential transverse soil movements that could interact with the pipelines.

Table 5-6 Slope Inclinometer A-Direction Azimuth Summary

Slope Indicator	Field measured A+ direction
NL-BH40	350 degrees
Stantec 2	351 degrees
NSR-BH-01	0 degrees
Stantec 1	2 degrees
NSR-BH-02	358 degrees
NSR-BH-03	330 degrees

5.6.2 Rate of Movement

From the inclinometer data, it is evident that there is some slope movement occurring at approximately 511 to 510 m elevation, as recorded in Boreholes Stantec 1 and NSR-BH1. Additionally, the pipeline distress occurred at about 510 m elevation. It is also possible that there is a movement plane at a greater depth, at about 486 to 480 m elevation. Both LiDAR imaging and inclinometer readings to date suggest that slope deformation vectors may vary + 20 degrees along the length of the pipe, which may introduce lateral stresses in addition to longitudinal stresses on the pipelines.

The rate of movement at this time in Boreholes Stantec 1 and NSR-BH01 is annualized to approximately 35 mm/year, indicating a very slow moving landslide. It is likely that the rate of movement could be greater following spring thaw and heavy rainfall events as the water infiltrates into the slope through the soil surface, sag ponds and open ground cracks. Continued monitoring is required to measure the magnitudes and rates of movement. Brooker and Peck (1993) have considered a number of landslides in similar weak Cretaceous clay shales and suggest considering an approximate rate of movement of 100 mm/year.

Evidence of active slow movements, defined to range from about 1.6 m/year and 13 m/month, were observed about 500 m west of the pipeline corridor between Boreholes Stantec 2 and NSR-BH-01. An active slump block was observed downslope and between Husky lease sites A16-18 and A15-18. The slump has a back scarp approximately 2-3 m high extending laterally over approximately 100 m. These active slump features are expected within this over steepened zone of the south slope (area 4 on Figure 3). In addition, the back scarps evident on the surface topography along the upper slope provide evidence of historical displacements that may have been in the order of metres over a relatively short time period.

Even though the movement of very slow landslides may be relatively steady, detailed monitoring has shown that movement may be episodic or that movement rates may vary greatly over timescales ranging from hours to years resulting from excessive precipitation and erosion as well as internal changes in the landslide mass (C-Core et al, 2009). This necessitates a regimented monitoring program as a pipeline integrity risk management response.

5.6.3 Vibrating Wire Piezometers

5.6.3.1 South Slope

The VW piezometers are installed within the clay shale bedrock. Up to two piezometers were grouted in place within the same borehole as the slope inclinometer. The latest suite of VW piezometers was read on October 12, 2016. The VW piezometer results are summarized on the Groundwater Monitoring Table included in **Appendix F**. The water elevation heads have been plotted with time and are also included in **Appendix F** and the most current readings are shown on the cross section on Figure 5. The data generally indicates a small downward gradient across

the clay shale slope. The water level generally follows the surface topography and the water level at the borehole near the river is approximately at the river elevation. Piezometric levels on the slope varied from about 2.5 to 11 m below the ground surface. The recorded piezometric levels have been slowly dropping during the months of September and October, which is to be expected during this relatively dry period of the year. It is possible that the recorded more rapid decrease in piezometric levels in the first week or two after installation reflect dissipation of excess pressures due to the installation grouting process.

5.6.3.2 North Slope

The VW piezometers are installed within the clay shale bedrock on the lower portion of the north slope. The latest suite of VW piezometers was read on October 12, 2016. The VW piezometer results are summarized on the table and graph included in **Appendix F**. The water elevation heads have been plotted with time and are also included in **Appendix F** and the most current readings are shown on the cross section on **Figure 6 of Appendix B**. The data generally indicates a small downward gradient across the clay shale slope. The water level generally follows the surface topography and the water level at the borehole near the river is approximately at the river elevation. The piezometric level on the north slope was measured to be about 13 m below the ground surface.

6.0 NORTH SASKATCHEWAN RIVER – SOUTH SLOPE STABILITY ASSESSMENT

The south slope of the North Saskatchewan River surrounding the NPS 16 and NPS 8 pipelines is a complex rotational rock slide in weak Cretaceous clay shales. The landslide contains rotational, translational and flow components and movement occurs episodically within the body of the landslide, and through time. In the region of the pipeline, the landslide is currently active as evidenced by open ground cracks, slope inclinometer movements and the pipeline distress that occurred to the NPS16 and NPS8 pipelines in July 2016. Given the available data to date, the most recent movement was likely caused by a high precipitation event, surface topography that impeded drainage and the weak pre-sheared foundation of Cretaceous clay shales. However, based on available slope indicator monitoring data, at least portions of the slope continue to creep along at a slower rate on an ongoing basis.

Understanding the geological model, mechanism, geotechnical properties and the current stability of the south slope assists in the assessment and treatment of the landslide. Categorically, landslides can either comprise those which can be mitigated through active support/remedial measures to reduce the hazard and those which must be managed with the implementation of early warning systems to reduce the effect of the hazard (Lato, et al, 2016). The south slope landslide is the latter.

The following section presents the current understanding of the geological model, mechanism, geotechnical properties and current stability of the south slope.

6.1 GEOLOGICAL MODEL

The overall south slope of the North Saskatchewan River at the pipeline crossing is at a shallow 5.5 degree slope inclination, which corresponds to approximately 10 Horizontal to 1 Vertical (10H:1V). The overall slope is approximately 104 m high over a horizontal length of about 1080 m from the river to the top of the slope. The river elevation is approximately 488 m elevation and the crest of the slope is approximately 592 m.

The topography extending over the lower slope comprises a gentle slope to a lower bench, followed by a gentle to moderately steep rise to a second bench. The upper slope comprises gently to moderately (locally steeply) sloping, hummocky to ridged terrain representative of horst and grabens or rotational block movement and terminates with an approximately 5-10 m high head scarp at the crest. Several sag ponds, wetlands and dry, linear depressions were evident within the ridged and hummocky terrain of the slide mass. These wetlands are most common along the upslope edges of the lower and mid slope benches, suggesting potential seepage or groundwater discharge from the upslope landslide mass. Fresh, open ground cracks were observed west of the pipeline corridor at Husky lease sites A16-18 and A15-18, which are located about three quarters of the way up the slope, as well as at the base of the slope at the water intake pond.

The near surface soils at the top of the south slope comprise till with clay shale fragments in the till matrix and colluvial deposits (highly fragmented, mottled clay till and clay shale with organic debris and/or colloidal organic staining) along the slope and up to about 34 m thickness at NSR-BH-2 near the site of the affected pipelines. Underlying these surficial deposits is an Upper Cretaceous aged marine clay shale belonging to the Lea Park Formation. The clay shale is high plastic, fragmented, blocky and slickensided in the upper reaches of the bedrock. Occasional slickensides were observed throughout the clay shale sequence. Discreet bentonite seams were noted at two zones, about 512 m elevation as identified in NSR-BH-01and from about 490 to 480 m elevation as identified in Boreholes Stantec1, NSR-BH-01 and Stantec 2. No evidence of water bearing zones/layers was observed within the drilling investigation and site reconnaissance. The borehole stratigraphy of the south slope cross section is provided in **Figure 5 in Appendix B.**

Based on the limited slope indicator monitoring to date, shear zones are located in the upper part of the Lea Park Formation clay shale at about 512 m elevation These movements have been recorded in Boreholes NSR-BH-01 and Stantec 1, which when extrapolated along the slope is generally coincident with the location of the pipeline buckles at about 510 m elevation. The current annualized rate of movement in these inclinometers is about 35 mm/year, as of October 12, 2016.

The deeper shear plane has not yet been corroborated by successive slope inclinometer movements to date. There is some suggestion of displacement at a depth of about 486 m elevation in Borehole NSR-BH-02. The subsurface stratigraphy suggests the depth of colluvium at the bottom part of the slope ranges from about 480 m elevation in Borehole NSR-BH-02 and about 486 m elevation in Borehole NSR-BH-03. A sequence of thin bentonite seams has been identified in this elevation range within the three boreholes set further back into the slope (Boreholes Stantec 1, NSR-BH-01 and Stantec 2) as well as those drilled on the north side of the river (Boreholes NSR-BH-04; NL-BH41 and NSR-BH-06). The bentonite seams are absent from the lower slope boreholes at this elevation (Boreholes NSR-BH-02 and NSR-BH-03), where colluvium is present.

The NPS16 and NPS8 pipelines were trenched along the south slope then installed by HDD across the river as indicated in **Figure 5 in Appendix B.** The pipelines are trenched within colluvial soils along the south slope to about 1.5 m depth and do not penetrate the underlying clay shale until the HDD segment of the pipeline. Continual slope movements along the upper shear zone are expected, which will promote retrogressive displacements to the surface. Potential movements at the lower shear zone present a hazard to the HDD crossing.

6.2 POTENTIAL LANDSLIDE MECHANISM

All slopes are acted upon by a set of forces; those that promote downslope movement (the driving forces) and those that resist downslope movement (the resisting forces). For a stable slope, the resisting forces are greater than the driving forces. Instability along a shear plane occurs when the ratio of the resisting forces to the driving forces, expressed as the factor of safety (FS), are less than 1. When FS equals 1, there is equilibrium between the resisting and driving forces.

The causes of the south slope landslide may be attributed to long term processes and short term events. The subsurface conditions of the south slope are comprised of extremely weak, high plastic, near horizontal bedded clay shales that are weathered near surface and contain thin seams of bentonite at distinct elevations. These clay shales have been affected by glacial rebound and erosion of the toe of the slope by the North Saskatchewan River and potentially by the impact of shearing induced by glacial drag. The initial onset of slope movement would have been because of rapid downcutting from ice melt drainage during deglaciation that incised the current North Saskatchewan River valley with oversteepened slopes. In addition, glacial rebound following glacial ice melt results in shearing in the clay shales creating planes of weakness (Matheson and Thomson, 1973). These extremely weak clay shales, now with planes of weakness and oversteepend slopes, resulted in valley wall landslides which continue to occur to present day as the river continues to erode the toe of the valley slopes. With the landslide debris (colluvium) and shales now at residual strength, small increases in driving forces or reductions in resistance can reactivate movements.

Additionally, intense rainfall and rapid snow melt events promote water accumulation within sag ponds and wetlands on the surface topography and seepage into the slope from these and within open ground cracks at surface promote an increase in groundwater levels, which both increase lateral thrust forces if in a tension crack and decrease resisting forces on the shear planes, further promoting landslide displacements.

The interpreted cross sectional subsurface geometry of the slope failure mechanisms at this site are provided in **Figure 5 in Appendix B**. Open ground cracks, back scarps and movements observed at depth within slope inclinometers are consistent with this portion of the landslide being currently active. The rate of movement to date in the slope inclinometers suggests a rate of about 35 mm/year at the 512 m elevation. Generally accepted velocity thresholds define very slow landslides to have displacement rates ranging from 16 mm/year to 1.6 m/year and slow landslides have displacement rates between 1.6 m/year and 13 m/month (Cruden and Varnes, 1996).

It is possible that an additional translational shear surface is present near the base of the slope. Evidence of colluvial deposits at the toe of the slope and above the river fluvial deposits suggest that displaced material has historically moved into the river, which would have been gradually eroded to present day conditions. The terrain mapping suggests an additional possibility that a more recent secondary landslide developed at the toe of the larger landslide mass. The geological profile suggests the base of the colluvium is at approximately 486 m elevation.

Open ground cracks located on the upper slopes of the landslide about 100 m west of the pipeline alignment at Husky lease site A16-18 suggest lateral movements up to 200 mm and vertical displacements up to 1 m. Backscarps observed along the south slope range from about 1 to 10 m high.

The upper shear surface at about 512 m elevation is more strongly developed based on inclinometer data and has affected the overlying sediments by rotational slip that has retrogressed back into the slope, which has been interpreted in **Figure 5 in Appendix B**. A lower shear surface is interpreted near the toe of the slope at about 480 m elevation.

6.3 NEAR SURFACE SOIL/PIPE INTERACTION PARAMETERS

This section addresses soil parameters to be used in soil-pipeline interaction (pipelines stress analysis) studies and the soil spring constants for use in pipe stress analysis of the existing NPS16 and NPS 8 pipelines.

6.3.1 Assumptions

The following assumptions apply to the determination of soil parameters for pipeline stress analysis:

1. The pipeline on the south slope of the North Saskatchewan River is shallow buried, in colluvium (high plastic, fine-grained soils).

2. The pipeline enters the HDD bore at the toe of the slope near the river bank, and is placed within undisturbed competent fine-grained, high plastic soils.
3. The depth of cover down the slope is in the order 1.5 m. Deeper burial may induce different stress regimes on the pipe, such as may occur in deep burial of an HDD bore.

4. The groundwater table is below the base of the pipeline for the entire slope length.

5. The pipeline was installed in about 1998. Therefore, backfill/trench soils are of similar consistency etc. as" undisturbed" soils.

6. Sections of the pipeline on the slope were recently (2016) exposed and backfilled, meaning that the backfill in these areas will not be as well "aged" as backfill in-place since construction.

6.3.2 Purpose of Analysis

It is understood that the stress analysis will consider the NPS 16 and NPS 8 pipelines under the current landslide conditions to assess the short to medium-term (up to 3 years) potential for excessive strain development due to soil movement that could lead to future loss of containment. Note that excessive strains in the pipeline could develop at several locations on the pipeline:

1. Towards the top of slope, where the pipeline is subjected to tensile loads at the near-vertical interface between moving and non-moving soil masses.

2. Base of slope where the pipeline transitions into heavy wall HDD pipe (where the present distress occurred).

3. Within the HDD bore where the pipeline crosses a near-horizontal interface between the upper moving soil mass and the lower non-moving soil mass.

6.3.3 Soil Conditions and Parameters

Table 6-1 lists soil parameters of the approach slope of the North Saskatchewan River for use in pipe stress analyses. The applicable assumptions and conditions are:

1. The NPS16 distress was assumed to be caused by excessive strains due to ground movement.

2. Soil spring values for soil-pipe interaction studies should be based on effective stress soil strengths, on the current understanding of very slow to slow slope movement. This assumption should be validated when additional slope indicator data is available and the potential for rapid, episodic movements are assessed.
3. Given that the pipeline stress analysis to be completed is a fit-for-purpose assessment, failure scenario conditions should be considered. Hence, maximum soil strengths will be mobilized during pipeline movement.

4. The soil parameters provided herein are suitable only for soil-pipe interaction and may not be suitable for geotechnical analyses such as slope stability.

Table 6-1 Soil parameters applicable to the south slope of the North Saskatchewan River.

Soil properties	Value
Bulk unit weight (Aged backfill and undisturbed soil)	19 kN/m^3
Effective soil cohesion (Aged backfill and undisturbed soil)	0 kPa (1)
Internal friction angle (Aged backfill and undisturbed soil)	38 degrees (2)
Bulk unit weight (Recent backfill)	17 kN/m^3
Effective soil cohesion (Recent backfill)	0 kPa (1)
Internal friction angle (Recent backfill)	30 degrees (2)

Notes:
(1) There is considerable evidence and the current trend in soil mechanics is that the cohesion intercept (effective cohesion) in the low stress range of interest to pipeline is zero.
(2) The Mohr-Coulomb envelope is known to curve at low stress levels (for example see Baracos, Graham and Domaschuk, 1980). This results in a zero effective cohesion at low stress levels but a higher friction angle. Also, given that the stress analysis is considering failure conditions, upper bound soil strengths will result in higher stresses in the pipeline. Also note that the soil strengths (effective cohesion and friction angles) derived from laboratory tests and discussed in Section 5.3 were performed for slope stability purposes and may not be directly applicable to use in soil-pipeline interaction studies.

For determining the soil stiffness (K), as defined in ALA (2001) and for example, $K_U = P_U/Y_{max}$, where P_U is the maximum soil resistance at the onset of plastic deformation and Y_{max} is the soil displacement at the onset of plastic deformation), soils should be treated as follows:

- Axial spring = dense sand
- Horizontal (lateral) spring = as per ALA, common displacement for all soils
- Upward (uplift) spring = dense sand
- Bearing (downward) spring = granular soils

Although the soils along the slope are understood to be fine-grained, the use of effective (drained) soil parameters listed in Table 6.1 means that the soils will, during pipe-soil interaction, behave in a drained manner. Although not explicitly stated in ALA (2001) where sands and

granular soils are identified, the document is implying that drained conditions are applicable, irrespective of the soil texture.

6.4 STABILITY OF THE SOUTH SLOPE

The terrain evaluation, geological/geotechnical investigation and instrumentation support the presence of an active, retrogressing, very slow to slow rock slide on the south slope of the North Saskatchewan River. This active landslide is functioning upon residual strengths and is sensitive to small disturbances/alterations and significant rainfall events and rapid snowmelt.

The South Slope is comprised of complex land formations, which are subject to periodic and gradual slope movements at different locations on the slope. These slope movements exert forces on the two trenched pipelines causing the pipelines to gradually move with the slope. The gradual movement of the pipelines creates a location of increased stress at the toe of the slope where there is a required bend in the pipe to transition to the trajectory of the HDD crossing of the river. This bend location sees increased stress because the HDD portion of the pipeline resists movement (acts as an anchor). The movement of the pipe within the slope relative to the non-movement of the pipe within the HDD eventually created enough compressive force to deform and subsequently cause failure of the one pipeline.

To manage pipeline integrity, engineering approaches to design can include:

1. Active remediation and slope stabilization measures or
2. Passive measures through monitoring and allowing slope movements to occur and the implementation of early warning systems to trigger mitigating actions.

The projected project life of the NPS16 and NPS8 pipelines is three years before the proposed replacement NPS20 pipeline will be in service.

Reducing the landslide risks to the two pipelines using active slope stabilization measures was considered through the following or combinations of the following: removing unstable soil material; increasing internal strength through drainage; reducing driving forces through grading or providing additional external resistance through buttressing, retaining walls or tie-backs.

Consideration of these active stabilizing measures would necessitate a stability analysis using limit equilibrium methods. Currently, given active movements on the south slope, the Factor of Safety is close to unity, in particular following high precipitation periods. A stability analysis would aim to evaluate the positive effect of the slope treatment through an increase in Factor of Safety. Implementing active slope stabilization measures on the south slope are considered infeasible given the large size and complexity of the landslide and for the following additional reasons:

- Given that high permeability zones were not encountered during the geotechnical drilling investigation, stabilization measures such as dewatering through horizontal drains

would not likely be feasible given the low permeability clay shale with closed discontinuities.

- Slope modifications such as slope re-grading or removal of soil loads at/near the top of the slope are not recommended given the scale of the slope and considering that small disturbances to the slope may initiate further movement.

- Buttressing the toe of the slope with a toe berm or retaining structure is not practical, as such measures would require multiple tiers and would need to extend some distance to both the west and east of the pipeline corridor at a very significant cost.

Given the significant challenges to developing feasible slope stabilizing measures along the south slope of the pipeline alignment, monitoring is a necessary requirement with a focus on developing a detailed geological model through in-situ and surface instrumentation and collection of terrain field observations, particularly focused on movement locations and shear zones.

The key consideration is the rate of movement observed in the soil mass as this affects the stress transferred to the pipelines. The pipeline stress analysis has modeled an allowable soil displacement of 105 mm for the pipelines to remain within the elastic stress zone. This displacement should occur slowly (assumed 35 mm/year) but does not account for sudden slope movements in excess of 105 mm. Although not evident on the pipeline corridor, it is possible to have these more sudden slope movements occur (see **Section 5.6.2**). Predicting the magnitude and timing of these more sudden movements is very challenging.

The current FS of the south slope is marginally above unity and is sensitive to small changes, such as rainfall events, that can initiate slope movements. Numerical modeling techniques can be used to determine the sensitivity of the variables, or boundary conditions, acting upon the slope. The variables required for stability analysis include the location and geometry of the failure surfaces (shear plane/backscarp), phreatic surface (water level), geotechnical properties (such as residual friction angle) and the presence of a water filled tension crack. The current understanding of the geological model suggests a potential failure surface at about 512 m elevation; the phreatic surface has started to stabilize through monitoring measurements of VW piezometers and the residual friction angle has been quantified. Reasonable estimates of these variables can be made to back analyze the slope. During the monitoring phase, this back analysis and sensitivity analysis of the variables could be considered to determine the potential effects (reduction in FS), especially from an increase in phreatic surface and a water filled tension crack.

For the next three years, monitoring the south slope with established thresholds considering reasonable risk tolerances supported by a decision tree matrix will be necessary to assess the risk to the pipelines. An iterative approach is required to: monitor and record future measurements; assess the risk to pipeline integrity through model updates and to implement mitigating design

measures as necessary. Section 8 provides details regarding the geotechnical recommendations of the proposed monitoring program.

7.0 NORTH SASKATCHEWAN RIVER - NORTH SLOPE STABILITY ASSESSMENT

The following section presents the current understanding of the geological model, mechanism and current stability of the north slope.

7.1 GEOLOGICAL MODEL

The overall north slope of the North Saskatchewan River at the pipeline crossing is at a slope inclination of about 8 degrees from about elevation 510 m to 600 m with much shallower slope inclinations of 3 to 4 degrees each occurring along the lower and upper slopes. The overall slope is approximately 132 m high over a horizontal length of about 1400 m from the river to the top of the slope. The river elevation is approximately 488 m elevation and the top of the valley side is approximately 620 m.

The topography extending over the slope comprises a very gently sloping lower slope, a gently sloping mid slope and a very gently sloping upper slope.

The near surface soils at the top of the north slope comprise thick glacial till with a glaciofluvial sand and gravel interlayer. The glaciofluvial layer may be an interglacial deposit between an older till and a younger till. The underlying bedrock surface was not delineated in the borehole drilling at the top of the slope.

The mid and lower upper slope consist of an inactive, slump-flow landslide comprising an upper depletion zone and a lower accumulation or deposition zone. Boreholes within the accumulation zone suggest that the landslide occurred in till and overlies earlier colluvial or alluvial fan deposits. Examination of the surface of the depletion zone, which contains undulating and hummocky deposits of landslide debris, also suggest that the source material is till. There is no borehole information in this area so the current model does not explain whether the rupture surface occurs in till or in the upper part of the underlying clay shales. The headscarp of the landslide is about 10 m high suggesting that the rupture surface was at least that depth below the original ground surface.

The near surface soils at the top of the north slope comprise well-drained, silty, sandy clay underlain by clay till. The near surface soils at the river comprised alluvial sand. Underlying these surficial deposits is an Upper Cretaceous aged marine clay shale belonging to the Lea Park Formation. The clay shale is high plastic, fragmented, blocky and slickensided in the upper reaches of the bedrock. Occasional slickensides were observed throughout the clay shale sequence. Discreet bentonite seams are located at two zones, about 512 m elevation as identified in NSR-BH-06 and from about 490 to 480 m elevation as identified in Boreholes NSR-BH-04, NL-BH41 and NSR-BH-06. It is understood that no pipeline integrity issues have been reported on the northern valley side over the life of the pipelines.

7.2 POTENTIAL LANDSLIDE MECHANISM

With the information available to date, the north slope landslide is classified as an inactive, rotational earth flow (slump-flow). The cross section of this site is provided in **Figure 6 in Appendix B**. No observations of open ground cracks were made along the pipeline alignment. One narrow (5 cm wide), ground crack was observed parallel to the crest of an east-facing, active landslide in a large, N-S trending gully located 100 to 300 m east of the pipeline alignment.

7.3 STABILITY OF THE NORTH SLOPE

Other than described in **Section 7.1**, the lower and upper slopes on the northern valley side show no evidence of landslide activity in the immediate vicinity of the pipelines. The landslide described in **Section 7.1** appears to have been inactive for some time. For example, there are no fresh ground cracks or scarps or other evidence of recent movement visible on the body of the landslide. There is a moderate degree of soil development (weathering and downward translocation of colloidal organics) on the landslide surface. Locally there are what appears to be shallow accumulations of silty eolian (wind-transported) materials on the surface of the landslide and in other areas partially buried, sub-angular to sub-rounded cobble and boulder sized rocks that may have been exposed by wind erosion. Near the top of the slope an active rotational landslide is failing into the gully and the retrogressing headscarp is currently within 70 m of the pipeline ROW.

8.0 GEOTECHNICAL RECOMMENDATIONS

8.1 SOUTH SLOPE MONITORING

Managing pipeline integrity risks to the NPS16 and NPS8 pipelines over the remaining three-year operational life of these pipelines requires a diligent risk management and monitoring program. The proposed landslide monitoring program aims to understand the dynamics of the slope movements to facilitate risk assessment and to assess the degree of instability through the establishment of thresholds that will enable early warning systems and mitigative measures, as necessary. Operational mitigative measures include alleviating pipe stresses through excavation or removal of backfill and/or providing a means to minimize the consequences of pipe damage through rapid shut-in of the damaged pipe section.

An allowable soil displacement of 105 mm has been determined through a pipeline stress analysis, which assumes a gradual displacement rate over the remaining three years of operational pipeline service. The soil displacements and rates observed to date in inclinometers NSR-BH-01 and Stantec 1 have shown a total of about 2 and 3 mm movement at a rate of about an annualized 35 mm/year over 26 and 36 days of monitoring, respectively.

It is understood that the pipelines will likely be replaced with a thicker walled pipe extending about 140 m upslope of the HDD overbend. In addition, a planned integrity dig site will facilitate a replacement section of pipe downslope of Borehole Stantec 2. These pipeline replacement sections will be fitted with real time pipeline strain monitoring systems. Trench improvements should also include modifying the soil loading on the pipeline such as replacing the trench backfill with granular or lightweight materials. Further details regarding pipeline monitoring protocols are provided in Stantec's stress analysis report.

The following sections presents the geotechnical recommendations related to slope monitoring and detailed assessment of the south slope.

8.1.1 In-Situ Monitoring

In-situ slope stability monitoring methods along the south slope should continue through on-going data collection at slope inclinometers and vibrating wire piezometers installed. Additional consideration should be given to installation of shallower slope inclinometers and/or survey monitoring pins at key locations along the pipeline to correlate with the pipeline strain monitoring. These methods currently require manual readings. The slope inclinometers can be retrofitted with real time monitoring ShapeAccelArrays (SAA) and data loggers connected to the vibrating wire piezometers. Further details and cost estimates for real time instrumentation will be provided in a subsequent report.

Based on the early indications of slope movement as evident in the inclinometers, it is recommended that a regular reading schedule be established to measure on-going slope movements and rates of movement. Readings in early November should be completed followed by monthly readings thereafter for the duration of the pipeline life. Reading frequency should be increased if rates of movement increase above 35 mm/year. Should any significant trench workings or excavations be undertaken in the area, Stantec should be notified and the monitoring reading frequency should be assessed.

8.1.2 Terrain Reconnaissance Monitoring

In addition to the instrument readings, a terrain reconnaissance should be completed in the fall of 2016 in conditions of no snow cover, if possible, to include a more detailed foot traverse of the south slope extending 200 m on both sides of the pipeline alignment. In particular, observations of the terrain immediately west of the corridor and south of the Husky well pad and GPS waypoint 005 as indicated on **Figure 2 in Appendix B** are necessary. The ground cracking and subsidence, as indicated by fresh scarps in this area is at a similar elevation to slightly above Borehole Stantec 2. Potential movements may also occur immediately above and/or below Borehole Stantec 2. Consideration to targeting additional instrumentation at this location is recommended. Survey monitoring points could also be considered in this area. Recommendations for additional locations of instrumentation and monitoring points will be provided under separate cover.

An annual terrain reconnaissance should be completed each spring (June) to traverse the slope and make observations of ground cracks, soil scarps and condition of the slope. In addition, a detailed foot traverse should be completed upon an increase in the rate of movement.

8.1.3 Remote Sensing Monitoring

Remote sensing landslide monitoring through satellite Interferometric Synthetic Aperture Radar (InSAR) techniques are able to measure millimetre displacement on slow-moving landslides. Historical imagery of repeat past orbits are available for the periods between 1992 and 2000, 2007 and 2011, and since 2014. This data is available at a nominal cost and can be used to interpret historical landslide displacements and vectors since the installation of the pipeline. Displacement maps created from this data will be reconciled with the terrain maps to better define the type and nature of activity experienced since the pipeline was installed and calibrate movements from forward-looking monitoring. Subsequent datasets will be processed as they are acquired from satellite data to supplement the in-situ monitoring of the borehole and pipeline instruments. Select locations for targets can be installed to supplement the dataset with fixed data points.

The monitoring is intended to facilitate determination of movement rates and vectors with respect to the pipelines and for terrain units within the landslide mass.

8.1.4 Rainfall Monitoring

Storm events can produce significant rainfall accumulations over limited (localized) areas. A significant rainfall event in the order of 95 mm occurred 9 days prior to the pipeline buckling, but was not documented by the nearest Environment Canada weather station. Given the significance of this data to the monitoring protocol and the distance that the Environment Canada weather stations are located from the North Saskatchewan River crossing, a temperature and rain gauge monitoring system, including measurements of snow depth and density (snow water equivalent) at the valve station on the south slope should be installed.

8.1.5 Model Updates

As instrumentation monitoring results and updated terrain reconnaissance are compiled, the geological model and condition of the slope will be updated to incorporate shear planes and tension scarps along the slope to be transferred to the pipeline stress model to provide the appropriate updates. The geotechnical team will continue to work with Husky and the pipeline stress engineers to develop and implement the monitoring program, decision tree protocols and mitigation solutions for the life of the 16TAN pipelines.

8.2 SURFACE DRAINAGE

Given that the south slope is functioning on residual strengths, small disturbances can initiate slope movement, such as heavy rainfall events or rapid snow melt. As such, promoting draining of surface water accumulations away from the corridor and from sag ponds and wetlands within about 100 m on both sides of the alignment is recommended.

8.3 SOUTH SLOPE EXISTING FACILITIES

8.3.1 Existing HDD Pipelines

Colluvium is present at the bottom of the slope and overlies alluvial deposits at about 486 m elevation. This provides evidence that the landslide mass has moved into the river at one or more times in the past covering alluvial deposits. The current HDD alignment may be affected by a deep seated shear surface at this elevation, which corresponds to a burial depth of about 20 m at about 0+400S on **Figure 5 in Appendix B**. Future monitoring will be important to determine magnitudes and rate of movement. In line pipeline surveys are also recommended that can measure ovality through this section of pipeline.

8.3.2 Husky Well Pad A16-18

Open ground cracks were observed at the Husky well pad A16-18, located about 100 m west of the pipeline alignment. GPS waypoint 005 on **Figure 2 in Appendix B** represents a select location of ground cracking. The cracks do not currently extend to the pipeline corridor. These cracks should be regularly monitored for propagation toward the pipeline corridor. Additionally, Husky should consider a caliper log of the surface casing at this well site to determine whether slope movements are affecting the well.

8.3.3 Water Intake Pond

Open ground cracks, initially identified by J.D. Mollard (Van Zeyl and Penner, 2016), were observed near the toe of the slope at the water intake site, located about 200 m east of the pipeline corridor. The ground cracking was observed along the northeast berm of the water pond and near the bottom of the slope on the soil stockpile. GPS waypoint 007 on **Figure 2 in Appendix B** represents a select location of ground cracking. It is recommended that instrumentation be installed at this site to monitor slope movements that may affect the water intake pond and produce potentially retrogressive slope movements within the pipeline alignment.

8.4 NORTH SLOPE MONITORING

Future monitoring of the instruments installed on the north slope should continue on the same monthly schedule as the south slope to establish potential zones of movement. Depending upon

results of monitoring, the reading schedule can be modified. Consideration to characterizing and monitoring the active landslide gully within 70 m of the right of way should be undertaken.

8.5 NPS20 NORTH SASKATCHEWAN RIVER HDD CROSSING

The geological cross sections across the south and north slopes of the North Saskatchewan River have been provided in Figures 5 and 6. The geotechnical feasibility assessment for the trenchless HDD crossing for the proposed NPS20 will be provided separately. Feasibility of the HDD pipeline crossing will consider the slope movement information received from the slope inclinometers to develop safe setbacks from shear zones. In conjunction to this assessment, an additional work scope to identify North Saskatchewan River crossing locations in more stable terrain is underway.

9.0 CLOSING

This report has been prepared for the sole use of Husky Energy and their agents, and may not be used by any third party without the expressed written consent of Stantec and Husky Energy. If there are any changes to the various assumptions outlined in this report, then a review and re-evaluation of the geotechnical recommendations as outlined in this report may be warranted.

Use of this report is subject to the Statement of General Conditions provided in **Appendix A**. It is the responsibility of Husky Energy, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

The report was prepared by a multi-discipline team with the professionals of record tacking responsibility for their respective sections as outlined in the Sign-Off sheet at the beginning of this document.

We trust the information in this report meets with your present requirements. Should you have any questions, please contact the undersigned at your convenience.

STANTEC CONSULTING LTD.

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Senior Geotechnical Engineer
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Fax: 780-917-7086
carrie.murray@stantec.com

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Appendix A
STATEMENT OF GENERAL TERMS AND CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

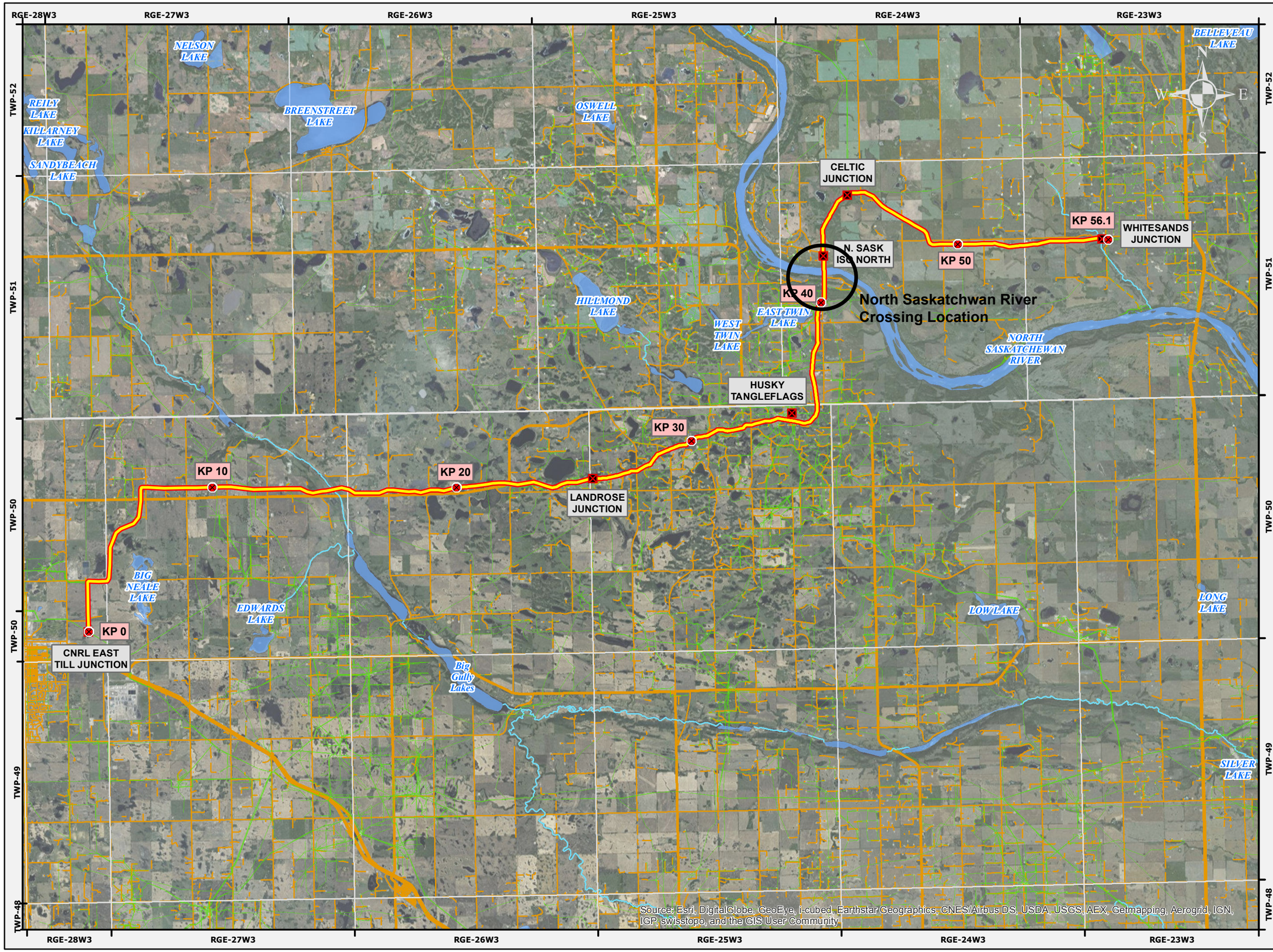
VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub- surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

Appendix B
FIGURES

HUSKY GATHERING SYSTEM

NORTH LEG Overview Map



Sources: ESRI, IHS

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

- KP Marker
- Facility
- Proposed Route RevA
- Existing Pipelines
- Primary Roads
- Secondary Roads
- Tertiary Roads
- Other Roads
- Rivers/Creeks
- Lakes

0 1 2 3 4
Kilometers

NAD 1983 UTM Zone 12N

Reference Scale: 1:140,000

BC
Project Location
AB

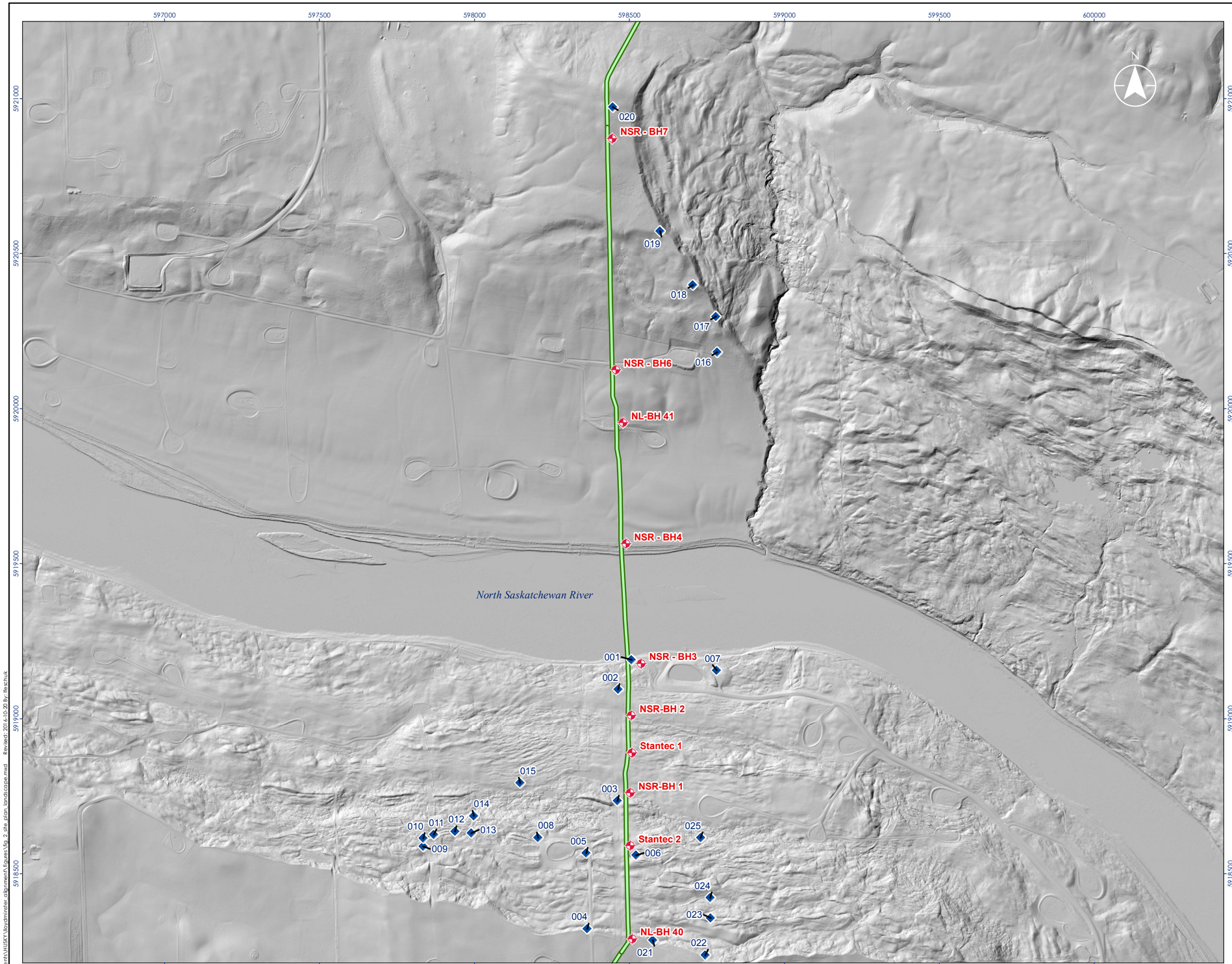
PREPARED BY Stantec

PREPARED FOR Husky Energy

FIGURE NO. Figure 1

Last Modified: 10/13/2016 By: kezhang

G:\PROJECTS\Husky\110902147\FIGURES\110902147_NL_OverviewMap_Rev1.mxd



Stantec

Husky Energy

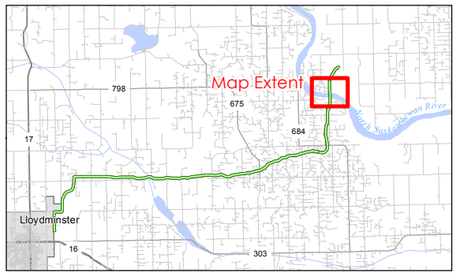
- Borehole Location
- Terrain Field Traverse Waypoint
- Alignment

0 250 500 metres

1:12,500 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Base features: Geogratis, ©Department of Natural Resources Canada, All rights reserved. GeoLOGIC Systems Ltd. 2015.
3. LiDAR from Husky.



Project Location

Lloydminster to North Saskatchewan River, Saskatchewan

110902147

Prepared by LF on 2016-10-18
Quality Review by MK on 2016-10-19
Approved by ID on 2016-10-20

Client/Project

Husky Energy Inc.
16TAN In-Service Assessment

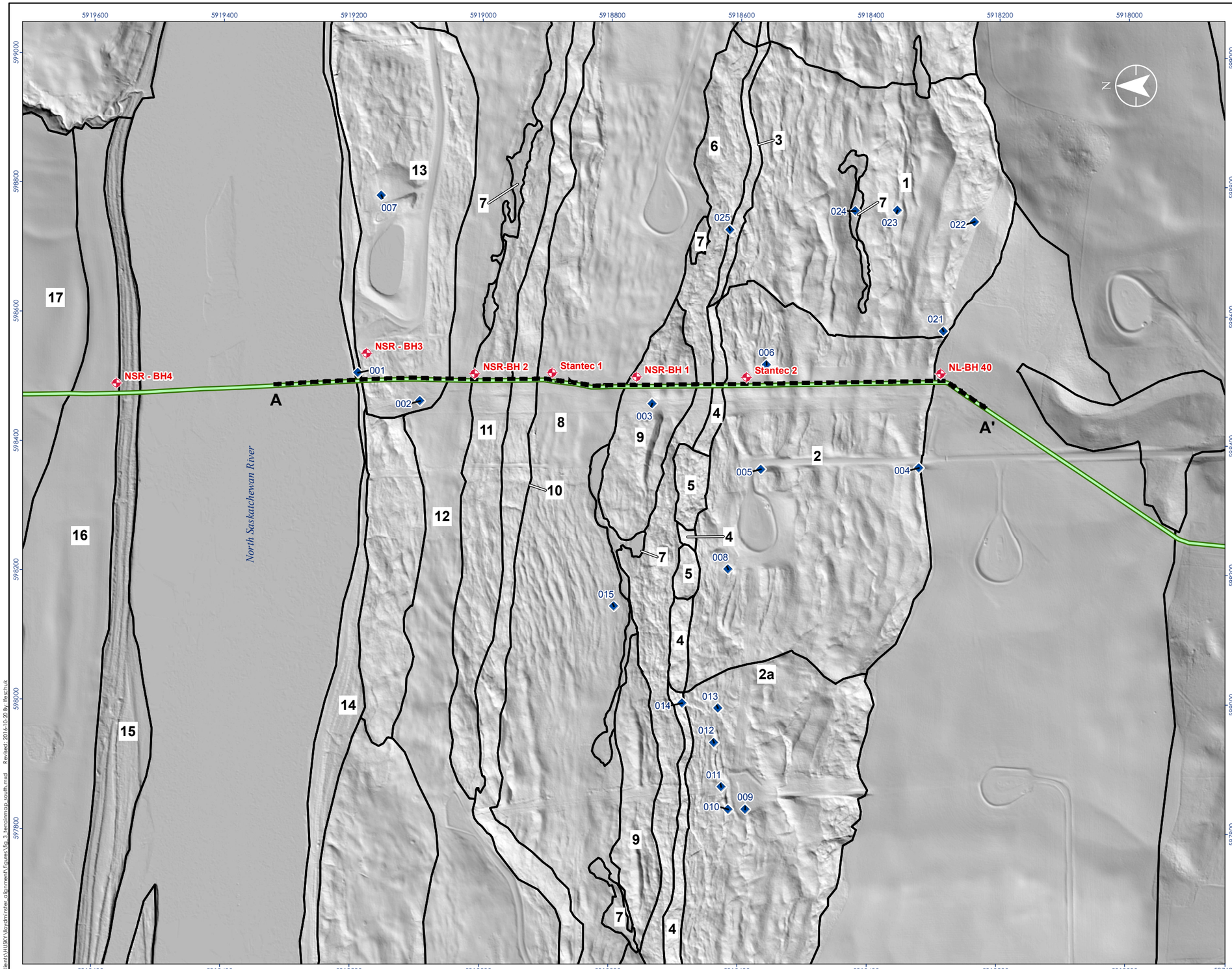
Figure No.

2

Title

Site Plan

Q:\Clients\HUSKY\Lloydminster alignment\figures\fig 2 site plan landscape.mxd Revised: 2016-10-20 By: lfleschuk



Stantec

Husky Energy

- Borehole Location
- Terrain Field Traverse Waypoint
- Alignment
- 16TAN Cross Section Profile
- 16 Terrain Map Unit*

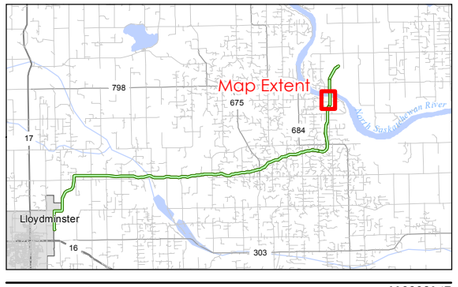
*Note: Map Unit descriptions are available in Table 3.1

0 100 200 metres

1:6,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Base features: Geogratis, ©Department of Natural Resources Canada. All rights reserved. GeoLOGIC Systems Ltd. 2015.
3. LiDAR from Husky.



Project Location

Lloydminster to North Saskatchewan River, Saskatchewan

110902147

Prepared by LF on 2016-10-18
Quality Review by MK on 2016-10-19
Approved by RG on 2016-10-20

Client/Project

Husky Energy Inc.
16TAN In-Service Assessment

Figure No.

3

Title

North Saskatchewan River Crossing South Slope - Terrain Map

G:\Clients\HUSKY\lloydminster alignment\Figures\Fig 3 terrainmap south.mxd Revised: 2016-10-20 By: lfeschuk

Stantec

Husky Energy

- Borehole Location
- Terrain Field Traverse Waypoint
- Alignment
- 16TAN Cross Section Profile
- 16 Terrain Map Unit*

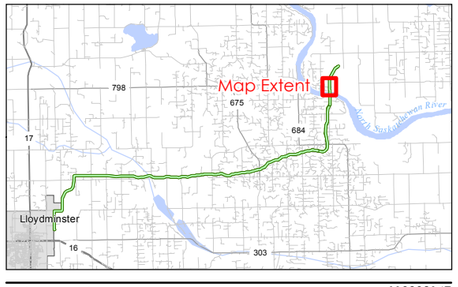
*Note: Map Unit descriptions are available in Table 3.1

0 100 200 metres

1:6,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Base features: Geogratis, ©Department of Natural Resources Canada. All rights reserved. GeoLOGIC Systems Ltd. 2015.
3. LiDAR from Husky.



Project Location

Lloydminster to North Saskatchewan River, Saskatchewan

110902147

Prepared by LF on 2016-10-18
Quality Review by MK on 2016-10-19
Approved by RG on 2016-10-20

Client/Project

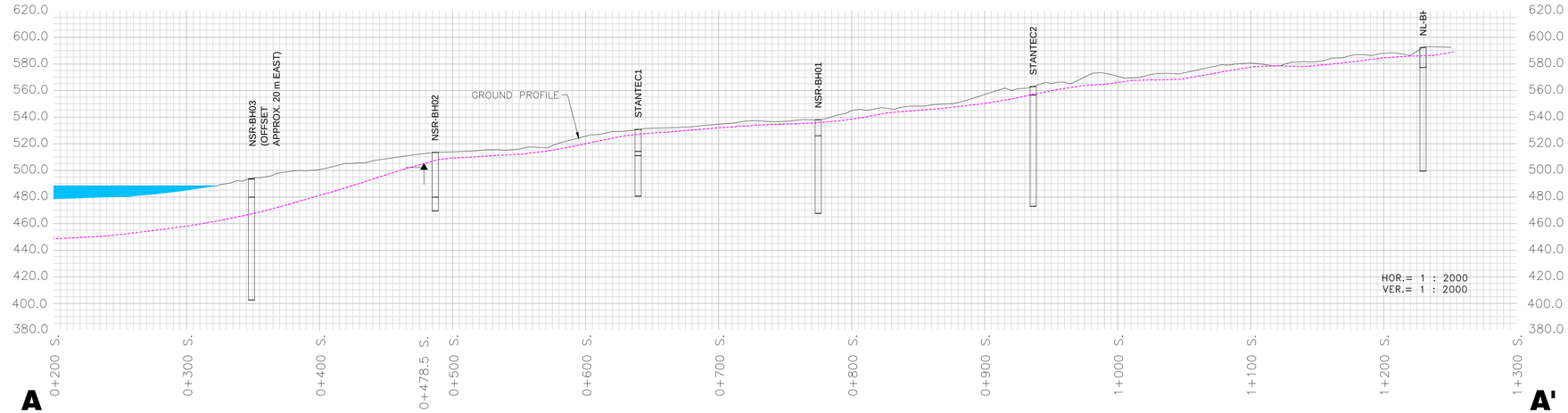
Husky Energy Inc.
16TAN In-Service Assessment

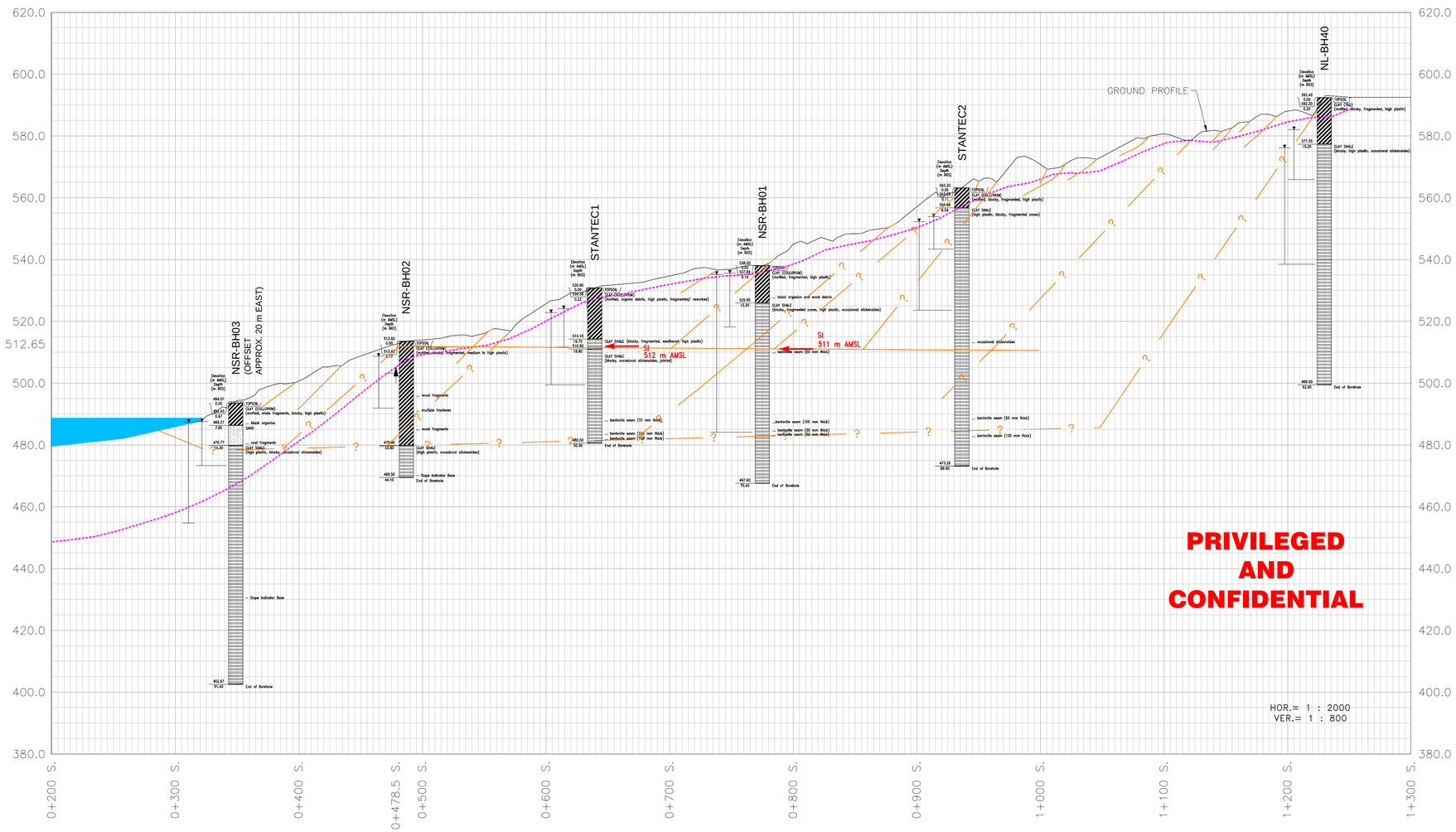
Figure No.

4

Title

North Saskatchewan River Crossing North Slope - Terrain Map





NOTES

1. UNLESS OTHERWISE INDICATED, SHOWN DIMENSIONS ARE IN METRES.
2. m BGS – METRES BELOW GROUND SURFACE
3. m AMSL – METRES ABOVE MEAN SEA LEVEL
4. BASED ON SURVEY: L12988CX1 (REV. 4)

LEGEND

- TOPSOIL
- CLAY
- SAND
- CLAY SHALE
- AFFECTED PIPELINE LOCATION
- APPROX. LOCATION OF EXISTING NPS16 AND NPS8 PIPELINES
- –?– SHEAR SURFACES AND BACKSCARPS (INTERPRETED)
- SI SLOPE INCLINOMETER DISPLACEMENT LOCATION (OCT. 12, 2016)
- VIBRATING WIRE PIEZOMETRIC ELEVATION (OCT. 12, 2016)

ENGINEERING COMPANY PERMIT STAMP

REGISTERED PROFESSIONAL ENGINEER STAMP

REF	DRAWING NUMBER	DRAWING TITLE
6		
5		
4		
3		
2		
1		

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	BY	CHK	ENG	APR
A	16–09–30	IFR (STANTEC 110902000)	MK	CM	–	–

REVISION HISTORY

Husky Midstream General Partnership

Stantec

16TAN REMEDIAL PIPELINE

TITLE –

NORTH SASKATCHEWAN RIVER CROSSING SOUTH SLOPE SITE
GEOTECHNICAL CROSS SECTION

SURFACE LOCATION 17–051–23W3

ALTERNATE DWG NUMBER

HUSKY DWG NUMBER –

VENDOR DWG NUMBER

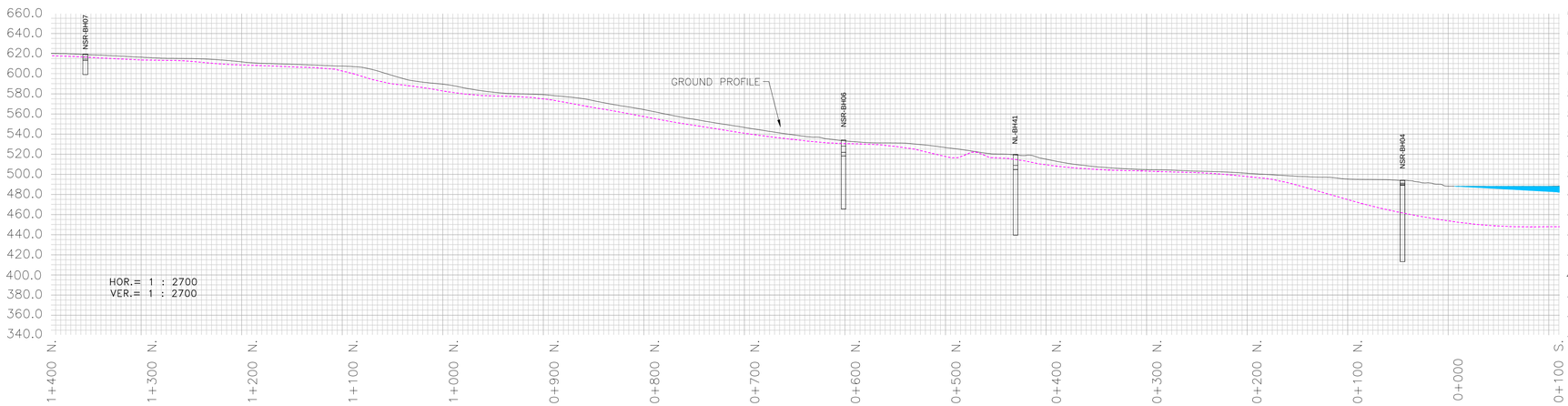
AMU/FLOC NUMBER

REV NO A

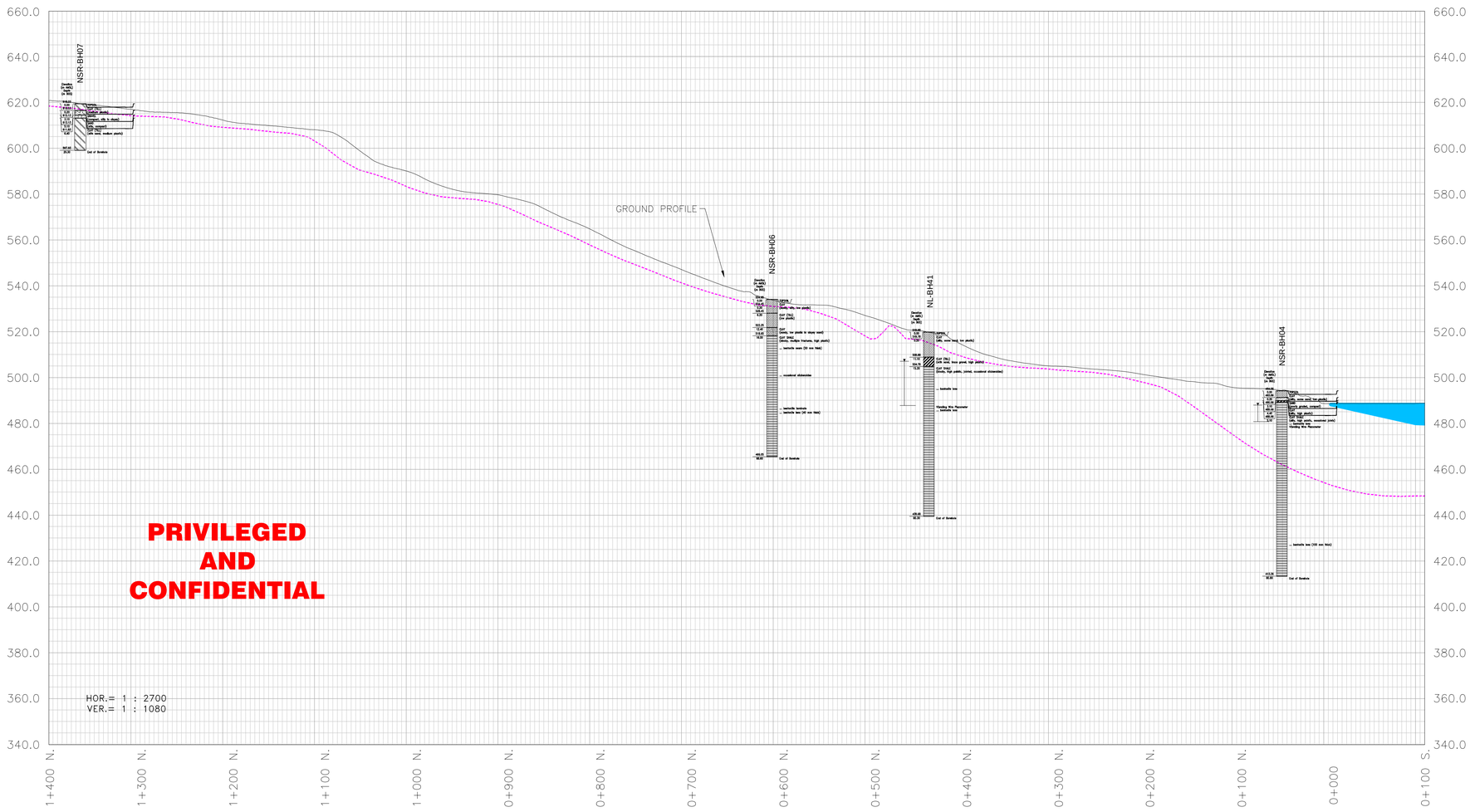
SCALE AS SHOWN

DCN NO 5

PROJECT NO 110902147



B **B'**



PRIVILEGED AND CONFIDENTIAL

NOTES

1. UNLESS OTHERWISE INDICATED, SHOWN DIMENSIONS ARE IN METRES.
2. m BGS – METRES BELOW GROUND SURFACE
3. m AMSL – METRES ABOVE MEAN SEA LEVEL
4. BASED ON SURVEY: L12988CX1 (REV. 4)
5. BOREHOLE RECORDS INCLUDED IN 16TAN GEOTECHNICAL REPORT (OCTOBER 21, 2016)

LEGEND

- TOPSOIL
- CLAY (LOW PLASTIC)
- CLAY (HIGH PLASTIC)
- CLAY SHALE
- SILT
- SILTY SAND
- SAND
- SANDY CLAY
- GRAVEL
- APPROX. LOCATION OF EXISTING NPS16 AND NPS8 PIPELINES
- VIBRATING WIRE PIEZOMETRIC ELEVATION (OCT. 12, 2016)

ENGINEERING COMPANY PERMIT STAMP

REGISTERED PROFESSIONAL ENGINEER STAMP

REF	DRAWING NUMBER	DRAWING TITLE
6		
5		
4		
3		
2		
1		

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	BY	CHK	ENG	APR
A	16–09–30	IFR (STANTEC 110902000)	MK	CM	–	–

REVISION HISTORY

Husky Midstream General Partnership

Stantec

16TAN REMEDIAL PIPELINE

TITLE –

NORTH SASKATCHEWAN RIVER CROSSING NORTH SLOPE SITE
GEOTECHNICAL CROSS SECTION

SURFACE LOCATION 17–051–23W3

ALTERNATE DWG NUMBER		REV NO
HUSKY DWG NUMBER	–	A
VENDOR DWG NUMBER		SCALE
AMU/FLOC NUMBER		AS SHOWN
DCN NO 6	PROJECT NO 110902147	

Appendix C
PHOTOS

Photo 1 **Moss covered scarp at waypoint 021, map unit 1.**

Photo 2 **Fresh ground crack and scarp at waypoint 005, map unit 2.**

Photo 3 **Fresh scarp at waypoint 008, map unit 2.**

Photo 4 **Fresh scarp at waypoint 14, map unit 2a.**

Photo 5 **Small wetland area at waypoint 024, within map unit 1**

Photo 6 **Wetland area near waypoint 015, map unit 7**

Photo 7 **Mid slope bench upslope of Stantec1 borehole, map unit 8.**

Photo 8 **Fluvial sediments near waypoint 001, map unit 14.**

Photo 9 **Foreground grass and brush occupy the lower slopes of map unit 19**

Photo 10 **North slope landslide depletion zone, map units 20 and 21.**

Appendix D
BOREHOLE RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Prairie Farm Rehabilitation Association (PFRA) Modified version of the Unified Soil Classification System (USCS) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. See page 4 for definitions and other details.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside of the PFRA Modified version of the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 – 25	2-4
Firm	0.5 - 1.0	25 – 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 – 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

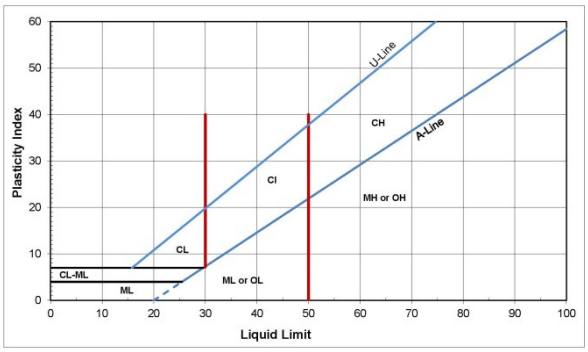
S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4;\ C_c = \frac{(D_{30})^2}{D_{10}\ x\ D_{60}} = 1\ to\ 3$	
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE OR P.I. LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE OR P.I. MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6;\ C_c = \frac{(D_{30})^2}{D_{10}\ x\ D_{60}} = 1\ to\ 3$	
			SP	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXUTRES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE OR P.I. LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE OR P.I. MORE THAN 7
FINE GRAINED SOILS	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$	CL	INORGANIC CLAYS OF LOW PLASTICITY GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30 < W_L < 50$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	Note:	
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER 'F'. E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50$	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOR, AND OFTEN FIBROUS TEXTURE	
BEDROCK			BR	SEE REPORT DESCRIPTION		

NOTE: BOUNDARY CLASSIFICATION POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.



NOTE: PLASTICITY CHART IS FOR SOILS PASSING 425 µm SIEVE

SOIL COMPENENTS BY PARTICLE SIZE DISTRIBUTION

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 – 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 - 20	____Y/EY
	MEDIUM	2	0.425		
	FINE	0.425	0.075	20 - 10	SOME
SILT (non-plastic) OR CLAY (plastic)		0.075		10 – 1	TRACE
OVERSIZE MATERIALS					
ROUNDED OR SUB-ROUNDED COBBLES 75 mm to 200 mm BOULDERS > 200 mm			ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m^3 IN VOLUME		

NOTE: ALL SIEVE SIZES ARE REFERENCED TO U.S. STANDARD ASTM E.11 - ALTERNATE EQUAVALENT METRIC SIEVE SIZES IN ACCORDANCE WITH CGSB SPEC. 8-GP-2M TO APPLY WHEN PRESCRIBED

Stantec

Borehole Coordinates
5918289 N
598509 E
Ground Elevation: 592.44

NL-BH40

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 10.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	592.19	TOPSOIL							592.44
		Stiff to very stiff brown high plastic CLAY TILL (CH) with silt, sandy, trace rootlets, damp							592
1		(LL:53, PL:21 at 0.8m)		BS	1				
		- brownish grey below 1.5m		SS	2	125	14		591
2		Very stiff mottled brown and grey with clay shale fragments, trace fine grained sand, trace gypsum, mottled with oxidation, damp, fragmented		BS	3				590
3		- oxidation seams from 2.0m to 2.8m - silty, blocky from 3.0m to 3.5m		SS	4	400	26		589
4		(LL: 58, PL: 22 at 4.2m)		BS	5				588
		- blocky, oxidized on fragment surfaces at 4.7m		SS	6	375	24		
5		- sand at 5.3m							587
6		- damp, gypsum crystals below 5.8m		BS	7				
				SS	8	450	18		586
7		- occasional sand below 7.2m		BS	9				585
		- trace gypsum at 7.6m		SS	10	450	22		
8									584
9				BS	11				
		- blocky, less oxidation at 9.3m		SS	12	450	25		583
10									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

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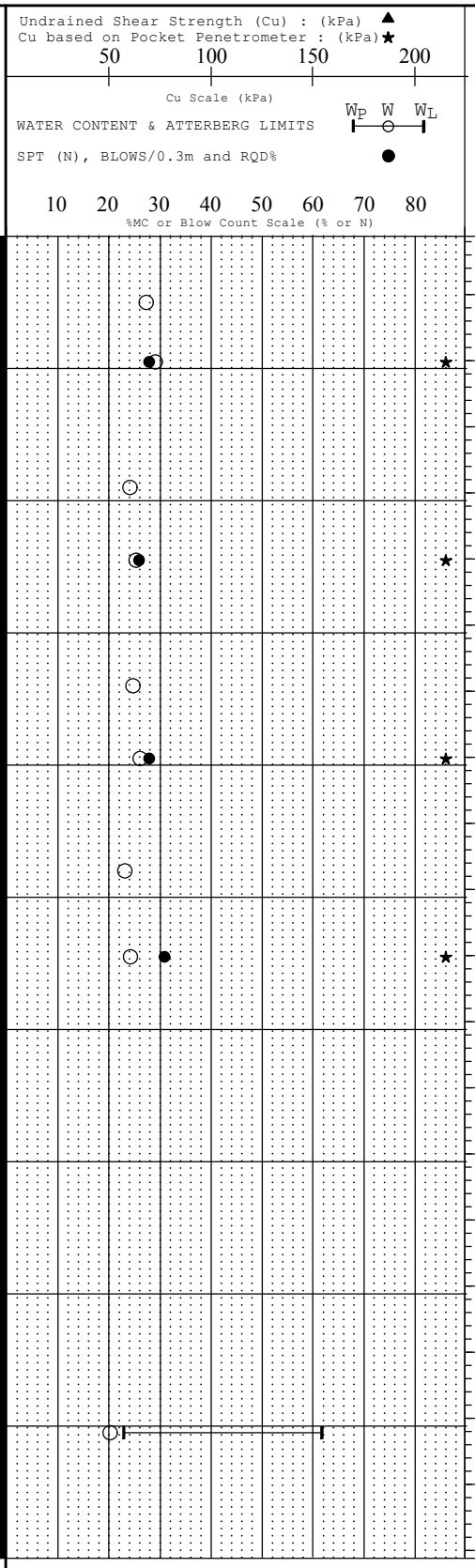
BH SIZE **150 mm/75 mm** Solid/HQ

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %
	576.24	(VW #1 water level depth at 10.3m on Oct 12, 2016)	BS	13		
		- blocky, fragmented, trace gypsum at 10.7m	SS	14	450	28
		- very stiff grey, silty, blocky, dry below 11.7m	BS	15		
			SS	16	450	26
			BS	17		
		- blocky below 13.8m	SS	18	400	28
			BS	19		
	577.24	(lost core from 15.0m to 16.0m)				
		- fragmented below 15.2m	SS	20	400	31
		(switch to rock coring at 15.2m)				
		Grey silty CLAY SHALE (CH), fragmented,				
	576.24	hard to extremely weak	RC	21	0	0
		(VW #2 water level depth at 16.2m on Oct 12, 2016)				
		- fine grained sandy, massive at 16.7m	RC	22	0	0
		(LL: 62, PL: 23 at 19.0m)	RC	23	0	0
		- silty, blocky, occasional sand pockets/partings, occasional slickensides, various angles, slightly shiny, planar, with sandy zones below 19.2m				



*Water level from water seepage observation during drilling
**Groundwater level measured on date indicated.

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PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		- excellent quality below 19.8m		RC	24	100			572
21									571
22				RC	25	98	95		570
23		- high plastic, silty, blocky, grey, occasional slickensides, various angles, planar, slightly shiny below 23.2m		RC	26	100			569
24									568
25		- sandy, with occasional fine grained sand pockets, 50mm thick at 25.0m		RC	27	100			567
26		(vibrating wire piezometer installed at 26.5m)		RC	28	93	82		566
27		(lost core from 27.4m to 28.3m)							565
28				RC	29	55	47		564
29		(lost core from 28.9m to 29.4m)							563
30		- planar joint at 29.6m - polished joint at 29.8m		RC	30	67	67		

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50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30									
		- occasional fine grained sand pockets below 30.5m							562
31				RC	31	96	83		
									561
				RC	32	100	100		
32									
				RC	33	78	73		560
33									
									559
34				RC	34	0	0		
									558
35									
				RC	35	100			557
36									
									556
37				RC	36	100			
									555
38		(LL: 67, PL: 21 at 37.9m)							
		- 20mm thick ironstone inclusion with pyrite crystals on outside diameter at 38.4m							554
39		- less sandy, silty, high plastic, blocky, occasional slickensides, occasional fine grained silty sand inclusion, light grey to light brown below 38.4m		RC	37	100	97		
		- slickensided joint at 39.3m							553
40									

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Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40				RC	38	100	98		552
41		- silty, sandy, fine grained below 40.8m (lost core from 41.1m to 41.7m)		RC	39	35	27		551
42									550
43				RC	40	68	68		549
44				RC	41	84	84		548
45				RC	42	98	92		547
46		- slickenside at 46.1m		RC	43	100	95		546
47									545
48				RC	44	100	100		544
49				RC	45	95			543
50									

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Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50									
									542
		- siltstone layer, 380mm thick, broken, medium strong, medium grey with silty, sandy clay shale interbeds at 50.7m		RC	46	88	87		
51									541
		- silty, high plastic, blocky, grey, some sand pockets, silty, fine grained, light grey-brown, no slickensides observed below 51.8m		RC	47	97	97		
52									540
53									539
54		(vibrating wire piezometer installed at 53.9m)		RC	48	98	93		
									538
55									537
				RC	49	73	73		
56		(lost core from 56.1m to 56.4m)							536
				RC	50	100	86		
57				RC	51	100	87		535
		- occasional slickenside below 57.5m planar, various angles, slightly shiny, occasional lenticular pyrite inclusion							
58									534
		(driller disturbed core below 58.6m)		RC	52	75	65		
59		(lost core from 59.2m to 59.4m)							533
60									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

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PROJECT HUE - Husky SGS Phase 4
LOCATION SGS Phase 4 & 16TAN POE
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PROJECT No. 110902147
BH SIZE 150 mm/75 mm Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60				RC	53	100			532
61				RC	54	97	95		531
62		- silty, fine grained sandy below 62.5m							530
63		(lost core from 63.8m to 64.0m)		RC	55	77	72		529
64		- thin silty fine grained sand laminations below 64.5m		RC	56	68	63		528
65		- siltstone lens, medium strong, 260mm thick, fractured, grey with calcite stringers/lamination at 65.0m		RC	57	84	84		527
66		- silty, high plastic, grey, blocky, jointed, some lenticular pyrite inclusions, occasional slickensides, planar, slightly shiny, thorough going, various angles below 65.3m		RC	58	97	75		526
67				RC	59	83	73		525
68		(lost core from 68.3m to 68.6m) - siltier from 68.6m to 69.7m							524
69		(driller disturbed core from 69.7m to 70.1m)		RC	60	93	83		523
70									

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CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 10.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70									
				RC	61	100	90		522
71									521
72		(driller disturbed core from 72.3m to 73.1m)		RC	62	93	55		520
73									519
74				RC	63	90	78		518
75				RC	64	100	72		517
76		- fine grained sandy from 76.2m to 77.5m							516
77				RC	65	100	98		515
78		- silty, blocky, occasional slickensides below 77.5m (lost core from 78.5m to 79.2m)		RC	66	45	32		514
79				RC	67	72	81		513
80									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918289 N
598509 E
Ground Elevation: 592.44

NL-BH40

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 10.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
80				RC	68	100	83		512
81		- very stiff to hard from 81.5 to 81.7m		RC	69	100	92		511
82		- slickensides, various angles, intersecting, planar, smooth at 82.0m							510
83		- occasional slickensides, planar, polished joints below 82.9m		RC	70	97	80		509
84				RC	71	95	78		508
85									507
86				RC	72	62	75		506
87		(driller disturbed core from 87.6m to 88.4m)		RC	73	0	0		505
88									504
89		(driller disturbed core below 89.3m)		RC	74	60	60		503
90									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918289 N
598509 E
Ground Elevation: 592.44

NL-BH40

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

LOCATION **SGS Phase 4 & 16TAN POE**

DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 10.3mBGS**

PROJECT No. **110902147**

BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
90				RC	75	0	0		502
91									501
92				RC	76	38	38		500
	499.54								
93		END OF BOREHOLE at 92.9m - borehole grouted with cement bentonite mix from ground level down to 92.9m - Slope Inclinometers casing installed at 89.9m - Stick up casing 1.0m above ground surface - Vibrating Wire Piezometer 1 installed 26.5m S/N: 1601349 - Vibrating Wire Piezometer 2 installed at at 53.9m S/N: 1600202							499
94									498
95									497
96									496
97									495
98									494
99									493
100									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	537.84	TOPSOIL							537.99
		Colluvium stiff brown CLAY (CH), silty, trace black organics to 1.6m, moist, trace gypsum		BS	1				
1				SS	2	100	10		537
2									536
	535.19	(VW #1 water level depth at 2.4m on Oct 12, 2016)		BS	3				
	535.19	(LL: 66, PL: 28 at 2.4m)							
3		(VW #2 water level depth at 2.8m on Oct 12, 2016)							535
		- mottled brown and grey, fragmented/reworked, some white mineral deposits below 3.1m		SS	4	400	12		
		(LL: 61, PL: 23 at 3.8m)		BS	5				
4									534
		- white mineral mottling from 4.6m to 7.0m		SS	6	450	14		
5				BS	7				533
6		- very stiff, fragmented, greyish brown, clay shale fragments, trace oxidation at 6.1m		SS	8	450	15		532
7				BS	9				531
		- grey, silty, trace sand, fragmented/reworked trace gypsum below 7.6m		SS	10	450	14		
8				BS	11				530
9		- stiff grey, silty, moist		SS	12	400	12		529
		- occasional black organics and wood debris, occasional wood chips, moist from 9.5m to 10.3m							
10									528

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10				BS	13				
		- very stiff below 10.6m		SS	14	450	20		527
11		- blackish grey, occasional organics and wood debris, occasional wood chips, moist from 11.2m to 11.4m		BS	15				
12	525.79								526
		Grey, silty CLAY SHALE (CH), blocky, extremely weak, occasional sand partings		SS	16	450	21		
13		- damp below 13.0m		BS	17				525
		- blocky below 13.7m		SS	18	450	43		
14				BS	19				524
15		(switched to rock coring at 15.2m)		SS	20	450	59		523
		- disturbed, fragmented, moderately jointed, nearly horizontal fractures with no fillings		RC	21	100	100		357.6
16									522
17				RC	22	97	97		521
18									520
19		- slickenside, slightly polished, high angle, through going from 18.8m to 19.7m		RC	23	100	100		519
20		(vibrating wire piezometer installed at 19.8m)							518

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20									
				RC	24	100	100		
21									517
		- occasional joints/fractures below 21.7m							
22				RC	25	100	100		516
23									515
				RC	26	100	100		
24		- hard, silty, some fragmented zones, occasional slickensides, planar, slightly shiny, various angles, through going from 24.1m to 25.1m							514
25				RC	27	98	98		513
26									512
		- highly fragmented from 26.8m to 27.2m		RC	28	90	85		
27		(LL: 81, PL: 25 at 27.1m) (LL: 151, PL: 48 at 27.2m)							511
		- bentonite seam, 50mm thick, light brown grey, slickenside on upper and lower contacts, with clay shale, slickenside, shiny at mid point of seam, undulating and through going at 27.2m							
28				RC	29	85	92		510
		- grey SILTSTONE 300mm thick weak to medium strong, fresh, dry, 45 degree fracture at 28.0m							
29									509
		- silty CLAY SHALE (CH), massive, blocky, occasional slickensides, various angles, planar, shiny, occasional small lenticular pyrite inclusions below 28.3m		RC	30	92	92		
30									508

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30									
31				RC	31	100	100		507
32									506
33				RC	32	100	92		505
34				RC	33	75	68		504
35		(lost core from 35.4m to 36.9m)							503
36				RC	34	0	0		502
37		- high plastic, occasional slickenside, high to low angle, planar, slightly shiny below 36.9m		RC	35	100	100		501
38									500
39				RC	36	100	100		499
40									498

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40				RC	37	100	93		
41									497
		- some thin silty fine grain sand partings, light brown below 41.5m							
42		- occasional slickenside below 42.1m		RC	38	100	100		496
43				RC	39	100	100		495
44									494
45				RC	40	100	95		493
46									492
		- less silty, high plastic, blocky, jointed and high angle slickensides, medium grey, some lenticular pyrite inclusions below 46.6m		RC	41	100	100		
47		- ironstone inclusion, 30mm thick, light brown, weak to medium strong at 47.2m							491
48				RC	42	100	97		490
49									489
		(LL: 109, PL: 28 at 49.4m)							
		(LL: 136, PL: 49 at 49.7m)		RC	43	100	100		
50									488

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
50		- bentonitic seam mottled, clay shale fragments, light brown to grey, no slickensides within or at contacts from 49.8m to 49.9m - high angle slickenside, near vertical, slightly horizontal, planar at 50.0m					
51			RC	44	100	100	487
52							486
53		- bentonite seam at 52.5m, 30mm thick, mottled with grey clay shale fragments, light brown, slickenside on upper surface, polished, striated, 15 degree angle on upper contact	RC	45	100	100	485
54		- bentonite seam at 53.6m, 80mm thick, mottled with grey clay shale fragments, light brown (vibrating wire piezometer installed at 53.9m)	RC	46	100	100	484
55							483
56			RC	47	100	100	482
57			RC	48	100	100	481
58		- occasional silty to fine grained sand inclusions, very few slickensides below 58.2m					480
59			RC	49	100	100	479
60							478

*Water level from water seepage observation during drilling
**Groundwater level measured on date indicated.

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60				RC	50	100	100		
61				RC	51	100	100		477
62				RC	52	100	100		476
63		- light grey SILTSTONE lens at 62.9m, 40mm thick, medium strong, fresh, light grey		RC	53	100	100		475
64				RC	54	100	100		474
65				RC	55	100	100		473
66				RC	56	100	100		472
67									471
68									470
69									469
70									468

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918759 N
598502 E
Ground Elevation: 537.99

NSR-BH01

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/28/2016** WATER LEVEL **VW1 on 10/12/2016: 2.4mBGS**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm or CORE %	SAMPLES N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70	467.59								
		END OF BOREHOLE at 70.4m - borehole routed with cement bentonite mix from ground level down to 70.4m - Slope Inclinometer casing installed at 70.1m - Vibrating Wire Piezometer 1 installed at 19.8m S/N: 1601352 - Vibrating Wire Piezometer 2 installed at 53.9m S/N: 1600204 - Stick up casing 1.0m above ground surface							
71									467
72									466
73									465
74									464
75									463
76									462
77									461
78									460
79									459
80									458

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919009 N
598505 E
Ground Elevation: 513.58

NSR-BH02

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/12/2016** WATER LEVEL **VW on 10/12/2016: 4.8mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	513.43	TOPSOIL							513.58
		Colluvium stiff brown CLAY (CI-CH) with sand, mottled with grey, with sand seams, traces of oxidation and rootlets, damp							513
1		(LL: 57, PL:23 at 1.1m)		BS	1				
		(LL: 44, PL:19 at 1.5m)		SS	2	406	10		512
2		- sandy from 2.4m to 5.9m		BS	3				511
3				SS	4	406	15		510
4		- inferred gravel/cobbles at 3.8m		BS	5				
		- seepage inferred at 4.6m							509
5		(Dry Density at 4.6m: 1403kg/m3) (LL:50, PL:20 at 4.6m)		ST	6	559			
		(VW water level depth at 4.8m on Oct 12, 2016)		SS	7	330	14		
		- silty from 5.1m to 6.5m		BS	8				508
6		- greyish brown CLAY (CH), light brown silty sand pockets, some oxidized striations, blocky, shale like, grey, occasional gypsum below 6.1m		SS	9	457	13		507
7				BS	10				
		- very stiff at 7.6m		SS	11	381	22		506
8									505
9				BS	12				
				SS	13	356	12		504
10									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919009 N
598505 E
Ground Elevation: 513.58

NSR-BH02

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/12/2016** WATER LEVEL **VW on 10/12/2016: 4.8mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10									
		- grey, fragmented/reworked/blocky below 10.3m		BS	14				503
11				SS	15	356	13		
									502
				BS	16				
12		- very stiff, dry at 12.2m		SS	17	457	28		501
13				BS	18				500
		- hard below 13.7m		SS	19	457	34		
14									499
				BS	20				
15				SS	21	432	35		498
16									
				BS	22				497
		(rock coring start at 16.6m)							
17		- wood fragment at 16.8m		RC	24	100			
		- brownish grey, silty, trace sand, fragmented clay shale and till, disturbed, highly weathered, extremely weak		SS	23	457	40		496
18									495
19				RC	25	95			
		(LL: 80, PL:23 at 19.3m)							494
20									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919009 N
598505 E
Ground Elevation: 513.58

NSR-BH02

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/12/2016** WATER LEVEL **VW on 10/12/2016: 4.8mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20				RC	26	100			493
21									492
		- multiple fractures at 21.6m (vibrating wire piezometer installed at 21.6m)		RC	27	100			
22		(LL: 85, PL:23 at 22.4m)							491
23				RC	28	87			490
24		(lost core at 23.7m to 23.9m) (LL: 89, PL:22 at 24.4m)							489
25				RC	29	100			488
26		(LL: 92, PL:26 at 26.4m)		RC	30	100			487
27		- sand pockets at 27.4m - trace of gravel from 27.4m to 27.7m - wood seam at 27.7m							486
28		- occasional brown stains at 28.3m		RC	31	100			485
29		(lost core from 28.8m to 30.3m)		RC	32	0			484
30									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919009 N
598505 E
Ground Elevation: 513.58

NSR-BH02

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/12/2016** WATER LEVEL **VW on 10/12/2016: 4.8mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30									
		- sandy from 30.4m to 31m							483
31		- inferred gravel/cobble at 31.0m - traces of sand from 31.0m to 32.0m (LL: 75, PL:21 at 30.5m)		RC	33	98			482
32				RC	34	100			481
33									480
	479.78								
34		Silty grey CLAY SHALE (CH) moist, occasional slickensides, various angles, through going, slightly shiny - trace pyrite at 34.2m		RC	35	100			479
35		- trace sand from 35.0m to 36.5m		RC	36	100			478
36		(LL: 83, PL:20 at 36.4m) - sand pockets/partings at 36.7m							477
37				RC	37	100			476
38				RC	38	100			475
39		(LL: 92, PL:22 at 39.3m) - slickensides below 39.3m, various angle, through going, slightly shiny,							474
40									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919009 N
598505 E
Ground Elevation: 513.58

NSR-BH02

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/12/2016** WATER LEVEL **VW on 10/12/2016: 4.8mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40		(LL: 88, PL:25 at 39.9m)		RC	39	100			473
41				RC	40	100			472
42									471
43				RC	41	100			470
44	469.48								
		END OF BOREHOLE at 44.1m Upon completion: - borehole backfilled with cement-bentonite mix from ground level down to 44.1m - Slope Indicator casing installed at 42.7m - Vibrating Wire Piezometer installed at 21.6m S/N: 1601350 - 1m stickup above ground surface - Bentonite Mix: 6 bags cement, 2 bags bentonite, and 60 gal water							469
45									468
46									467
47									466
48									465
49									464
50									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0		TOPSOIL							494.07
	493.37								
		Colluvium stiff brown CLAY (CI-CH)		BS	1				
1		trace sand, damp to moist, occasional oxidation, trace grey mottling, shale fragments, trace gypsum, small white inclusion							494
				SS	2	350	9		493
2				BS	3				492
3		- greyish brown, reworked/fragmented below 3.1m		SS	4	450	14		491
4		- blocky/fragmented with occasional grey silt partings some gypsum, trace fine grained sand from 3.9m to 4.8m		BS	5				490
				SS	6	400	18		
5				BS	7				489
6		- blocky clay shale fragments, trace silt partings at 6.1m		SS	8	400	18		488
	487.37								
	487.37	(VW #1 water level depth at 6.5m on Oct 12, 2016) (VW #2 water level depth at 6.7m on Oct 12, 2016)							
7				BS	9				487
	486.27	- trace black organics at 7.6m		SS	10	300	16		
8		Compact brown poorly graded SAND (SP), silty, saturated/wet, fine grained sand - seepage inferred at 8.1m		BS	11				486
9		(sloughing to 8.7m during drilling)		SS	12	450	20		485
10									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10				BS	13				484
		(sloughing to 9.2m during drilling)		SS	14	450	14		
11									483
				BS	15				
12		(sloughing to 10.1m during drilling)		SS	16	450	14		482
		- occasional coal fragments, black, 100mm thick from 12.6m to 13.6m							
13				BS	17				481
				SS	18				
14	479.77								480
		Extremely weak grey CLAY SHALE (CH), completely to highly weathered, moist, extremely weak, occasional slickensides		BS	19				
15									479
		(slough to 10.5m, no sample collected)							
16									478
		(slough to 13.6m, no sample collected)							
17									477
				BS	23				
18		(augered to 18.3m to confirm bedrock stratigraphy)							476
		(switched to rock coring at 18.3m)		SS	24		50		
19		- silty grey CLAY SHALE (CH), very weak to weak, occasional nearly horizontal joints, occasional elongated silt inclusion, occasional elongated pyrite inclusion below 19.5m		RC	25	93	93		475
		- horizontal joint at19.7m							
20									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		- greenish grey from 19.8m to 25.3m		RC	26	100	100		474
		(vibrating wire piezometer installed at 20.7m)							
21									473
22		- occasional slickensides, slightly polished, high angle, thorough going from 21.9m to 23.2m		RC	27	100	100		472
23				RC	28	100	100		471
24		- occasional shell fragments below 24.4m							470
25				RC	29	100	100		469
26				RC	30	100	100		468
27									467
28				RC	31	100	100		466
29									465
				RC	32	100	100		
30									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
30							464
31			RC	33	100	100	463
32			RC	34	100	100	462
33							461
34			RC	35	100	100	460
35							459
36		(samples disturbed by driller from 35.5m to 36.6m)	RC	36	100		458
37		- slickensides, polished, vertical angle, through going from 36.6m to 37.6m	RC	37	97	90	457
38							456
39		(vibrating wire piezometer installed at 39.3m)	RC	38	100	100	455
40							

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40		- occasional pyrite/shell inclusions below 40.4m - no slickensides observed below 40.0m		RC	39	100	100		454
41									453
42				RC	40	100	100		452
43				RC	41	100	100		451
44									450
45				RC	42	100	97		449
		- occasional trace of pyrite from 45.5m to 50.0m							
46				RC	43	100	100		448
47									447
48				RC	44	100	100		446
49									445
50				RC	45	100	98		

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50									444
51				RC	46	100	100		443
52				RC	47	100	100		442
53									441
54				RC	48	100	100		440
		- shell fragments at 54.7m							
55				RC	49	100	100		439
56									438
57				RC	50	100	100		437
58				RC	51	100	100		436
59									435
60									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60				RC	52	100	100		434
61		- multiple horizontal fractures from 61.0m to 65.5m		RC	53	100	100		433
62									432
63				RC	54	100	100		431
64				RC	55	100	100		430
65									429
66				RC	56	100	100		428
67		- thin bentonite layer, 5mm thick at 66.7m - thin bentonite layer, 5mm thick at 67.3m							427
68		- thin bentonite layer, 5mm thick at 67.7m		RC	57	100	100		426
69		- bentonite layer, 25mm thick, preserved wood chips at 68.8m		RC	58	100	100		425
70		- thin bentonite layer, 10mm thick at 69.7m							

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70									424
71				RC	59	100	100		423
		- laminated, fissile below 71.6m							
72				RC	60	100	100		422
		- siltstone layer, 40mm thick at 72.4m							
73									421
74		- bentonite seam, 50mm thick, light grey, with clay shale fragments, very hard, waxy, no slickensides obeserved at 73.8m		RC	61	100	100		420
75				RC	62	100	100		419
76									418
77				RC	63	100	100		417
78				RC	64	100	100		416
79									415
80									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
80		- occasional pyrite inclusion below 80.3m - siltstone layer, light grey, 40mm thick, at 80.4m		RC	65	100	100		414
81				RC	66	100	100		413
82		- siltstone layer, 40mm thick, light grey, at 82.2m							412
83				RC	67	100	100		411
84				RC	68	100	100		410
85									409
86		(driller disturbed samples from 86.1m to 86.3m)		RC	69	100	100		408
87				RC	70	100	100		407
88									406
89				RC	71	100	100		405
90									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919177 N
598538 E
Ground Elevation: 494.07

NSR-BH03

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/31/2016** WATER LEVEL **VW1 on 10/12/2016: 6.5mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
90				RC	72	82	82		404
91	402.67	(lost core from 91.0m to 91.4m)							403
92		END OF BOREHOLE at 91.4m - borehole grouted in stages with cement bentonite mix from 91.4m to 61.0m on September 3, 2016 - Slope inclinometer casing installed at 62.7m on September 4, 2016 - Vibrating wire piezometer 1 installed at 20.7m S/N: 1601877 - Vibrating wire piezometer 2 installed at 39.3m S/N: 1600201 - Stick up casing 1.0m above ground surface - borehole grouted with cement bentonite mix from ground level down to 62.7m on September 4, 2016							402
93									401
94									400
95									399
96									398
97									397
98									396
99									395
100									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	530.58	TOPSOIL							530.78
		Colluvium stiff brown CLAY (CH) with sand, mottled with grey, trace of oxidation damp, trace of organics / rootlets, gympsum crystals and small white pockets to 1.8m (LL: 53, PL:19 at 0.8m)		BS	1				530
1				SS	2	320	10		529
2		(LL: 49, PL:25 at 2.4m)		BS	3				528
		- moist below 2.8m							
3		- trace black organics at 3.2m		SS	4	450	10		527
		- brownish black, ocassional debris at 3.6m							
4		- occasional to frequent organics below 3.6m		BS	5				526
		- grey below 4.6m		SS	6	450	11		
5				BS	7				525
		- black organics and wood fragments below 5.5m							
6		- very stiff, trace black organics below 6.1m		SS	8	450	17		
	522.88	(VW #1 water level depth at 6.7m on Oct 12, 2016)		BS	9				524
7									
	522.88	- mottled brown and grey, fragmented/reworked, trace to some oxidation below 7.6m (VW #2 water level depth at 7.9m on Oct 12, 2016)		SS	10	450	19		523
8		- silty below 8.4m		BS	11				522
9		- grey, reworked, trace wood fractures and organics, trace oxidation, moist, trace sand below 9.0m		SS	12	450	18		521
10									

*Water level from water seepage observation during drilling
**Groundwater level measured on date indicated.

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10				BS	13				
		- trace organics and wood fibres from 10.7m to 11.0m		SS	14	450	21		520
11				BS	15				519
12		- mottled grey and brown, with oxidized striations, fragmented, reworked, trace gypsum below 12.2m		SS	16	450	21		518
13				BS	17				
14				SS	18	450	28		517
				BS	19				516
15		- mottled brown and grey below 15.2m		SS	20	450	26		515
16		- reworked, mottled grey and brown at 16.0m		BS	21				
	514.08								514
17		Grey CLAY SHALE (CH), blocky/fragmented, some oxidation, some gypsum, weathered, high plastic		SS	22	450	21		
				BS	23				513
18		- completely weathered, damp, some gypsum below 18.3m		SS	24	450	21		512
19		(vibrating wire piezometer installed at 19.0m)		BS	25				
		- silty below 19.8m (auger refusal at 19.8m)		SS	26	100	50		511
20									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		(switched to rock coring at 19.9m) Grey CLAY SHALE (CH), fresh, damp, silty, massive, occasional joints, few slickensides, horizontal, smooth, planar, extremely weak, high plastic (LL: 93, PL:23 at 21.0m)		RC	28	89	89		510
21		(LL: 98, PL:25 at 21.5m)		RC	29	100	100		509
22									508
23				RC	30	100	100		507
24									506
25				RC	31	100	100		505
26				RC	32	100	100		504
27		(LL: 96, PL:25 at 27.0m)							503
28		- blocky, jointed below 28.5m		RC	33	100	93		502
29		(LL: 100, PL:26 at 29.1m)		RC	34	100	100		501
30									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30		- joint at 30.4m: planar						500
31		(vibrating wire piezometer installed at 31.3m) (LL: 98, PL:24 at 31.6m) - SILTSTONE slightly weathered, medium strong, indurated medium grey, intersecting calcite lenses, vertical joint, 500mm thick	RC	35	71	71		499
32			RC	36	84	84		498
33		- jointed with occasional slickensides below 33.5m: horizontal to high angle, smooth, planar joint - occasional silt inclusions, light greyish brown - occasional lenticular pyrite inclusions; up to 5mm (LL: 103, PL:25 at 34.2m)						497
34			RC	37	92	92		496
35		- silty below 35.7m - joint at 35.7m: rough, planar	RC	38	100	100		495
36								494
37		(LL: 92, PL:25 at 37.2m)	RC	39	92	92		493
38								492
39		(LL: 113, PL:27 at 39.2m) - with silt laminations 75mm thick at 39.4m	RC	40	100	100		491
40								

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40				RC	41				490
41									489
42		- bentonite seam, 70mm thick, light brown mottled with grey clay shale fragments at 42.1m (LL: 113, PL:26 at 42.4m)		RC	42	90	84		488
43				RC	43	100	100		487
44									486
45				RC	44	100	100		485
46		(LL: 96, PL:24 at 45.8m) - bentonite seam, 150mm thick, mottled light brown to medium grey clay shale fragments, waxy, slickensided, vertical fracture, hard at 46.4m		RC	45	100	100		484
47									483
48		(LL: 96, PL:22 at 47.9m) - bentonite seam, 100mm thick, mottled light brown to medium grey clay shale fragments, waxy, hard at 48.0m		RC	46	97	97		482
49				RC	47	100	100		481
50									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918890 N
598508 E
Ground Elevation: 530.78

STANTEC1

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/27/2016** WATER LEVEL **VW1 on 10/12/2016: 6.7mBGS**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm or CORE %	SAMPLES N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50	480.48	(LL: 98, PL:29 at 49.9m) slickenside, shiny, high angle, planar at 50.2m							
		END OF BOREHOLE at 50.3m - borehole grouted with cement bentonite mix from ground level down to 50.3m - Slope Indicator casing installed at 50.3m - Vibrating Wire Piezometer 1 installed at 19.0m S/N: 1601876 - Vibrating Wire Piezometer 2 installed at 31.3m S/N: 1600203 - stick up 1.0m above ground surface							

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

ELEVATION(m): 480, 479, 478, 477, 476, 475, 474, 473, 472, 471

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

STANTEC GEO 2016 110902147_BHLOGS_SOUTHSLOPE.GPJ MASTER1.GDT 10/20/16

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	563.14	TOPSOIL							563.24
		Colluvium stiff mottled brown and grey CLAY (CH) trace sand, trace oxidation, dry to damp, trace rootlets to 1.5m							
1		(LL: 70, PL:32 at 0.8m)		BS	1				563
		- blocky fragmented clay and clayshale, some oxidation, silty, trace sand, occasional gypsum below 1.5m		SS	2	350	7		562
2		(LL: 74, PL:30 at 2.6m)		BS	3				561
3				SS	4	375	10		560
4		- grey below 3.9m		BS	5				559
		- trace sand, extremely weak, dry, completely weathered at 4.6m		SS	6	300	12		
5									558
6		- very stiff, blocky, reworked, some sand, trace oxidation, trace gypsum below 5.7m (rock coring start at 6.0m)		BS	7				
	556.74			SS	8	400	16		557
7		Brownish grey CLAY SHALE (CH), silty, blocky, trace sand, extremely weak, dry completely weathered, high plastic (LL: 54, PL:19 at 7.1m)		RC	9	58	53		556
8		- siltstone lens, 200mm thick, medium strong, grey at 7.6m - laminated below 7.6m - very silty below 8.3m		RC	10	73			555
9	552.34	(VW #1 water level depth at 9.3m on Oct 12, 2016)							554
10				RC	11	100	90		

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
10							553
	552.34	- silty below 10.6m (VW #2 water level depth at 10.9m on Oct 12, 2016)					
11			RC	12	93	88	552
12		- blocky, silty, occasional silt pockets, light grey below 12.0m					551
			RC	13	100	100	
13							550
14			RC	14	92	72	549
15		- sandy, fine grained, grey below 15.1m (lost core from 15.2m to 15.4m) (LL: 74, PL:22 at 15.4m)					548
16			RC	15	77	77	547
17			RC	16	98	90	546
18							545
19			RC	17	77	72	544
20		- SILTSTONE, broken, light grey, 300mm thick,					

MONITOR WELL/ PIEZOMETER

119.1

*Water level from water seepage observation during drilling
**Groundwater level measured on date indicated.

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		medium strong at 19.8m (vibrating wire piezometer installed at 19.8m) (LL: 67, PL:20 at 20.3m)		RC	18	53	53		543
21									542
22				RC	19	78	72		541
23		- SILTSTONE, medium grey, medium strong, broken, 125mm thick at 22.6m - silty, trace to some fine grained sand below 22.7m		RC	20	90	90		540
24									539
25				RC	21	97	97		538
26				RC	22	85	58		537
27		(lost core from 26.9m to 27.4m)		RC	23	100	100		536
28		- some buff to light brown, silty, very fine grained sand laminations, blocky/jointed below 27.4m (LL: 80, PL:24 at 27.8m)		RC	24	100	85		535
29									534
30				RC	25	100	100		

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30									533
31				RC	26	100	100		532
32				RC	27	47	42		531
33									530
34				RC	28	100	100		529
35		(lost core from 35.0m to 35.6m)							528
36		(LL: 95, PL:26 at 36.1m) - blocky, fragmented, very stiff silty clay shale, some fine grained sand from 36.1m to 36.5m		RC	29	47	40		527
37				RC	30	98	98		526
38		- soft zone 75mm thick, fragmented, silty at 37.8m							525
39				RC	31	98	93		524
40		(lost core from 39.6m to 41.9m) (vibrating wire piezometer installed at 39.6m)							

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40				RC	32				523
41		(lost core from 41.1m to 42.0m)		RC	33	18	18		522
42		- grey silty with fine grained sand partings/striations, blocky below 42.6m		RC	34	100	100		521
43				RC	35	83	58		520
44		(poor recovery, softened by driller from 44.9m to 45.7m)		RC	36	100	95		519
45		- high angle fractures below 46.7m		RC	37	100	92		518
46		- high angle fracture, slightly polished at 48.0m		RC	38	58	50		517
47		- hard, grey, silty CLAY SHALE (CH), less sandy, laminar silt/pyrite inclusions below 48.8m - occasional slickensides, polished, slightly rough to smooth, planar, various angles (spacing 10-30cm) below 48.8m							516
48									515
49									514
50									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50									513
				RC	39	45			
51									512
		- SILTSTONE, medium strong from 51.5m to 51.8m		RC	40	75	65		
52									511
		- high angle fractures, polished below 52.6m		RC	41	95	95		
53									510
54		(LL: 98, PL:27 at 53.8m)		RC	42	90	73		509
55									508
				RC	43	98	88		
56									507
57		(LL: 100, PL:26 at 56.9m)		RC	44	92	82		506
58									505
				RC	45	97	93		
59									504
60									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60				RC	46	93	78		503
61				RC	47	100	100		502
62									501
63				RC	48	93	80		500
64		- ironstone concretion at 64.4m		RC	49	97	97		499
65									498
66				RC	50	100	100		497
67									496
68		(LL: 86, PL:23 at 68.2m)		RC	51	100	100		495
69				RC	52	98	98		494
70									

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70									493
71		- SILTSTONE layer, 260mm thick massive, grey with calcite veins, medium strong at 71.0m		RC	53	93	70		492
72				RC	54	95	93		491
73		- 50mm thick mottled light brown to grey bentonite seam at 73.5m		RC	55	100	87		490
74									489
75				RC	56	95	92		488
76									487
77				RC	57	95	85		486
78		- SILTSTONE lens, 100mm thick, medium strong from 77.8m to 78.0m		RC	58	93	78		485
79		- bentonite seam from 79.3m to 79.4m (LL: 92, PL:23 at 79.7m)							484
80				RC	59	100	100		

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
80							483
81			RC	60	100	100	482
82		(driller disturbed core at RC 61)	RC	61	87	60	481
83							480
84		(LL: 74, PL:20 at 84.2m)	RC	62	100	100	479
85							478
86		(driller disturbed core at RC 62)	RC	63	97	97	477
87			RC	64	93	63	476
88							475
89		(LL: 87, PL:23 at 89.5m)	RC	65	70	47	474
	473.34						
90							

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5918590 N
598503 E
Ground Elevation: 563.24

STANTEC2

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **8/22/2016** WATER LEVEL **VW1 on 10/12/2016: 9.3mBGS**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm or CORE %	SAMPLES N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
90		END OF BOREHOLE - borehole grouted with cement bentonite mix from ground level down to 89.9m - Slope Inclinometer casing was installed 89.9m - Vibrating Wire Piezometer 1 installed at 19.8m S/N: 1600205 - Vibrating Wire Piezometer 2 installed at 39.6m S/N: 1601351 - Stick up casing 1.0m above ground surface							473
91									472
92									471
93									470
94									469
95									468
96									467
97									466
98									465
99									464
100									

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

*Water level from water seepage observation during drilling ▽
**Groundwater level measured on date indicated. ▼

NL-BH40

Figure 1 NL-BH40 RC 21 - RC 29

Figure 2 NL-BH40 RC 30 - RC 39

Figure 3 **NL-BH40 RC 40 - RC 46**

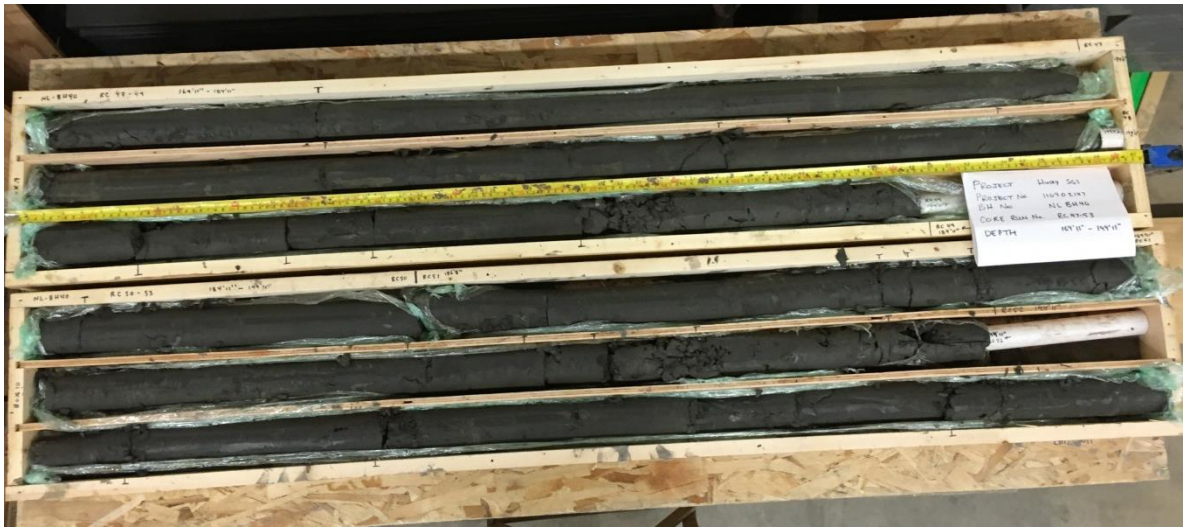

Figure 4 **NL-BH40 RC 47 – RC 53**

Figure 5 NL-BH40 RC 54 – RC 63

Figure 6 NL-BH40 RC 64 – RC 73

Figure 7 NL-BH40 RC 74 – RC 76

STANTEC2

Figure 8 STANTEC2 RC 9 – RC 17

Figure 9 STANTEC2 RC 18 – RC 27

Figure 10 STANTEC2 RC 28 – RC 34

Figure 11 STANTEC2 RC 35 – RC 44

Figure 12 STANTEC2 RC 45 – RC 53

Figure 13 STANTEC2 RC 54 – RC 59

NSR-BH01

Figure 14 NSR-BH01 RC 20 – RC 28

Figure 15 NSR-BH01 RC 29 – RC 36

Figure 16 NSR-BH01 RC 37 – RC 40

Figure 17 NSR-BH01 RC 41 – RC 48

Figure 18 NSR-BH01 RC 49 – RC 56

STANTEC1

Figure 19 STANTEC1 RC 29 – RC 34

Figure 20 STANTEC1 RC 35 – RC 42

Figure 21 STANTEC1 RC 43 – RC 47

NSR-BH02

Figure 22 NSR-BH02 RC 24 – RC 31

Figure 23 NSR-BH02 RC 32 – RC 41

NSR-BH03

Figure 24 NSR-BH03 RC 25 – RC 36

Figure 25 NSR-BH03 RC 37 – RC 40

Figure 26 NSR-BH03 RC 41 – RC 46

Figure 27 NSR-BH03 RC 47 – RC 54

Figure 28 NSR-BH03 RC 55 – RC 58

Figure 29 NSR-BH03 RC 59 – RC 66

Figure 30 NSR-BH03 RC 67 – RC 72

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	519.78	TOPSOIL							519.98
		Colluvium firm brown silty CLAY (CL), some sand, low plastic, damp							
				BS	1				
1									519
				SS	2	100	5		
2									518
		- very stiff, light brown, sandy, silty, dry to damp below 2.4m		ST	3	480			
		- increased silt content below 2.4m							
3				SS	4	300	25		517
		- trace gravel from 3.8 to 4.9m		BS	5				
4									516
		- hard at 4.6m							
		- moist, grey mottling below 4.6m		SS	6	275	34		
5									515
		(sieve analysis on sample BS7 at 5.4m		BS	7				
		0.2% gravel, 9.5% sand, 60.2% silt, 30.2% clay)							
6		(LL:32, PL:16 at 5.5m)							514
		- stiff at 6.1m							
		- trace oxidation below 6.1m		SS	8	350	13		
7				BS	9				513
				SS	10	450	21		
8									512
				BS	11				
9									511
		- increased sand and silt below 9.1 m							
				SS	12	450	27		
10				BS	13				510

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10		- light brown to grey below 10.3m							
				SS	14	450	40		
11	508.88	Hard brown CLAY TILL (CH) with sand, trace gravel, high plastic, moist							509
		- trace of oxidation to 12.6m		BS	15				
		- occasional sand partings from 11.4m to 13.6m							
12		(LL:57, PL:26 at 12.2m)		SS	16	450	35		508
		(water level depth: 12.7mBGS on October 12, 2016)							
13				BS	17				507
14				SS	18	450	35		506
		- brown sandy CLAY TILL with gravel below 14.3m							
		- seepage inferred at 14.5m		BS	19				
15	504.78	Extremely weak grey silty CLAY SHALE (CH), blocky, laminated, trace oxidation, highly weathered, dry to moist		SS	20	450	46		505
16				BS	21				504
17		(LL:69, PL:27 at 16.9m)		SS	22	450	68		503
				BS	23				
18				SS	24	450	65		502
19				BS	25				501
20		(switched to rock coring at 19.8m)							500

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		- grey silty CLAY SHALE (CH), fresh, very weak, damp, occasional joints below 19.9m, slickensides multiple angle, rough to smooth,		SS	26	450	56		
				RC	27	97	97		
21									499
				RC	28	97	83		
22									498
23		(LL:89, PL:27 at 23.0m)		RC	29	97	100		497
24		- silty, grey to white bentonitic lens at 24.1m - slickensides, rough, undulating, nearly horizontal from 24.4m to 27.4m							496
25				RC	30	100	100		495
26		- claystone/siltstone, medium strong, grey, 75mm thick from 26.0m							494
				RC	31	100	100		
27									493
28		(UCS on sample RC32-1 at 28 m: 1.0 MPa)		RC	32	100	100		492
29									491
				RC	33	100	100		
30									490

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30									
31		(LL:162, PL:44 at 30.9m) - slickensides from 31.0m to 31.2m		RC	34	100	100		489
32		(Vibrating Wire Piezometer installed at 32.0m) - bentonite lens, 200mm at 32.6m (lost core from 32.7m to 33.0m)		RC	35	75	75		488
33									487
34				RC	36	100	100		486
35		(lost core from 34.9m to 35.1m)							485
36				RC	37	100	100		484
37		- pyrite joint filling at 37.1m		RC	38	100	100		483
38									482
39				RC	39	100	100		481
40									480

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10 20 30 40 50 60 70 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
40			RC	40	100	100	
		- silty / trace sand inclusions from 40.6m to 40.9m					
41							479
			RC	41	100	100	
42							478
43			RC	42	100	100	477
44		- silty from 44.2m to 44.4m					476
45		(lost core from 44.9m to 45.7m) (driller induced fractures)	RC	43	97	97	475
46			RC	44	100	100	474
47							473
48		(driller induced fractures from 48.0 to 48.8m)	RC	45	100	100	472
49			RC	46	85	85	471
50		(lost core from 49.7m to 49.9m)					470

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50									
51				RC	47	100	100		469
		(LL:68, PL:22 at 51.5m)							
52				RC	48	100	100		468
53									467
		- grey claystone / siltstone from 53.3m to 53.4m							
54				RC	49	87	87		466
55									465
56				RC	50	100	100		464
57				RC	51	100	100		463
58									462
59				RC	52	100	100		461
60									460

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT Husky Energy Inc.
PROJECT HUE - Husky SGS Phase 4
LOCATION SGS Phase 4 & 16TAN POE
DATES (mm/dd/yyyy): BORING 9/10/2016 WATER LEVEL on 10/12/2016: 12.7mBGS

PROJECT No. 110902147
BH SIZE 150 mm/75 mm Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60		- no slickensides observed below 60.0m - pyrite inclusions at 60.7m		RC	53	55	55		
61				RC	54	100	100		459
62									458
63				RC	55	100	100		457
64		(occasional driller induced fractures below 64.0m)		RC	56	100	100		456
65									455
66				RC	57	100	100		454
67		- pyrite inclusions at 67.3m							453
68				RC	58	100	100		452
69				RC	59	100	100		451
70									450

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70									
71				RC	60	100	100		449
72				RC	61	100	100		448
73		- horizontal laminations below 73.2m							447
74				RC	62	100	100		446
75				RC	63	100	100		445
76		- occasional slickensides below 76.2m							444
77				RC	64	100	100		443
78				RC	65	100	100		442
79									441
80				RC	66	100	100		440

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919955 N
598478 E
Ground Elevation: 519.98

NL-BH41

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

LOCATION **SGS Phase 4 & 16TAN POE**

DATES (mm/dd/yyyy): BORING **9/10/2016** WATER LEVEL **on 10/12/2016: 12.7mBGS**

PROJECT No. **110902147**

BH SIZE **150 mm/75 mm** Solid/HQ

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm or CORE %	SAMPLES N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
80	439.68								
		END OF BOREHOLE at 80.3m - borehole grouted with cement bentonite mix from 80.3m to surface - Slope Indicator casing installed at 80.3m - Stick up casing 1.0m above ground surface - Vibrating Wire Piezometer installed at 32.0m S/N: 1600206							
81									439
82									438
83									437
84									436
85									435
86									434
87									433
88									432
89									431
90									430

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
Cu Scale (kPa): 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
%MC or Blow Count Scale (% or N): 10, 20, 30, 40, 50, 60, 70, 80

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
0	493.86	TOPSOIL					494.06
		Colluvium firm, light brown silty CLAY (CL), some sand, damp	BS	1			494
1		(sieve analysis on sample SS2 at 1.5m 1% gravel, 14.9% sand, 65.8% silt, 19.3% clay)	SS	2	300	5	493
2			BS	3			492
3	490.96	Compact brown poorly graded SAND (SP), with gravel, trace silt, moist	SS	4	200	27	491
4			BS	5			490
	489.66	- brown and wet below 4.2m					
5		Extremely weak grey CLAY SHALE (CH), silty, completely weathered, damp	SS	6	450	17	489
			BS	7A			
6		- bentonite lenses from 5.7m to 5.9m (LL:69, PL:29 at 5.7m)	BS	7			488
		(water level depth: 6.2mBGS on October 12, 2016) - occasional trace pyrite below 6.4m	SS	8	350	19	
7			BS	9			487
8			SS	10	450	41	486
			BS	11			
9			SS	12	450	60	485
10							

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	ELEVATION(m)
10			BS	13			484
11			SS	14	450	50	483
		(switched to rock coring at 11.2m) Grey CLAY SHALE (CH), completely weathered, extremely weak, silty/sand joint fillings, damp multiple nearly horizontal fractures below 11.2m (LL:70, PL:29 at 11.7m)	RC	15	67	47	
12							482
13			RC	16	93	90	481
		(Vibrating Wire Piezometer installed at 13.4m) - pyrite inclusion at 13.5m					
14		- blocky with silt inclusions / partings from 14.1m to 14.4m	RC	17	100	85	480
15		(occasional driller induced fractures below 15.2m)					479
16			RC	18	100	100	478
17			RC	19	100	100	477
18							476
19		(UCS on sample RC20 at 18.9m: 0.79MPa)	RC	20	100	100	475
20							

STRATA PLOT

MONITOR WELL/ PIEZOMETER

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20				RC	21	100	100		474
21				RC	22	100	100		473
22				RC	23	100	100		472
23				RC	24	100	100		471
24		- occasional silt inclusion below 24.5m		RC	25	100	100		470
25				RC	26	100	100		469
26				RC	27	100	100		468
27									467
28									466
29		- grey claystone/siltstone,150mm thick, medium strong, slightly weathered, dry at 29.1m							465
30									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30		- UCS on sample RC27 at 29.9m: 0.40MPa							464
		(lost core from 30.4m to 31.2m)							
31				RC	28	72	58		463
32				RC	29	100	100		462
33		- thin laminations below 33.4m							461
34				RC	30	100	100		460
35									459
36		(LL:77, PL:26 at 35.7m)		RC	31	100	100		458
37				RC	32	100	100		457
38									456
39				RC	33	100	100		455
40									

**Groundwater level measured on date indicated. ▼

Stantec

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Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40				RC	34	100	100		454
41		(lost core at 40.9m, recovered on next run)		RC	35	100	100		453
42		(lost core at 42.5m, recovered on next run)		RC	36	100	100		452
43				RC	37	100	100		451
44				RC	38	100	100		450
45		- pyrite filling at 46.3m		RC	39	100	100		449
46		(UCS on sample RC38 at 47.4m: 1.32MPa)		RC	40	100	100		448
47									447
48									446
49									445
50									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT Husky Energy Inc.
PROJECT HUE - Husky SGS Phase 4
LOCATION SGS Phase 4 & 16TAN POE
DATES (mm/dd/yyyy): BORING 9/13/2016 WATER LEVEL on 10/12/2016: 6.2mBGS

PROJECT No. 110902147
BH SIZE 150 mm/75 mm Solid/HQ

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50									444
51		(LL:61, PL:23 at 51m)		RC	41	100	100		443
52				RC	42	100	100		442
53									441
54		- pyrite inclusions at 54.5m		RC	43	100	100		440
55				RC	44	100	100		439
56									438
57				RC	45	100	100		437
58				RC	46	100	100		436
59									435
60									

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
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NSR-BH04

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60		- no slickensides observed below 60.0m		RC	47	100	100		434
61				RC	48	100	100		433
62									432
63				RC	49	77	77		431
64		- grey CLAY SHALE (CH), silty, very weak to weak, damp		RC	50	100	100		430
65									429
66		- bentonite lens, 100mm thick, from 66.3m to 66.4m (LL:165, PL:50 at 66.3m) - grey siltstone, 100mm thick at 66.4m		RC	51	100	100		428
67									427
68				RC	52	100	100		426
69				RC	53	100	100		425
70									

**Groundwater level measured on date indicated. ▼

Stantec

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5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL **on 10/12/2016: 6.2mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
70		- no slickensides observed below 70.0m							424
71				RC	54	100	100		423
72				RC	55	100	100		422
73									421
74		- grey claystone/siltstone from 74.0m to 74.3m		RC	56	100	100		420
75				RC	57	100	100		419
76									418
77				RC	58	100	100		417
78				RC	59	100	100		416
79									415
80									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5919565 N
598489 E
Ground Elevation: 494.06

NSR-BH04

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

LOCATION **SGS Phase 4 & 16TAN POE**

PROJECT No. **110902147**

BH SIZE **150 mm/75 mm** Solid/HQ

DATES (mm/dd/yyyy): BORING **9/13/2016** WATER LEVEL on 10/12/2016: 6.2mBGS

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
80				RC	60	100	100		414
	413.26								
81		END OF BOREHOLE at 80.8m - borehole grouted with cement bentonite mix from 80.8m to surface - Slope Indicator casing installed at 80.8m - Stick up casing 1.0m above ground surface - Vibrating Wire Piezometer installed at 13.4m S/N: 1502830							413
82									412
83									411
84									410
85									409
86									408
87									407
88									406
89									405
90									

**Groundwater level measured on date indicated. ▼

Stantec

Borehole Coordinates
5920124 N
598456 E
Ground Elevation: 534.65

NSR-BH06

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	534.45	TOPSOIL							534.65
		Colluvium very stiff light brown sandy CLAY (CL), silty, fine grained sand, low plastic, dry							534
1				BS	1				
				SS	2	450	17		533
2		- brown, some sand, trace gravel, moist from 2.1m to 3.0m		BS	3				532
3				SS	4	450	30		531
4				BS	5				
		- occasional sand partings from 4.0m to 4.7m							530
		(LL:27, PL:13 at 4.6m) (sieve analysis on sample ST6 at 4.6m) (1% gravel, 37.3% sand, 34.2% silt, 27.5% clay)		ST	6	540			
5				SS	7	450	23		529
6	528.45	Very stiff to hard brown CLAY TILL (CL), trace gravel, low plastic, moist		SS	8	450	30		528
7				BS	9				
		- occasional sand partings below 7.1m							527
		- trace oxidation from 7.6m to 8.1m		SS	10	450	27		
8				BS	11				526
9		- trace coal, moist below 9.1m		SS	12	450	32		525
10									

Stantec

Borehole Coordinates
5920124 N
598456 E
Ground Elevation: 534.65

NSR-BH06

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10				BS	13				
		- very dense light brown fine grained SAND (SP-SM) with silt, moist from 10.3m to 11.5m							524
		- with clay to 10.5m to 11.5m		SS	14	450	57		
11									
				BS	15				523
		- very stiff brownish grey CLAY TILL (CH), trace sand, trace gravel, high plastic, moist below 11.5 m							
12	522.25			SS	16	450	32		
		Very stiff brown sandy CLAY (CL) to clayey sand (SC), trace gravel, fine grained sand, moist							522
13				BS	17				
		(auger refusal, possible boulders at 13.6)							521
14		(SPT gravel piece at 13.6m)		SS	18	450	60		
		(Moved NSR-BH06 3.0m to the west and augered to 13.6m)							
		(Original borehole filled with bentonite chips from 0.3m to 13.65m, with soil partings from 0 to 0.3m)							520
15		- occasional oxidation stains below 15.2m		SS	20		28		
									519
16	518.65	Extremely weak grey silty CLAY SHALE (CH), completely weathered, blocky, moist, multiple horizontal, rough fractures (SPT refusal at 16.6m)		BS	21				
									518
17				SS	22		49		
				BS	23				517
18		(switched to rock coring at 18.3m)		SS	24		51		
									516
19				RC	25	100	87		
									515
20		- grey sandy CLAY SHALE (CH), fine grained sand							

Stantec

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NSR-BH06

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LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20		from 19.8m to 21.0m							
		- bentonite seam, light grey, 50mm thick at 20.6m		RC	26	100	100		514
21									513
22				RC	27	100	100		512
23				RC	28	100	100		511
		- light grey silt inclusions from 23.7m to 24.1m							
24									510
25				RC	29	100	100		509
		- light grey silt inclusions from 25.5m to 25.7m							
26		- grey siltstone from 26.4m to 26.6m (lost core from 26.7m to 27.4m)		RC	30	47	42		508
27									507
28				RC	31	100	83		506
29									505
		- occasional slickenside, shiny, smooth, horizontal to 45 degree angle, through going		RC	32	100	100		
30									

Stantec

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Ground Elevation: 534.65

NSR-BH06

CLIENT Husky Energy Inc.
PROJECT HUE - Husky SGS Phase 4
LOCATION SGS Phase 4 & 16TAN POE
DATES (mm/dd/yyyy): BORING 9/18/2016 WATER LEVEL N/A: mBGS

PROJECT No. 110902147
BH SIZE 150 mm/75 mm Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
30		from 29.6m to 29.8m - pyrite inclusion at 29.9m							
									504
31		- occassional grey to brown silt inclusions below 31.0m		RC	33	68	82		
									503
32		(lost core at 32.0m) - slickenside, near vertical angle, smooth from 32.4m to 32.7m		RC	34	100	100		502
33		- siltstone/claystone, 300mm thick, grey from 32.6m to 32.9m - slickenside, high angle to vertical, smooth from 33.2m to 33.5m (driller induced fractures from 33.5m to 35.1m)							501
34				RC	35	100	100		500
35				RC	36	100	100		499
36		(driller induced fractures from 36.6m to 38.0m) - silt pockets and shell inclusion at 36.7m							498
37				RC	37	100	100		497
38		(lost core from 37.8m to 40.9m) - occasional slickenside, high angle, smooth from 38.5m to 39.4m		RC	38	100	100		496
39									495
40									

Stantec

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NSR-BH06

CLIENT **Husky Energy Inc.**
PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
40		Silty grey CLAY SHALE (CH), blocky, moist, occasional silt inclusions below 40.0m - occasional slickenside, high angle, smooth below 40.4m		RC	39	95	95		494
41		(LL:84, PL:24 at 41.5m)		RC	40	98	98		493
42		- silt joint infilling at 42.7m		RC	41	100	100		492
43									491
44		(lost core from 44.8m to 45.1m)		RC	42	75	75		490
45									489
46		- bentonitic lens at 46.8m		RC	43	100	100		488
47									487
48		- bentonite lens, light grey, 40mm thick - shell inclusion at 48.6m		RC	44	100	100		486
49				RC	45	100	100		485
50									

Stantec

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NSR-BH06

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PROJECT **HUE - Husky SGS Phase 4**
LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
50		- occasional silt inclusion below 50.0m - no slickensides observed below 50.0m							
51				RC	46	100	100		484 483
52		(driller induced fractures from 51.8m to 54.9m)		RC	47	100	100		482
53									481
54				RC	48	100	100		480
55				RC	49	97	97		479
56		(lost core from 56.1m to 56.4m) (driller disturbed sample from 56.4m to 56.7m)							478
57		(lost core from 57.3m to 57.6m, recovered on next run)		RC	50	100	100		477
58		- vertical angle joint from 58.0m to 59.2m		RC	51	100	100		476
59									475
60									

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NSR-BH06

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LOCATION **SGS Phase 4 & 16TAN POE**
DATES (mm/dd/yyyy): BORING **9/18/2016** WATER LEVEL **N/A: mBGS**

PROJECT No. **110902147**
BH SIZE **150 mm/75 mm** Solid/HQ

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
60				RC	52	100	100		474
61				RC	53	100	97		473
62									472
63		(driller induced vertical fracture from 63.1m to 63.7m)		RC	54	100	100		471
64				RC	55	100	100		470
65									469
66				RC	56	100	100		468
67		(LL:73, PL:24 at 67.4m)							467
68	466.05			RC	57	100	100		466
69		END OF BOREHOLE at 68.6m - borehole backfilled with soil cuttings from ground surface to 0.6m, bentonite mix from 0.6m to 3.7m, and grout from 3.7m to 68.6m							465
70									

Stantec

Borehole Coordinates
5920871 N
598445 E
Ground Elevation: 618.23

NSR-BH07

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

LOCATION **SGS Phase 4 & 16TAN POE**

PROJECT No. **110902147**

BH SIZE **150 mm/75 mm** Solid

DATES (mm/dd/yyyy): BORING **9/16/2016** WATER LEVEL **dry on September 17, 2016: mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
0	618.03	TOPSOIL							618.23
		Very stiff brown CLAY TILL (CI), trace sand, trace gravel, medium plastic, moist							618
		- occasional grey mottling to 1.2m		BS	1				
1		- occasional white mineral deposits to 3.1m							617
				SS	2	200	20		
		- some sand and gravel below 1.7m							
2				BS	3A				
		(LL:48, PL:18 at 2.3m)							616
		(sieve analysis on sample ST3 at 2.3 m 2.8% gravel, 24.1% sand, 31.3% silt, 41.8% clay)		ST	3	420			
3	615.13								
		Compact brown silty, clayey GRAVEL with sand (GC-GM), moist		SS	4	200	24		615
		- angular gravel inclusions below 3.1 m							
4		(sieve analysis on sample BS5 at 3.9 m 45.3% gravel, 31.3% sand, 23.4% fines)		BS	5				614
				SS	6	250	18		
5	613.13								
		Compact brown silty SAND (SM), some clay, trace gravel, moist							613
				BS	7				
6	611.83			SS	8	400	30		612
		Hard brown CLAY TILL (CI) with sand, trace gravel, medium plastic, moist							
7				BS	9				611
				SS	10	450	34		
8									610
				BS	11				
9				SS	12	450	33		609
10									

Stantec

Borehole Coordinates
5920871 N
598445 E
Ground Elevation: 618.23

NSR-BH07

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

LOCATION **SGS Phase 4 & 16TAN POE**

PROJECT No. **110902147**

BH SIZE **150 mm/75 mm** Solid

DATES (mm/dd/yyyy): BORING **9/16/2016** WATER LEVEL **dry on September 17, 2016: mBGS**

Undrained Shear Strength (Cu) : (kPa) ▲
Cu based on Pocket Penetrometer : (kPa) ★
50 100 150 200
Cu Scale (kPa)
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N), BLOWS/0.3m and RQD% ●
10 20 30 40 50 60 70 80
%MC or Blow Count Scale (% or N)

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY mm or CORE %	N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
10		Hard brown CLAY TILL (CI) with sand, trace gravel, medium plastic, moist		BS	13				608
				SS	14	450	34		
11				BS	15				607
12				ST	16	490			606
				SS	17	450	40		
13		- occasional sand partings from 13.0 to 17.5m							605
14				SS	18	450	42		604
				BS	19				
15		(SPT on sample SS20 gravel at 15.2m)		SS	20	450	48		603
16				BS	21				602
17		- trace coal inclusions from 16.8 m to 19.3m		SS	22	450	44		601
				BS	23				
18				SS	24	450	38		600
19				BS	25				599
20		- very stiff below 19.8m							

Stantec

Borehole Coordinates
5920871 N
598445 E
Ground Elevation: 618.23

NSR-BH07

CLIENT **Husky Energy Inc.**

PROJECT **HUE - Husky SGS Phase 4**

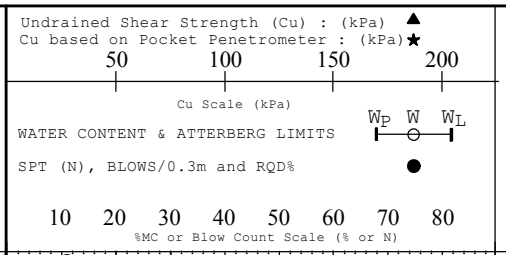
PROJECT No. **110902147**

LOCATION **SGS Phase 4 & 16TAN POE**

BH SIZE **150 mm/75 mm**
Solid

DATES (mm/dd/yyyy): BORING **9/16/2016** WATER LEVEL **dry on September 17, 2016: mBGS**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm or CORE %	SAMPLES N-VALUE or RQD %	MONITOR WELL/ PIEZOMETER	ELEVATION(m)
20	597.93			SS	26	450	25		598
		END OF BOREHOLE at 20.3m Upon completion - borehole open and dry - borehole backfilled with soil cuttings from 0.0 m to 0.3 m and 9.3 m to 20.3 m; with bentonite chips from 0.3 m to 9.3 m							
21									597
22									596
23									595
24									594
25									593
26									592
27									591
28									590
29									589
30									



NSR-BH04

Figure 1 NSR-BH04 RC 15 - RC 21

Figure 2 NSR-BH04 RC 22 - RC 29

Figure 3 **NSR-BH04 RC 30 - RC 37**

Figure 4 **NSR-BH04 RC 38 - RC 45**

Figure 5 **NSR-BH04 RC 46 - RC 53**

Figure 6 **NSR-BH04 RC 54 - RC 60**

NL-BH41

Figure 7 NL-BH41 RC 27 - RC 33

Figure 8 NL-BH41 RC 34 - RC 41

Figure 9 NL-BH41 RC 42 - RC 49

Figure 10 NL-BH41 RC 50 - RC 57

Figure 11 NL-BH41 RC 58 - RC 61

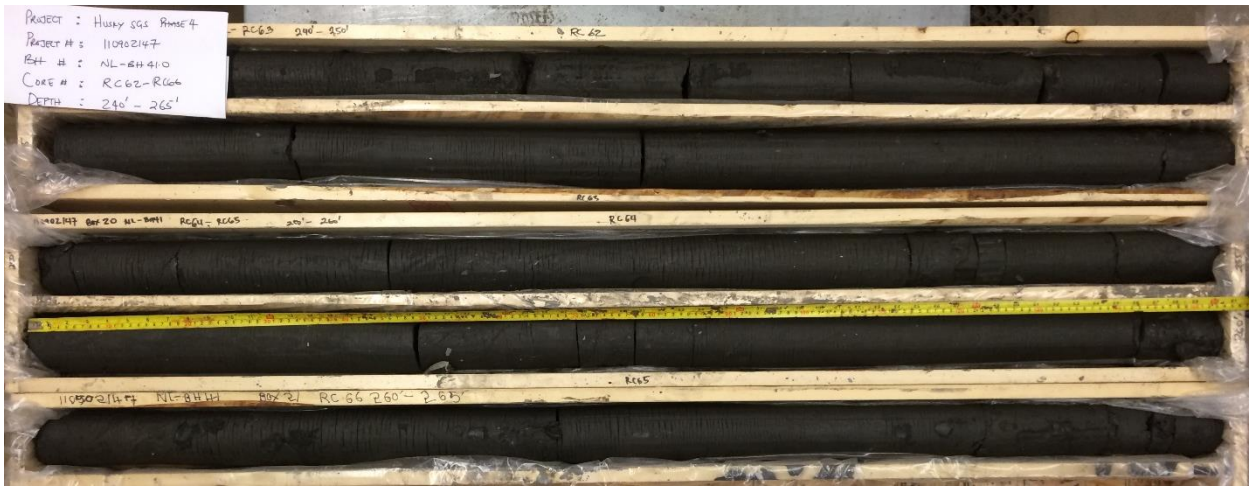


Figure 12 NL-BH41 RC 62 - RC 66

NSR-BH06

Figure 13 NSR-BH06 RC 25 - RC 32

Figure 14 NSR-BH06 RC 33 - RC 38

Figure 15 NSR-BH06 RC 39 - RC 46

Figure 16 NSR-BH06 RC 47 - RC 52

Figure 17 NSR-BH06 RC 53 - RC 57

Appendix E
LABORATORY TEST RESULTS

Atterberg Limit Test Results

	BH No.	Sample ID	Sample Depth (m)	Sample Elevation (m)	LL	PL	PI	Soil Classification
South Slope	NL-BH40	BS 1	0.8	591.6	53	21	32	CH
		BS 5	4.2	588.2	58	22	36	CH
		RC 23	18.3	574.2	62	23	39	CH
		RC 36	36.6	555.9	67	21	46	CH
	Stantec 2	BS 1	0.8	562.4	70	32	38	CH
		BS 3	2.6	560.6	74	30	44	CH
		RC 9	7.1	556.1	54	19	35	CH
		RC 15-1	15.4	547.8	74	22	52	CH
		RC 18	20.3	542.9	67	21	46	CH
		RC 24-1	27.8	535.4	80	24	56	CH
		RC 29	36.1	527.1	95	26	69	CH
		RC 42	53.8	509.4	98	27	71	CH
		RC 44	56.9	506.3	100	26	74	CH
		RC 51	68.2	495.0	86	23	63	CH
		RC 59	79.7	483.5	92	23	69	CH
		RC 62	84.2	479.0	74	20	54	CH
		RC 65	89.5	473.7	88	23	65	CH
	NSR-BH01	BS 3	2.4	535.6	66	28	38	CH
		BS 5	3.8	534.2	61	23	38	CH
		RC 27	24.5	513.5	81	25	56	CH
		RC 28	26.1	511.9	151	48	103	CH
		RC 43	49.1	488.9	109	28	81	CH
		RC 44	50.6	487.4	136	49	87	CH
	Stantec 1	BS 1	0.8	530.0	53	19	34	CH
		BS 3	2.4	528.4	69	25	44	CH
		RC 28	21.0	509.8	93	23	70	CH
		RC 29-1	21.5	509.3	98	25	73	CH
		RC 32-2	27.0	503.8	96	25	71	CH
		RC 34-1	29.1	501.7	100	26	74	CH
		RC 35	31.6	499.2	98	24	74	CH
		RC 37	34.2	496.6	103	25	78	CH
		RC 39	37.2	493.6	92	25	67	CH
		RC 40-2	39.2	491.6	113	27	86	CH
		RC 42-2	42.4	488.4	113	26	87	CH
		RC 44-2	45.8	485.0	96	24	72	CH
		RC 46	47.9	482.9	96	22	74	CH

		RC	47	49.9	480.9	98	25	73	CH
	NSR-BH02	BS	1	1.1	512.5	57	23	34	CH
		SS	2	1.5	512.1	44	19	25	CI
		ST	6	4.6	509.0	50	20	30	CH
		RC	25	18.2	495.4	80	23	57	CH
		RC	27	21.2	492.4	85	23	62	CH
		RC	29	24.3	489.3	89	22	67	CH
		RC	30	25.8	487.8	92	26	66	CH
		RC	33	30.4	483.2	75	21	54	CH
		RC	36	34.9	478.7	83	20	63	CH
		RC	38	38.0	475.6	92	22	70	CH
		RC	39	39.5	474.1	88	25	63	CH
	NSR-BH03	RC	35	33.5	460.5	91	21	70	CH
		RC	45	48.8	445.3	89	24	65	CH
		RC	59	70.1	424.0	70	21	49	CH
North Slope	NSR-BH04	BS	7	5.4	488.7	69	29	40	CH
		RC	15	11.7	482.4	70	29	41	CH
		RC	30	35.7	458.3	77	26	51	CH
		RC	41	51.0	443.0	61	23	38	CH
		RC	51	66.3	427.8	165	50	115	CH
	NL-BH41	BS	7	5.4	514.6	32	16	16	CL-CI
		SS	16	12.2	507.8	57	26	31	CH
		SS	22	16.7	503.3	69	27	42	CH
		RC	29	24.1	495.9	89	27	62	CH
		RC	34	31.3	488.7	162	44	118	CH
		RC	47	51.1	468.9	68	22	46	CH
	NSR-BH06	ST	6	4.6	530.1	27	13	14	CL
		RC	40	41.5	493.2	84	24	60	CH
		RC	57	67.4	467.3	73	24	49	CH
	NSR-BH07	ST	3	2.3	615.9	48	18	30	CI

Grain Size Distribution

Borehole ID	Sample ID	Sample depth (m)	Sample Elevation (m)	% Retained				
				Gravel	Sand	Fines	Silt	Clay
NL-BH40	RC23	19.0	573.4	0.0	0.4	99.6	54.8	44.8
Stantec2	BS3	2.6	560.6	0.0	1.2	98.8	47.4	51.5
NSR-BH01	RC28-1	27.1	510.9	0.0	3.9	96.1	55.1	41.0
NSR-BH01	RC-43-1	49.4	488.6	0.0	0.1	99.9	41.2	58.6
NSR-BH01	RC43-2	49.7	488.3	0.0	6.5	93.5	46.0	47.5
Stantec1	BS3	2.4	528.4	0.0	1.3	98.7	60.3	38.4
Stantec1	RC34	29.1	501.7	0.0	0.3	99.7	50.2	49.5
Stantec1	RC39	37.2	493.6	0.0	0.2	99.8	49.3	50.6
Stantec1	RC46	47.9	482.9	0.0	0.2	99.8	60.0	39.8
NSR-BH02	SS2	1.5	512.1	0.0	0.9	99.1	63.1	36.0
NSR-BH02	BS1	0.8	512.8	0.0	11.3	88.7	47.0	42.7
NSR-BH02	ST6	4.6	509.0	0.0	1.5	98.5	63.3	35.2
NSR-BH02	RC27-2	22.4	491.2	0.0	0.4	99.6	60.0	39.6
NSR-BH02	RC29-1	24.4	489.2	0.0	1.3	98.7	56.7	42.0
NSR-BH02	RC36-2	36.4	477.2	0.0	1.4	98.6	58.4	40.2
NSR-BH04	BS2	1.5	492.6	0.0	14.9	85.1	65.8	19.3
NL-BH41	BS7	5.4	514.6	0.2	9.5	90.3	60.2	30.2
NL-BH41	RC47	51.1	468.9	0.0	0.4	99.6	28.0	51.6
NSR-BH06	ST6	4.6	530.1	1.0	37.3	61.7	34.2	27.5
NSR-BH07	ST3	2.3	615.9	2.8	24.1	73.1	31.3	41.8
NSR-BH07	BS5	3.8	614.4	45.3	31.4	23.4	-	-

Unconfined Compressive Strength Test Results

Borehole ID	Sample ID	Sample Depth (m)	Sample Elevation (m)	WC (%)	Total Unit Weight (KN/m3)	Dry Unit Weight (kN/m3)	Unconfined Compressive Strength (kPa)	Undrained shear Strength "Cu" (kPa)
NSR-BH07	ST3	2.4	615.8	6.2	20.1	19.0	318.3	159.2
NSR-BH06	ST6	4.6	530.1	6.6	21.4	20.1	202.5	101.3
NLBH41	ST3	2.4	517.6	27.8	19.4	15.1	569.7	284.8
NLBH41	RC32	28.0	492.0	18.3	25.3	21.4	1000.2	500.2
NSR-BH04	RC20	18.9	475.2	18.9	21.0	17.7	788.0	394.2
NSR-BH04	RC27	29.9	464.2	17.6	25.7	21.8	404.0	202.0
NSR-BH04	RC38	47.4	446.7	15.8	25.7	22.2	1319.2	659.6
NSR-BH03	RC61	74.0	420.1	13.6	21.6	19.0	1095.3	547.6
NSR-BH03	RC67	83.0	411.1	13.9	20.5	18.0	1489.9	744.9
NSR-BH02	ST6	4.6	509.0	25.7	19.6	15.6	160.4	80.2
NSR-BH02	RC26	20.1	493.5	25.8	19.5	15.5	236.3	118.2
NSR-BH02	RC34	32.6	481.0	21.8	19.3	15.9	349.2	174.6
NSR-BH02	RC37	36.8	476.8	16.6	21.1	18.1	837.3	418.7
Stantec2	RC14	14.9	548.3	20.2	20.1	16.7	307.6	153.8
Stantec2	RC28	34.4	528.8	18.7	20.8	17.5	325.8	162.9
Stantec2	RC44	57.2	506.0	14.1	21.8	19.1	2230.2	1115.1
Stantec2	RC63	85.8	477.4	13.3	21.7	19.2	1257.9	629.0

Chemical Test Results

Borehole / Sample ID	Approximate Depth (m)	Approximate Elevation (m)	Resistivity @ 25° C (ohm-m)	pH	Soluble Chloride (mg/L)	Soluble Sulphate (mg/L)
STANTEC 1 BS3	2.4	528.4	0.90	7.92	79	8300
STANTEC 2 BS3	2.6	560.6	1.7	6.88	<5.0	3800
NSR BH2 BS1	3.8	509.8	1.4	7.79	35	4700
NSR BH2 BS8	1.1	512.5	2.1	7.57	41	2600
NSR BH2 BS8 Lab-Dup	1.1	512.5	N/A	7.62	45	3000
NL_BH41 ST3	2.4	518.6	24	8.16	<5.0	83
NSR BH06 BS3	2.3	533.7	2.0	7.82	6.8	3500
NSR BH07 SS2	1.5	616.7	14	8.07	<5.0	230

Stantec

Moisture Content of Soil or Aggregate

CSA A23.2-11A
ASTM D2216

OFFICE
10160 - 112 ST
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10575 106 ST
Edmonton, Alberta
Canada T5H 2X5

Tel: (780) 917-7463

Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40
Sample	BS1	BS3	SS4	BS5	SS6	BS7	SS8
Tare No.	17A	24A	29	2C	ET	DN	C5
Mass Tare Container	9.3	9.3	9.3	9.5	8.8	9.2	9.2
Mass Sample (Wet+Tare) (g)	150.8	188	119.5	117.9	141.5	199	109.8
Mass Sample (Dry+Tare) (g)	132.5	154.7	99.3	97.4	114	155	87.7
Mass of Water (g)	18.30	33.30	20.20	20.50	27.50	44.00	22.10
Mass Dry Sample (g)	123.20	145.40	90.00	87.90	105.20	145.80	78.50
Moisture Content (%)	14.9%	22.9%	22.4%	23.3%	26.1%	30.2%	28.2%
Comments							

Borehole / Test Pit No.	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40
Sample	BS9	SS10	BS11	SS12	BS13	SS14	BS15
Tare No.	16A	MM	27A	DT	EE	ZZ3	EZ
Mass Tare Container	9.3	9.4	9.3	8.6	8.7	9.5	8.5
Mass Sample (Wet+Tare) (g)	109.2	159.5	189.6	137.9	164.8	153	88
Mass Sample (Dry+Tare) (g)	88.5	128.3	151.7	110.7	131.2	120.6	72.5
Mass of Water (g)	20.70	31.20	37.90	27.20	33.60	32.40	15.50
Mass Dry Sample (g)	79.20	118.90	142.40	102.10	122.50	111.10	64.00
Moisture Content (%)	26.1%	26.2%	26.6%	26.6%	27.4%	29.2%	24.2%
Comments							

Borehole / Test Pit No.	NL BH40	NL BH40	NL BH40	NL BH40	NL BH40		
Sample	SS16	BS17	SS18	BS19	SS20		
Tare No.	ED	23A	Q11	10A	EV		
Mass Tare Container	8.7	9	8.5	9.2	8.7		
Mass Sample (Wet+Tare) (g)	112	168.7	128.1	109.5	140.3		
Mass Sample (Dry+Tare) (g)	91.1	137	103.3	90.6	114.6		
Mass of Water (g)	20.90	31.70	24.80	18.90	25.70		
Mass Dry Sample (g)	82.40	128.00	94.80	81.40	105.90		
Moisture Content (%)	25.4%	24.8%	26.2%	23.2%	24.3%		
Comments							

Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

Reviewed By: _____

Stantec

Moisture Content of Soil or Aggregate
CSA A23.2-11A
ASTM D2216

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Project:	HUE - Husky SGS Phase 4	Date Tested:	8-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NL-BH40	NL-BH40	NL-BH40	NL-BH40	NL-BH40	NL-BH40	NL-BH40
Sample	**RC27**	**RC25**	**RC23**	**RC33**	**RC35**	**RC70**	**RC36**
Tare No.	7	DD	DA	EF	FA	3	D2
Mass Tare Container	8.6	9	8.5	8.6	8.6	8.8	8.6
Mass Sample (Wet+Tare) (g)	107.7	103.3	177.4	177.5	93.8	132	159.6
Mass Sample (Dry+Tare) (g)	90.9	88.8	148.9	148.9	82.1	114.5	136.4
Mass of Water (g)	16.80	14.50	28.50	28.60	11.70	17.50	23.20
Mass Dry Sample (g)	82.30	79.80	140.40	140.30	73.50	105.70	127.80
Moisture Content (%)	20.4%	18.2%	20.3%	20.4%	15.9%	16.6%	18.2%
Comments							
Borehole / Test Pit No.	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**
Sample	**RC65**	**RC63**	**RC74**	**RC72**	**RC50**	**RC38**	**RC30**
Tare No.	17A	24A	ED	23A	Q11	16A	3A
Mass Tare Container	9.5	9.4	8.7	9.2	8.6	9.2	9.6
Mass Sample (Wet+Tare) (g)	195.5	106.5	106.7	117.4	152.3	102.6	106
Mass Sample (Dry+Tare) (g)	171.4	91.6	90.2	101.7	130.6	87.7	87.1
Mass of Water (g)	24.10	14.90	16.50	15.70	21.70	14.90	18.90
Mass Dry Sample (g)	161.90	82.20	81.50	92.50	122.00	78.50	77.50
Moisture Content (%)	14.9%	18.1%	20.2%	17.0%	17.8%	19.0%	24.4%
Comments							
Borehole / Test Pit No.	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**	**NL-BH40**
Sample	**RC54**	**RC67**	**RC51**	**RC48**	**RC41**	**RC44**	**RC76**
Tare No.	29	ET	EI	ZC	14	Q1	37A
Mass Tare Container	9.2	8.8	9	9.4	9.1	8.6	9.4
Mass Sample (Wet+Tare) (g)	136.8	122.4	102	98.1	107.3	79.4	120.8
Mass Sample (Dry+Tare) (g)	119.3	104.1	89.7	84.8	91.7	70.3	105.6
Mass of Water (g)	17.50	18.30	12.30	13.30	15.60	9.10	15.20
Mass Dry Sample (g)	110.10	95.30	80.70	75.40	82.60	61.70	96.20
Moisture Content (%)	15.9%	19.2%	15.2%	17.6%	18.9%	14.7%	15.8%
Comments							
Borehole / Test Pit No.	**NL-BH40**	**NL-BH40**	**NL-BH40**				
Sample	**RC61**	**RC59**	**RC46**				
Tare No.	C1	D5	DS				
Mass Tare Container	9.4	8.6	8.7				
Mass Sample (Wet+Tare) (g)	112	156.8	125.7				
Mass Sample (Dry+Tare) (g)	97.5	132.3	109.8				
Mass of Water (g)	14.50	24.50	15.90				
Mass Dry Sample (g)	88.10	123.70	101.10				
Moisture Content (%)	16.5%	19.8%	15.7%				
Comments							

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Moisture Content of Soil or Aggregate
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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	**BS1**	**SS2**	**BS3**	**SS4**	**BS5**	**SS6**	**BS7**
Tare No.	32A	21A	D23	1	CN	CB	CA
Mass Tare Container	9.4	9.1	8.4	8.3	8.8	9.1	9.1
Mass Sample (Wet+Tare) (g)	164.1	97.4	130.3	158.4	154.1	109.9	145.4
Mass Sample (Dry+Tare) (g)	132.3	78.9	102.3	120.7	120.4	89.9	127.5
Mass of Water (g)	31.80	18.50	28.00	37.70	33.70	20.00	17.90
Mass Dry Sample (g)	122.90	69.80	93.90	112.40	111.60	80.80	118.40
Moisture Content (%)	25.9%	26.5%	29.8%	33.5%	30.2%	24.8%	15.1%
Comments							
Borehole / Test Pit No.	STANTEC 2						
Sample	**SS8**						
Tare No.	Q4						
Mass Tare Container	8.6						
Mass Sample (Wet+Tare) (g)	149						
Mass Sample (Dry+Tare) (g)	129						
Mass of Water (g)	20.00						
Mass Dry Sample (g)	120.40						
Moisture Content (%)	16.6%						
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

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Project:	HUE - Husky SGS Phase 4	Date Tested:	3-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC9	RC10	RC11-1	RC11-2	RC12	RC13-1	RC13-2
Tare No.	C5	ET	ZC	29	24A	17A	D2
Mass Tare Container	9.2	8.9	9.4	9.2	9.2	9.3	8.5
Mass Sample (Wet+Tare) (g)	131.3	92	213.1	59.7	52.2	136.6	171.6
Mass Sample (Dry+Tare) (g)	116.3	76.5	174.4	49.6	45.3	113.2	138.5
Mass of Water (g)	15.00	15.50	38.70	10.10	6.90	23.40	33.10
Mass Dry Sample (g)	107.10	67.60	165.00	40.40	36.10	103.90	130.00
Moisture Content (%)	14.0%	22.9%	23.5%	25.0%	19.1%	22.5%	25.5%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC14-1	RC15-1	RC15-2	RC16	RC17	RC18	RC19
Tare No.	FA	ER	6	DA	EF	D12	16A
Mass Tare Container	8.6	8.5	8.9	8.5	8.6	8.7	9
Mass Sample (Wet+Tare) (g)	153.2	199.3	68.6	222.6	105.5	85	150.6
Mass Sample (Dry+Tare) (g)	126.9	169.9	60.4	190.6	91.1	72.8	127.4
Mass of Water (g)	26.30	29.40	8.20	32.00	14.40	12.20	23.20
Mass Dry Sample (g)	118.30	161.40	51.50	182.10	82.50	64.10	118.40
Moisture Content (%)	22.2%	18.2%	15.9%	17.6%	17.5%	19.0%	19.6%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC20	RC21-1	RC21-2	RC22	RC24-1	RC24-2	RC25
Tare No.	7	D11	EW	EH	36A	TX	4M
Mass Tare Container	8.7	9	8.6	8.5	9.3	8.7	8.4
Mass Sample (Wet+Tare) (g)	149.2	95.7	121.6	98.5	64	122.2	119
Mass Sample (Dry+Tare) (g)	123.4	81.4	101.6	82.9	53.8	105.5	102.7
Mass of Water (g)	25.80	14.30	20.00	15.60	10.20	16.70	16.30
Mass Dry Sample (g)	114.70	72.40	93.00	74.40	44.50	96.80	94.30
Moisture Content (%)	22.5%	19.8%	21.5%	21.0%	22.9%	17.3%	17.3%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2				
Sample	RC26-1	RC26-2	RC27				
Tare No.	DU	1	34A				
Mass Tare Container	8.5	8.4	9.3				
Mass Sample (Wet+Tare) (g)	120.3	83.2	85.1				
Mass Sample (Dry+Tare) (g)	102.5	72.2	74.1				
Mass of Water (g)	17.80	11.00	11.00				
Mass Dry Sample (g)	94.00	63.80	64.80				
Moisture Content (%)	18.9%	17.2%	17.0%				
Comments							

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Project:	HUE - Husky SGS Phase 4	Date Tested:	3-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC28	RC29	RC30	RC31-1	RC31-2	RC34	RC35
Tare No.	3	D13	Q1	D6	9	222	DO
Mass Tare Container	8.5	8.5	8.7	8.8	8.3	8.9	9.1
Mass Sample (Wet+Tare) (g)	77.8	138.2	67.8	84.6	63.2	125.7	51.1
Mass Sample (Dry+Tare) (g)	66.7	110.2	57.5	72.8	54.2	106.7	43.8
Mass of Water (g)	11.10	28.00	10.30	11.80	9.00	19.00	7.30
Mass Dry Sample (g)	58.20	101.70	48.80	64.00	45.90	97.80	34.70
Moisture Content (%)	19.1%	27.5%	21.1%	18.4%	19.6%	19.4%	21.0%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC37	RC40	RC42	RC44	RC45	RC47	RC49
Tare No.	J4	CT	15	32A	CB	J2	D3
Mass Tare Container	9.3	6.8	8.7	9.6	9.1	9.1	8.5
Mass Sample (Wet+Tare) (g)	81.5	47.2	137.7	79.4	83.1	84.8	58.8
Mass Sample (Dry+Tare) (g)	70.8	38.6	117.6	67.8	71.6	74.5	51.6
Mass of Water (g)	10.70	8.60	20.10	11.60	11.50	10.30	7.20
Mass Dry Sample (g)	61.50	31.80	108.90	58.20	62.50	65.40	43.10
Moisture Content (%)	17.4%	27.0%	18.5%	19.9%	18.4%	15.7%	16.7%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2	STANTEC 2
Sample	RC~~2~~51	RC53	RC54	RC56	RC57	RC59	RC60
Tare No.	17	33A	CL	EX	CM	2	19
Mass Tare Container	8.6	9.1	8.5	8.6	8.7	8.6	8.6
Mass Sample (Wet+Tare) (g)	289.6	70.2	113.9	52.9	53.5	177.1	109.9
Mass Sample (Dry+Tare) (g)	249.6	60.7	98.1	47.1	46.8	154.6	95.8
Mass of Water (g)	40.00	9.50	15.80	5.80	6.70	22.50	14.10
Mass Dry Sample (g)	241.00	51.60	89.60	38.50	38.10	146.00	87.20
Moisture Content (%)	16.6%	18.4%	17.6%	15.1%	17.6%	15.4%	16.2%
Comments							

Borehole / Test Pit No.	STANTEC 2	STANTEC 2	STANTEC 2				
Sample	RC62	RC63	RC65				
Tare No.	3A	EM	EI				
Mass Tare Container	9.6	8.5	8.4				
Mass Sample (Wet+Tare) (g)	179.5	60.1	134.6				
Mass Sample (Dry+Tare) (g)	158.1	53.7	117				
Mass of Water (g)	21.40	6.40	17.60				
Mass Dry Sample (g)	148.50	45.20	108.60				
Moisture Content (%)	14.4%	14.2%	16.2%				
Comments							

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Moisture Content of Soil or Aggregate

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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1
Sample	**BS1**	**SS2**	**BS3**	**SS4**	**BS5**	**SS6**	**BS7**
Tare No.	15	CT	J4	D21	D11	EB	EP
Mass Tare Container	8.7	8.6	9.2	8.5	8.4	8.6	8.6
Mass Sample (Wet+Tare) (g)	122.7	98.6	173	134.4	178.7	137.5	165.4
Mass Sample (Dry+Tare) (g)	97.5	78.8	129.6	108.2	141.7	107.6	126.5
Mass of Water (g)	25.20	19.80	43.40	26.20	37.00	29.90	38.90
Mass Dry Sample (g)	88.80	70.20	120.40	99.70	133.30	99.00	117.90
Moisture Content (%)	28.4%	28.2%	36.0%	26.3%	27.8%	30.2%	33.0%
Comments							
Borehole / Test Pit No.	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**
Sample	**SS8**	**BS9**	**SS10**	**BS11**	**SS12**	**BS13**	**SS14**
Tare No.	D5	TX	4M	DY	34A	3	D13
Mass Tare Container	8.7	8.8	8.4	8.5	9.3	8.4	8.5
Mass Sample (Wet+Tare) (g)	117.1	144.3	135.8	151.6	144.8	194.1	159.3
Mass Sample (Dry+Tare) (g)	90.4	112.4	103.1	119.8	126.3	153.3	126.1
Mass of Water (g)	26.70	31.90	32.70	31.80	18.50	40.80	33.20
Mass Dry Sample (g)	81.70	103.60	94.70	111.30	117.00	144.90	117.60
Moisture Content (%)	32.7%	30.8%	34.5%	28.6%	15.8%	28.2%	28.2%
Comments							
Borehole / Test Pit No.	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	**NSR BH1**	
Sample	**BS15**	**SS16**	**BS17**	**SS18**	**BS19**	**SS20**	
Tare No.	CZ	Q2	DB	9	DE	EX	
Mass Tare Container	8.6	8.7	8.7	8.7	8.6	8.6	
Mass Sample (Wet+Tare) (g)	175.3	149	174.7	116.5	163.3	150.7	
Mass Sample (Dry+Tare) (g)	133.5	119.3	139.8	94.5	133.2	124.6	
Mass of Water (g)	41.80	29.70	34.90	22.00	30.10	26.10	
Mass Dry Sample (g)	124.90	110.60	131.10	85.80	124.60	116.00	
Moisture Content (%)	33.5%	26.9%	26.6%	25.6%	24.2%	22.5%	
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

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Project:	HUE - Husky SGS Phase 4	Date Tested:	3-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1
Sample	**RC21**	**RC22**	**RC23**	**RC24**	**RC25**	**RC26**	**RC27**
Tare No.	EE	ZZ3	EZ	ED	23A	Q11	10A
Mass Tare Container	8.8	8.3	8.4	8.6	9.1	8.5	9.3
Mass Sample (Wet+Tare) (g)	182.6	218.4	185.8	96.3	80.9	228.3	102.3
Mass Sample (Dry+Tare) (g)	152.6	182.2	153.5	80.8	69.8	192.3	86.1
Mass of Water (g)	30.00	36.20	32.30	15.50	11.10	36.00	16.20
Mass Dry Sample (g)	143.80	173.90	145.10	72.20	60.70	183.80	76.80
Moisture Content (%)	20.9%	20.8%	22.3%	21.5%	18.3%	19.6%	21.1%
Comments							
Borehole / Test Pit No.	**NSR BH1**	**NSR BH1**					
Sample	**RC28-1**	**RC28-2**					
Tare No.	EV	16					
Mass Tare Container	8.7	9.7					
Mass Sample (Wet+Tare) (g)	172.3	260					
Mass Sample (Dry+Tare) (g)	141.8	204.8					
Mass of Water (g)	30.50	55.20					
Mass Dry Sample (g)	133.10	195.10					
Moisture Content (%)	22.9%	28.3%					
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

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Project:	HUE - Husky SGS Phase 4	Date Tested:	8-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1
Sample	RC54	RC40	RC56	RC36	RC50	RC38	RC35
Tare No.	C5	D20	19A	27A	EA	DC	DT
Mass Tare Container	9.3	8.8	9.2	9.2	8.6	8.6	8.6
Mass Sample (Wet+Tare) (g)	189.5	225.2	75.7	80.4	146.1	121.9	144.5
Mass Sample (Dry+Tare) (g)	164.6	194.5	66.8	69.6	128.2	107.1	126
Mass of Water (g)	24.90	30.70	8.90	10.80	17.90	14.80	18.50
Mass Dry Sample (g)	155.30	185.70	57.60	60.40	119.60	98.50	117.40
Moisture Content (%)	16.0%	16.5%	15.5%	17.9%	15.0%	15.0%	15.8%
Comments							
Borehole / Test Pit No.	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	NSR BH1	
Sample	RC48	RC45	RC29	RC31	RC46	RC45	
Tare No.	30A	D6	D19	IGGY	8	3	
Mass Tare Container	9.4	8.4	8.6	8.4	8.6	8.8	
Mass Sample (Wet+Tare) (g)	168	73	118.8	42.9	122.9	88	
Mass Sample (Dry+Tare) (g)	145.4	63.2	101.7	37.9	105.9	66.2	
Mass of Water (g)	22.60	9.80	17.10	5.00	17.00	21.80	
Mass Dry Sample (g)	136.00	54.80	93.10	29.50	97.30	57.40	
Moisture Content (%)	16.6%	17.9%	18.4%	16.9%	17.5%	38.0%	
Comments		175'9"				172'3"	
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**BS1**	**SS2**	**BS3**	**SS4**	**BS5**	**SS6**	**BS7**
Tare No.	D1	EB	DT	12	CK	4A	38
Mass Tare Container	8.7	8.6	8.9	8.5	8.5	9.2	9.3
Mass Sample (Wet+Tare) (g)	245.9	83.7	148.6	93.8	149.1	118.6	124.5
Mass Sample (Dry+Tare) (g)	200.9	70.9	113.9	69.8	114.5	85.1	93.4
Mass of Water (g)	45.00	12.80	34.70	24.00	34.60	33.50	31.10
Mass Dry Sample (g)	192.20	62.30	105.00	61.30	106.00	75.90	84.10
Moisture Content (%)	23.4%	20.5%	33.0%	39.2%	32.6%	44.1%	37.0%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**BS9**	**SS14**	**SS18**	**BS19**	**SS20**	**BS21**	**SS22**
Tare No.	DO	15A	CC	7A	14A	1B	CF
Mass Tare Container	9.1	9.5	9.3	9.3	9.5	8.5	9.2
Mass Sample (Wet+Tare) (g)	123.2	104	105.1	106.3	101.8	178.1	84.5
Mass Sample (Dry+Tare) (g)	94.4	81.8	87.9	85.6	87.3	143.5	68.6
Mass of Water (g)	28.80	22.20	17.20	20.70	14.50	34.60	15.90
Mass Dry Sample (g)	85.30	72.30	78.60	76.30	77.80	135.00	59.40
Moisture Content (%)	33.8%	30.7%	21.9%	27.1%	18.6%	25.6%	26.8%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**BS23**	**BS25**	**SS26**	**SS8**	**SS10**	**BS11**	**SS12**
Tare No.	EU	CS	D19	DY	RJ	222	JG
Mass Tare Container	8.7	8.6	8.6	8.9	8.5	9	8.9
Mass Sample (Wet+Tare) (g)	155.8	111.2	38.1	146.6	107.3	129.8	133.3
Mass Sample (Dry+Tare) (g)	126.6	92.1	35.2	117.4	83.4	99.6	104.8
Mass of Water (g)	29.20	19.10	2.90	29.20	23.90	30.20	28.50
Mass Dry Sample (g)	117.90	83.50	26.60	108.50	74.90	90.60	95.90
Moisture Content (%)	24.8%	22.9%	10.9%	26.9%	31.9%	33.3%	29.7%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1		
Sample	**BS13**	**BS15**	**SS16**	**BS17**	**SS24**		
Tare No.	SO	CI	D9	19A	14		
Mass Tare Container	8.6	9.4	8.5	9.3	9.4		
Mass Sample (Wet+Tare) (g)	225.3	169.5	82.2	142.9	117.1		
Mass Sample (Dry+Tare) (g)	176.5	124.5	64.9	112.1	93.7		
Mass of Water (g)	48.80	45.00	17.30	30.80	23.40		
Mass Dry Sample (g)	167.90	115.10	56.40	102.80	84.30		
Moisture Content (%)	29.1%	39.1%	30.7%	30.0%	27.8%		
Comments							

Reviewed By: _____

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Moisture Content of Soil or Aggregate

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ASTM D2216

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Project:	HUE - Husky SGS Phase 4	Date Tested:	1-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**RC35**	**RC35**	**RC37**	**RC38-2**	**RC38-1**	**RC39**	**RC40-1**
Tare No.	CB	CN	32A	Q4	18	CT	J4
Mass Tare Container	9.1	8.8	9.4	8.5	8.7	8.6	9.2
Mass Sample (Wet+Tare) (g)	207.7	126.5	143	112.4	70.6	107.9	97.9
Mass Sample (Dry+Tare) (g)	176.1	108.1	119.6	97.7	61.9	92.1	84.7
Mass of Water (g)	31.60	18.40	23.40	14.70	8.70	15.80	13.20
Mass Dry Sample (g)	167.00	99.30	110.20	89.20	53.20	83.50	75.50
Moisture Content (%)	18.9%	18.5%	21.2%	16.5%	16.4%	18.9%	17.5%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**RC46-1**	**RC46-2**	**RC47**	**RC40-2**	**RC41**	**RC42-1**	**RC42-2**
Tare No.	D21	D11	EB	EP	D5	TX	4M
Mass Tare Container	8.6	8.5	8.6	8.5	8.6	8.8	8.4
Mass Sample (Wet+Tare) (g)	178.9	81.8	76.3	333.1	132.8	132.8	102
Mass Sample (Dry+Tare) (g)	153.7	71.5	65.9	280.5	113.4	113.1	87.1
Mass of Water (g)	25.20	10.30	10.40	52.60	19.40	19.70	14.90
Mass Dry Sample (g)	145.10	63.00	57.30	272.00	104.80	104.30	78.70
Moisture Content (%)	17.4%	16.3%	18.2%	19.3%	18.5%	18.9%	18.9%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1
Sample	**RC28**	**RC43**	**RC29-1**	**RC30**	**RC31**	**RC32-1**	**RC32-2**
Tare No.	DU	1	34A	3	D13	CZ	Q1
Mass Tare Container	8.6	8.4	9.4	8.6	8.6	8.7	8.8
Mass Sample (Wet+Tare) (g)	162.4	129.3	98	107.5	113.7	91.9	148.9
Mass Sample (Dry+Tare) (g)	136.6	110.3	83.3	91.2	96.4	79.2	126.5
Mass of Water (g)	25.80	19.00	14.70	16.30	17.30	12.70	22.40
Mass Dry Sample (g)	128.00	101.90	73.90	82.60	87.80	70.50	117.70
Moisture Content (%)	20.2%	18.6%	19.9%	19.7%	19.7%	18.0%	19.0%
Comments							

Borehole / Test Pit No.	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1	STANTEC 1		
Sample	**RC44-2**	**RC45**	**RC34-1**	**RC34-2**	**RC33**		
Tare No.	DB	9	D19	222	DO		
Mass Tare Container	8.8	8.7	8.7	9.1	9.2		
Mass Sample (Wet+Tare) (g)	74.6	137.6	180.8	142.1	153.5		
Mass Sample (Dry+Tare) (g)	64.5	118	155.8	122.7	128		
Mass of Water (g)	10.10	19.60	25.00	19.40	25.50		
Mass Dry Sample (g)	55.70	109.30	147.10	113.60	118.80		
Moisture Content (%)	18.1%	17.9%	17.0%	17.1%	21.5%		
Comments							

Reviewed By: _____

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Moisture Content of Soil or Aggregate
CSA A23.2-11A
ASTM D2216

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Project:	HUE - Husky SGS Phase 4	Date Tested:	24-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2
Sample	**BS1**	**SS2**	**BS3**	**SS4**	**BS5**	**SS7**	**BS8**
Tare No.	D12	EF	DA	D2	15	Q4	CA
Mass Tare Container	8.8	8.6	8.5	8.6	8.7	8.5	9.1
Mass Sample (Wet+Tare) (g)	183.7	113	117.7	122.1	167.8	109.2	153.5
Mass Sample (Dry+Tare) (g)	146.4	91.1	96	99.4	140.5	87.5	124.3
Mass of Water (g)	37.30	21.90	21.70	22.70	27.30	21.70	29.20
Mass Dry Sample (g)	137.60	82.50	87.50	90.80	131.80	79.00	115.20
Moisture Content (%)	27.1%	26.5%	24.8%	25.0%	20.7%	27.5%	25.3%
Comments							
Borehole / Test Pit No.	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**
Sample	**SS9**	**BS10**	**SS11**	**BS12**	**SS13**	**BS14**	**SS15**
Tare No.	21A	22A	14	19A	D9	CI	SO
Mass Tare Container	9.2	9.4	9.3	9.3	8.5	9.4	8.6
Mass Sample (Wet+Tare) (g)	130.8	133.4	121.9	178.9	127	178.6	118.3
Mass Sample (Dry+Tare) (g)	105.9	107.6	97.5	137.5	96.9	139.2	96.3
Mass of Water (g)	24.90	25.80	24.40	41.40	30.10	39.40	22.00
Mass Dry Sample (g)	96.70	98.20	88.20	128.20	88.40	129.80	87.70
Moisture Content (%)	25.7%	26.3%	27.7%	32.3%	34.0%	30.4%	25.1%
Comments							
Borehole / Test Pit No.	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**
Sample	**BS16**	**SS17**	**BS18**	**SS19**	**BS20**	**SS21**	**BS22**
Tare No.	JL	2Z	IB	DO	FA	ER	6
Mass Tare Container	8.9	9	8.5	9.1	8.6	8.6	8.9
Mass Sample (Wet+Tare) (g)	137	111.4	188.3	120.6	106.3	132.1	156
Mass Sample (Dry+Tare) (g)	112.8	97.3	149.9	103.8	90.3	115.3	122.7
Mass of Water (g)	24.20	14.10	38.40	16.80	16.00	16.80	33.30
Mass Dry Sample (g)	103.90	88.30	141.40	94.70	81.70	106.70	113.80
Moisture Content (%)	23.3%	16.0%	27.2%	17.7%	19.6%	15.7%	29.3%
Comments							
Borehole / Test Pit No.	**NSR BH2**						
Sample	**SS23**						
Tare No.	36A						
Mass Tare Container	9.3						
Mass Sample (Wet+Tare) (g)	107.7						
Mass Sample (Dry+Tare) (g)	89.8						
Mass of Water (g)	17.90						
Mass Dry Sample (g)	80.50						
Moisture Content (%)	22.2%						
Comments							

Reviewed By: _____

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Moisture Content of Soil or Aggregate

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Project:	HUE - Husky SGS Phase 4	Date Tested:	26-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2	NSR BH2
Sample	RC37-1	RC38-1	RC36-1	RC35-1	RC34-2	RC34-1	RC33-1
Tare No.	RJ	D1	D19	CJ	EV	CF	14A
Mass Tare Container	8.5	8.9	8.6	8.7	8.7	9.1	9.5
Mass Sample (Wet+Tare) (g)	87.2	87.2	58.3	63.5	54.3	55.4	177.9
Mass Sample (Dry+Tare) (g)	74.6	73.4	51.1	54.1	46.2	46.8	144.7
Mass of Water (g)	12.60	13.80	7.20	9.40	8.10	8.60	33.20
Mass Dry Sample (g)	66.10	64.50	42.50	45.40	37.50	37.70	135.20
Moisture Content (%)	19.1%	21.4%	16.9%	20.7%	21.6%	22.8%	24.6%
Comments							
Borehole / Test Pit No.	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**
Sample	**RC36-2**	**RC40-1**	**RC40-2**	**RC25-2**	**RC25-1**	**RC28-1**	**RC29-2**
Tare No.	CY	8	D15	96	FB	DC	D20
Mass Tare Container	8.6	8.6	8.5	8.5	8.7	8.7	9
Mass Sample (Wet+Tare) (g)	123.7	119.7	67.8	163.8	80.9	63.2	101.1
Mass Sample (Dry+Tare) (g)	106	100.3	57.9	135.1	63.6	51.4	81.2
Mass of Water (g)	17.70	19.40	9.90	28.70	17.30	11.80	19.90
Mass Dry Sample (g)	97.40	91.70	49.40	126.60	54.90	42.70	72.20
Moisture Content (%)	18.2%	21.2%	20.0%	22.7%	31.5%	27.6%	27.6%
Comments							
Borehole / Test Pit No.	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**		
Sample	**BS27-2**	**RC38-2**	**RC39-1**	**RC31-2**	**RC30-1**		
Tare No.	IGGY	EZ1	CH	DT	CK		
Mass Tare Container	8.7	8.6	9.4	9.2	8		
Mass Sample (Wet+Tare) (g)	143.4	144.3	124	45.9	159.3		
Mass Sample (Dry+Tare) (g)	114.1	122.7	104.6	37.9	126.5		
Mass of Water (g)	29.30	21.60	19.40	8.00	32.80		
Mass Dry Sample (g)	105.40	114.10	95.20	28.70	118.50		
Moisture Content (%)	27.8%	18.9%	20.4%	27.9%	27.7%		
Comments							
Borehole / Test Pit No.	**NSR BH2**	**NSR BH2**	**NSR BH2**	**NSR BH2**			
Sample	**BS26-1**	**BS27-1**	**RC31-1**	**BS29-1**			
Tare No.	4A	38	CC	7A			
Mass Tare Container	9.4	9.4	9.5	9.3			
Mass Sample (Wet+Tare) (g)	62	86.1	86.4	132			
Mass Sample (Dry+Tare) (g)	50.2	68.1	75	107.4			
Mass of Water (g)	11.80	18.00	11.40	24.60			
Mass Dry Sample (g)	40.80	58.70	65.50	98.10			
Moisture Content (%)	28.9%	30.7%	17.4%	25.1%			
Comments							

Reviewed By: _____

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Moisture Content of Soil or Aggregate
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ASTM D2216

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Project:	HUE - Husky SGS Phase 4	Date Tested:	7-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03
Sample	BS1	SS2	BS3	SS4	BS5	SS6	BS7
Tare No.	CW	36A	EH	EW	DH	7	EF
Mass Tare Container	8.5	9.4	8.6	8.7	9	8.7	8.6
Mass Sample (Wet+Tare) (g)	197.1	134	231.9	133.1	262.1	143	169.4
Mass Sample (Dry+Tare) (g)	153.7	106.3	178	103.4	194.3	109	136.9
Mass of Water (g)	43.40	27.70	53.90	29.70	67.80	34.00	32.50
Mass Dry Sample (g)	145.20	96.90	169.40	94.70	185.30	100.30	128.30
Moisture Content (%)	29.9%	28.6%	31.8%	31.4%	36.6%	33.9%	25.3%
Comments							
Borehole / Test Pit No.	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03
Sample	SS8	BS9	SS10	BS11	SS12	BS13	SS14
Tare No.	DA	6	FA	D2	17A	24A	29
Mass Tare Container	8.5	8.8	8.6	8.8	9.6	9.2	9.2
Mass Sample (Wet+Tare) (g)	138.5	163.8	114.1	123.8	120.3	192	115.7
Mass Sample (Dry+Tare) (g)	109.4	129.7	90.5	101.9	100.2	157.4	97.4
Mass of Water (g)	29.10	34.10	23.60	21.90	20.10	34.60	18.30
Mass Dry Sample (g)	100.90	120.90	81.90	93.10	90.60	148.20	88.20
Moisture Content (%)	28.8%	28.2%	28.8%	23.5%	22.2%	23.3%	20.7%
Comments							
Borehole / Test Pit No.	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03
Sample	BS15	SS16	BS17	BS19	BS23	SS24	???
Tare No.	26	ET	C5	10A	Q11	23A	ED
Mass Tare Container	9	8.5	8.9	9.2	8.6	9.2	8.7
Mass Sample (Wet+Tare) (g)	158.3	144.9	90.2	215.5	156.6	191	182.3
Mass Sample (Dry+Tare) (g)	134.2	121.5	71.5	183.4	131.1	162.6	151.6
Mass of Water (g)	24.10	23.40	18.70	32.10	25.50	28.40	30.70
Mass Dry Sample (g)	125.20	113.00	62.60	174.20	122.50	153.40	142.90
Moisture Content (%)	19.2%	20.7%	29.9%	18.4%	20.8%	18.5%	21.5%
Comments							unlabelled sample
Borehole / Test Pit No.	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03	NSR-BH03
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

Reviewed By: _____

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Project:	HUE - Husky SGS Phase 4	Date Tested:	15-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH3	NSR BH3	NSR BH3	NSR BH3	NSR BH3	NSR BH3	NSR BH3
Sample	**RC35**	**RC41**	**RC43**	**RC37**	**RC65**	**RC58**	**RC63**
Tare No.	114	ER	D10	D21	D23	CA	15A
Mass Tare Container	8.6	8.5	8.6	8.6	8.2	9.1	9.4
Mass Sample (Wet+Tare) (g)	411.2	167.4	293.8	128.8	249.6	149.3	153.1
Mass Sample (Dry+Tare) (g)	362.2	146.5	254.5	110.6	219.4	122.2	134.7
Mass of Water (g)	49.00	20.90	39.30	18.20	30.20	27.10	18.40
Mass Dry Sample (g)	353.60	138.00	245.90	102.00	211.20	113.10	125.30
Moisture Content (%)	13.9%	15.1%	16.0%	17.8%	14.3%	24.0%	14.7%
Comments						BENTONITE SEAM	
Borehole / Test Pit No.	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**
Sample	**RC47**	**RC25**	**RC29**	**RC61**	**RC53**	**RC59**	**RC45**
Tare No.	IB	CS	SO	EM	ZZ3	EE	C5
Mass Tare Container	8.5	8.6	8.6	8.5	8.4	8.7	9.2
Mass Sample (Wet+Tare) (g)	224.2	154.7	145.7	163.8	110.5	330.4	415.1
Mass Sample (Dry+Tare) (g)	194.2	130.7	123.9	142.8	97	294.5	365.9
Mass of Water (g)	30.00	24.00	21.80	21.00	13.50	35.90	49.20
Mass Dry Sample (g)	185.70	122.10	115.30	134.30	88.60	285.80	356.70
Moisture Content (%)	16.2%	19.7%	18.9%	15.6%	15.2%	12.6%	13.8%
Comments							
Borehole / Test Pit No.	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**
Sample	**RC33**	**RC49**	**RC55**	**RC69**	**RC39**	**RC31**	**RC67**
Tare No.	4A	CF	RJ	D20	19A	77A	FA
Mass Tare Container	9.1	8.1	8.4	8.8	9.3	9.2	8.4
Mass Sample (Wet+Tare) (g)	186	282.2	301.2	172.2	171.9	329.2	176.1
Mass Sample (Dry+Tare) (g)	159.8	246.7	264.1	152.4	147.7	282.9	155.4
Mass of Water (g)	26.20	35.50	37.10	19.80	24.20	46.30	20.70
Mass Dry Sample (g)	150.70	238.60	255.70	143.60	138.40	273.70	147.00
Moisture Content (%)	17.4%	14.9%	14.5%	13.8%	17.5%	16.9%	14.1%
Comments							
Borehole / Test Pit No.	**NSR BH3**	**NSR BH3**	**NSR BH3**	**NSR BH3**			
Sample	**RC71**	**RC57**	**RC27**	**RC51**			
Tare No.	DC	DT	EU	30A			
Mass Tare Container	8.6	8.6	8.7	9.3			
Mass Sample (Wet+Tare) (g)	185.3	124.6	212.6	168			
Mass Sample (Dry+Tare) (g)	163.1	106.3	180.4	147.3			
Mass of Water (g)	22.20	18.30	32.20	20.70			
Mass Dry Sample (g)	154.50	97.70	171.70	138.00			
Moisture Content (%)	14.4%	18.7%	18.8%	15.0%			
Comments							

Reviewed By: _____

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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 6, 2016
Tested By:	JA

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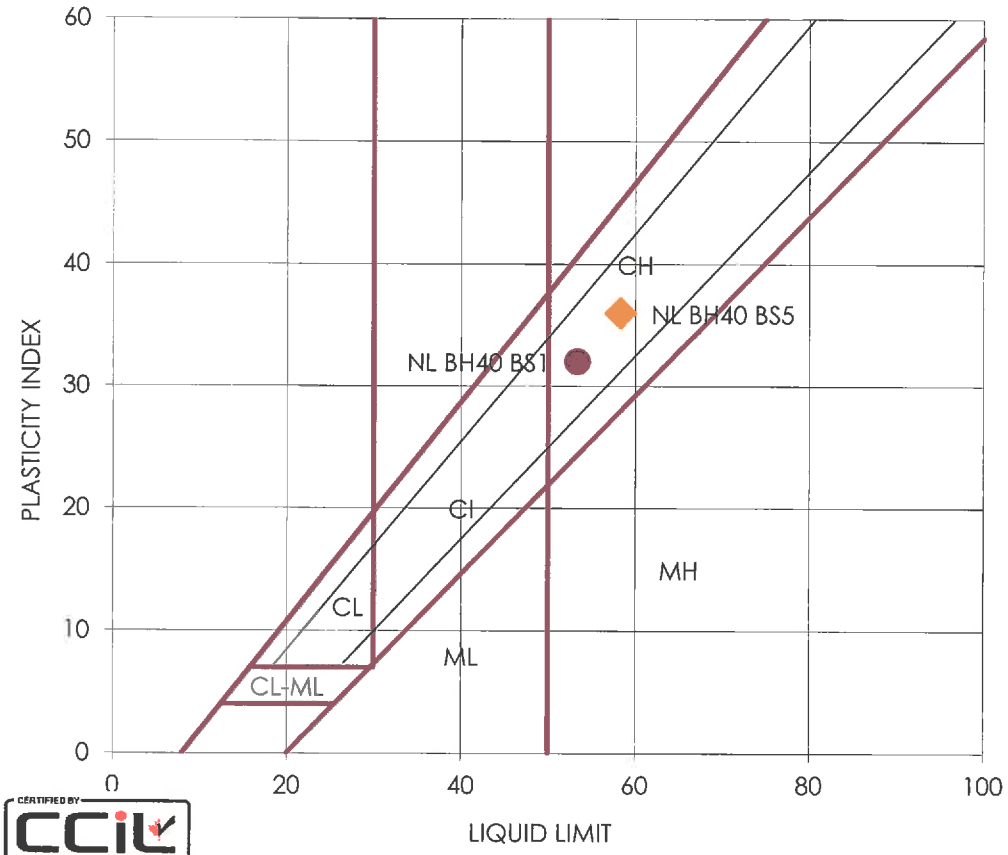
Sample: NL BH40 BS1			Sample: NL BH40 BS5	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	20	21
23B	42B	Container Number	22B	37
37.55	37.39	Wt. Sample (wet+tare)(g)	37.26	33.51
29.67	29.68	Wt. Sample (dry+tare)(g)	29.10	26.70
15.26	15.57	Wt. Tare (g)	15.53	15.24
14.4	14.1	Wt. Dry Soil (g)	13.6	11.5
7.9	7.7	Wt. Water (g)	8.2	6.8
54.7%	54.6%	Water Content (%)	60.1%	59.4%
53.2%	53.5%	Corrected Water Content (%)	58.5%	58.2%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BS	BE	Container Number	AI	AM
20.38	20.57	Wt. Sample (wet+tare)(g)	20.35	20.8
19.26	19.4	Wt. Sample (dry+tare)(g)	19.21	19.53
13.92	13.88	Wt. Tare (g)	14.1	13.85
5.3	5.5	Wt. Dry Soil (g)	5.1	5.7
1.1	1.2	Wt. Water (g)	1.1	1.3
21.0%	21.2%	Water Content (%)	22.3%	22.4%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	53		LL	58
PL	21		PL	22
PI	32		PI	36
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 6, 2016
Tested By:	JA

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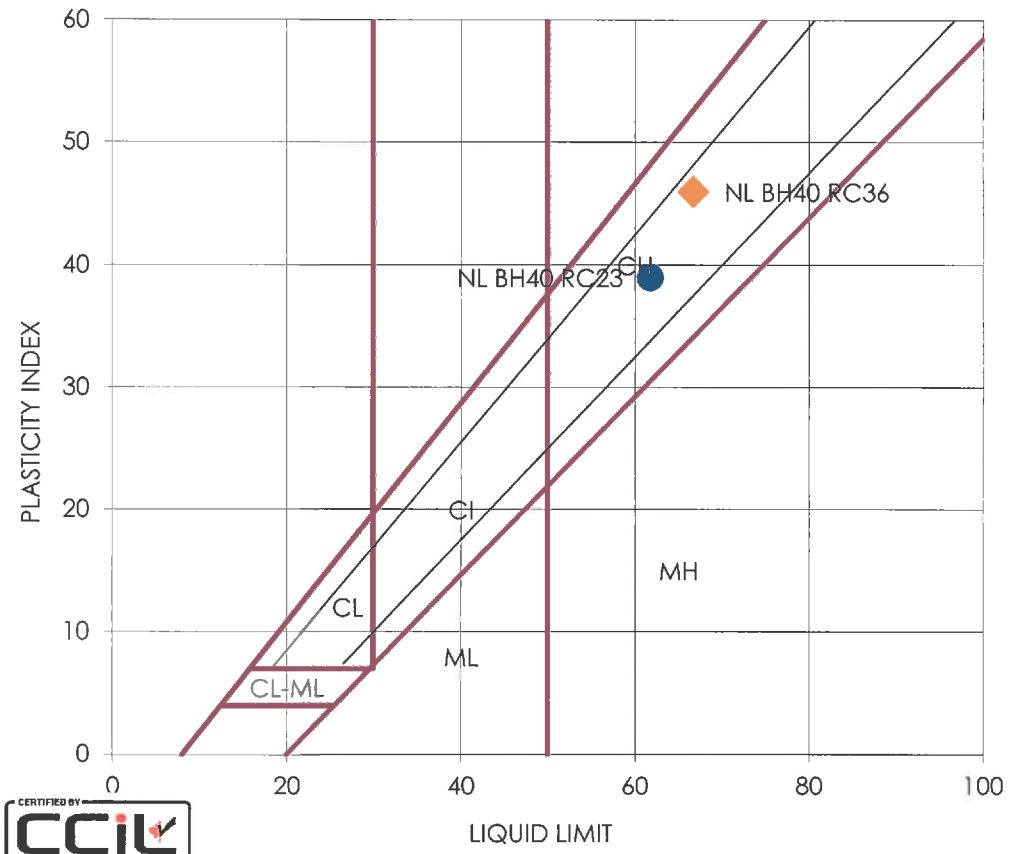
Sample: NL BH40 RC23			Sample: NL BH40 RC36	
LIQUID			LIQUID	
1	2	Trial No.	1	2
25	24	Number of Blows	21	21
40B	45B	Container Number	23B	26B
38.36	36.97	Wt. Sample (wet+tare)(g)	34.42	36.59
29.56	28.81	Wt. Sample (dry+tare)(g)	26.65	28.02
15.28	15.70	Wt. Tare (g)	15.25	15.45
14.3	13.1	Wt. Dry Soil (g)	11.4	12.6
8.8	8.2	Wt. Water (g)	7.8	8.6
61.6%	62.2%	Water Content (%)	68.2%	68.2%
61.6%	61.9%	Corrected Water Content (%)	66.7%	66.8%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AH	AJ	Container Number	AR	AO
20.01	20.59	Wt. Sample (wet+tare)(g)	20.56	20.97
18.9	19.41	Wt. Sample (dry+tare)(g)	19.44	19.77
13.97	14.18	Wt. Tare (g)	14.12	14.18
4.9	5.2	Wt. Dry Soil (g)	5.3	5.6
1.1	1.2	Wt. Water (g)	1.1	1.2
22.5%	22.6%	Water Content (%)	21.1%	21.5%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	62		LL	67
PL	23		PL	21
PI	39		PI	46
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

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Tested By:	JA

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Sample: STANTEC2 BS1

LIQUID		
1	2	Trial No.
20	20	Number of Blows
44B	6B	Container Number
36.04	34.25	Wt. Sample (wet+tare)(g)
27.40	26.31	Wt. Sample (dry+tare)(g)
15.54	15.13	Wt. Tare (g)
11.9	11.2	Wt. Dry Soil (g)
8.6	7.9	Wt. Water (g)
72.8%	71.0%	Water Content (%)
70.9%	69.1%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
BK	AR	Container Number
20.7	20.27	Wt. Sample (wet+tare)(g)
19.17	18.78	Wt. Sample (dry+tare)(g)
14.35	14.12	Wt. Tare (g)
4.8	4.7	Wt. Dry Soil (g)
1.5	1.5	Wt. Water (g)
31.7%	32.0%	Water Content (%)

AVERAGE VALUES	
1	2
LL	70
PL	32
PI	38

CLASSIFICATION: CH

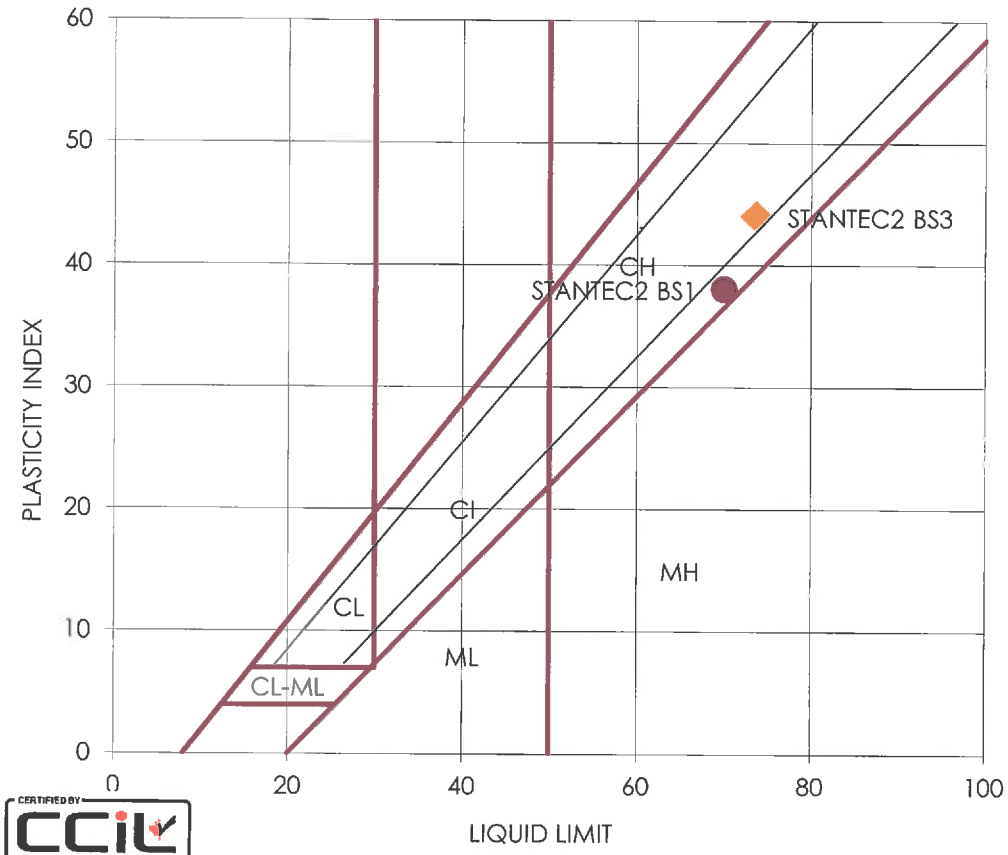
Sample: STANTEC2 BS3

LIQUID		
1	2	Trial No.
21	21	Number of Blows
8B	35B	Container Number
36.28	36.69	Wt. Sample (wet+tare)(g)
27.28	27.66	Wt. Sample (dry+tare)(g)
15.37	15.64	Wt. Tare (g)
11.9	12.0	Wt. Dry Soil (g)
9.0	9.0	Wt. Water (g)
75.6%	75.1%	Water Content (%)
74.0%	73.6%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
AH	AO	Container Number
20.38	20.63	Wt. Sample (wet+tare)(g)
18.88	19.15	Wt. Sample (dry+tare)(g)
13.98	14.18	Wt. Tare (g)
4.9	5.0	Wt. Dry Soil (g)
1.5	1.5	Wt. Water (g)
30.6%	29.8%	Water Content (%)

AVERAGE VALUES	
1	2
LL	74
PL	30
PI	44

CLASSIFICATION: CH



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 6, 2016
Tested By:	JA

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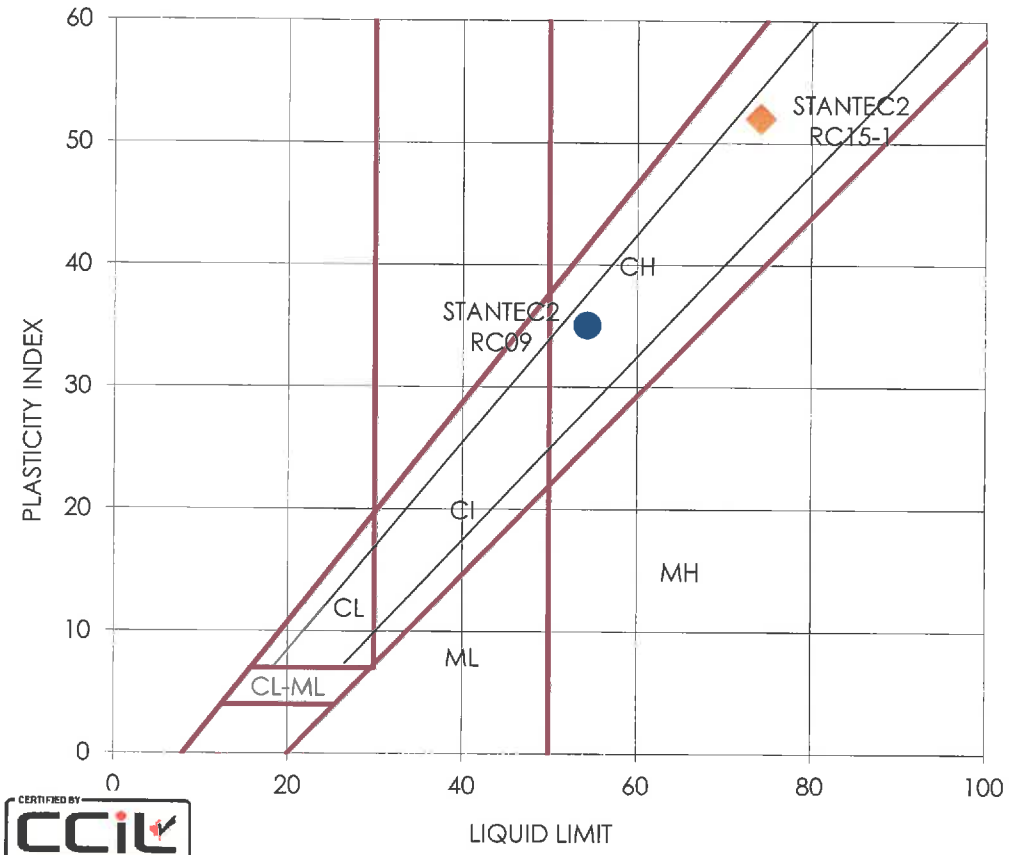
Sample: STANTEC2 RC09			Sample: STANTEC2 RC15-1	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	20	20
19B	11B	Container Number	21B	4B
36.55	36.67	Wt. Sample (wet+tare)(g)	36.04	35.67
28.94	29.09	Wt. Sample (dry+tare)(g)	27.20	26.97
15.22	15.51	Wt. Tare (g)	15.57	15.60
13.7	13.6	Wt. Dry Soil (g)	11.6	11.4
7.6	7.6	Wt. Water (g)	8.8	8.7
55.5%	55.8%	Water Content (%)	76.0%	76.5%
54.0%	54.7%	Corrected Water Content (%)	74.0%	74.5%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BR	BQ	Container Number	AX	AY
21.78	20.58	Wt. Sample (wet+tare)(g)	20.01	20.68
20.58	19.57	Wt. Sample (dry+tare)(g)	18.87	19.52
14.13	14.08	Wt. Tare (g)	13.75	14.08
6.5	5.5	Wt. Dry Soil (g)	5.1	5.4
1.2	1.0	Wt. Water (g)	1.1	1.2
18.6%	18.4%	Water Content (%)	22.3%	21.3%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	54		LL	74
PL	19		PL	22
PI	35		PI	52
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
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Tested By:	JA

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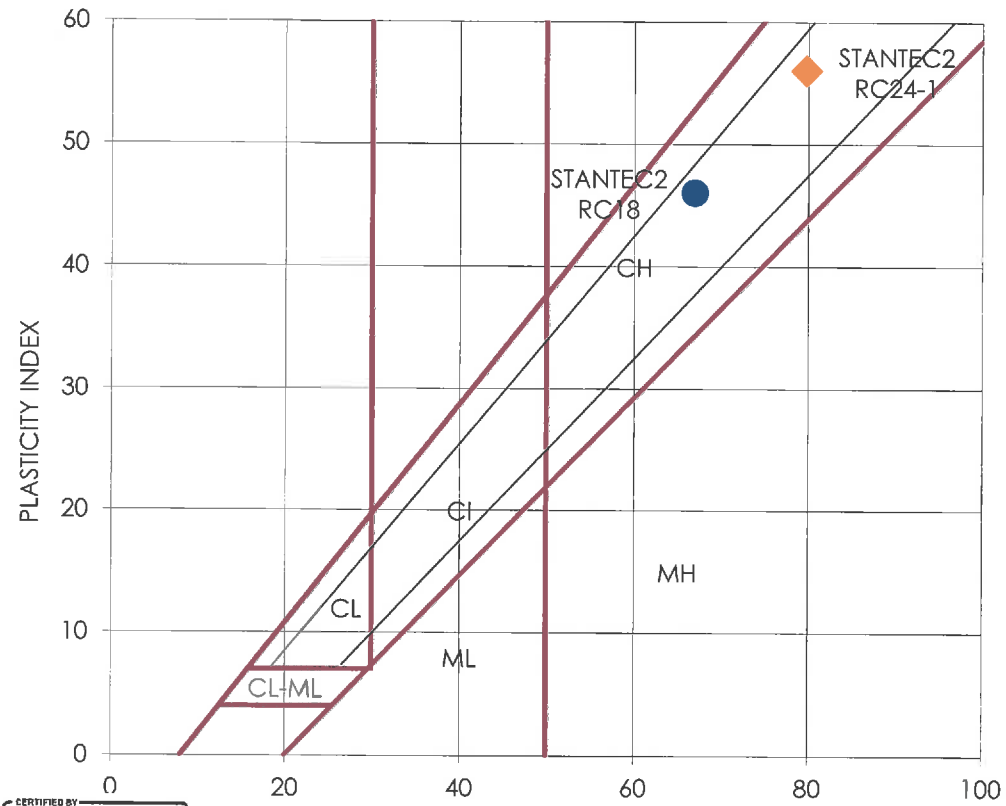
Sample:

STANTEC2 RC18			STANTEC2 RC24-1	
LIQUID			LIQUID	
1	2	Trial No.	1	2
21	21	Number of Blows	27	29
18B	33B	Container Number	7B	14B
35.37	35.40	Wt. Sample (wet+tare)(g)	38.05	32.98
27.23	27.24	Wt. Sample (dry+tare)(g)	28.12	25.29
15.18	15.47	Wt. Tare (g)	15.56	15.49
12.1	11.8	Wt. Dry Soil (g)	12.6	9.8
8.1	8.2	Wt. Water (g)	9.9	7.7
67.6%	69.3%	Water Content (%)	79.1%	78.5%
66.1%	67.9%	Corrected Water Content (%)	79.8%	79.9%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BH	BM	Container Number	BI	BT
20.2	20.14	Wt. Sample (wet+tare)(g)	20.99	20.42
19.17	19.06	Wt. Sample (dry+tare)(g)	19.66	19.18
14.05	13.91	Wt. Tare (g)	14.2	13.95
5.1	5.2	Wt. Dry Soil (g)	5.5	5.2
1.0	1.1	Wt. Water (g)	1.3	1.2
20.1%	21.0%	Water Content (%)	24.4%	23.7%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	67		LL	80
PL	21		PL	24
PI	46		PI	56
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 8, 2016
Tested By:	JA

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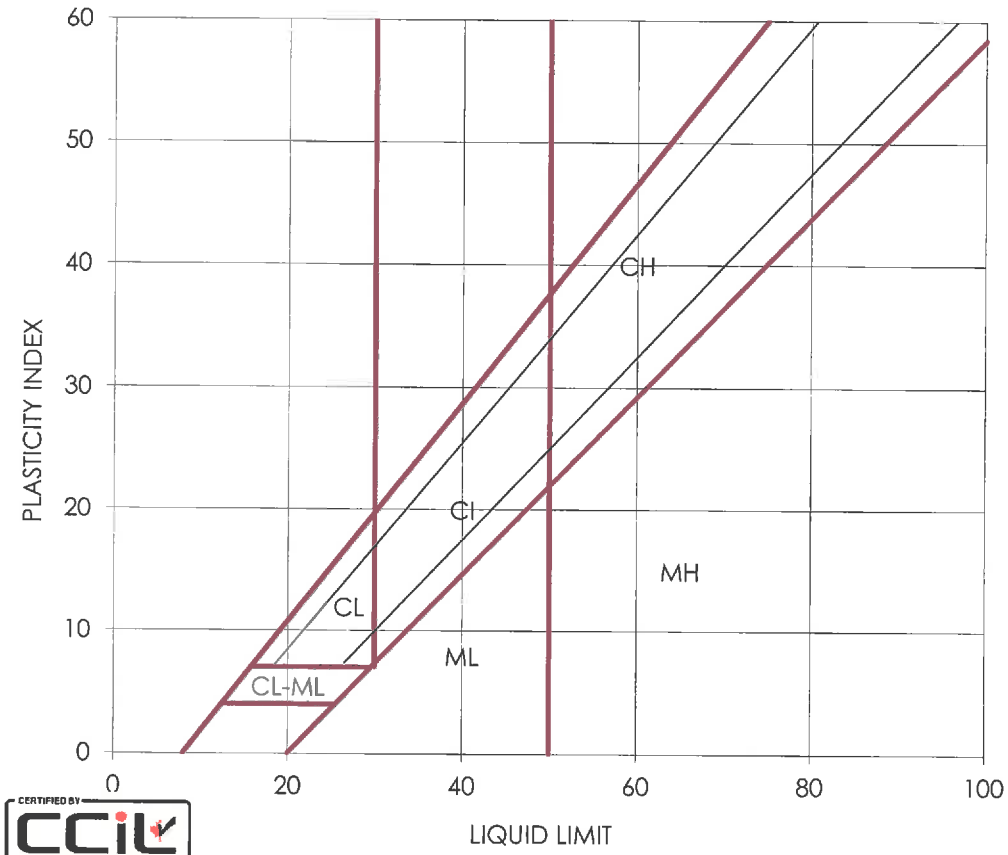
Sample:

STANTEC2 RC29		
LIQUID		
1	2	Trial No.
28	30	Number of Blows
39B	20B	Container Number
35.54	32.10	Wt. Sample (wet+tare)(g)
25.88	24.08	Wt. Sample (dry+tare)(g)
15.46	15.47	Wt. Tare (g)
10.4	8.6	Wt. Dry Soil (g)
9.7	8.0	Wt. Water (g)
92.7%	93.1%	Water Content (%)
94.0%	95.2%	Corrected Water Content (%)
PLASTIC		
1	2	Trial No.
BL	AD	Container Number
20.82	20.94	Wt. Sample (wet+tare)(g)
19.46	19.55	Wt. Sample (dry+tare)(g)
14.2	14.2	Wt. Tare (g)
5.3	5.4	Wt. Dry Soil (g)
1.4	1.4	Wt. Water (g)
25.9%	26.0%	Water Content (%)
AVERAGE VALUES		
1	2	
LL	95	
PL	26	
PI	69	
CLASSIFICATION		
CH		

Sample:

STANTEC2 RC42	
LIQUID	
1	2
23	25
13B	27B
35.08	35.11
25.43	25.52
15.71	15.79
9.7	9.7
9.7	9.6
99.3%	98.6%
98.3%	98.6%
PLASTIC	
1	2
AC	AQ
20.42	20.08
19.1	18.76
14.22	13.88
4.9	4.9
1.3	1.3
27.0%	27.0%
AVERAGE VALUES	
1	2
LL	98
PL	27
PI	71
CLASSIFICATION	
CH	



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ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
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Project No:	110902147
Date Received:	August 9, 2016
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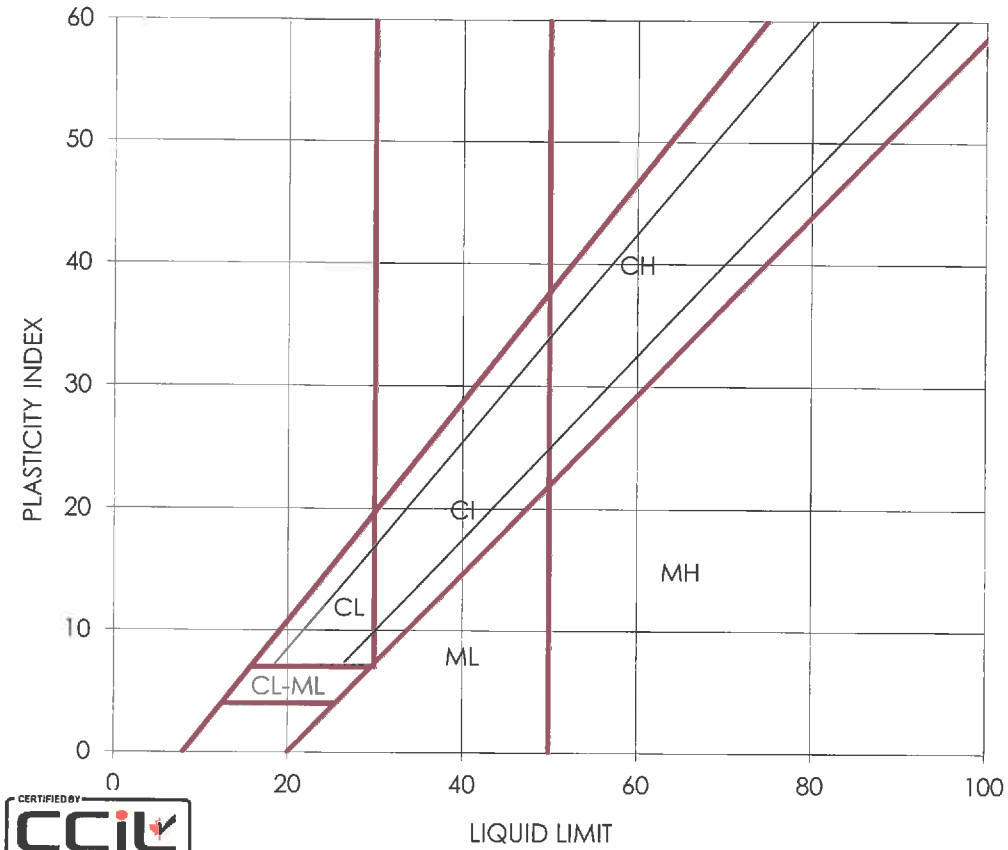
Sample:

STANTEC2 RC44			STANTEC2 RC51	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	22	22
17B	24B	Container Number	31B	34B
36.96	33.63	Wt. Sample (wet+tare)(g)	33.55	34.24
26.06	24.31	Wt. Sample (dry+tare)(g)	25.12	25.40
15.43	15.22	Wt. Tare (g)	15.53	15.28
10.6	9.1	Wt. Dry Soil (g)	9.6	10.1
10.9	9.3	Wt. Water (g)	8.4	8.8
102.5%	102.5%	Water Content (%)	87.9%	87.4%
99.8%	100.4%	Corrected Water Content (%)	86.6%	86.0%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AT	AA	Container Number	AE	AU
20.17	20.54	Wt. Sample (wet+tare)(g)	20.77	20.9
18.86	19.2	Wt. Sample (dry+tare)(g)	19.5	19.64
13.84	14.12	Wt. Tare (g)	14.11	14.13
5.0	5.1	Wt. Dry Soil (g)	5.4	5.5
1.3	1.3	Wt. Water (g)	1.3	1.3
26.1%	26.4%	Water Content (%)	23.6%	22.9%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	100		LL	86
PL	26		PL	23
PI	74		PI	63
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Method B- One Point

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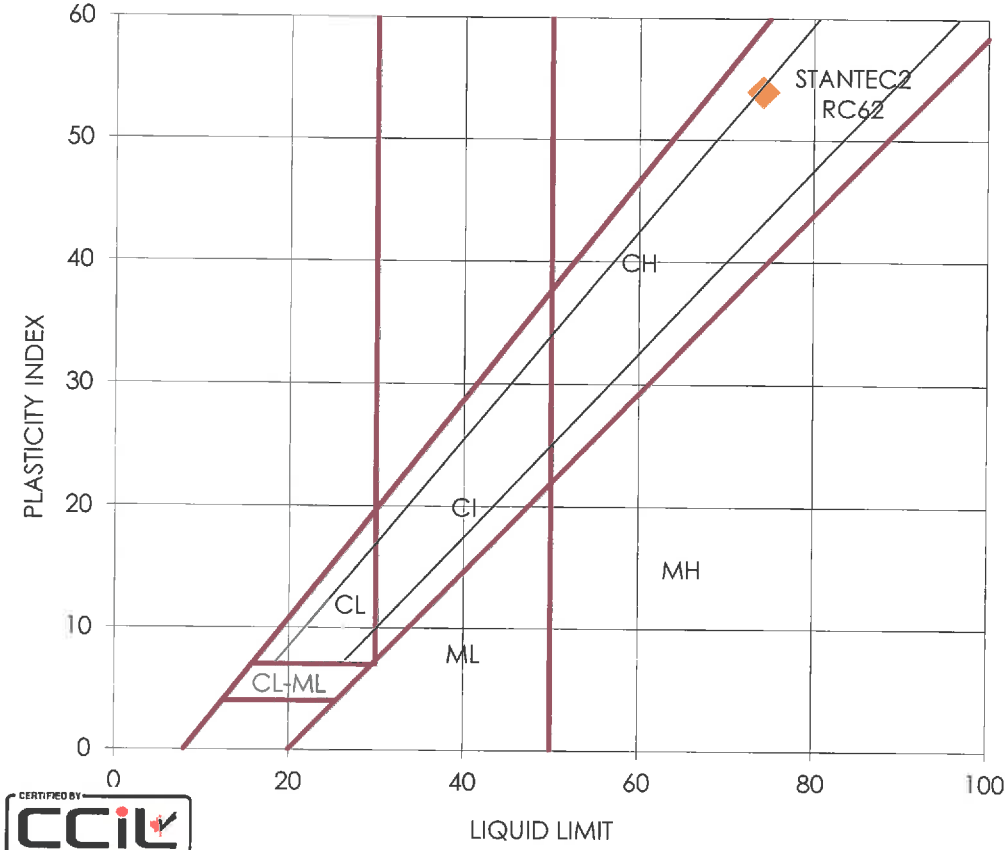
Sample:

STANTEC2 RC59			STANTEC2 RC62	
LIQUID			LIQUID	
1	2	Trial No.	1	2
25	25	Number of Blows	21	22
37B	22B	Container Number	9B	41B
35.55	35.05	Wt. Sample (wet+tare)(g)	34.90	38.28
25.83	25.72	Wt. Sample (dry+tare)(g)	26.56	28.52
15.24	15.53	Wt. Tare (g)	15.59	15.52
10.6	10.2	Wt. Dry Soil (g)	11.0	13.0
9.7	9.3	Wt. Water (g)	8.3	9.8
91.8%	91.6%	Water Content (%)	76.0%	75.1%
91.8%	91.6%	Corrected Water Content (%)	74.4%	73.9%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AI	AM	Container Number	AS	AW
20.34	20.6	Wt. Sample (wet+tare)(g)	20.31	20.79
19.18	19.37	Wt. Sample (dry+tare)(g)	19.26	19.69
14.1	13.85	Wt. Tare (g)	14.13	14.25
5.1	5.5	Wt. Dry Soil (g)	5.1	5.4
1.2	1.2	Wt. Water (g)	1.1	1.1
22.8%	22.3%	Water Content (%)	20.5%	20.2%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	92		LL	74
PL	23		PL	20
PI	69		PI	54
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Method B- One Point

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Project No:	110902147
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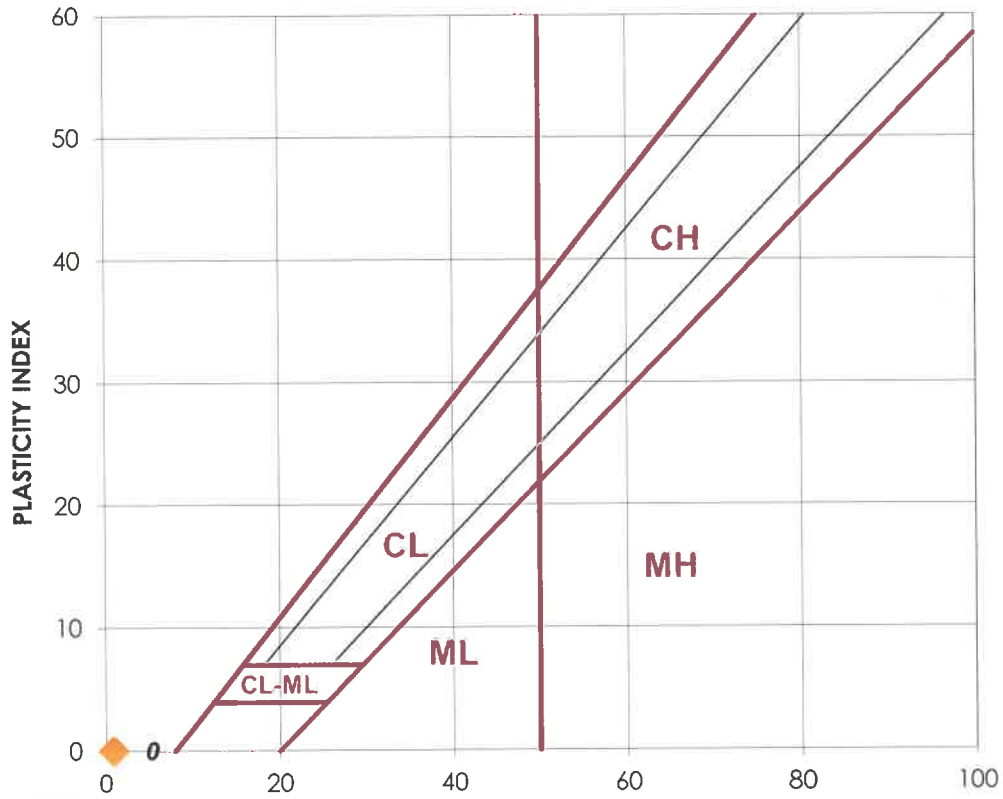
Sample:			Sample:	
STANTEC2 RC65				
LIQUID			LIQUID	
1	2	Trial No.	1	2
28	29	Number of Blows		
15B	3B	Container Number		
36.95	36.24	Wt. Sample (wet+tare)(g)		
27.03	26.57	Wt. Sample (dry+tare)(g)		
15.52	15.37	Wt. Tare (g)		
11.5	11.2	Wt. Dry Soil (g)		
9.9	9.7	Wt. Water (g)		
86.2%	86.3%	Water Content (%)		
87.4%	87.9%	Corrected Water Content (%)		
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BD	BN	Container Number		
20.28	20.22	Wt. Sample (wet+tare)(g)		
19.11	19.05	Wt. Sample (dry+tare)(g)		
14.12	14.04	Wt. Tare (g)		
5.0	5.0	Wt. Dry Soil (g)		
1.2	1.2	Wt. Water (g)		
23.4%	23.4%	Water Content (%)		
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	88		LL	
PL	23		PL	
PI	65		PI	
CLASSIFICATION			CLASSIFICATION	
CH			NON-PLASTIC	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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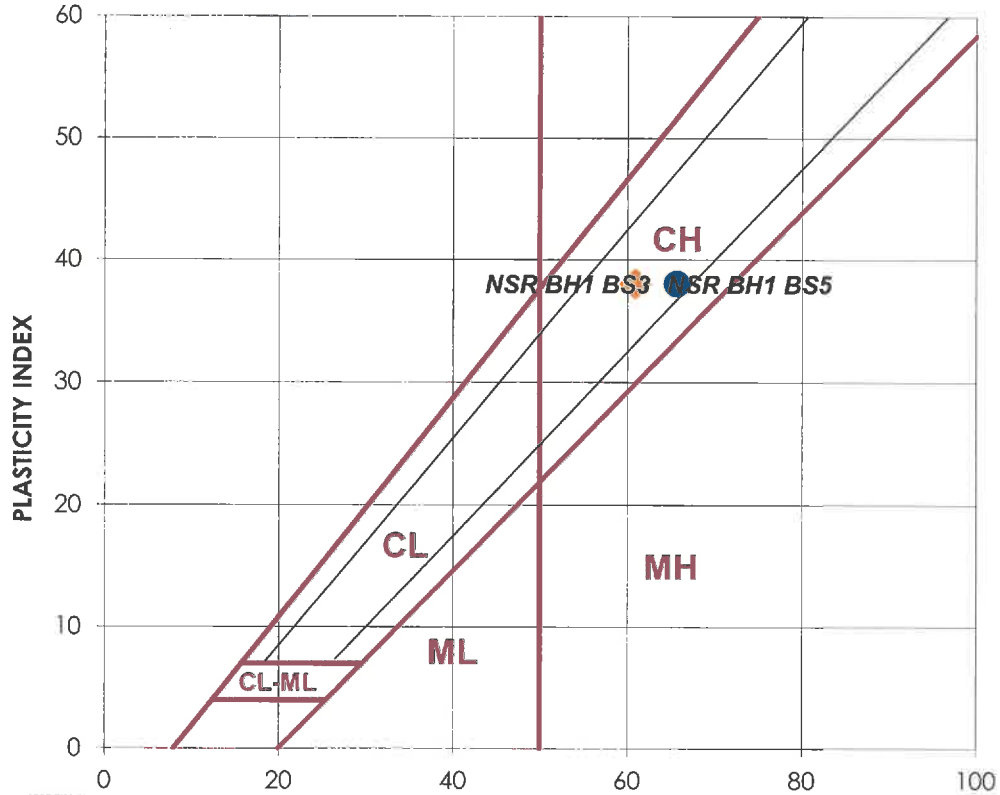
Sample: NSR BH1 BS3			Sample: NSR BH1 BS5	
LIQUID			LIQUID	
1	2	Trial No.	1	2
28	30	Number of Blows	20	20
4B	21B	Container Number	19B	11B
36.52	36.34	Wt. Sample (wet+tare)(g)	29.85	31.34
28.32	28.21	Wt. Sample (dry+tare)(g)	24.21	25.25
15.62	15.60	Wt. Tare (g)	15.22	15.51
12.7	12.6	Wt. Dry Soil (g)	9.0	9.7
8.2	8.1	Wt. Water (g)	5.6	6.1
64.6%	64.5%	Water Content (%)	62.7%	62.5%
65.5%	65.9%	Corrected Water Content (%)	61.1%	60.9%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AK	AN	Container Number	AZ	BU
20.68	20.83	Wt. Sample (wet+tare)(g)	20.13	23.25
19.29	19.38	Wt. Sample (dry+tare)(g)	18.97	21.53
14.27	14.14	Wt. Tare (g)	13.93	14.17
5.0	5.2	Wt. Dry Soil (g)	5.0	7.4
1.4	1.5	Wt. Water (g)	1.2	1.7
27.7%	27.7%	Water Content (%)	23.0%	23.4%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	66		LL	61
PL	28		PL	23
PI	38		PI	38
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 8, 2016
Tested By:	JA

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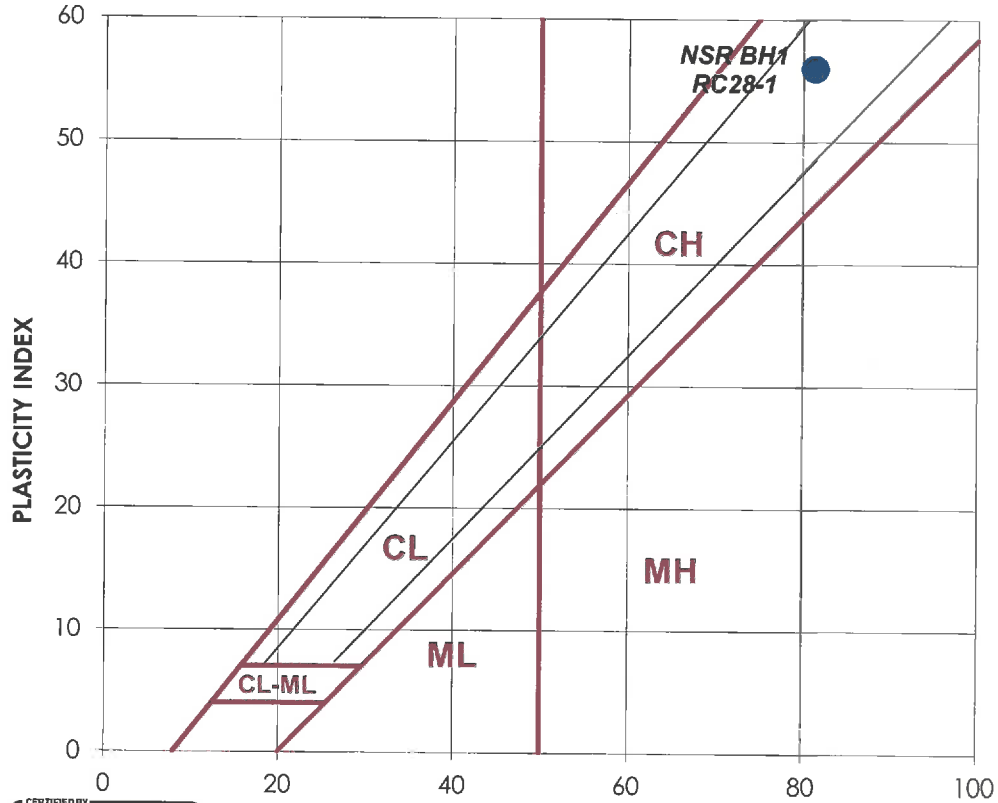
Sample:

NSR BH1 RC28-1			NSR BH1 RC28-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
29	29	Number of Blows	22	23
46B	12B	Container Number	23B	42B
34.97	35.91	Wt. Sample (wet+tare)(g)	31.65	33.60
26.22	26.60	Wt. Sample (dry+tare)(g)	21.73	22.69
15.26	14.97	Wt. Tare (g)	15.26	15.56
11.0	11.6	Wt. Dry Soil (g)	6.5	7.1
8.8	9.3	Wt. Water (g)	9.9	10.9
79.8%	80.1%	Water Content (%)	153.3%	153.0%
81.3%	81.5%	Corrected Water Content (%)	151.0%	151.5%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BC	BF	Container Number	BS	BE
20.57	21.01	Wt. Sample (wet+tare)(g)	20.11	20.27
19.3	19.66	Wt. Sample (dry+tare)(g)	18.09	18.2
14.19	14.14	Wt. Tare (g)	13.91	13.86
5.1	5.5	Wt. Dry Soil (g)	4.2	4.3
1.3	1.4	Wt. Water (g)	2.0	2.1
24.9%	24.5%	Water Content (%)	48.3%	47.7%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	81		LL	151
PL	25		PL	48
PI	56		PI	103
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Reviewed By:

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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 10, 2016
Tested By:	JA

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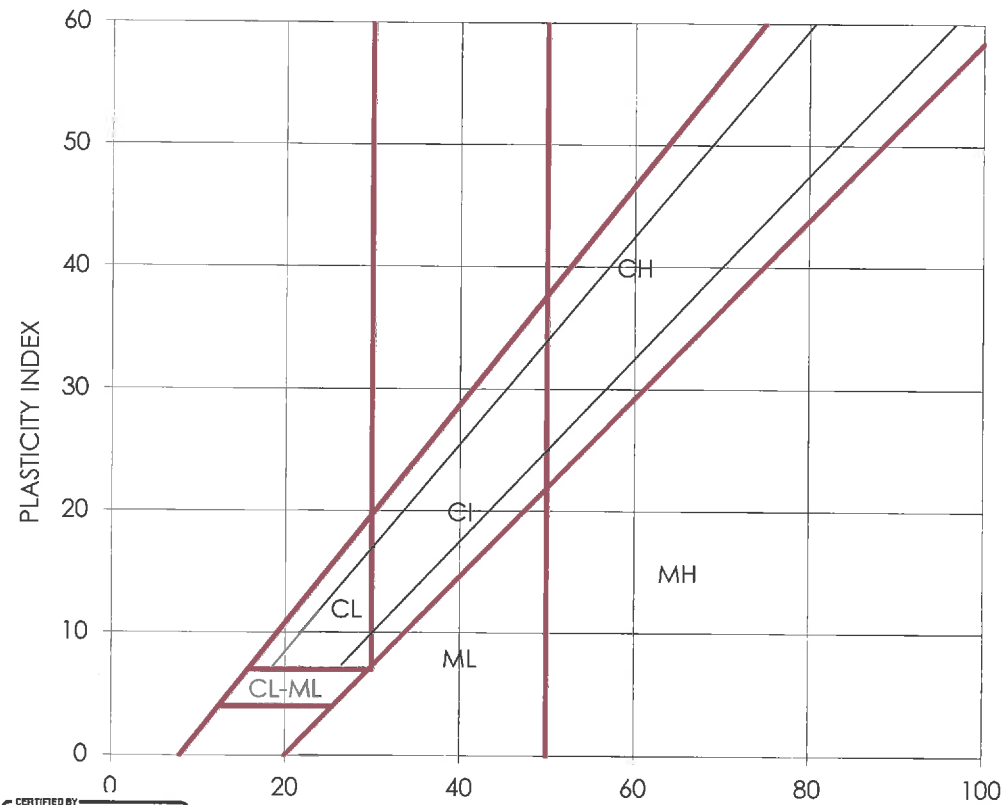
Sample:

NSR BH1 RC43-1			NSR BH1 RC43-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	25	29
35B	8B	Container Number	6B	44B
38.73	34.19	Wt. Sample (wet+tare)(g)	34.39	32.36
26.54	24.26	Wt. Sample (dry+tare)(g)	23.28	22.73
15.65	15.36	Wt. Tare (g)	15.13	15.53
10.9	8.9	Wt. Dry Soil (g)	8.2	7.2
12.2	9.9	Wt. Water (g)	11.1	9.6
111.9%	111.6%	Water Content (%)	136.3%	133.8%
109.0%	109.2%	Corrected Water Content (%)	136.3%	136.2%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BB	BO	Container Number	BK	BJ
20.66	20.3	Wt. Sample (wet+tare)(g)	20.79	20.32
19.26	18.93	Wt. Sample (dry+tare)(g)	18.64	18.23
14.18	14.01	Wt. Tare (g)	14.32	13.98
5.1	4.9	Wt. Dry Soil (g)	4.3	4.3
1.4	1.4	Wt. Water (g)	2.2	2.1
27.6%	27.8%	Water Content (%)	49.8%	49.2%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	109		LL	136
PL	28		PL	49
PI	81		PI	87
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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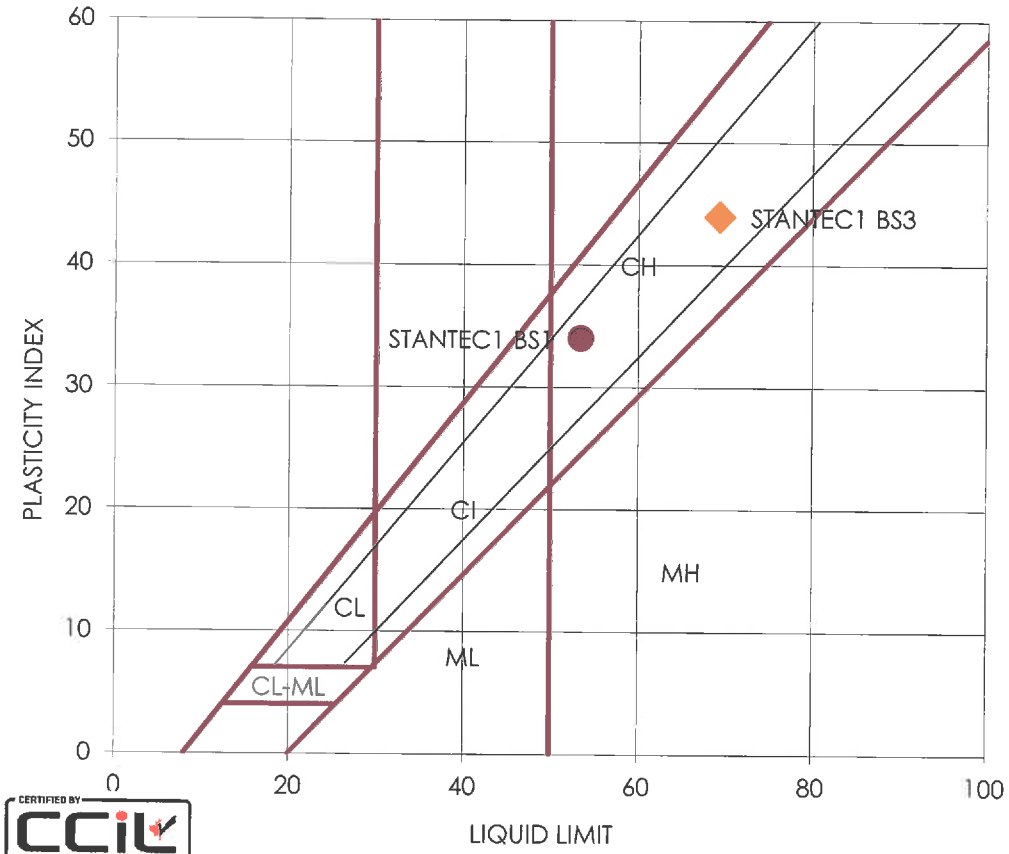
Sample:

STANTEC1 BS1			STANTEC1 BS3	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	21	21
32B	43B	Container Number	12B	46
37.93	36.36	Wt. Sample (wet+tare)(g)	36.65	35.31
29.87	28.93	Wt. Sample (dry+tare)(g)	27.66	27.00
15.16	15.35	Wt. Tare (g)	14.97	15.27
14.7	13.6	Wt. Dry Soil (g)	12.7	11.7
8.1	7.4	Wt. Water (g)	9.0	8.3
54.8%	54.7%	Water Content (%)	70.8%	70.8%
53.3%	53.6%	Corrected Water Content (%)	69.4%	69.4%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AB	AU	Container Number	BG	BU
21.31	21.98	Wt. Sample (wet+tare)(g)	21.35	20.87
20.15	20.71	Wt. Sample (dry+tare)(g)	20.03	19.52
13.95	14.05	Wt. Tare (g)	14.71	14
6.2	6.7	Wt. Dry Soil (g)	5.3	5.5
1.2	1.3	Wt. Water (g)	1.3	1.4
18.7%	19.1%	Water Content (%)	24.8%	24.5%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	53		LL	69
PL	19		PL	25
PI	34		PI	44
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 4, 2016
Tested By:	JA

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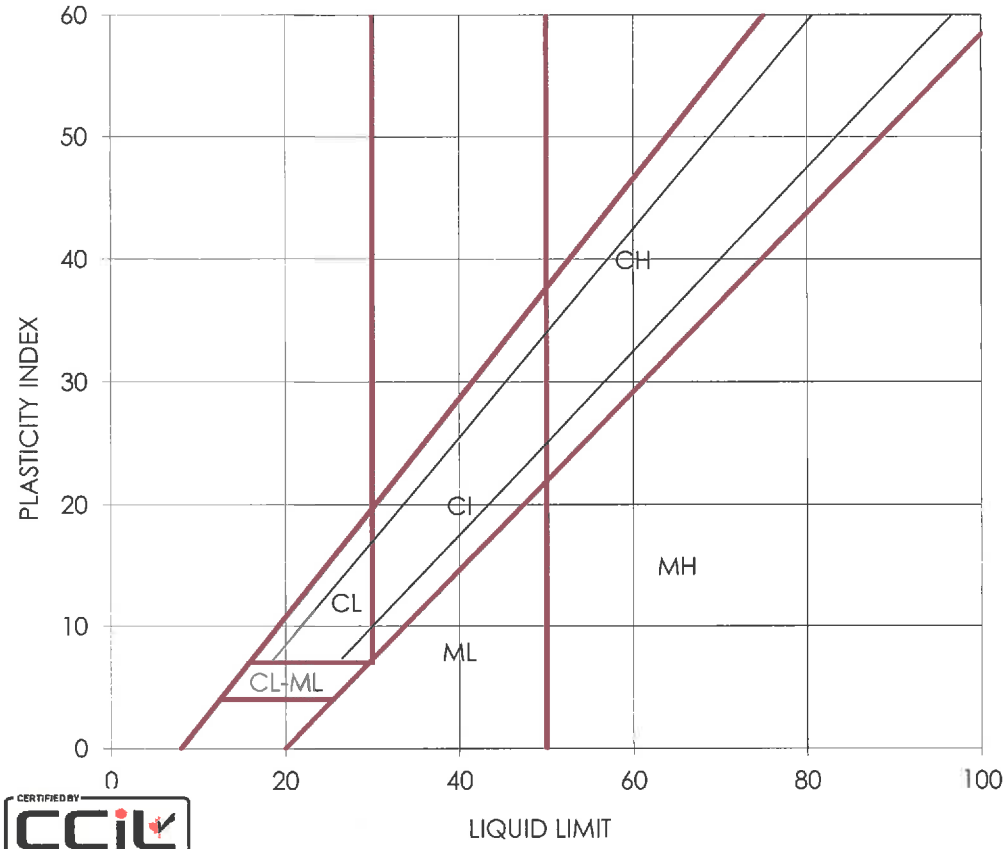
Sample: STANTEC 1 RC28			Sample: STANTEC 1 RC32-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
22	23	Number of Blows	27	29
7B	14B	Container Number	18B	33B
30.98	33.01	Wt. Sample (wet+tare)(g)	32.41	32.42
23.48	24.53	Wt. Sample (dry+tare)(g)	24.04	24.17
15.48	15.51	Wt. Tare (g)	15.17	15.46
8.0	9.0	Wt. Dry Soil (g)	8.9	8.7
7.5	8.5	Wt. Water (g)	8.4	8.3
93.8%	94.0%	Water Content (%)	94.4%	94.7%
92.3%	93.1%	Corrected Water Content (%)	95.2%	96.4%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BI	BT	Container Number	BH	BM
20.83	21.09	Wt. Sample (wet+tare)(g)	20.55	20.15
19.57	19.74	Wt. Sample (dry+tare)(g)	19.24	18.93
14.22	13.96	Wt. Tare (g)	14.06	13.92
5.4	5.8	Wt. Dry Soil (g)	5.2	5.0
1.3	1.4	Wt. Water (g)	1.3	1.2
23.6%	23.4%	Water Content (%)	25.3%	24.4%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	93		LL	96
PL	23		PL	25
PI	70		PI	71
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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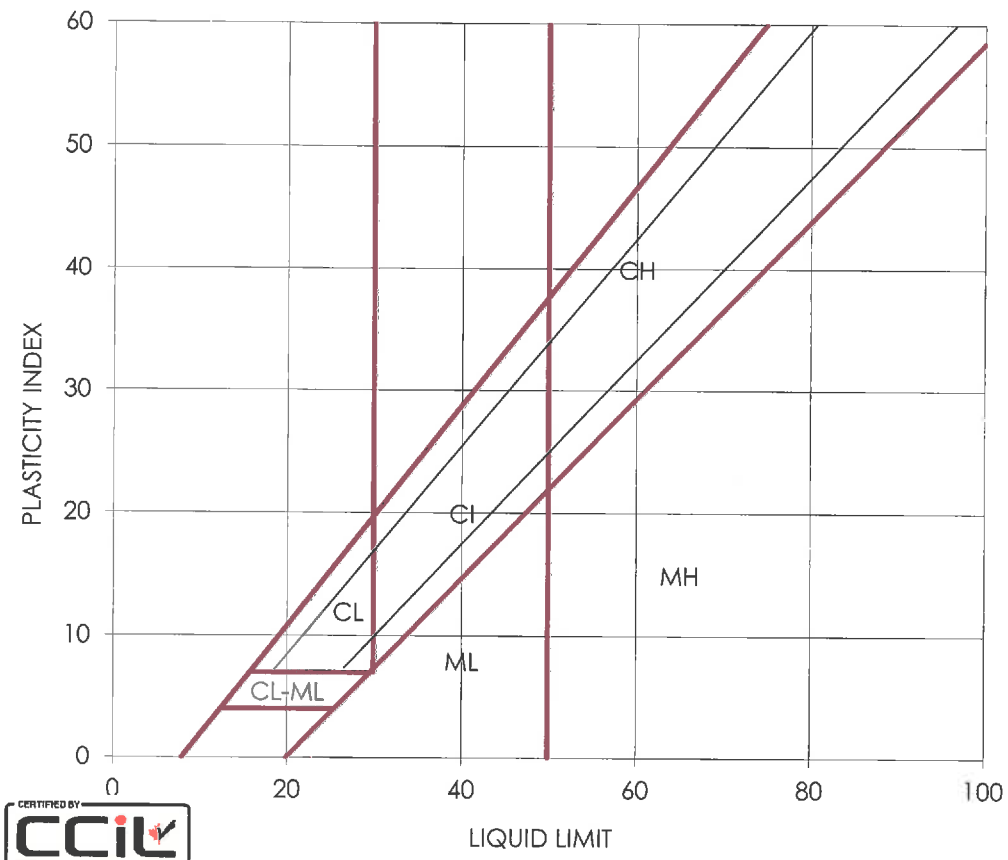
Sample:

STANTEC1 RC29-1			STANTEC1 RC42-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows	29	30
27	16B	Container Number	2B	5B
32.70	32.97	Wt. Sample (wet+tare)(g)	33.77	33.38
24.03	24.24	Wt. Sample (dry+tare)(g)	24.07	23.99
15.43	15.59	Wt. Tare (g)	15.30	15.47
8.6	8.7	Wt. Dry Soil (g)	8.8	8.5
8.7	8.7	Wt. Water (g)	9.7	9.4
100.8%	100.9%	Water Content (%)	110.6%	110.2%
98.1%	98.8%	Corrected Water Content (%)	112.6%	112.7%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AX	AY	Container Number	BQ	BR
20.57	20.76	Wt. Sample (wet+tare)(g)	20.35	20.41
19.23	19.41	Wt. Sample (dry+tare)(g)	19.07	19.13
13.76	14.09	Wt. Tare (g)	14.09	14.14
5.5	5.3	Wt. Dry Soil (g)	5.0	5.0
1.3	1.4	Wt. Water (g)	1.3	1.3
24.5%	25.4%	Water Content (%)	25.7%	25.7%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	98		LL	113
PL	25		PL	26
PI	73		PI	87
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 4, 2016
Tested By:	JA

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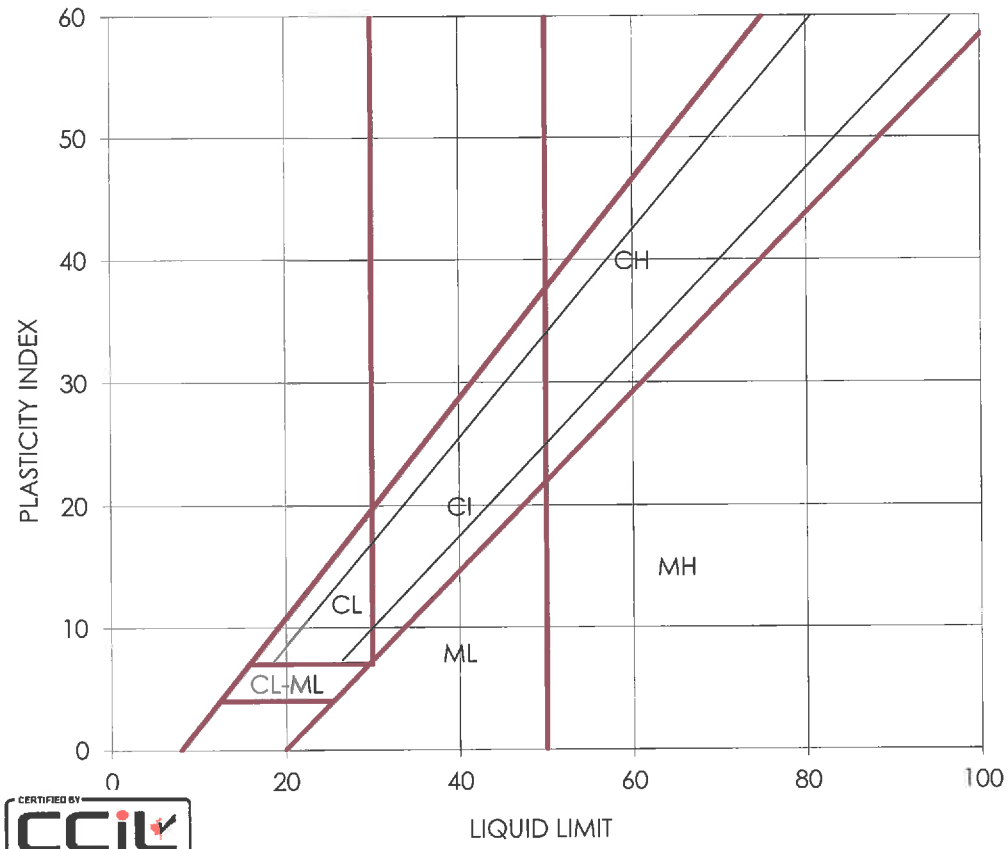
Sample:			Sample:	
STANTEC 1 RC34-1			STANTEC 1 RC35	
LIQUID			LIQUID	
1	2	Trial No.	1	2
29	30	Number of Blows	23	24
20B	39B	Container Number	13B	29B
34.89	35.27	Wt. Sample (wet+tare)(g)	35.52	33.62
25.25	25.48	Wt. Sample (dry+tare)(g)	25.69	24.78
15.45	15.43	Wt. Tare (g)	15.76	15.83
9.8	10.1	Wt. Dry Soil (g)	9.9	9.0
9.6	9.8	Wt. Water (g)	9.8	8.8
98.4%	97.4%	Water Content (%)	99.0%	98.8%
100.1%	99.6%	Corrected Water Content (%)	98.0%	98.3%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BL	AP	Container Number	AQ	AL
20.77	21	Wt. Sample (wet+tare)(g)	20.02	21.14
19.41	19.6	Wt. Sample (dry+tare)(g)	18.83	19.77
14.21	14.21	Wt. Tare (g)	13.89	14.22
5.2	5.4	Wt. Dry Soil (g)	4.9	5.6
1.4	1.4	Wt. Water (g)	1.2	1.4
26.2%	26.0%	Water Content (%)	24.1%	24.7%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	100		LL	98
PL	26		PL	24
PI	74		PI	74
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 6, 2016
Tested By:	JA

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Sample: STANTEC1 RC40-2

LIQUID		
1	2	Trial No.
29	29	Number of Blows
30B	47B	Container Number
32.91	33.37	Wt. Sample (wet+tare)(g)
23.66	23.96	Wt. Sample (dry+tare)(g)
15.26	15.60	Wt. Tare (g)
8.4	8.4	Wt. Dry Soil (g)
9.3	9.4	Wt. Water (g)
110.1%	112.6%	Water Content (%)
112.1%	114.6%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
RJ	AJ	Container Number
20.14	20.37	Wt. Sample (wet+tare)(g)
18.83	19.04	Wt. Sample (dry+tare)(g)
13.98	14.18	Wt. Tare (g)
4.9	4.9	Wt. Dry Soil (g)
1.3	1.3	Wt. Water (g)
27.0%	27.4%	Water Content (%)

AVERAGE VALUES	
1	2
LL	113
PL	27
PI	86

CLASSIFICATION: **CH**

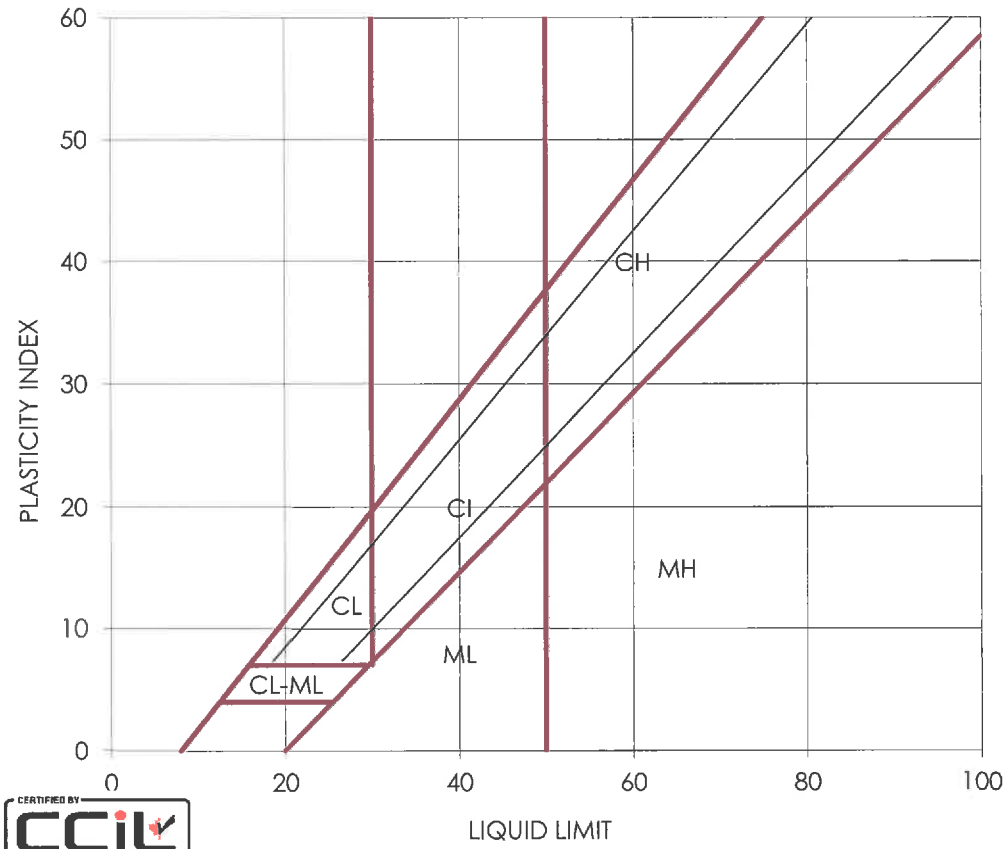
Sample: STANTEC1 RC47

LIQUID	
1	2
29	30
10B	36B
32.52	35.43
24.16	25.58
15.45	15.33
8.7	10.3
8.4	9.9
96.0%	96.1%
97.7%	98.2%

PLASTIC	
1	2
BO	BB
20.56	20.88
19.21	19.55
14	14.2
5.2	5.4
1.4	1.3
25.9%	24.9%

AVERAGE VALUES	
1	2
LL	98
PL	25
PI	73

CLASSIFICATION: **CH**



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Stantec

Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 4, 2016
Tested By:	JA

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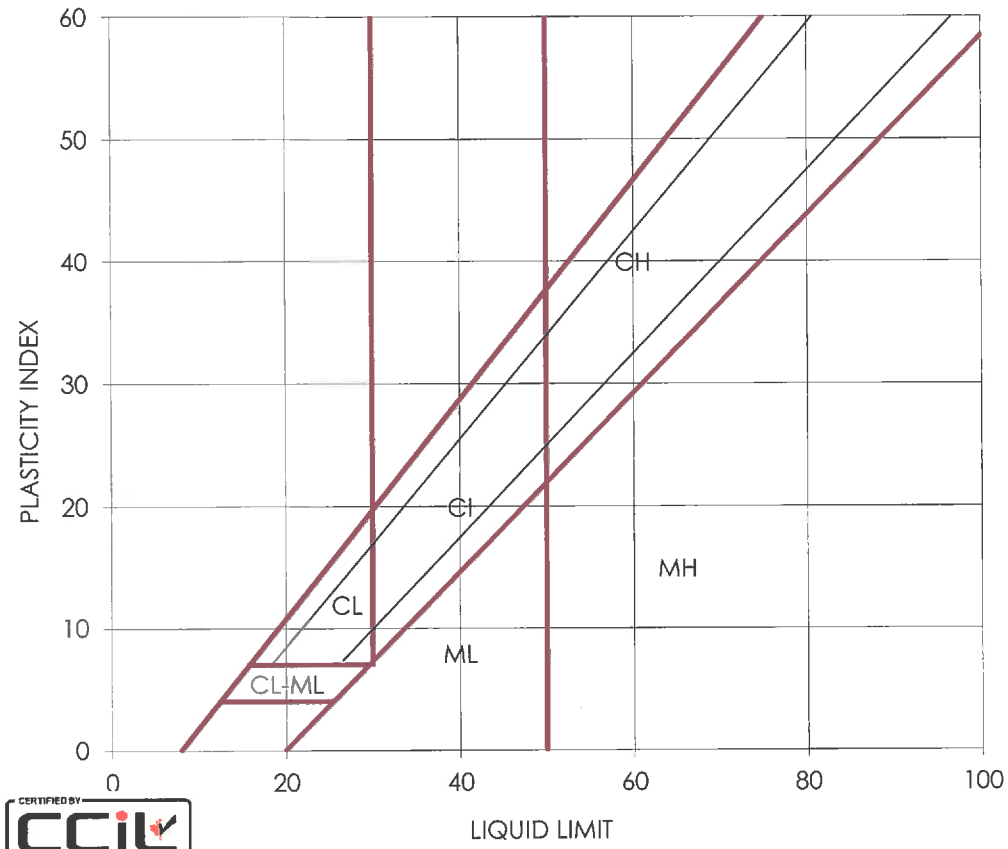
Sample:

STANTEC 1 RC44-2		
LIQUID		
1	2	Trial No.
29	30	Number of Blows
24B	17B	Container Number
33.19	33.90	Wt. Sample (wet+tare)(g)
24.48	24.92	Wt. Sample (dry+tare)(g)
15.20	15.37	Wt. Tare (g)
9.3	9.6	Wt. Dry Soil (g)
8.7	9.0	Wt. Water (g)
93.9%	94.0%	Water Content (%)
95.6%	96.1%	Corrected Water Content (%)
PLASTIC		
1	2	Trial No.
AT	AA	Container Number
20.2	20.86	Wt. Sample (wet+tare)(g)
18.95	19.54	Wt. Sample (dry+tare)(g)
13.85	14.13	Wt. Tare (g)
5.1	5.4	Wt. Dry Soil (g)
1.3	1.3	Wt. Water (g)
24.5%	24.4%	Water Content (%)
AVERAGE VALUES		
1	2	
LL	96	
PL	24	
PI	72	
CLASSIFICATION		
CH		

Sample:

STANTEC 1 RC46	
LIQUID	
1	2
20	20
39B	31B
34.56	34.71
24.95	25.17
15.27	15.51
9.7	9.7
9.6	9.5
99.3%	98.8%
96.6%	96.1%
PLASTIC	
1	2
AV	AE
20.28	20.47
19.14	19.36
14.14	14.11
5.0	5.3
1.1	1.1
22.8%	21.1%
AVERAGE VALUES	
1	2
LL	96
PL	22
PI	74
CLASSIFICATION	
CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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LABORATORY
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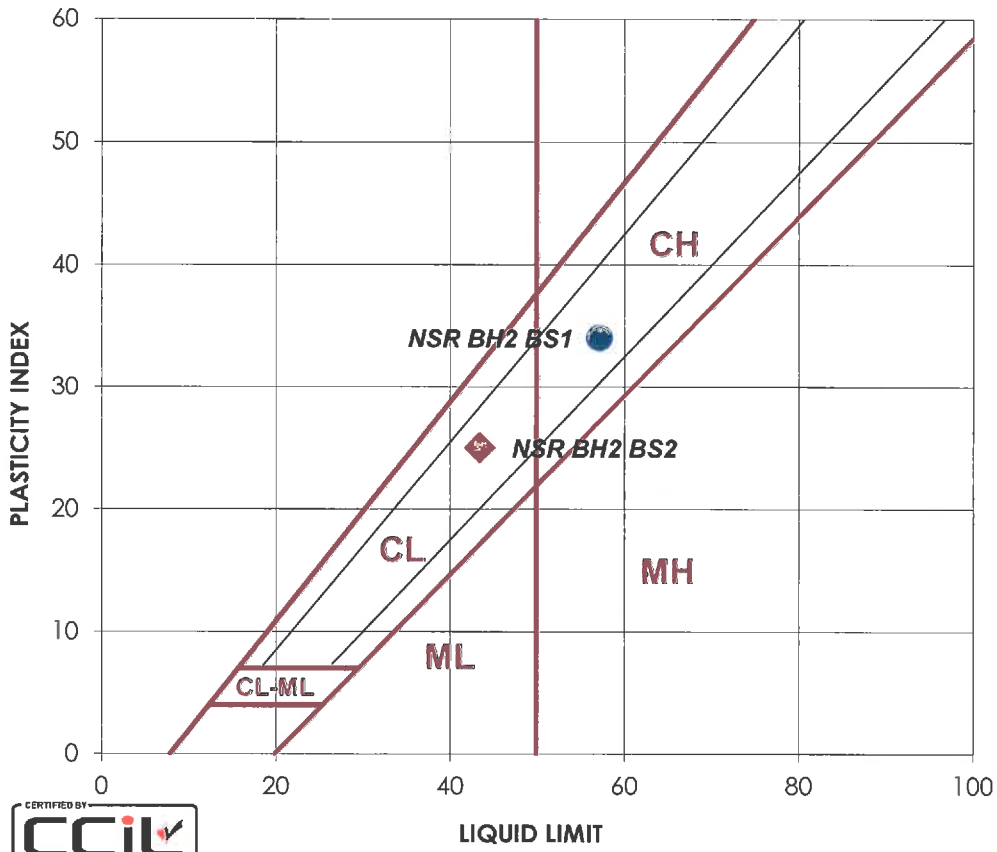
Sample:

NSR BH2 BS1			NSR BH2 BS2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
24	24	Number of Blows	20	21
7B	14B	Container Number	18B	33B
35.57	36.14	Wt. Sample (wet+tare)(g)	38.90	36.68
28.26	28.61	Wt. Sample (dry+tare)(g)	31.58	30.14
15.56	15.48	Wt. Tare (g)	15.18	15.46
12.7	13.1	Wt. Dry Soil (g)	16.4	14.7
7.3	7.5	Wt. Water (g)	7.3	6.5
57.6%	57.3%	Water Content (%)	44.6%	44.6%
57.3%	57.1%	Corrected Water Content (%)	43.4%	43.6%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
B1	B5	Container Number	BH	BM
20.76	20.34	Wt. Sample (wet+tare)(g)	20.7	20.41
19.53	19.14	Wt. Sample (dry+tare)(g)	19.66	19.4
14.2	13.96	Wt. Tare (g)	14.06	13.92
5.3	5.2	Wt. Dry Soil (g)	5.6	5.5
1.2	1.2	Wt. Water (g)	1.0	1.0
23.1%	23.2%	Water Content (%)	18.6%	18.4%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	57		LL	44
PL	23		PL	19
PI	34		PI	25
CLASSIFICATION			CLASSIFICATION	
CH			CL	



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Reviewed By:

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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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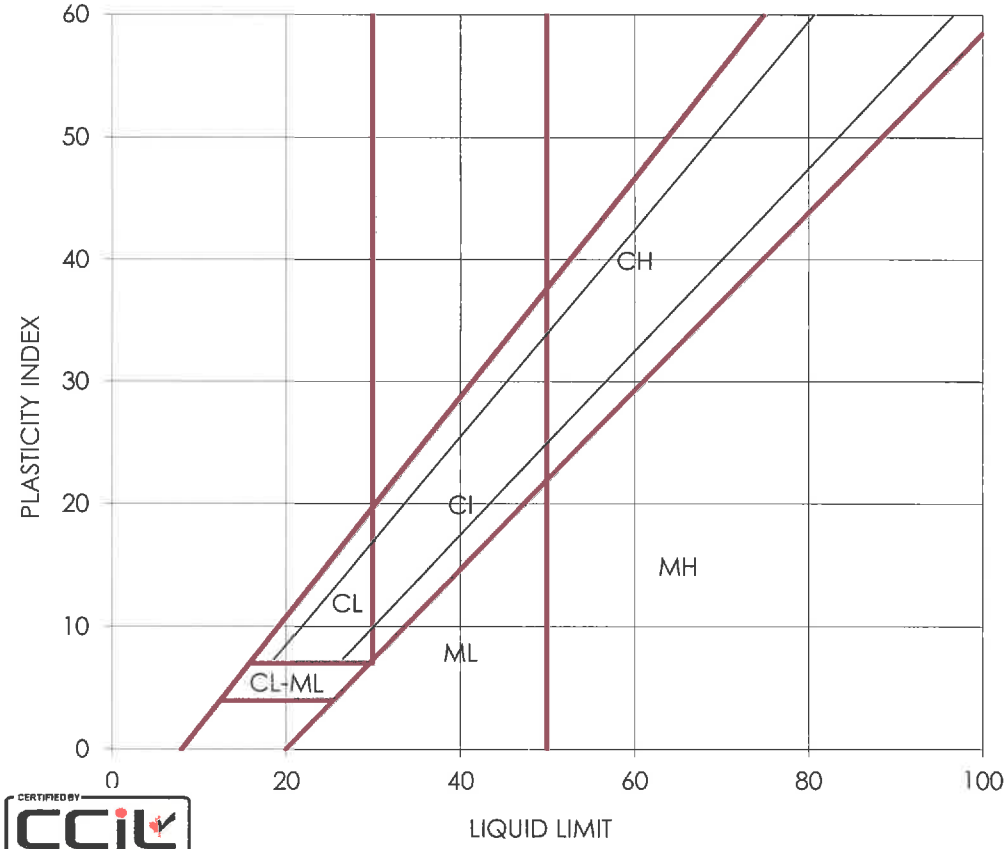
Sample:

NSR BH2 RC27-2		
LIQUID		
1	2	Trial No.
20	20	Number of Blows
17B	24B	Container Number
31.85	33.45	Wt. Sample (wet+tare)(g)
24.20	24.97	Wt. Sample (dry+tare)(g)
15.39	15.20	Wt. Tare (g)
8.8	9.8	Wt. Dry Soil (g)
7.7	8.5	Wt. Water (g)
86.8%	86.8%	Water Content (%)
84.5%	84.5%	Corrected Water Content (%)
PLASTIC		
1	2	Trial No.
AT	AA	Container Number
20.16	20.81	Wt. Sample (wet+tare)(g)
18.99	19.58	Wt. Sample (dry+tare)(g)
13.85	14.13	Wt. Tare (g)
5.1	5.5	Wt. Dry Soil (g)
1.2	1.2	Wt. Water (g)
22.8%	22.6%	Water Content (%)
AVERAGE VALUES		
1	2	
LL	85	
PL	23	
PI	62	
CLASSIFICATION		
CH		

Sample:

NSR BH2 RC29-1	
LIQUID	
1	2
29	30
34B	31B
35.72	35.65
26.19	26.28
15.26	15.52
10.9	10.8
9.5	9.4
87.2%	87.1%
88.8%	89.0%
PLASTIC	
1	2
AV	AE
20.46	20.67
19.31	19.5
14.14	14.11
5.2	5.4
1.2	1.2
22.2%	21.7%
AVERAGE VALUES	
1	2
LL	89
PL	22
PI	67
CLASSIFICATION	
CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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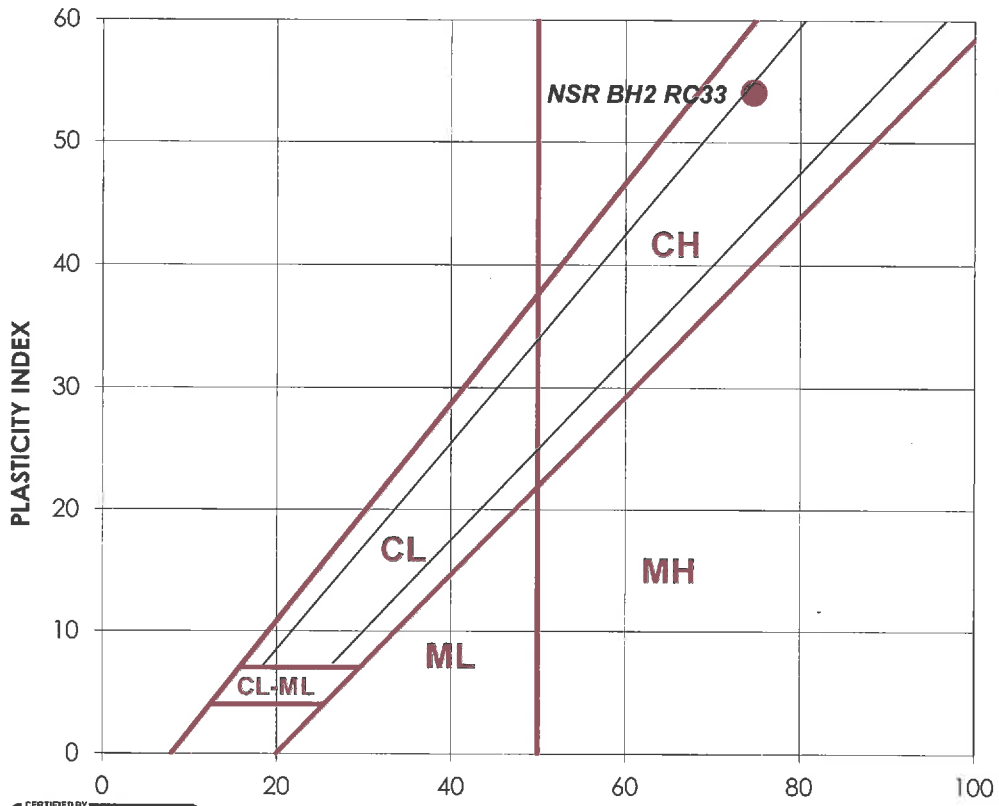
Sample:			Sample:	
NSR BH2 RC33			NSR BH2 RC30	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	20	Number of Blows	22	23
3B	15B	Container Number	41B	9B
36.08	34.69	Wt. Sample (wet+tare)(g)	35.41	35.95
27.10	26.35	Wt. Sample (dry+tare)(g)	25.82	26.13
15.37	15.51	Wt. Tare (g)	15.52	15.56
11.7	10.8	Wt. Dry Soil (g)	10.3	10.6
9.0	8.3	Wt. Water (g)	9.6	9.8
76.6%	76.9%	Water Content (%)	93.1%	92.9%
74.5%	74.9%	Corrected Water Content (%)	91.7%	92.0%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BD	AW	Container Number	BN	AS
20.68	20.93	Wt. Sample (wet+tare)(g)	20.4	20.74
19.56	19.73	Wt. Sample (dry+tare)(g)	19.1	19.4
14.13	14.25	Wt. Tare (g)	14.04	14.13
5.4	5.5	Wt. Dry Soil (g)	5.1	5.3
1.1	1.2	Wt. Water (g)	1.3	1.3
20.6%	21.9%	Water Content (%)	25.7%	25.4%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	75		LL	92
PL	21		PL	26
PI	54		PI	66
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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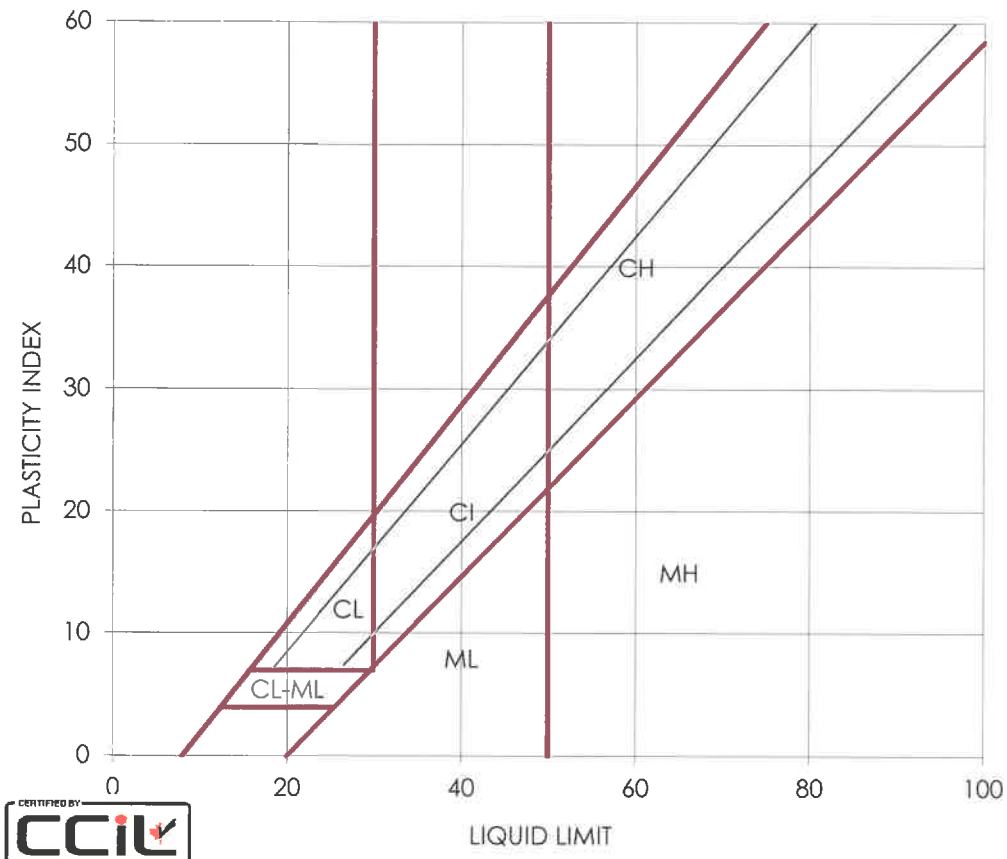
Sample:

NSR BH2 RC38-2			NSR BH2 RC36-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
29	30	Number of Blows	27	28
23B	42B	Container Number	22B	37
34.27	35.79	Wt. Sample (wet+tare)(g)	34.00	35.95
25.21	26.20	Wt. Sample (dry+tare)(g)	25.66	26.66
15.26	15.56	Wt. Tare (g)	15.51	15.24
10.0	10.6	Wt. Dry Soil (g)	10.2	11.4
9.1	9.6	Wt. Water (g)	8.3	9.3
91.1%	90.1%	Water Content (%)	82.2%	81.3%
92.7%	92.1%	Corrected Water Content (%)	82.9%	82.5%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BS	BE	Container Number	AI	AM
20.32	20.6	Wt. Sample (wet+tare)(g)	20.2	20.78
19.14	19.39	Wt. Sample (dry+tare)(g)	19.15	19.62
13.9	13.88	Wt. Tare (g)	14.09	13.85
5.2	5.5	Wt. Dry Soil (g)	5.1	5.8
1.2	1.2	Wt. Water (g)	1.1	1.2
22.5%	22.0%	Water Content (%)	20.8%	20.1%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	92		LL	83
PL	22		PL	20
PI	70		PI	63
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 6, 2016
Tested By:	JA

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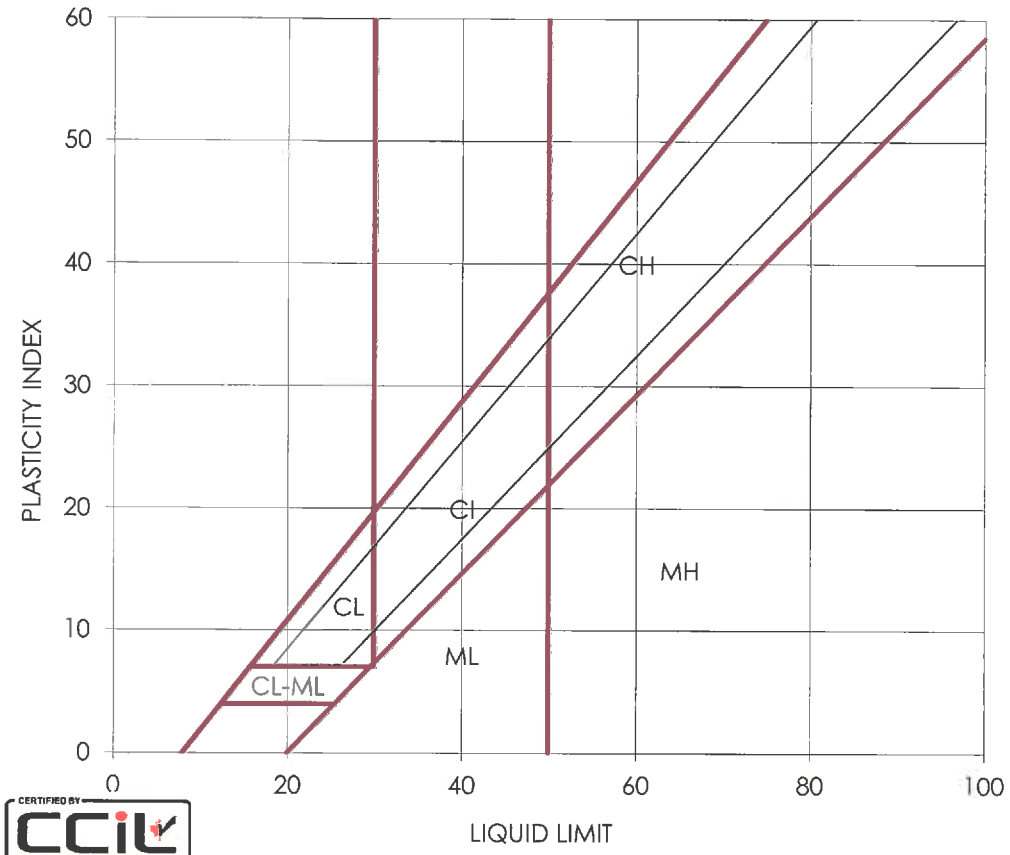
Sample:

NSR BH2 RC39-1			NSR BH2 RC36-2	
LIQUID			LIQUID	
1	2	Trial No.	1	2
29	30	Number of Blows	27	28
41B	9	Container Number	22B	37
35.80	34.57	Wt. Sample (wet+tare)(g)	34.00	35.95
26.41	25.78	Wt. Sample (dry+tare)(g)	25.66	26.66
15.52	15.58	Wt. Tare (g)	15.51	15.24
10.9	10.2	Wt. Dry Soil (g)	10.2	11.4
9.4	8.8	Wt. Water (g)	8.3	9.3
86.2%	86.2%	Water Content (%)	82.2%	81.3%
87.8%	88.1%	Corrected Water Content (%)	82.9%	82.5%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BN	AS	Container Number	AI	AM
20.58	20.59	Wt. Sample (wet+tare)(g)	20.2	20.78
19.29	19.32	Wt. Sample (dry+tare)(g)	19.15	19.62
14.05	14.13	Wt. Tare (g)	14.09	13.85
5.2	5.2	Wt. Dry Soil (g)	5.1	5.8
1.3	1.3	Wt. Water (g)	1.1	1.2
24.6%	24.5%	Water Content (%)	20.8%	20.1%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	88		LL	83
PL	25		PL	20
PI	63		PI	63
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 9, 2016
Date Tested:	September 7, 2016
Tested By:	JA

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Sample: NSR BH2 ST6

LIQUID		
1	2	Trial No.
20	20	Number of Blows
13B	29B	Container Number
37.87	37.47	Wt. Sample (wet+tare)(g)
30.32	30.08	Wt. Sample (dry+tare)(g)
15.74	15.81	Wt. Tare (g)
14.6	14.3	Wt. Dry Soil (g)
7.6	7.4	Wt. Water (g)
51.8%	51.8%	Water Content (%)
50.4%	50.4%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
AL	AQ	Container Number
20.76	21.15	Wt. Sample (wet+tare)(g)
19.65	19.93	Wt. Sample (dry+tare)(g)
14.22	13.89	Wt. Tare (g)
5.4	6.0	Wt. Dry Soil (g)
1.1	1.2	Wt. Water (g)
20.4%	20.2%	Water Content (%)

AVERAGE VALUES	
1	2
LL	50
PL	20
PI	30

CLASSIFICATION: **CH-CI**

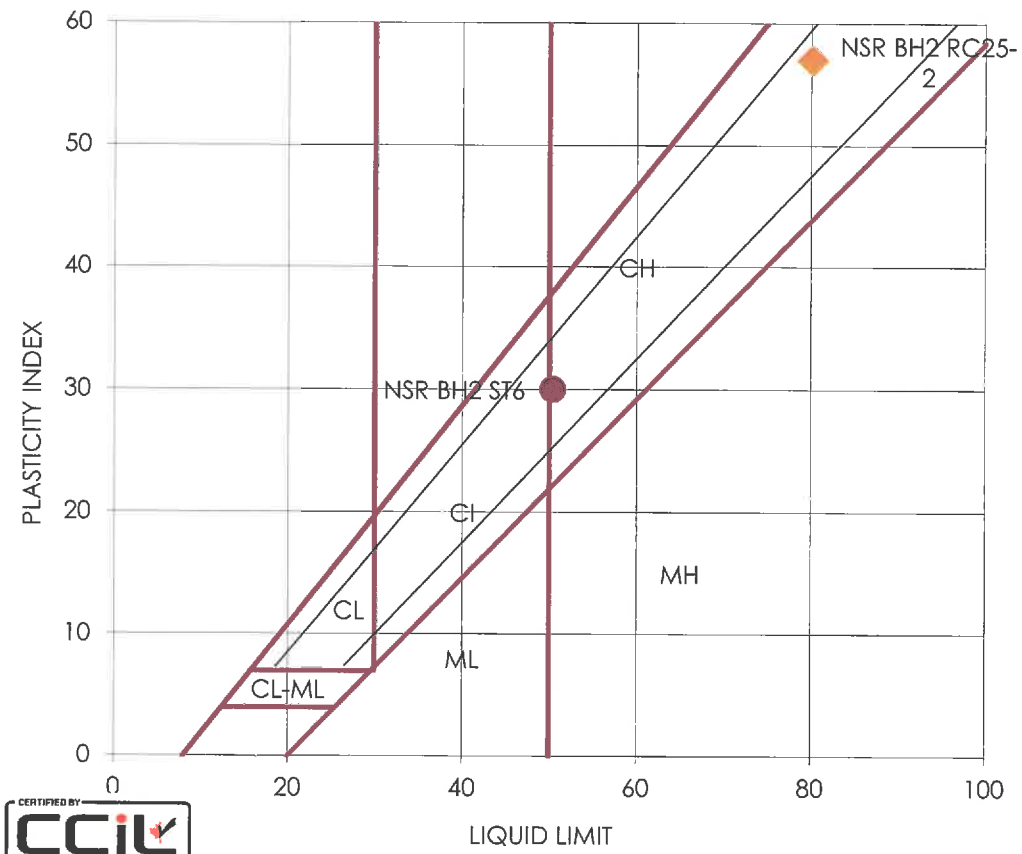
Sample: NSR BH2 RC25-2

LIQUID		
1	2	Trial No.
21	22	Number of Blows
20B	39B	Container Number
34.33	37.52	Wt. Sample (wet+tare)(g)
25.82	27.59	Wt. Sample (dry+tare)(g)
15.43	15.40	Wt. Tare (g)
10.4	12.2	Wt. Dry Soil (g)
8.5	9.9	Wt. Water (g)
81.9%	81.5%	Water Content (%)
80.2%	80.2%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
RL	AP	Container Number
20.93	21.03	Wt. Sample (wet+tare)(g)
19.66	19.75	Wt. Sample (dry+tare)(g)
14.2	14.2	Wt. Tare (g)
5.5	5.6	Wt. Dry Soil (g)
1.3	1.3	Wt. Water (g)
23.3%	23.1%	Water Content (%)

AVERAGE VALUES	
1	2
LL	80
PL	23
PI	57

CLASSIFICATION: **CH**



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 20, 2016
Date Tested:	September 19, 2016
Tested By:	JA

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Sample: NSR BH3 RC35

LIQUID		
1	2	Trial No.
21	21	Number of Blows
27B	13B	Container Number
34.94	35.95	Wt. Sample (wet+tare)(g)
25.72	26.20	Wt. Sample (dry+tare)(g)
15.77	15.69	Wt. Tare (g)
10.0	10.5	Wt. Dry Soil (g)
9.2	9.8	Wt. Water (g)
92.7%	92.8%	Water Content (%)
90.7%	90.8%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
BL	AP	Container Number
20.73	20.63	Wt. Sample (wet+tare)(g)
19.46	19.37	Wt. Sample (dry+tare)(g)
14.21	14.2	Wt. Tare (g)
5.3	5.2	Wt. Dry Soil (g)
1.3	1.3	Wt. Water (g)
24.2%	24.4%	Water Content (%)

AVERAGE VALUES	
1	2
LL	91
PL	24
PI	67

CLASSIFICATION: **CH**

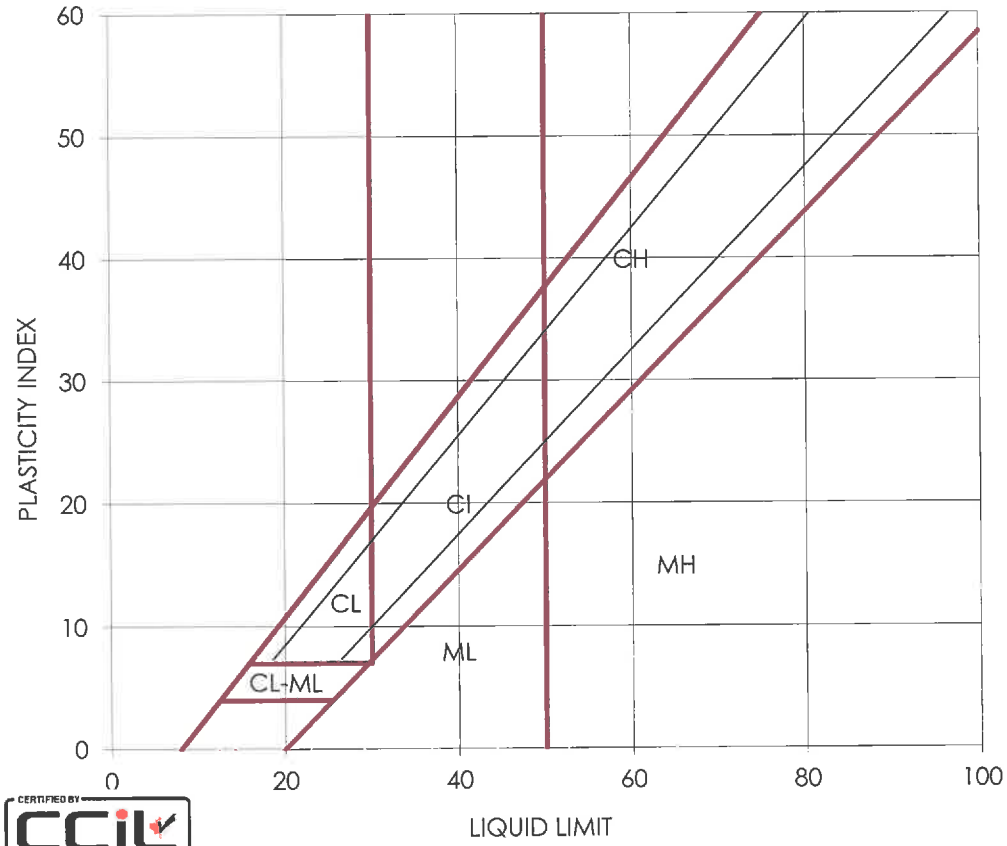
Sample: NSR BH3 RC45

LIQUID	
1	2
20	20
14B	70
34.31	35.48
25.30	25.96
15.49	15.53
9.8	10.4
9.0	9.5
91.8%	91.3%
89.4%	88.8%

PLASTIC	
1	2
BI	BI
20.7	20.6
19.42	19.31
14.21	13.96
5.2	5.4
1.3	1.3
24.6%	24.1%

AVERAGE VALUES	
1	2
LL	89
PL	24
PI	65

CLASSIFICATION: **CH**



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Reviewed By:

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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	August 20, 2016
Date Tested:	September 19, 2016
Tested By:	JA

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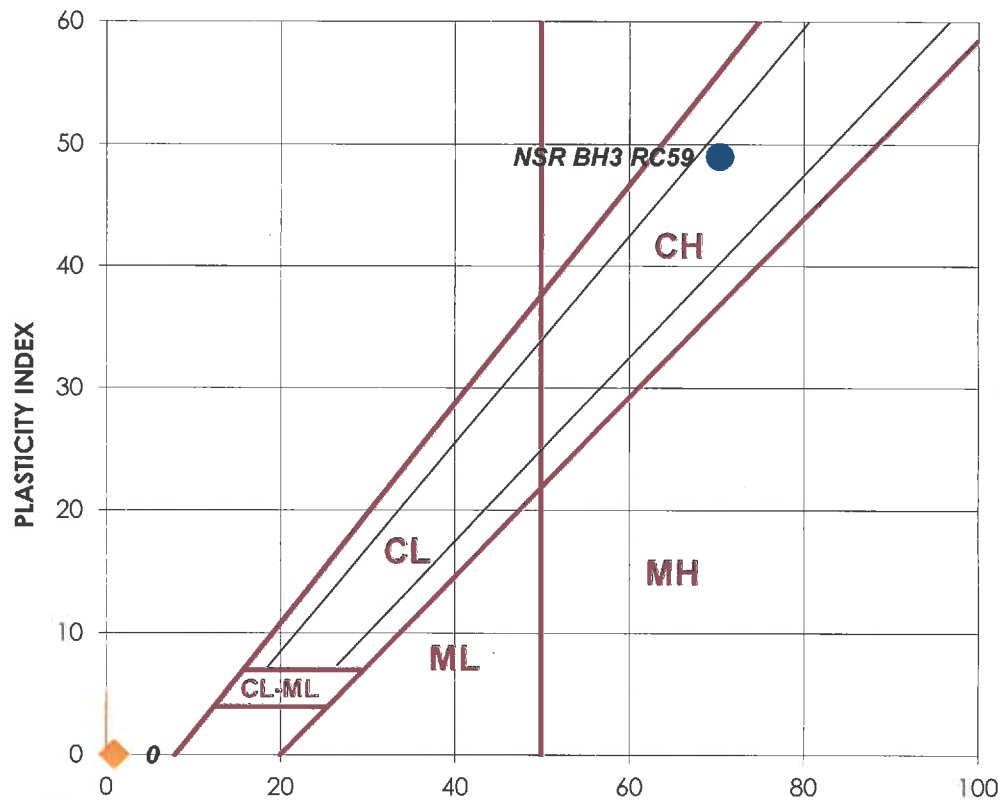
Sample: NSR BH3 RC59			Sample:	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	21	Number of Blows		
20B	39B	Container Number		
35.84	37.23	Wt. Sample (wet+tare)(g)		
27.30	28.08	Wt. Sample (dry+tare)(g)		
15.44	15.43	Wt. Tare (g)		
11.9	12.7	Wt. Dry Soil (g)		
8.5	9.2	Wt. Water (g)		
72.0%	72.3%	Water Content (%)		
70.1%	70.8%	Corrected Water Content (%)		
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AL	AQ	Container Number		
20.74	20.36	Wt. Sample (wet+tare)(g)		
19.61	19.2	Wt. Sample (dry+tare)(g)		
14.22	13.88	Wt. Tare (g)		
5.4	5.3	Wt. Dry Soil (g)		
1.1	1.2	Wt. Water (g)		
21.0%	21.8%	Water Content (%)		
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	70		LL	
PL	21		PL	
PI	49		PI	
CLASSIFICATION			CLASSIFICATION	
CH			NON-PLASTIC	



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Reviewed By:

Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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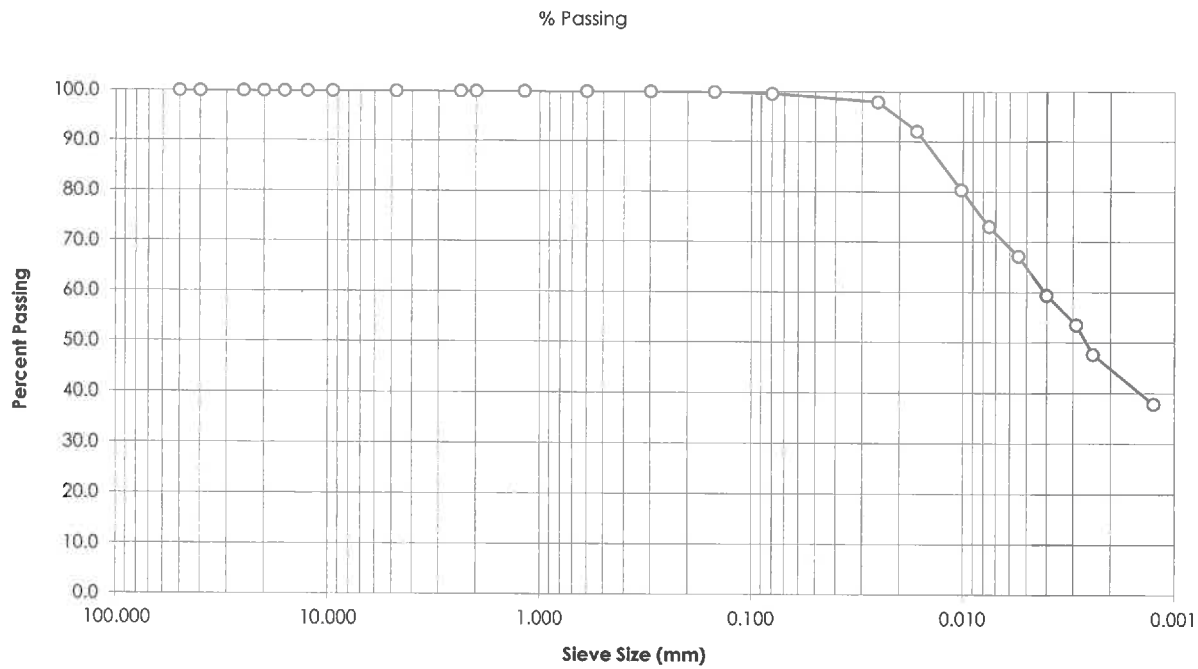
SAMPLE No.: RC23
SOURCE: NL BH40
TESTED BY: JA

DATE TESTED: September 10, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0055	67.2
40.0	100.0	0.0040	59.4
25.0	100.0	0.0029	53.5
20.0	100.0	0.0024	47.6
16.0	100.0	0.0013	37.8
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	100.0		
0.150	99.9		
0.080	99.6		
0.0253	98.0		
0.0166	92.1		
0.0102	80.3		
0.0075	73.1		

Gravel:	0.0%	D_{10}:	-
Sand:	0.4%	D_{30}:	-
Silt:	54.8%	D_{60}:	0.0041
Clay:	44.8%	C_U:	-
		C_C:	-

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Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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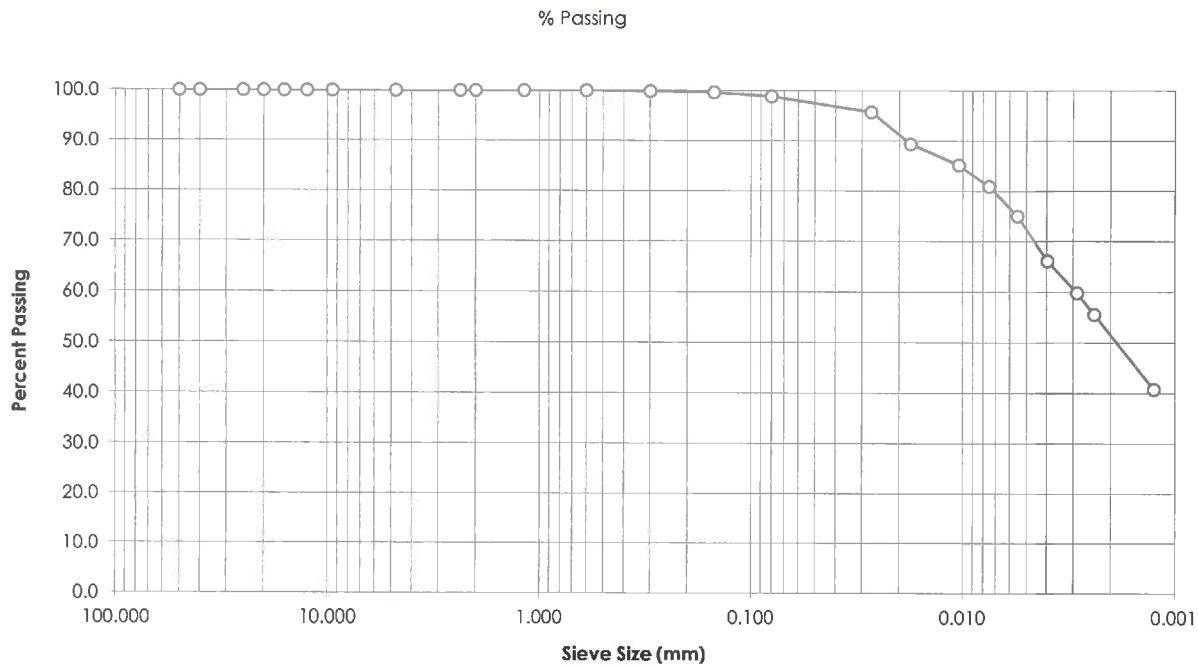
Tel: (780) 917-7463

SAMPLE No.: BS3
SOURCE: STANTEC2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay, trace sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0055	75.0
40.0	100.0	0.0040	66.1
25.0	100.0	0.0029	59.8
20.0	100.0	0.0024	55.6
16.0	100.0	0.0013	40.8
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	99.9		
0.150	99.6		
0.080	98.8		
0.0270	95.7		
0.0176	89.4		
0.0104	85.1		
0.0075	80.9		

Gravel:	0.0%	D_{10}:	-
Sand:	1.2%	D_{30}:	-
Silt:	47.4%	D_{60}:	0.0029
Clay:	51.5%	C_u:	-
		C_c:	-

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Grain Size Analysis
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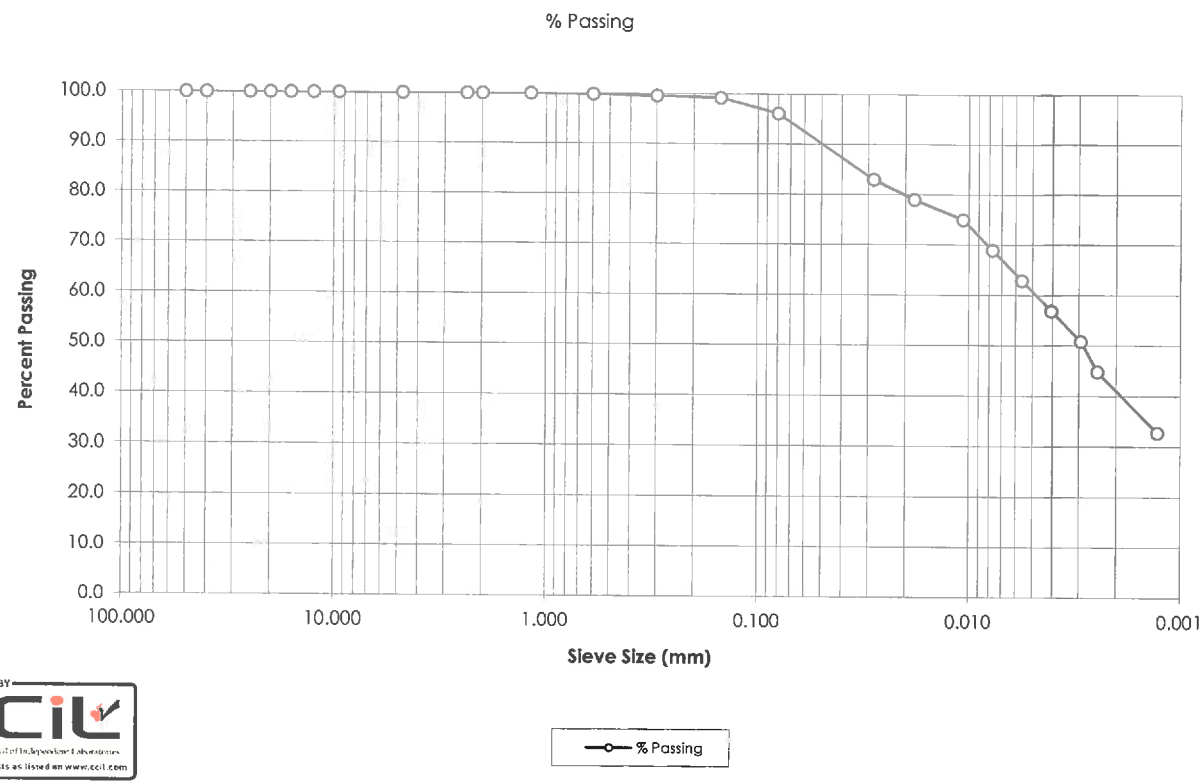
SAMPLE No.: RC28-1
SOURCE: NSR BH1
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Clay and/or silt, trace sand



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Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0056	62.9
40.0	100.0	0.0041	56.9
25.0	100.0	0.0029	50.8
20.0	100.0	0.0025	44.8
16.0	100.0	0.0013	32.8
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.8		
0.300	99.6		
0.150	99.2		
0.080	96.1		
0.0282	83.0		
0.0182	79.0		
0.0107	74.9		
0.0077	68.9		

Gravel:	0.0%	D_{10}:	-
Sand:	3.9%	D_{30}:	-
Silt:	55.1%	D_{60}:	0.0049
Clay:	41.0%	C_u:	-
		C_c:	-

Comments:

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Grain Size Analysis
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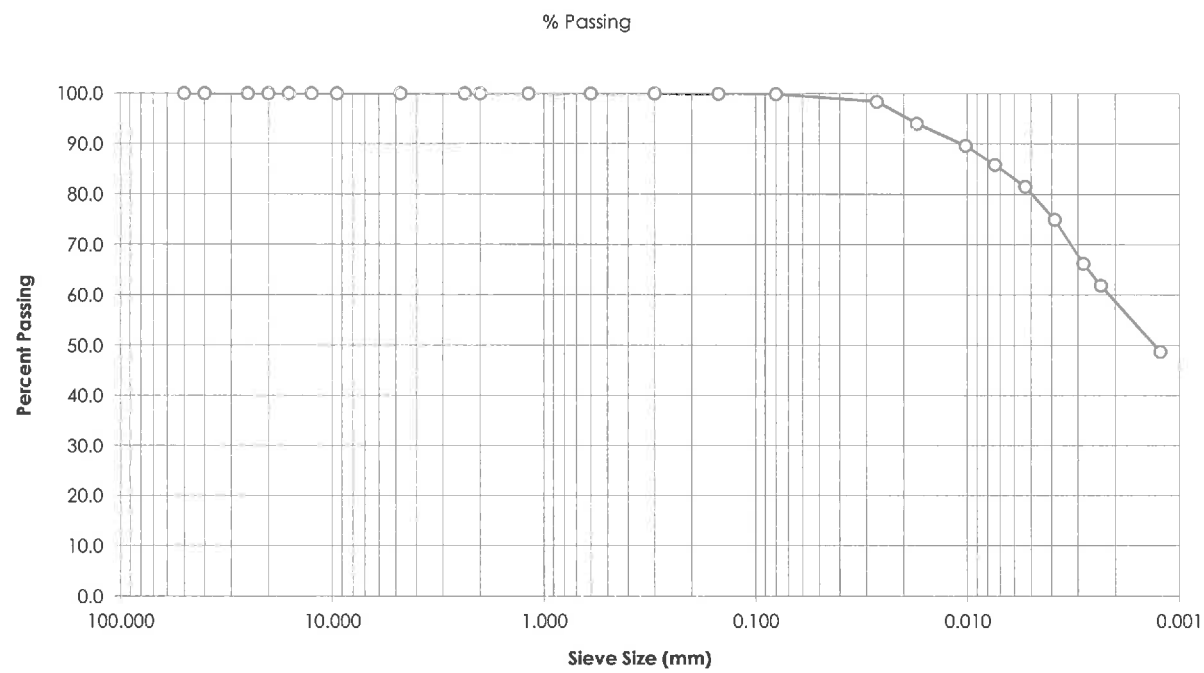
SAMPLE No.: RC43-1
SOURCE: NSR BH1
TESTED BY: JA

DATE TESTED: September 10, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0053	81.5
40.0	100.0	0.0039	75.0
25.0	100.0	0.0028	66.2
20.0	100.0	0.0023	61.9
16.0	100.0	0.0012	48.7
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	100.0		
0.150	99.9		
0.080	99.9		
0.0267	98.4		
0.0173	94.0		
0.0102	89.6		
0.0074	85.9		

Gravel:	0.0%	D_{10}:	-
Sand:	0.1%	D_{30}:	-
Silt:	41.2%	D_{60}:	0.0022
Clay:	58.6%	C_U:	-
		C_C:	-

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Project Name: HUE - Husky SGS Phase 4
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LABORATORY
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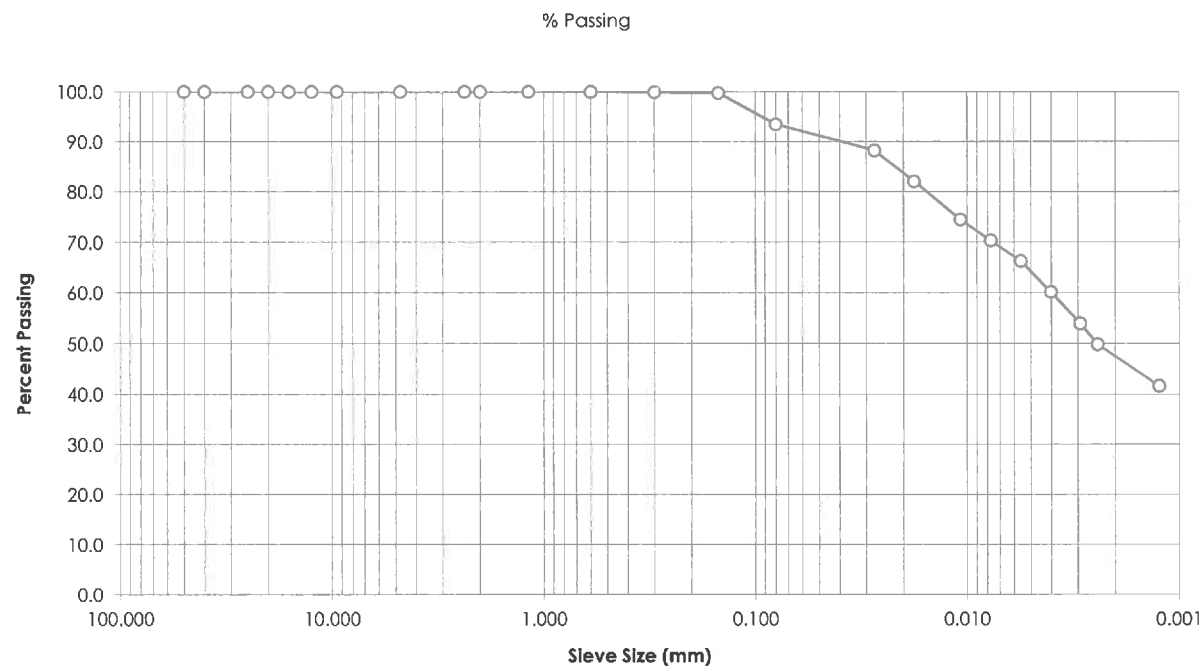
SAMPLE No.: RC43-2
SOURCE: NSR BH1
TESTED BY: JA

DATE TESTED: September 10, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0056	66.3
40.0	100.0	0.0040	60.1
25.0	100.0	0.0029	54.0
20.0	100.0	0.0024	49.9
16.0	100.0	0.0012	41.6
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	99.9		
0.150	99.8		
0.080	93.5		
0.0274	88.2		
0.0178	82.1		
0.0108	74.5		
0.0077	70.4		

Gravel:	0.0%	D_{10}:	-
Sand:	6.5%	D_{30}:	-
Silt:	46.0%	D_{60}:	0.0040
Clay:	47.5%	C_U:	-
		C_C:	-

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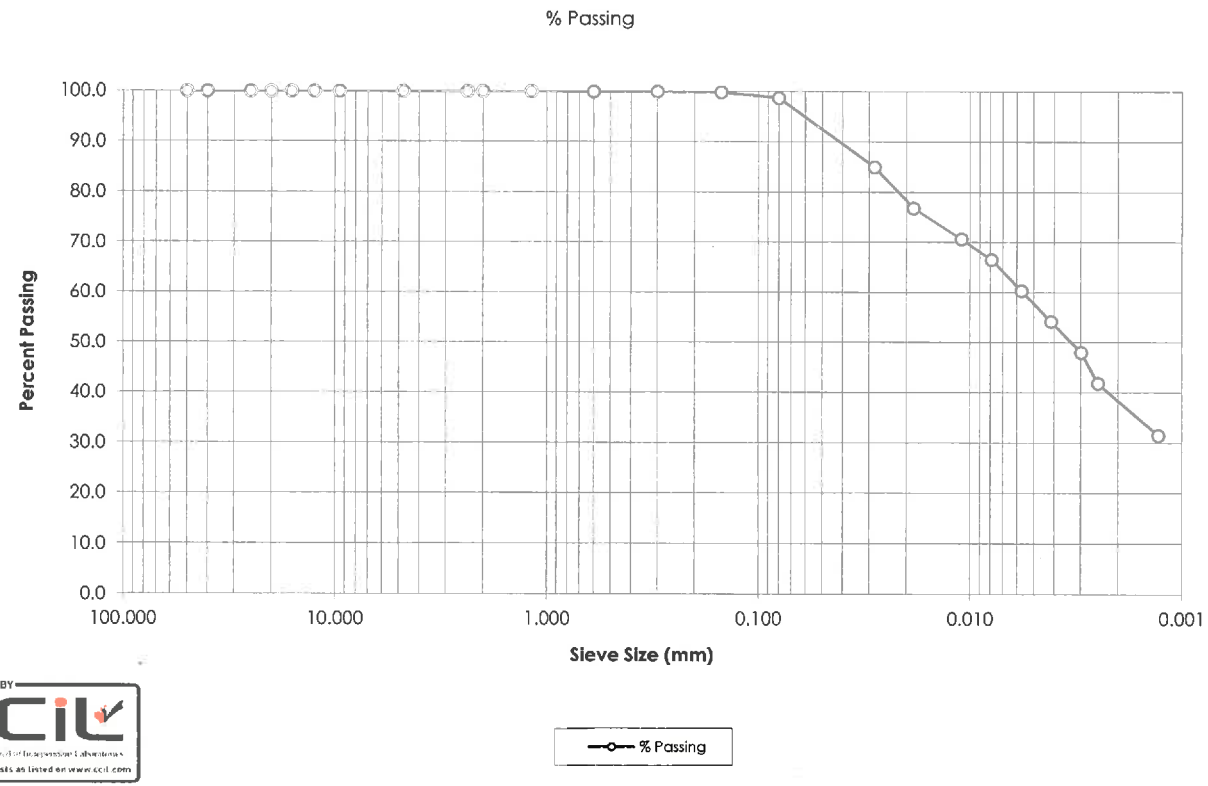
SAMPLE No.: BS3
SOURCE: STANTEC1
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0057	60.3
40.0	100.0	0.0041	54.1
25.0	100.0	0.0030	48.0
20.0	100.0	0.0025	41.8
16.0	100.0	0.0013	31.5
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.9		
0.150	99.8		
0.080	98.7		
0.0282	85.0		
0.0185	76.8		
0.0109	70.6		
0.0079	66.5		

Gravel:	0.0%	D_{10}:	-
Sand:	1.3%	D_{30}:	-
Silt:	60.3%	D_{60}:	0.0056
Clay:	38.4%	C_U:	-
		C_C:	-

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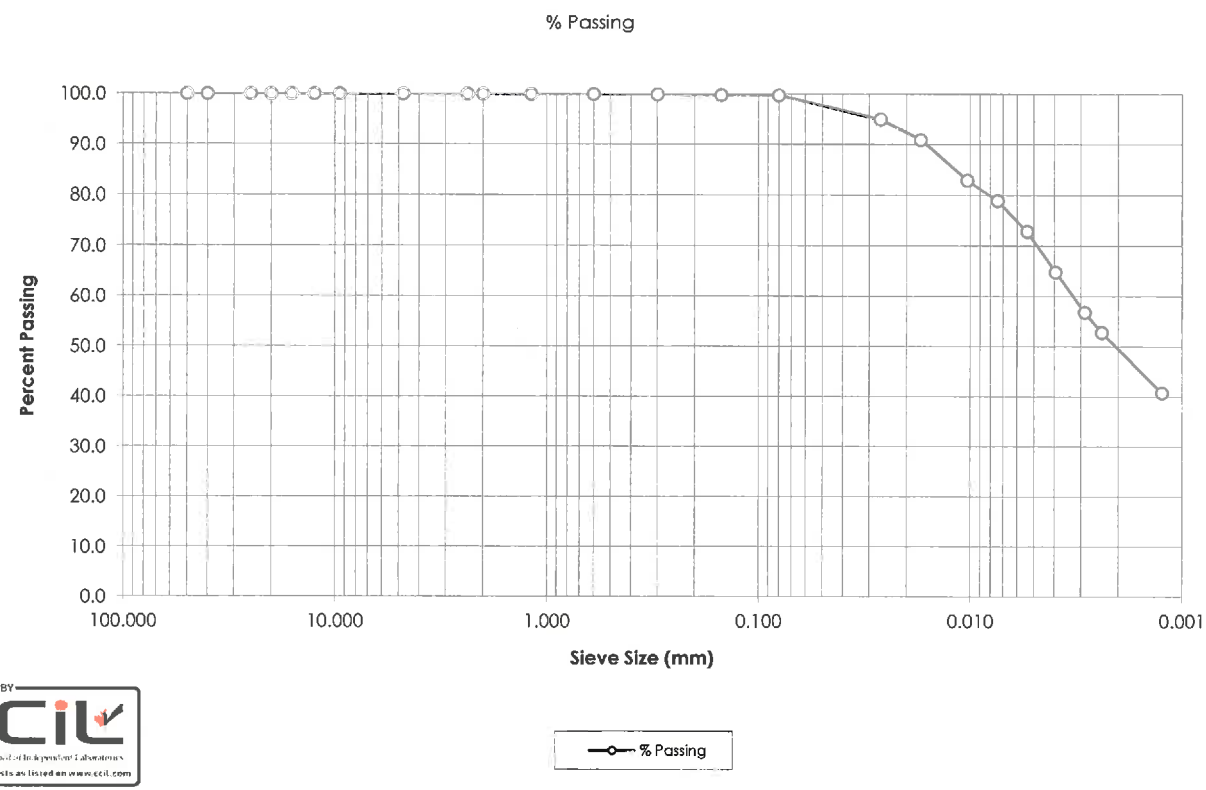
SAMPLE No.: RC34-1
SOURCE: STANTEC1
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0054	72.9
40.0	100.0	0.0039	64.8
25.0	100.0	0.0029	56.8
20.0	100.0	0.0024	52.8
16.0	100.0	0.0012	40.8
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	99.9		
0.600	99.9		
0.300	99.8		
0.150	99.8		
0.080	99.7		
0.0265	95.0		
0.0171	90.9		
0.0103	82.9		
0.0074	78.9		

Gravel:	0.0%	D_{10}:	-
Sand:	0.3%	D_{30}:	-
Silt:	50.2%	D_{60}:	0.0033
Clay:	49.5%	C_u:	-
		C_c:	-

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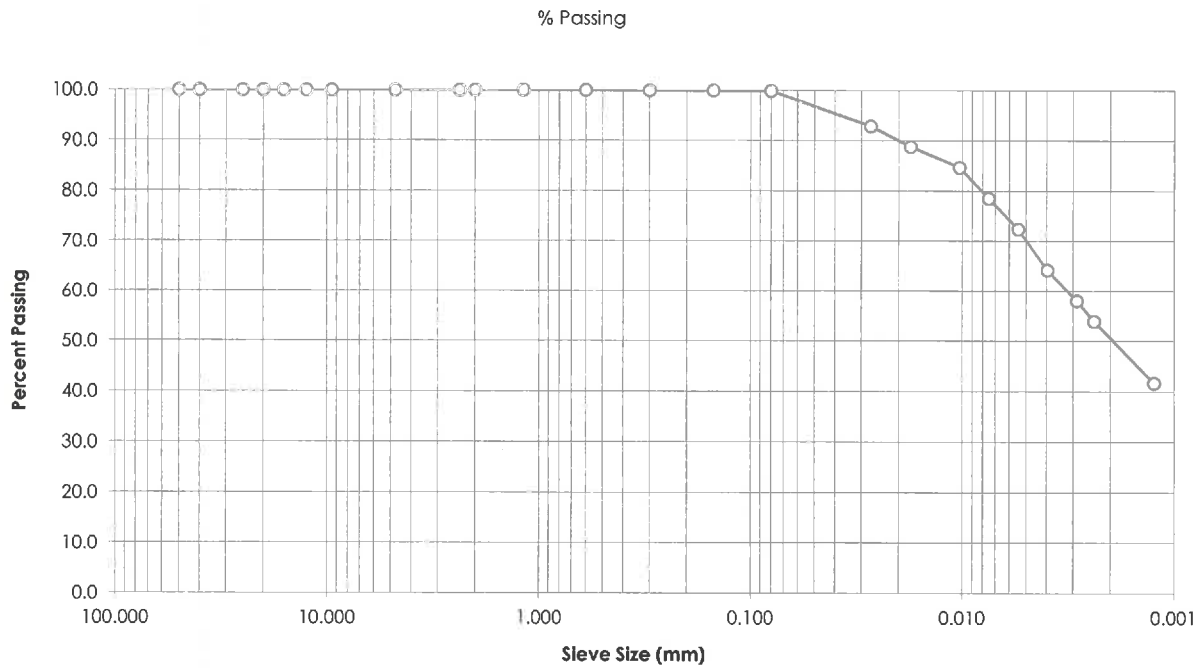
SAMPLE No.: RC39
SOURCE: STANTEC1
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0054	72.4
40.0	100.0	0.0040	64.2
25.0	100.0	0.0029	58.0
20.0	100.0	0.0024	53.9
16.0	100.0	0.0012	41.6
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	99.9		
0.150	99.9		
0.080	99.8		
0.0270	92.9		
0.0175	88.8		
0.0103	84.7		
0.0075	78.5		

Gravel:	0.0%	D_{10}:	-
Sand:	0.2%	D_{30}:	-
Silt:	49.3%	D_{60}:	0.0032
Clay:	50.6%	C_u:	-
		C_c:	-

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Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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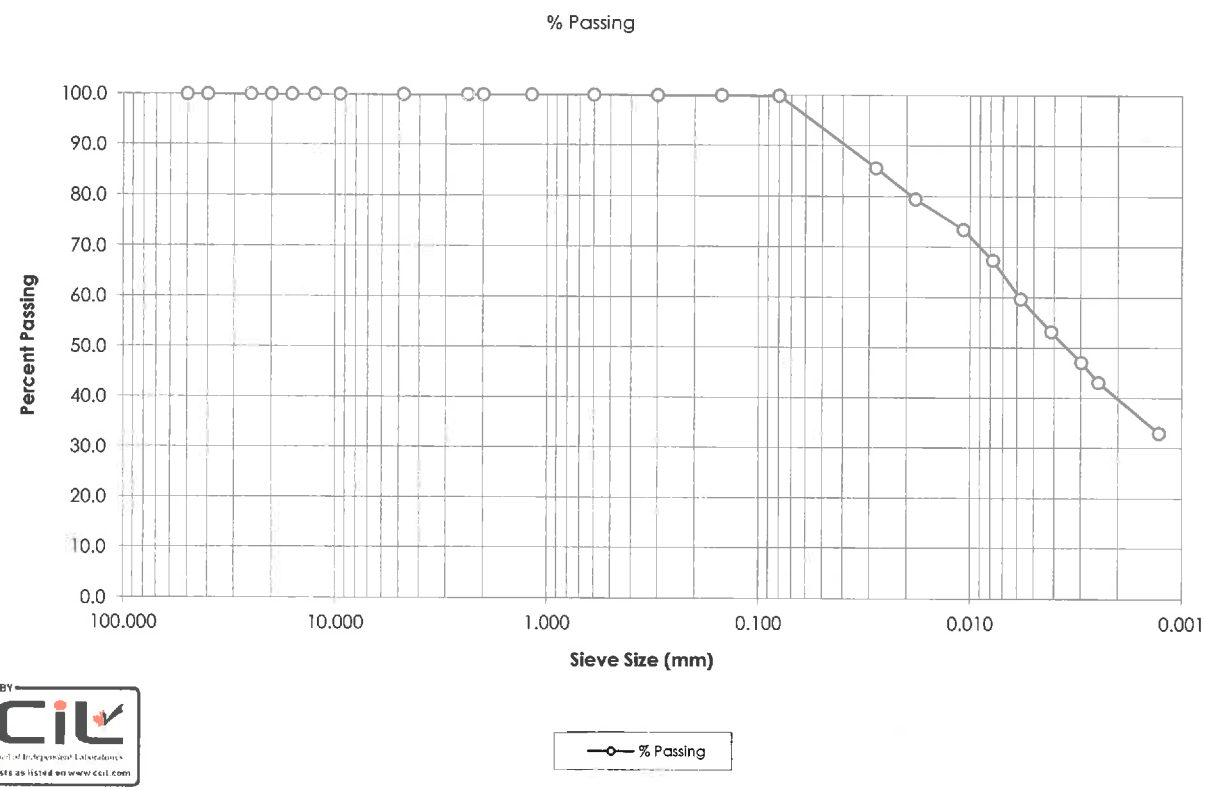
SAMPLE No.: RC46-1
SOURCE: STANTEC1
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0058	59.7
40.0	100.0	0.0041	53.2
25.0	100.0	0.0030	47.1
20.0	100.0	0.0025	43.1
16.0	100.0	0.0013	33.0
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	99.9		
0.150	99.9		
0.080	99.8		
0.0279	85.6		
0.0182	79.5		
0.0108	73.4		
0.0078	67.4		

Gravel:	0.0%	D_{10}:	-
Sand:	0.2%	D_{30}:	-
Silt:	60.0%	D_{60}:	0.0059
Clay:	39.8%	C_u:	-
		C_c:	-

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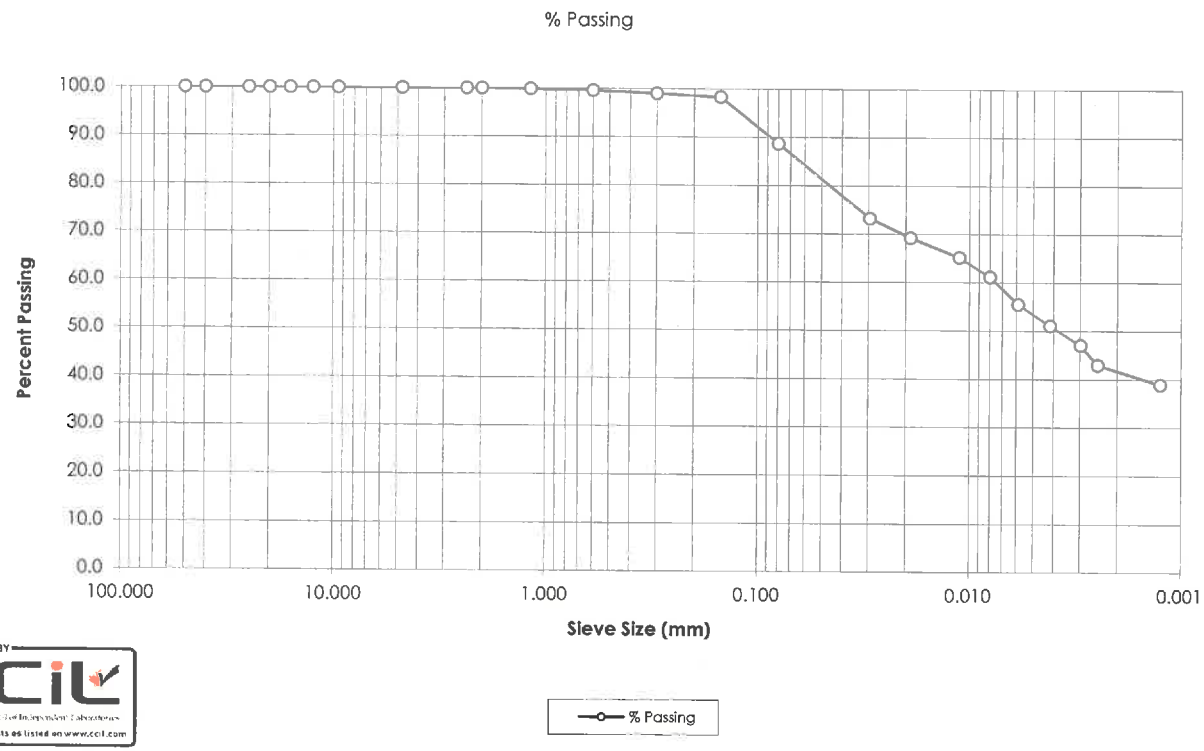
Tel: (780) 917-7463

SAMPLE No.: BS1
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Clay and/or silt, some sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0059	55.5
40.0	100.0	0.0042	51.0
25.0	100.0	0.0030	47.0
20.0	100.0	0.0025	43.0
16.0	100.0	0.0013	38.9
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	99.9		
0.600	99.6		
0.300	99.0		
0.150	98.3		
0.080	88.7		
0.0295	73.2		
0.0190	69.2		
0.0112	65.1		
0.0080	61.1		

Gravel:	0.0%	D_{10}:	-
Sand:	11.3%	D_{30}:	-
Silt:	47.0%	D_{60}:	0.0076
Clay:	41.7%	C_u:	-
		C_c:	-

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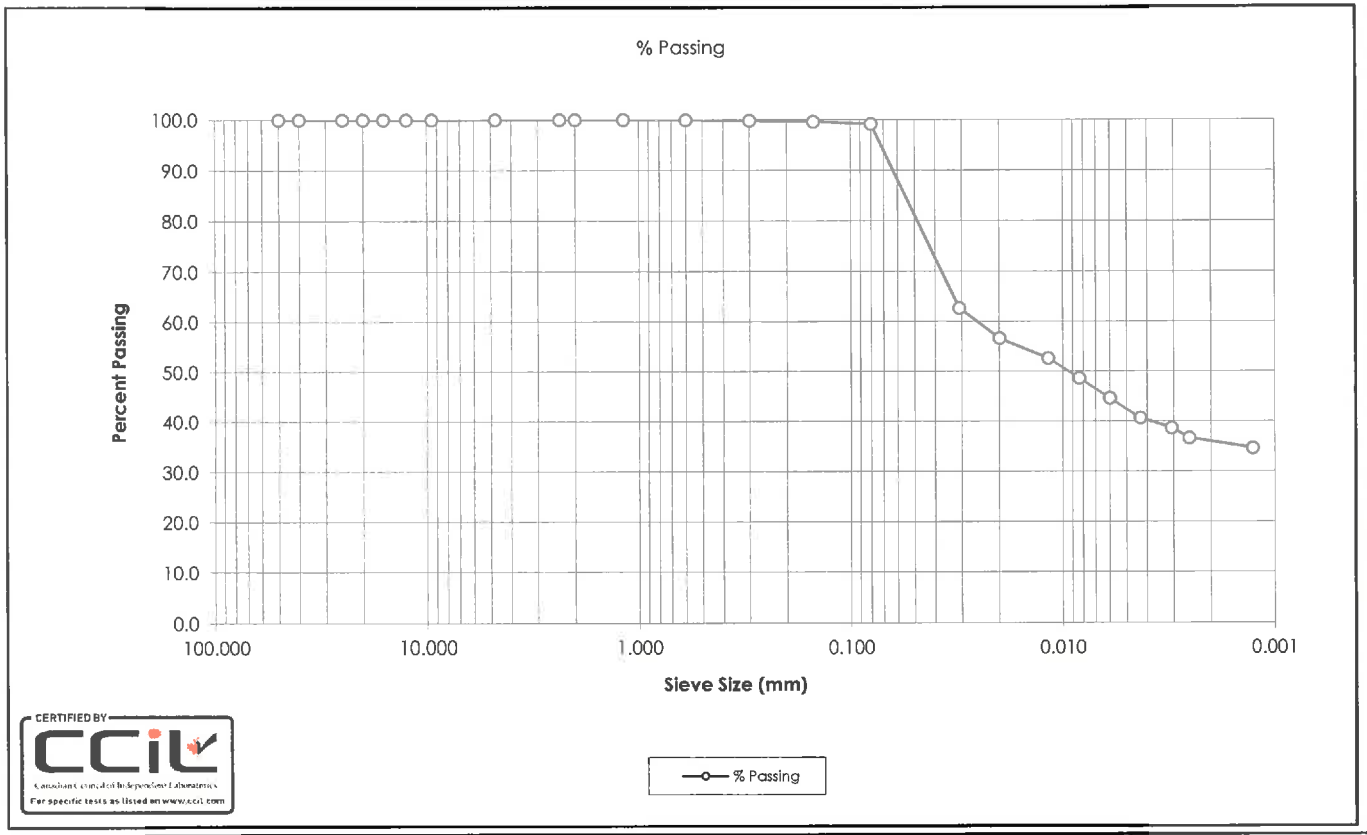
SAMPLE No.: BS2
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Clay and/or silt



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0060	44.6
40.0	100.0	0.0043	40.6
25.0	100.0	0.0031	38.6
20.0	100.0	0.0025	36.6
16.0	100.0	0.0013	34.6
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.8		
0.150	99.6		
0.080	99.1		
0.0307	62.7		
0.0199	56.6		
0.0117	52.6		
0.0084	48.6		

Gravel:	0.0%	D_{10}:	-
Sand:	0.9%	D_{30}:	-
Silt:	63.2%	D_{60}:	0.0261
Clay:	36.0%	C_u:	-
		C_c:	-

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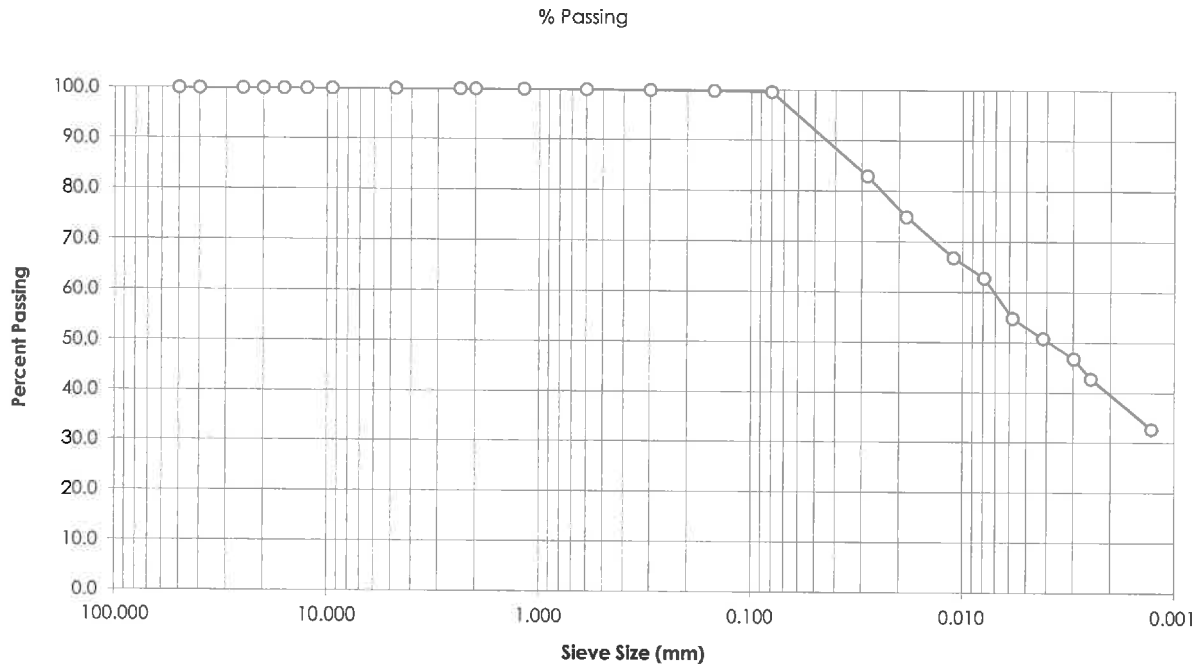
SAMPLE No.: RC27-2
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0058	54.8
40.0	100.0	0.0042	50.8
25.0	100.0	0.0030	46.8
20.0	100.0	0.0025	42.8
16.0	100.0	0.0013	32.7
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.9		
0.150	99.8		
0.080	99.6		
0.0282	82.9		
0.0185	74.9		
0.0111	66.9		
0.0079	62.8		

Gravel:	0.0%	D_{10}:	-
Sand:	0.4%	D_{30}:	-
Silt:	60.0%	D_{60}:	0.0072
Clay:	39.5%	C_u:	-
		C_c:	-

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Project No: 110902147

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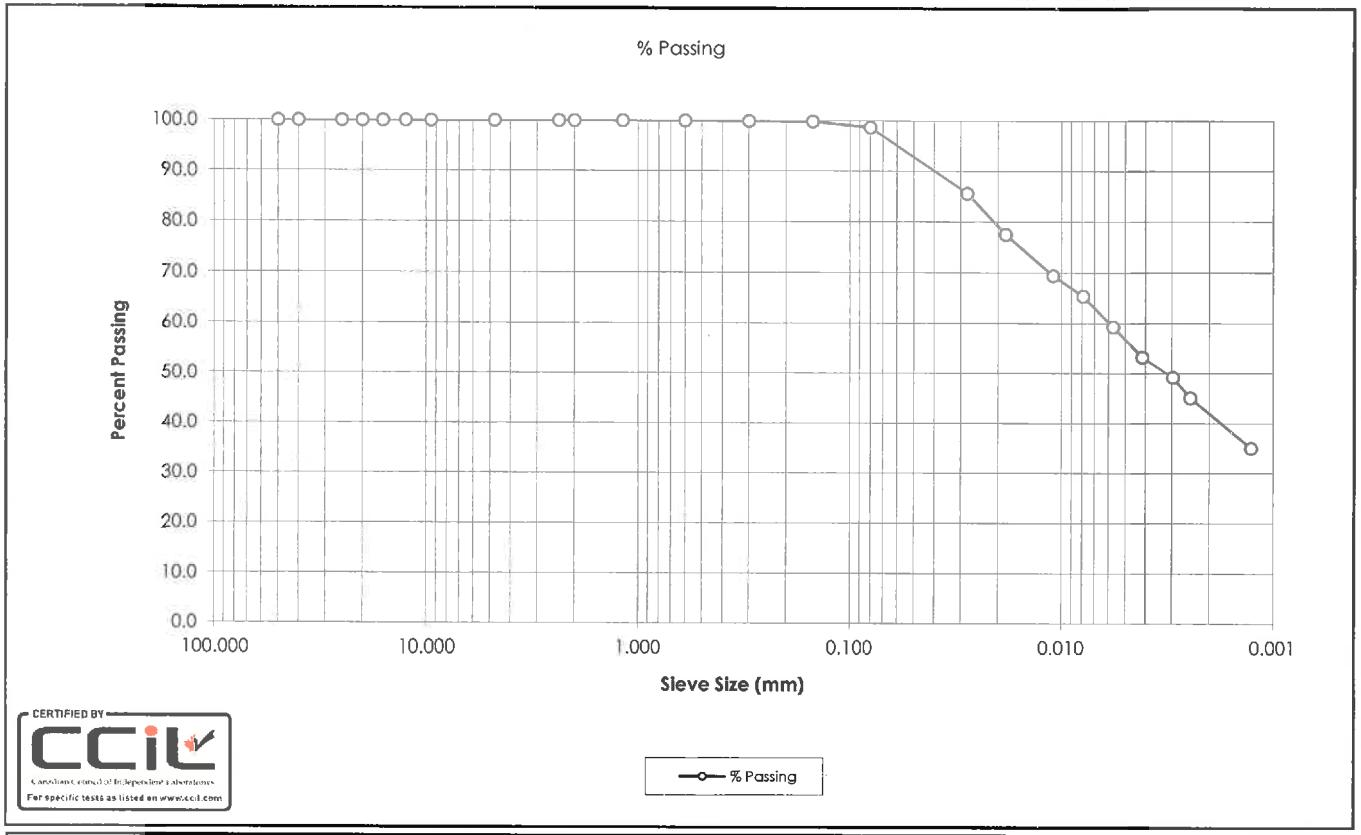
SAMPLE No.: RC29-1
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay, trace sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0057	59.3
40.0	100.0	0.0041	53.2
25.0	100.0	0.0030	49.2
20.0	100.0	0.0025	45.1
16.0	100.0	0.0013	35.0
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	100.0		
0.300	99.9		
0.150	99.9		
0.080	98.7		
0.0279	85.6		
0.0184	77.5		
0.0109	69.4		
0.0079	65.4		

Gravel:	0.0%	D_{10}:	-
Sand:	1.3%	D_{30}:	-
Silt:	56.7%	D_{60}:	0.0060
Clay:	42.0%	C_u:	-
		C_c:	-

CERTIFIED BY CCIL
Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Comments:

Reviewed by:

Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

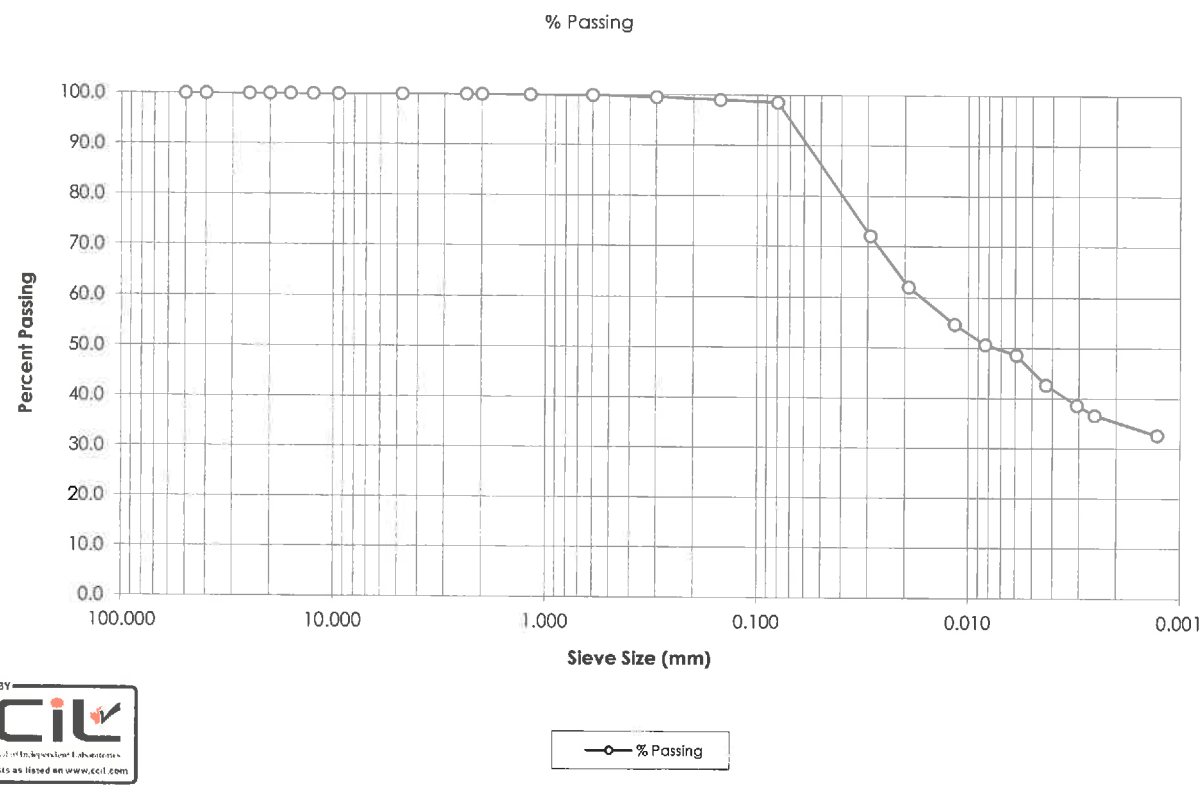
Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

OFFICE
10160 - 112 ST
Edmonton, Alberta
Canada T5K 2L6
Tel: (780) 917-7000

LABORATORY
10575 106 ST
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

SAMPLE No.: ST6
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay, trace sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0059	48.6
40.0	100.0	0.0043	42.6
25.0	100.0	0.0031	38.6
20.0	100.0	0.0025	36.6
16.0	100.0	0.0013	32.6
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	99.9		
0.600	99.9		
0.300	99.6		
0.150	99.0		
0.080	98.5		
0.0291	72.1		
0.0192	62.1		
0.0116	54.7		
0.0083	50.7		

Gravel:	0.0%	D_{10}:	-
Sand:	1.5%	D_{30}:	-
Silt:	63.3%	D_{60}:	0.0172
Clay:	35.3%	C_u:	-
		C_c:	-

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A consortium of Independent Laboratories
For specific tests as listed on www.ccil.com

Comments:

Reviewed by:

Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

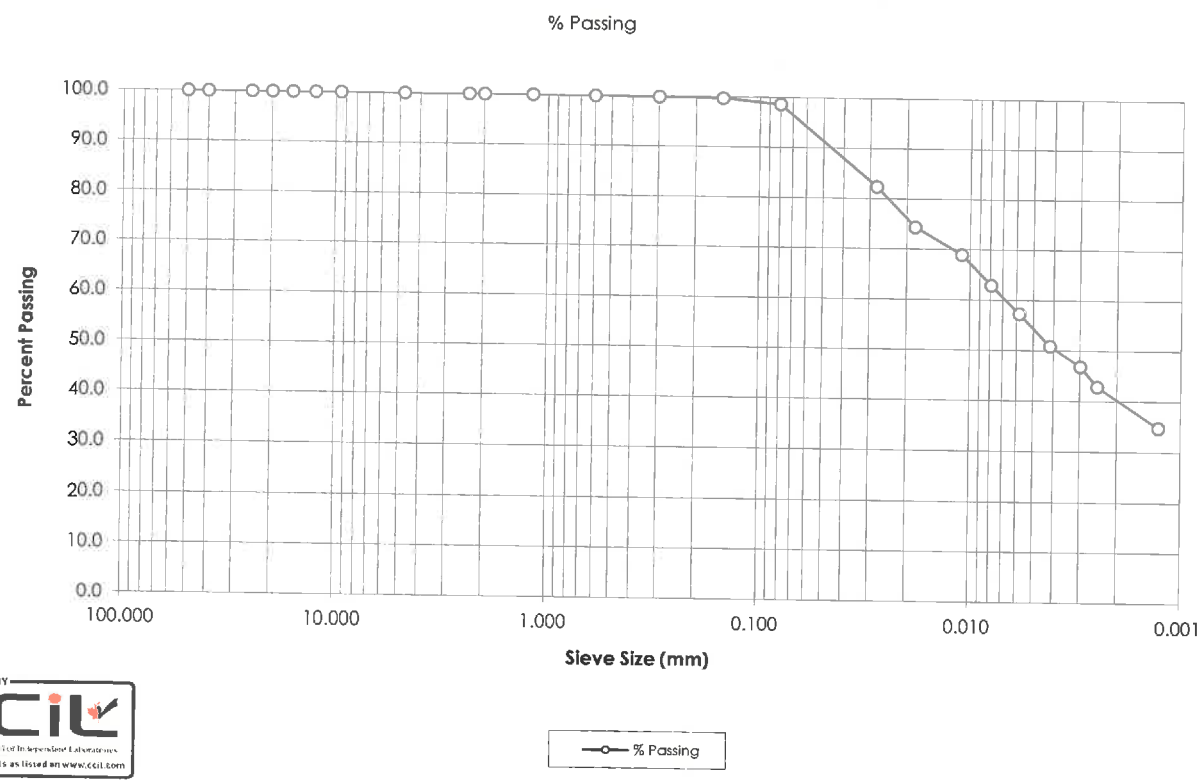
Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

OFFICE
10160 - 112 ST
Edmonton, Alberta
Canada T5K 2L6
Tel: (780) 917-7000

LABORATORY
10575 106 ST
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

SAMPLE No.: RC36-2
SOURCE: NSR BH2
TESTED BY: JA

DATE TESTED: September 9, 2016
DATE RECEIVED: August 19, 2016
SAMPLE DESCRIPTION: Fat clay, trace sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0058	57.3
40.0	100.0	0.0042	50.8
25.0	100.0	0.0030	46.8
20.0	100.0	0.0025	42.8
16.0	100.0	0.0013	34.8
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.8		
0.150	99.7		
0.080	98.6		
0.0279	82.4		
0.0182	74.3		
0.0109	68.9		
0.0079	62.9		

Gravel:	0.0%	D_{10}:	-
Sand:	1.4%	D_{30}:	-
Silt:	58.4%	D_{60}:	0.0069
Clay:	40.2%	C_u:	-
		C_c:	-

CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Comments:

Reviewed by:

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: 110902147.05.500.200.200.100
Site Location: LLYODMINSITER, HUE-HUSKY SGS PHASE 4
Your C.O.C. #: A124193

Attention:Carrie Murray

STANTEC CONSULTING LTD
10160-112 STREET
EDMONTON, AB
CANADA T5K 2L6

Report Date: 2016/09/19
Report #: R2263588
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B678487
Received: 2016/09/12, 12:50

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (Soluble)	4	2016/09/16	2016/09/17	AB SOP-00033 / AB SOP-00020	SM 22 4500-Cl G m
Resistivity	4	N/A	2016/09/16	AB WI-00065	Auto Calc
Conductivity @25C (Soluble)	4	2016/09/16	2016/09/16	AB SOP-00033 / AB SOP-00004	SM 22 2510 B m
pH @25C (Soluble)	4	2016/09/16	2016/09/16	AB SOP-00033 / AB SOP-00006	SM 22 4500 H+B m
Soluble Ions	4	2016/09/16	2016/09/17	AB SOP-00033 / AB SOP-00042	EPA 200.7 CFR 2012 m
Soluble Paste	4	2016/09/16	2016/09/16	AB SOP-00033	Carter 2nd ed 15.2m
Soluble Ions Calculation	4	N/A	2016/09/16	AB WI-00065	Auto Calc

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Wendy Sears, Project manager
Email: WSears@maxxam.ca
Phone# (403)735-2277
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Maxxam Job #: B678487
Report Date: 2016/09/19

STANTEC CONSULTING LTD
Client Project #: 110902147.05.500.200.200.100
Site Location: LLYODMINSITER, HUE-HUSKY SGS PHASE 4
Sampler Initials: LO

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		PM2712		PM2713		PM2714		PM2715		
Sampling Date		2016/08/27		2016/08/22		2016/08/12		2016/08/12		
COC Number		A124193		A124193		A124193		A124193		
	UNITS	**STANTEC 1 BS3**	**RDL**	**STANTEC 2 BS3**	**RDL**	**NSR BH2 BS1**	**RDL**	**NSR BH2 BS8**	**RDL**	**QC Batch**
Calculated Parameters										
Resistivity @ 25 °C	ohm-m	0.90	0.050	1.7	0.050	1.4	0.050	2.1	0.050	8395462
Calculated Sulphate (SO4)	%	0.73	0.00044	0.32	0.00042	0.35	0.00037	0.21	0.00041	8395914
Soluble Parameters										
Soluble Chloride (Cl)	mg/L	79	5.0	<5.0	5.0	35	5.0	41	5.0	8401602
Soluble Conductivity	dS/m	11	0.020	5.8	0.020	7.2	0.020	4.7	0.020	8400784
Soluble pH	pH	7.92	N/A	6.88	N/A	7.79	N/A	7.57	N/A	8400787
Saturation %	%	88	N/A	84	N/A	74	N/A	81	N/A	8400247
Soluble Sulphate (SO4)	mg/L	8300	5.0	3800	5.0	4700	5.0	2600	5.0	8401466

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam ID		PM2715		
Sampling Date		2016/08/12		
COC Number		A124193		
	UNITS	**NSR BH2 BS8 Lab-Dup**	**RDL**	**QC Batch**
Soluble Parameters				
Soluble Chloride (Cl)	mg/L	45	5.0	8401602
Soluble Conductivity	dS/m	5.3	0.020	8400784
Soluble pH	pH	7.62	N/A	8400787
Saturation %	%	81	N/A	8400247
Soluble Sulphate (SO4)	mg/L	3000	5.0	8401466

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

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Maxxam Job #: B678487
Report Date: 2016/09/19

STANTEC CONSULTING LTD
Client Project #: 110902147.05.500.200.200.100
Site Location: LLYODMINSITER, HUE-HUSKY SGS PHASE 4
Sampler Initials: LO

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	19.0°C

Results relate only to the items tested.

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Maxxam
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Success Through Science®

Maxxam Job #: B678487
Report Date: 2016/09/19

STANTEC CONSULTING LTD
Client Project #: 110902147.05.500.200.200.100
Site Location: LLYODMINSITER, HUE-HUSKY SGS PHASE 4
Sampler Initials: LO

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8400247	LX	QC Standard	Saturation %	2016/09/16		102	%	89 - 111
8400247	LX	RPD [PM2715-01]	Saturation %	2016/09/16	0.24		%	12
8400784	BJO	QC Standard	Soluble Conductivity	2016/09/16		101	%	84 - 116
8400784	BJO	Spiked Blank	Soluble Conductivity	2016/09/16		99	%	90 - 110
8400784	BJO	Method Blank	Soluble Conductivity	2016/09/16	<0.020		dS/m	
8400784	BJO	RPD [PM2715-01]	Soluble Conductivity	2016/09/16	11		%	35
8400787	VP7	QC Standard	Soluble pH	2016/09/16		99	%	97 - 103
8400787	VP7	Spiked Blank	Soluble pH	2016/09/16		100	%	97 - 103
8400787	VP7	RPD [PM2715-01]	Soluble pH	2016/09/16	0.66		%	N/A
8401466	PM5	QC Standard	Soluble Sulphate (SO4)	2016/09/17		94	%	81 - 119
8401466	PM5	Method Blank	Soluble Sulphate (SO4)	2016/09/17	<5.0		mg/L	
8401466	PM5	RPD [PM2715-01]	Soluble Sulphate (SO4)	2016/09/17	13		%	35
8401602	AF6	Matrix Spike [PM2715-01]	Soluble Chloride (Cl)	2016/09/17		109	%	75 - 125
8401602	AF6	QC Standard	Soluble Chloride (Cl)	2016/09/17		103	%	75 - 125
8401602	AF6	Spiked Blank	Soluble Chloride (Cl)	2016/09/17		102	%	75 - 125
8401602	AF6	Method Blank	Soluble Chloride (Cl)	2016/09/17	<5.0		mg/L	
8401602	AF6	RPD [PM2715-01]	Soluble Chloride (Cl)	2016/09/17	9.4		%	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam Job #: B678487
Report Date: 2016/09/19

STANTEC CONSULTING LTD
Client Project #: 110902147.05.500.200.200.100
Site Location: LLYODMINSITER, HUE-HUSKY SGS PHASE 4
Sampler Initials: LO

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Maria Magdalena Florescu, Ph.D., P.Chem., QP, Inorganics Senior Analyst

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam

Calgary: 4000 19st St. NE, T2E 6P8. Ph: (403) 291-3077, Fax: (403) 735-2240, Toll free: (800) 386-7247
Edmonton: 9331 - 48 Street, T6B 2R4. Ph: (780) 577-7100, Fax: (780) 450-4187, Toll free: (877) 465-8889
www.maxxamanalytics.com

489 (1)

Chain of Custody

A124193

Page: 1 of 1

	Invoice To: C/O Report Address ☑	Report To: Same as Invoice ☐	Report Distribution (E-Mail):
Company:	STANTEC		CARRIE.MURRAY@STANTEC.COM
Contact:	CARRIE MURRAY		NERISSA.DHARMA@STANTEC.COM
Address:	10160 112ST NW		GEOMATERIALS DISPATCH@STANTEC.COM
	Prov: ALBERTA PC:	Prov: PC:	
Contact #s:	Ph (780) 917-7211 Cell (780) 566-7532	Ph: Cell:	

REGULATORY GUIDELINES:
- ☐ AT1
- ☐ CCME
- ☐ Regulated Drinking Water
- ☐ Other:

All samples are held for 60 calendar days after sample receipt, unless specified otherwise.

PO #:	1109021 47.05.500.200.200.100
Project # / Name:	HUE-HUSKY SGS PHASE 4
Site Location:	LLYODMINISTER
Quote #:	
Sampled By:	L.O

SERVICE REQUESTED: ☐ RUSH (Contact lab to reserve) Date Required: ☑ REGULAR (5 to 7 Days)

See reverse for package specifics

	Sample ID	Depth (unit)	Matrix GW / SW Soil	Date/Time Sampled YY/MM/DD 24:00	SOIL: BTEX F1-F4	Sieve (75 micron)	Regulated Metals (CCME / AT1)	Salinity 4	Assessment ICP Metals	Basic Class II Landfill	WATER: ☐VOCs ☐BTEX F1	☐BTEX F1-F4 ☐BTEX F1-F2	☐ Routine Water ☐ Turb ☐ F	☐ DOC ☐ TOC	Regulated Metals (CCME / AT1) Total	Dissolved	☐ Total ☐ Dissolved Mercury	Other Analysis: PH	SULPHATES	CHLORIDES	RESISTIVITY	HOLD - Do not Analyze	# of Containers Submitted
1	STANTEC 1 BS3			16/08/27														✓	✓	✓	✓		
2	STANTEC 2 BS3	2.6-2.8m		16/08/22														✓	✓	✓	✓		
3	NSR BH2 BS1	1.1-1.4m		16/08/12														✓	✓	✓	✓		
4	NSR BH 2 BS8	5.7-5.9m		16/08/12														✓	✓	✓	✓		
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							

Please indicate Filtered, Preserved or Both (F, P, F/P) → 2 F/P

B678487

Relinquished By (Signature/Print):	Date (YY/MM/DD): 16/09/12	Time (24:00): 12:49
Relinquished By (Signature/Print):	Date (YY/MM/DD):	Time (24:00):
Special Instructions:	# of Jars Used & Not Submitted	

LAB USE ONLY

Received By:	Date: 2016/09/12	Time: 1250	Maxxam Job #: B695
Delaney McErricker			Custody Seal: NU; Temperature: 19, 18, 20; Ice: No
Lab Comments:			

AB FCD-00331 Rev3 2010/05

Maxxam Analytics International Corporation o/a Maxxam Analytics

Stantec **Shelby Tube Report**

Project No.: 110902147
Project Name: HUE - Husky SGS Phase 4
Date: September 5, 2016
Sample No.: NRS BH2 ST6 Depth: 4.6-5.2M
Tester: JA

Pre-Extrusion

				Tests Performed:
INSIDE DIAMETER OF TUBE	A	7.32	cm	ATTERBERG LIMITS, HYDROMETERS, MOISTURES, AND UCS
AREA	B	42.10	cm^2	
OUTSIDE LENGTH	C	61.50	cm	
TOP RUNOUT	D	17.80	cm	
BOT. RUNOUT	E	0.00	cm	
LENGTH OF SAMPLE	F	43.70	cm	
VOLUME OF SAMPLE	G	1839.80	cm^3	
WEIGHT OF SOIL AND TUBE	H	4930.9	g	
WEIGHT OF TUBE	I	1685.2	g	
WEIGHT OF SOIL	J	3245.7	g	

Post-Extrusion

Shelby Tube Condition	SHELBY TUBE IS TO LONG, HAVE TO CUT 6" OF THE TUBE TO EXTRACT SAMPLE	Post Extrusion Length of Sample
Pocket Pen Value (kg/cm^2)		
Sample Description	TILL - CLAY AND SILT, TR SAND, OXIDIZE STAIN	
Remarks		

		Moisture Content		Moisture Content	
WET WEIGHT OF SOIL & TARE	K	1415.7	g		g
DRY WEIGHT OF SOIL & TARE	L	1165.2	g		g
WEIGHT OF WATER	M	250.2	g		g
WEIGHT OF DRY SOIL	N	974.7	g		g
TARE NO & TARE WEIGHT	O	190.5	g		g
MOISTURE CONTENT (M/N) X 100		25.70	%		%
AVERAGE MOISTURE CONTENT	P	25.70	%		
DENSITY (J/G)	Q	1.764	g/cm^3		
WET DENSITY (Q X 1000)	R	1764	kg/m^3		
DRY DENSITY R / (1 + P)	S	1403	kg/m^3		

Visual Description

TOP BOTTOM

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

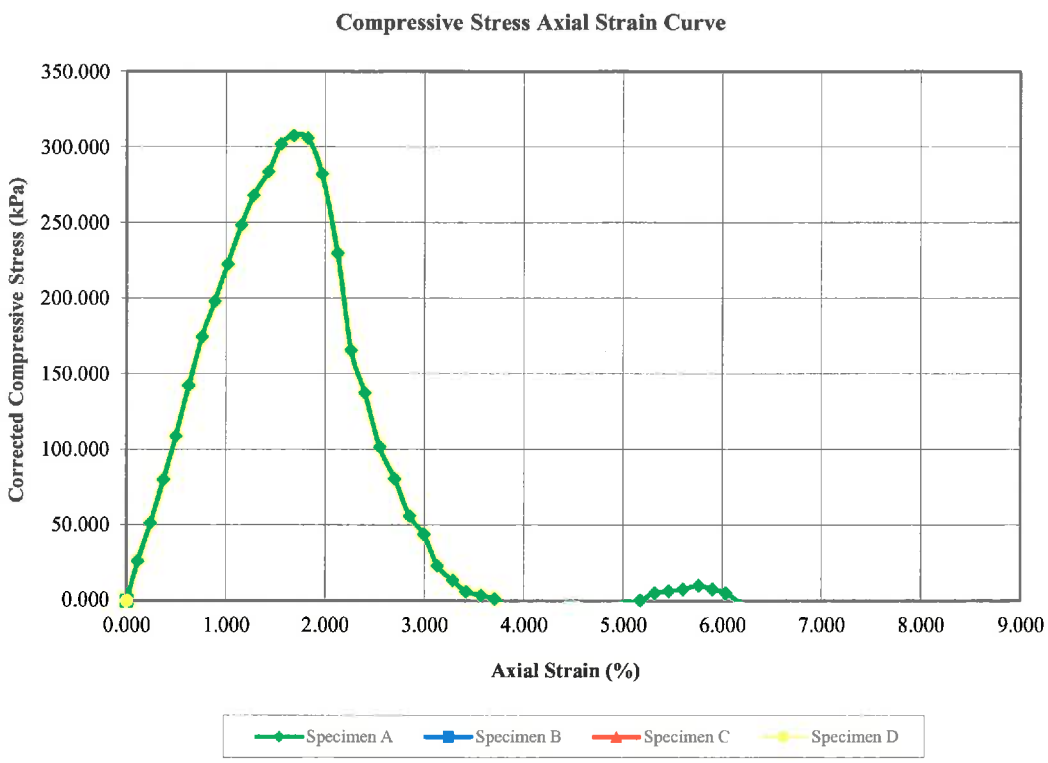
Checked By JC

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	B	C	D
Water Content (%)	20.20			
Dry Density (g/cm3)	1.707			
Saturation (%)	96.86			
Void Ratio	0.55			
Diameter (mm)	60.877			
Height (mm)	123.087			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	307.647			
Undrained Shear Strength (kgf/cm^2)	1.569			
Undrained Shear Strength (kPa)	153.823			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	1.69			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	STANTEC2 RC14	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

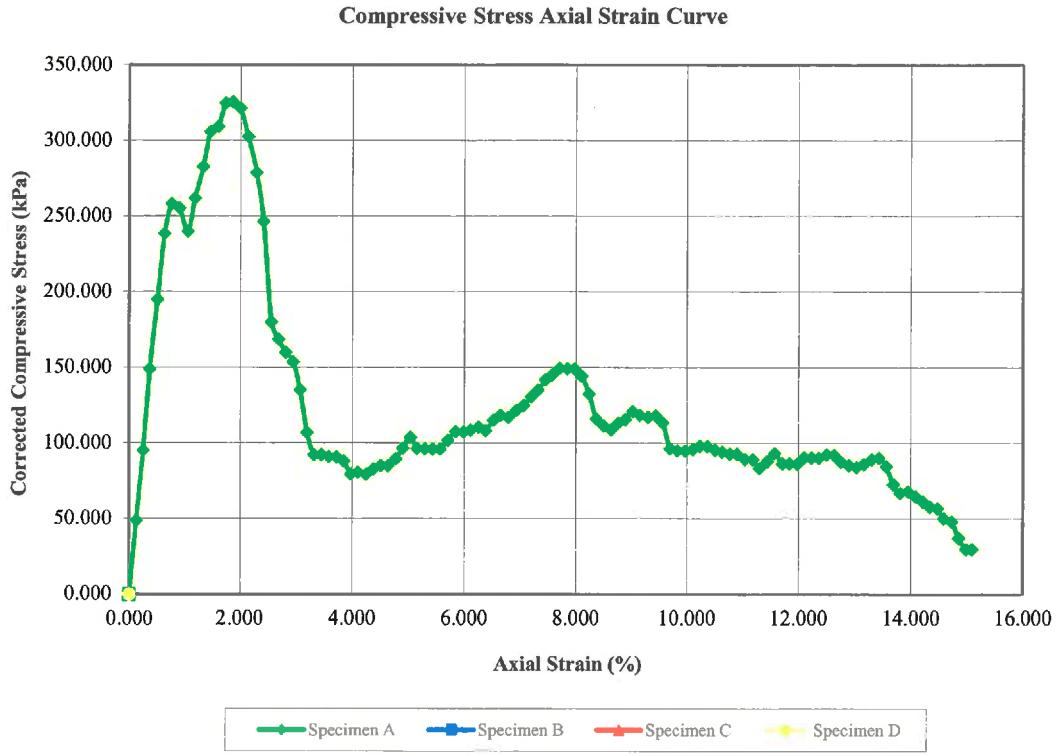
Checked By

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	B	C	D
Water Content (%)	18.72			
Dry Density (g/cm3)	1.785			
Saturation (%)	98.55			
Void Ratio	0.51			
Diameter (mm)	60.857			
Height (mm)	126.430			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	325.816			
Undrained Shear Strength (kgf/cm^2)	1.661			
Undrained Shear Strength (kPa)	162.908			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	1.86			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	STANTEC2 RC28	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.70
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

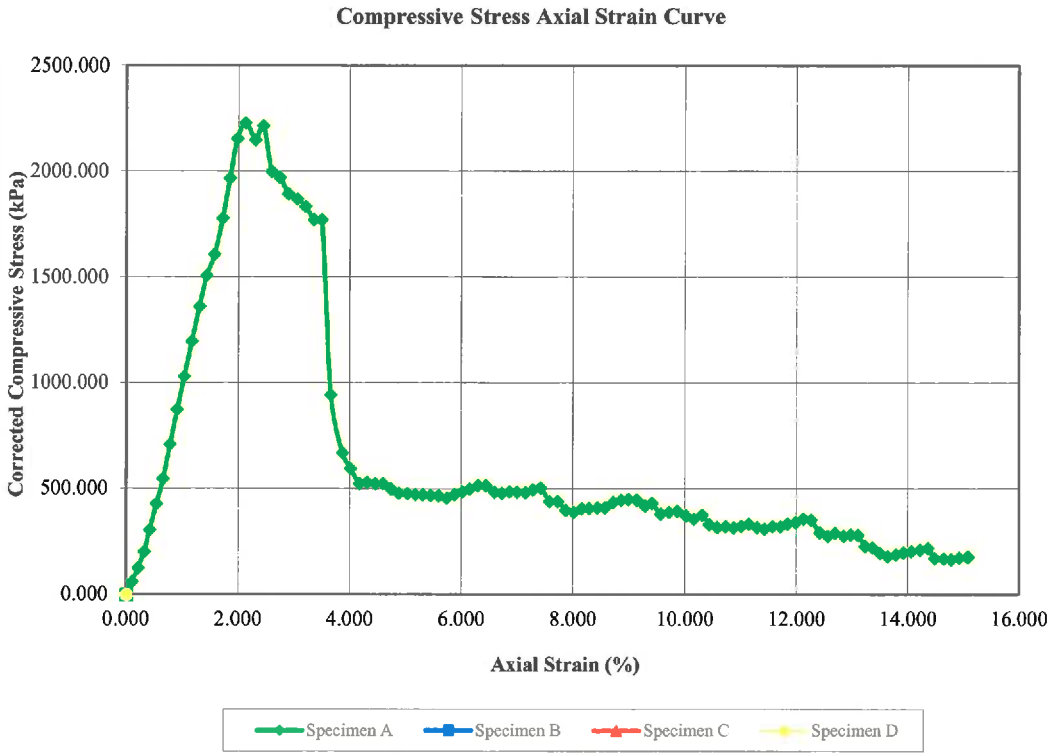
Checked By

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	B	C	D
Water Content (%)	14.10			
Dry Density (g/cm3)	1.946			
Saturation (%)	98.26			
Void Ratio	0.39			
Diameter (mm)	58.530			
Height (mm)	119.147			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	2230.205			
Undrained Shear Strength (kgf/cm^2)	11.371			
Undrained Shear Strength (kPa)	1115.102			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.12			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	STANTEC2 RC44	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.70
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

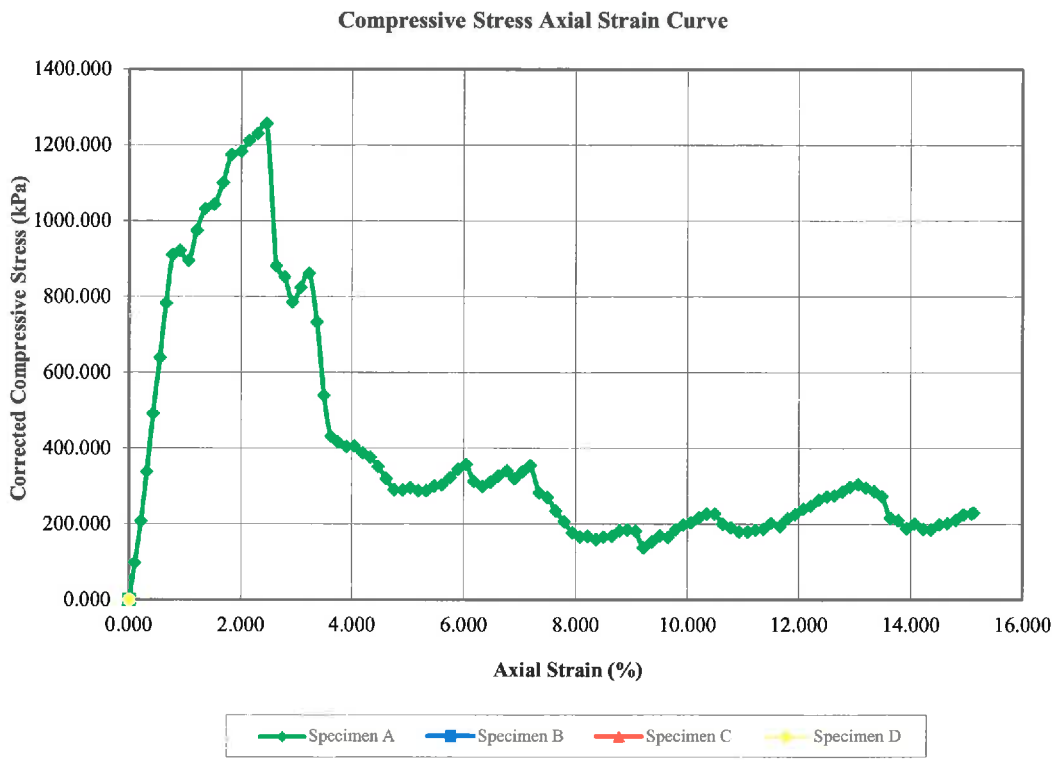
Checked By

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	B	C	D
Water Content (%)	13.34			
Dry Density (g/cm3)	1.955			
Saturation (%)	94.59			
Void Ratio	0.38			
Diameter (mm)	58.267			
Height (mm)	117.640			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	1257.923			
Undrained Shear Strength (kgf/cm^2)	6.414			
Undrained Shear Strength (kPa)	628.961			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.45			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	STANTEC2 RC63	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.70
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

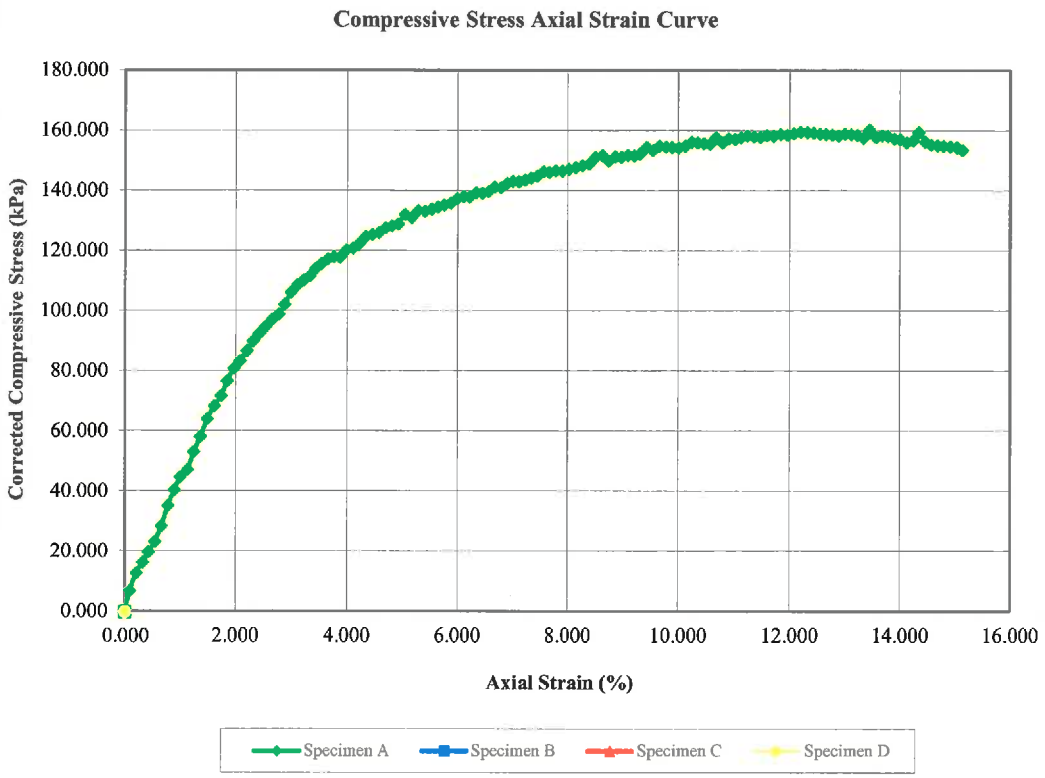
Checked By

Date 9/7/2016

Computed By JA

Date 9/5/2016

Tested By JA



Before Test	Specimen A	B	C	D
Water Content (%)	25.70			
Dry Density (g/cm3)	1.593			
Saturation (%)	102.67			
Void Ratio	0.66			
Diameter (mm)	73.163			
Height (mm)	145.820			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	160.401			
Undrained Shear Strength (kgf/cm^2)	0.818			
Undrained Shear Strength (kPa)	80.200			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	13.45			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Till - Clay and silt, tr sand, oxidize stain
Project	HUE Husky SGS Phase 4	Specimen B	
Sampling Date	August 12, 2016	Specimen C	
Sample #	NRS BH2 ST6	Specimen D	
Client	Husky	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

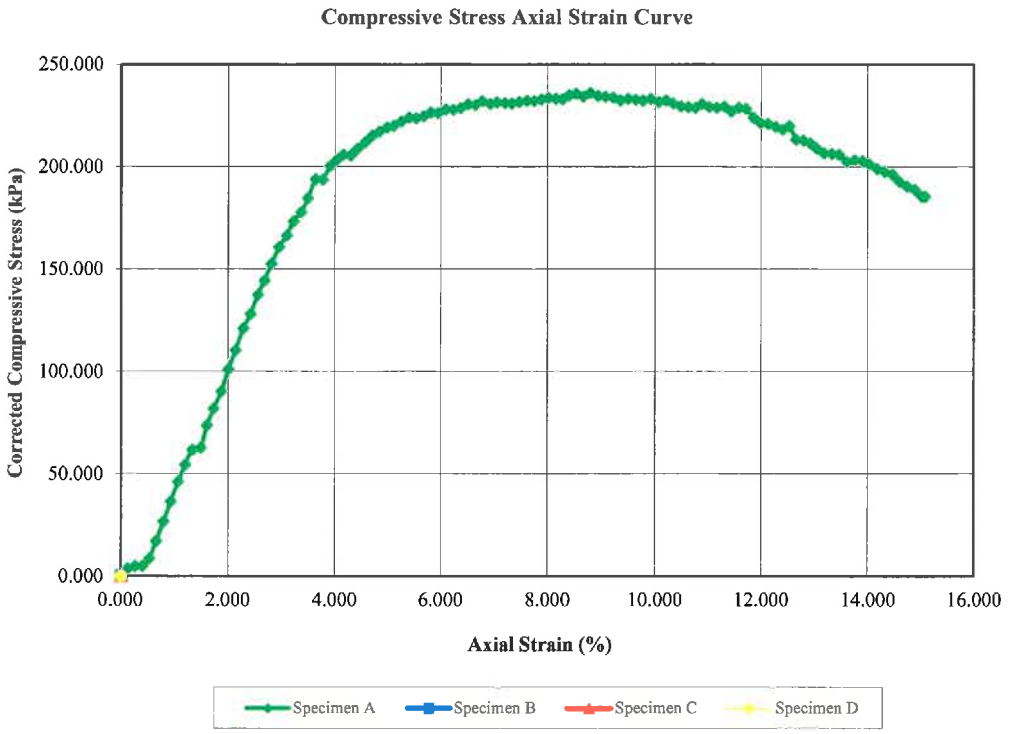
Checked By JC

Date 9/12/2016

Computed By J.A

Date ######

Tested By J.A



Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	25.78			
Dry Density (g/cm3)	1.578			
Saturation (%)	97.96			
Void Ratio	0.71			
Diameter (mm)	61.587			
Height (mm)	122.483			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	236.313			
Undrained Shear Strength (kgf/cm^2)	1.205			
Undrained Shear Strength (kPa)	118.156			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	8.79			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH2 RC26	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.70
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

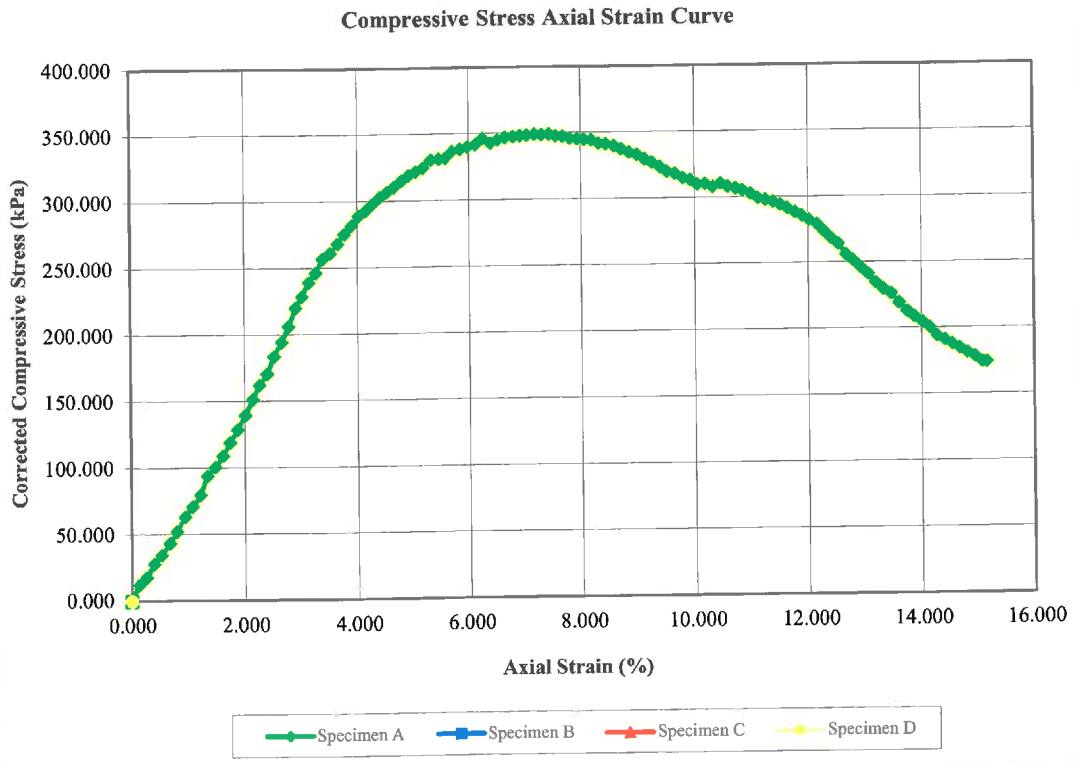
Checked By

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	21.81			
Dry Density (g/cm3)	1.619			
Saturation (%)	90.78			
Void Ratio	0.64			
Diameter (mm)	64.413			
Height (mm)	127.497			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	349.159			
Undrained Shear Strength (kgf/cm^2)	1.780			
Undrained Shear Strength (kPa)	174.579			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	7.43			
Description				

Project Information	
Project Num	110902147
Project	HUE - Husky SGS Phase 4
Sampling Date	
Sample #	NSR BH2 RC34
Client	Husky Oil Operation Ltd.

Specimen Description	
Specimen A	Clay Shale
Specimen B	
Specimen C	
Specimen D	

Test Variables	
Specific Gravity	2.65
Liquid Limit:	
Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/12/16

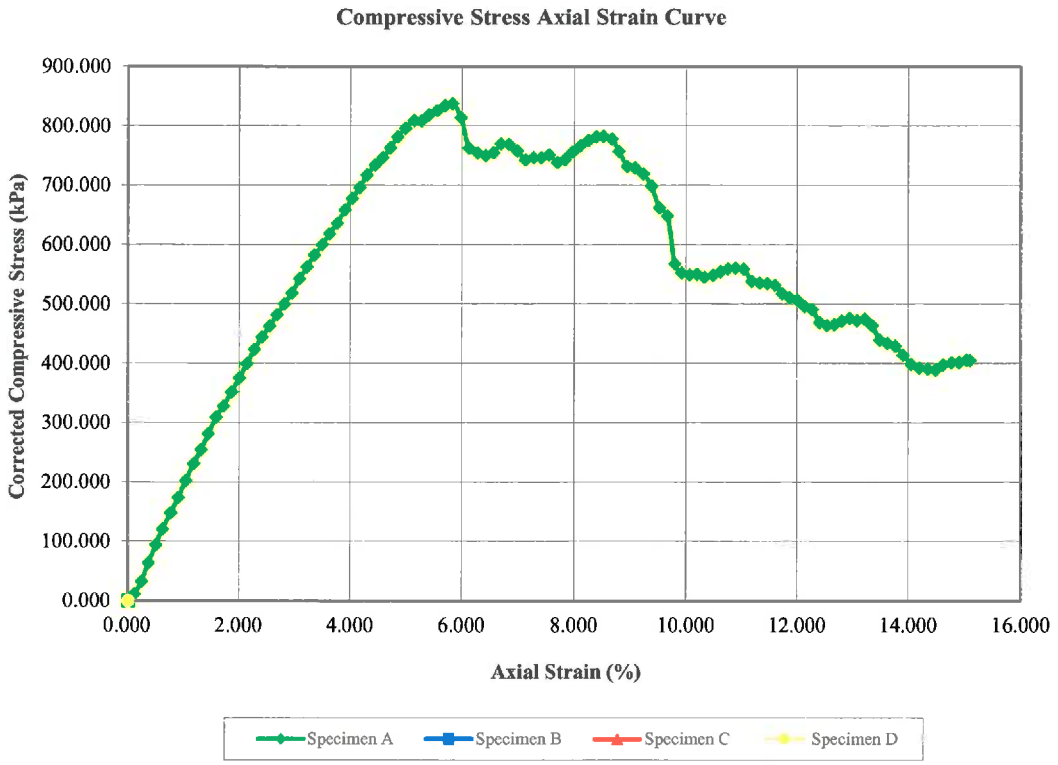
Checked By JK

Date 9/12/2016

Computed By J.A

Date 9/10/2016

Tested By J.A



Before Test	Specimen A	B	C	D
Water Content (%)	16.56			
Dry Density (g/cm3)	1.843			
Saturation (%)	96.15			
Void Ratio	0.47			
Diameter (mm)	60.727			
Height (mm)	120.367			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	837.331			
Undrained Shear Strength (kgf/cm^2)	4.269			
Undrained Shear Strength (kPa)	418.665			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	5.82			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	RC37	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.70
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/29/16

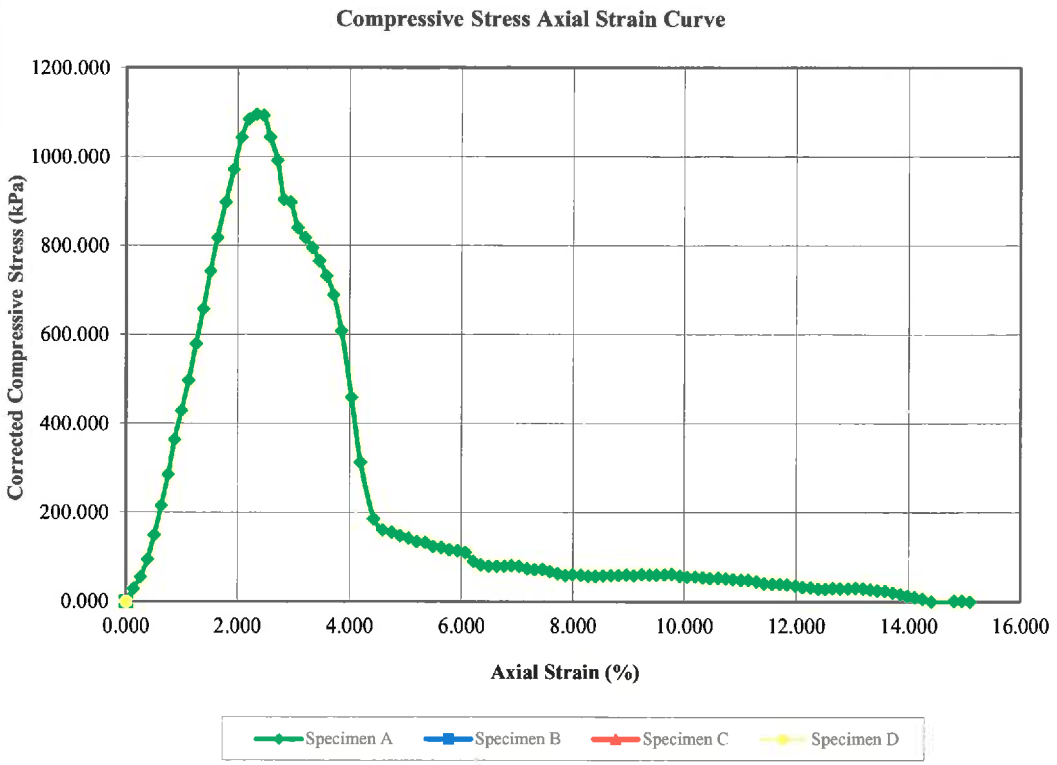
Checked By SX

Date 9/19/2016

Computed By JA

Date 9/16/2016

Tested By JA



Before Test	Specimen A	B	C	D
Water Content (%)	13.62			
Dry Density (g/cm3)	1.937			
Saturation (%)	98.00			
Void Ratio	0.37			
Diameter (mm)	77.467			
Height (mm)	122.567			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	1095.286			
Undrained Shear Strength (kgf/cm^2)	5.584			
Undrained Shear Strength (kPa)	547.643			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.33			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH3 RC61	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 9/20/16

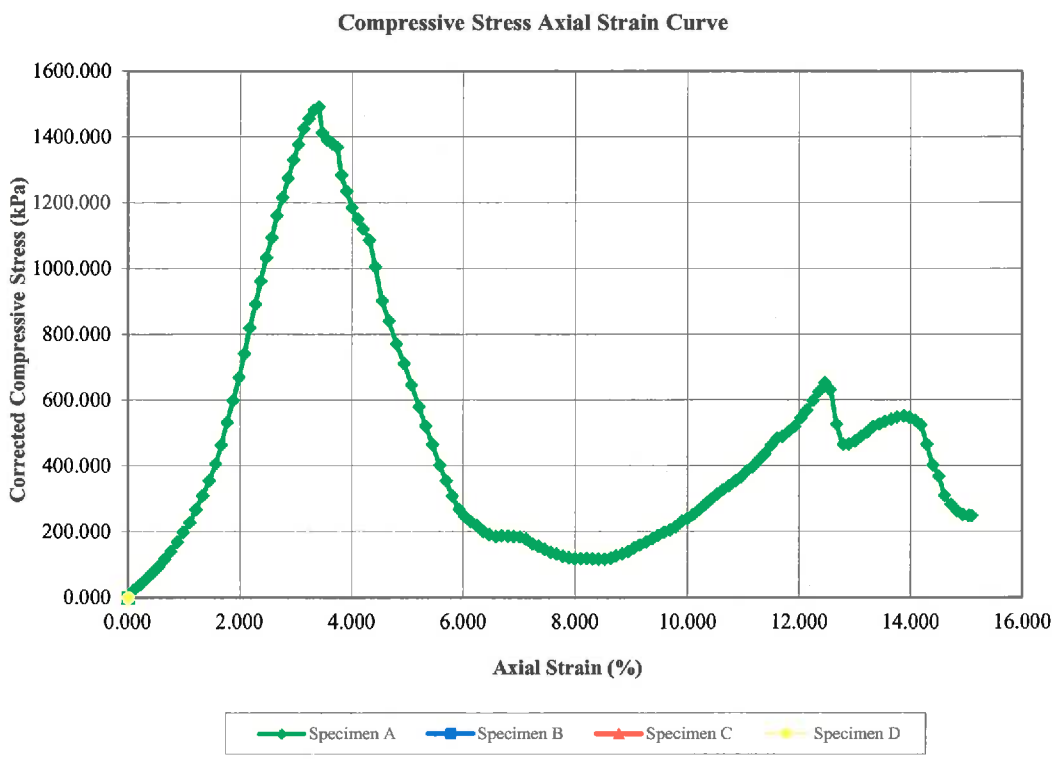
Checked By BX

Date 9/19/2016

Computed By JA

Date 9/16/2016

Tested By JA



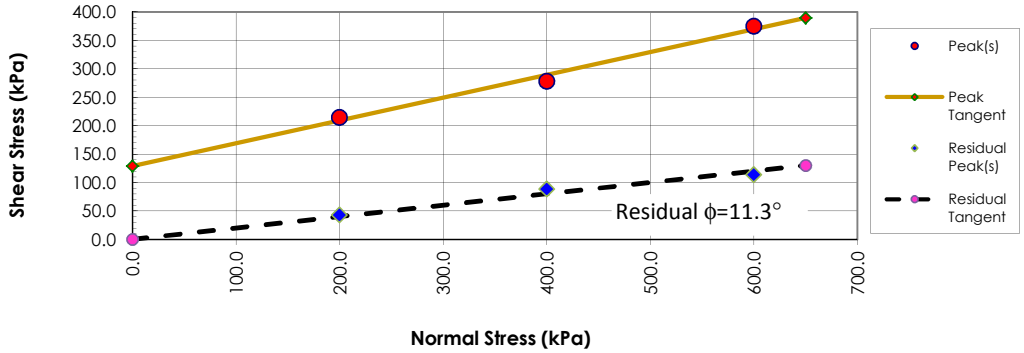
Before Test	Specimen A	B	C	D
Water Content (%)	13.85			
Dry Density (g/cm3)	1.873			
Saturation (%)	88.51			
Void Ratio	0.41			
Diameter (mm)	77.520			
Height (mm)	156.167			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	1489.854			
Undrained Shear Strength (kgf/cm^2)	7.596			
Undrained Shear Strength (kPa)	744.927			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	3.40			
Description				

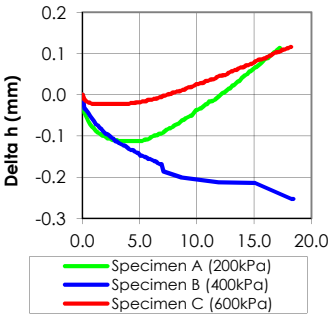
Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay Shale
Project	HUE - Husky SGS Phase 4	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH3 RC67	Specimen D	
Client	Husky Oil Operation Ltd.	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

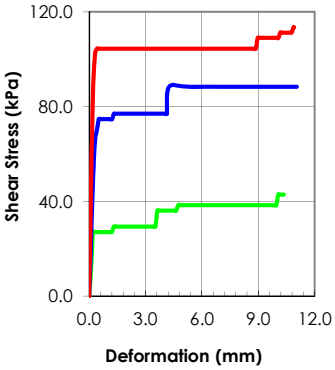
Remarks

Stantec Consulting Ltd.
Direct Shear Test

Stantec







Initial	Specimen A	B	C	D
Moisture (%)	21.8	20.2	20.5	
Dry Density (g/cm3)	1.705	1.652	1.668	
Void Ratio	0.555	0.604	0.589	
Saturation (%)	100.00	88.62	92.22	
Diameter (mm)	60.00	59.90	59.80	
Height (mm)	25.00	25.20	25.00	

Final	A	B	C	D
Moisture (%)	21.7	20.4	19.9	
Dry Density (g/cm3)	1.644	1.608	1.639	
Void Ratio	0.612	0.648	0.617	
Saturation (%)	98.11	90.34	98.21	
Diameter (mm)	60.00	59.90	59.80	
Height (mm)	24.586	24.448	23.772	
Normal Stress (kPa)	200.0	400.0	600.0	
Peak Stress (kPa)	214.2	278.3	374.6	
Residual Stress (kPa)	42.8	88.4	113.5	
Max. Shear Strain (%)	17.267	18.439	18.234	
Rate (mm/min)	0.007	0.007	0.008	

Project Date	
Date	14-Sep-16

Project:	Husky SGS Phase 4
Location:	-
Project Number:	110902147.5.500.200.210.100
Boring Number	-
Sample Number:	NSR-BH1 RC27
Depth:	25.3-25.5m
Sample Type:	Undisturbed
Description:	Grey Mudstone
Test Type:	Direct Shear
Remarks:	Area correction has not been applied. Presented stresses are nominal stresses.

Reviewed By: H.Kempson

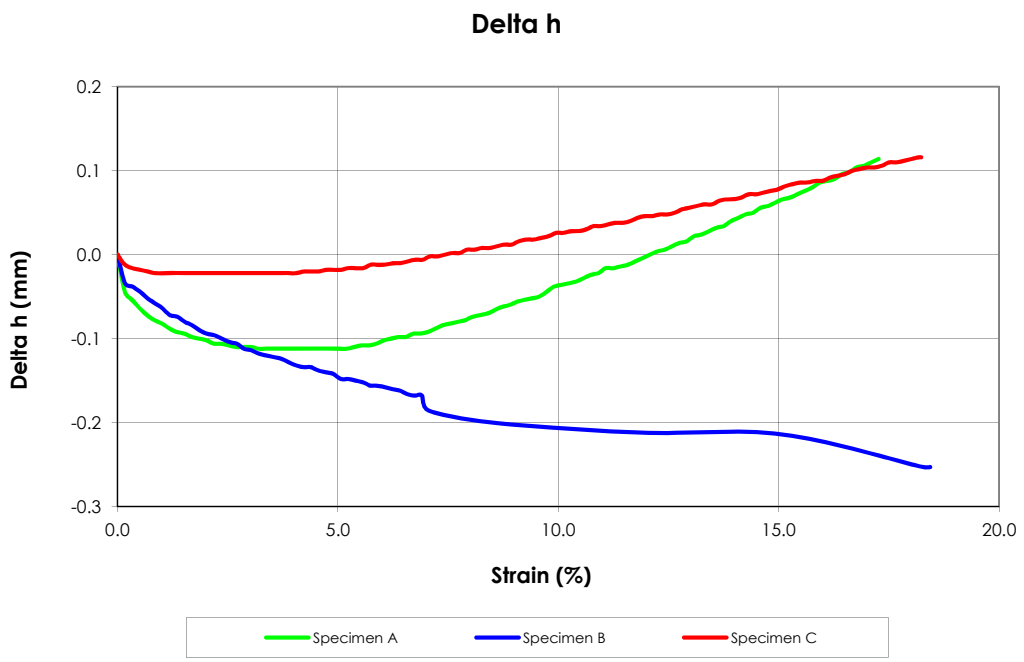
Date: 14-Sep-16

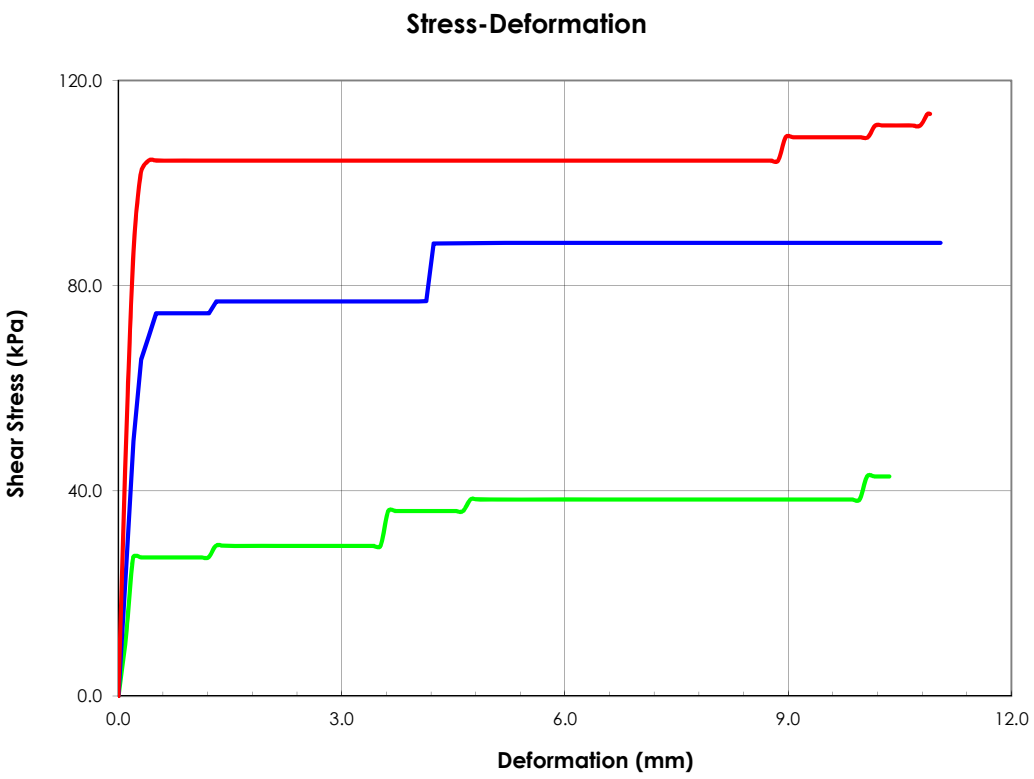
Tested By: C.Oost

Stantec Consulting Ltd.

Direct Shear Test

Stantec





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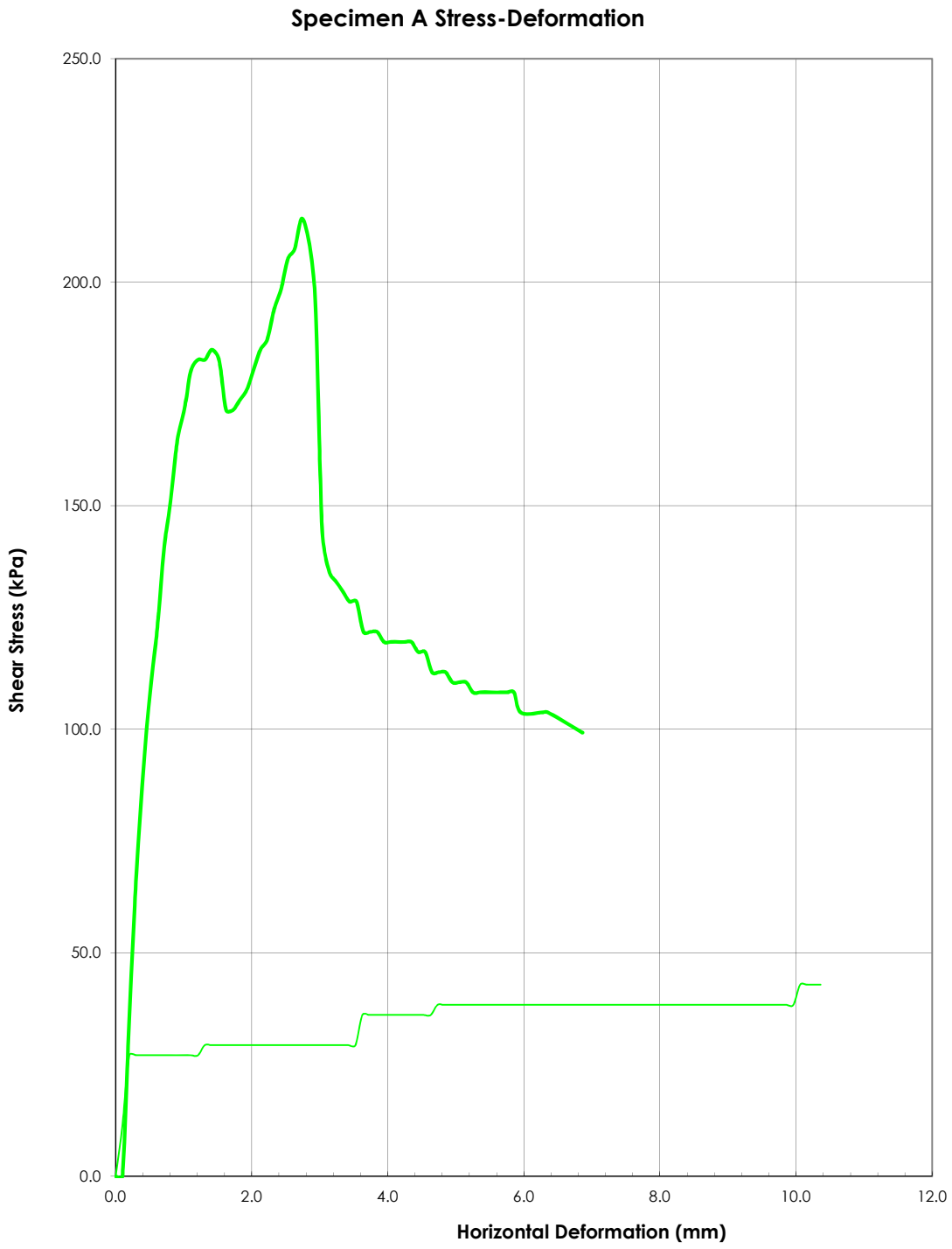
Stantec Consulting Ltd.

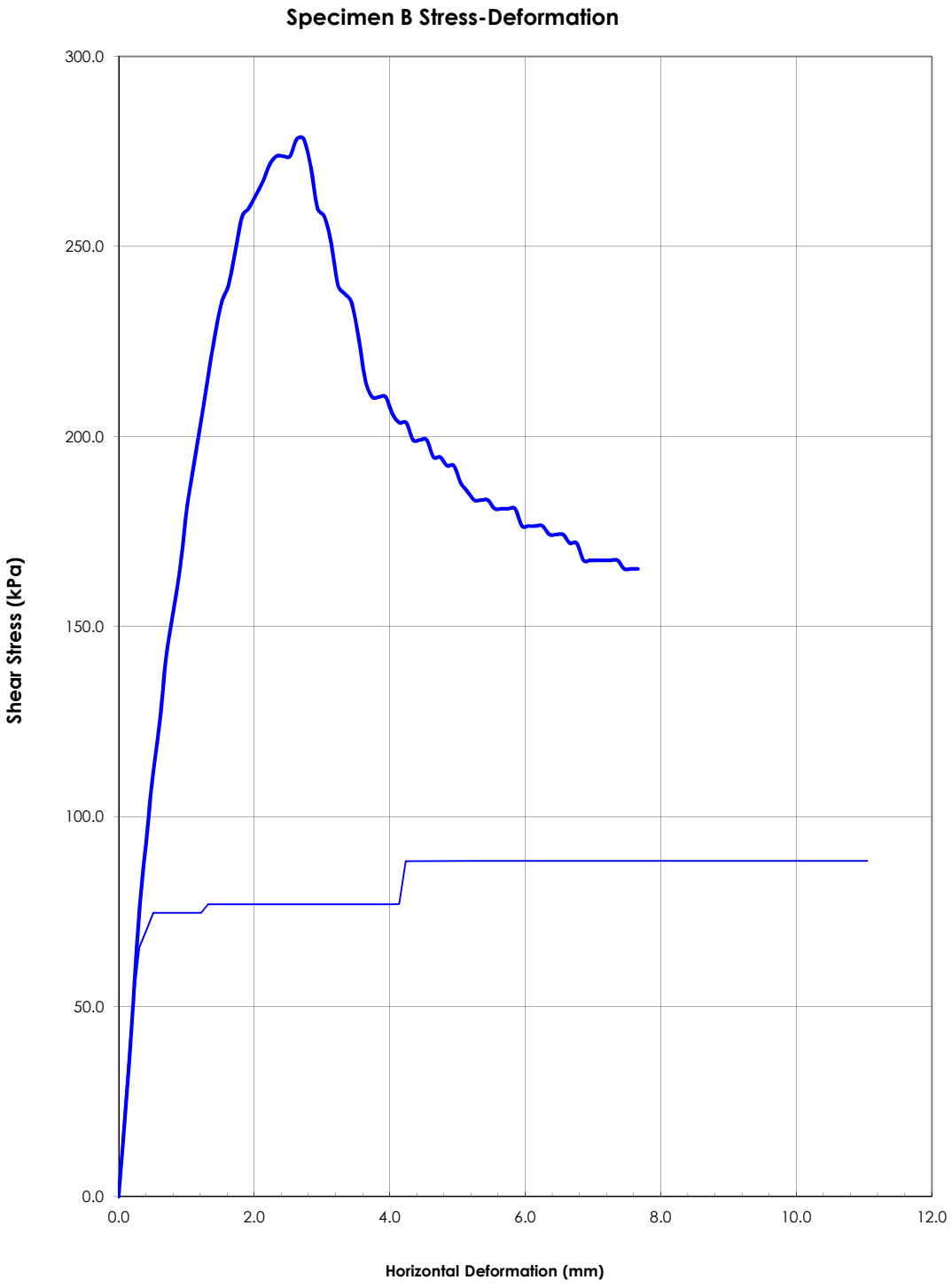
Direct Shear Test

Stantec



Stantec Consulting Ltd.

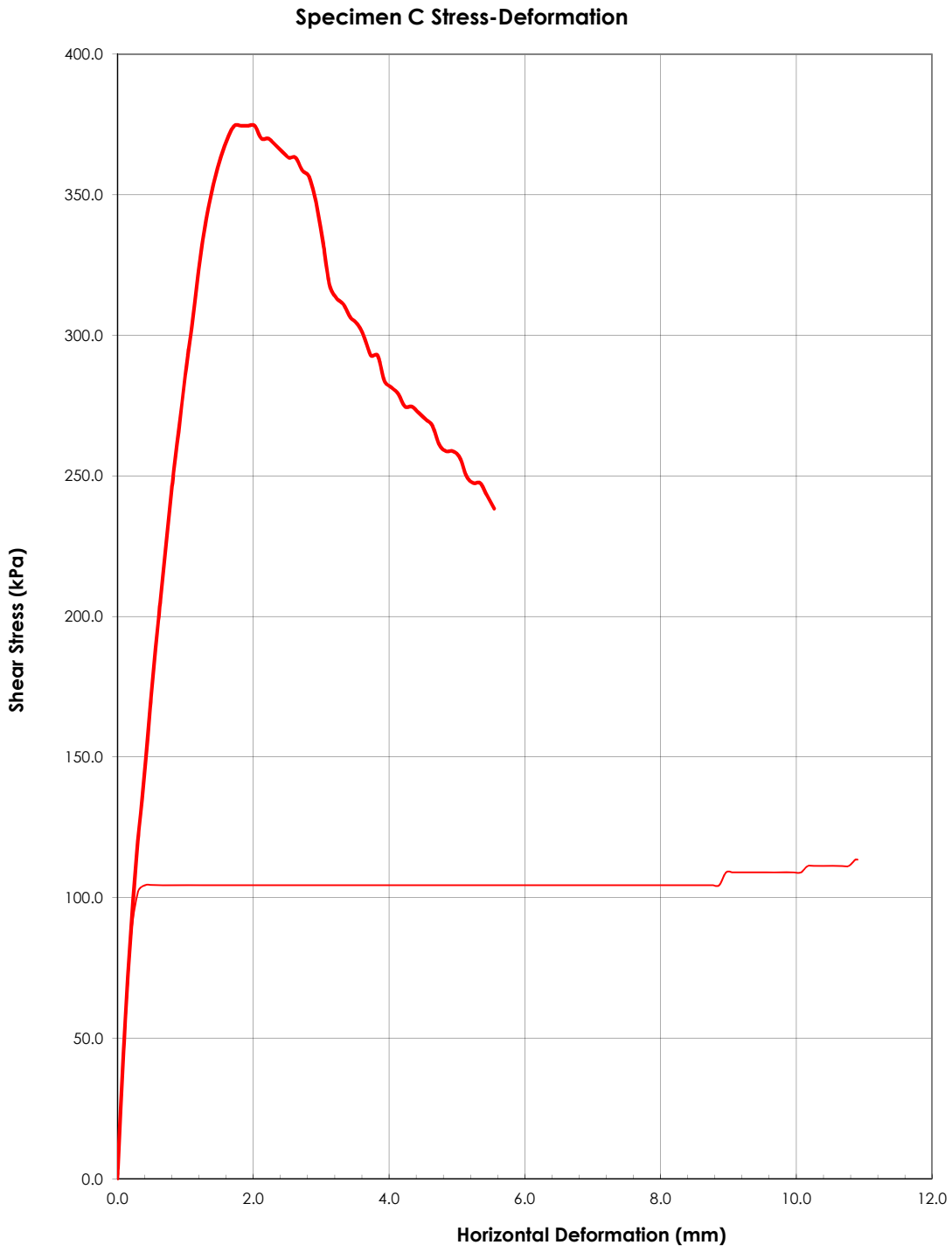
Direct Shear Test



Stantec Consulting Ltd.

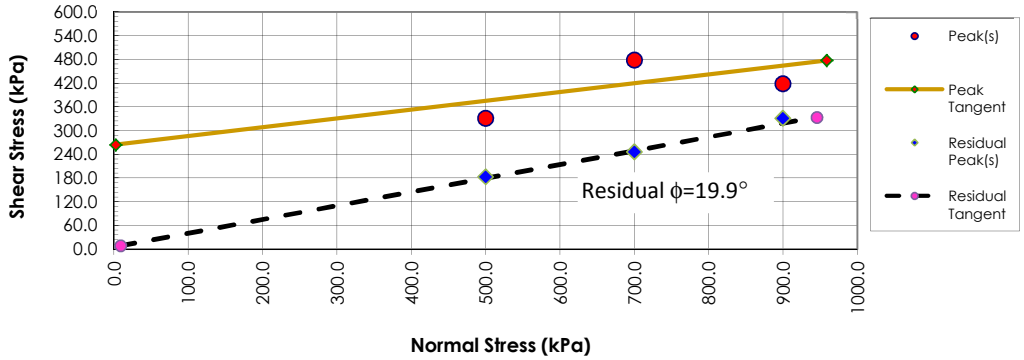
Direct Shear Test

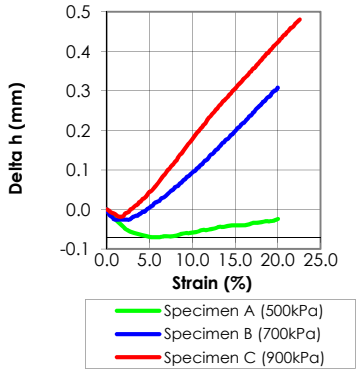
Stantec

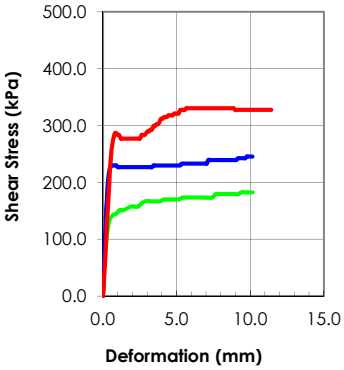


Stantec Consulting Ltd.
Direct Shear Test

Stantec







Initial	Specimen A	B	C	D
Moisture (%)	19.5	16.9	19.4	
Density (g/cm3)	1.754	1.821	1.735	
Void Ratio	0.511	0.455	0.528	
Saturation (%)	100.00	98.40	97.26	
Diameter (mm)	50.7	50.7	50.7	
Height (mm)	25.5	25.5	25.5	

Final	A	B	C	D
Moisture (%)	15.2	15.4	14.0	
Density (g/cm3)	1.781	1.815	1.765	
Void Ratio	0.488	0.460	0.501	
Saturation (%)	93.97	100.00	92.02	
Diameter (mm)	50.7	50.7	50.7	
Height (mm)	24.476	22.720	23.834	
Normal Stress (kPa)	500.0	700.0	900.0	
Peak Stress (kPa)	330.5	478.4	418.6	
Residual Stress (kPa)	182.5	245.5	330.5	
Strain (%)	20.004	20.000	22.552	
Rate (mm/min)	0.01	0.01	0.01	

Project Date	
Date	26-Sep-16

Project:	Husky SGS Phase 4
Location:	-
Project Number:	110902147.5.500.200.210.100
Boring Number	-
Sample Number:	NSR BH2 RC39
Depth:	40.8-41.0 m
Sample Type:	Undisturbed
Description:	Dark Grey Mudstone
Test Type:	Direct Shear
Remarks:	Area correction has not been applied. Presented stresses are nominal stresses.

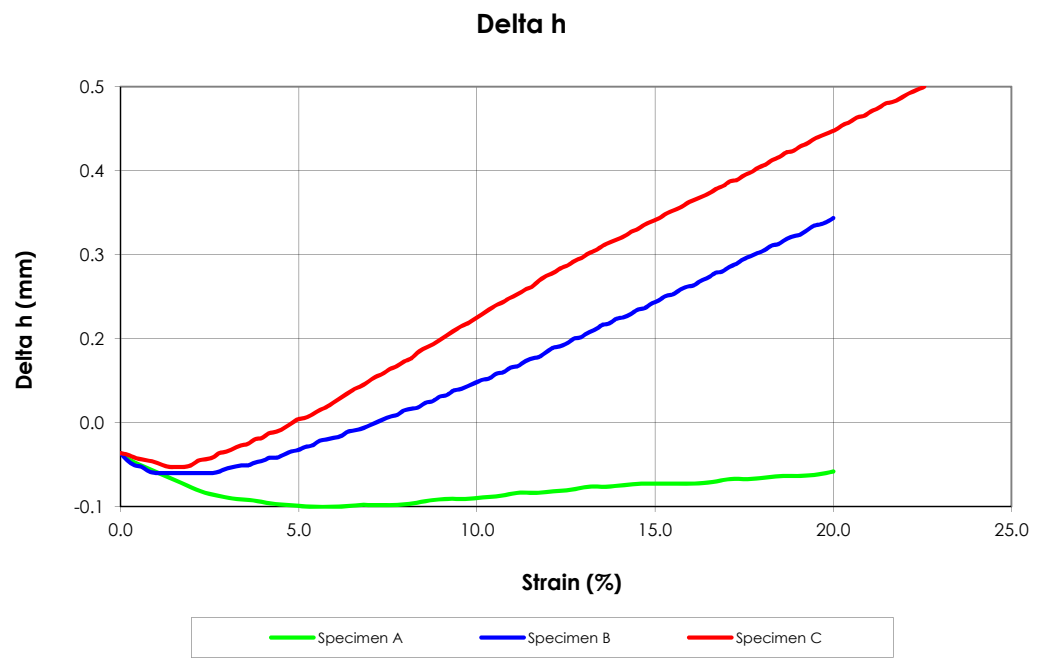
Reviewed By: H.Kempner

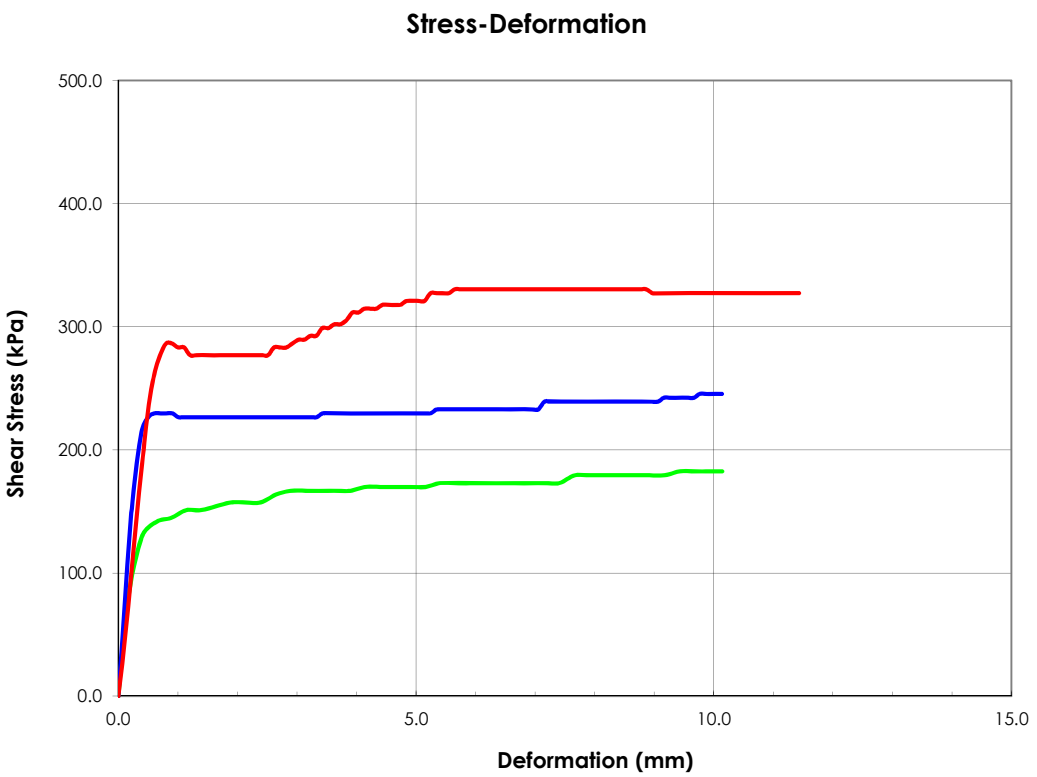
Date: 26-Sep-16

Tested By: C.Tollifson

Stantec Consulting Ltd.

Direct Shear Test





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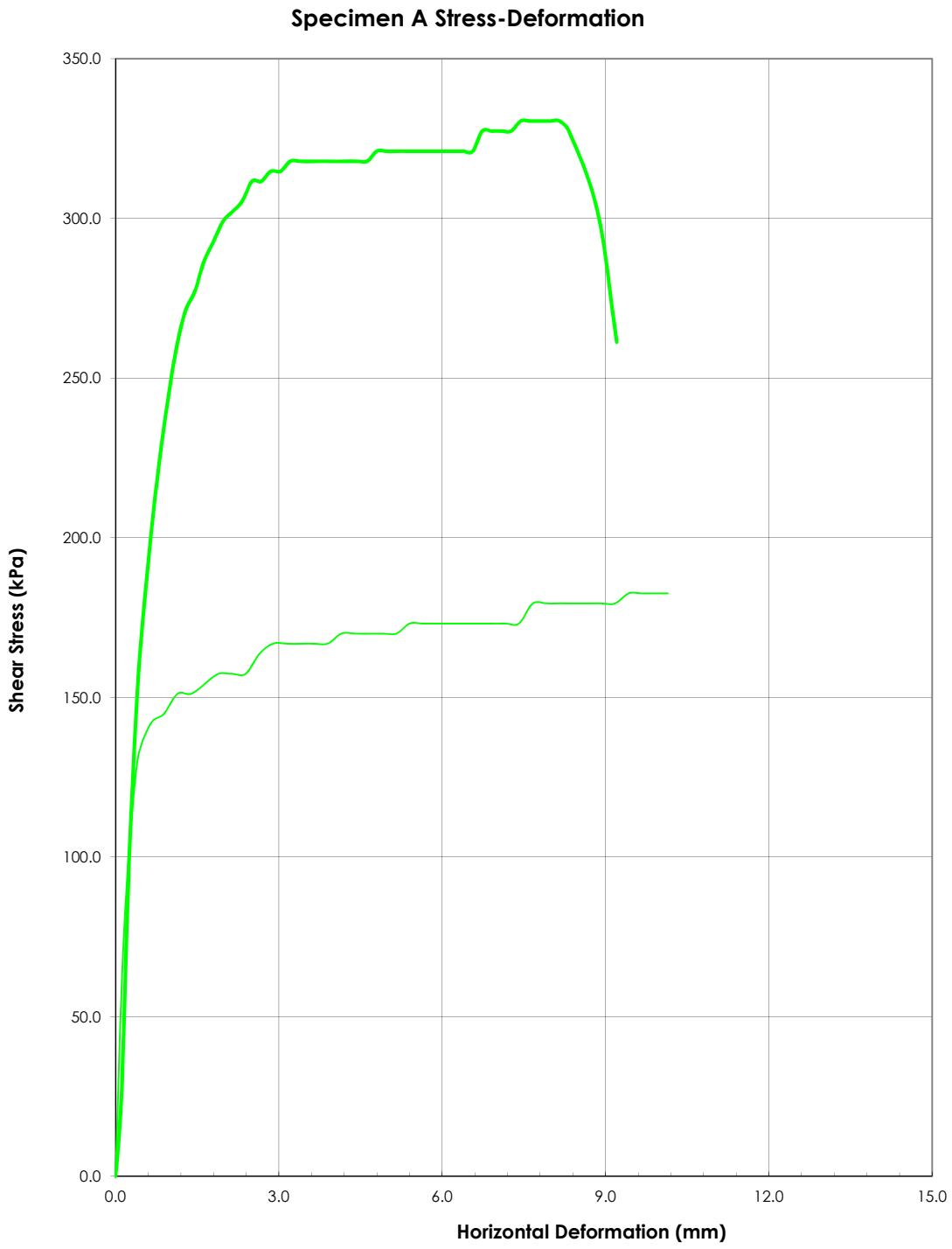
Stantec Consulting Ltd.

Direct Shear Test

Stantec



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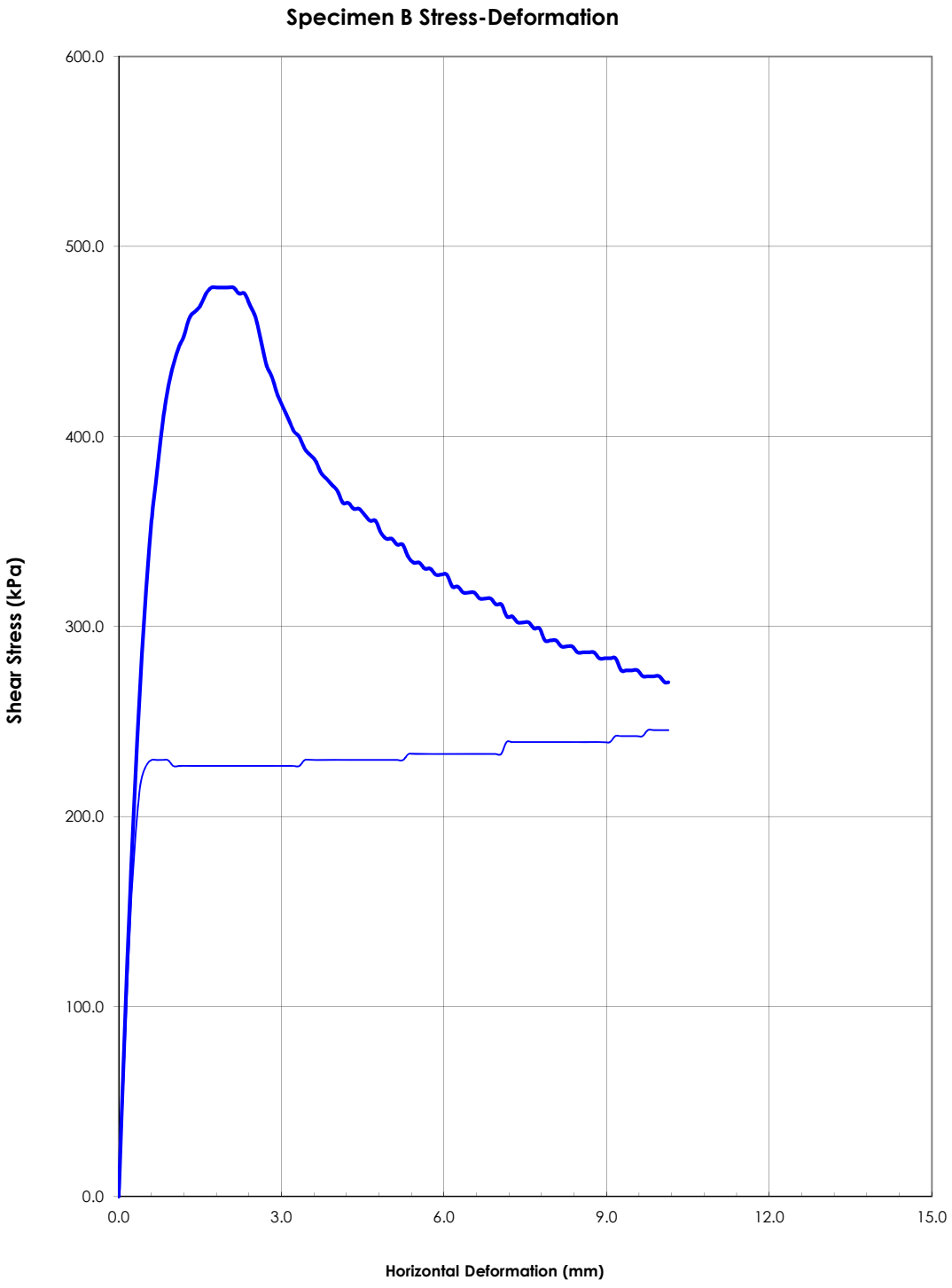
Stantec Consulting Ltd.

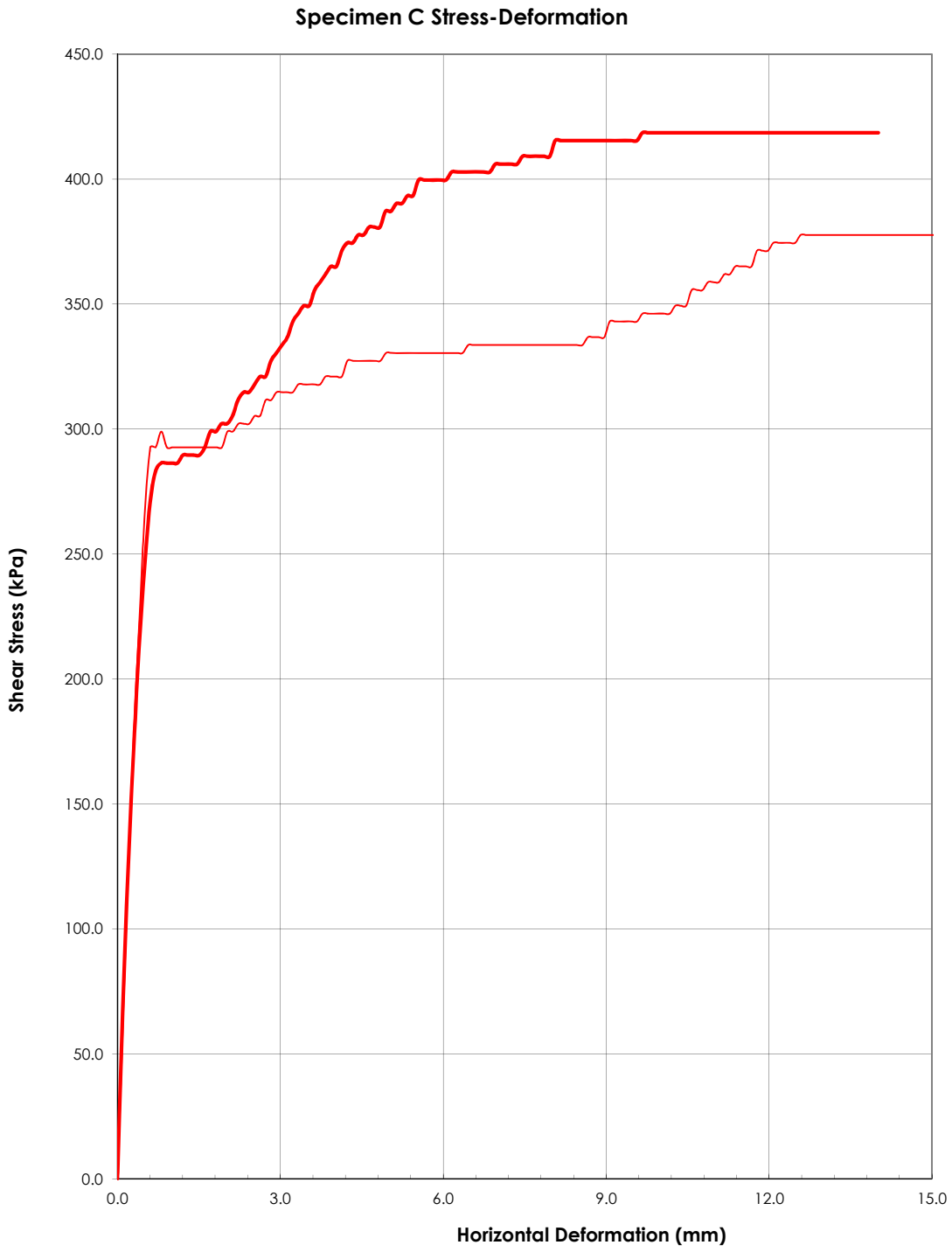
Direct Shear Test

Stantec



Stantec Consulting Ltd.

Direct Shear Test



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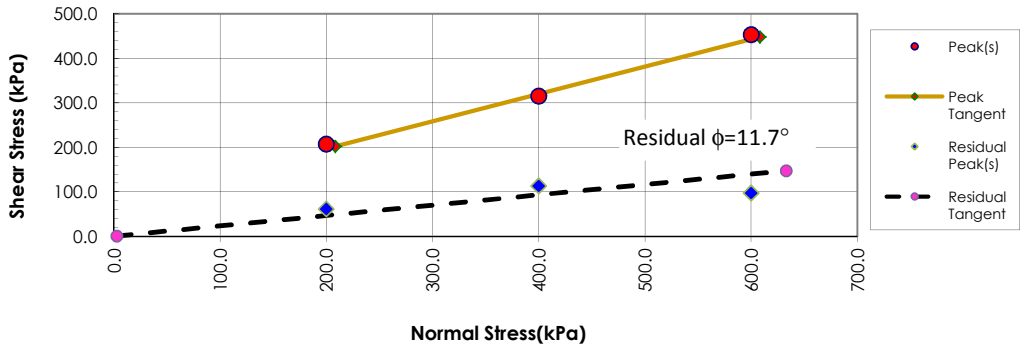
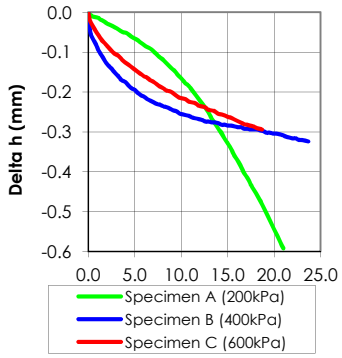
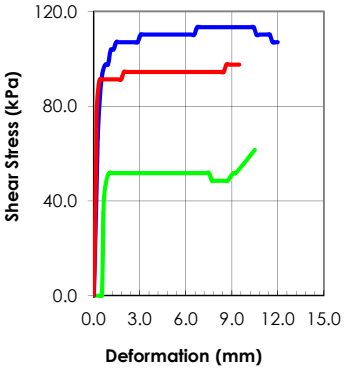
Stantec Consulting Ltd.
Direct Shear Test

Stantec







Initial	Specimen A	B	C	D
Moisture (%)	18.9	19.1	19.1	
Dry Density (g/cm3)	1.670	1.467	1.698	
Void Ratio	0.587	0.807	0.561	
Saturation (%)	85.46	62.59	90.25	
Diameter (mm)	50.70	50.70	50.70	
Height (mm)	19.00	25.50	25.50	

Final	A	B	C	D
Moisture (%)	17.9	19.1	19.0	
Dry Density (g/cm3)	1.539	1.603	1.639	
Void Ratio	0.722	0.653	0.617	
Saturation (%)	68.52	84.36	87.70	
Diameter (mm)	50.00	50.70	50.70	
Height (mm)	18.674	24.692	24.818	
Normal Stress (kPa)	200.0	400.0	600.0	
Peak Stress (kPa)	207.1	314.7	453.2	
Residual Stress (kPa)	61.5	113.3	97.6	
Max. Shear Strain (%)	20.992	23.665	18.698	
Rate (mm/min)	0.007	0.007	0.007	

Project Date	
Date	14-Sep-16

Project:	Husky SGS Phase 4
Location:	-
Project Number:	110902147.5.500.200.210.100
Boring Number	-
Sample Number:	Stantec 1 RC29
Depth:	22.9-23.2m
Sample Type:	Undisturbed
Description:	Grey Mudstone
Test Type:	Direct Shear
Remarks:	Area correction has not been applied. Presented stresses are nominal stresses.

Reviewed By: H.Kempson

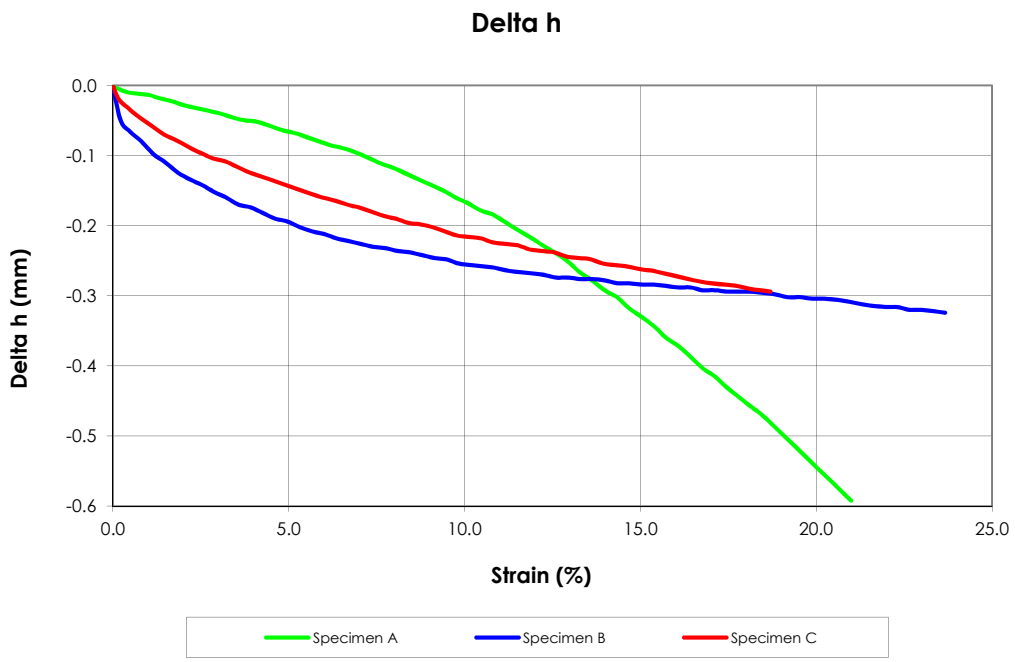
Date: 14-Sep-16

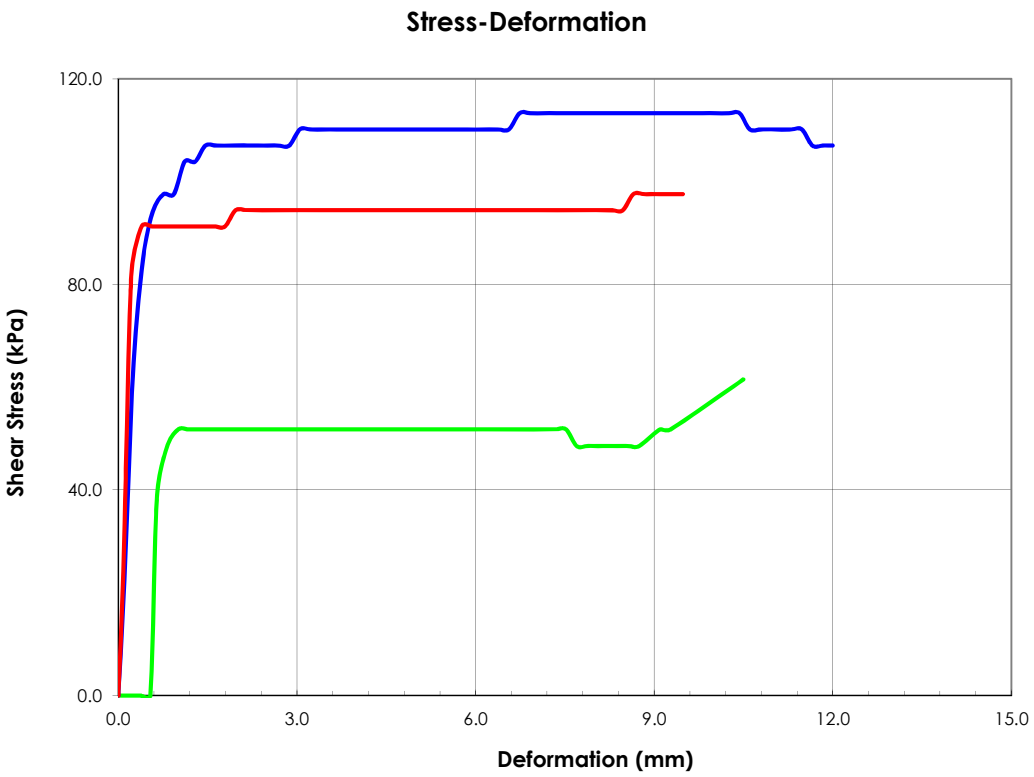
Tested By: C.Oost

Stantec Consulting Ltd.

Direct Shear Test

Stantec



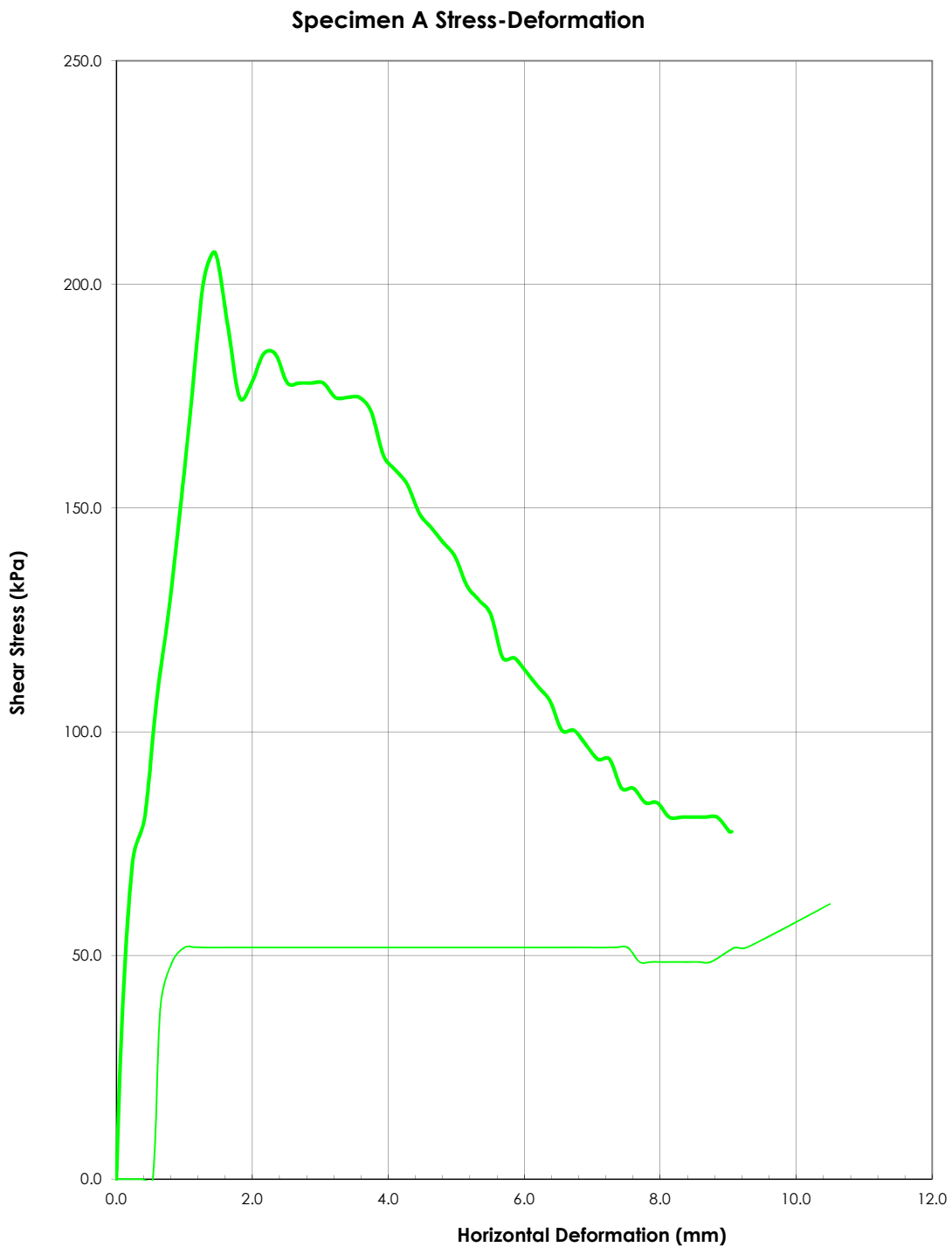


lab_110902147_dsh_stn1rc29.HSD

Stantec Consulting Ltd.

Direct Shear Test

Stantec



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Direct Shear Test

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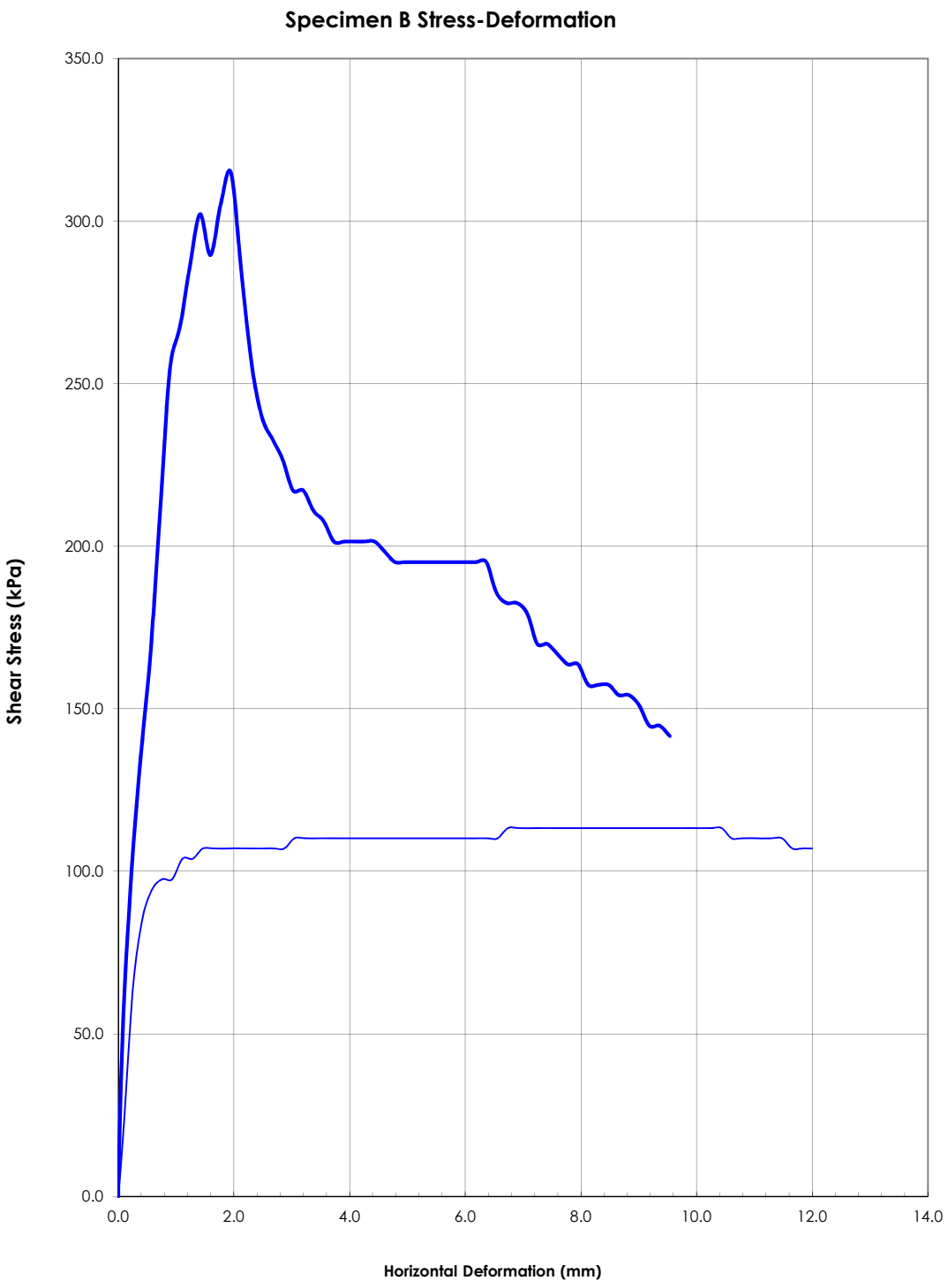

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Direct Shear Test

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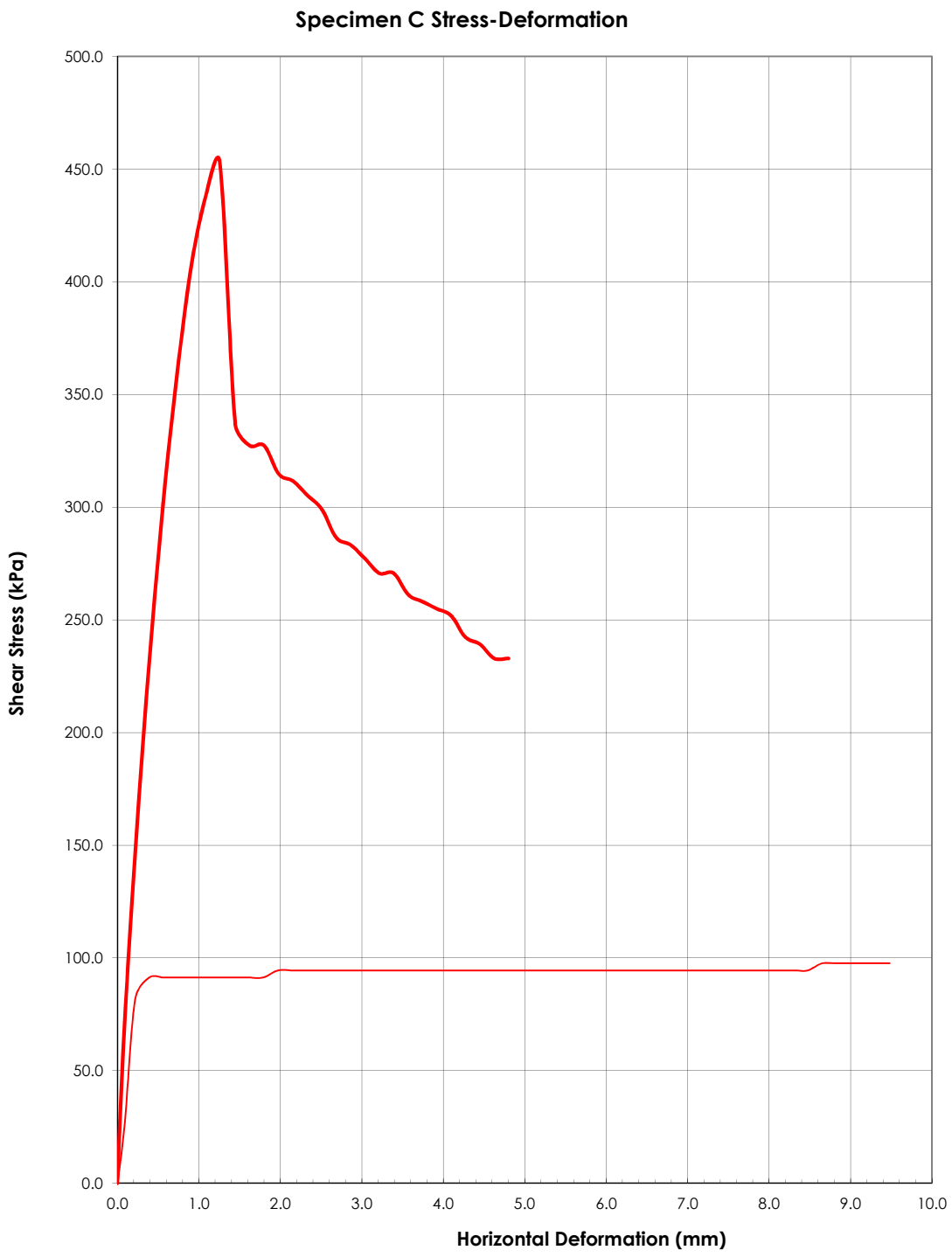

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Direct Shear Test

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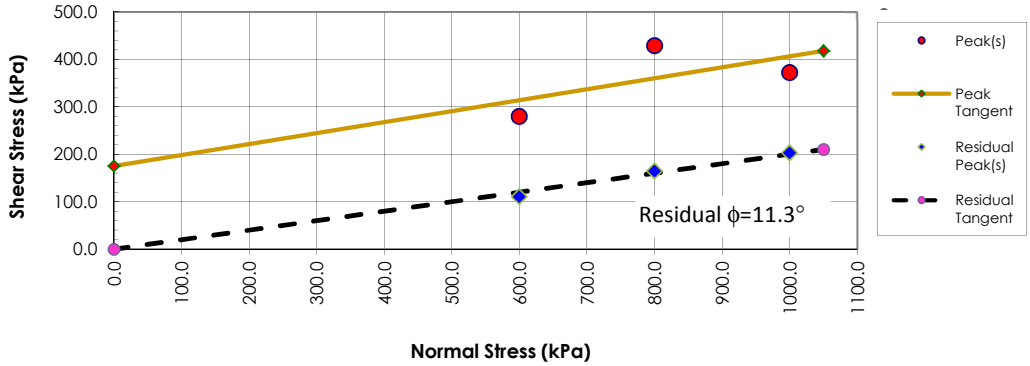
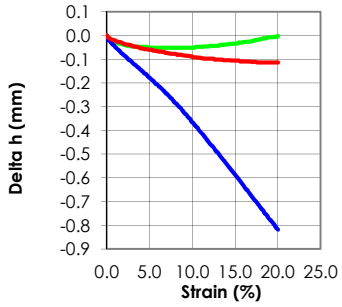
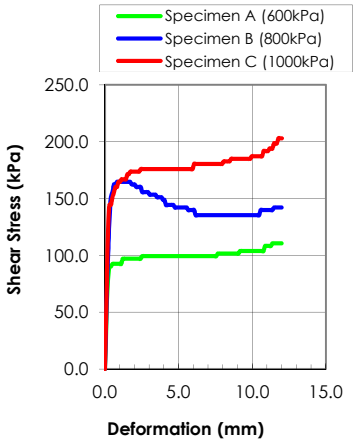




Initial	Specimen A	B	C	D
Moisture (%)	35.7	36.0	36.0	
Density (g/cm3)	1.402	1.291	1.313	
Void Ratio	0.890	1.053	1.018	
Saturation (%)	100.00	90.66	93.82	
Diameter (mm)	60.0	60.0	60.0	
Height (mm)	25.2	25.2	25.2	



Final	A	B	C	D
Moisture (%)	30.2	33.2	34.3	
Density (g/cm3)	1.430	1.293	1.311	
Void Ratio	0.854	1.049	1.022	
Saturation (%)	100.00	93.99	100.00	
Diameter (mm)	60.0	60.0	60.0	
Height (mm)	24.072	23.798	22.406	
Normal Stress (kPa)	600.0	800.0	1000.0	
Peak Stress (kPa)	279.6	428.4	372.1	
Residual Stress (kPa)	110.5	164.6	202.9	
Strain (%)	20.003	20.003	20.027	
Rate (mm/min)	0.01	0.01	0.01	

Project Date	
Date	26-Sep-16

Project:	Husky SGS Phase 4
Location:	-
Project Number:	110902147.5.500.200.210.100
Boring Number	-
Sample Number:	Stantec 1 RC 45
Depth:	46.4-46.6 m
Sample Type:	Undisturbed
Description:	Grey Bentonitic Mudstone
Test Type:	Direct Shear
Remarks:	Area correction has not been applied. Presented stresses are nominal stresses.

Reviewed By: H. Kempman

Date: 9/26/2016

Tested By: C.Tollifson

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Direct Shear Test

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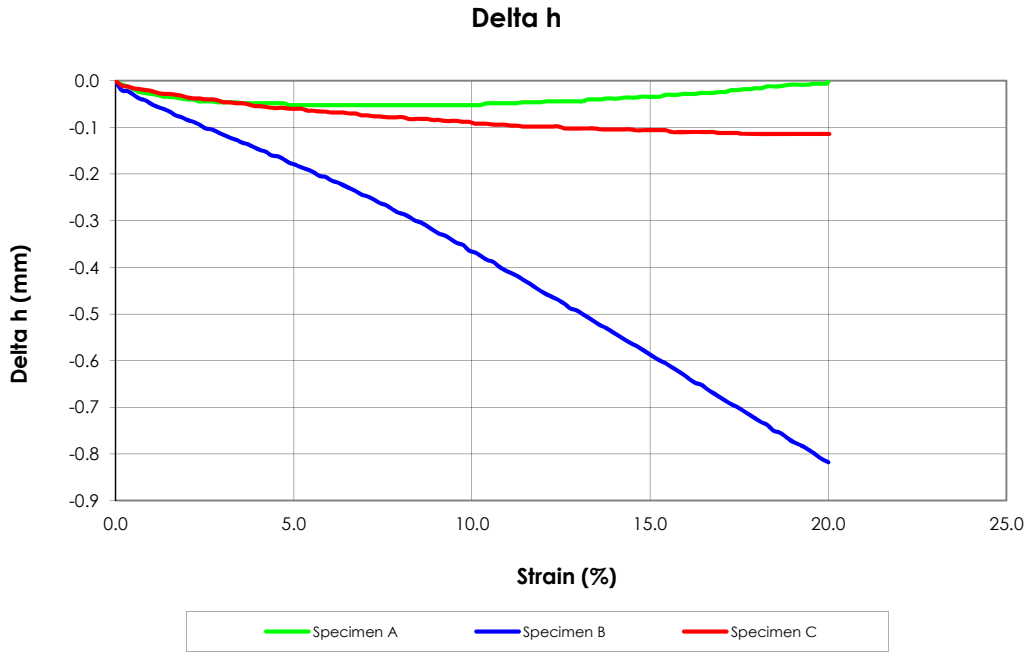

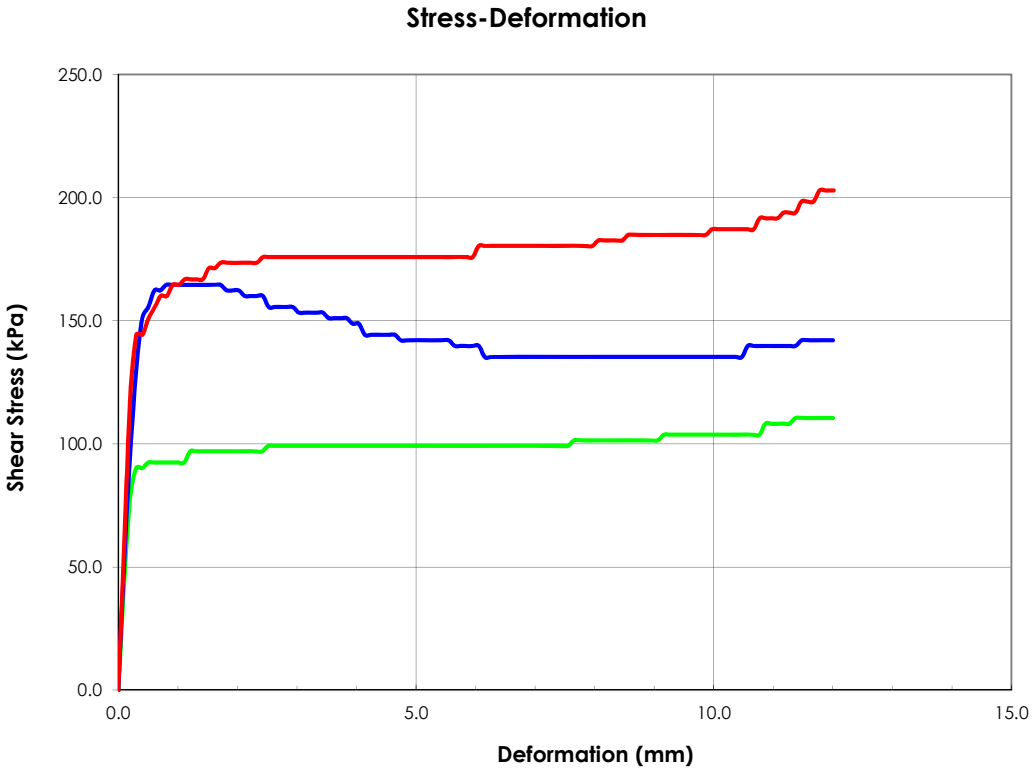

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Direct Shear Test

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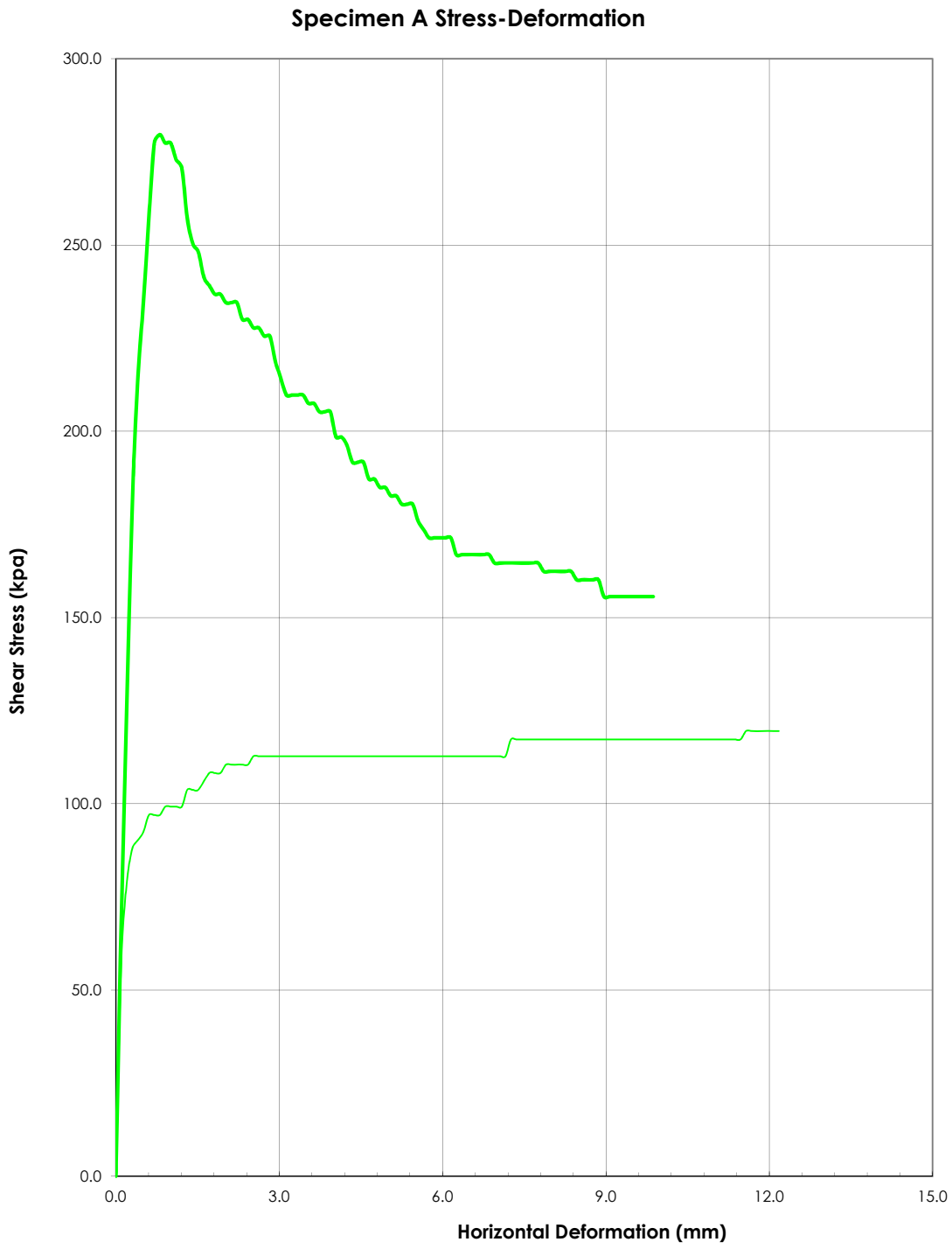

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Direct Shear Test

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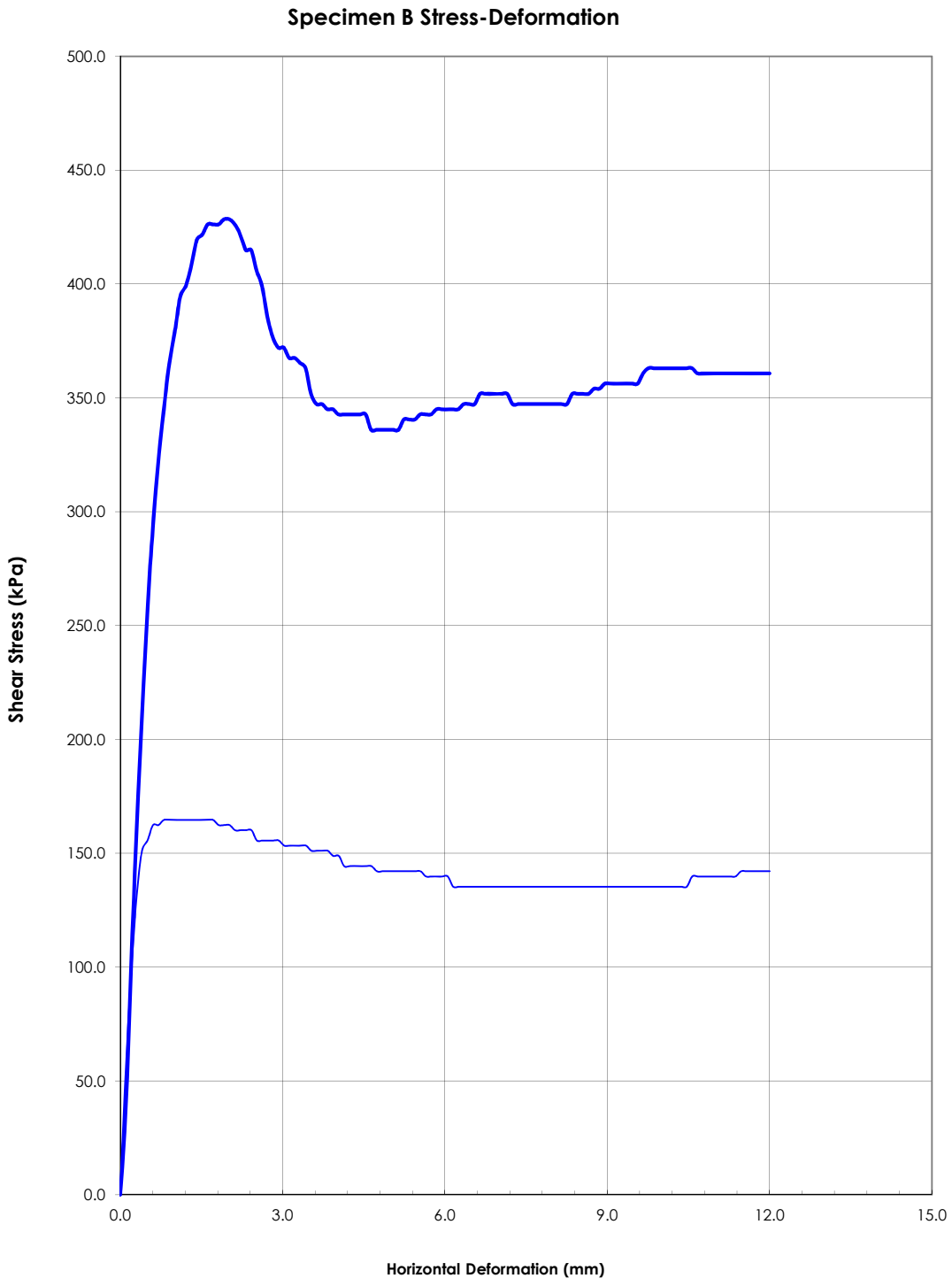

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Direct Shear Test

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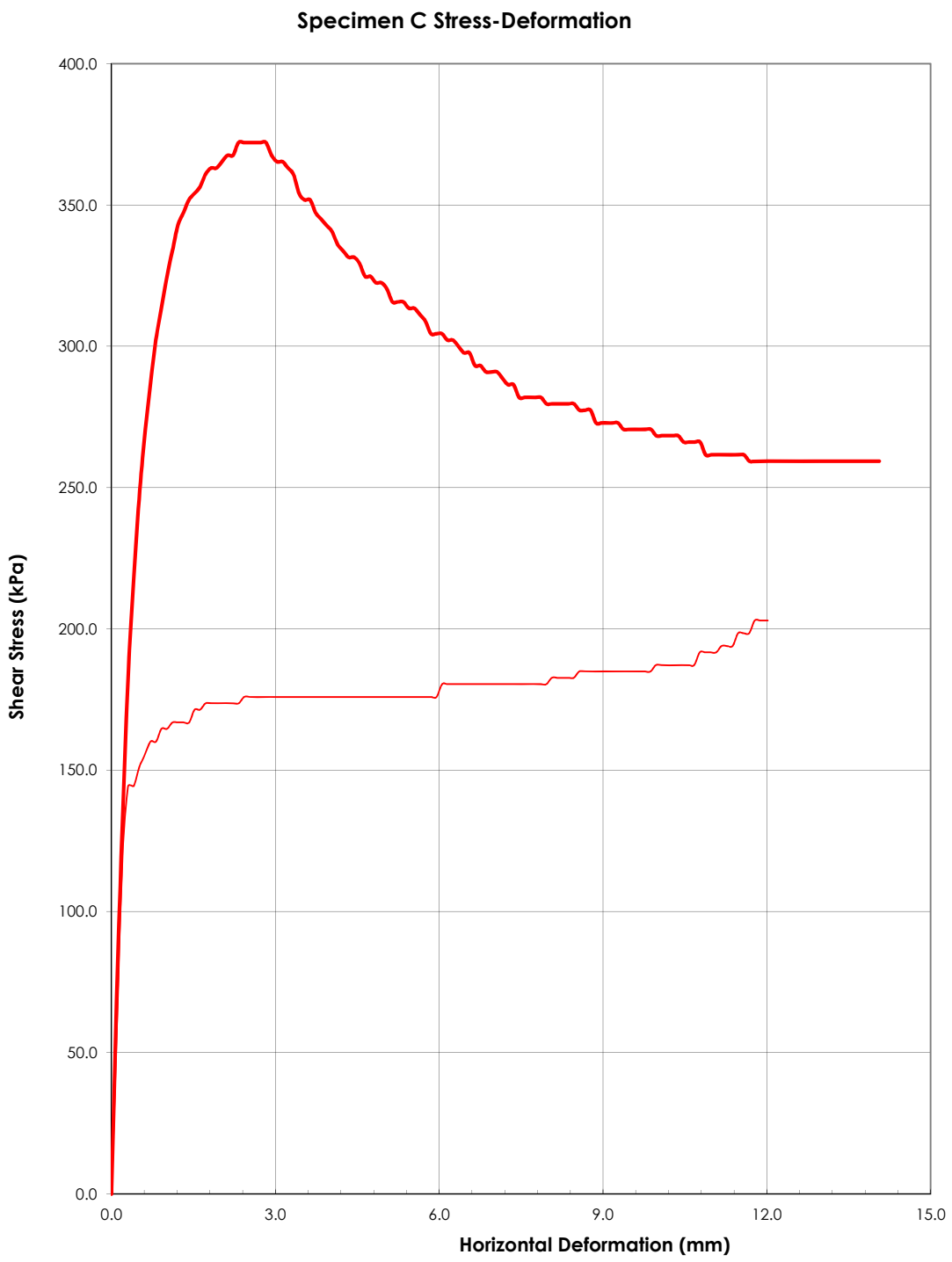

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Moisture Content of Soil or Aggregate
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Tel: (780) 917-7463

Project:	HUE - Husky SGS Phase 4	Date Tested:	18-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	SM

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4
Sample	SS8	BS7A	BS9	BS1	SS2	BS3	SS4
Tare No.	CW	12	EX	DF	13	20A	28A
Mass Tare Container	8.5	8.5	8.6	8.7	8.7	9.1	8.7
Mass Sample (Wet+Tare) (g)	174.1	178.5	163.1	154.1	159.8	173.8	170.4
Mass Sample (Dry+Tare) (g)	142.3	145.8	132.4	136.7	136.7	144.6	161.4
Mass of Water (g)	31.80	32.70	30.70	17.40	23.10	29.20	9.00
Mass Dry Sample (g)	133.80	137.30	123.80	128.00	128.00	135.50	152.70
Moisture Content (%)	23.8%	23.8%	24.8%	13.6%	18.0%	21.5%	5.9%
Comments							
Borehole / Test Pit No.	**NSR BH4**	**NSR BH4**	**NSR BH4**	**NSR BH4**	**NSR BH4**	**NSR BH4**	**NSR BH4**
Sample	**BS5**	**SS6**	**BS7**	**SS10**	**BS11**	**SS12**	**BS13**
Tare No.	DA	14A	JL	DE	EF	FA	6
Mass Tare Container	8.3	8.4	8.8	8.6	8.2	8.3	8.5
Mass Sample (Wet+Tare) (g)	159.2	157	152.3	156.1	169.2	156.6	161.9
Mass Sample (Dry+Tare) (g)	146.1	128.6	116.3	128.5	138.5	133.1	135
Mass of Water (g)	13.10	28.40	36.00	27.60	30.70	23.50	26.90
Mass Dry Sample (g)	137.80	120.20	107.50	119.90	130.30	124.80	126.50
Moisture Content (%)	9.5%	23.6%	33.5%	23.0%	23.6%	18.8%	21.3%
Comments							
Borehole / Test Pit No.	**NSR BH4**						
Sample	**SS14**						
Tare No.	DZ						
Mass Tare Container	8.5						
Mass Sample (Wet+Tare) (g)	156						
Mass Sample (Dry+Tare) (g)	133.7						
Mass of Water (g)	22.30						
Mass Dry Sample (g)	125.20						
Moisture Content (%)	17.8%						
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

Reviewed By: _____

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Tel: (780) 917-7463

Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4
Sample	RC38	RC26	RC24	RC22	RC53	RC45	RC51
Tare No.	CF	RJ	D20	19A	77A	EA	DC
Mass Tare Container	9.2	8.4	8.8	9.2	9.2	8.6	8.6
Mass Sample (Wet+Tare) (g)	213.9	172.8	132.6	259.7	243.8	106.8	138.2
Mass Sample (Dry+Tare) (g)	185.6	148.2	115.8	227.2	213.7	93.4	119.3
Mass of Water (g)	28.30	24.60	16.80	32.50	30.10	13.40	18.90
Mass Dry Sample (g)	176.40	139.80	107.00	218.00	204.50	84.80	110.70
Moisture Content (%)	16.0%	17.6%	15.7%	14.9%	14.7%	15.8%	17.1%
Comments				222'4" - 222'9"			
Borehole / Test Pit No.	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4
Sample	RC31	ERC44	RC47	RC35	RC43	RC33	RC37
Tare No.	DT	EV	30A	EP	EK	MM	CZ
Mass Tare Container	8.5	8.6	9.3	8.5	8.5	9.4	8.6
Mass Sample (Wet+Tare) (g)	107.9	201.1	187.2	201.4	205.9	80.5	81.7
Mass Sample (Dry+Tare) (g)	93.9	176.6	164.6	176.2	181.2	70.9	71.7
Mass of Water (g)	14.00	24.50	22.60	25.20	24.70	9.60	10.00
Mass Dry Sample (g)	85.40	168.00	155.30	167.70	172.70	61.50	63.10
Moisture Content (%)	16.4%	14.6%	14.6%	15.0%	14.3%	15.6%	15.8%
Comments							
Borehole / Test Pit No.	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4	NSR BH4
Sample	RC22	RC??	RC22	RC??	RC20	RC15	RC18
Tare No.	TX	D10	D23	CN	28	19	12
Mass Tare Container	8.7	8.5	8.4	8.8	9.2	8.6	8.6
Mass Sample (Wet+Tare) (g)	118.2	133.2	113.4	112.3	129.5	108.7	80.8
Mass Sample (Dry+Tare) (g)	102.7	118.1	97.3	99.9	108.5	92.9	70.1
Mass of Water (g)	15.50	15.10	16.10	12.40	21.00	15.80	10.70
Mass Dry Sample (g)	94.00	109.60	88.90	91.10	99.30	84.30	61.50
Moisture Content (%)	16.5%	13.8%	18.1%	13.6%	21.1%	18.7%	17.4%
Comments		242'3" - 242'7"		252'10" - 253'1"			
Borehole / Test Pit No.	NSR BH4	NSR BH4					
Sample	RC41	RC16					
Tare No.	EF	CW					
Mass Tare Container	8.6	8.4					
Mass Sample (Wet+Tare) (g)	227.6	204.8					
Mass Sample (Dry+Tare) (g)	194.1	175.1					
Mass of Water (g)	33.50	29.70					
Mass Dry Sample (g)	185.50	166.70					
Moisture Content (%)	18.1%	17.8%					
Comments							

Reviewed By: _____

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Moisture Content of Soil or Aggregate
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Project:	HUE - Husky SGS Phase 4	Date Tested:	2016/09/015
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NL-BH41	NL-BH41	NL-BH41	NL-BH41	NL-BH41	NL-BH41	NL-BH41
Sample	**BS1**	**SS2**	**BS3A**	**SS4**	**BS5**	**SS6**	**BS7**
Tare No.	EW	CH	D12	ZZ1	DB	9	ZZZ
Mass Tare Container	8.7	9.3	8.5	8.5	8.6	8.6	8.9
Mass Sample (Wet+Tare) (g)	167.1	50.1	133.5	78.4	151.8	120.4	211.2
Mass Sample (Dry+Tare) (g)	140.7	43.1	123.2	72	142.8	112.5	179.1
Mass of Water (g)	26.40	7.00	10.30	6.40	9.00	7.90	32.10
Mass Dry Sample (g)	132.00	33.80	114.70	63.50	134.20	103.90	170.20
Moisture Content (%)	20.0%	20.7%	9.0%	10.1%	6.7%	7.6%	18.9%
Comments							
Borehole / Test Pit No.	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**
Sample	**SS8**	**BS9**	**SS10**	**BS11**	**SS12**	**BS13**	**SS14**
Tare No.	DD	J4	CT	15	32A	CB	J2
Mass Tare Container	9.1	9.2	8.6	8.7	9.9	9.1	9.1
Mass Sample (Wet+Tare) (g)	82.2	154.8	125.5	155.2	144	170.4	101.3
Mass Sample (Dry+Tare) (g)	72.1	131.7	104.6	133.5	122	141.7	88.6
Mass of Water (g)	10.10	23.10	20.90	21.70	22.00	28.70	12.70
Mass Dry Sample (g)	63.00	122.50	96.00	124.80	112.10	132.60	79.50
Moisture Content (%)	16.0%	18.9%	21.8%	17.4%	19.6%	21.6%	16.0%
Comments							
Borehole / Test Pit No.	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**
Sample	**BS15**	**SS16**	**BS17**	**SS18**	**BS19**	**SS20**	**BS21**
Tare No.	D3	17	33A	CL	EK	CM	DA
Mass Tare Container	8.5	8.6	9.1	8.5	8.5	8.6	8.5
Mass Sample (Wet+Tare) (g)	160.9	119.8	143.4	145.1	142.9	111.4	154.3
Mass Sample (Dry+Tare) (g)	141.8	96.2	112.3	122.8	130.1	91.1	126.8
Mass of Water (g)	19.10	23.60	31.10	22.30	12.80	20.30	27.50
Mass Dry Sample (g)	133.30	87.60	103.20	114.30	121.60	82.50	118.30
Moisture Content (%)	14.3%	26.9%	30.1%	19.5%	10.5%	24.6%	23.2%
Comments							
Borehole / Test Pit No.	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**	**NL-BH41**		
Sample	**SS22**	**BS23**	**SS24**	**BS25**	**SS26**		
Tare No.	2	19	DN	DH	7		
Mass Tare Container	8.5	8.6	9.2	9.1	8.6		
Mass Sample (Wet+Tare) (g)	134.1	126.6	105.9	131.9	116.5		
Mass Sample (Dry+Tare) (g)	110.7	107.5	90.5	112.8	102.1		
Mass of Water (g)	23.40	19.10	15.40	19.10	14.40		
Mass Dry Sample (g)	102.20	98.90	81.30	103.70	93.50		
Moisture Content (%)	22.9%	19.3%	18.9%	18.4%	15.4%		
Comments							

Reviewed By: SA

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Moisture Content of Soil or Aggregate
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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NL BH41	NL BH41	NL BH41	NL BH41	NL BH41	NL BH41	NL BH41
Sample	**RC34**	**RC31**	**RC28**	**RC29**	**RC27**	**RC45**	**RC36**
Tare No.	D22	D1	38	CK	21A	EE	7A
Mass Tare Container	8.8	8.8	9.4	8.6	9.2	8.6	9.2
Mass Sample (Wet+Tare) (g)	177.2	269.4	93.3	126.9	200.3	120.1	364.5
Mass Sample (Dry+Tare) (g)	137.7	225.8	74.4	105.1	170.7	103.5	313.6
Mass of Water (g)	39.50	43.60	18.90	21.80	29.60	16.60	50.90
Mass Dry Sample (g)	128.90	217.00	65.00	96.50	161.50	94.90	304.40
Moisture Content (%)	30.6%	20.1%	29.1%	22.6%	18.3%	17.5%	16.7%
Comments							
Borehole / Test Pit No.	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**
Sample	**RC33**	**RC43**	**RC40**	**RC49**	**RC56**	**RC62**	**RC38**
Tare No.	CC	EV	114	EE	18	15A	DN
Mass Tare Container	9.3	8.7	8.6	8.7	8.4	9.5	9
Mass Sample (Wet+Tare) (g)	166	161	184.5	133.6	269.2	195.3	122.1
Mass Sample (Dry+Tare) (g)	140.3	138.4	153.7	117	234.5	170.1	106.7
Mass of Water (g)	25.70	22.60	30.80	16.60	34.70	25.20	15.40
Mass Dry Sample (g)	131.00	129.70	145.10	108.30	226.10	160.60	97.70
Moisture Content (%)	19.6%	17.4%	21.2%	15.3%	15.3%	15.7%	15.8%
Comments							
Borehole / Test Pit No.	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**	**NL BH41**
Sample	**RC47**	**RC54**	**RC60**	**RC52**	**RC50**	**RC58**	**RC66**
Tare No.	7	C5	CS	SO	EM	ZZ3	DT
Mass Tare Container	8.6	9.2	8.6	8.5	8.5	8.4	9
Mass Sample (Wet+Tare) (g)	262.9	216.9	219	148.1	190.5	74.8	249.2
Mass Sample (Dry+Tare) (g)	230.8	188.9	191.8	129.2	165.3	65.7	219.6
Mass of Water (g)	32.10	28.00	27.20	18.90	25.20	9.10	29.60
Mass Dry Sample (g)	222.20	179.70	183.20	120.70	156.80	57.30	210.60
Moisture Content (%)	14.4%	15.6%	14.8%	15.7%	16.1%	15.9%	14.1%
Comments							
Borehole / Test Pit No.	**NL BH41**						
Sample	**RC64**						
Tare No.	4A						
Mass Tare Container	9.2						
Mass Sample (Wet+Tare) (g)	128.1						
Mass Sample (Dry+Tare) (g)	112.3						
Mass of Water (g)	15.80						
Mass Dry Sample (g)	103.10						
Moisture Content (%)	15.3%						
Comments							

Reviewed By: _____

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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH6	NSR BH6	NSR BH6	NSR BH6	NSR BH6	NSR BH6	NSR BH6
Sample	**BS1**	**SS2**	**BS3**	**SS4**	**BS5**	**SS7**	**SS8**
Tare No.	6	17A	EZ	3	96	14A	EX
Mass Tare Container	8.7	9.4	8.4	8.6	8.5	9.4	8.6
Mass Sample (Wet+Tare) (g)	122.4	108	233.8	141	126.9	152.5	136
Mass Sample (Dry+Tare) (g)	114.8	100.4	203	129.9	116.7	128.7	122.3
Mass of Water (g)	7.60	7.60	30.80	11.10	10.20	23.80	13.70
Mass Dry Sample (g)	106.10	91.00	194.60	121.30	108.20	119.30	113.70
Moisture Content (%)	7.2%	8.4%	15.8%	9.2%	9.4%	19.9%	12.0%
Comments							
Borehole / Test Pit No.	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**
Sample	**BS9**	**SS10**	**BS11**	**SS12**	**BS13**	**SS14**	**BS15**
Tare No.	DA	DF	28A	SAM	2	DU	16A
Mass Tare Container	8.5	8.6	9.3	9.1	8.5	8.5	9.4
Mass Sample (Wet+Tare) (g)	173.4	160.9	210.3	157.3	234.6	103.8	174.9
Mass Sample (Dry+Tare) (g)	157.7	142.6	186.2	142.9	210.2	92.7	159.2
Mass of Water (g)	15.70	18.30	24.10	14.40	24.40	11.10	15.70
Mass Dry Sample (g)	149.20	134.00	176.90	133.80	201.70	84.20	149.80
Moisture Content (%)	10.5%	13.7%	13.6%	10.8%	12.1%	13.2%	10.5%
Comments							
Borehole / Test Pit No.	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**	**NSR BH6**
Sample	**SS16**	**BS17**	**SS18**	**SS18**	**BS19**	**SS20**	**BS21**
Tare No.	6A	DN	D7	DA	D12	D11	2A
Mass Tare Container	9.1	9.1	8.3	8.5	8.7	8.4	9.2
Mass Sample (Wet+Tare) (g)	119.3	123.3	25.6	97.2	130.9	105.2	194.4
Mass Sample (Dry+Tare) (g)	97	101.1	22.5	83.3	107	84.2	163.5
Mass of Water (g)	22.30	22.20	3.10	13.90	23.90	21.00	30.90
Mass Dry Sample (g)	87.90	92.00	14.20	74.80	98.30	75.80	154.30
Moisture Content (%)	25.4%	24.1%	21.8%	18.6%	24.3%	27.7%	20.0%
Comments				15/25/35			
Borehole / Test Pit No.	**NSR BH6**	**NSR BH6**	**NSR BH6**				
Sample	**BS23**	**SS22**	**SS24**				
Tare No.	14	D21	D5				
Mass Tare Container	9.3	8.6	8.6				
Mass Sample (Wet+Tare) (g)	168.5	136.6	152.1				
Mass Sample (Dry+Tare) (g)	140.4	117.1	129.3				
Mass of Water (g)	28.10	19.50	22.80				
Mass Dry Sample (g)	131.10	108.50	120.70				
Moisture Content (%)	21.4%	18.0%	18.9%				
Comments							

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Moisture Content of Soil or Aggregate
CSA A23.2-11A
ASTM D2216

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Project:	HUE - Husky SGS Phase 4	Date Tested:	30-Sep-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	JA

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06
Sample	RC57	RC34	RC26	RC38	RC32	RC46	RC40
Tare No.	34A	EK	SAM	DN	2	DU	16A
Mass Tare Container	9.2	8.5	9.1	9.1	8.5	8.5	9.4
Mass Sample (Wet+Tare) (g)	356.6	185.7	291.6	155.5	206.4	163	202
Mass Sample (Dry+Tare) (g)	312.4	159.4	244	134	174.4	140.2	173.6
Mass of Water (g)	44.20	26.30	47.60	21.50	32.00	22.80	28.40
Mass Dry Sample (g)	303.20	150.90	234.90	124.90	165.90	131.70	164.20
Moisture Content (%)	14.6%	17.4%	20.3%	17.2%	19.3%	17.3%	17.3%
Comments							
Borehole / Test Pit No.	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06	NSR BH06
Sample	RC28	RC36	RC44	RC43	RC42	RC48	RC55
Tare No.	28A	DA	EX	14A	96	3	EZ
Mass Tare Container	9.3	8.6	8.6	9.4	8.5	8.6	8.5
Mass Sample (Wet+Tare) (g)	134.4	146.8	121.4	138.5	332.7	368.4	317.2
Mass Sample (Dry+Tare) (g)	112.6	127.7	105.8	111.8	288.3	323.7	277.5
Mass of Water (g)	21.80	19.10	15.60	26.70	44.40	44.70	39.70
Mass Dry Sample (g)	103.30	119.10	97.20	102.40	279.80	315.10	269.00
Moisture Content (%)	21.1%	16.0%	16.0%	26.1%	15.9%	14.2%	14.8%
Comments							
Borehole / Test Pit No.	NSR BH06	NSR BH06	NSR BH06	NSR BH06			
Sample	RC50	RC54	RC30	RC52			
Tare No.	17A	6	9	D13			
Mass Tare Container	9.5	8.8	8.5	8.5			
Mass Sample (Wet+Tare) (g)	237.8	259.4	173.6	211.6			
Mass Sample (Dry+Tare) (g)	204.6	225.1	148.7	183			
Mass of Water (g)	33.20	34.30	24.90	28.60			
Mass Dry Sample (g)	195.10	216.30	140.20	174.50			
Moisture Content (%)	17.0%	15.9%	17.8%	16.4%			
Comments							
Borehole / Test Pit No.							
Sample							
Tare No.							
Mass Tare Container							
Mass Sample (Wet+Tare) (g)							
Mass Sample (Dry+Tare) (g)							
Mass of Water (g)							
Mass Dry Sample (g)							
Moisture Content (%)							
Comments							

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Moisture Content of Soil or Aggregate

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Project:	HUE - Husky SGS Phase 4	Date Tested:	31-Aug-16
Client:	Husky Oil Operations Ltd.		
Project No.:	110902147	Tested By:	NN

Moisture Content Worksheet

Borehole / Test Pit No.	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7
Sample	BS1	SS2	BS3A	SS4	SS6	BS7	SS8
Tare No.	CM	9	ZZ1	D13	CH	DB	EW
Mass Tare Container	8.7	8.6	8.5	8.5	9.2	8.6	8.7
Mass Sample (Wet+Tare) (g)	188.2	81.8	116.1	54.8	113.3	131.1	86
Mass Sample (Dry+Tare) (g)	159.7	70.3	102.8	53.2	109.1	120.4	81.5
Mass of Water (g)	28.50	11.50	13.30	1.60	4.20	10.70	4.50
Mass Dry Sample (g)	151.00	61.70	94.30	44.70	99.90	111.80	72.80
Moisture Content (%)	18.9%	18.6%	14.1%	3.6%	4.2%	9.6%	6.2%
Comments							
Borehole / Test Pit No.	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7
Sample	SS10	BS11	SS12	BS5	BS13	SS14	BS15
Tare No.	CY	D9	D19	IGGY	8	DW	36A
Mass Tare Container	8.5	8.5	8.6	8.4	8.6	8.5	9.3
Mass Sample (Wet+Tare) (g)	147.7	103.5	105.8	160.8	150.5	121.1	132.5
Mass Sample (Dry+Tare) (g)	137.8	95.7	97.4	152.9	138.1	113	120.2
Mass of Water (g)	9.90	7.80	8.40	7.90	12.40	8.10	12.30
Mass Dry Sample (g)	129.30	87.20	88.80	144.50	129.50	104.50	110.90
Moisture Content (%)	7.7%	8.9%	9.5%	5.5%	9.6%	7.8%	11.1%
Comments							
Borehole / Test Pit No.	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7	NSR BH7
Sample	BS??	SS17	SS18	BS19	SS??	SS20	BS21
Tare No.	EH	FB	EC	222	1	D5	J4
Mass Tare Container	8.5	8.7	8.6	9	8.4	8.7	9.2
Mass Sample (Wet+Tare) (g)	155.4	139.6	172.4	138.2	136.3	113	142.5
Mass Sample (Dry+Tare) (g)	144.8	126.8	158.3	128.9	123.6	103.8	130.5
Mass of Water (g)	10.60	12.80	14.10	9.30	12.70	9.20	12.00
Mass Dry Sample (g)	136.30	118.10	149.70	119.90	115.20	95.10	121.30
Moisture Content (%)	7.8%	10.8%	9.4%	7.8%	11.0%	9.7%	9.9%
Comments							
Borehole / Test Pit No.	NSR BH7	NSR BH7	NSR BH7	NSR BH7			
Sample	SS22	BS23	SS24	BS25			
Tare No.	DO	12A	D24	DI			
Mass Tare Container	9.1	9.3	8.7	9			
Mass Sample (Wet+Tare) (g)	104.9	257.9	208.6	168.7			
Mass Sample (Dry+Tare) (g)	95.8	238.1	191.5	152.8			
Mass of Water (g)	9.10	19.80	17.10	15.90			
Mass Dry Sample (g)	86.70	228.80	182.80	143.80			
Moisture Content (%)	10.5%	8.7%	9.4%	11.1%			
Comments							

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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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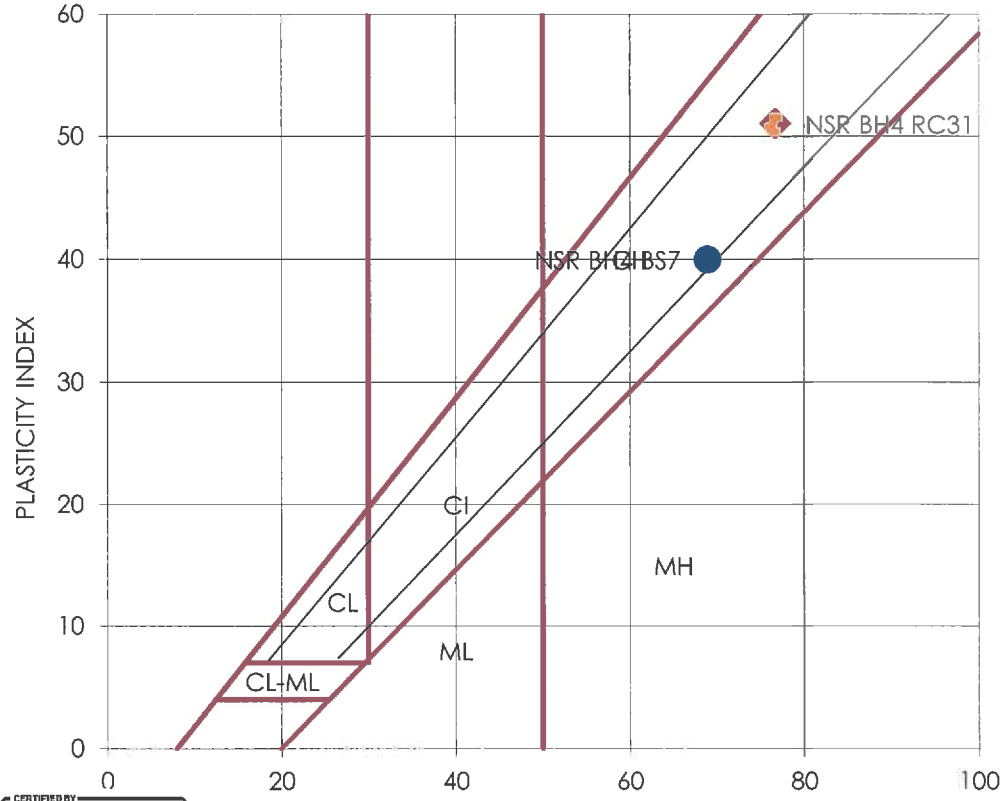
Sample: NSR BH4 BS7			Sample: NSR BH4 RC31	
LIQUID			LIQUID	
1	2	Trial No.	1	2
21	22	Number of Blows	29	29
13B	29B	Container Number	17B	24B
34.43	39.36	Wt. Sample (wet+tare)(g)	36.27	35.49
26.71	29.63	Wt. Sample (dry+tare)(g)	27.27	26.79
15.72	15.79	Wt. Tare (g)	15.37	15.20
11.0	13.8	Wt. Dry Soil (g)	11.9	11.6
7.7	9.7	Wt. Water (g)	9.0	8.7
70.2%	70.3%	Water Content (%)	75.6%	75.1%
68.8%	69.2%	Corrected Water Content (%)	77.0%	76.4%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AB	AX	Container Number	BH	BM
20.55	20.3	Wt. Sample (wet+tare)(g)	20.32	20.31
19.03	18.89	Wt. Sample (dry+tare)(g)	19.04	19.01
13.76	14.09	Wt. Tare (g)	14.06	13.91
5.3	4.8	Wt. Dry Soil (g)	5.0	5.1
1.5	1.4	Wt. Water (g)	1.3	1.3
28.8%	29.4%	Water Content (%)	25.7%	25.5%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	69		LL	77
PL	29		PL	26
PI	40		PI	51
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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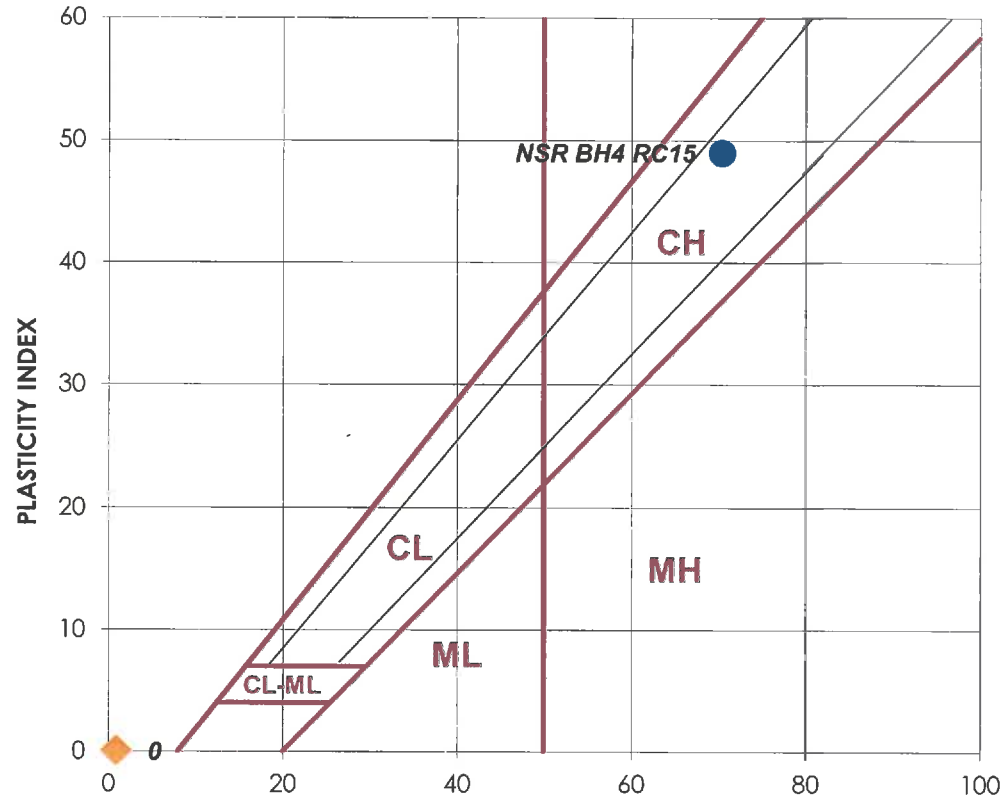
Sample:			Sample:	
NSR BH4 RC15				
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	20	Number of Blows		
26B	23B	Container Number		
31.93	37.47	Wt. Sample (wet+tare)(g)		
25.03	28.13	Wt. Sample (dry+tare)(g)		
15.46	15.27	Wt. Tare (g)		
9.6	12.9	Wt. Dry Soil (g)		
6.9	9.3	Wt. Water (g)		
72.1%	72.6%	Water Content (%)		
70.2%	70.7%	Corrected Water Content (%)		
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BJ	BK	Container Number		
20.24	20.72	Wt. Sample (wet+tare)(g)		
19.15	19.61	Wt. Sample (dry+tare)(g)		
13.98	14.31	Wt. Tare (g)		
5.2	5.3	Wt. Dry Soil (g)		
1.1	1.1	Wt. Water (g)		
21.1%	20.9%	Water Content (%)		
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	70		LL	
PL	21		PL	
PI	49		PI	
CLASSIFICATION			CLASSIFICATION	
CH			NON-PLASTIC	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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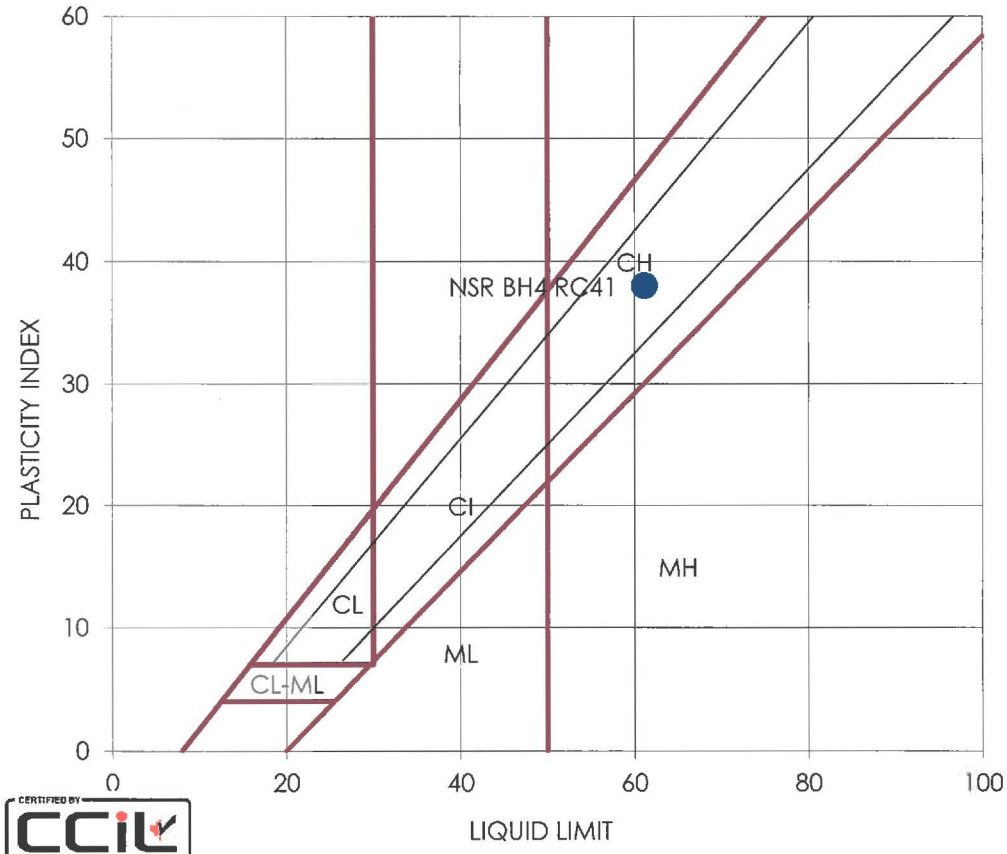
Sample: NSR BH4 RC41			Sample: NSR BH4 RC51	
LIQUID			LIQUID	
1	2	Trial No.	1	2
25	22	Number of Blows	21	21
11B	19B	Container Number	4B	21B
37.10	35.72	Wt. Sample (wet+tare)(g)	33.69	31.96
28.88	27.87	Wt. Sample (dry+tare)(g)	22.35	21.64
15.49	15.19	Wt. Tare (g)	15.58	15.53
13.4	12.7	Wt. Dry Soil (g)	6.8	6.1
8.2	7.9	Wt. Water (g)	11.3	10.3
61.4%	61.9%	Water Content (%)	167.5%	168.9%
61.4%	61.0%	Corrected Water Content (%)	164.0%	165.4%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BI	BR	Container Number	BQ	BT
20.37	20.24	Wt. Sample (wet+tare)(g)	20.24	20.43
19.18	19.1	Wt. Sample (dry+tare)(g)	18.21	18.28
14.21	14.14	Wt. Tare (g)	14.09	13.96
5.0	5.0	Wt. Dry Soil (g)	4.1	4.3
1.2	1.1	Wt. Water (g)	2.0	2.2
23.9%	23.0%	Water Content (%)	49.3%	49.8%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	61		LL	165
PL	23		PL	50
PI	38		PI	115
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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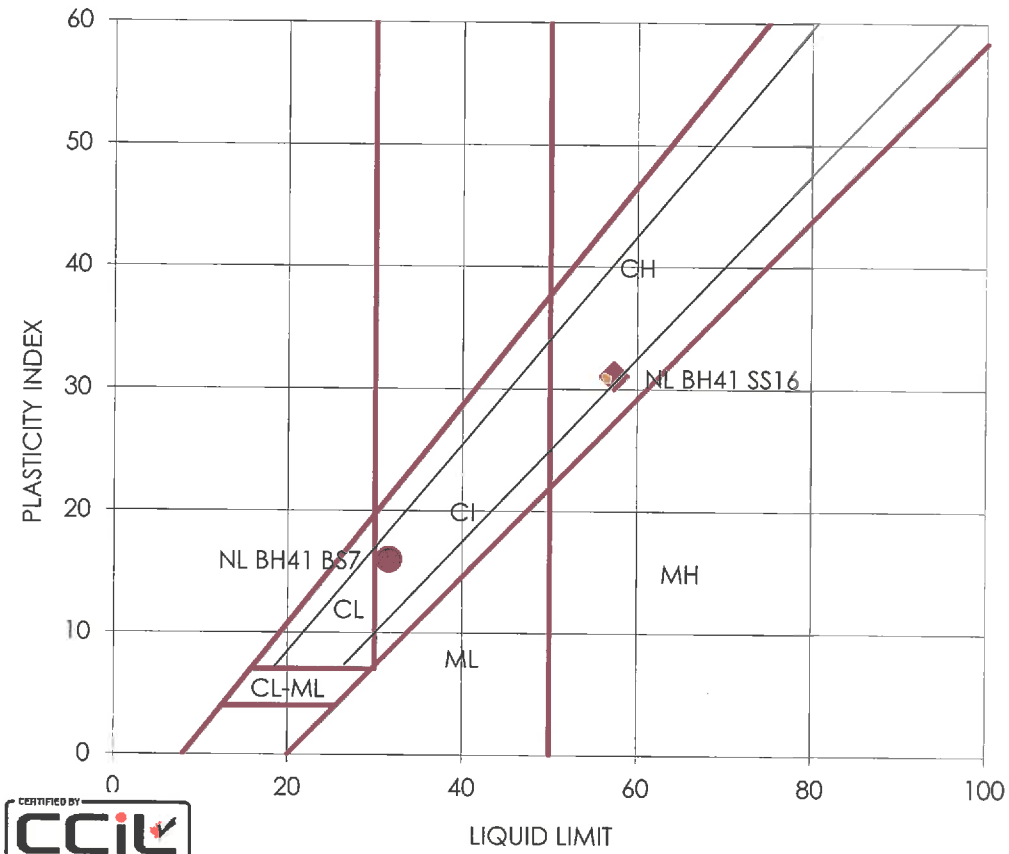
Sample:

NL BH41 BS7			NL BH41 SS16	
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	20	Number of Blows	21	23
32B	43B	Container Number	5B	2B
41.49	40.99	Wt. Sample (wet+tare)(g)	38.64	36.43
35.03	34.71	Wt. Sample (dry+tare)(g)	30.08	28.67
15.15	15.35	Wt. Tare (g)	15.44	15.30
19.9	19.4	Wt. Dry Soil (g)	14.6	13.4
6.5	6.3	Wt. Water (g)	8.6	7.8
32.5%	32.4%	Water Content (%)	58.5%	58.0%
31.6%	31.6%	Corrected Water Content (%)	57.2%	57.5%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
AB	BU	Container Number	BG	AU
20.1	20.18	Wt. Sample (wet+tare)(g)	20.88	21.57
19.23	19.32	Wt. Sample (dry+tare)(g)	19.61	20.06
13.95	14	Wt. Tare (g)	14.7	14.06
5.3	5.3	Wt. Dry Soil (g)	4.9	6.0
0.9	0.9	Wt. Water (g)	1.3	1.5
16.5%	16.2%	Water Content (%)	25.9%	25.2%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	32		LL	57
PL	16		PL	26
PI	16		PI	31
CLASSIFICATION			CLASSIFICATION	
CI-CL			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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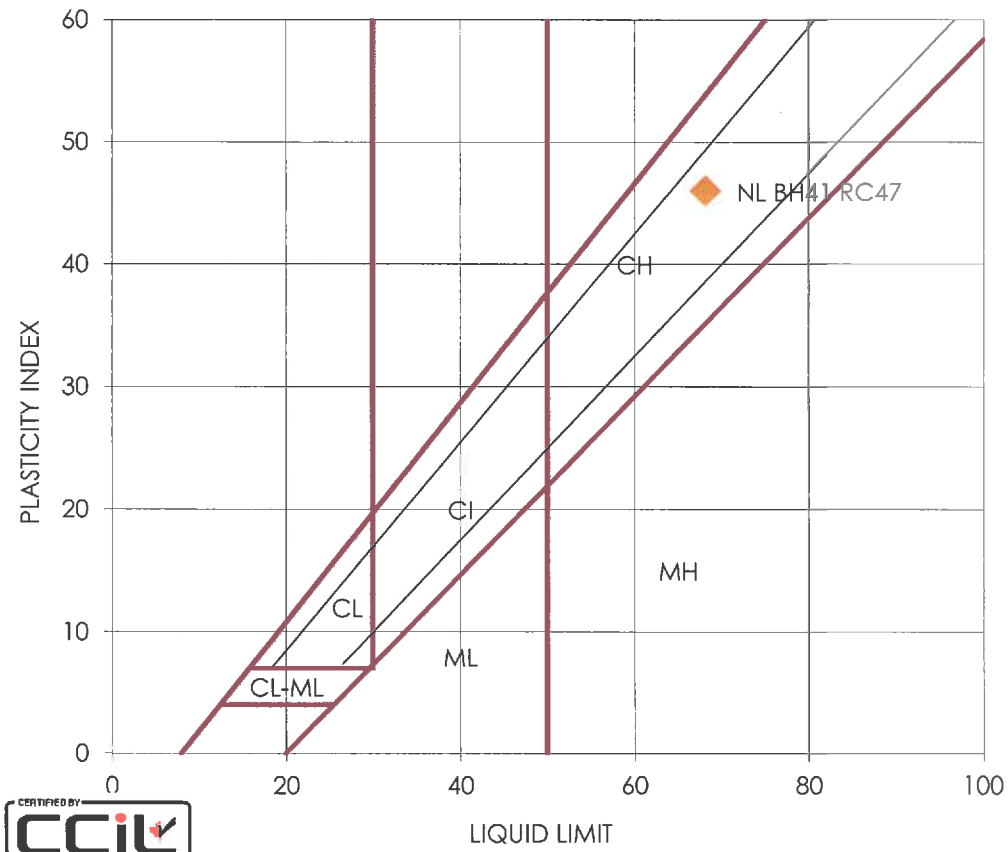
Sample: NL BH41 RC34			Sample: NL BH41 RC47	
LIQUID			LIQUID	
1	2	Trial No.	1	2
22	23	Number of Blows	21	21
30B	47B	Container Number	20B	39B
32.95	33.74	Wt. Sample (wet+tare)(g)	39.76	35.74
21.95	22.48	Wt. Sample (dry+tare)(g)	29.79	27.39
15.25	15.60	Wt. Tare (g)	15.44	15.43
6.7	6.9	Wt. Dry Soil (g)	14.4	12.0
11.0	11.3	Wt. Water (g)	10.0	8.4
164.2%	163.7%	Water Content (%)	69.5%	69.8%
161.7%	162.0%	Corrected Water Content (%)	68.0%	68.4%
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
BA	AF	Container Number	BC	AP
20.32	20.71	Wt. Sample (wet+tare)(g)	20.63	20.87
18.37	18.71	Wt. Sample (dry+tare)(g)	19.44	19.66
13.94	14.08	Wt. Tare (g)	14.21	14.2
4.4	4.6	Wt. Dry Soil (g)	5.2	5.5
2.0	2.0	Wt. Water (g)	1.2	1.2
44.0%	43.2%	Water Content (%)	22.8%	22.2%
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	162		LL	68
PL	44		PL	22
PI	118		PI	46
CLASSIFICATION			CLASSIFICATION	
CH			CH	



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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Sample: NL BH41 SS22

LIQUID		Trial No.
1	2	
26	27	Number of Blows
36B	10B	Container Number
35.24	34.84	Wt. Sample (wet+tare)(g)
27.19	26.99	Wt. Sample (dry+tare)(g)
15.37	15.47	Wt. Tare (g)
11.8	11.5	Wt. Dry Soil (g)
8.1	7.9	Wt. Water (g)
68.1%	68.1%	Water Content (%)
68.4%	68.8%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
AC	AP	Container Number
20.58	20.62	Wt. Sample (wet+tare)(g)
19.26	19.24	Wt. Sample (dry+tare)(g)
14.29	14.15	Wt. Tare (g)
5.0	5.1	Wt. Dry Soil (g)
1.3	1.4	Wt. Water (g)
26.6%	27.1%	Water Content (%)

AVERAGE VALUES	
1	2
LL	69
PL	27
PI	42

CLASSIFICATION: **CH**

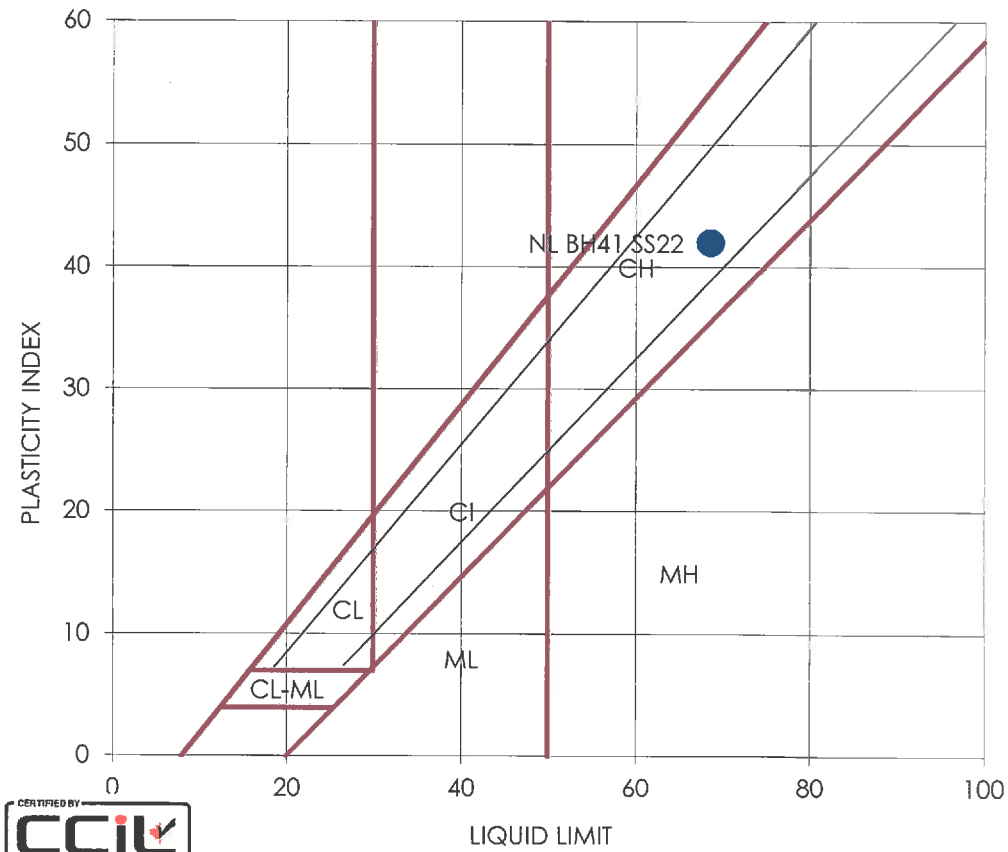
Sample: NL BH41 RC29

LIQUID		Trial No.
1	2	
26	27	Number of Blows
38B	15B	Container Number
31.81	33.88	Wt. Sample (wet+tare)(g)
24.23	25.30	Wt. Sample (dry+tare)(g)
15.60	15.56	Wt. Tare (g)
8.6	9.7	Wt. Dry Soil (g)
7.6	8.6	Wt. Water (g)
87.8%	88.1%	Water Content (%)
88.3%	88.9%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
AK	AN	Container Number
20.59	20.56	Wt. Sample (wet+tare)(g)
19.22	19.19	Wt. Sample (dry+tare)(g)
14.26	14.11	Wt. Tare (g)
5.0	5.1	Wt. Dry Soil (g)
1.4	1.4	Wt. Water (g)
27.6%	27.0%	Water Content (%)

AVERAGE VALUES	
1	2
LL	89
PL	27
PI	62

CLASSIFICATION: **CH**



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Reviewed By: _____

Stantec

Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 5, 2016
Tested By:	JA

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Edmonton, Alberta
Canada T5K 2L6
Tel: (780) 917-7000

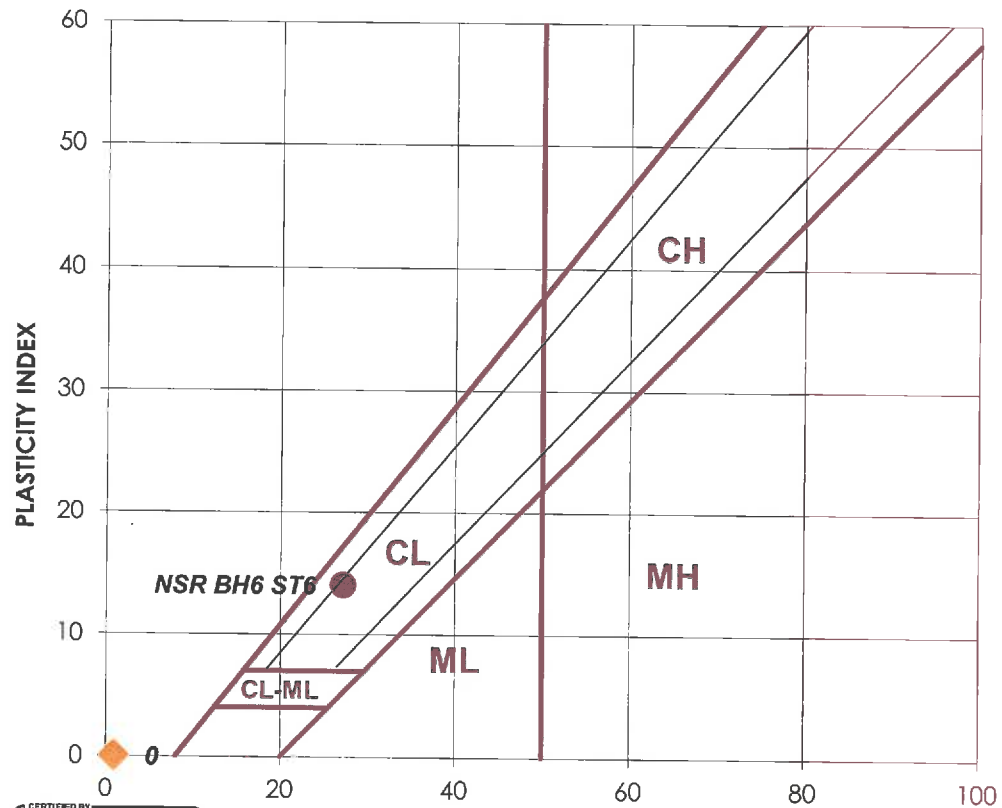
LABORATORY
10575 106 ST
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

Sample:

NSR BH6 ST6			
LIQUID			
1	2	Trial No.	
20	20	Number of Blows	
46B	12B	Container Number	
41.91	40.65	Wt. Sample (wet+tare)(g)	
36.10	35.04	Wt. Sample (dry+tare)(g)	
15.29	15.01	Wt. Tare (g)	
20.8	20.0	Wt. Dry Soil (g)	
5.8	5.6	Wt. Water (g)	
27.9%	28.0%	Water Content (%)	
27.2%	27.3%	Corrected Water Content (%)	
PLASTIC			
1	2	Trial No.	
BC	BF	Container Number	
21.37	21.52	Wt. Sample (wet+tare)(g)	
20.54	20.69	Wt. Sample (dry+tare)(g)	
14.18	14.15	Wt. Tare (g)	
6.4	6.5	Wt. Dry Soil (g)	
0.8	0.8	Wt. Water (g)	
13.1%	12.7%	Water Content (%)	
AVERAGE VALUES			
1	2		
LL	27		
PL	13		
PI	14		
CLASSIFICATION			
CL			

Sample:

LIQUID		
Trial No.	1	2
Number of Blows		
Container Number		
Wt. Sample (wet+tare)(g)		
Wt. Sample (dry+tare)(g)		
Wt. Tare (g)		
Wt. Dry Soil (g)		
Wt. Water (g)		
Water Content (%)		
Corrected Water Content (%)		
PLASTIC		
Trial No.	1	2
Container Number		
Wt. Sample (wet+tare)(g)		
Wt. Sample (dry+tare)(g)		
Wt. Tare (g)		
Wt. Dry Soil (g)		
Wt. Water (g)		
Water Content (%)		
AVERAGE VALUES		
	1	2
LL		
PL		
PI		
CLASSIFICATION		
NON-PLASTIC		



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Stantec

Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 4, 2016
Tested By:	JA

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LABORATORY
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Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

Sample: NSR BH6 RC40

LIQUID		
1	2	Trial No.
26	27	Number of Blows
23B	42B	Container Number
33.33	34.90	Wt. Sample (wet+tare)(g)
25.09	26.08	Wt. Sample (dry+tare)(g)
15.27	15.56	Wt. Tare (g)
9.8	10.5	Wt. Dry Soil (g)
8.2	8.8	Wt. Water (g)
83.9%	83.8%	Water Content (%)
84.3%	84.6%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
BD	BN	Container Number
20.32	20.24	Wt. Sample (wet+tare)(g)
19.11	19.04	Wt. Sample (dry+tare)(g)
14.12	14.03	Wt. Tare (g)
5.0	5.0	Wt. Dry Soil (g)
1.2	1.2	Wt. Water (g)
24.2%	24.0%	Water Content (%)

AVERAGE VALUES	
1	2
LL	84
PL	24
PI	60

CLASSIFICATION: CH

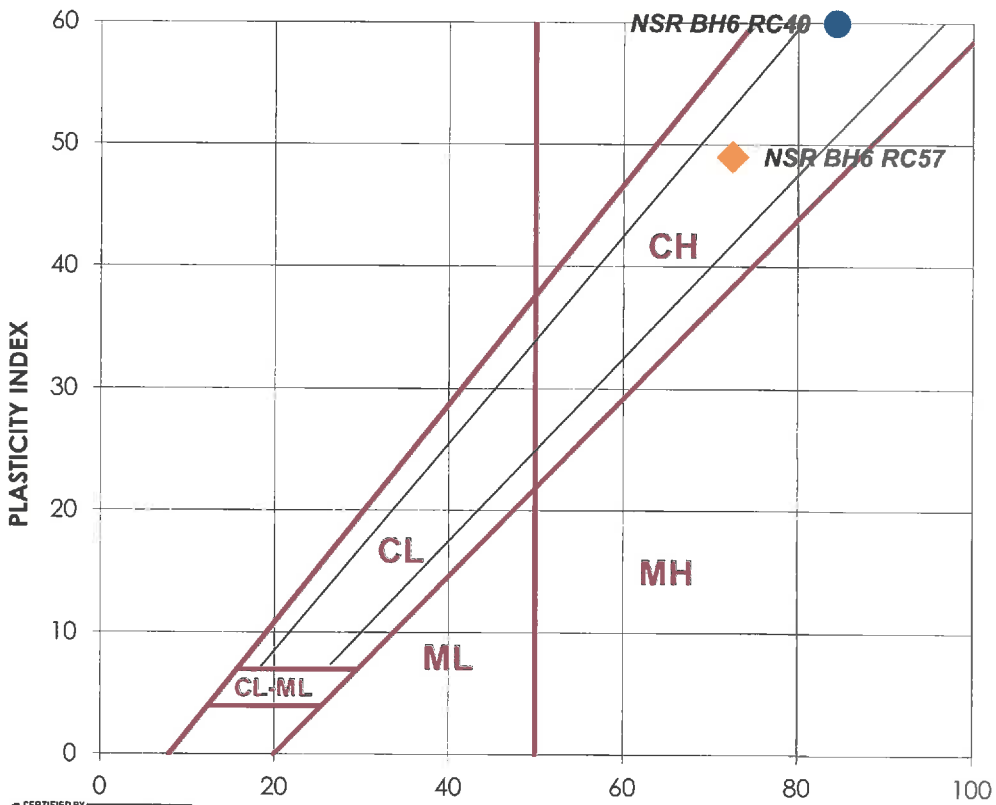
Sample: NSR BH6 RC57

LIQUID		
1	2	Trial No.
20	21	Number of Blows
7B	14B	Container Number
34.30	36.11	Wt. Sample (wet+tare)(g)
26.29	27.34	Wt. Sample (dry+tare)(g)
15.55	15.49	Wt. Tare (g)
10.7	11.9	Wt. Dry Soil (g)
8.0	8.8	Wt. Water (g)
74.6%	74.0%	Water Content (%)
72.6%	72.5%	Corrected Water Content (%)

PLASTIC		
1	2	Trial No.
AA	AT	Container Number
20.34	20.43	Wt. Sample (wet+tare)(g)
19.13	19.2	Wt. Sample (dry+tare)(g)
14.12	13.84	Wt. Tare (g)
5.0	5.4	Wt. Dry Soil (g)
1.2	1.2	Wt. Water (g)
24.2%	22.9%	Water Content (%)

AVERAGE VALUES	
1	2
LL	73
PL	24
PI	49

CLASSIFICATION: CH



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Atterberg Limits
ASTM D4318
Method B- One Point

Client:	Husky Oil Operations Ltd.
Project Name:	HUE - Husky SGS Phase 4
Project No:	110902147
Date Received:	September 26, 2016
Date Tested:	October 6, 2016
Tested By:	JA

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LABORATORY
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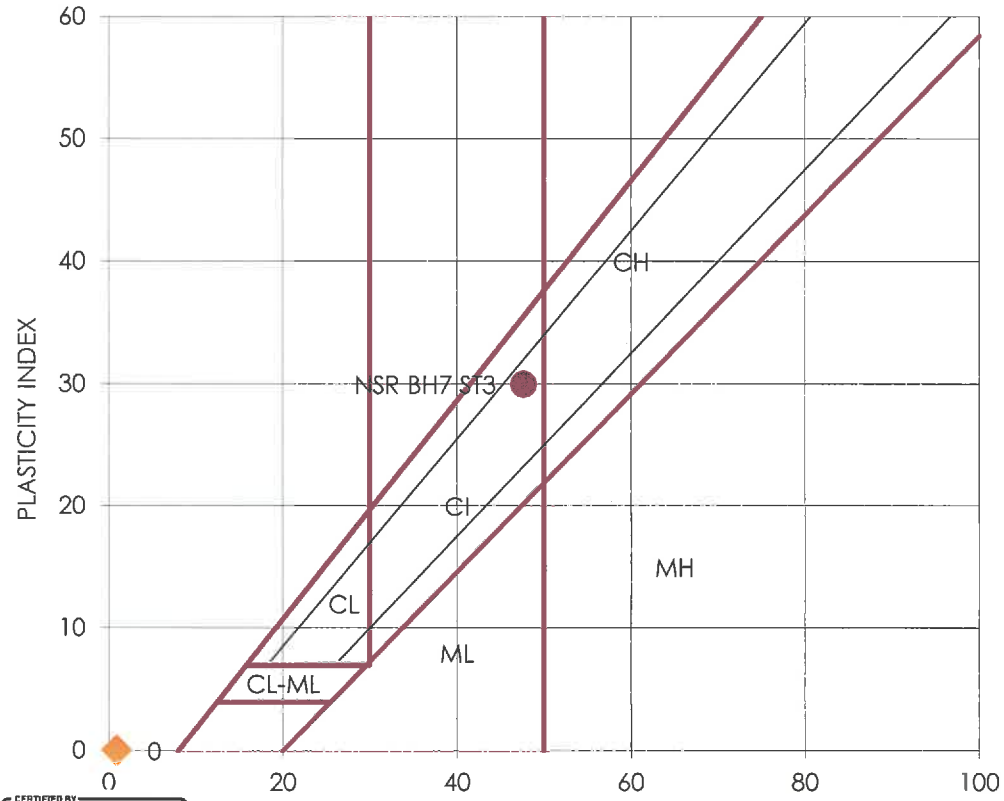
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

Sample:			Sample:	
NSR BH7 ST3				
LIQUID			LIQUID	
1	2	Trial No.	1	2
20	20	Number of Blows		
BD	JA	Container Number		
36.21	37.78	Wt. Sample (wet+tare)(g)		
28.34	29.60	Wt. Sample (dry+tare)(g)		
12.39	12.77	Wt. Tare (g)		
16.0	16.8	Wt. Dry Soil (g)		
7.9	8.2	Wt. Water (g)		
49.3%	48.6%	Water Content (%)		
48.0%	47.3%	Corrected Water Content (%)		
PLASTIC			PLASTIC	
1	2	Trial No.	1	2
E5	C3	Container Number		
18.07	17.89	Wt. Sample (wet+tare)(g)		
17.11	16.97	Wt. Sample (dry+tare)(g)		
11.78	11.67	Wt. Tare (g)		
5.3	5.3	Wt. Dry Soil (g)		
1.0	0.9	Wt. Water (g)		
18.0%	17.4%	Water Content (%)		
AVERAGE VALUES			AVERAGE VALUES	
1	2		1	2
LL	48		LL	
PL	18		PL	
PI	30		PI	
CLASSIFICATION			CLASSIFICATION	
CI			NON-PLASTIC	



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Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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Edmonton, Alberta
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LABORATORY
10575 106 ST
Edmonton, Alberta
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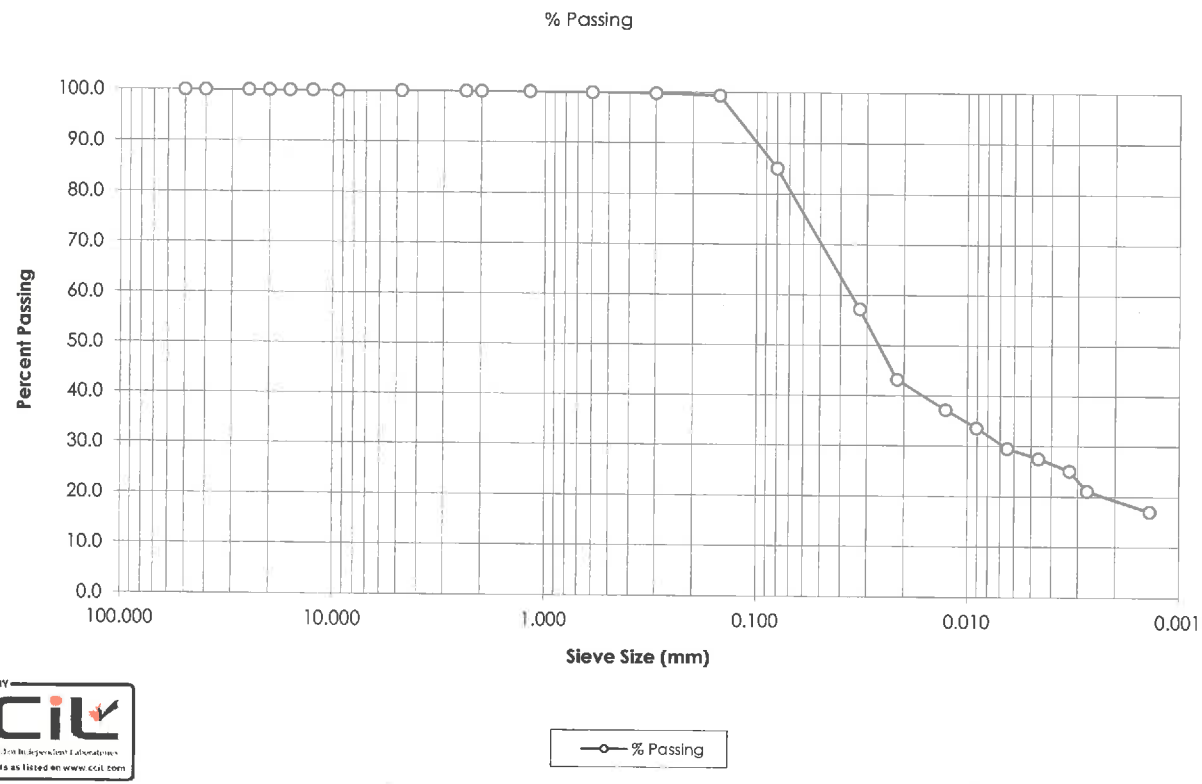
Tel: (780) 917-7463

SAMPLE No.: SS2
SOURCE: NSR BH4
TESTED BY: JA

DATE TESTED: October 4, 2016
DATE RECEIVED: September 12, 2016
SAMPLE DESCRIPTION: Clay and/or silt, some sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0065	29.5
40.0	100.0	0.0046	27.5
25.0	100.0	0.0033	25.1
20.0	100.0	0.0027	21.1
16.0	100.0	0.0014	17.1
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.7		
0.150	99.3		
0.080	85.1		
0.0325	57.2		
0.0215	43.2		
0.0127	37.2		
0.0091	33.5		

Gravel:	0.0%	D_{10}:	-
Sand:	14.9%	D_{30}:	0.0068
Silt:	65.8%	D_{60}:	0.0381
Clay:	19.3%	C_U:	-
		C_C:	-

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Consistent results from Independent Laboratories
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Comments:

Reviewed by:

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Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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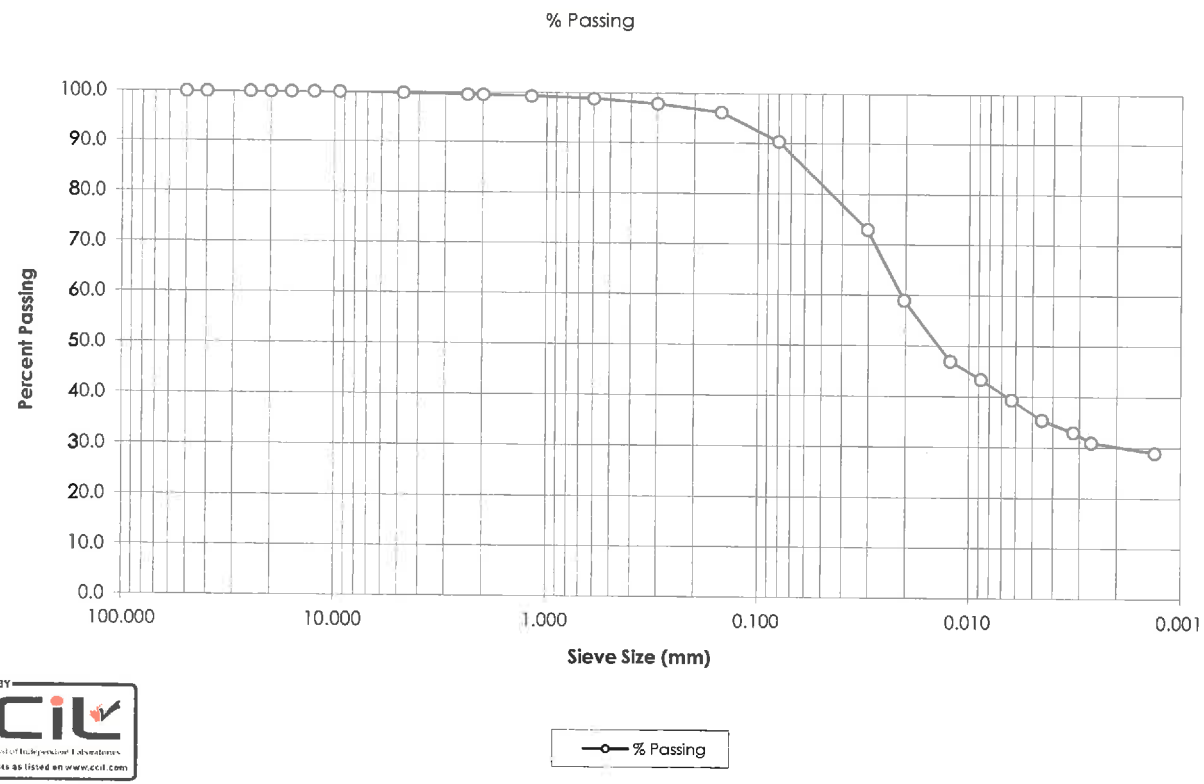
SAMPLE No.: BS7
SOURCE: NL BH41
TESTED BY: JA

DATE TESTED: October 4, 2016
DATE RECEIVED: September 12, 2016
SAMPLE DESCRIPTION: Silty clay, trace sand



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0063	39.4
40.0	100.0	0.0045	35.4
25.0	100.0	0.0032	33.0
20.0	100.0	0.0026	31.0
16.0	100.0	0.0013	29.0
12.5	100.0		
9.5	100.0		
4.75	99.8		
2.36	99.5		
2.00	99.5		
1.18	99.3		
0.600	98.8		
0.300	97.9		
0.150	96.2		
0.080	90.3		
0.0303	73.0		
0.0203	59.0		
0.0123	47.0		
0.0088	43.4		

Gravel:	0.2%	D_{10}:	-
Sand:	9.5%	D_{30}:	0.0020
Silt:	60.2%	D_{60}:	0.0212
Clay:	30.2%	C_u:	-
		C_c:	-

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For specific tests as listed on www.ccil.com

Comments:

Reviewed by:

Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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Canada T5K 2L6
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LABORATORY
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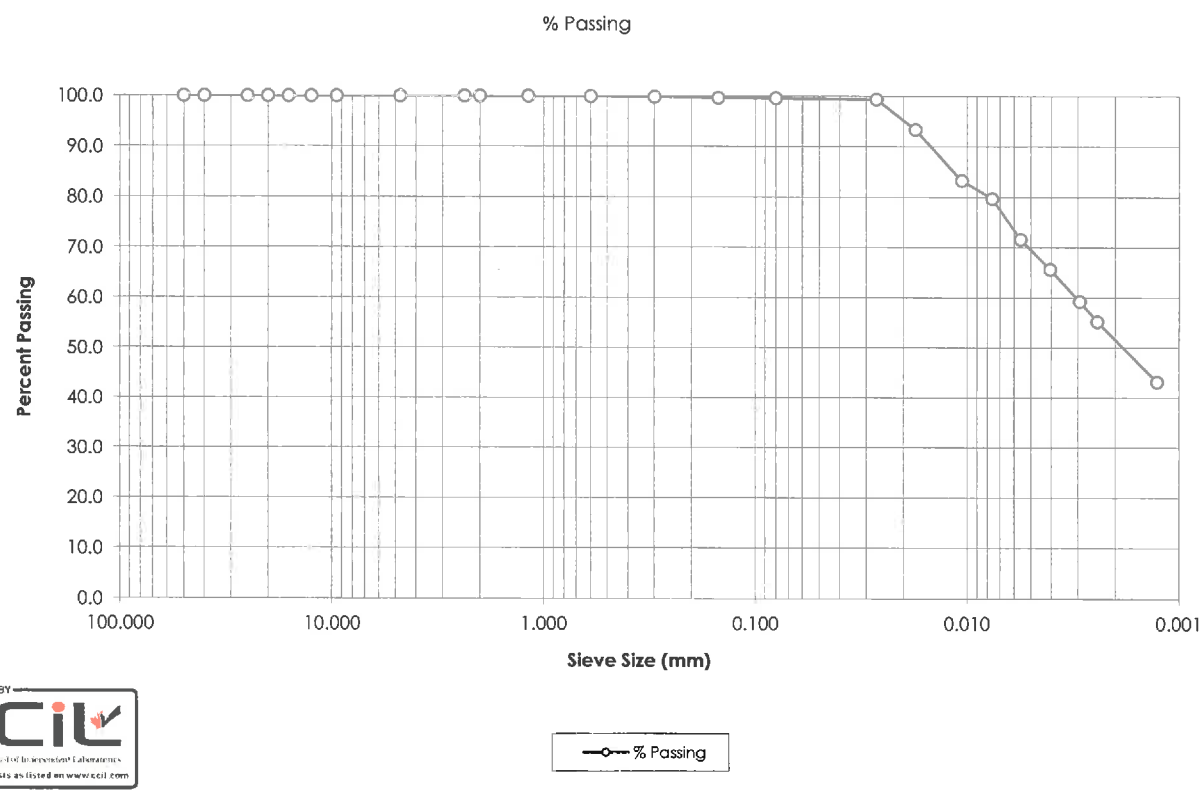
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

SAMPLE No.: RC47
SOURCE: NL BH41
TESTED BY: JA

DATE TESTED: October 4, 2016
DATE RECEIVED: September 12, 2016
SAMPLE DESCRIPTION: Fat clay



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0056	71.7
40.0	100.0	0.0041	65.6
25.0	100.0	0.0029	59.2
20.0	100.0	0.0024	55.2
16.0	100.0	0.0013	43.2
12.5	100.0		
9.5	100.0		
4.75	100.0		
2.36	100.0		
2.00	100.0		
1.18	100.0		
0.600	99.9		
0.300	99.8		
0.150	99.7		
0.080	99.6		
0.0269	99.4		
0.0175	93.4		
0.0106	83.3		
0.0076	79.7		

Gravel:	0.0%	D_{10}:	-
Sand:	0.4%	D_{30}:	-
Silt:	48.0%	D_{60}:	0.0031
Clay:	51.6%	C_u:	-
		C_c:	-

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Comments:

Reviewed by:

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Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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LABORATORY
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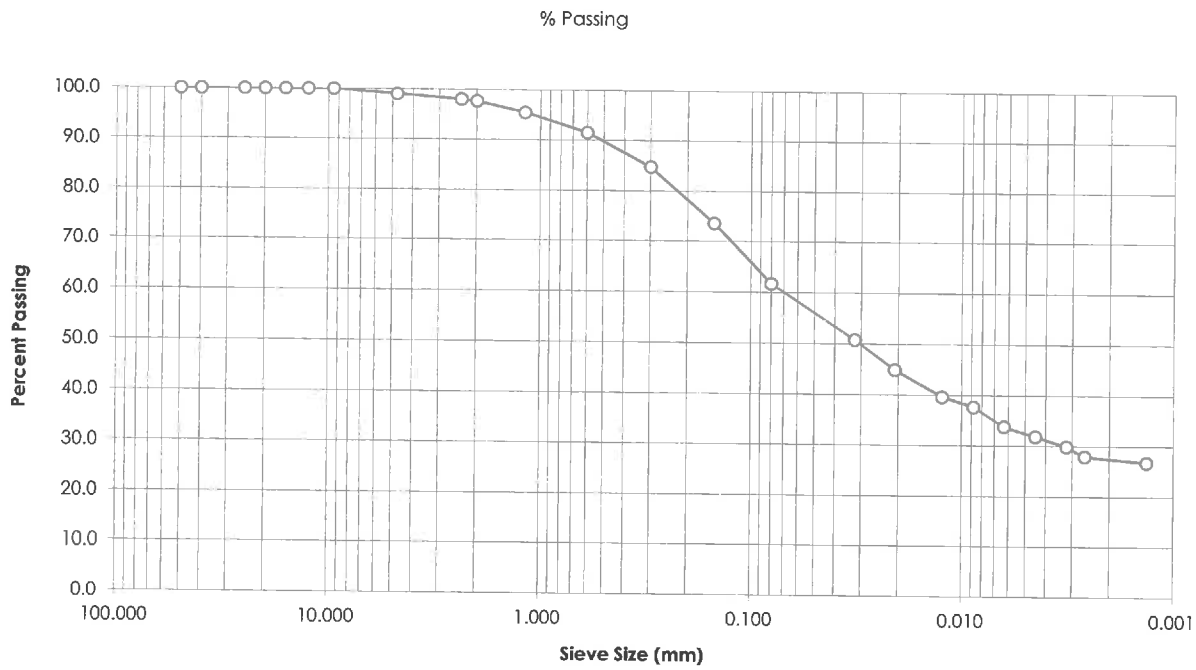
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

SAMPLE No.: ST6
SOURCE: NSR BH6
TESTED BY: JA

DATE TESTED: October 5, 2016
DATE RECEIVED: September 12, 2016
SAMPLE DESCRIPTION: Lean clay and sand, tr gravel



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0063	33.8
40.0	100.0	0.0045	31.8
25.0	100.0	0.0032	29.9
20.0	100.0	0.0026	27.9
16.0	100.0	0.0013	26.8
12.5	100.0		
9.5	100.0		
4.75	99.0		
2.36	98.0		
2.00	97.7		
1.18	95.5		
0.600	91.5		
0.300	84.8		
0.150	73.6		
0.080	61.7		
0.0321	50.8		
0.0207	44.9		
0.0124	39.7		
0.0088	37.7		

Gravel:	1.0%	D_{10}:	-
Sand:	37.3%	D_{30}:	0.0033
Silt:	34.2%	D_{60}:	0.0732
Clay:	27.5%	C_u:	-
		C_c:	-

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Comments:

Reviewed by:

Stantec

Grain Size Analysis
Hydrometer Report
ASTM D422
CANFEM

Client: Husky Oil Operations Ltd.
Project Name: HUE - Husky SGS Phase 4
Project No: 110902147

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LABORATORY
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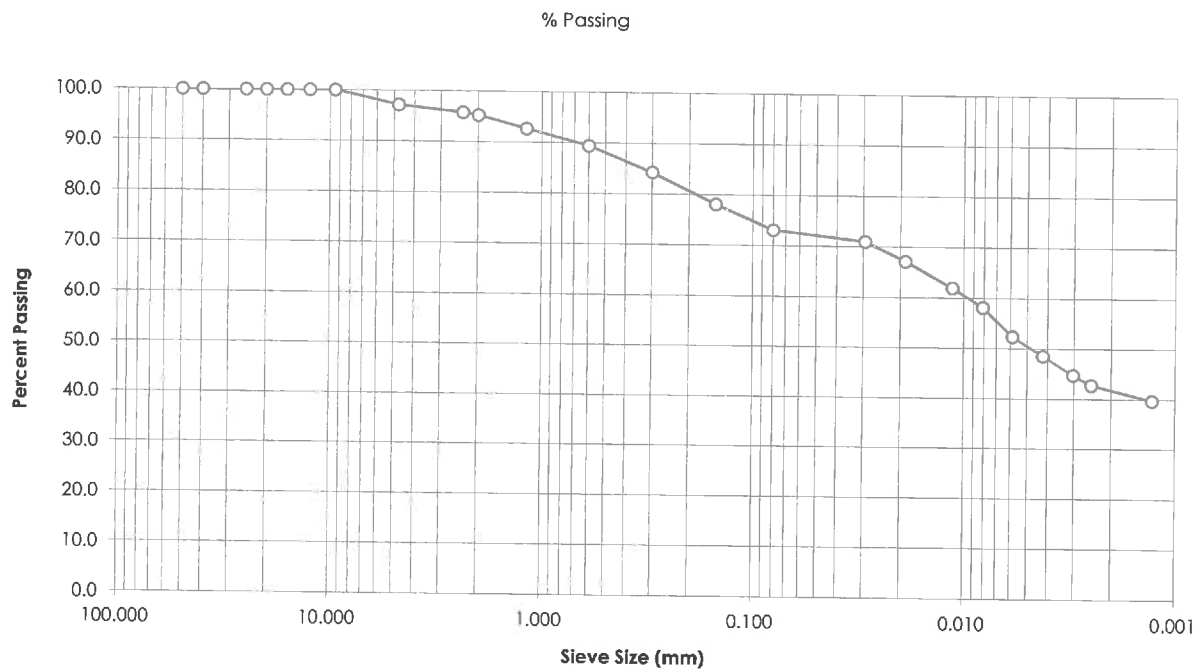
Edmonton, Alberta
Canada T5H 2X5
Tel: (780) 917-7463

SAMPLE No.: ST3
SOURCE: NSR BH7
TESTED BY: JA

DATE TESTED: October 5, 2016
DATE RECEIVED: September 12, 2016
SAMPLE DESCRIPTION: Sandy, silty clay, tr gravel



Sieve (mm)	Sample % Passing	Sieve (mm)	Sample % Passing
50.0	100.0	0.0059	52.4
40.0	100.0	0.0042	48.5
25.0	100.0	0.0030	44.7
20.0	100.0	0.0025	42.8
16.0	100.0	0.0013	39.7
12.5	100.0		
9.5	100.0		
4.75	97.2		
2.36	95.8		
2.00	95.3		
1.18	92.7		
0.600	89.4		
0.300	84.3		
0.150	78.1		
0.080	73.1		
0.0294	71.0		
0.0189	67.1		
0.0113	62.0		
0.0081	58.1		

Gravel:	2.8%	D_{10}:	-
Sand:	24.1%	D_{30}:	-
Silt:	31.3%	D_{60}:	0.0097
Clay:	41.8%	C_u:	-
		C_c:	-

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For specific tests as listed on www.ccil.com

Comments:

Reviewed by:

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your P.O. #: 110902147.5.600.100
Your Project #: 110902147.5.600.100.210.200.40
Site Location: LLOYDMINSTER, AB/HUSKY SGS PAHSE 4
Your C.O.C. #: A174613

Attention:LAWRENCE ONWUDE

STANTEC CONSULTING LTD
10160-112 STREET
EDMONTON, AB
CANADA T5K 2L6

Report Date: 2016/10/11
Report #: R2279831
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B686543
Received: 2016/10/03, 10:28

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (Soluble)	3	2016/10/07	2016/10/07	AB SOP-00033 / AB SOP-00020	SM 22 4500-Cl G m
Resistivity	3	N/A	2016/10/07	AB WI-00065	Auto Calc
Conductivity @25C (Soluble)	3	2016/10/07	2016/10/07	AB SOP-00033 / AB SOP-00004	SM 22 2510 B m
pH @25C (Soluble)	3	2016/10/07	2016/10/07	AB SOP-00033 / AB SOP-00006	SM 22 4500 H+B m
Soluble Ions	3	2016/10/07	2016/10/07	AB SOP-00033 / AB SOP-00042	EPA 200.7 CFR 2012 m
Soluble Paste	3	2016/10/07	2016/10/07	AB SOP-00033	Carter 2nd ed 15.2m
Soluble Ions Calculation	3	N/A	2016/10/11	AB WI-00065	Auto Calc

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Wendy Sears, Project manager
Email: WSears@maxxam.ca
Phone# (403)735-2277
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

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Success Through Science®

Maxxam Job #: B686543
Report Date: 2016/10/11

STANTEC CONSULTING LTD
Client Project #: 110902147.5.600.100.210.200.40
Site Location: LLOYDMINSTER, AB/HUSKY SGS PAHSE 4
Your P.O. #: 110902147.5.600.100
Sampler Initials: LO

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		PR0620		PR0621		PR0622		
Sampling Date		2016/09/13		2016/09/18		2016/09/16		
COC Number		A174613		A174613		A174613		
	UNITS	**NL_BH41 ST3**	**RDL**	**NSR BH06 BS3**	**RDL**	**NSR BH07 SS2**	**RDL**	**QC Batch**
Calculated Parameters								
Resistivity @ 25 °C	ohm-m	24	0.050	2.0	0.050	14	0.050	8420137
Calculated Chloride (Cl)	%	<0.00035	0.00035	0.00038	0.00028	<0.00022	0.00022	8429456
Calculated Sulphate (SO4)	%	0.0058	0.00035	0.20	0.00028	0.010	0.00022	8429456
Soluble Parameters								
Soluble Chloride (Cl)	mg/L	<5.0	5.0	6.8	5.0	<5.0	5.0	8426745
Soluble Conductivity	dS/m	0.42	0.020	4.9	0.020	0.74	0.020	8425858
Soluble pH	pH	8.16	N/A	7.82	N/A	8.07	N/A	8425660
Saturation %	%	70	N/A	56	N/A	43	N/A	8424992
Soluble Sulphate (SO4)	mg/L	83	5.0	3500	5.0	230	5.0	8426605

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam Job #: B686543
Report Date: 2016/10/11

STANTEC CONSULTING LTD
Client Project #: 110902147.5.600.100.210.200.40
Site Location: LLOYDMINSTER, AB/HUSKY SGS PAHSE 4
Your P.O. #: 110902147.5.600.100
Sampler Initials: LO

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	19.3°C

Results relate only to the items tested.

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Maxxam
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Maxxam Job #: B686543
Report Date: 2016/10/11

STANTEC CONSULTING LTD
Client Project #: 110902147.5.600.100.210.200.40
Site Location: LLOYDMINSTER, AB/HUSKY SGS PAHSE 4
Your P.O. #: 110902147.5.600.100
Sampler Initials: LO

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8424992	LX	QC Standard	Saturation %	2016/10/07		100	%	89 - 111
8424992	LX	RPD	Saturation %	2016/10/07	0.11		%	12
8425660	VP7	QC Standard	Soluble pH	2016/10/07		100	%	97 - 103
8425660	VP7	Spiked Blank	Soluble pH	2016/10/07		101	%	97 - 103
8425660	VP7	RPD	Soluble pH	2016/10/07	0.97		%	N/A
8425858	BJO	QC Standard	Soluble Conductivity	2016/10/07		100	%	84 - 116
8425858	BJO	Spiked Blank	Soluble Conductivity	2016/10/07		99	%	90 - 110
8425858	BJO	Method Blank	Soluble Conductivity	2016/10/07	<0.020		dS/m	
8425858	BJO	RPD	Soluble Conductivity	2016/10/07	1.0		%	35
8426605	JK9	QC Standard	Soluble Sulphate (SO4)	2016/10/07		97	%	81 - 119
8426605	JK9	Method Blank	Soluble Sulphate (SO4)	2016/10/07	<5.0		mg/L	
8426605	JK9	RPD	Soluble Sulphate (SO4)	2016/10/07	4.0		%	35
8426745	CH7	Matrix Spike	Soluble Chloride (Cl)	2016/10/07		105	%	75 - 125
8426745	CH7	QC Standard	Soluble Chloride (Cl)	2016/10/07		104	%	75 - 125
8426745	CH7	Spiked Blank	Soluble Chloride (Cl)	2016/10/07		102	%	75 - 125
8426745	CH7	Method Blank	Soluble Chloride (Cl)	2016/10/07	<5.0		mg/L	
8426745	CH7	RPD	Soluble Chloride (Cl)	2016/10/07	1.6		%	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam Job #: B686543
Report Date: 2016/10/11

STANTEC CONSULTING LTD
Client Project #: 110902147.5.600.100.210.200.40
Site Location: LLOYDMINSTER, AB/HUSKY SGS PAHSE 4
Your P.O. #: 110902147.5.600.100
Sampler Initials: LO

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Maria Magdalena Florescu, Ph.D., P.Chem., QP, Inorganics Senior Analyst

Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam

Calgary: 4000 19st St. NE, T2E 6P8. Ph: (403) 291-3077; Fax: (403) 735-2240, Toll free: (800) 386-7247
Edmonton: 9331 - 48 Street, T6B 2R4. Ph: (780) 577-7100, Fax: (780) 450-4187, Toll free: (877) 465-8889
www.maxxamanalytics.com

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Chain of Custody

A171613

Page: 1 of 1

	Invoice To: C/O Report Address ☑	Report To: Same as Invoice ☐
Company:	STANTEC	
Contact:	LAWRENCE ONWUDE	
Address:	10160 112ST NW	
	Prov: ALBERTA PC:	Prov: PC:
Contact #s:	Ph (780) 969-2257 Cell (780) 862-6360	Ph: Cell:

Report Distribution (E-Mail):
LAWRENCE.ONWUDE@STANTEC.COM
GEOMATERIALSDISPATCH@STANTEC.COM

REGULATORY GUIDELINES:
☐ AT1
☐ CCME
☐ Regulated Drinking Water
☐ Other:

All samples are held for 60 calendar days after sample receipt, unless specified otherwise.

PO #: 110902147.5.000 10 210.200.400
Project # / Name: HUSKY SGS PHASE 4
Site Location: LLOYDMINSTER, AB
Quote #:
Sampled By: LO

SERVICE REQUESTED: ☐ RUSH (Contact lab to reserve) Date Required: ☑ REGULAR (5 to 7 Days)

See reverse for package specifics

	Sample ID	Depth (unit)	Matrix GW / SW Soil	Date/Time Sampled YY/MM/DD 24:00	SOIL: BTEX F1-F4	Sieve (75 micron)	Regulated Metals (CCME / AT1)	Salinity 4	Assessment ICP Metals	Basic Class II Landfill	WATER: ☐VOCs ☐BTEX F1 ☐BTEX F1-F4 ☐BTEX F1-F2	☐ Routine Water ☐ Turb ☐ F	☐ TOC ☐ DOC	Regulated Metals (CCME / AT1) Total	Dissolved	Mercury ☐ Total ☐ Dissolved	Other Analysis: CHLORIDES	pH - SOIL	RESISTIVITY/CONDUCTIVITY	SULPHATES	HOLD - Do not Analyze	# of Containers Submitted
1	NL-BH41 ST3	23-2.9m		16/09/13													✓	✓	✓	✓		
2	NSR BH06 BS3			16/09/18													✓	✓	✓	✓		
3	NSR BH07 SS2	1.5-1.7m		16/09/16													✓	✓	✓	✓		
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						F/P

Please indicate Filtered, Preserved or Both (F, P, F/P)

Relinquished By (Signature/Print):	Date (YY/MM/DD):	Time (24:00):
Ryley Proznik	(16/10/03)	(10:26)
Relinquished By (Signature/Print):	Date (YY/MM/DD):	Time (24:00):

Special Instructions:

# of Jars Used & Not Submitted

LAB USE ONLY

Received By:	Date:	Time:	Maxxam Job #: B686543/DW
Jenna Walter	20161003	1028	

Lab Comments:

Custody Seal	Temperature	Ice
No	19, 20, 19	No

AB FCD-00331 Rev3 2010/05

Maxxam Analytics International Corporation o/a Maxxam Analytics

Edmonton Laboratory
10575-106 Street
Edmonton, AB T5H 2X5
Ph: 780-917-7000
Fax: 780-917-7269

UNIT WEIGHTS - SPT SAMPLES

Project No.: 110902147.5.500.200.210.100 Date: September 16, 2016

Project: HUE - Husky SGS Phase 4 Technician: JA

Test Hole Number	Sample Number	Depth (m)	Moisture Content (%)	Wet Density (kg/m³)	Dry Density (kg/m³)	Total Unit Weight (kN/m³)
NSR BH3	RC61	242'10"-243'11"	13.6	2189	1927	21
NSR BH3	RC67	272'2"-273'3"	13.9	2183	1918	21

Reviewed By:

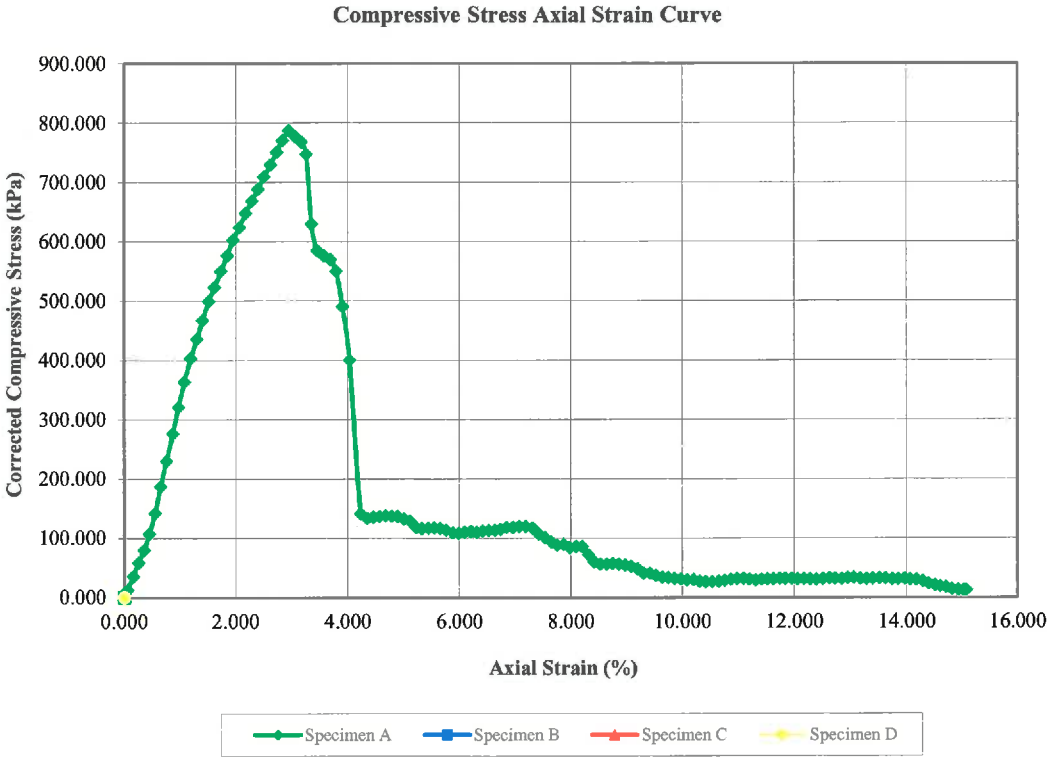
Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Tested By JA Date 10/7/2016

Computed By JA Date 10/13/2016

Checked By [illegible] Date 10/13/16



Before Test	Specimen A	B	C	D
Water Content (%)	18.93			
Dry Density (g/cm3)	1.803			
Saturation (%)	99.13			
Void Ratio	0.53			
Diameter (mm)	76.290			
Height (mm)	152.900			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	788.338			
Undrained Shear Strength (kgf/cm^2)	4.019			
Undrained Shear Strength (kPa)	394.169			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.94			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay shale
Project	HUE - HUSKY SGS OPERATIONS	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH4 RC 20	Specimen D	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.75
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/18/16

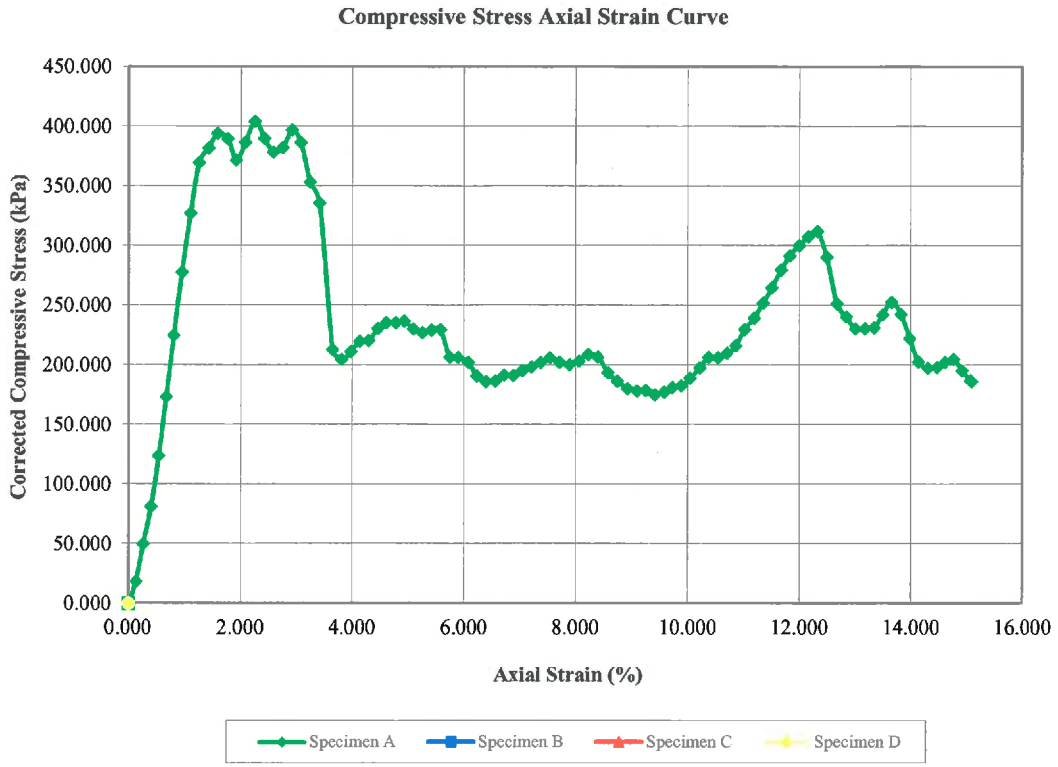
Checked By

Date 10/13/2016

Computed By JA

Date

Tested By



Before Test	Specimen A	B	C	D
Water Content (%)	17.58			
Dry Density (g/cm3)	2.225			
Saturation (%)	190.34			
Void Ratio	0.26			
Diameter (mm)	70.810			
Height (mm)	102.010			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	404.035			
Undrained Shear Strength (kgf/cm^2)	2.060			
Undrained Shear Strength (kPa)	202.018			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.25			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay shale
Project	HUE - HUSKY SGS OPERATIONS	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH4 RC27	Specimen D	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.80
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/13/16

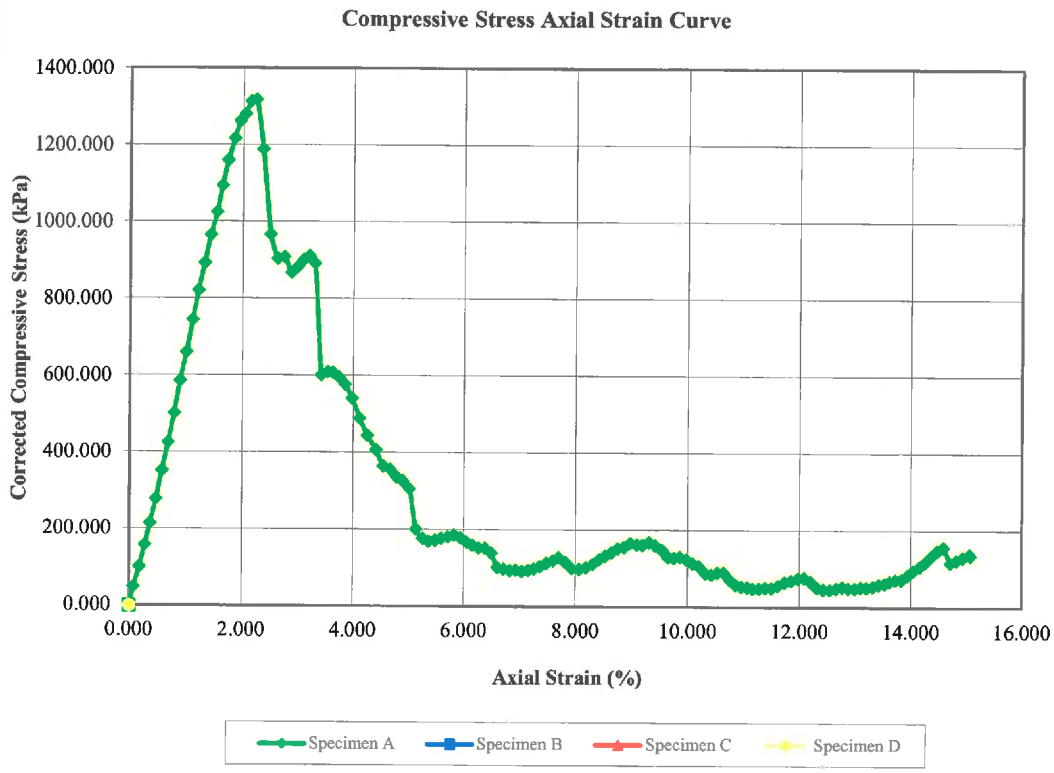
Checked By BDC

Date 10/13/2016

Computed By JA

Date 10/7/2016

Tested By JA



Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	15.76			
Dry Density (g/cm3)	2.262			
Saturation (%)	185.52			
Void Ratio	0.24			
Diameter (mm)	71.060			
Height (mm)	149.830			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	1319.212			
Undrained Shear Strength (kgf/cm^2)	6.726			
Undrained Shear Strength (kPa)	659.606			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	2.24			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay shale
Project	HUE - HUSKY SGS OPERATIONS	Specimen B	
Sampling Date		Specimen C	
Sample #	NSR BH4 RC38	Specimen D	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.80
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/18/16

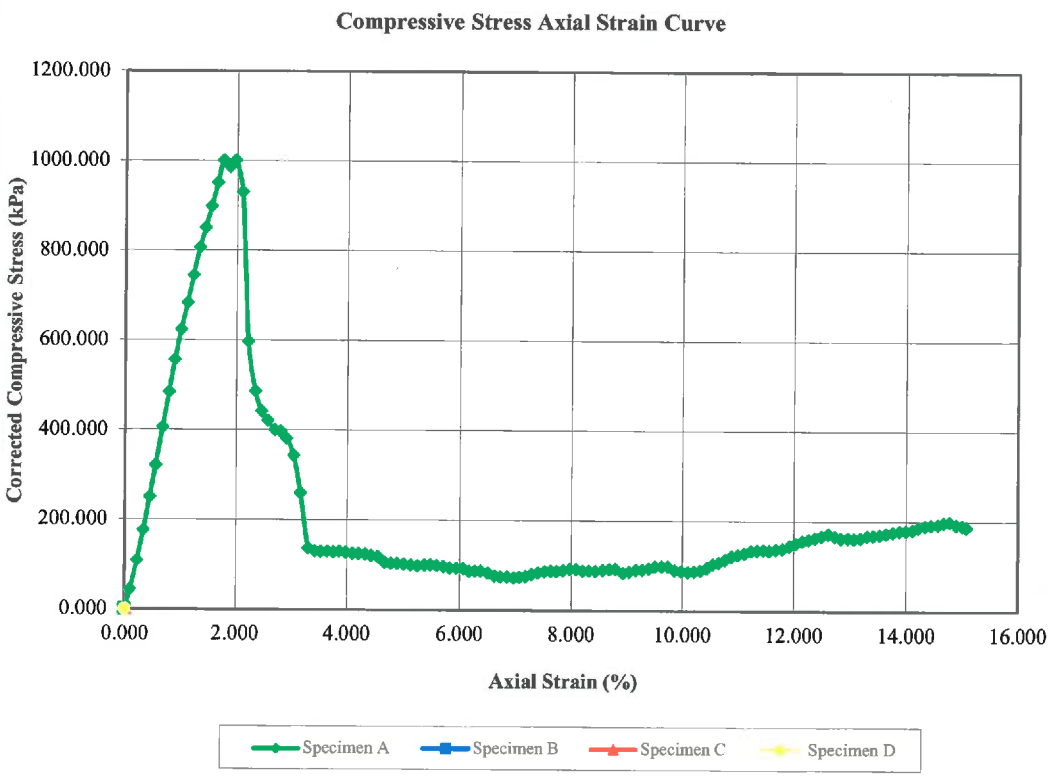
Checked By JX

Date 10/13/2016

Computed By JA

Date 10/7/2016

Tested By JA



Before Test	Specimen A	B	C	D
Water Content (%)	18.33			
Dry Density (g/cm3)	2.181			
Saturation (%)	180.99			
Void Ratio	0.28			
Diameter (mm)	69.730			
Height (mm)	147.037			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	1000.328			
Undrained Shear Strength (kgf/cm^2)	5.100			
Undrained Shear Strength (kPa)	500.164			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	1.76			
Description				

Project Information		Specimen Description	
Project Num	110902147	Specimen A	Clay shale
Project	HUE - HUSKY SGS OPERATIONS	Specimen B	
Sampling Date		Specimen C	
Sample #	NL BH41 RC32	Specimen D	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.80
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/13/16

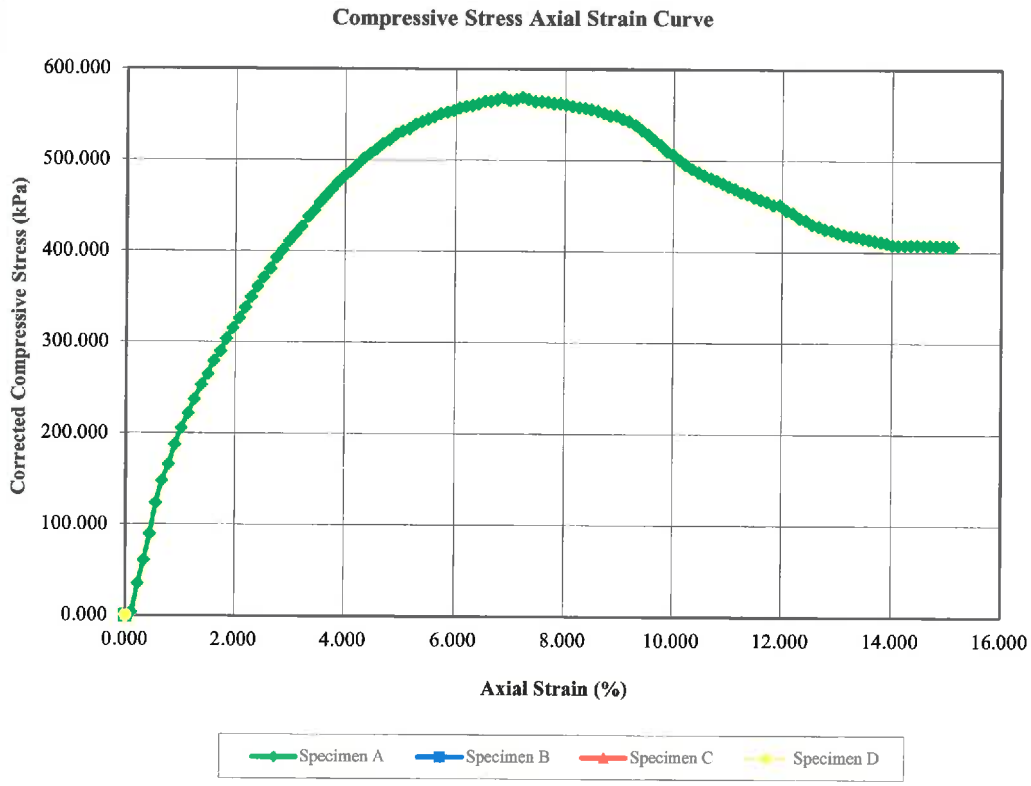
Checked By JC

Date 10/5/2016

Computed By JA

Date 10/4/2016

Tested By JA



Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	27.83			
Dry Density (g/cm3)	1.544			
Saturation (%)	97.96			
Void Ratio	0.78			
Diameter (mm)	72.763			
Height (mm)	145.217			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	569.689			
Undrained Shear Strength (kgf/cm^2)	2.905			
Undrained Shear Strength (kPa)	284.845			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	7.22			
Description				

Project Information		Specimen Description	
Project Num	110902147.5.600.100.210.200.40	Specimen A	TILL - Clay and silt, tr sand and gravel
Project	HUE - HUSKY SGS PHASE 4	Specimen B	
Sampling Date	September 13, 2016	Specimen C	
Sample #	NL BH41 ST3	Specimen D	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.75
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/13/16

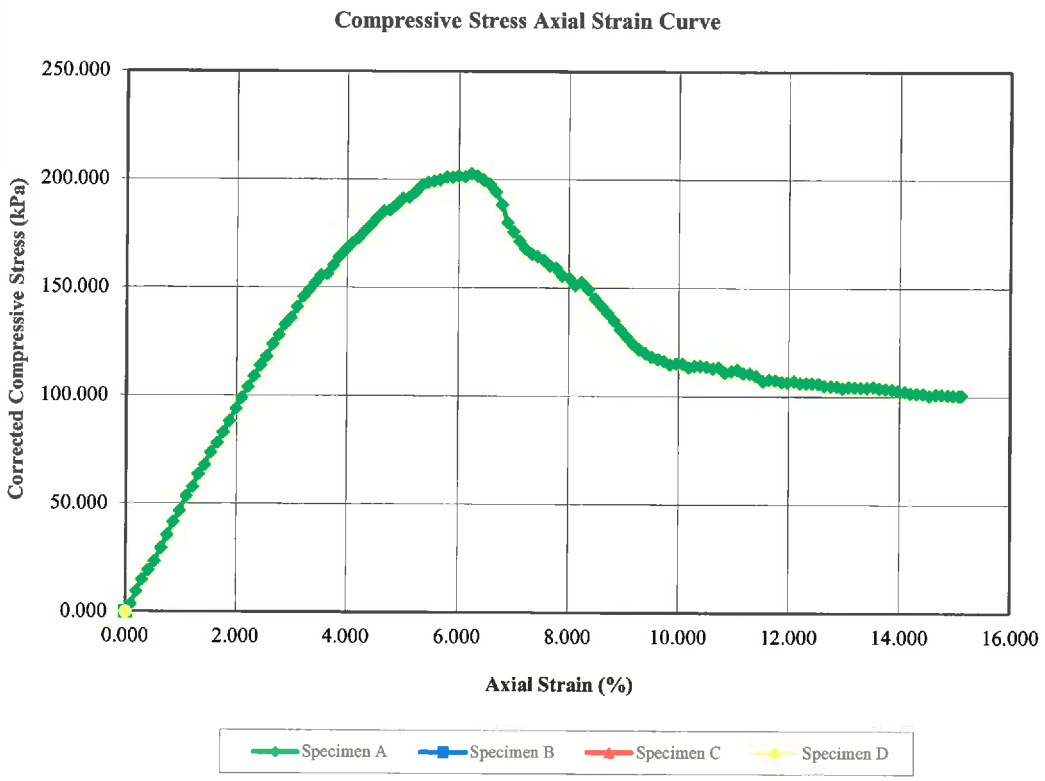
Checked By JK

Date 10/5/2016

Computed By JA

Date 10/4/2016

Tested By JA



Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	6.60			
Dry Density (g/cm3)	2.051			
Saturation (%)	59.84			
Void Ratio	0.29			
Diameter (mm)	73.130			
Height (mm)	150.470			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	202.539			
Undrained Shear Strength (kgf/cm^2)	1.033			
Undrained Shear Strength (kPa)	101.270			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	6.22			
Description				

Project Information		Specimen Description	
Project Num	110902147.5.600.100.210.200.40	Specimen A	TILL - Clay and silt, tr sand and gravel, oxidze stain
Project	HUE - HUSKY SGS PHASE 4		
Sampling Date	September 18, 2016	Specimen B	
Sample #	NSR BH06 ST6	Specimen C	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

Remarks

Stantec Consulting Ltd.

Unconfined Compression Test Report (ASTM D2166)

Date 10/13/16

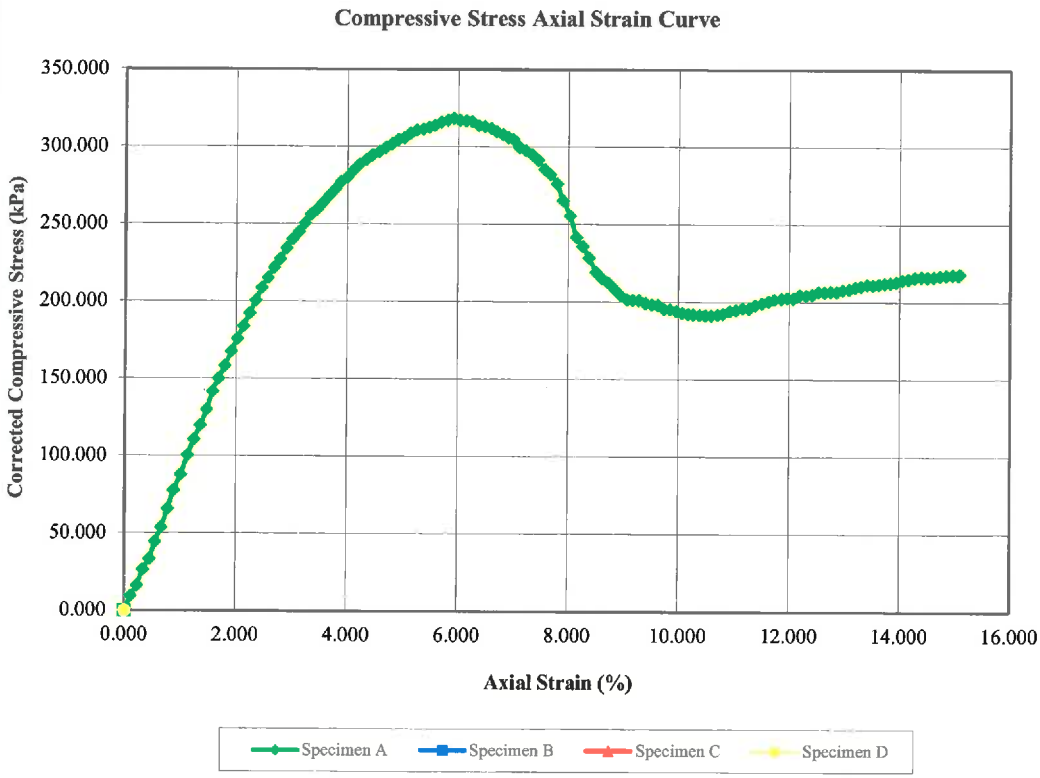
Checked By

Date 10/5/2016

Computed By JA

Date 10/4/2016

Tested By JA



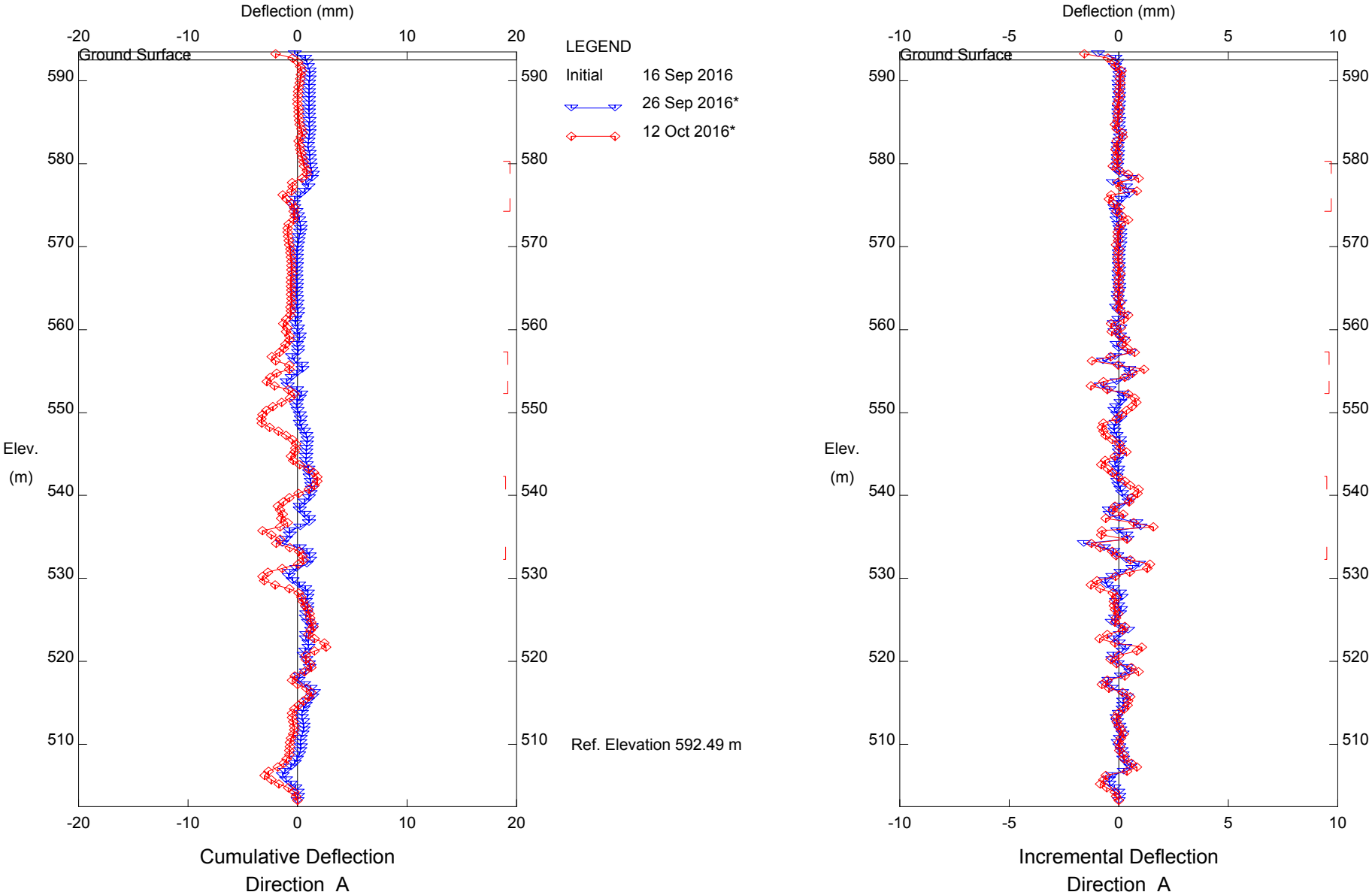
Before Test	Specimen A	Specimen B	Specimen C	Specimen D
Water Content (%)	6.17			
Dry Density (g/cm3)	1.934			
Saturation (%)	44.15			
Void Ratio	0.37			
Diameter (mm)	73.460			
Height (mm)	149.820			
Test Data	**A**	**B**	**C**	**D**
Unconfined Strength (kPa)	318.310			
Undrained Shear Strength (kgf/cm^2)	1.623			
Undrained Shear Strength (kPa)	159.155			
Rate of Strain (mm/min)	2.000000			
Strain at Failure (%)	5.91			
Description				

Project Information		Specimen Description	
Project Num	110902147.5.600.100.210.200.40	Specimen A	TILL - Clay and silt, tr sand and gravel, oxidze stain, white deposit
Project	HUE - HUSKY SGS PHASE 4		
Sampling Date	September 16, 2016	Specimen B	
Sample #	NSR BH07 ST3	Specimen C	
Client	HUSKY OIL OPERATION LTD	**Test Variables**	
		Specific Gravity	2.65
		Liquid Limit:	
		Plastic Limit:	

Remarks

Appendix F
MONITORING RESULTS

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NL_40

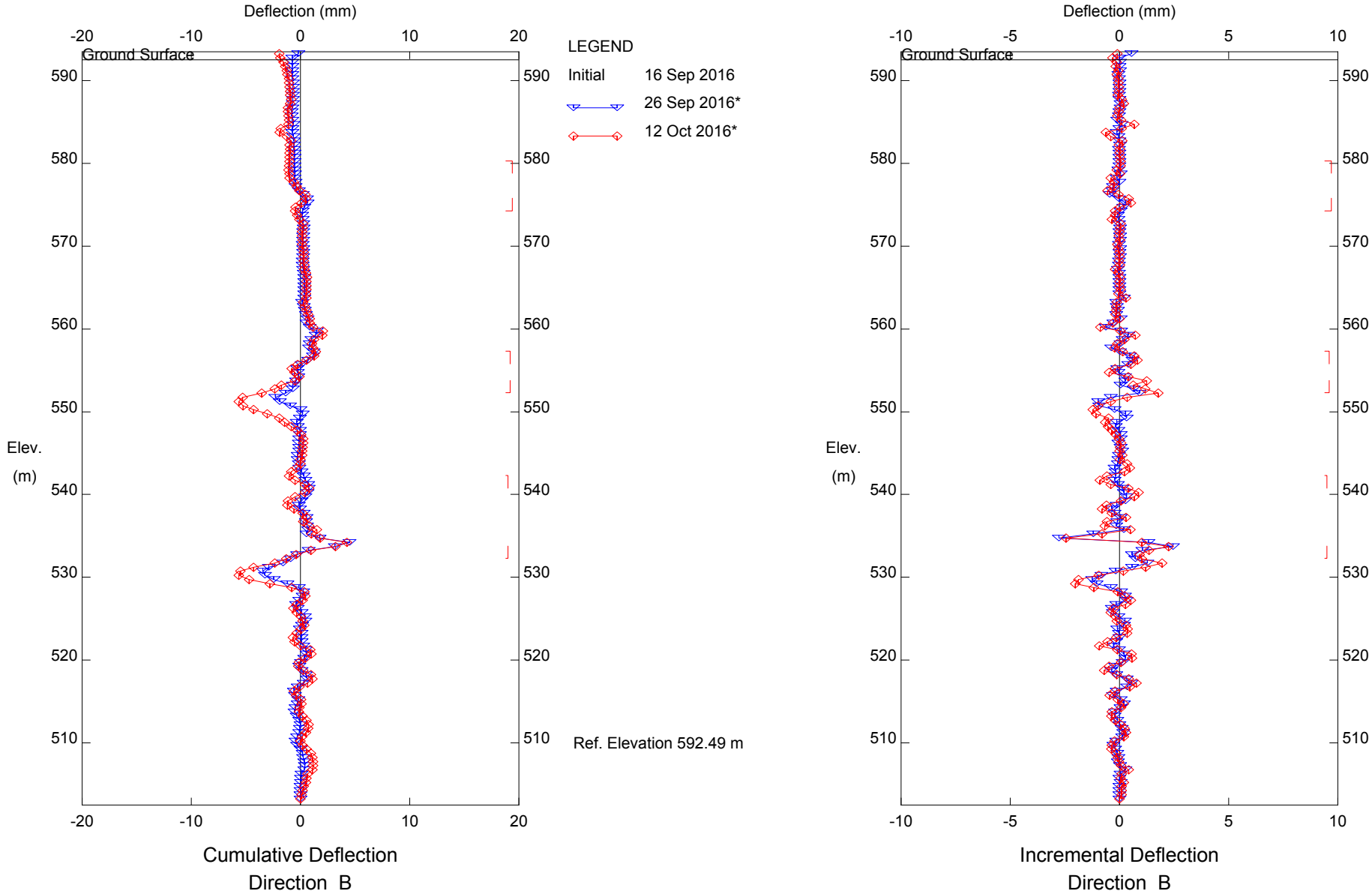
HUSKY ENERGY

LLOYDMINISTER, AB

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

NL_40_cor.gtl

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NL_40

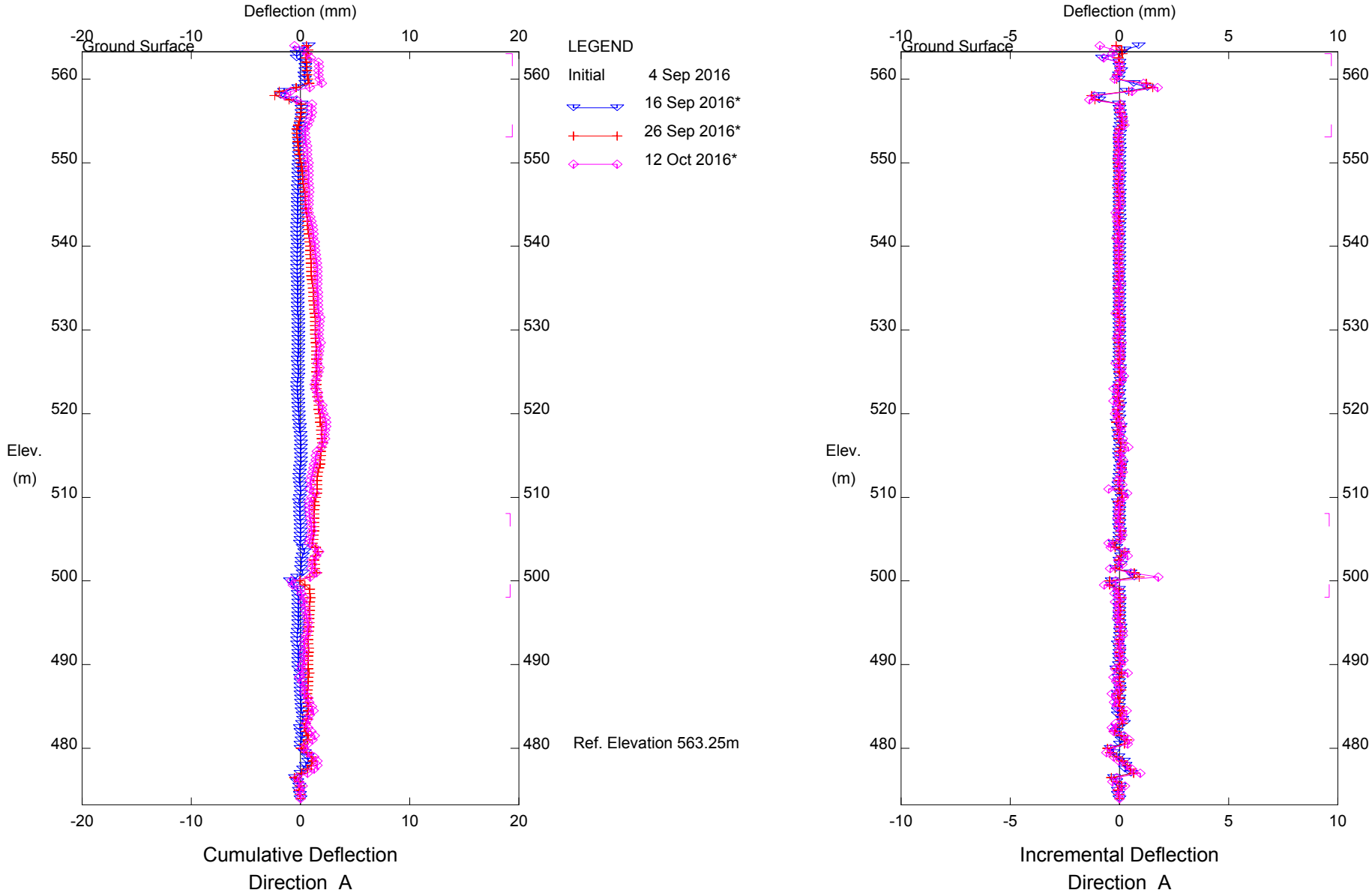
HUSKY ENERGY

LLOYDMINISTER, AB

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

NL_40_cor.gtl

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer STANTEC 2

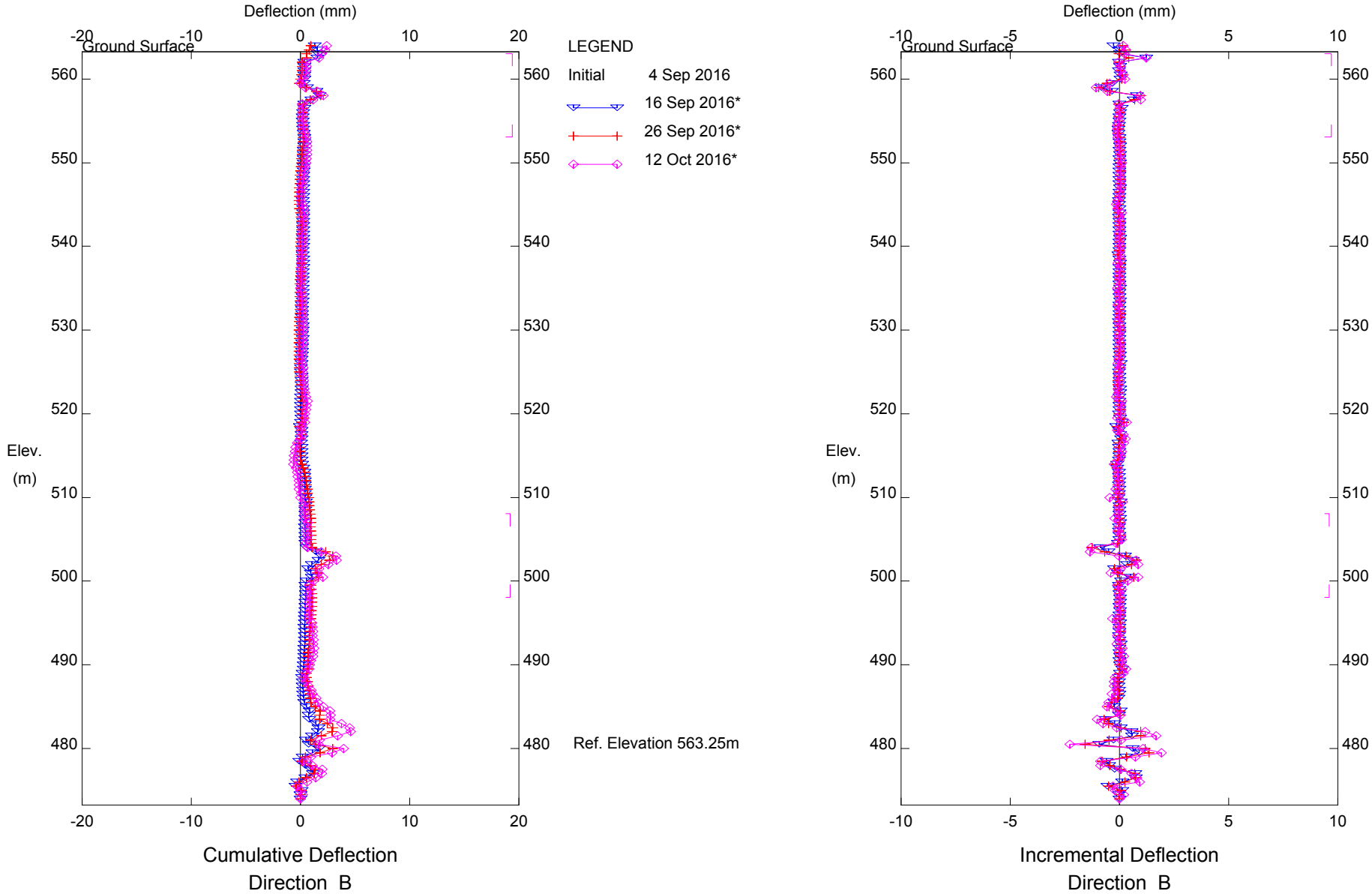
HUSKY ENERGY

LLOYDMINISTER, AB

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

STANTEC 2_cor.gtl

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer STANTEC 2

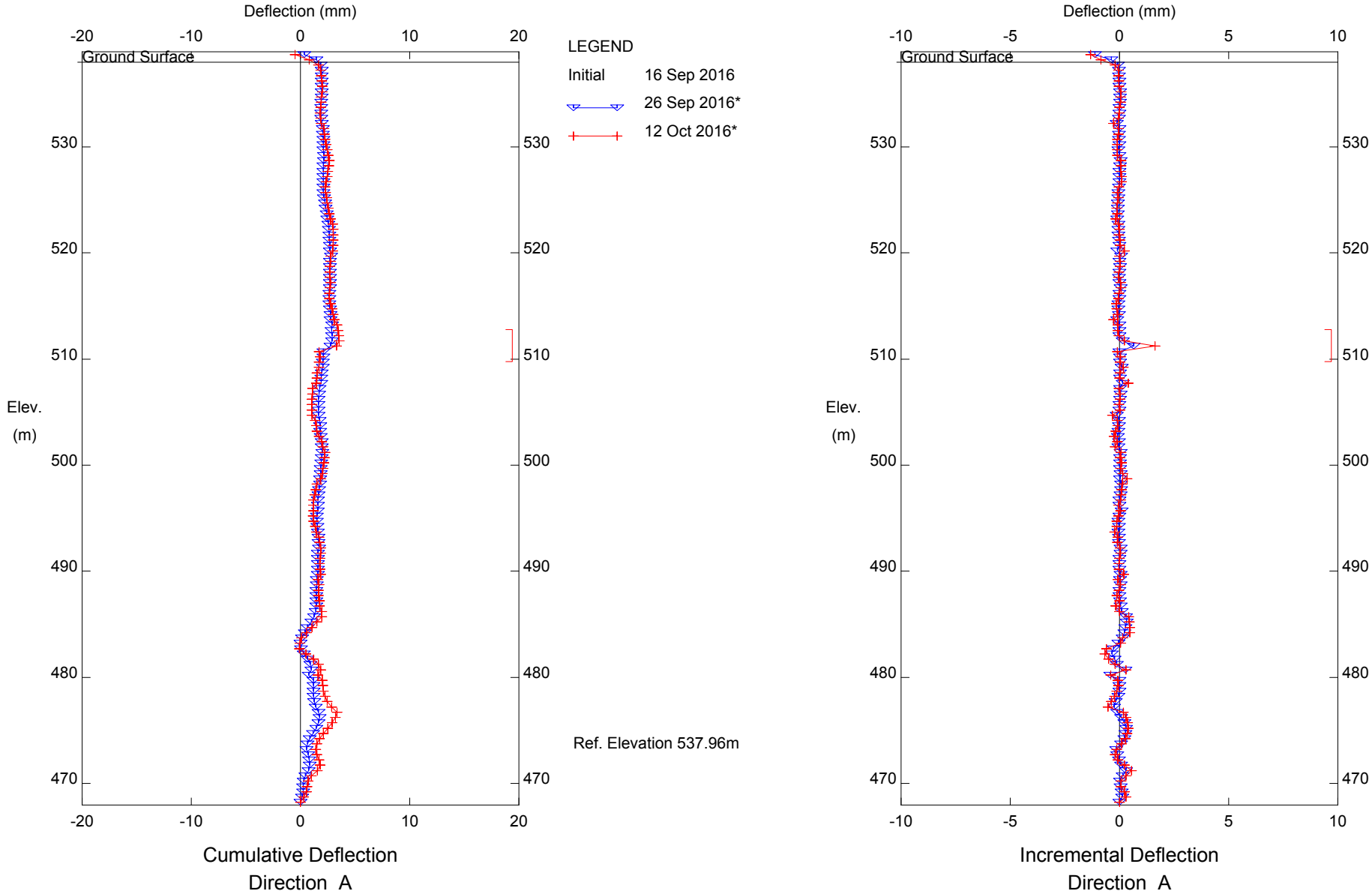
HUSKY ENERGY

LLOYDMINISTER, AB

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

STANTEC 2_cor.gtl

Stantec Consulting Ltd - Edmonton



SGS PHASE 4, Inclinometer NSR-BH01

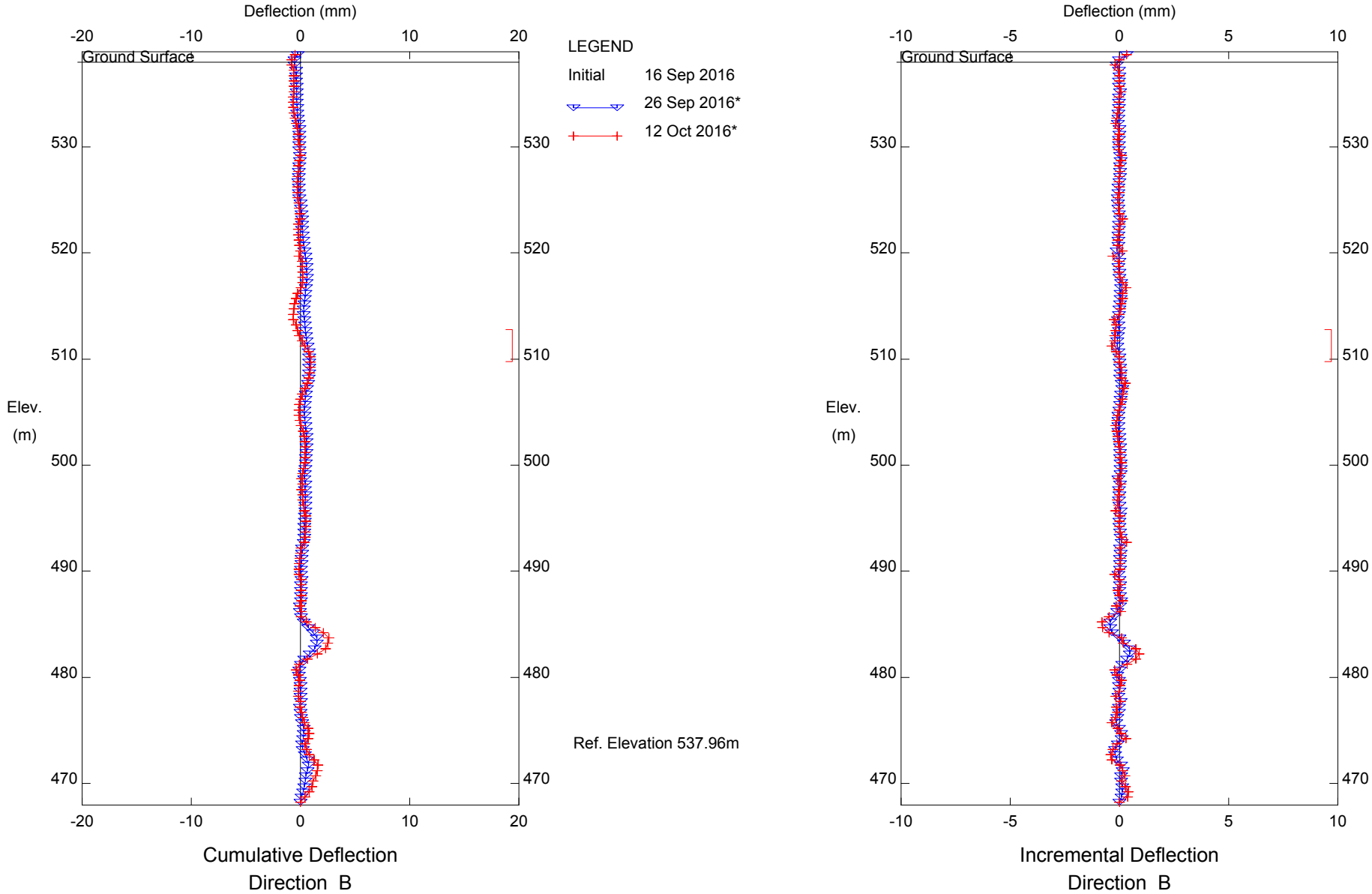
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH01.cor.gtl

Stantec Consulting Ltd - Edmonton



SGS PHASE 4, Inclinometer NSR-BH01

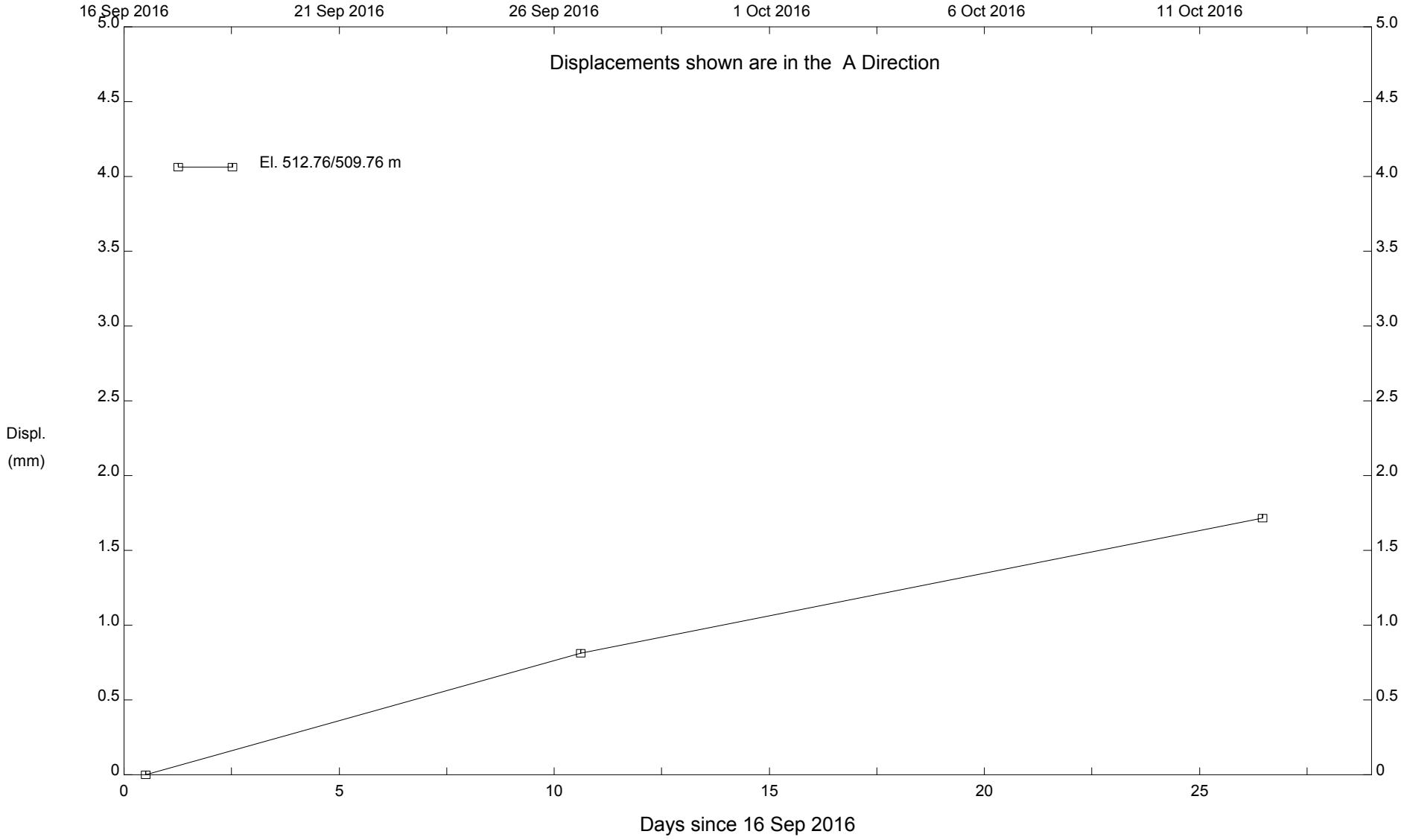
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH01.cor.gtl

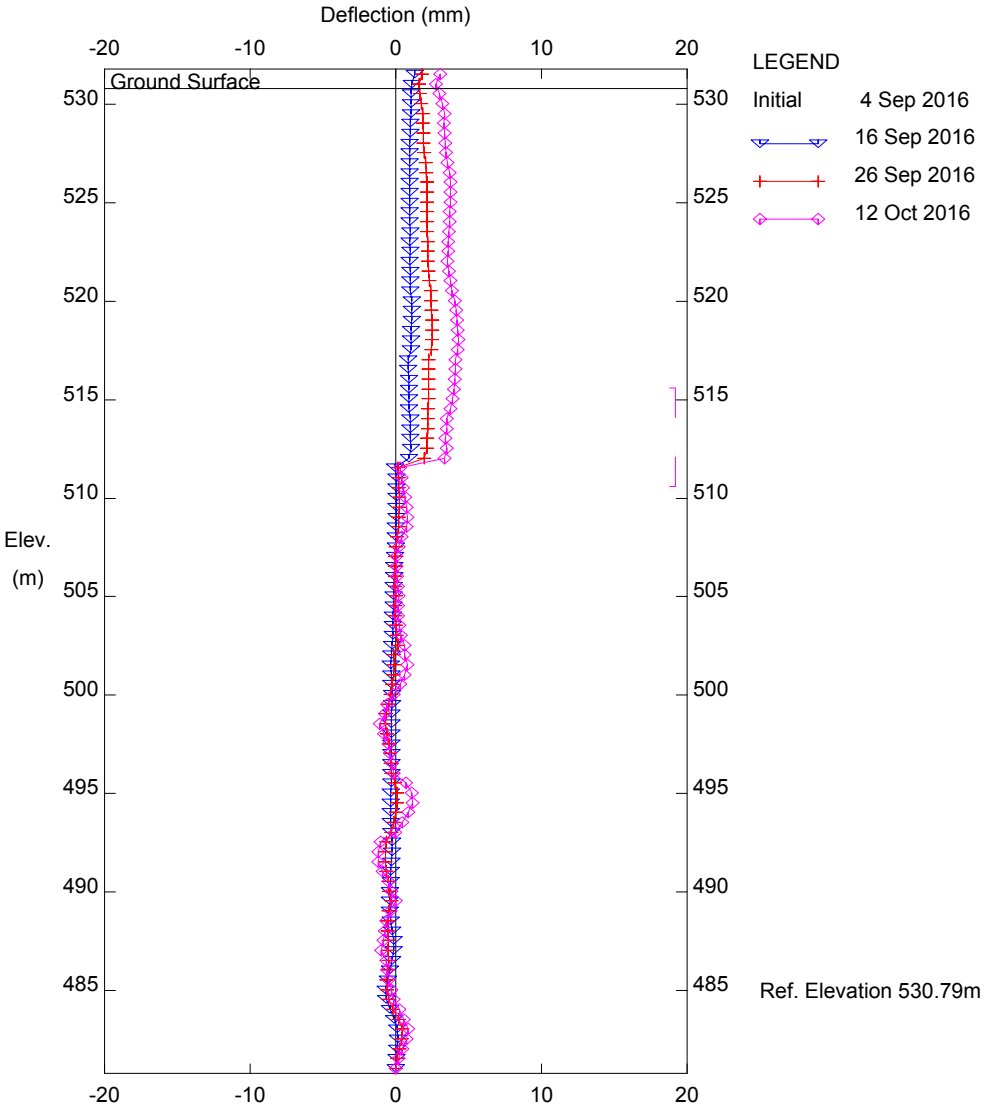
Stantec Consulting Ltd - Edmonton



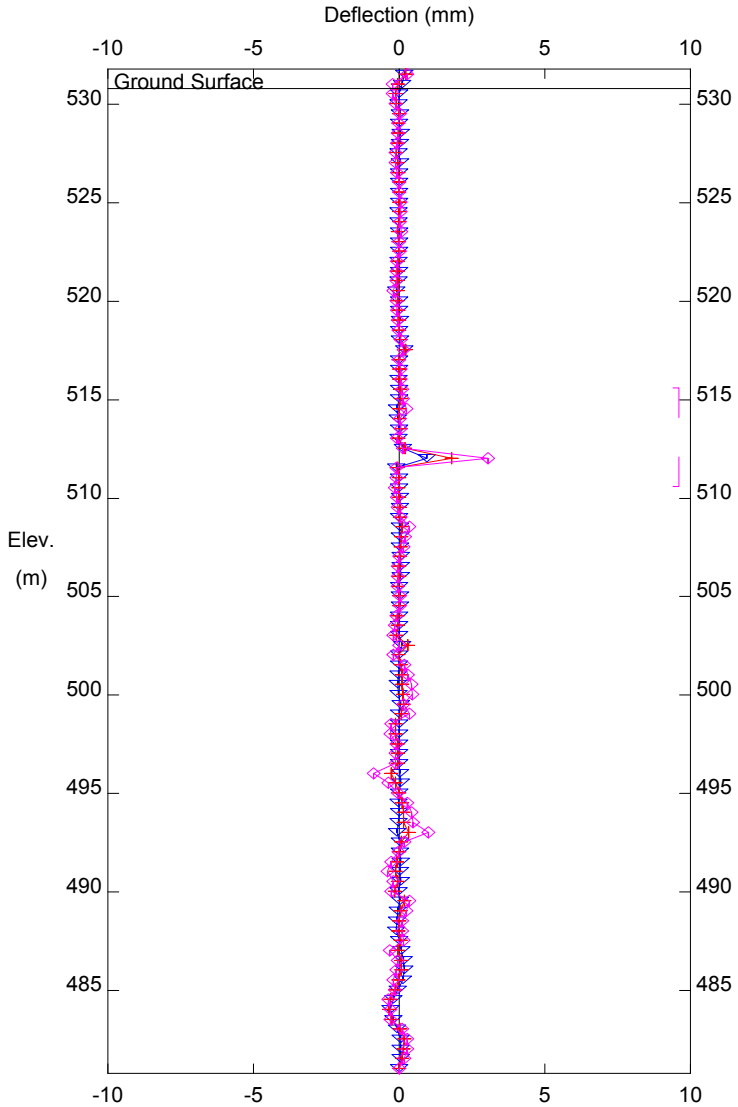
SGS PHASE 4, Inclinometer NSR-BH01

HUSKY ENERGY

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction A



Incremental Deflection
Direction A

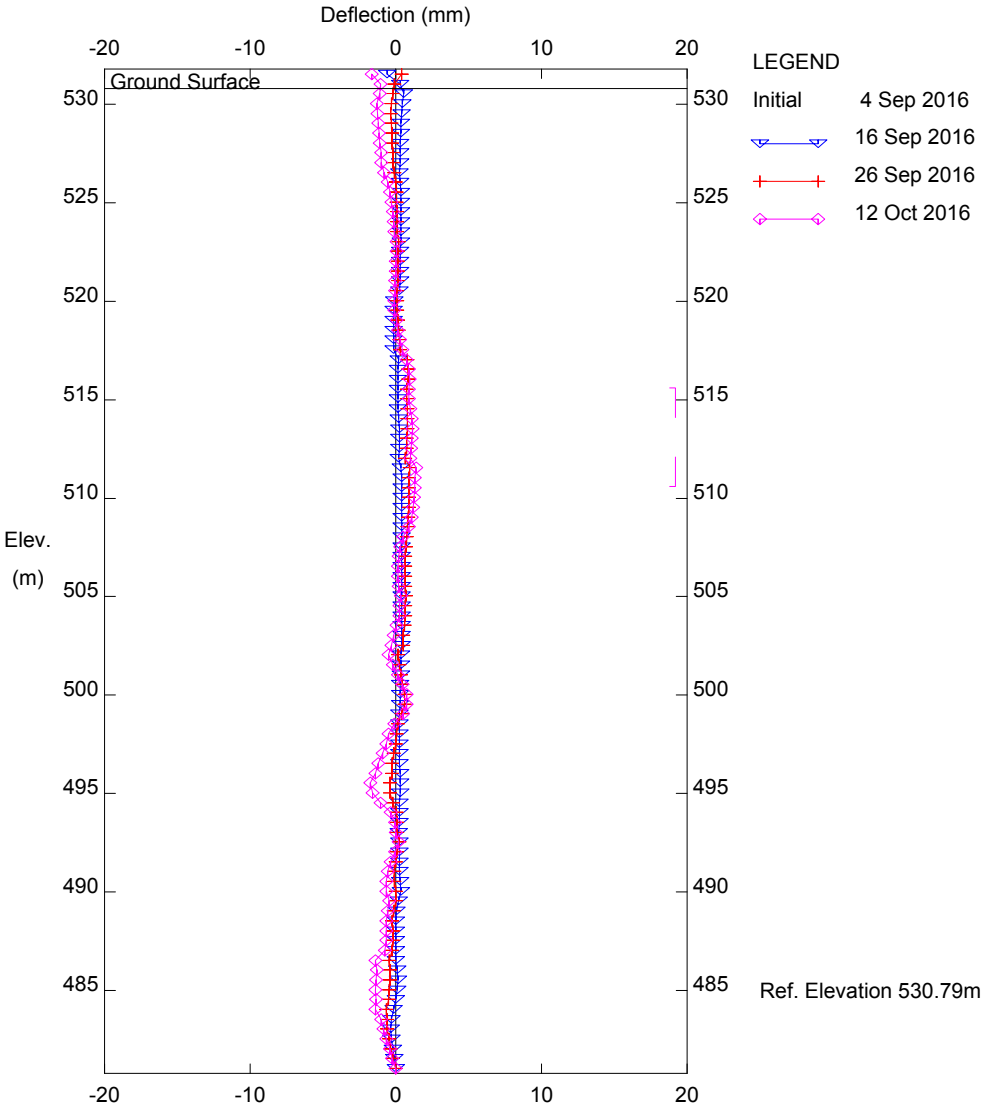
SGS_PHASE 4, Inclinometer STANTEC 1

HUSKY ENERGY

LLOYDMINISTER, AB

STANTEC 1.gtl

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction B

LEGEND

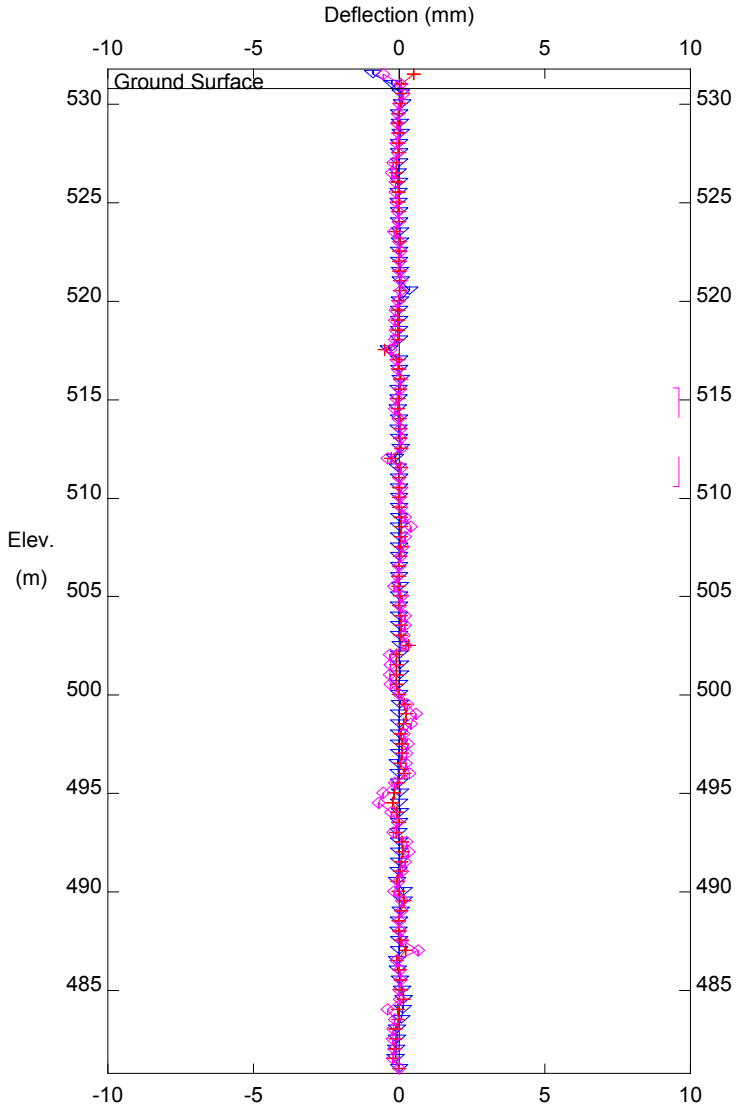
Initial 4 Sep 2016

16 Sep 2016

26 Sep 2016

12 Oct 2016

Ref. Elevation 530.79m



Incremental Deflection
Direction B

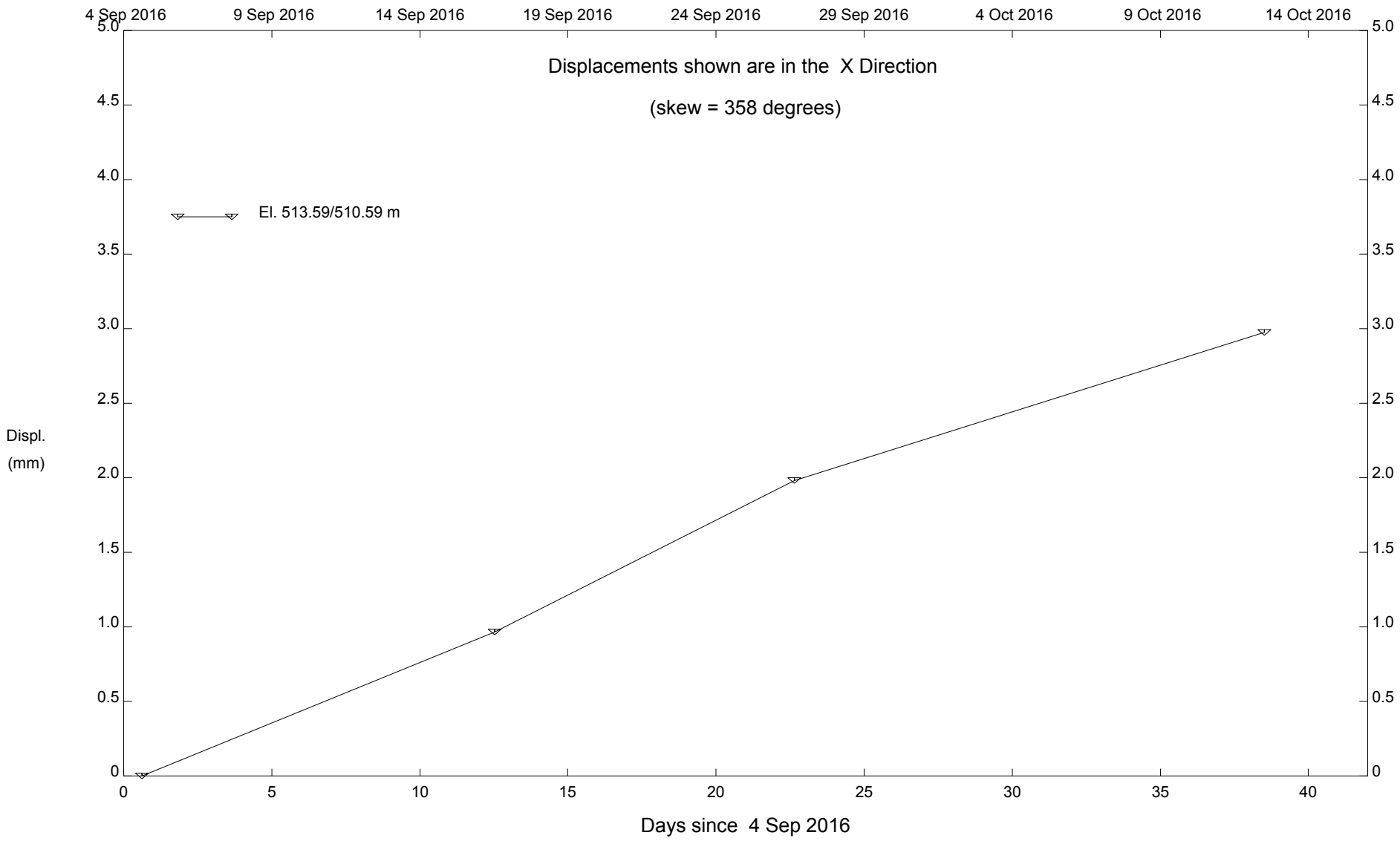
SGS_PHASE 4, Inclinometer STANTEC 1

HUSKY ENERGY

LLOYDMINISTER, AB

STANTEC 1.gtl

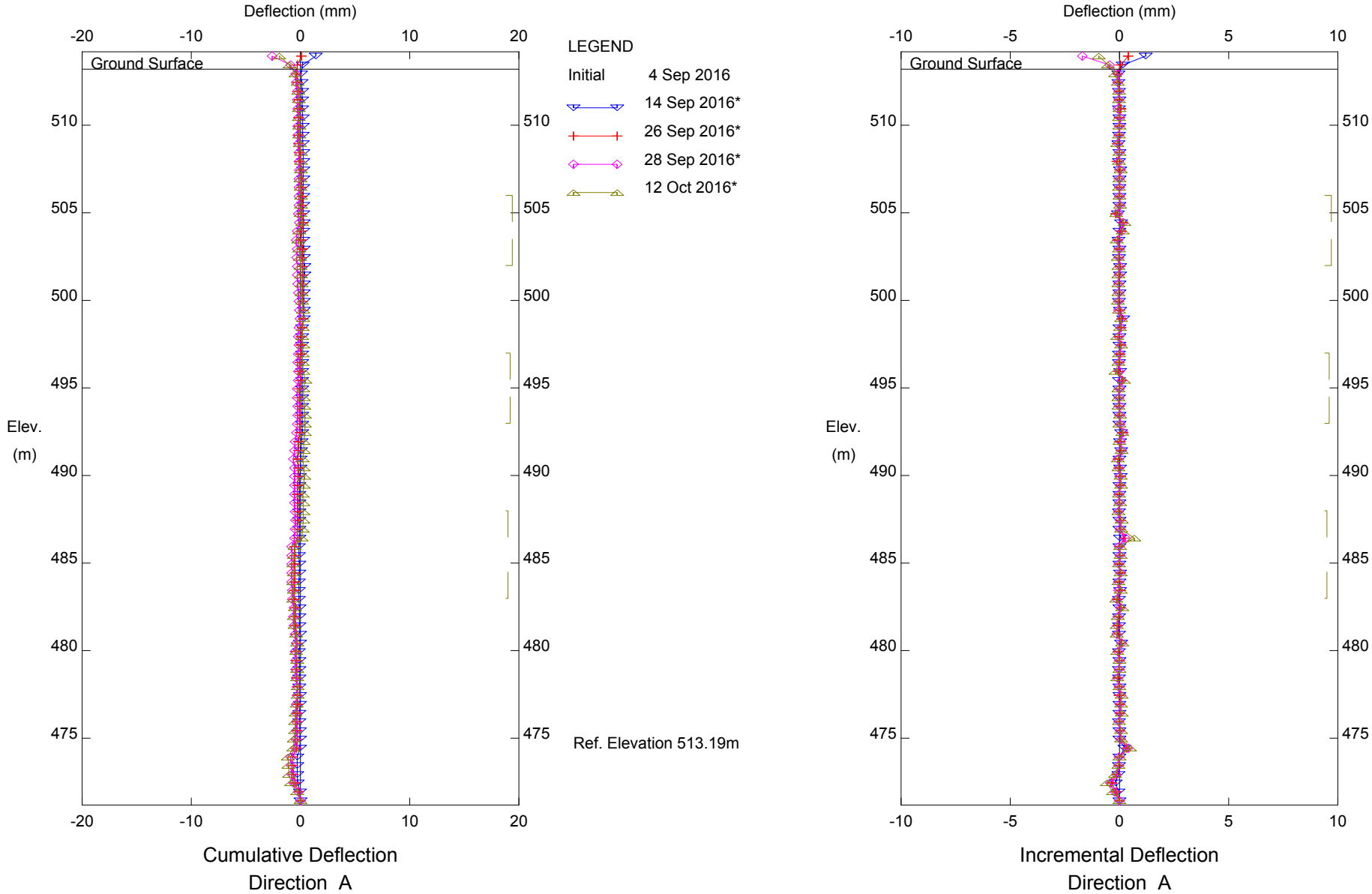
Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer STANTEC 1

HUSKY ENERGY

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NSR-BH02

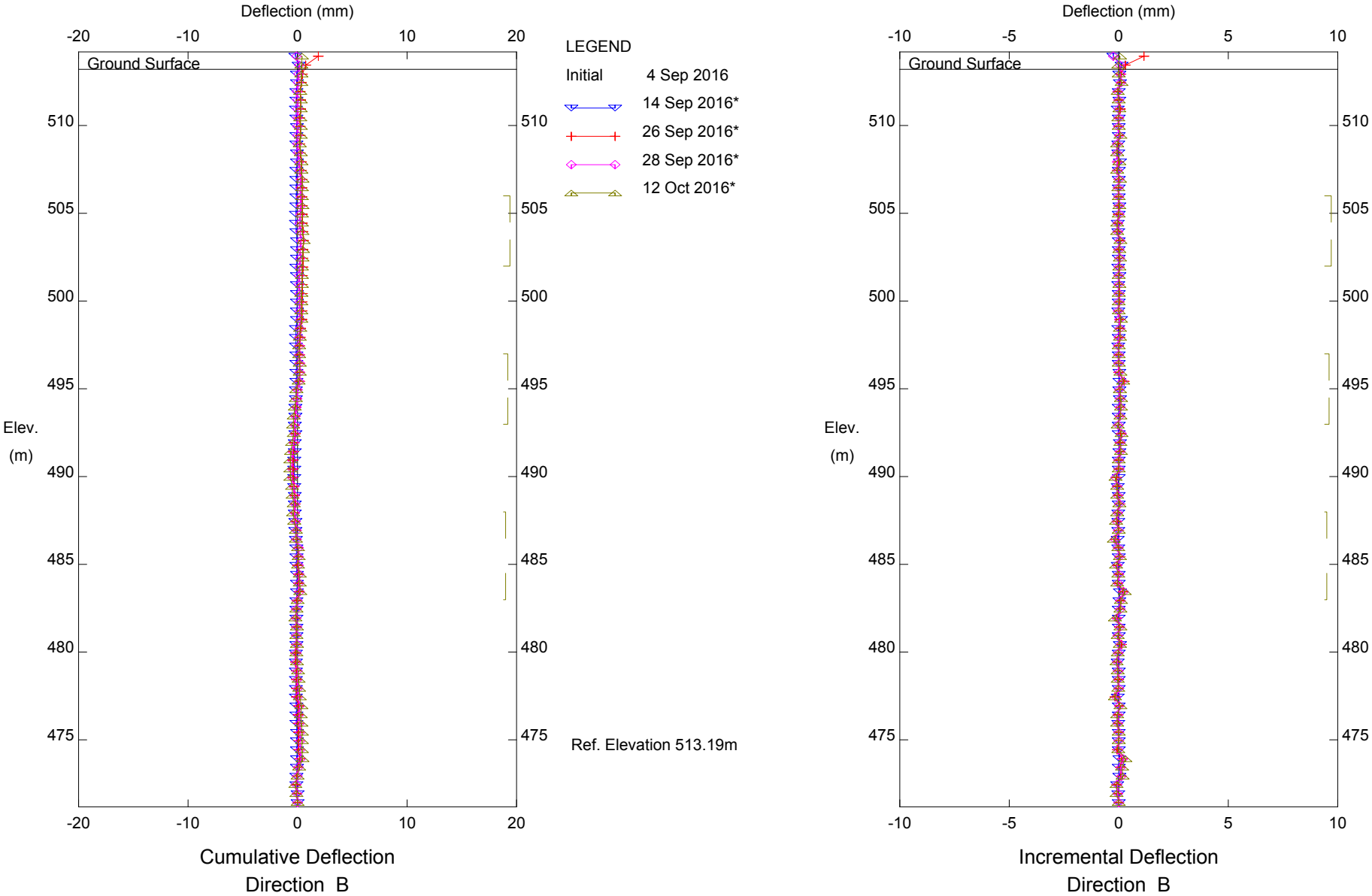
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH02_BIAS.GTL

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NSR-BH02

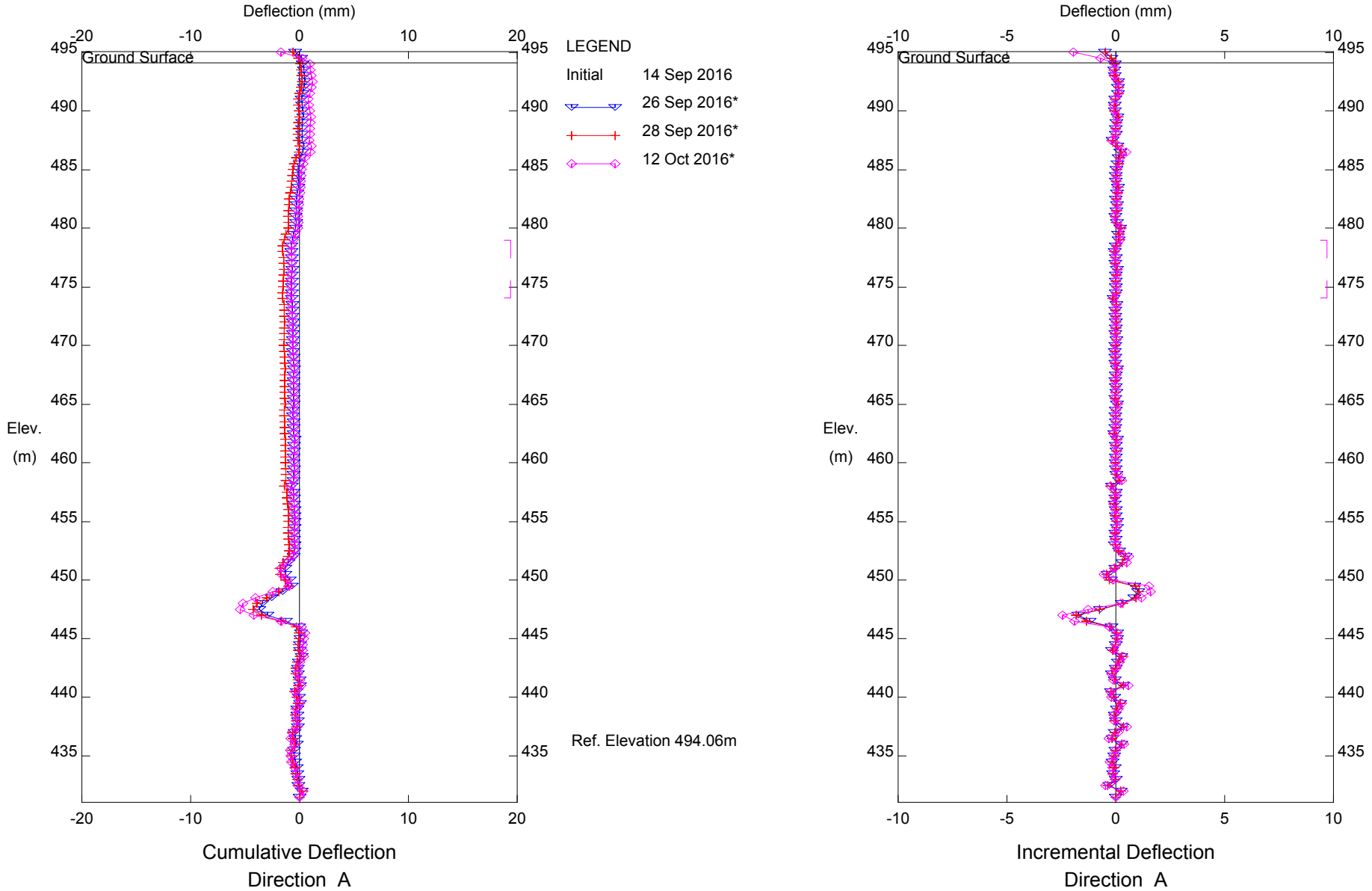
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH02_BIAS.GTL

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NSR-BH03

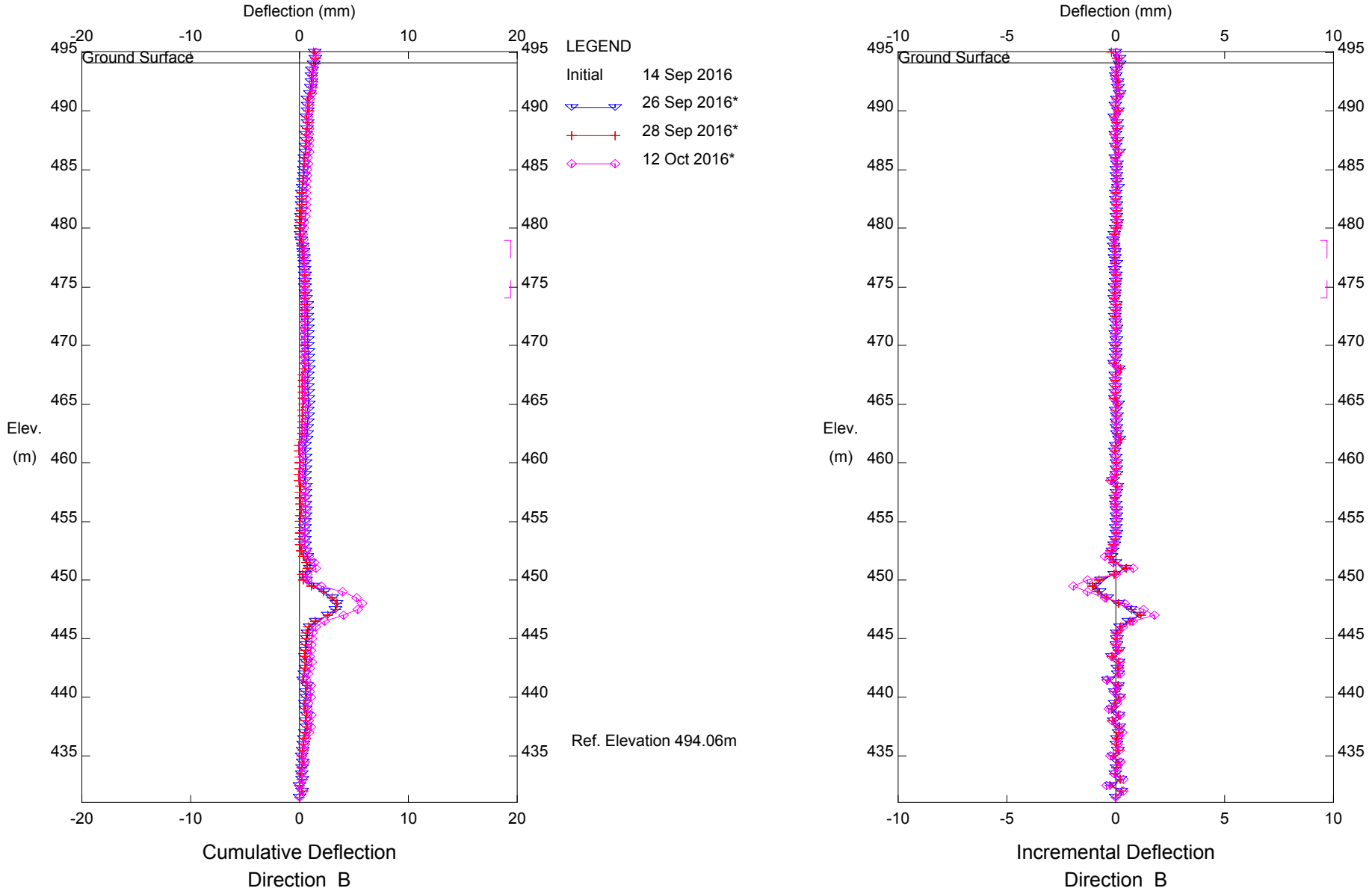
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH03_Rot_cor2.gtl

Stantec Consulting Ltd - Edmonton



SGS_PHASE 4, Inclinometer NSR-BH03

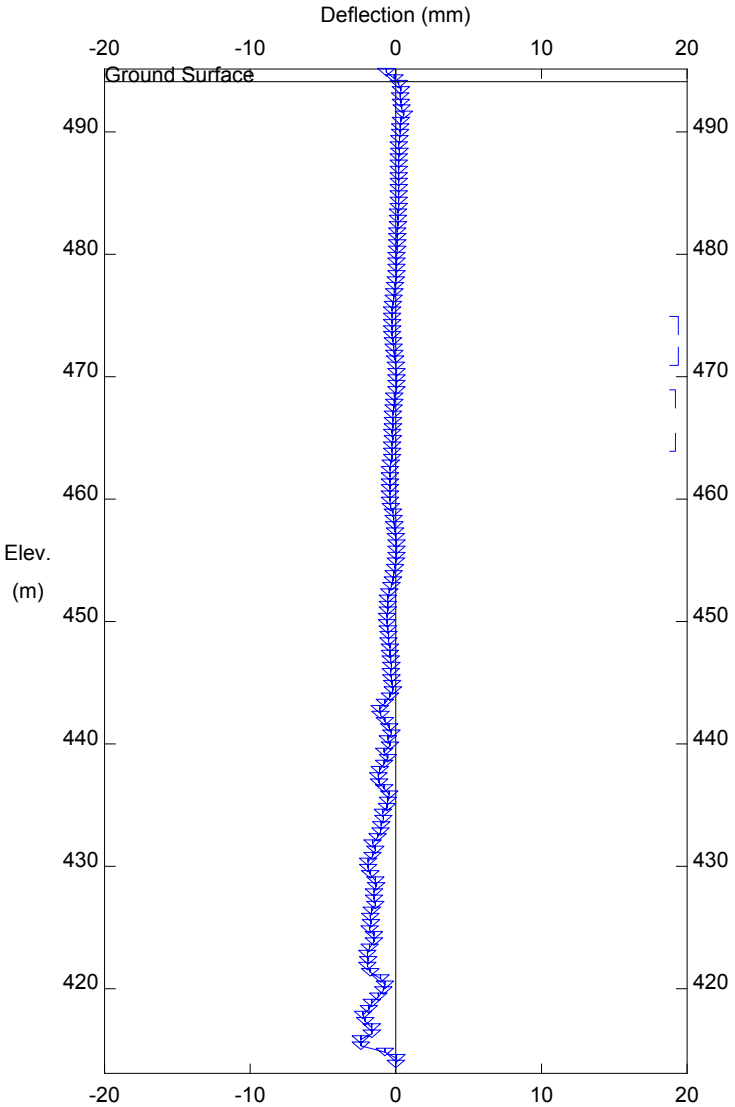
HUSKY ENERGY

LLOYDMINISTER, AB

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

NSR-BH03_Rot_cor2.gtl

Stantec Consulting Ltd - Edmonton



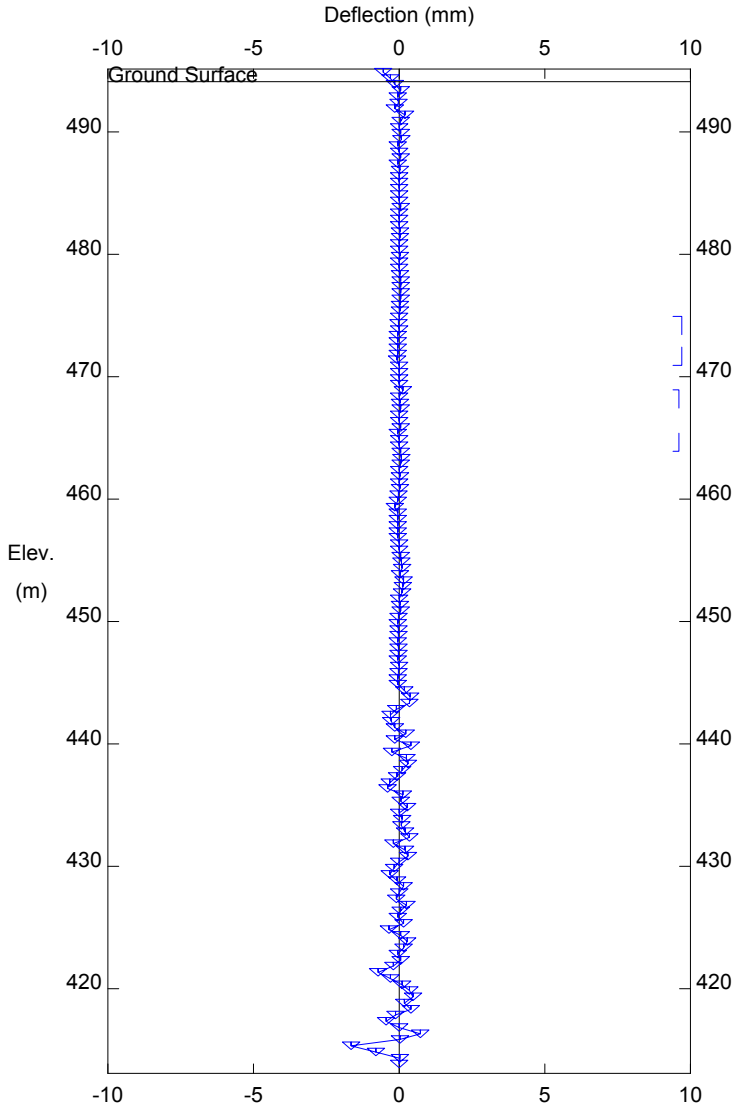
Cumulative Deflection
Direction B

LEGEND

Initial 27 Sep 2016

12 Oct 2016*

Ref. Elevation 494.1m



Incremental Deflection
Direction B

HUSKY_PHASE 4, Inclinometer NSR-BH04

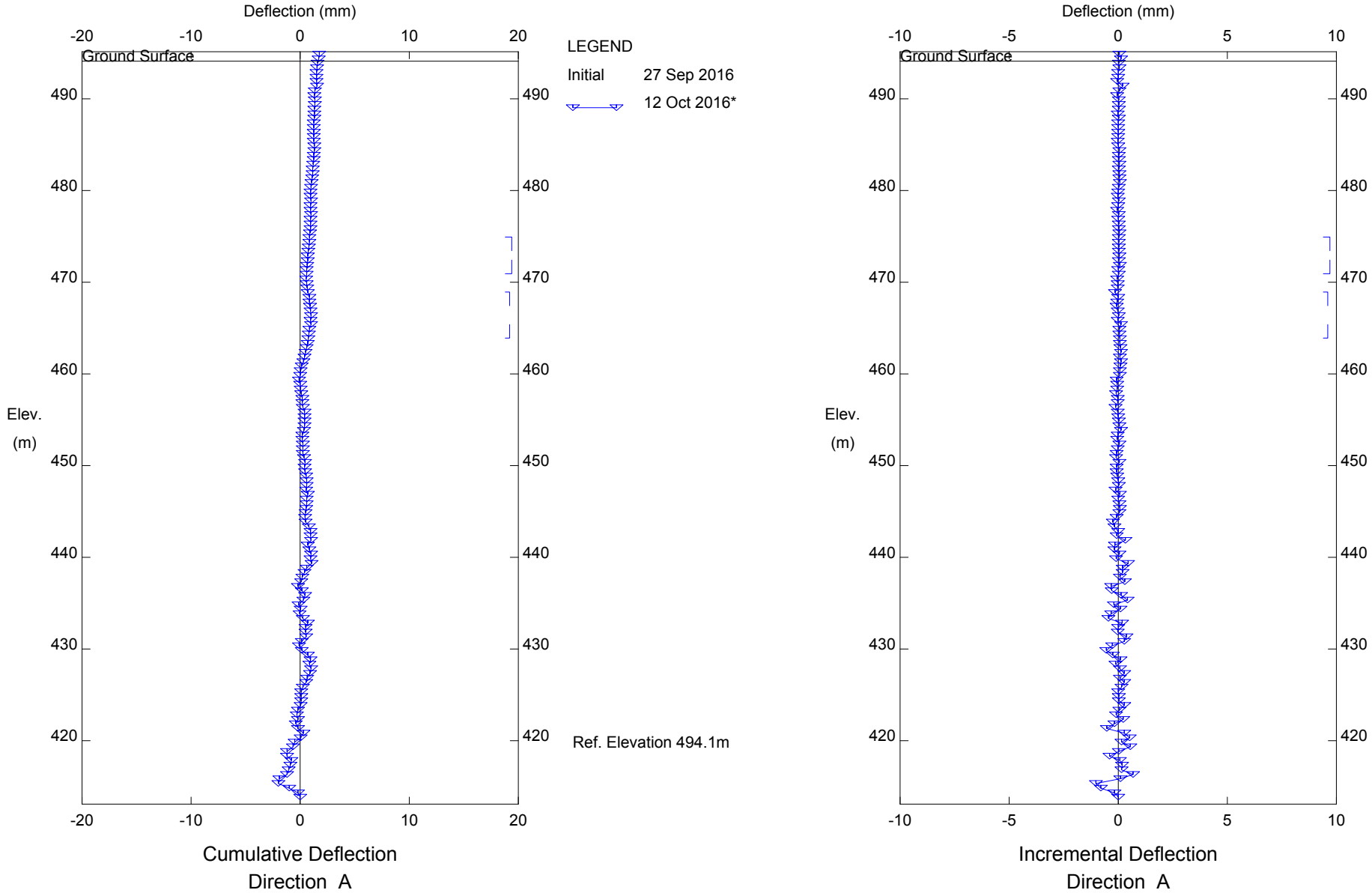
HUSKY SGS

LLOYDMINISTER, AB

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

NSR-BH04.cor.gtl

Stantec Consulting Ltd - Edmonton



HUSKY_PHASE 4, Inclinometer NSR-BH04

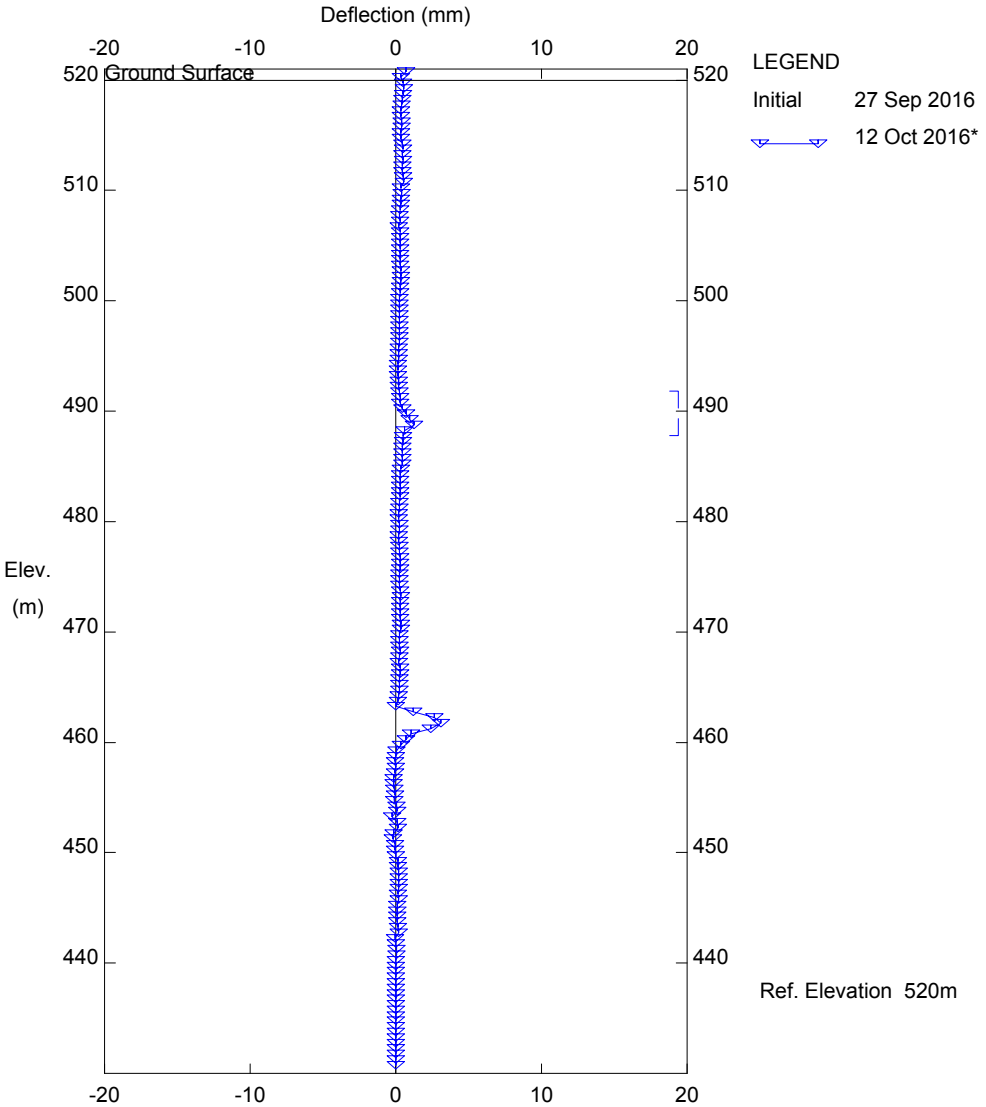
HUSKY SGS

LLOYDMINISTER, AB

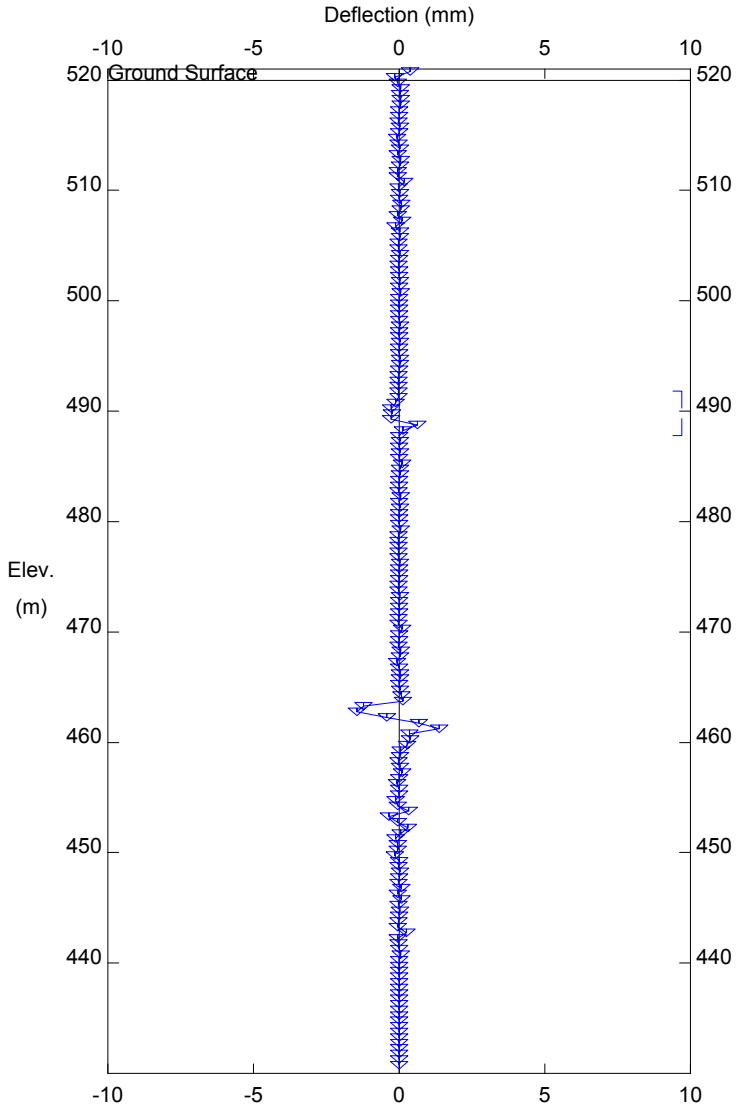
Sets marked * include zero shift and/or rotation corrections.

NSR-BH04.GTL

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction A



Incremental Deflection
Direction A

SGS PHASE 4, Inclinometer NL-BH41

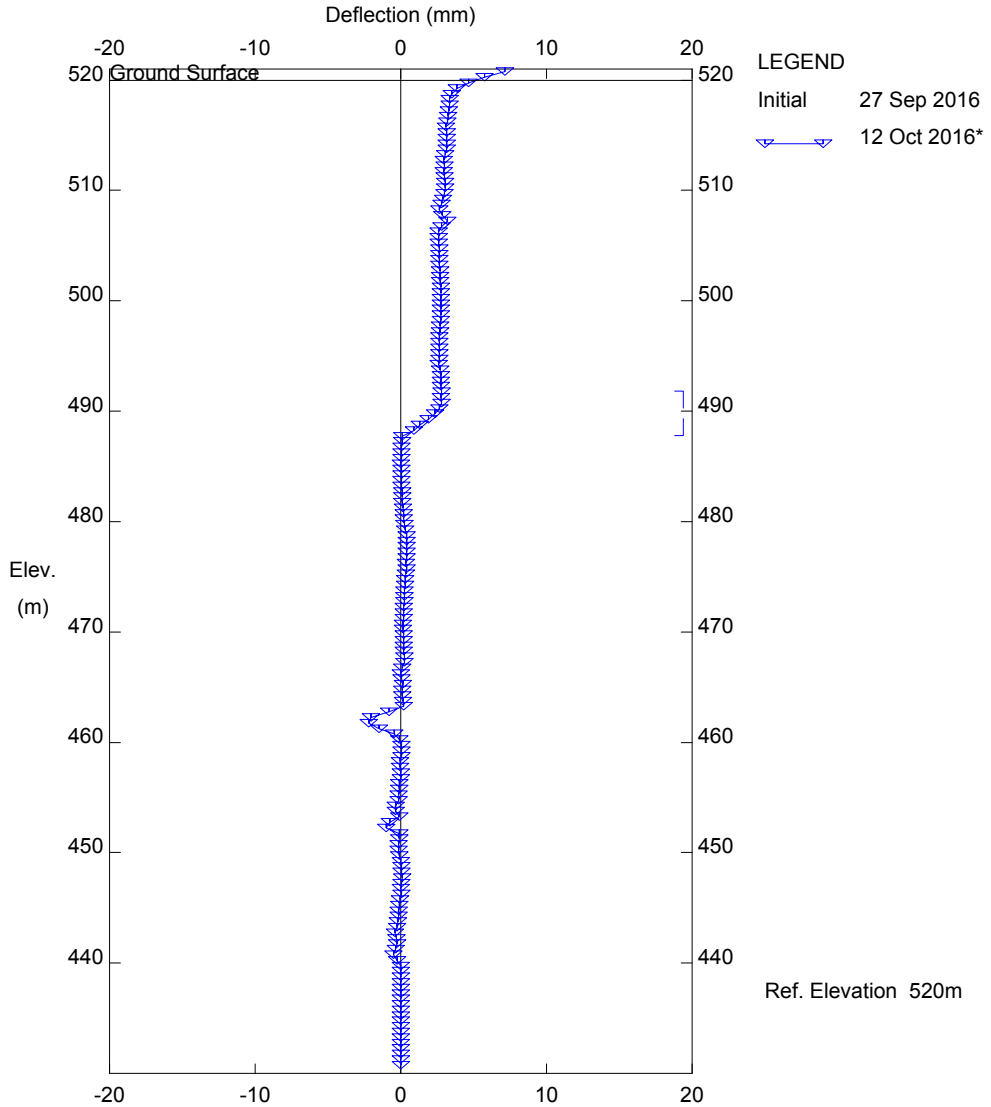
HUSKY ENERGY

LLOYDMINISTER, AB

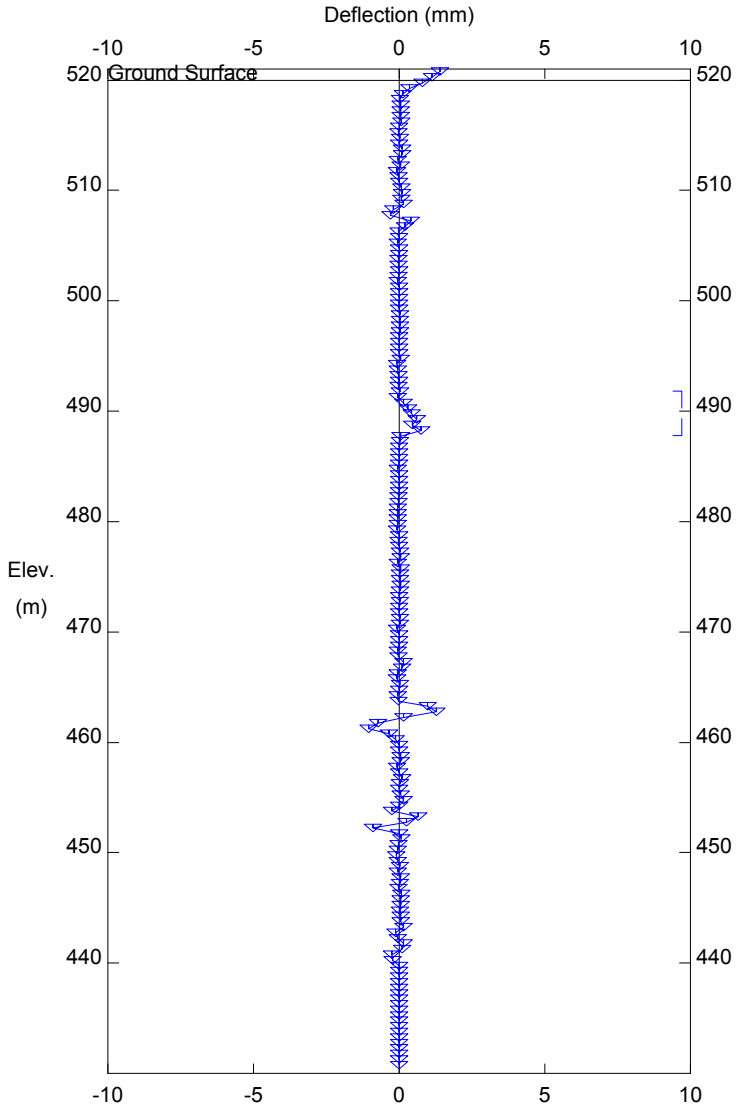
Sets marked * include zero shift and/or rotation corrections.

NL-BH41_cor.gtl

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction B



Incremental Deflection
Direction B

SGS PHASE 4, Inclinometer NL-BH41

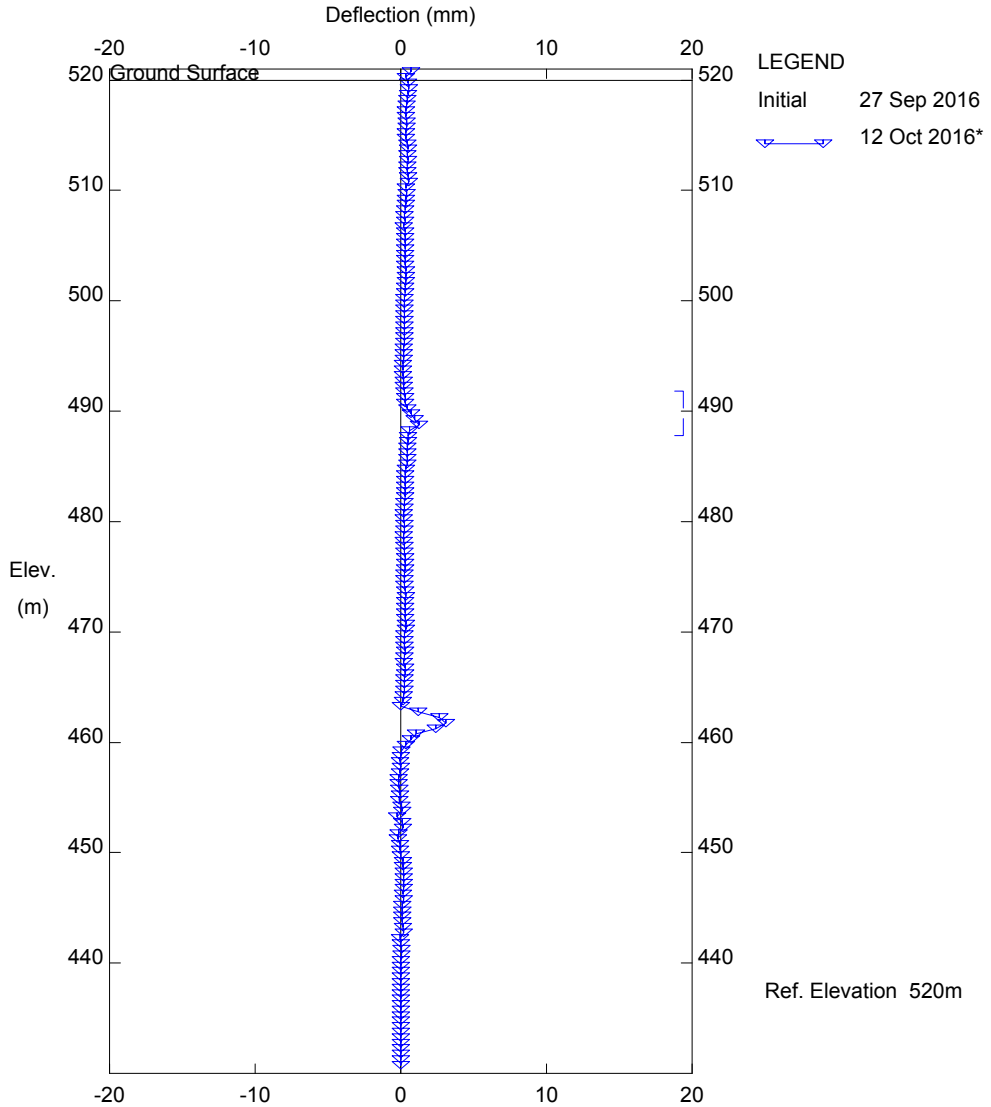
HUSKY ENERGY

LLOYDMINISTER, AB

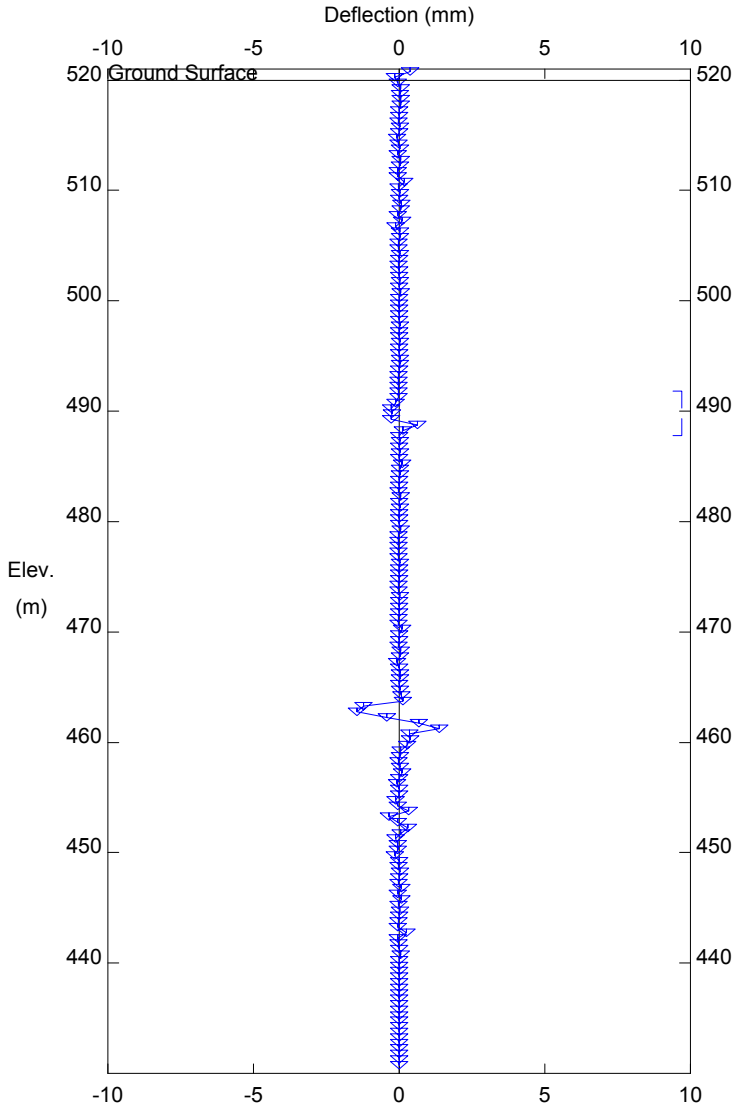
Sets marked * include zero shift and/or rotation corrections.

NL-BH41_cor.gtl

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction A



Incremental Deflection
Direction A

SGS PHASE 4, Inclinometer NL-BH41

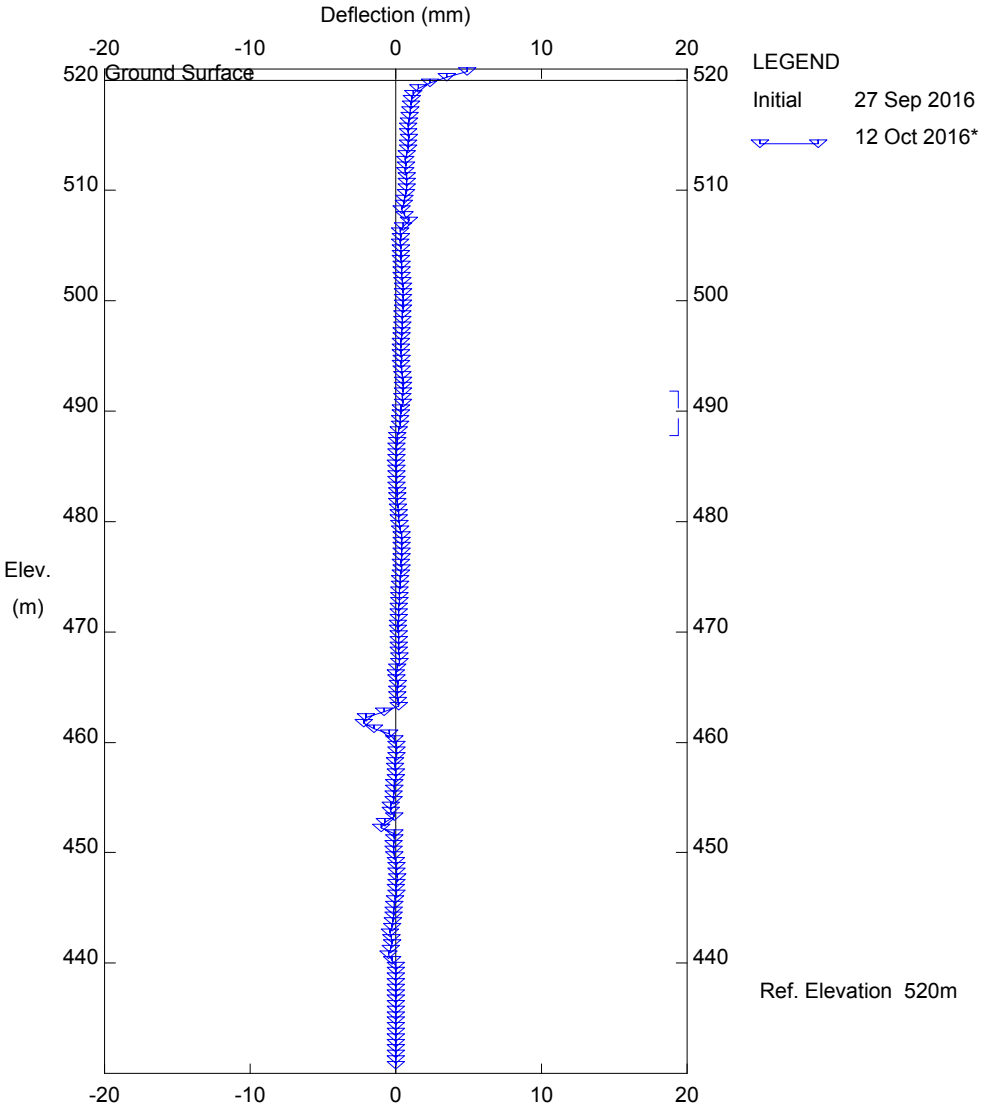
HUSKY ENERGY

LLOYDMINISTER, AB

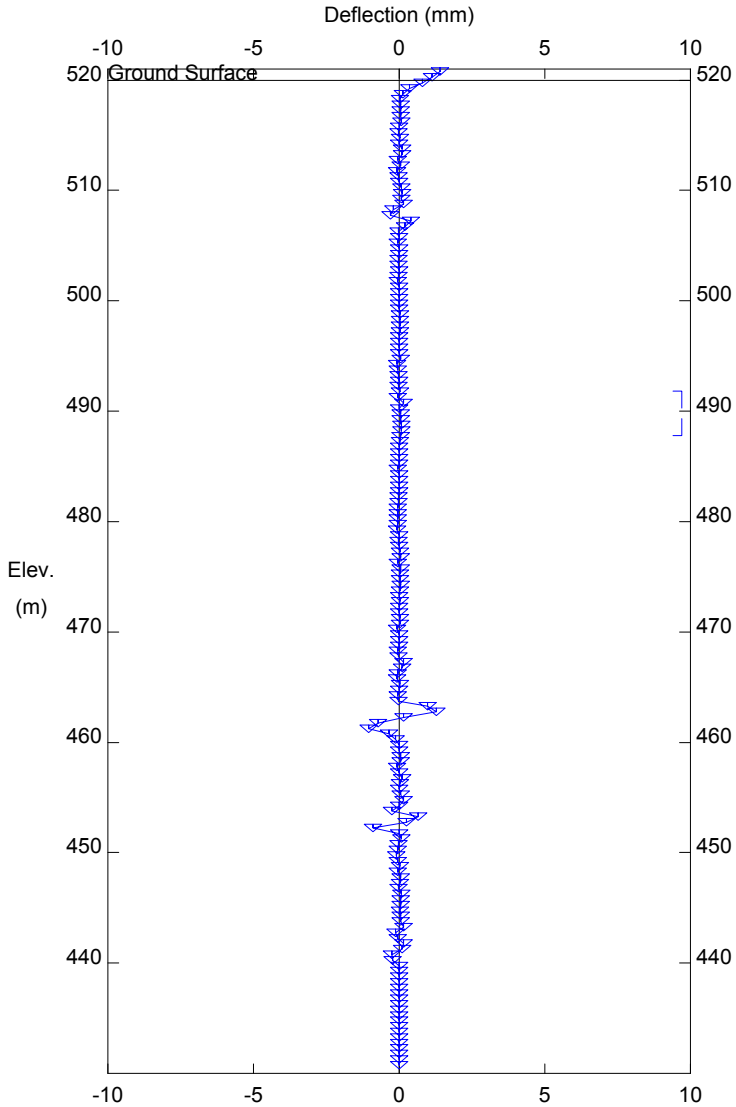
Sets marked * include zero shift and/or rotation corrections.

NL-BH41_ALT.GTL

Stantec Consulting Ltd - Edmonton



Cumulative Deflection
Direction B



Incremental Deflection
Direction B

SGS PHASE 4, Inclinometer NL-BH41

HUSKY ENERGY

LLOYDMINISTER, AB

Sets marked * include zero shift and/or rotation corrections.
Adjusted data set from elevation 490 m to 487 m

NL-BH41_ALT.GTL

Stantec

Vibrating Wire Piezometer Reading Summary Table

VW #	Installation Elev. (m)	Installation Depth (m)	August 31, 2016		September 04, 2016		September 15/16, 2016		September 26/27, 2016		October 12, 2016	
			Water Level (mbg)	Groundwater Elevation (m)	Water Level (mbg)	Groundwater Elevation (m)	Water Level (mbg)	Groundwater Elevation (m)	Water Level (mbg)	Groundwater Elevation (m)	Water Level (mbg)	Groundwater Elevation (m)
1	566.0	26.5	-	-	-	-	8.1	584.4	9.2	583.3	10.3	582.2
2	538.5	53.9	-	-	-	-	12.3	580.1	15.1	577.4	16.2	576.3
1	543.4	19.8	5.5	557.7	7.1	556.2	8.5	554.8	8.9	554.4	9.3	554.0
2	523.6	39.6	5.1	558.1	7.7	555.6	9.6	553.7	10.2	553.0	10.9	552.4
1	518.1	19.8	-	-	-	-	2.3	535.7	2.4	535.6	2.4	535.6
2	484.0	53.9	-	-	-	-	2.7	535.2	2.8	535.1	2.8	535.1
1	511.7	19.1	5.1	525.6	5.7	525.1	6.3	524.5	6.5	524.3	6.7	524.0
2	499.5	31.3	5.0	525.8	5.8	525.0	7.0	523.8	7.4	523.4	7.9	522.9
1	492.0	21.6			3.8	509.8	4.3	509.3	4.6	509.0	4.8	508.8
1	473.3	20.7	-	-	-	-	6.3	487.8	6.5	487.6	6.5	487.6
2	454.8	39.3	-	-	-	-	6.4	487.7	6.7	487.4	6.7	487.4
1	480.7	13.4	-	-	-	-	-	-	5.6	488.5	6.2	487.9
1	488.0	32.0	-	-	-	-	-	-	12.8	507.2	12.7	507.3