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GEOTECHNICAL INVESTIGATION AND SLOPE STABILITY STUDY EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SASKATCHEWAN PMEL FILE NO. 9551 AUGUST 31, 2015

PREPARED FOR:

TOWN OF OUTLOOK BOX 518 OUTLOOK, SASKATCHEWAN S0L 2N0

ATTENTION: MR. TRENT MICHELMAN

EXECUTIVE SUMMARY

P. Machibroda Engineering Ltd. (PMEL) was authorized by the Town of Outlook to complete a slope stability study for the East Bank of the South Saskatchewan River, proximate the Skytrail Bridge, in Outlook, Saskatchewan.

The existing East Bank of the South Saskatchewan River was a historical landslide and recent slope movement has been due to the reactivation of the historical landslide. The slope movement has damaged the Skytrail Bridge, residential homes and other infrastructure on the slope or near the crest of slope.

The primary cause that initiated the recent movement is difficult to determine due to the complexity of the slope. It is likely due to a combination of factors, including (but not limited too), erosion along the river (i.e., change of river flow), increase in groundwater level (i.e., irrigation, increase precipitation, etc.), and surcharge loading on slope and at crest of slope (i.e., fill placement, bridge piers, etc.).

A geotechnical investigation and instrumentation installation was carried out to determine the soil and groundwater conditions, location of shear plane, and rate of slope movement. The slope monitoring measured an active shear plane at a geodetic elevation of approximately 475 to 476 metres (approximately 60 metres below crest of slope and 20 meters below the river elevation). Slope movement of approximately 25 and 43 mm was measured between April, 2015 and August 2015 in SI 15-1 and SI 15-2 respectively.

Based on the investigation and monitoring it was theorized that the slope was at or slightly less than equilibrium. A number of remedial options were considered to increase the stability of the slope. Due to the size of the landslide and depth of the slip plane, lowering of the groundwater table was considered as the only feasible option for increasing the stability of the slope. Further investigation and analysis would be required to determine the feasibility of this remedial option. If efforts are not made to stabilize the slope, the slope movement will likely to continue and potentially regress further upslope of the crest of slope and impact properties and infrastructure. A comprehensive monitoring program is recommended to continue monitoring slope movement and provide the necessary information to stakeholders to make decisions regarding infrastructure and properties.

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1.0 INTRODUCTION

1.1 <u>General</u>

The following report has been prepared on the results of a geotechnical investigation and slope stability study conducted for the East Bank of the South Saskatchewan River, proximate the Skytrail Bridge, in Outlook, Saskatchewan.

Authorization to proceed with this investigation was provided on September 16, 2015 via the signed Consulting Agreement. The Terms of Reference for this investigation were presented in P. Machibroda Engineering Ltd. (PMEL) Proposal No. 0510-6655REV2, dated September 16, 2014.

The field test drilling and sampling were conducted between December 11 and 12, 2014, March 24 and 25, 2015, and April 6, 7 and 9, 2015. Groundwater level monitoring and slope inclinometer readings were conducted between January 23, 2015 and August 20, 2015.

1.2 Background Information

PMEL completed a slope stability study of the East Bank of the South Saskatchewan River within the area of the Skytrail Bridge in 2008 (refer to PMEL File No. S08-6559, report dated November 19, 2008. The purpose of the study was to assess the slope stability of the slope and quantify the risk to existing infrastructure.

The study theorized that the slope was meta-stable (i.e., at or near a Factory of Safety of 1.0) the probable failure mode was a deep seated composite surface. It was recommended that a slope inclinometer(s) be installed to accurately determine the elevation of the slip plane and determine the rate of lateral slope movement.

PMEL also completed a slope stability study in 1986/1987 as part of the geotechnical investigation for the existing swimming pool located immediately south of the Bridge (refer to PMEL File No. S87-1123, dated January 8, 1987). The study identified that the pool was located on a historical landslide that had marginally stabilized due to deposition of river alluvium. The report also noted that surficial slumping had occurred along the river banks and at the crest of slope (due to placement of fill on residential properties), and slight changes in the slope conditions could re-initiate slope movement.

1.3 <u>Visual Site Review</u>

Mr. Graham Baxter, P.Eng. of PMEL conducted a visual site inspection of the subject site on June 30, 2014. It was observed that there had been continual slope movement (as originally noted in PMEL's initial slope stability study) within the area of the Skytrail Bridge. Additional slope movement and instability (in the form of tension cracks and leaning trees) was observed along the crest of the slope to the north and south of the Skytrail Bridge. The Bridge had been damaged and closed to pedestrian traffic due to movement of the Bridge piers based on the slope.

Evidence of slope instability affecting properties along Tufts Crescent, in the form of tension cracking, leaning tress and downward movement of residential houses (resulting breakage of a sanitary sewer line of one property and differential downward movement of another), was also observed. It is suspected that the houses are within a secondary failure block that is developing.

2.0 FIELD INVESTIGATION

Four (4) test holes, located as shown on the Site Plan, Drawing No. 9551-1, were drilled using our powered auger equipment. Test Hole Nos. SI 14-1 and 14-1A were 150 mm in diameter, dry drilled using our truck-mounted continuous flight auger drilling equipment and extended to depths of 40.5 and 8.5 below existing ground surface, respectively. Test Hole Nos. SI 15-1 and SI 15-2 were 100 mm in diameter, drilled using our track-mounted air rotary drilling equipment and extended to depths of 61.5 and 67 metres below existing ground surface, respectively.

Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered.

Both disturbed and undisturbed samples were collected during test drilling. Disturbed samples of auger cuttings and drill cuttings, collected during test drilling, were sealed in plastic bags to minimize moisture loss. The soil samples were taken to our laboratory for analysis. Undisturbed soil samples were collected by hydraulically pushing a thin walled (Shelby) tube into the bottom of the test hole as drilling advanced. The Shelby tubes were sealed in polyethylene to minimize moisture loss.

A standpipe piezometer (slotted, 50 mm PVC pipe) was installed in Test Hole No. 14-1A, to monitor groundwater levels.

Slope inclinometer casing (85 mm diameter) was installed in Test Hole Nos. SI 14-1, SI 15-1 and SI 15-2 to monitor horizontal ground movement.

3.0 FIELD DRILL LOGS

The field drill logs recorded during test drilling have been shown plotted on Drawing Nos. 9551-2 to 5A, inclusive.

A survey of the subject site was completed by PMEL on July 9, 2015 using handheld Global Positioning Equipment (Trimble, Model No. GeoXH 6000).

3.1 <u>Soil Profile</u>

In general, the subgrade soil conditions consisted of a silt and/or sand deposit overlying glacial till followed by clay shale, which extended to a depth of at least 67 metres below existing grade, the maximum depth explored with our test holes at this site. A silt and sand deposit was encountered between the depths of approximately 49 and 64 metres below existing grade in Test Hole No. SI 15-2.

3.2 <u>Groundwater Conditions and Sloughing</u>

Groundwater seepage and sloughing conditions were encountered during test drilling. The depths at which groundwater seepage and sloughing conditions were encountered have been shown on the field drill logs, as shown on Drawing Nos. 9551-2 to 5E, inclusive. A summary of the groundwater levels recorded in the standpipe piezometers installed during this investigation and the 2008 investigation has been presented in Table I.

Test	Piezometer Rim	Ground Surface						
Hole No.	Elevation* (metres)	Elevation* (metres)	November 17, 2008	June 4, 2015	July 9, 2015	August 20, 2015		
08-1*	513.0	512.0	496.5	506.8	506.7	506.7		
08-4*	507.5	506.7	498.7	498.7	498.5	498.5		
14-1A	537.7	536.7		532.4	532.5	532.9		

 TABLE I.
 RECORDED GROUNDWATER LEVELS

*Piezometers installed in PMEL's 2008 investigation (S08-6559)

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Based on the results of the groundwater monitoring, the groundwater table was situated between approximately 3.8 to 7 metres below existing grade on August 20, 2015. Higher water levels should be expected during and/or following spring snowmelt and/or periods of precipitation.

A comparison of the 2008 and 2015 water levels recorded in Test Hole Nos. 08-1 and 08-4 revealed that the groundwater levels have remained unchanged in Test Hole No. 08-4. However, the groundwater levels have risen approximately 10 metres in the last 7 years in Test Hole No. 08-1.

3.3 <u>Cobblestones and Boulders</u>

The glacial till consisted of a heterogeneous mixture of gravel, sand, silt and clay-sized particles. A random distribution of larger particle sizes in the cobblestone range (60 to 200 mm) and boulder-sized range (larger than 200 mm) should be expected at the subject site.

It should be recognized that the statistical probability of encountering cobblestones and/or boulders in the four small diameter Test Holes conducted at this large site was low. Intertill deposits of cobblestones, boulders, boulder pavements and isolated deposits of saturated sand or gravel should be anticipated. The frequency of encountering such deposits will increase proportionately with the number of piles installed or volume of soil excavated.

3.4 <u>Slope Inclinometer Survey</u>

The results of the slope inclinometer readings have been shown plotted in Appendix B. The baseline slope inclinometer readings for Slope Inclinometer No. SI 14-1 was on January 23, 2015 and four (4) subsequent readings were conducted between April 29, 2015 and August 20, 2015. The baseline slope inclinometer readings for SI Nos. 15-1 and 15-2 were April 29, 2015, and three (3) subsequent readings were conducted between June 4, 2015 and August 20, 2015.

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The summarized cumulative displacement and incremental change of the slope indicator readings have been presented as "Profile Change" and "Tilt Change" on the slope inclinometer plots, respectively.

An examination of the SI 15-1 and 15-2 plots revealed that some slope movement (total cumulative displacement of approximately 25 mm and 43 mm, respectively) has occurred between April 29, 2015 and August 20, 2015. SI 15-1 has recorded approximately 25 mm of lateral movement in the northwest direction and SI 15-2 has recorded approximately 43 mm movement in the west - southwest direction. The plots revealed that the slip plane was located approximately 32 and 36.5 metres below existing grade (Geodetic Elevations of 475.7 and 476.5 metres) in SI 15-1 and 15-2 respectively.

An examination of the SI 14-1 plots revealed some slight movement recorded between January 23, 2015 and August 20, 2015. However, the magnitude of movement was nearly indiscernible and no clear slip plane was captured at this location. SI 14-1 may not have been installed deep enough to accurately capture a slip plane.

4.0 LABORATORY ANALYSIS

The soil classification and index tests performed during this investigation consisted of a visual classification of the soil, water contents, unconfined compressive strength, Atterberg limits, unit weight and direct shear strength testing.

The results of soil classification and index tests conducted on representative samples of soil recovered from this site have been plotted alongside the depth at which the samples were recovered as shown on Drawing Nos. 9551-2 to 5E, inclusive.

The results of the direct shear strength testing and grain size distribution analysis have been presented in Appendix C.

5.0 SLOPE STABILITY ANALYSIS

5.1 Possible Cause of Slope Movement

The East Bank of the South Saskatchewan River along the west side of the Town of Outlook was a historical landslide. The recent observed slope movement has been due to the reactivation of the historical landslide. The reasons for reactivation of the landslide are difficult to determine, due to the complexity of the slope and was likely a result of a number of different conditions impacting the slope. Conditions that could have impacted the stability of the slope include, but not limited to, erosion along the river, increase in groundwater conditions and urban development. Due to the size of the landslide and the marginal stability of the slope, as noted in the past, slight changes in the slope conditions can re-initiate slope movement.

Based on historical aerial photographs, the flow of the South Saskatchewan River has changed significantly since 1949. Sometime between 1960 and 1965 a dyke (extended sometime after 1970) was constructed upstream of the west bridge abutment of the Skytrail Bridge. The dyke extends approximately 350 metres perpendicular across the river from the west bank. Since the construction of the dyke the river flow has narrowed against the east bank of the river likely causing some erosion of the river bank and removal of alluvium deposits in the bed of the river. This unloading of material at the toe of the slope would have negatively impacted the stability of the slope, however the magnitude of erosion and its impact is difficult to quantify.

A rise of the groundwater level in the slope would negatively impact the stability of the slope. Fluctuations in the groundwater level are typically attributed to climate changes (i.e., increase or decrease in precipitation and snowmelt), urban development (i.e., irrigation) and changes in upland land use.

A comparison of the water levels in the 2008 piezometers revealed no change in the groundwater level of Test Hole 08-4, but a significant rise (10 metres) was noted in Test Hole 08-1 since 2008. No monitoring of the piezometers was conducted between 2008 and 2015. As such, it is difficult to establish trends in the groundwater conditions in the slope.

The construction of residential lots and roadways, bridges and utilities, on and at the crest of the slope could impact the stability of the slope. This type of development affects slope stability by, but not limited to, altering drainage paths, groundwater discharge or recharge, removal of vegetation (affects infiltration rate of surface water into the soil) and site grading (adding fill to crest of slope or removal of soil from toe of slope).

5.2 <u>Theoretical Slope Stability Analysis</u>

The theoretical slope stability analysis was performed using the SLOPE/W computer program available through Geo-Slope International Ltd.¹ The Morgenstern-Price Method of slices was used for all analysis (utilizing a half-sine side force function).

5.2.1 <u>Surface Geometry</u>

The surface geometry of the subject site was interpreted from elevation locations surveyed by PMEL on July 9, 2015 using handheld Global Positioning Equipment (Trimble, Model No. GeoXH 6000).

The slope was approximately 45 metres in height with an average slope gradient of approximately 5 to 7 degrees.

¹ Geo-Slope International Ltd., 2007. Slope/W User's Manual, A Comprehensive Program for Slope Stability Analysis, Geo-Slope International Ltd., Calgary, Alberta.

5.2.2 Soil Stratigraphy

The stratigraphic units as well as the lithologic boundaries were interpreted based on the results of the drilling investigations conducted by PMEL. The slope was analyzed for circular and composite failures.

5.2.3 <u>Piezometric Conditions</u>

The piezometric conditions used for the slope stability analysis were inferred from the groundwater levels recorded during this investigation. A hydrostatic pore pressure condition was used for the analysis.

It should be noted that the inferred groundwater conditions in the slope analysis was simplified and may not reflect actual conditions. The modelled groundwater conditions assumed one groundwater level impacting the entire soil profile.

5.2.4 Soil Properties

The soil properties obtained during this investigation as well as the design strength parameters used for the theoretical slope stability analysis have been presented in Table II. The soil strength parameters selected for analysis were based on published strength parameters, laboratory testing on soil samples collected during this investigation and a back analysis of the historical slope failure (see Section 5.3).

Material Type	Total Unit Weight (kN/m ³)	Effective Unit Cohesion (kPa)	Effective Internal Angle of Friction (Degrees)
Silt/Sand	18.5	0	30
Glacial Till	21.5	25	25
Clay Shale	18.5	25	25
Residual Clay Shale*	18.5	0	6
Bedrock - Impenetrable			

TABLE II.SOIL PARAMETERS FOR ANALYSIS

5.3 Back Analysis

The Factor of Safety of a slope is defined as the ratio of the available shear strength of the soil, to the minimum shear strength required to maintain stability. A Factor of Safety of less than or equal to 1.0 would indicate the potential for slope failure.

Based on the size of the landslide and measured movement of the slope, it is assumed that the slope is at or slightly less than equilibrium (active creep movement), indicated by a Factor of Safety of 1 or slightly less. A back analysis of the slope was performed to assess the soil strength properties of the soil in order to assess the feasibility of possible stabilization (remedial) methods. It was assumed that the clay shale along the shear plane was at or near residual shear strength. The depth and thickness of the shear plane was interpreted from the SI readings in SI 15-1 and 15-2.

Based on the back analysis, the slope at Section A-A' (Skytrail Bridge) and Section B-B' (Truft Crescent) had Factors of Safety of slightly less than 1.0 and 0.9, respectively. This indicates that the slope is at slightly less than equilibrium. The results of the back analysis have been shown on Drawing Nos. D-1 and D-2.

5.4 <u>Remedial Options</u>

A number of conceptual remedial options were considered to stabilize the slope, these included, slope flattening, lowering the groundwater table, shear key, toe loading (i.e., buttress), erosion control (i.e., river bank armouring) and shear zone reinforcement (i.e., shear piles).

Due to the size of the landslide and depth of the slip plane, slope flattening, construction of a shear key, placement of a buttress, and/or shear zone reinforcement are not considered feasible or possible options to stabilize the slope (both from an economic or constructability standpoint). Lowering the groundwater table, via the installation of sub-horizontal drains, could be a feasible option for increasing the slope stability. Erosion control (i.e., river bank armouring) would likely not be sufficient to increasing stability of the slope, but should be considered to prevent further erosion along the river embankment. As further erosion would change the conditions of the slope and lower the probability, of any remedial option, in stabilizing the slope.

To analyze the effectiveness of lowering the groundwater in improving the Factor of Safety of the slope, Stratigraphic Section A-A' and B-B' were both modelled by lowering the water table 20 metres below the measured groundwater level at the crest of slope. The 20 metre drop in the groundwater elevation was based on a reasonable drop using a passive drainage system (i.e., gravity drained). Based on the analyses, the Factor of Safety of the slope would increase from 1.0 to 1.2 (a 20% increase).

Factors of Safety of 1.3 to 1.5 are typically acceptable Factors of Safety for the long-term stabilization of a slope. A Factor of Safety of 1.5 is typically recommended for permanent buildings such as houses. As such, lowering the groundwater to a reasonable level may not increase the Factor of Safety of the slope to a typical acceptable level. However, considering the size of the slope, a Factor of Safety of 1.2 could be sufficient in minimizing further slope movement enough to extend the service life of existing structures and utilities on the slope. Additionally it may also lessen the risk of the landslide regressing further upland and potentially damaging further properties and infrastructure.

An alternative to stabilization is the "do nothing" approach. Based on the stability analysis, the slope will continue to move. There is a high probability the slope movement may regress upslope and further impact properties and infrastructure. If no stabilization option is implement it is highly recommended that a comprehensive slope monitoring program is implement. The purpose of the monitoring program would be to regularly monitor movement of the slope via the slope inclinometers (more would be need to be installed) and survey monuments installed across the slope and on existing infrastructure. This will provide the necessary information to stakeholders to make decisions on infrastructure and properties (i.e., repairs to accommodate movement or location of new infrastructure).

5.5 Further Investigation and Analysis

A full year of readings of the slope inclinometers is recommended to establish the yearly movement rate of the slope at the location of the inclinometers. A deeper inclinometer is recommended at the crest of slope near Tuft Crescent.

Further recommendations have been summarized below for determining the feasibility of the above described dewatering remedial option, and what further instrumentation may be required to implement a long-term monitoring program.

5.5.1 <u>Dewatering Remedial Option</u>

The following further investigation, instrumentation and analysis are recommended to determine the feasibility of the recommended remedial option.

Installation of nested piezometers within the vicinity of the areas proposed to be stabilized. At a minimum one set at the crest of slope and one set mid-slope. Nested piezometers are monitoring wells that are installed at different depths at one location. The purpose of the nested piezometers is to determine if the groundwater conditions differ through the soil profile (i.e., perched conditions, confined aquifer, recharge area, etc.) and to perform slug tests to estimate the hydraulic conductivity of the soil profile. Slug tests consist of pumping the groundwater water level down in the piezometer and measuring the recovery rate to estimate the rate at which water moves through the soil profile.

Based on the results of the slug tests, a groundwater seepage analysis would be completed to determine the most feasible dewatering design.

PMEL can provide a detailed scope of work and budget cost estimate, for the above recommendations upon request.

5.5.2 Long-Term Monitoring Program

If a long-term monitoring program is implemented the following installation of instrumentation is recommended.

- Slope inclinometers (with vibrating water piezometers) at different locations on the slope to monitor the rate of slope movement;
- Survey monuments/settlement plates near and on existing infrastructure to measure vertical and horizontal movement; and
- Tilt plates and/or crack meters on existing infrastructure.

The extent and amount of instrumentation required will be dependent on the size of the area and type of infrastructure that would be encompassed in the monitoring program. PMEL can provide a scope of work and budget cost estimate upon request.

6.0 LIMITATIONS

The presentation of the summary of the field drill logs, geotechnical investigation and slope stability analysis has been completed as authorized. Four, 100/150 mm diameter test holes were completed at this site. A field drill log was compiled for each Test Hole during test drilling which, we believe, was representative of the subsurface conditions at the Test Hole locations at the time of test drilling.

Variations in the subsurface conditions from that shown on the drill logs at locations other than the exact Test Hole locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

No detectable evidence (odor or staining) of environmentally sensitive materials was detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep test holes. Instrumentation was installed in each test hole and the hole annulus was backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

This report has been prepared for the exclusive use of Town of Outlook and their agents for specific application to the slope stability study conducted for the East Bank of the South Saskatchewan River, proximate the Skytrail Bridge, in Outlook, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Party. Governing Agencies such as municipal, provincial, or federal agencies having jurisdictions with respect to this development and/or construction of the facilities described herein have full jurisdiction with respect to the described development. Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

The acceptance of responsibility for the design/construction recommendations presented in this report are contingent on adequate and/or full time inspection (as required, based on site conditions at the time of construction) by a representative of the Geotechnical Consultant. P. Machibroda Engineering Ltd. (PMEL) will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfills your requirements for this project. Should you require additional information, please contact us.

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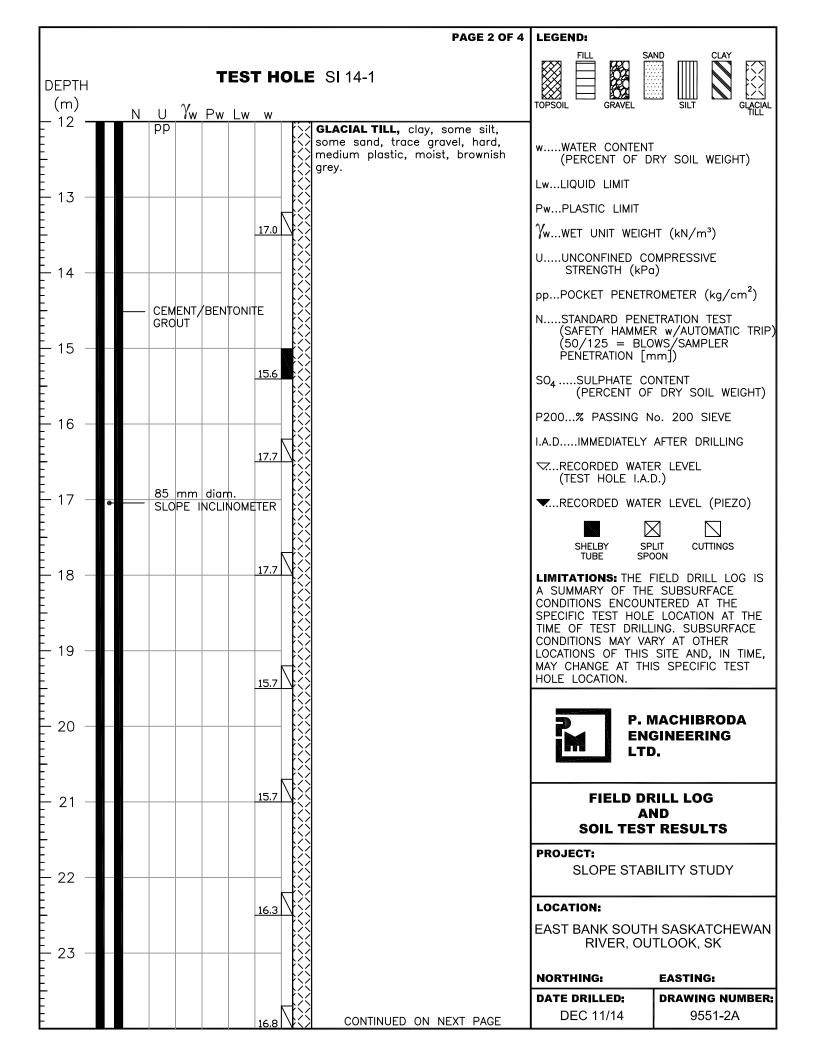
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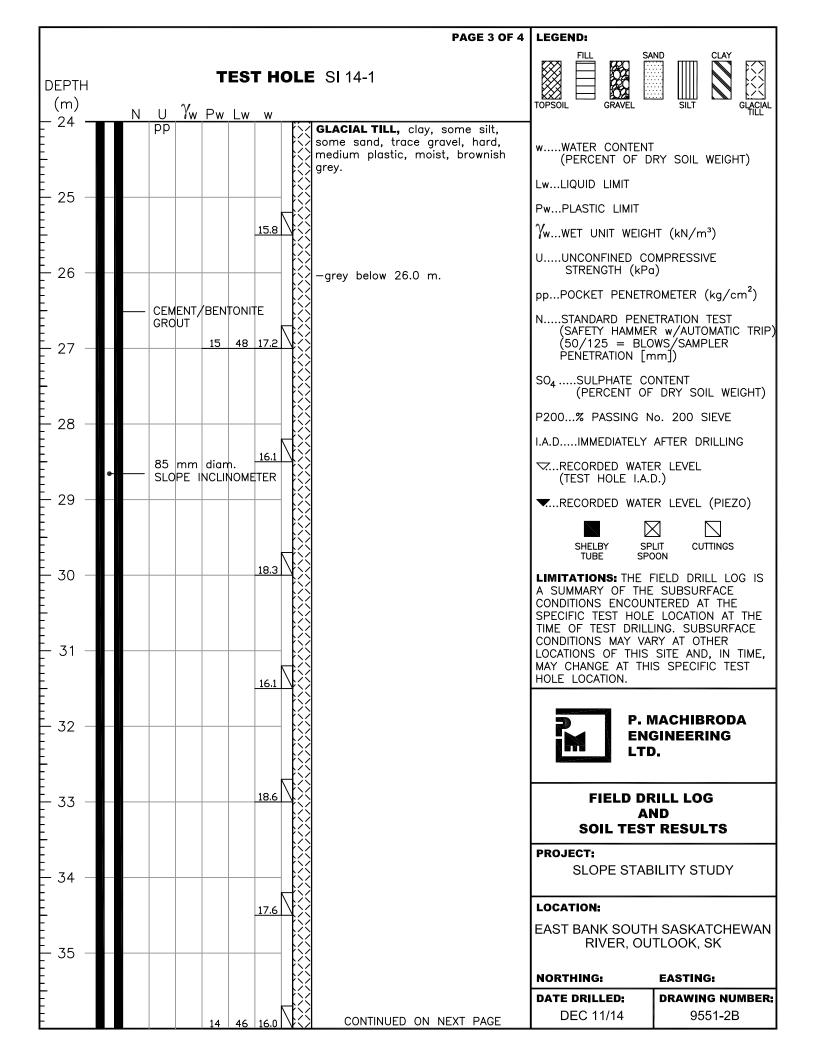


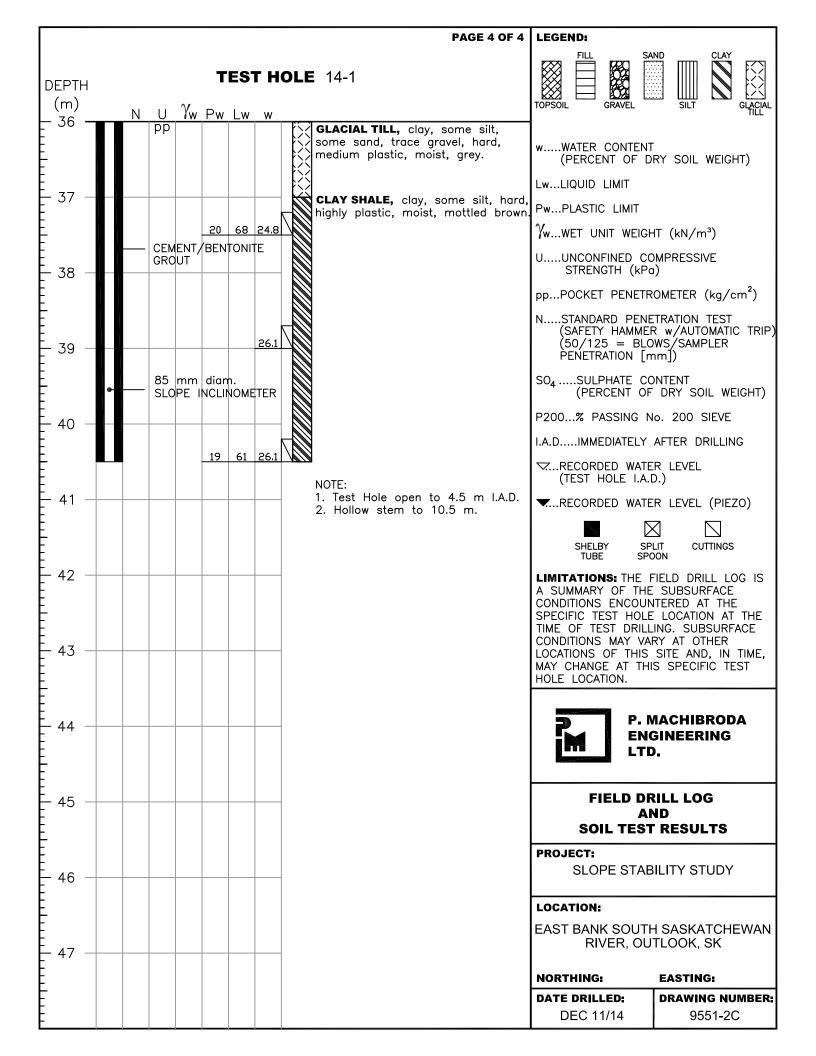


DRAWING TITLE.									
SITE PLAN - TEST HOLE LOCATIONS									
PROJECT: SLOPE STABILITY STUDY - EAST BANK SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK									
APPROVED BY:	DRAWN BY:								
GB	TP								
DATE: JULY, 2015	DRAWING NUMBER:								
SCALE: AS SHOWN	9551-1								

					ER. I	ELEV	.= 5	37.7	m PAGE 1 OF 4	LEGEND:	
DEPTH (m)		TEST HOLE SI 14-1							TOPSOIL GRAVEL		
			<u> q</u>	<u>* vv</u>	<u>1 vv</u>				EV: 536.7 m TOPSOIL, organic, moist, brownish black, rootlets. SILT, some clay, stiff, low plastic, moist, brown.	wWATER CONTENT (PERCENT OF D LwLIQUID LIMIT	RY SOIL WEIGHT)
							13.9	Z X X	GLACIAL TILL, clay, some silt, some sand, trace gravel, very stiff, medium plastic, moist, brown.	PwPLASTIC LIMIT γwwet Unit weigh UUnconfined co STRENGTH (kPG	MPRESSIVE
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8 — 							<u>12.1</u> 21.8		SAND, loose, poorly graded, fine to medium grained, wet, brown, seepage, sloughing.		/ACHIBRODA GINEERING).
							<u>16.4</u>		GLACIAL TILL, clay, some silt, some sand, trace gravel, very stiff, medium plastic, moist, brownish grey. —oxide staining 8.7 m to 37.0 m.	AI	RILL LOG ND ' RESULTS
- - - - - -							16.0			PROJECT: SLOPE STAE	SILITY STUDY
- - - - - - - - - - - - - - - - - - -							16.3			EAST BANK SOUTH RIVER, OU	H SASKATCHEWAN TLOOK, SK
					14	43	17.8		-hard below 12.0 m. CONTINUED ON NEXT PAGE	NORTHING: DATE DRILLED: DEC 11/14	EASTING: DRAWING NUMBER: 9551-2

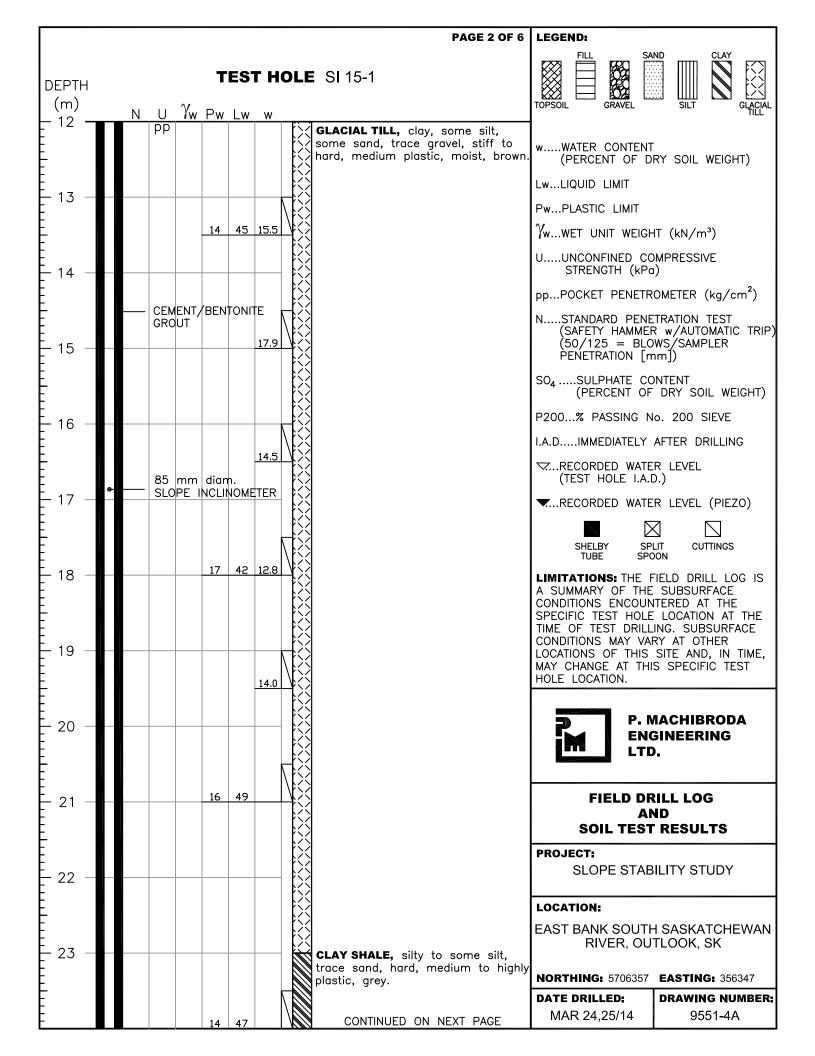




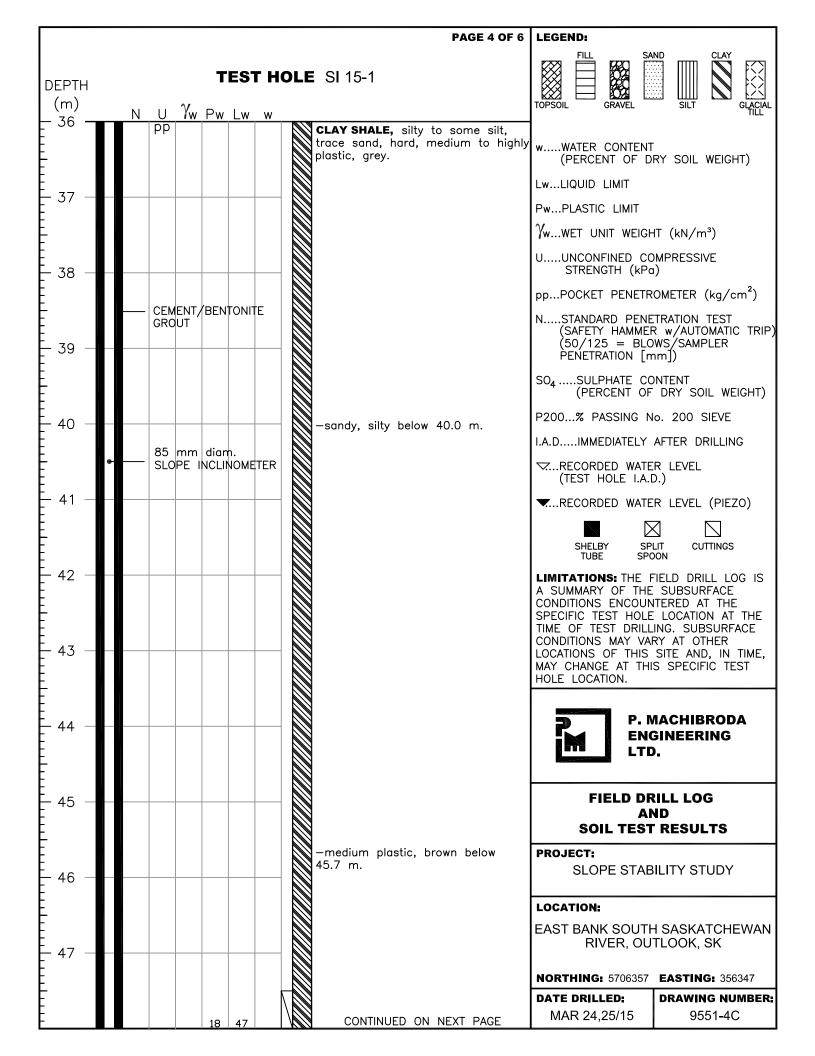


		ZO. EL	EV.=	537.7	'n			LEGEND:	
DEPTH (m)			T v Pw				14-1A EV: 536.7 m	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
	ŀ	ор ВЕNТОГ					TOPSOIL, organic, moist, brownish black, rootlets. SILT, some clay, stiff, low plastic, moist, brown.	wWATER CONTEN (PERCENT OF D LwLIQUID LIMIT	r RY SOIL WEIGHT)
2		CUTTIN	25				GLACIAL TILL, clay, some silt, some sand, trace gravel, very stiff, medium plastic, moist, brown. —oxide staining 1.6 m to 8.0 m.	PwPLASTIC LIMIT γwwet unit weigi UUnconfined co STRENGTH (kPo ppPOCKET PENETF	DMPRESSIVE
3						XXXXXXXX		(50/125 = BLC PENETRATION [r SO₄SULPHATE CC	R w/AUTOMATIC TRIP) DWS/SAMPLER nm])
4	532.9 m AUG 20/	15					-very stiff below 4.0 m.	P200% PASSING N I.A.DIMMEDIATELY	Io. 200 SIEVE AFTER DRILLING TR LEVEL
5		50 mr SCH 4 RIVER	0 PVC			XXXXXXXX		SHELBY SF	·
6								LIMITATIONS: THE A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS MAY CHANGE AT TH HOLE LOCATION.	E SUBSURFACE ITERED AT THE E LOCATION AT THE ING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,
8	N	50 mn MACHIN SCH 4	IE SLO	OTTED			SAND, loose, poorly graded, fine to medium grained, wet, brown, seepage, sloughing.		MACHIBRODA GINEERING).
9		SCREEI SAND ANNUL	N PACKE						RILL LOG ND F RESULTS
- - 10							NOTE: 1. Test Hole sloughed to 7.6 m I.A.D.		BILITY STUDY
- - - 11									H SASKATCHEWAN TLOOK, SK EASTING:
								DEC 11/14	DRAWING NUMBER: 9551-3

		INCLINOMETER ELEV.= 507.7 m PAGE 1 OF 6						LEGEND:			
DEPTH (m)			JADB				T HO		E SI 15-1 EV: 506.7 m	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
			pp						SAND, silty, trace gravel, loose to compact, well graded, fine to coarse grained, moist, brown.	wWATER CONTENT (PERCENT OF D LwLIQUID LIMIT	RY SOIL WEIGHT)
							8.4			PwPLASTIC LIMIT YwWET UNIT WEIGH UUNCONFINED CO	
- 2 -			CEN		/BEN	TONI				STRENGTH (kPc	1)
- - - 3 -			GRC				9.7			NSTANDARD PENE (SAFETY HAMMEI (50/125 = BLC PENETRATION [n	R w/AUTOMATIC TRIP) WS/SAMPLER
										SO ₄ SULPHATE CO (PERCENT OF P200% PASSING N	DRY SOIL WEIGHT)
			85	mm	diar	n.	6.5			I.A.DIMMEDIATELY	AFTER DRILLING
E E 5 — E	G-		SLC	PE	INCLII	NOME	TER			(TEST HOLE I.A.I	D.)
	6-				diar INCLII		TER	$\overline{\left\langle \begin{array}{c} \\ \\ \\ \\ \end{array} \right\rangle}$		TUBE SPO	LIT CUTTINGS DON
- 6									GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to hard, medium plastic, moist, brown	LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER
							13.2			MAY CHANGE AT THI HOLE LOCATION.	
- 8 – 											/ACHIBRODA GINEERING).
- - - -							8.9				RILL LOG ND ' RESULTS
E E 10 -										PROJECT: SLOPE STAE	SILITY STUDY
<u>-</u> - - 11 –							12.1				H SASKATCHEWAN TLOOK, SK
Ē								K		NORTHING: 5706357	EASTING: 356347
Ē							13.6		CONTINUED ON NEXT PAGE	DATE DRILLED: MAR 24,25/15	DRAWING NUMBER: 9551-4



	PAGE 3 OF 6	LEGEND:	
DEPTH (m)	TEST HOLE SI 15-1 N U Ýw Pw Lw w	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
24 –	PP trace sand, hard, medium to highly plastic, grey.	wWATER CONTENT (PERCENT OF D	Ry soil weight)
- 25 -		LwLIQUID LIMIT	
		PwPLASTIC LIMIT	
-		WwWET UNIT WEIGH	IT (kN/m³)
E - 26 -		UUNCONFINED CO STRENGTH (kPc	DMPRESSIVE
		ppPOCKET PENETR	OMETER (kg/cm²)
27 —	CEMENT/BENTONITE GROUT	NSTANDARD PENE (SAFETY HAMME) (50/125 = BLC PENETRATION [n	R w/AUTOMATIC TRIP) WS/SAMPLER
		SO ₄ SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
- - 28 -		P200% PASSING N	o. 200 SIEVE
	85 mm diam.	I.A.DIMMEDIATELY	AFTER DRILLING
	SLOPE INCLINOMETER	CRECORDED WATE (TEST HOLE I.A.I	R LEVEL D.)
- 29 -		RECORDED WATE	R LEVEL (PIEZO)
- 30 - 		LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER
		MAY CHANGE AT THI HOLE LOCATION.	
- 32 -			ACHIBRODA GINEERING).
		FIELD DF	
— 33 —	18 39	AI	ND RESULTS
- - 34 -		PROJECT: SLOPE STAE	ILITY STUDY
- - - - 35 —			H SASKATCHEWAN TLOOK, SK
		NORTHING: 5706357	EASTING: 356347
Ē		DATE DRILLED:	DRAWING NUMBER:
Ę	CONTINUED ON NEXT PAGE	MAR 24,25/15	9551 - 4B

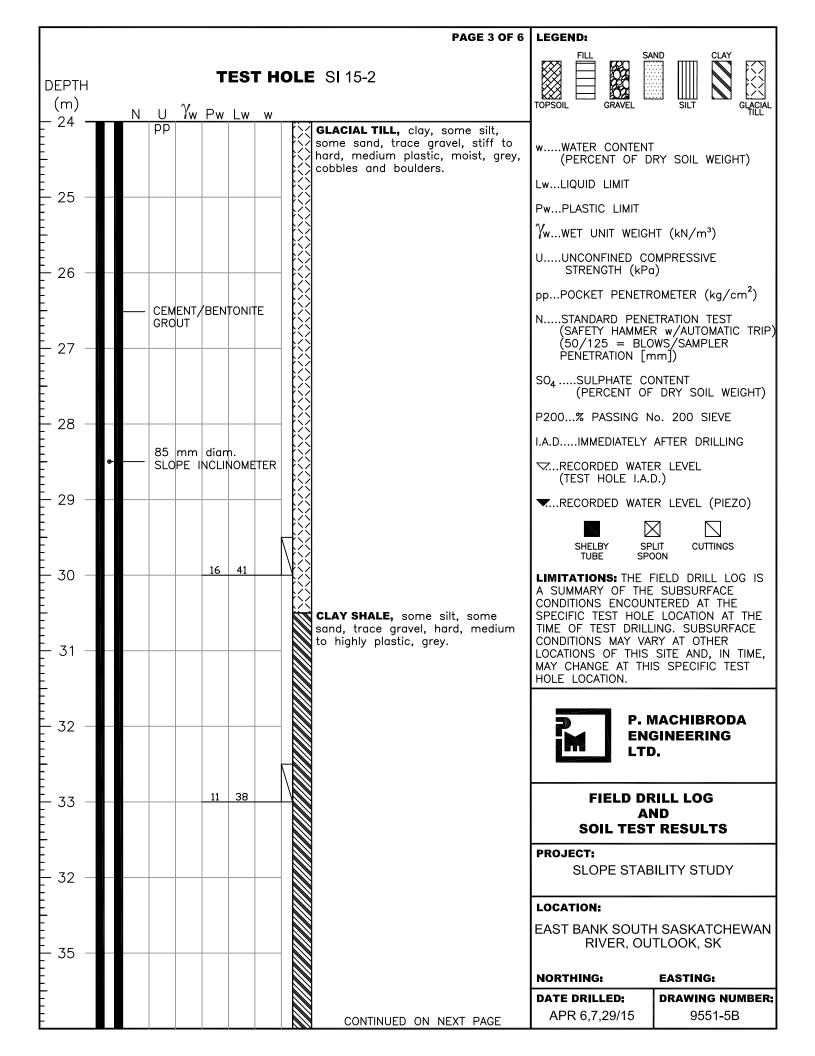


	PAGE 5 OF 6	LEGEND:	
DEPTH (m)	TEST HOLE SI 15-1 N U Yw Pw Lw w	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
- 48 -	PP CLAY SHALE, sandy, silty, trace sand, hard, medium plastic, brown		r Ry Soil Weight)
- - 49	-grey below 48.8 m.	LwLIQUID LIMIT	
- 49 -		PwPLASTIC LIMIT	
		Wwwwet unit weigh	HT (kN/m³)
- 50 —		UUNCONFINED CO STRENGTH (kPo	
Ē		ppPOCKET PENETR	ROMETER (kg/cm²)
- - - 51 -	CEMENT/BENTONITE GROUT	NSTANDARD PENE (SAFETY HAMME (50/125 = BLC PENETRATION [r	R w/AUTOMATIC TRIP))WS/SAMPLER
		SO ₄ SULPHATE CO (PERCENT OF	ONTENT DRY SOIL WEIGHT)
- 52 -		P200% PASSING N	lo. 200 SIEVE
	85 mm diam.	I.A.DIMMEDIATELY	AFTER DRILLING
	SLOPE INCLINOMETER	RECORDED WATE (TEST HOLE I.A.	
- 53 -		TRECORDED WATE	ER LEVEL (PIEZO)
-		SHELBY SF	
54 — - - - - 55 —		LIMITATIONS: THE A SUMMARY OF THE CONDITIONS ENCOUR SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS	SUBSURFACE NTERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER
		MAY CHANGE AT TH HOLE LOCATION.	IS SPECIFIC TEST
56 —			MACHIBRODA GINEERING).
E 57 -		FIELD DF	RILL LOG
			ND F RESULTS
- - 58	15 48	PROJECT: SLOPE STAE	BILITY STUDY
E		LOCATION:	
- - 59			H SASKATCHEWAN TLOOK, SK
E		NORTHING: 5706357	EASTING: 356347
E	CONTINUED ON NEXT PAGE	DATE DRILLED: MAR 24,25/15	DRAWING NUMBER: 9551-4D

					PAGE 6 OF 6	LEGEND:	
DEPTH (m) – 60 –	N_U	Ŷw Pw	E ST H	TOPSOIL GRAVEL	ND SILT		
	pp			CLAY SHALE, san sand, hard, mediu	dy, silty, trace ım plastic, brown.	wWATER CONTEN (PERCENT OF D	RY SOIL WEIGHT)
E 61 —						LwLIQUID LIMIT	
						PwPLASTIC LIMIT	
						γ_{wwet} unit weight	HT (kN/m³)
62 -				NOTE: 1. Test Hole sloug	ghed to 55.0 m	UUNCONFINED CO STRENGTH (kPo	
E				I.A.D. 2. Soil samples c	ollected from drill	ppPOCKET PENETR	OMETER (kg/cm²)
- - 63				31.5 m, every 3.5 31.5 m to 61.5 r	6 m between 0 to 0 m between m.	NSTANDARD PENE (SAFETY HAMME (50/125 = BLC PENETRATION [r	R w/AUTOMATIC TRIP) WS/SAMPLER
						SO ₄ SULPHATE CO (PERCENT OF	ONTENT DRY SOIL WEIGHT)
E 64 -						P200% PASSING N	lo. 200 SIEVE
E						I.A.DIMMEDIATELY	AFTER DRILLING
						RECORDED WATE (TEST HOLE I.A.	
E 65 -						RECORDED WATE	R LEVEL (PIEZO)
						SHELBY SF	
- 66 -						LIMITATIONS: THE A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE
- 67 -						LOCATIONS OF THIS MAY CHANGE AT TH HOLE LOCATION.	SITE AND, IN TIME,
- - 68							/ACHIBRODA GINEERING
						LTI	
E 69 -						FIELD DE	
							ND ' RESULTS
- - 70						PROJECT: SLOPE STAE	SILITY STUDY
E						LOCATION:	
- - 71							H SASKATCHEWAN TLOOK, SK
E						NORTHING: 5706357	EASTING: 356347
						DATE DRILLED: MAR 24,25/15	DRAWING NUMBER: 9551-4E

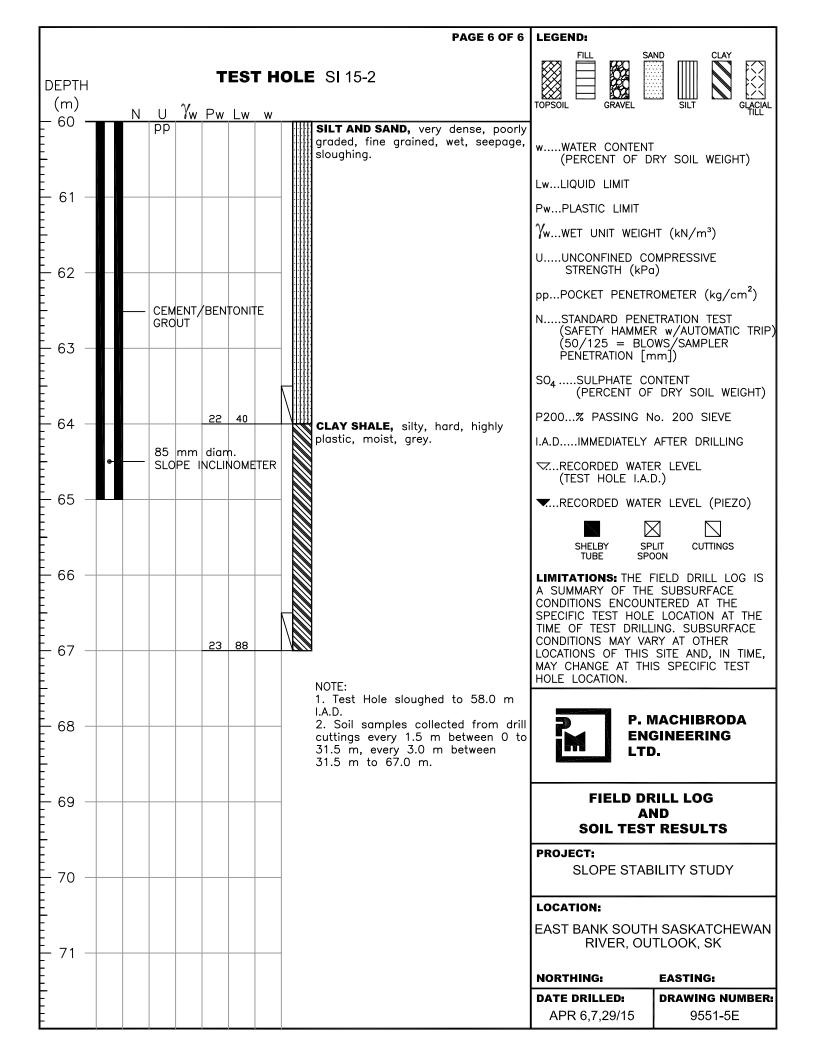
	INCLINOMETER -ROADBOX	LEGEND:			
DEPTH (m)			SI 15-2 V: 512.0 m	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
	pp		SAND, silty, trace clay, compact, poorly graded, fine grained, brown.	wWATER CONTENT (PERCENT OF D LwLIQUID LIMIT	RY SOIL WEIGHT)
E II				PwPLASTIC LIMIT	
Ē		5.8		YwWET UNIT WEIG⊦	
2				UUNCONFINED CC STRENGTH (kPc	
E I				ppPOCKET PENETR	OMETER (kg/cm²)
	— CEMENT/BE GROUT			NSTANDARD PENE (SAFETY HAMMER (50/125 = BLO PENETRATION [m	R w/AUTOMATIC TRIP) WS/SAMPLER
				SO ₄ SULPHATE CC (PERCENT OF	NTENT DRY SOIL WEIGHT)
- 4				P200% PASSING N	o. 200 SIEVE
				I.A.DIMMEDIATELY	AFTER DRILLING
	- 85 mm di		GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to	RECORDED WATE (TEST HOLE I.A.I	
_ 5		😥	hard, medium plastic, moist, grey, cobbles and boulders.	RECORDED WATE	R LEVEL (PIEZO)
Ē				SHELBY SP TUBE SPC	
				LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VAI LOCATIONS OF THIS MAY CHANGE AT THI	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,
		23.4		HOLE LOCATION.	
					MACHIBRODA GINEERING).
<u> </u>		18.6		FIELD DR	RILL LOG
				AND SOIL TEST RESULTS	
- 10				PROJECT: SLOPE STAB	ILITY STUDY
		18.3		LOCATION:	
- 11					H SASKATCHEWAN TLOOK, SK
				NORTHING:	EASTING:
		18.2	CONTINUED ON NEXT PAGE	DATE DRILLED: APR 6,7,29/15	DRAWING NUMBER: 9551-5

	PAGE 2	2 OF 6 LEGEND:
DEPTH (m)	TEST HOLE SI 15-2	TOPSOIL FILL GRAVEL SAND GRAVEL SILT CLAY SILT CLAY GLACIAL
- 12 -	PP GLACIAL TILL, clay, some sil some sand, trace gravel, stif hard, medium plastic, moist, cobbles and boulders.	f to water content
- - 13 -		LwLIQUID LIMIT PwPLASTIC LIMIT
		YwWET UNIT WEIGHT (kN/m³) UUNCONFINED COMPRESSIVE STRENGTH (kPa)
— 14 —		ppPOCKET PENETROMETER (kg/cm ²)
- 	GROUT	NSTANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])
		SO ₄ SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)
- 16 -	85 mm diam.	P200% PASSING No. 200 SIEVE
- - - - 17	SLOPE INCLINOMETER	✓RECORDED WATER LEVEL (TEST HOLE I.A.D.)✓RECORDED WATER LEVEL (PIEZO)
		SHELBY SPLIT CUTTINGS TUBE SPOON
18 — 		LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME,
		MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.
20 —		P. MACHIBRODA ENGINEERING LTD.
- 21 —		FIELD DRILL LOG AND SOIL TEST RESULTS
- - 22 -		PROJECT: SLOPE STABILITY STUDY
- 23 -		LOCATION: EAST BANK SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK
		NORTHING: EASTING:
	16 44 CONTINUED ON NEXT PAG	DATE DRILLED: DRAWING NUMBER: GE APR 6,7,29/15 9551-5A



	PAGE 4 OF 6	LEGEND:	
DEPTH (m)	TEST HOLE SI 15-2	TOPSOIL GRAVEL	ND SILT CLAY GLACIAL
- 36 -	PP CLAY SHALE, some silt, some sand, trace gravel, hard, medium to highly plastic, grey.	wWATER CONTENT (PERCENT OF D	RY SOIL WEIGHT)
E - 37 -		LwLIQUID LIMIT	
		PwPLASTIC LIMIT	
		WwWET UNIT WEIGH	HT (kN/m³)
- - 38 -		UUNCONFINED CO STRENGTH (kPo	DMPRESSIVE 1)
		ppPOCKET PENETR	OMETER (kg/cm²)
- - - - 39 -	CEMENT/BENTONITE GROUT	NSTANDARD PENE (SAFETY HAMMEI (50/125 = BLC PENETRATION [n	R w/AUTOMATIC TRIP) WS/SAMPLER
		SO ₄ SULPHATE CO (PERCENT OF	ONTENT DRY SOIL WEIGHT)
- 40 —		P200% PASSING N	lo. 200 SIEVE
	85 mm diam.	I.A.DIMMEDIATELY	AFTER DRILLING
	SLOPE INCLINOMETER	CRECORDED WATE (TEST HOLE I.A.)	
- 41 -		RECORDED WATE	R LEVEL (PIEZO)
- - - -			
42 — - 43 —		LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER
		MAY CHANGE AT THI HOLE LOCATION.	
- - 44			/ACHIBRODA GINEERING).
- - 45 -		FIELD DF	
	15 47		ND " RESULTS
<u>-</u> 46 —		PROJECT: SLOPE STAE	SILITY STUDY
É		LOCATION:	
- - - 47 —			H SASKATCHEWAN TLOOK, SK
		NORTHING:	EASTING:
	16 39 CONTINUED ON NEXT PAGE	DATE DRILLED: APR 6,7,29/15	DRAWING NUMBER: 9551-5C

	PAGE 5 OF 6	LEGEND:	
DEPTH (m)	TEST HOLE SI 15-2	TOPSOIL FILL GRAVEL	ND SILT CLAY GLACIAL
- 48 -	PP CLAY SHALE, some silt, some sand, trace gravel, hard, medium to highly plastic, grey.	wWATER CONTENT (PERCENT OF D	- Ry Soil Weight)
- - 49 -	SILT AND SAND, very dense, poorly graded, fine grained, wet, seepage, sloughing.	PwPLASTIC LIMIT	IT (1 N (3)
- - - 50 -		YwWET UNIT WEIGH UUNCONFINED CO STRENGTH (kPa	MPRESSIVE
	CEMENT/BENTONITE	ppPOCKET PENETR NSTANDARD PENE (SAFETY HAMME) (50/125 = BLC	TRATION TEST R w/AUTOMATIC TRIP)
- 51 - - - -		PENETRATION [n SO₄SULPHATE CO	nm])
- 52 —	■ 85 mm diam. SLOPE INCLINOMETER	P200% PASSING N I.A.DIMMEDIATELY	AFTER DRILLING
- 53 		(TEST HOLE I.A. ▼RECORDED WATE	D.)
- - 54 —		SHELBY SPO TUBE SPO LIMITATIONS: THE I A SUMMARY OF THE CONDITIONS ENCOUN	TILT CUTTINGS DON FIELD DRILL LOG IS SUBSURFACE JTERED AT THE
- - - - -		SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	ING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,
- 			MACHIBRODA GINEERING).
57 —			RILL LOG ND F RESULTS
- 	22 30	PROJECT: SLOPE STAE	BILITY STUDY
- - - - 59 —			H SASKATCHEWAN TLOOK, SK
Ē		NORTHING:	EASTING:
	CONTINUED ON NEXT PAGE	DATE DRILLED: APR 6,7,29/15	DRAWING NUMBER: 9551-5D



APPENDIX A EXPLANATION OF TERMS ON TEST HOLE LOGS

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

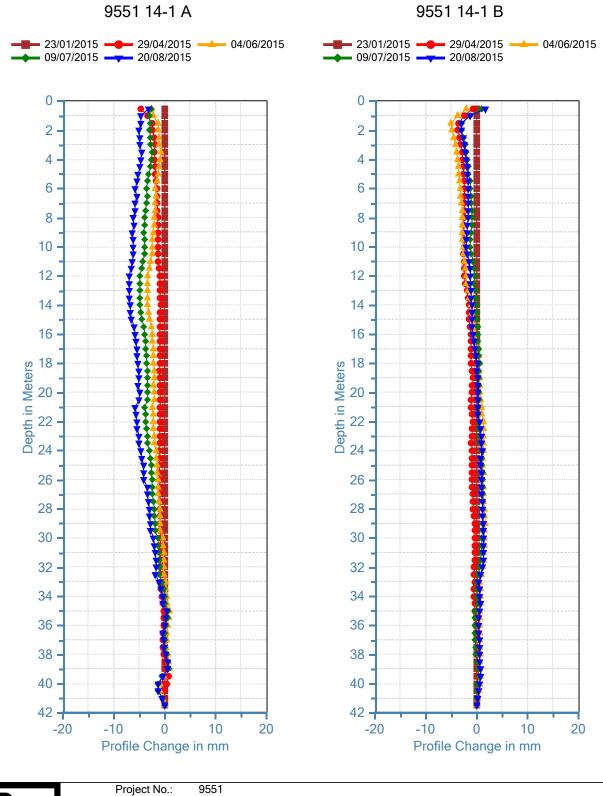
Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

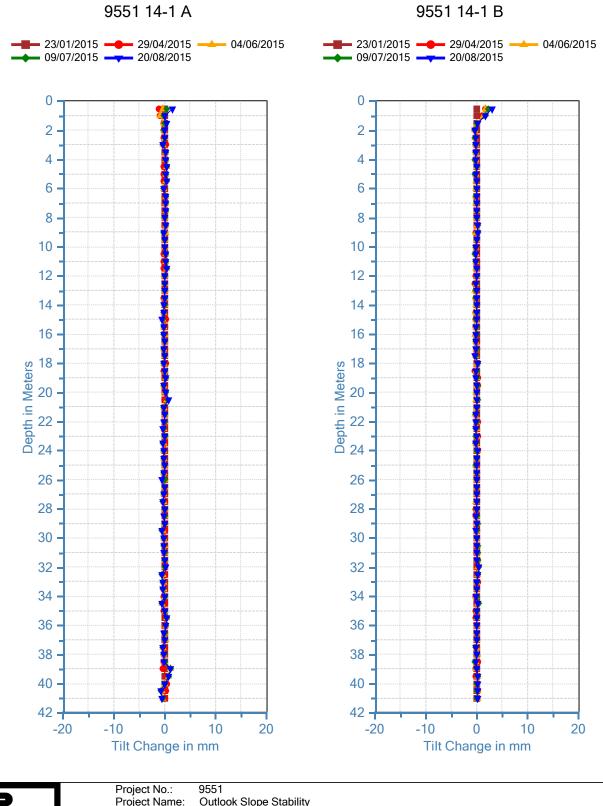
Poorly Graded Well Graded Mottled Nuggety Laminated Slickensided Fissured	 predominance of particles of one grain size. having no excess of particles in any size range with no intermediate sizes lacking. marked with different coloured spots. structure consisting of small prismatic cubes. structure consisting of thin layers of varying colour and texture. having inclined planes of weakness that are slick and glossy in appearance. containing shrinkage cracks.
Fissured Fractured	 containing shrinkage cracks. broken by randomly oriented interconnecting cracks in all 3 dimensions.

	MAJOR [DIVISI	ON	GROUP SYMBOL	т	YPICAL DE	SCRIPTION	ı	LABORATORY	CLASSIFICATION	CRITERIA
н		ANIC	SOILS	Pt	PEAT AN	D OTHER HIG	HLY ORGAN	C SOILS	STRONG COLOUR OR (DOUR AND OFTEN FIE	BROUS TEXTURE
) SIEVE	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLE	AN GRAVELS	GW	WELL-GRADE MIXTURES		GRAVEL-SA	ND	$C_u = \frac{D_{6d}}{D_1}$	$D_{1} > 4$ $C_{c} = (D_{30})^{2} = 1 \text{ to } 3$ $D_{60} \times D_{10}$	3
4 NO. 20	GRAVELS half coarse an No. 4 sie	ULL.		GP	POORLY-GRA		LS AND GRA	/EL-SAND	NOT MEETING ALL	ABOVE REQUIREMEN	TS FOR GW
C THAN	GR than he r than			GM	SILTY GRAVE >12% FINES	ELS, GRAVEL	-SAND-SILT M	IIXTURES	ATTERBERG LI	MITS BELOW "A" LINE (OR PI < 4
ARGEF	More t large	DIR	TY GRAVELS	GC	CLAYEY GRA MIXTURES		EL-SAND-CLA	Y	ATTERBERG LIN	11TS ABOVE "A" LINE W	ITH PI > 7
COARSE-GRAINED SOLLS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	SANDS More than half coarse fraction smaller than No. 4 sieve size	CLI	EAN SANDS	sw	WELL-GRADE MIXTURES		RAVELLY SAM	NDS	$C_u = \frac{D_{ev}}{D_1}$	$C_{c} > 6 C_{c} = \frac{(D_{30})^{2}}{D_{60} \times D_{10}} = 1 \text{ to } 3$	3
IALF BY	NDS f coarse No. 4 sie			SP	POORLY-GRA <5% FINES	ADED SANDS	OR GRAVELI	Y SANDS	NOT MEETING ALL G	RADATION REQUIREM	ENTS FOR SW
THAN H	SA than hal er than I			SM	SILTY SANDS >12% FINES	6, SAND-SILT	MIXTURES		ATTERBERG LI	MITS BELOW "A" LINE (DR PI < 4
(MORE	More	DIF	RTY SANDS	sc	CLAYEY SAN >12% FINES	DS, SAND-CL	AY MIXTURE	s	ATTERBERG LIN	/ITS ABOVE "A" LINE W	(ITH PI >7
		SILTS	ML	INORGANIC S					W _L < 50		
ASSING		"A" line on plasticity chart; gligible organic content		МН				W _L > 50			
FINE-GRAINED SOILS THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	CLAYS Above 'A" line on plasticity chart; negligible organic content			CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS				W _L < 30		
AINED S F BY WE SIEVE (CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS			CITY, SILTY	W _L >30 < 50		
FINE-GRAINED SOILS IAN HALF BY WEIGHT NO. 200 SIEVE SIZE)				СН	INORGANIC (CLAYS	CLAYS OF HIG	GH PLASTICIT	Y, FAT		W _L > 50	
(MORE TH				OL	ORGANIC SIL		ANIC SILTY (LAYS OF		W _L < 50	
N)	Below "A"	CLAY line on	'S plasticity chart	он	ORGANIC CLAYS OF HIGH PLASTICITY					W _L > 50	
		00									
			TY CHART SSIFICATIO								
		50 -	OF FINE C	RAINED SC	JILO.						
	_	40 -									
	DIEX (D)							СН	- "A" LINE		
		30 -							MH or OH		
						CI					
				CL							
		10 -									
				CL-ML		ML	or OL				
		0 -		ML	/						

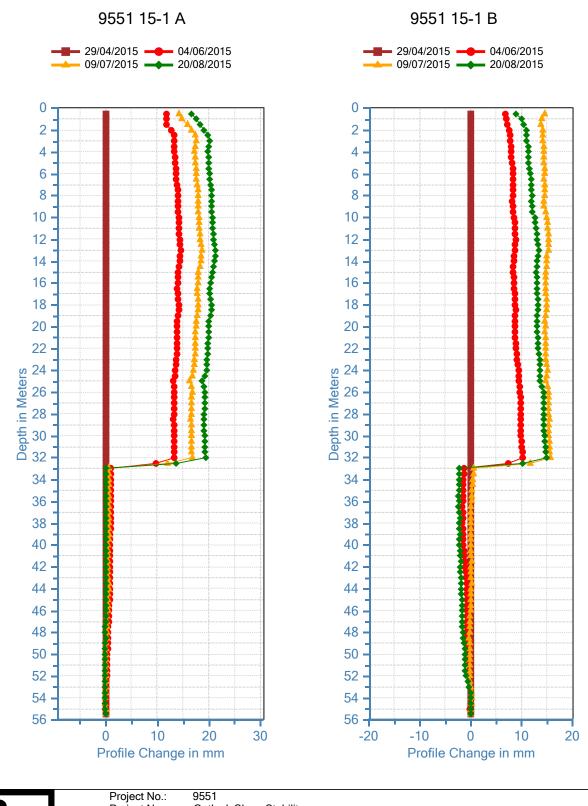
APPENDIX B SLOPE INCLINOMETER PLOTS



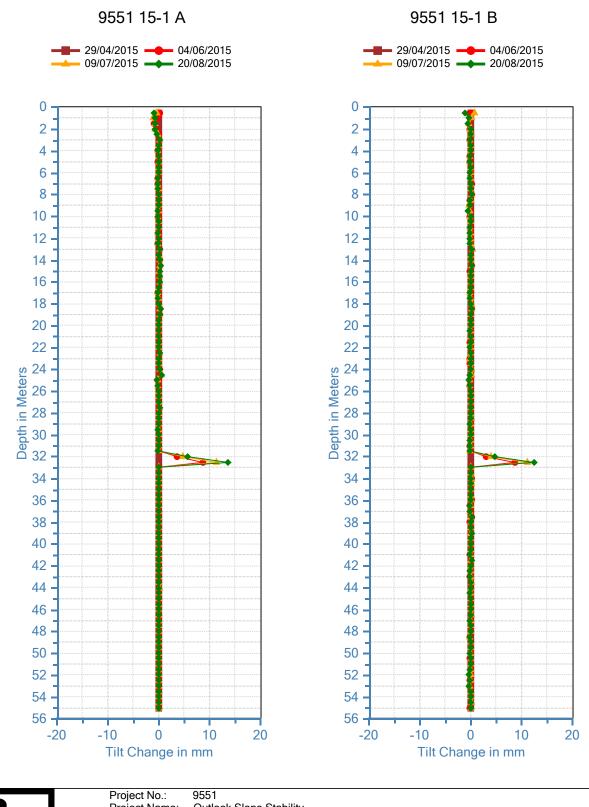
Project No.: Project Name: Location:	Outlook, Saskatchewan
Location: Test Hole No. Drawing No.	14-1 Appendix B1



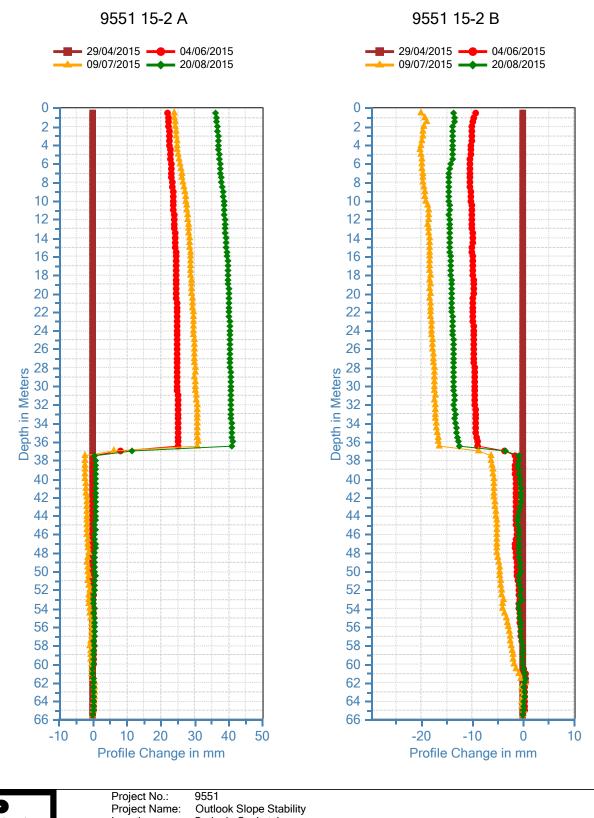
	Project No.:	9001	
	Project Name:	Outlook Slope Stability	
◢	Location:	Outlook, Saskatchewan	
	Test Hole No.	14-1	
	Drawing No.	Appendix B2	



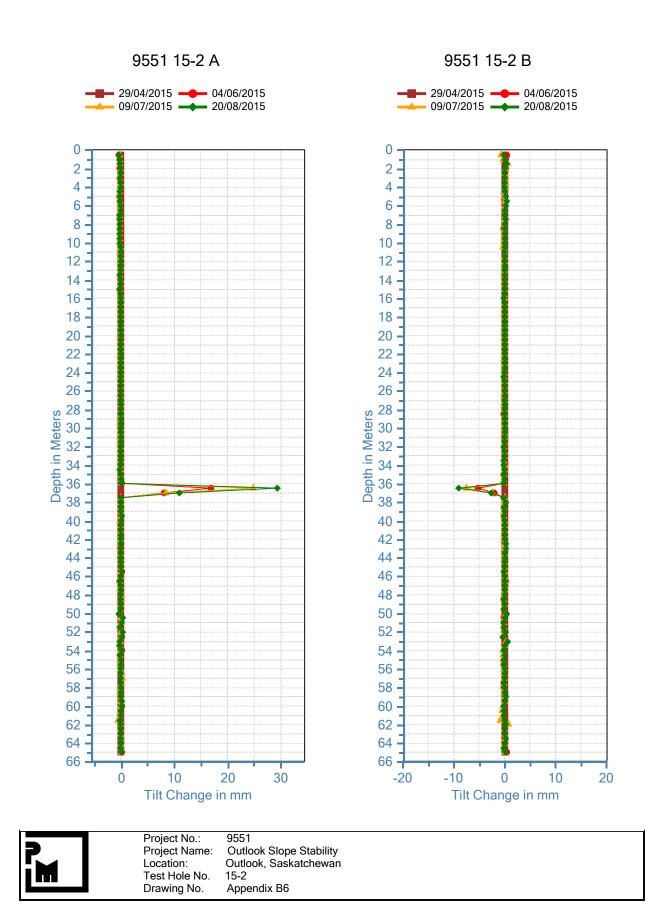
Project No.:	9551
Project Name:	Outlook Slope Stability
Location:	Outlook, Saskatchewan
Test Hole No.	15-1
Drawing No.	Appendix B3



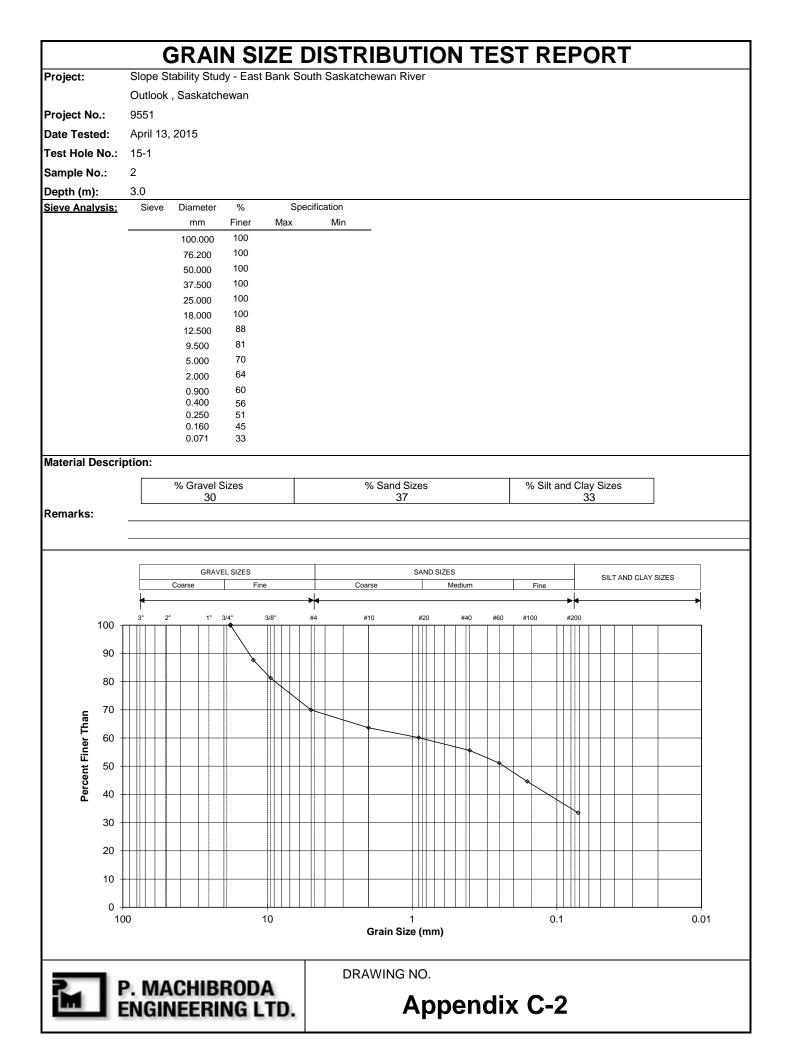
	Project No.:	9551
2	Project Name:	Outlook Slope Stability
	Location:	Outlook, Saskatchewan
	Test Hole No.	15-1
	Drawing No.	Appendix B4

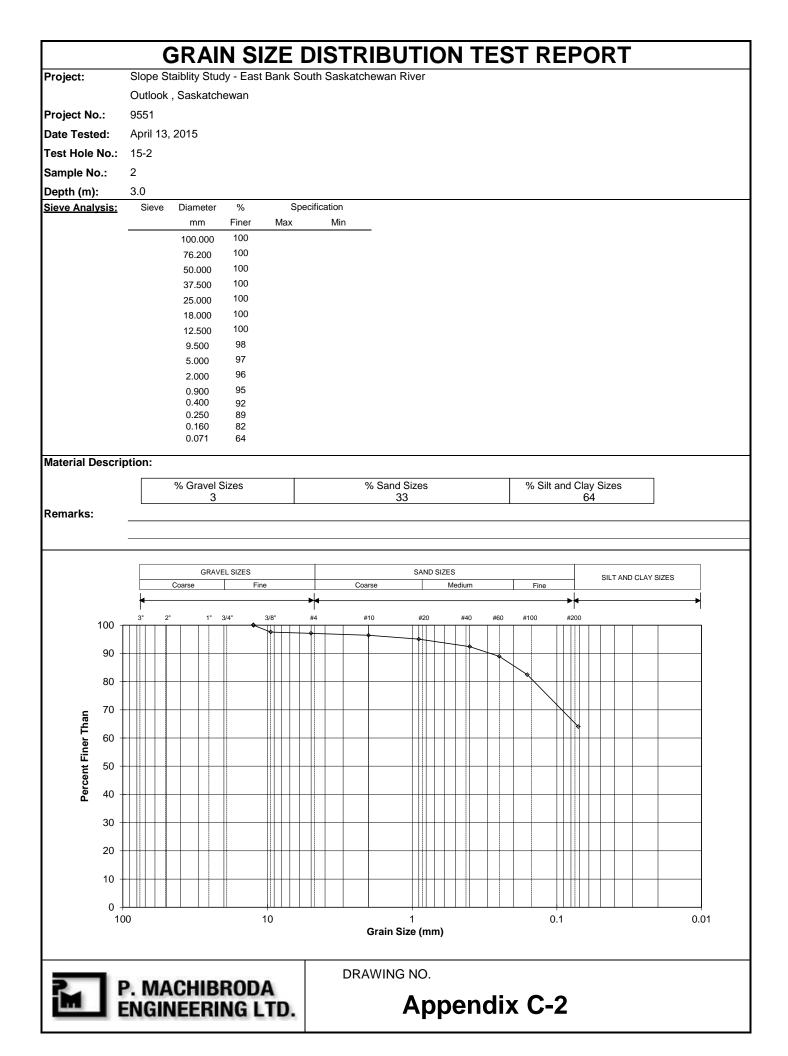


	Project No.:	9551
2	Project Name:	Outlook Slope Stability
	Location:	Outlook, Saskatchewan
	Test Hole No.	15-2
	Drawing No.	Appendix B5

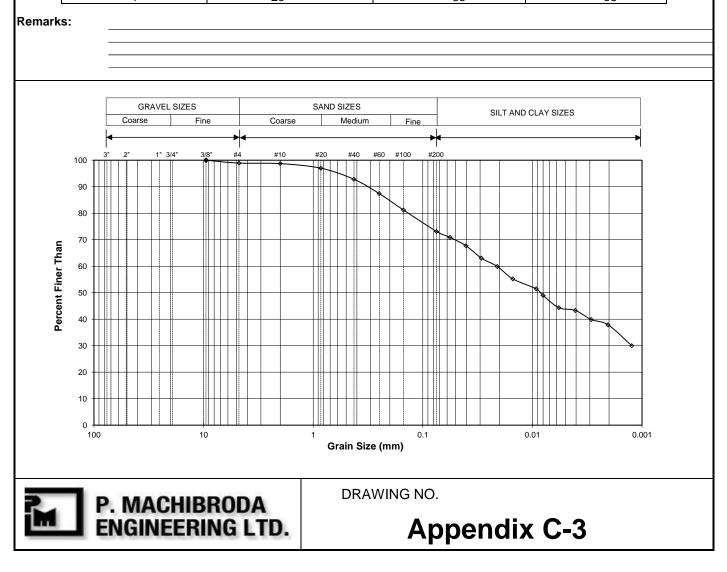








ASTM D422: GRAIN SIZE ANALYSIS OF SOIL Slope Stability Study - East Bank South Saskatchewan River Project: Outlook, Saskatchewan Project No.: 9551 Date Tested: April 14, 2015 15-2 Test Hole No.: Sample No.: 19 Depth (m): 28.5 Sieve Analysis: Sieve % Hydrometer Analysis: Diameter % Diameter mm Finer mm Finer 100 Dispersing Agent: 0.0564 70.9 1.5" 38.1 Sodium Hexametaphosphate 100 0.0404 67.7 1" 25.4 100 0.0292 63.0 3/4" 19.1 1/2" 12.7 100 0.0209 59.9 100 0.0151 55.2 3/8" 9.5 99 0.0092 51.5 #4 4.75 2 99 0.0080 48.9 #10 97 0.0057 44.3 # 20 0.85 # 40 0.425 92.8 0.0041 43.3 0.25 87.4 0.0029 39.9 #60 # 100 0.15 81.2 0.0020 37.9 # 200 0.075 0.0012 30.0 73.1 Material Description: % Gravel Sizes % Sand Sizes % Silt Sizes % Clay Sizes 26 35 38



ASTM D422: GRAIN SIZE ANALYSIS OF SOIL Slope Stability Study - East Bank South Saskatchewan River Project: Outlook, Saskatchewan Project No.: 9551 Date Tested: April 14, 2015 15-2 Test Hole No.: Sample No.: 29 Depth (m): 57.0 Sieve Analysis: Sieve % Hydrometer Analysis: Diameter % Diameter mm Finer mm Finer 100 Dispersing Agent: 0.0659 30.9 1.5" 38.1 Sodium Hexametaphosphate 100 0.0471 27.7 1" 25.4 100 0.0336 24.5 3/4" 19.1 1/2" 12.7 100 0.0239 23.0 100 0.0170 21.4 3/8" 9.5 100 0.0134 21.1 #4 4.75 2 100 0.0089 18.0 #10 100 0.0064 15.2 # 20 0.85 # 40 0.425 99.7 0.0043 12.4 0.25 0.0032 #60 93.4 10.7 # 100 0.15 59.3 0.0023 9.5 # 200 0.075 36.3 0.0013 8.4 Material Description: % Gravel Sizes % Sand Sizes % Silt Sizes % Clay Sizes 0 64 27 9 Remarks: GRAVEL SIZES SAND SIZES SILT AND CLAY SIZES Coarse Medium Fine Coarse Fine 1" 3/4" 3/8' #20 #40 #60 #100 #200 #4 #10 100 90 80 70 Percent Finer Than 60 50 40 30 20 10 0 10 0.01 0.001 0.1 100 1 Grain Size (mm) DRAWING NO. P. MACHIBRODA

P. MACHIBRODA ENGINEERING LTD.

Appendix C-4

ASTM D422: GRAIN SIZE ANALYSIS OF SOIL

Slope Stability Study - East Bank South Saskatchewan River

Project:

Outlook, Saskatchewan

Project No.: 9551

Date Tested: April 24, 2015

Test Hole No.: 15-6

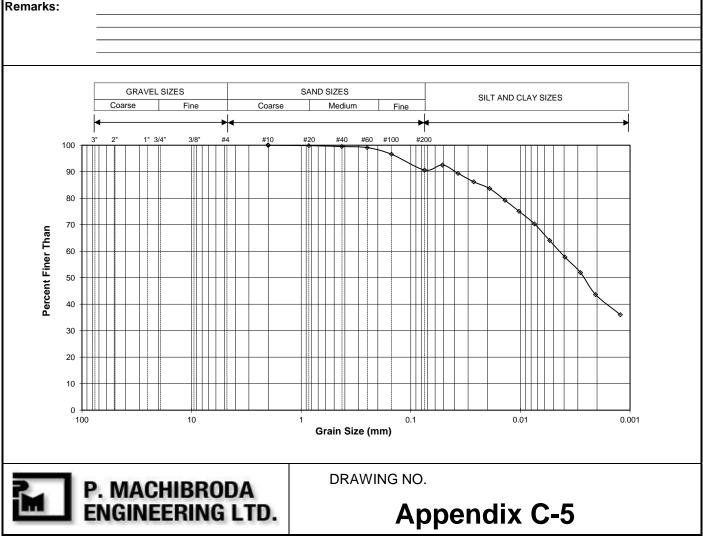
Sample No.:

Depth (m): 67.0

Sieve Analysis:	Sieve	Diameter	%	Hydrometer Analysis:	Diameter	%	
		mm	Finer		mm	Finer	
	1.5"	38.1	100	Dispersing Agent:	0.0515	92.5	
	1"	25.4	100	Sodium Hexametaphosphate	e 0.0371	89.4	
	3/4"	19.1	100		0.0267	86.2	
	1/2"	12.7	100		0.0191	83.6	
	3/8"	9.5	100		0.0138	79.2	
	#4	4.75	100		0.0103	75.1	
	# 10	2	100		0.0074	70.3	
	# 20	0.85	100		0.0054	64.0	
	# 40	0.425	99.5		0.0039	57.8	
	#60	0.25	99.1		0.0028	51.9	
	# 100	0.15	96.6		0.0021	43.6	
	# 200	0.075	90.6		0.0012	36.0	

Material Description:

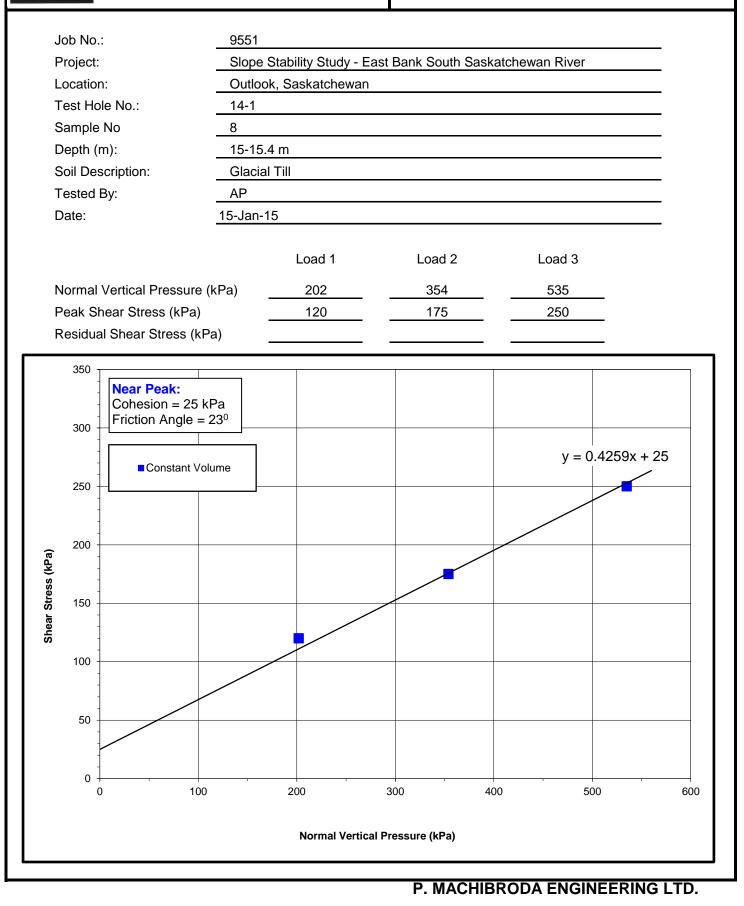
% Gravel Sizes	% Sand Sizes	% Silt Sizes	% Clay Sizes
0	9	47	44



P. MACHIBRODA ENGINEERING LTD.

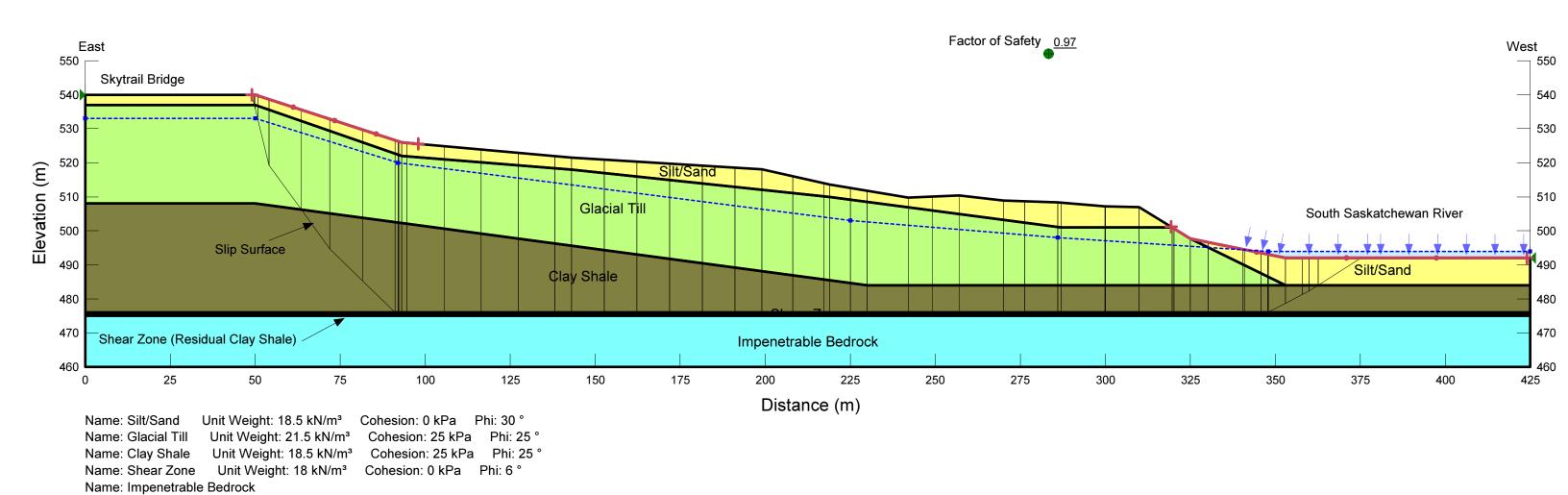
806 - 48th Street East, Saskatoon, SK, S7K 6K9 Phone: (306) 665-8444 Fax: (306)652-2092 Web: www.machibroda.com

DIRECT SHEAR TEST (ASTM D3080-04)



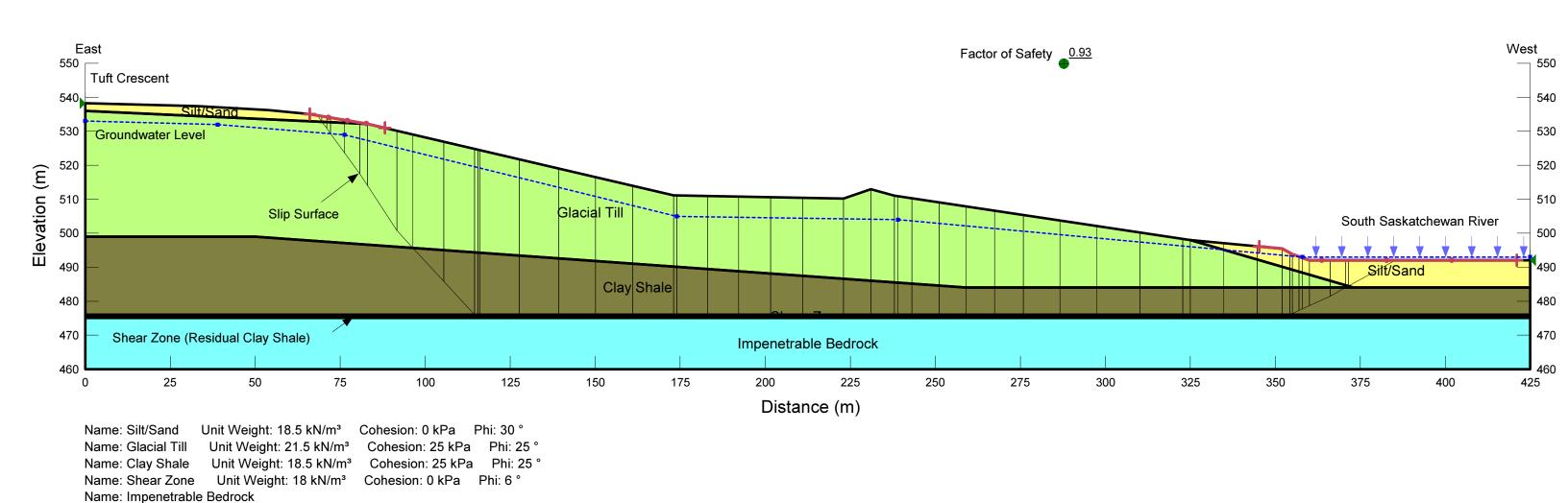
APPENDIX D TYPICAL SLOPE STABILITY PLOTS

STRATGRAPHIC SECTION A-A' - BACK ANALYSIS



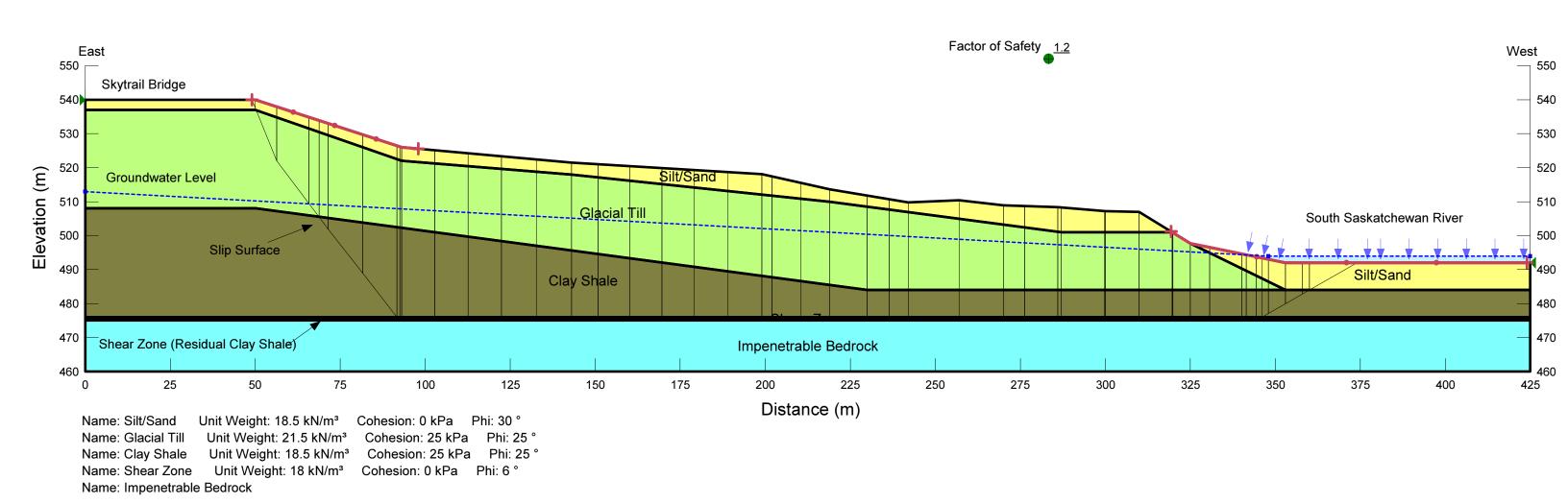
P. MACHIBRODA ENGINEERING LTD.

STRATAGRAPHIC SECTION B-B' - BACK ANALYSIS



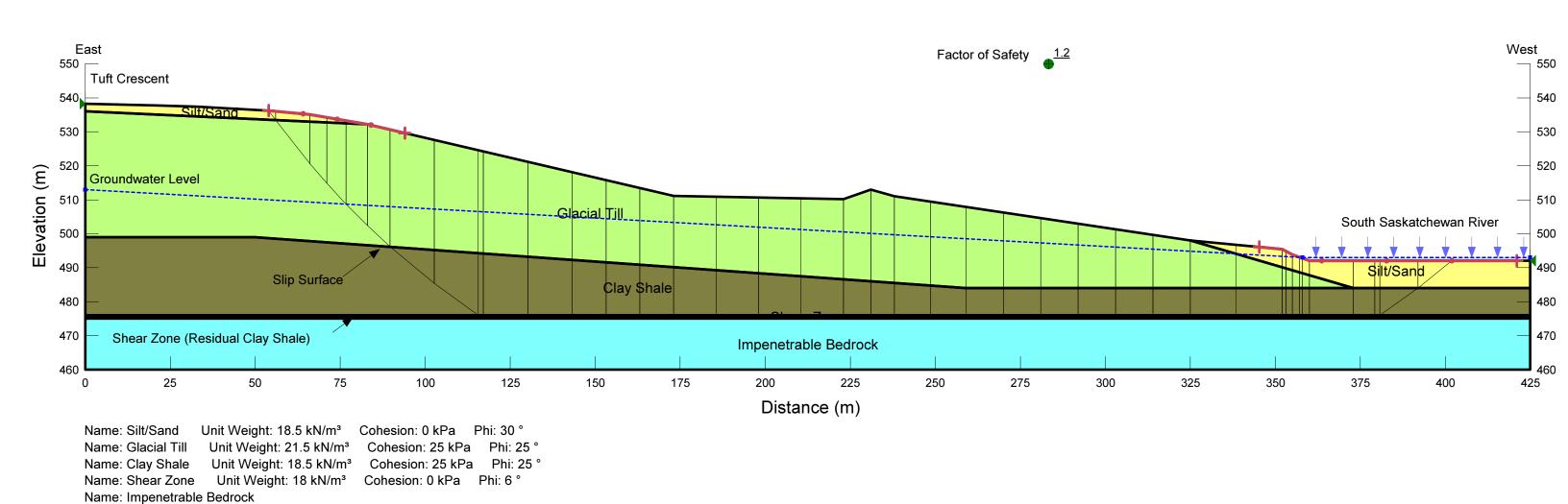
P. MACHIBRODA ENGINEERING LTD.

STRATGRAPHIC SECTION A-A' - 20 METRE LOWER GROUNDWATER LEVEL



P. MACHIBRODA ENGINEERING LTD.

STRATAGRAPHIC SECTION B-B' - 20 METRE LOWER GROUNDWATER LEVEL





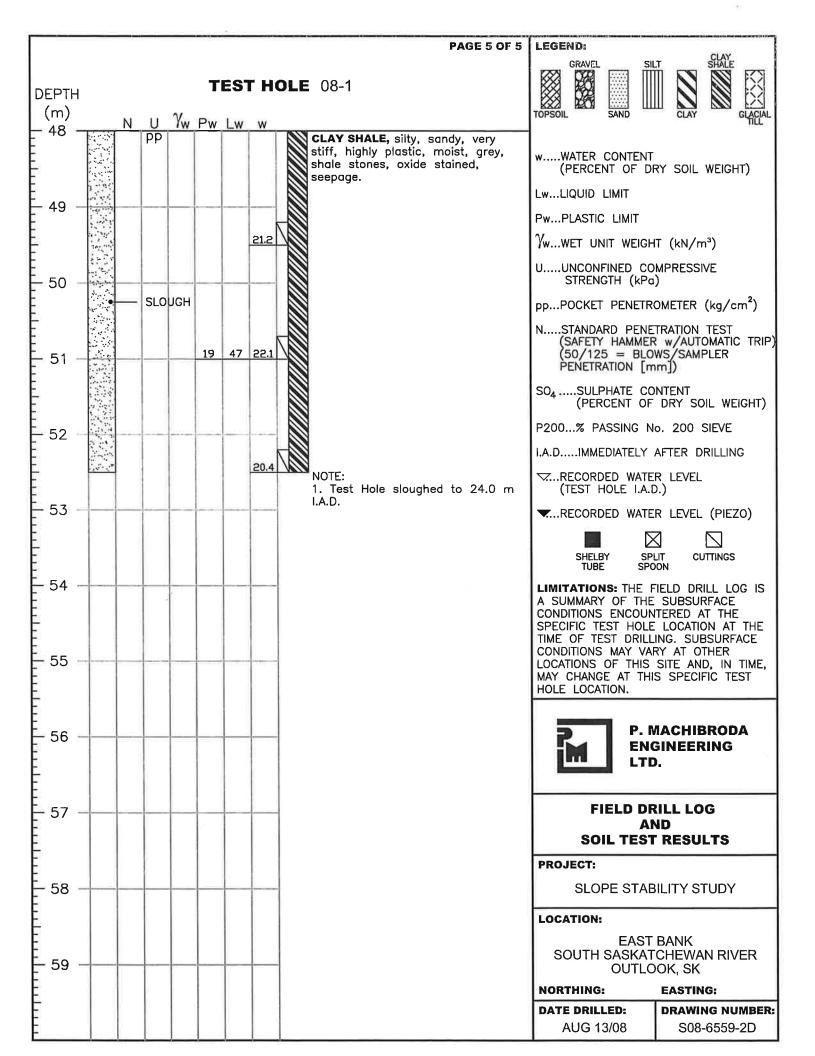
APPENDIX E TEST HOLE LOGS FROM PMEL REPORT NO. S08-6559

	PIEZO. ELEV.= 5	01.2 m	PAGE 1 OF 5	LEGEND:	01.8%
DEPTH (m)		ST HOLE	08-1 V: 500.2 m	TOPSOIL SAND	
	PP BENTONITE SE		SILT, some clay, trace sand, stiff, medium plastic, moist, brown.	wWATER CONTENT (PERCENT OF DF	RY SOIL WEIGHT)
Ē.,				LwLIQUID LIMIT	
E				PwPLASTIC LIMIT	
		8.1		YwWET UNIT WEIGH	T (kN/m³)
2 -			GLACIAL TILL, clay, some silt, some sand, trace gravel, very stiff to hard, medium plastic, moist,	UUNCONFINED CO STRENGTH (kPa)
Ē	CUTTINGS		brown, oxide stained, gypsum crystals.	ppPOCKET PENETRO	DMETER (kg/cm²)
- 3 -		12.9		NSTANDARD PENE (SAFETY HAMMER (50/125 = BLO' PENETRATION [m	w/AUTOMATIC TRIP)
	50 mm diam SCH 40, PVC RISER PIPE			SO ₄ SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
Ē 4 -		BX		P200% PASSING N	o. 200 SIEVE
	15	46 14.5		I.A.DIMMEDIATELY	AFTER DRILLING
				CRECORDED WATE (TEST HOLE I.A.E).)
5 -				RECORDED WATE	R LEVEL (PIEZO)
				SHELBY SPI TUBE SPO	
- 6 -	20.7	15.1		LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VAR	SUBSURFACE TERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER
		15.2		LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	
8 -					ACHIBRODA GINEERING).
Ē 9 —		17.4		FIELD DR	
Ē				SOIL TEST	
				PROJECT: SLOPE STAB	ILITY STUDY
		19.5		LOCATION:	
E - 11 -				EAST SOUTH SASKAT	BANK CHEWAN RIVER OK, SK
-				NORTHING:	EASTING:
Ē	488.7 m NOV 17/08			DATE DRILLED: AUG 13/08	DRAWING NUMBER: S08-6559-2
-			CONTINUED ON NEXT PAGE	700 13/00	000-0009-2

	PAGE 2 OF 5	LEGEND:	-01 N/
DEPTH (m)	TEST HOLE 08-1	TOPSOIL SAND	
- 12 -	PP 20.2 20.0 20	wWATER CONTENT (PERCENT OF DE	RY SOIL WEIGHT)
	CUTTINGS Crystals.	LwLIQUID LIMIT	
- 13 - -		PwPLASTIC LIMIT	
	20.5	WWET UNIT WEIGH	T (kN/m³)
E - 14		UUNCONFINED CO STRENGTH (kPa	MPRESSIVE)
-		ppPOCKET PENETR	DMETER (kg/cm²)
- - - 15 -		NSTANDARD PENE (SAFETY HAMMER (50/125 = BLO PENETRATION [m	w/AUTOMATIC TRIP
	• 50 mm diam.	SO4SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
E 	RISER PIPE	P200% PASSING N	o. 200 SIEVE
-		I.A.DIMMEDIATELY	AFTER DRILLING
		TEST HOLE I.A.	
- 17 -		RECORDED WATE	R LEVEL (PIEZO)
		SHELBY SP TUBE SPC	
- 18 -	19.9 17.3	LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE
- 19 - - -	16.1	LOCATIONS OF THIS MAY CHANGE AT TH HOLE LOCATION.	SITE AND, IN TIME.
20 -	BENTONITE SEAL		ACHIBRODA GINEERING).
E 21 -	16.3	FIELD DI	
Ē			ND F RESULTS
-		PROJECT:	
- 22 -		SLOPE STAE	BILITY STUDY
-	17.4	LOCATION:	
E - 23		SOUTH SASKAT	BANK CHEWAN RIVER DOK, SK
Ē		NORTHING:	EASTING:
-	SAND PACKED	DATE DRILLED: AUG 13/08	DRAWING NUMBER
-	CONTINUED ON NEXT PAGE		

	PAGE 3 OF 5	LEGEND:	1227/125-50
DEPTH (m)	TEST HOLE 08-1 N U γ_{w} Pw Lw w	TOPSOIL SAND	
- 24 -	PP 20.9 15.9 CLACIAL TILL, clay, some silt, some sand, trace gravel, very stiff to hard, medium plastic, moist, grey.	wWATER CONTENT (PERCENT OF D	RY SOIL WEIGHT)
- 25 -	SLOUGH	LwLIQUID LIMIT PwPLASTIC LIMIT	
-		YwWET UNIT WEIGH	IT (kN∕m³)
- 26 -	50 mm diam.	UUNCONFINED CC STRENGTH (kPa)
-	SCH 40, PVC RISER PIPE	PPPOCKET PENETR	
E 27 -		(50/125 = BLO PENETRATION [m	WS/SAMPLER hm])
		(2)1	DRY SOIL WEIGHT)
- 28 -		P200% PASSING N	
		TEST HOLE I.A.	R LEVEL D.)
- 29 -			
Ē		SHELBY SP	LIT CUTTINGS
- 30 -	21.3 15.2	LIMITATIONS: THE A A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE
- 31 - -		LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	SITE AND, IN TIME,
- 32 -			MACHIBRODA Gineering D.
		FIELD DI	
- 33 -		A	ND F RESULTS
- 34 -		PROJECT: SLOPE STAE	BILITY STUDY
	15.5	LOCATION:	
- 35 -	CLAY SHALE, silty, some sand, ver stiff to hard, highly plastic, moist, grey.	y SOUTH SASKAT	BANK CHEWAN RIVER DOK, SK
-		NORTHING:	EASTING:
	CONTINUED ON NEXT PAGE	DATE DRILLED: AUG 13/08	DRAWING NUMBER S08-6559-2B

									PAGE 4 OF 5	LEGEN	D:				
DEPTH (m)	Ν	U	γw	T			OLE	₫ 08-1		G TOPSOIL	RAVEL SAN			SHALE	GLACIAL
— 36 —		pp	21.5			18.3		CLAY SHALE, silty, so stiff to hard, highly grey, shale stones.	ome sand, very plastic, moist,	wWA	TER CON	NTENT OF DR	Y SOIL	WEIGH	-IT)
	-	SLO	UGH							LwLIG	UID LIM	IT			
E 37 -										PwPL	ASTIC LI	ΜΙΤ			
Ē				20	50	19.8				γ .we	T UNIT	WEIGH	「 (kN/r	m³)	
- - 38 -								-oxide stained below	38.0 m.	UUN ST	ICONFINE TRENGTH	ED COI (kPa)	IPRESS	IVE	
Ē				dian						ppPO	CKET PE	ENETRO	METER	(kg/c	m²)
- - 39 -		RISE	1 40, ER P	IPE		19.5				(SA (50	ANDARD AFETY HA D/125 = NETRATIC	AMMER = BLOV	w/AUT VS/SAM	OMATIC) TRIP
Ē										SO ₄	SULPHA (PERCEN	TE CON	NTENT DRY SO	OIL WE	ight)
E 40 -	11 11 11 11 11 11 11 11 11 11 11 11 11									P200	% PASSI	ING No	. 200	SIEVE	
	200 B					24.2				I.A.D	.IMMEDIA	TELY A	FTER [DRILLIN	G
	1.1.1.1					24.2		—sandy, firm to stiff	5000,000		Corded Est Holi			-	
- 41 -				dian				below 40.9 m.	, seepage	. RE	CORDED	WATER	R LEVEL	_ (PIEZ	20)
		SCH	40 EEN	SLC PVC	WE) L					SHELBY TUBE	SPL SPO	- IT С		
- 42 -			18.5	28	58	21.0				A SUM CONDIT SPECIF TIME C	ATIONS: IMARY OI TIONS EN TIC TEST OF TEST TIONS MA	F THE NCOUN HOLE DRILLI	SUBSU IERED LOCATI NG. SU	RFACE AT THE ON AT BSURF	E THE
- 43 -						26.9				LOCATI MAY C	ONS OF HANGE A LOCATION	THIS AT THIS	SITE AN	ID, IN	
- 44 -										P	1		ACHI INEEI		A
E 45 -	5-00 5-00 5-00		<u> </u>		-	23.2					FIEL	D DR		DG	
Ē											SOIL .	AN TEST		II TS	
Ē										PROJE	_				_
46 -					-			-very stiff below 46	.0 m.		SLOPE	STAB	ILITY S	TUDY	
E				28	63	22.0				LOCAT	TION:				
- 47 -										so	UTH SA	SKAT	BANK CHEW/ OK, SK		/ER
Ē										NORTI			EASTI		
Ē													DRAW		
F	16 M					20.9		CONTINUED ON	NEXT PAGE		JG 13/08	8	S08	3-6559	-2C

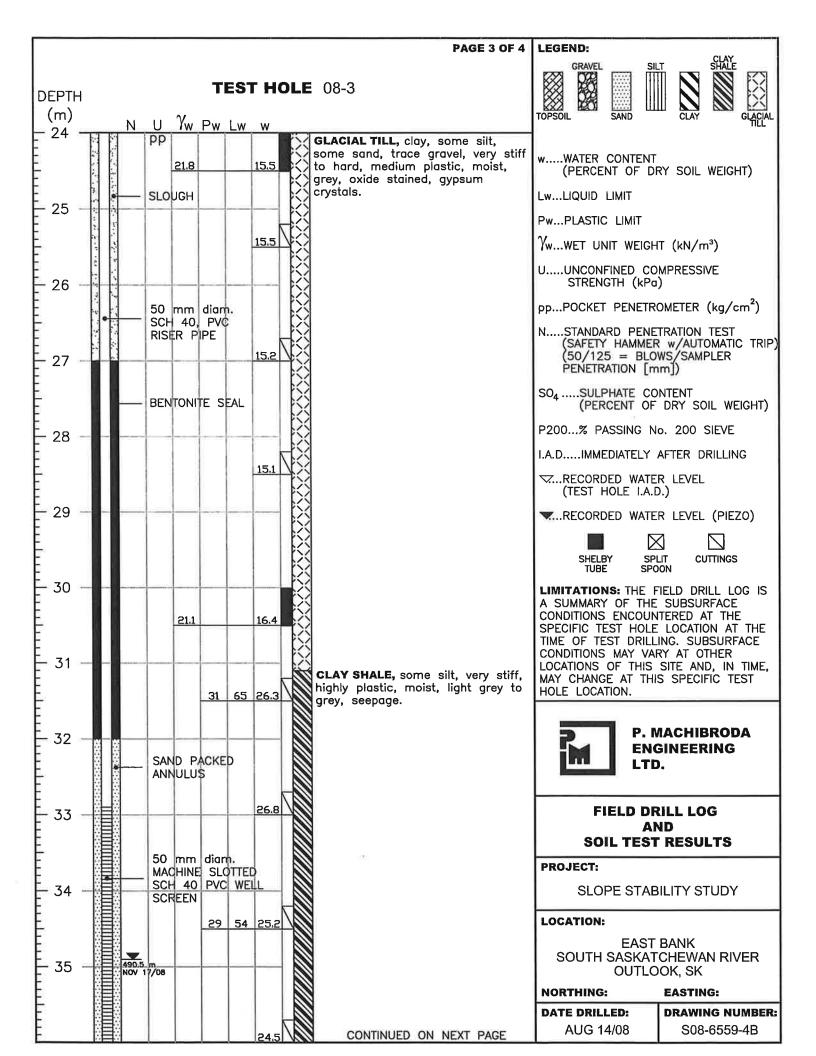


	PIEZO. ELEV.= 511.	1 m	PAGE 1 OF 2	LEGEND:	
DEPTH (m)		T HOLE		TOPSOIL SAND	
	PP BENTONITE SEAL		TOPSOIL, organic, roots, rootlets. SILT, some clay, some sand, stiff, medium plastic, damp, brown.	wWATER CONTENT (PERCENT OF DI	
E. 1				LwLIQUID LIMIT	
E' T				PwPLASTIC LIMIT	
Ē		6.6		γ_{wwet} unit weigh	T (kN/m³)
2 -	-			UUNCONFINED CO STRENGTH (kPa	
Ē				ppPOCKET PENETR	OMETER (kg/cm²)
- - 3 -		6.0		NSTANDARD PENE (SAFETY HAMMER (50/125 = BLO PENETRATION [m	R w/AUTOMATIC TRIP) WS/SAMPLER
	50 mm diam. SCH 40, PVC RISER PIPE			SO ₄ SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
E 4 -			GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to	P200% PASSING N	o. 200 SIEVE
Ē		1 -12	very stiff, medium plastic, moist, brown, oxide stained.	I.A.DIMMEDIATELY	AFTER DRILLING
		15.5		RECORDED WATE (TEST HOLE I.A.I	
E 5 -				RECORDED WATE	R LEVEL (PIEZO)
- 6 				LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VAI LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,
- 8 -	-				ACHIBRODA GINEERING
),
<u> </u>		14.8	—gypsum crystals below 9.0 m.	FIELD DR	
	500.7 m NOV 17/08				ND ' RESULTS
Ē	NOV 17/08			PROJECT:	
E 10 -					BILITY STUDY
E .		16.6		LOCATION:	
- - 11 -			—grey below 10.8 m.	SOUTH SASKAT	BANK CHEWAN RIVER OK, SK
	SAND PACKED			NORTHING:	EASTING:
E	ANNULUS			DATE DRILLED:	DRAWING NUMBER:
F		20.7	CONTINUED ON NEXT PAGE	SEP 24/08	S08-6559-3

		PAGE 2 OF 2	LEGEND:	
DEPTH (m)	TES NU WPwLw	HOLE 08-2	TOPSOIL SAND	
- 12 - - 13 - - 14 -	PP 50 mm diam. SCH 40, PVC RISER PIPE 50 mm diam. MACHINE SLOTTEL SCH 40 PVC WE SCREEN 16 54 SAND PACKED ANNULUS SLOUGH	GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to very stiff, medium plastic, moist, grey, oxide stained, gypsum crystals. CLAY, some silt, some sand, firm, highly plastic, moist, brown.	LwLIQUID LIMIT PwPLASTIC LIMIT YwWET UNIT WEIGH UUNCONFINED CO STRENGTH (KPC PPPOCKET PENETR NSTANDARD PENE (SAFETY HAMMEI (50/125 = BLC PENETRATION [n	RY SOIL WEIGHT) HT (kN/m ³) DMPRESSIVE DOMETER (kg/cm ²) ETRATION TEST R w/AUTOMATIC TRIP) DWS/SAMPLER hm])
- - 16 -			P200% PASSING N I.A.DIMMEDIATELY	DRY SOIL WEIGHT) Io. 200 SIEVE AFTER DRILLING
- 17 -			SHELBY SP	D.) ER LEVEL (PIEZO)
- 18 - - - 19 -			TUBE SPO LIMITATIONS: THE I A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	E SUBSURFACE NTERED AT THE LOCATION AT THE LING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,
20 -			D P. r	MACHIBRODA GINEERING).
- 21 -				RILL LOG ND f RESULTS
- - 22 -			PROJECT: SLOPE STAE	BILITY STUDY
- - - 23 -			SOUTH SASKAT	BANK CHEWAN RIVER DOK, SK
Ē			NORTHING:	EASTING:
-			DATE DRILLED: SEP 24/08	DRAWING NUMBER: S08-6559-3A

				r	
	PIEZO. ELEV.= 526	.6 m	PAGE 1 OF 4	LEGEND:	01.82
DEPTH (m)	TES	T HOLE	08-3 EV: 525.4 m	TOPSOIL SAND	
	PP PP		TOPSOIL, dark brown, roots,		
	BENTONITE SEAL		rootlets. SILT, some clay, some sand, stiff, medium plastic, damp, light brown.	wWATER CONTENT (PERCENT OF D	Ry soil weight)
Ē,				LwLIQUID LIMIT	
E				PwPLASTIC LIMIT	
E		7.9		γ_{wwet} unit weigh	IT (kN∕m³)
2				UUNCONFINED CC STRENGTH (kPc	MPRESSIVE)
Ē	CUTTINGS			PPPOCKET PENETR	OMETER (kg/cm²)
- - - - - - -		10.6	GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to very stiff, medium plastic, moist, brown, oxide stained, gypsum crystals.	NSTANDARD PENE (SAFETY HAMMER (50/125 = BLC PENETRATION [m	R w/AUTOMATIC TRIP) WS/SAMPLER
				SO4SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
F 4 -				P200% PASSING N	o. 200 SIEVE
Ē				I.A.DIMMEDIATELY	AFTER DRILLING
		9.0		CRECORDED WATE (TEST HOLE I.A.I	R LEVEL D.)
E 5				RECORDED WATE	R LEVEL (PIEZO)
	50 mm diam. SCH 40, PVC RISER PIPE				
		12.6		LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA	SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE
		13.7		LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	
8 -					MACHIBRODA GINEERING).
9 -		15.5		1042	RILL LOG ND T RESULTS
Ē				PROJECT:	
E 10 -		+		SLOPE STAE	BILITY STUDY
Ē		16.6		LOCATION:	
- 11 -			-very stiff to hard, grey below 10.8 m.	SOUTH SASKAT	BANK CHEWAN RIVER OCK, SK
E				NORTHING:	EASTING:
E				DATE DRILLED:	DRAWING NUMBER:
E			CONTINUED ON NEXT PAGE	AUG 14/08	S08-6559-4

-								_					PA	GE 2 OF 4	LE	GEN	ND:				2050.00	
DEPTH (m)	N	U	γ _w	T Pw			OLE	∎ 0	8-	3					ТОР	SOIL	GRAVEL	SAND	SILT	CLAY	SHALE	GLACIAL
- 12 -		pp	20.6			15.8		sor to	me ha	sanc rd, n	d, tro nediu	ace g im pl	some ravel, astic, gyps	very stiff moist,	- w			CON ^T ENT O	TENT OF DRY	' SOIL	WEIG	HT)
E - 13 -							ß	сгу	sta	ıls.			571		Lw	LI	QUID	LIMIT				
							RR S								1			C LIM				
Ē						15.3	HX:								Ι %	W	ET U	NIT W	EIGHT	(kN/	m³)	
- 14 -		-					K								U) COM (kPa)	PRESS	SIVE	
E		CUT	TING	5											pp	P(OCKE	T PEN	NETRO	METER	(kg/	cm²)
- 						16.2	ZŠ								N	(S	AFET	Y HAN	PENET MMER BLOW N [mn	w/AUT	TOMAT	C TRIP
-															sc) ₄	SUL (PEF	PHATE	CON F OF I	TENT DRY S	OIL W	EIGHT)
E 16 -				_			R	Ś							P2	00.	% P	ASSIN	IG No.	200	SIEVE	
-						17.4	TR:								I.A	.D	IMM	EDIAT	ELY AI	-ter i	DRILLII	١G
-						17.4													WATER I.A.D.		L	
E 17 -		-				-	R								-	R	ECOR	DED	WATER	LEVE	L (PIE	ZO)
		SCF	mm 1 40 ER P	PV													SHEL TUB		SPLIT SPOO			5
- 18 -			21.1			17.2									A CC SF TII CC	SUN NDI PECI ME NDI	MMAR TIONS FIC T OF TI TIONS	Y OF 5 ENC EST F EST E 5 MAY	THE COUNT HOLE DRILLIN (VAR)	SUBSU ERED LOCAT IG. SU ⁄ AT (IRFACE AT TH ION A IBSURI DTHER	E F THE FACE
- 19 -						16.9	N								M/	AY C	CHAN	OF 1 GE AT ATION.	THIS	ITE AN SPEC	ND, IN IFIC T	TIME, EST
20 -		- SLC	русн				TXXXXXXX									P			P. M/ ENGI LTD.			
- 21 -	1.14.00 E. 18. 4					16.3													D DRI ANI EST	D		
E - 22 -					_										P	30J	ECT: SLC	PE S	TABII		TUDY	(
Ē						14.3	K	\geq								CA	TION	;				
- 23 -	2-22 2-22 2-22 2-22 2-22 2-22 2-22 2-2	_																E. I SAS	AST E KATC	HEW		VER
Ē	2 - 1 2 - 1						8	Ś								_	HING	_		EASTI		
	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1							×	9	CONT	INUE	D ON	NEXT	PAGE	D			. LED: 14/08			I NG N 3-6559	UMBER: 9-4A



							1	PAGE 4 OF 4	LEGEND:	
DEPTH (m)	N	υγ		EST H	IOLE	∎ 08-3			TOPSOIL SAND	
- 36 -		PP	PACKE			CLAY SHALE highly plastic grey, seepag	, moist, lig	very stiff, ght grey to	wWATER CONTEN (PERCENT OF	IT DRY SOIL WEIGHT)
E 37 -			m diari NE SLC						LwLIQUID LIMIT	
Ē		SCH 4	O PVC						PwPLASTIC LIMIT	$HT (kN/m^3)$
						NOTE: 1. Test Hole dry I.A.D.	open to 3	7.5 m and	UUNCONFINED C STRENGTH (kP	OMPRESSIVE
- 38 -										ROMETER (kg/cm²)
- - 39 -									NSTANDARD PEN (SAFETY HAMME (50/125 = BL PENETRATION [ER w/AUTOMATIC TRIP) OWS/SAMPLER
Ē									SO4SULPHATE C (PERCENT O	ONTENT F DRY SOIL WEIGHT)
E 40 -									P200% PASSING	No. 200 SIEVE
Ē									I.A.DIMMEDIATELY	AFTER DRILLING
									TRECORDED WAT (TEST HOLE I.A	ER LEVEL .D.)
- 41 -			-						RECORDED WAT	ER LEVEL (PIEZO)
									SHELBY S	
- 42 -						n			A SUMMARY OF TH CONDITIONS ENCOU	NTERED AT THE E LOCATION AT THE
- 43 -			_						CONDITIONS MAY V	ARY AT OTHER S SITE AND, IN TIME,
- - 44 -										MACHIBRODA IGINEERING D.
- - - -			_						A	RILL LOG ND T RESULTS
									PROJECT:	
- 46 -					-				SLOPE STA	BILITY STUDY
									LOCATION:	
E 47 -			_		-				SOUTH SASKA	T BANK TCHEWAN RIVER OOK, SK
Ē									NORTHING:	EASTING:
Ē									DATE DRILLED:	DRAWING NUMBER:
F	1 1				1				AUG 14/08	S08-6559-4C

	PIEZO. ELEV.= 495.	7 m	PAGE 1 OF 3	LEGEND:	
DEPTH (m)		T HOLE	08-4 EV: 494.9 m	GRAVEL SI FILL SAND	
	PP BENTONITE SEAL		FILL, sand and gravel, trace silt, compact to dense, well graded, fine to coarse grained, moist, brown. SAND, trace silt, compact, poorly	wWATER CONTENT (PERCENT OF D LwLIQUID LIMIT	Ry Soil Weight)
		8.3	graded, fine grained, moist, brown, oxide stained.	PwPLASTIC LIMIT YwWET UNIT WEIGH	
2 -				UUNCONFINED CC STRENGTH (kPc ppPOCKET PENETR	ı)
		7.4		NSTANDARD PENE	TRATION TEST R w/AUTOMATIC TRIP) WS/SAMPLER
	• 50 mm diam. SCH 40, PVC RISER PIPE			***> -> -> -> -> -> -> -> -> -> -> -> -> ->	DRY SOIL WEIGHT)
				P200% PASSING N	
		8.5		TEST HOLE I.A.I	
5	CUTTINGS			RECORDED WATE	
			-dense below 5.5 m.	SHELBY SP	LIT CUTTINGS
		11.2	SILT, sandy, trace clay, firm, low plastic, moist, brown, oxide stained.	A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA	SUBSURFACE ITERED AT THE LOCATION AT THE ING, SUBSURFACE RY AT OTHER
		17.9		LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	SITE AND, IN TIME, S SPECIFIC TEST
8 -	486.9 m NOV 17/08		GLACIAL TILL, clay, silty, some sand, trace gravel, stiff, medium plastic, moist, brown, oxide stained, gypsum crystals.		ACHIBRODA GINEERING).
- 9 -	2.0	14.0	—hard below 9.1 m.	FIELD DF	RILL LOG ND
				SOIL TEST PROJECT:	RESULTS
- 10 -					BILITY STUDY
	4.0	16.0		LOCATION:	PANK
- 11 -				SOUTH SASKAT	BANK CHEWAN RIVER OOK, SK
E E				NORTHING:	EASTING:
		18.4	CONTINUED ON NEXT PAGE	DATE DRILLED: AUG 27/08	DRAWING NUMBER: S08-6559-5

			PAGE 2 OF 3	LEGEND:						
DEPTH (m) - 12 -	N U ⁷ w Pw Lw	T HOLE	TOPSOIL SAND							
			GLACIAL TILL , clay, silty, some sand, trace gravel, hard, medium plastic, moist, brown, oxide stained, gypsum crystals.	wWATER CONTENT (PERCENT OF D	Ry Soil Weight)					
- 13 -				LwLIQUID LIMIT						
Ē				PwPLASTIC LIMIT						
Ē		21.7		γ_{wwet} unit weigh	IT (kN∕m³)					
- 14 -		—		UUNCONFINED CC STRENGTH (kPc						
Ē				PPPOCKET PENETR	COMETER (kg/cm²)					
- - 15 -		20.5		NSTANDARD PENE (SAFETY HAMME (50/125 = BLC PENETRATION [n	R w/AUTOMATIC TRIP					
-	50 mm diam. SCH 40, PVC RISER PIPE			SO ₄ SULPHATE CO (PERCENT OF	ONTENT DRY SOIL WEIGHT)					
E 16 -				P200% PASSING N	lo. 200 SIEVE					
Ē		18.4		I.A.DIMMEDIATELY	AFTER DRILLING					
Ē				RECORDED WATE (TEST HOLE I.A.I						
E 17 -				RECORDED WATE	R LEVEL (PIEZO)					
-				SHELBY SP						
- 18 -		26.8		LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VA LOCATIONS OF THIS MAY CHANGE AT THI HOLE LOCATION.	E SUBSURFACE ITERED AT THE LOCATION AT THE ING. SUBSURFACE RY AT OTHER SITE AND, IN TIME,					
-										
- 20 -					MACHIBRODA GINEERING).					
E 21 -		28.8		FIELD DF						
Ē				11525	ND F RESULTS					
Ē				PROJECT:						
- 22 -			CLAY SHALE, silty, trace sand, very stiff, highly plastic, moist, grey.	SLOPE STAE	BILITY STUDY					
		25.1		LOCATION:						
E 23 -				SOUTH SASKAT	BANK CHEWAN RIVER DOK, SK					
E				NORTHING:	EASTING:					
L		26.8	CONTINUED ON NEXT PAGE	DATE DRILLED: AUG 27/08	DRAWING NUMBER: S08-6559-5A					

r						_	_		<u> </u>								_		-	
											PAGE	E 3 OF 3	LEGE					CLAY		
DEPTH (m)	TEST HOLE 08-4												TOPSOIL GRAVEL SILT SILT SHALE							
- 24 -	N •	SCH	mm	diam PVC				CLAY SI stiff, hig	HALE, s ghly plo	silty, tr astic, r	race sa moist, d	nd, very grey.	(PERCE			' SOIL	WEIGH	HT)	
- 25 -					_	25.6							PwF		C LIMI		(kN/r	n ³)		
26 -						ngton on the log							UL	JNCON	IFINED IGTH (сом				
* * * 1 * *		CUT	TINGS	5									NS	STANDA	T PEN	ENETF	RATION	TEST		
E 27 -		<u></u>				<u>25.5</u>			27				() F	50/12 PENETR	25 = 1 Ration	BLOW: [mm	S/SAM 1])	PLER	C TRIP)	
- - - 28 -														(PEF	PHATE RCENT ASSING	OFE	DRY SO		EIGHT)	
						26.1								ECORI	EDIATE DED W	ATER	LEVEL		IG	
- 				diam SLO									l i		HOLE DED W	ATER		_ (PIE)	ZO)	
		SCH	40 EEN	PVC	WEL	L 25.4								SHEL TUB		SPLIT SPOOI			1	
- 30 -		- SLO	UGH			<u>20,4</u>							A SU COND SPEC TIME	IMMAR DITIONS IFIC T OF TI	NS: TH Y OF S ENCO EST H EST DI S MAY	THE SOUNTE	SUBSU ERED LOCATI IG. SU	RFACE AT THI ON AT BSURF	E THE	
- 31 -													LOCA MAY	TIONS	OF TI GE AT	HIS S	ITE AN	D, IN	TIME, EST	
- 32 -														M	- E		ACHII INEEI			
- 33 -															IELD	ANI	D			
- 34 -								—wet, s 34.0 m		e, slou	ighing t	pelow	PRO	JECT: SLC	PE S	TABIL	LITY S	TUDY	,	
														ATION		AST B			/ER	
- 35 -			-					-sandy	below	35.0	m.				OU	TLOC	DK, SK			
-	2.2.7												NOR	THING): 		EASTI	_		
-								NOTE: 1. Test I.A.D.	Hole s	slough	ed to 2	29.6 m		e dril Aug 2		1		I NG NI 3-6559	JMBER :)-5B	