D R A F T

TECHNICAL MEMORANDUM

DATE May 24, 2013 **PROJECT No.** 08-1111-0022 Addendum 4

TO Jan Wieczorek, P. Eng.
AECOM

FROM M. Soderman / K. Bentley **EMAIL** msoderman@golder.com
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FOUNDATION ENGINEERING SERVICES FOR PROPOSED LONG-TERM EARTH FILL STOCKPILES HIGHWAY 404 EXTENSION – QUEENSVILLE SIDEROAD TO RAVENSHOE ROAD
G.W.P. 2005-07-00, CONTRACT 2010-2055

Introduction

Golder Associates Ltd. (Golder) has been retained by AECOM to provided foundation services pertaining to two proposed long-term stockpiles associated with the Highway 404 extension project, in accordance with the Terms of Reference from The Ministry of Transportation (MTO) titled "Revised Addendum for Evaluation of Proposed Earth Fill Stockpile", received from AECOM on March 21, 2013 and based on follow up telephone conversations with MTO Foundations on April 4 and 8, 2013 and AECOM on April 8, 2013. The revised addendum work consists of performing a desktop study of existing geotechnical information and providing foundation recommendations for construction of two proposed long-term earth fill stockpiles required for two sites as noted below and shown on Drawing 1.

Stockpile Area 'A' – located on the east side of the proposed Hwy 404 extension, in the area bounded by the Hwy 404 South - Woodbine Avenue N-S off-ramp; proposed 4 m high stockpile and capacity of up to 38,048 m^3;

Stockpile Area 'B' – located west of Woodbine Avenue, between the Hwy 404 S – Woodbine N/S off-ramp and an adjacent proposed stormwater management pond; proposed 3 m high stockpile and capacity of up to 3,140 m^3.

This memorandum summarizes the factual results of available subsurface information (including laboratory test data) in the area and provides geotechnical information related to earth fill stockpile placement, the results of global slope stability analysis, and comments related to surface water drainage, erosion protection and general stockpile construction. Based on a conversation with AECOM on April 8, 2013 we understand that there are no buried services near Stockpile 'B', and any existing buried services near Stockpile 'A' are located at least 5 m from the proposed stockpile footprint toe of slope. As a result, settlement is not considered to be a concern. If buried services are located within or near the proposed stockpile footprint, an assessment of the expected settlement of the buried services should be performed. The design of any encasements or mitigation measures to protect any buried services from unacceptable settlements is the responsibility of others.

General

Referring to the base plan provided by AECOM as shown on Drawing 1, the existing ground surface at the proposed stockpile locations is relatively flat lying and ranges from about Elevations 228 m to 230 m within the footprint of Stockpile 'A' and Elevations 228 m to 232 m within the footprint of Stockpile 'B'. The general area ground cover consists of grass and tree clumps in places as observed during site visits in 2010.

We understand that the stockpiles may be located within the regulatory floodplain and near the Maskinonge River Wetland Complex; this memorandum addresses only the geotechnical foundation aspects of the proposed stockpiles and any environmental impacts or floodplain impacts have not been considered.

Desktop Study - Subsurface Conditions

A search for available subsurface information in the vicinity of the proposed stockpiles was performed by Golder for the current project (G.W.P. 2005-07-00) and at the MTO GEOCRES library. The desktop study identified two previous boreholes (SWM9-BH1 and SWM9-BH2) which were advanced to depths of about 4.3 m as part of the hydrogeological investigation for the stormwater management ponds associated with the Highway 404 Extension project. This work is summarized in a report prepared by Golder titled "Hydrogeological Investigation and Design Report – Highway 404 Extension from Queensville Sideroad to Ravenshoe Road – Town of East Gwillimbury – Ministry of Transportation, Ontario – W.P. 2005-07-00", September, 2010, GEOCRES No. 31D-499.

The boreholes were advanced as part of the investigation for Stormwater Management Pond 9 and the approximate locations of these boreholes and SWM 9 relative to the proposed stockpile areas are shown on Drawing 1. The two boreholes are located about 100 m to 200 m from the stockpile footprints.

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced as part of the previous investigation and the results of in situ and laboratory testing are given on the Record of Borehole sheets attached; the results of geotechnical laboratory testing are also shown on the borehole records.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the soils encountered at the site consist of topsoil underlain by a predominantly cohesive glacial till deposit. A more detailed description of the major soil deposits encountered in the boreholes is provided below.

Topsoil

An approximately 300 mm thick layer of topsoil was encountered immediately below the existing ground surface in Boreholes SWM9-BH1 and SWM9-BH2.

Glacial Till

A till deposit comprised predominantly of silty clay to clayey silt was encountered below the topsoil in Boreholes SWM9-BH1 and SWM9-BH2 at a depth of 0.3 m below ground surface (Elevation 229.3 m and 228.5 m, respectively). Boreholes SWM9-BH1 and SWM9-BH2 were terminated within the silty clay till to clayey silt till deposit at a depth of 4.3 m below ground surface (Elevation 225.3 m and 224.5 m in the respective boreholes). The measured SPT 'N'-values recorded within the silty clay to clayey silt till range from 10 to 28 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency. The result of one grain size distribution test carried out on a sample of the silty clay till to clayey silt till indicates 36 per cent clay, 62 per cent silt, and 2 per cent sand.

The measured water content of five samples of the silty clay till to clayey silt till ranges from 15 per cent to 23 per cent.

A 0.7 m thick deposit of sandy silt till to sand and silt till, containing some clay, trace gravel was encountered within the silty clay to clayey silt till in Borehole SWM9-BH1 at a depth of 1.4 m below ground surface (Elevation 228.2 m). A measured SPT 'N'-value within the sandy silt till to sand and silt till is 16 blows per 0.3 m of penetration, indicating a compact relative density. The result of a grain size distribution test carried out on a sample of the sandy silt till to sand and silt till indicates 14 per cent clay, 46 per cent silt, 33 per cent sand and 7 per cent gravel. The measured water content of one sample of the sandy silt till to sand and silt till is 11 percent.

Groundwater Conditions

Water levels were noted within the boreholes during and after the drilling operations and are summarized below:

Borehole	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
SWM9-BH1	229.6	Dry	-	Mar. 13, 2009	Open Borehole
SWM9-BH2	228.8	1.8	227.0	Mar. 12, 2009	Open Borehole

It should be noted that groundwater level(s) will fluctuate seasonally and is expected to rise during wet periods of the year.

Discussion and Engineering Recommendations

This section of the Technical Memorandum provides geotechnical / foundation design recommendations based on the information collected from the desktop study for the proposed two long-term stockpile areas, designated as Stockpile A and Stockpile B. The recommendations are based on the interpretation of the available factual data obtained from the boreholes advanced during a previous investigation at SWM Pond 9. The recommendations are intended to provide the designers with sufficient information to complete the design of the proposed stockpiles. Where comments are made on construction, they are provided in order to highlight those aspects which could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

Proposed Stockpiles

The proposed Stockpile A and Stockpile B locations are shown on Drawing 1 and typical cross-sections of the stockpiles provided by AECOM on April 9, 2013 (Dwg. Name: 2538-199-00_CT_TYP.dwg, dated April 9, 2013) are shown on Drawing 2. The details of each stockpile are provided below.

Stockpile	Approximate Stockpile Footprint Dimensions (Length x Average Width)	Approximate Stockpile Volume (m^3)	Stockpile Crest Elevation (m)	Approximate Maximum Fill height (m)
Stockpile A	220 m x 50 m	38,048	233 m	4
Stockpile B	65 m x 25 m	3,140	232 m	3

Recent correspondence from AECOM suggests that the approximately northern half of stockpile A may need to be removed/re-graded to accommodate the future Woodbine Avenue North-Highway 404 North (Eastbound) Ramp at the next stage of Highway extension. Therefore, AECOM has recommended that the stockpile fill in this area be “re-usable”. For the purpose of this geotechnical assessment, it is assumed that the stockpile fill material in all areas will consist of clean excess earth material (free of excessive organics) from the construction of the Highway 404 project. Any structures, including roadway/ramp pavements founded on the stockpile material should be designed on the basis of the structural quality of the material as placed to support such structures.

Stability

Limit equilibrium slope stability analyses were performed using the commercially available program “Slide V.6”, produced by Rocscience Inc., employing the Morgenstern-Price method of analysis at critical sections for each of the stockpiles to verify that the Factor of Safety against global instability is greater than or equal to 1.3 for the proposed configuration of the stockpiles. The soil parameters (shown on figures 1 and 2) used for the analyses were estimated from empirical correlations (CHBDC, 2006)[1] with the available borehole, laboratory and SPT information in the area of the stockpiles. As indicated in the previous section, the stockpile fill material is assumed to consist of clean suitable earth fill (i.e. excess material) that can be reasonably compacted to at least 90 per cent of its Standard Proctor maximum dry density (SPMDD) and is free of excessive organics. The configuration of the stockpiles used in the models are based on the typical design sections provided by AECOM, which indicate the side-slopes of each stockpile to be at 3 Horizontal : 1 Vertical. A variable width mid-height bench is also proposed for Stockpile B. The piezometric conditions used in the analyses are based on the highest groundwater level noted during drilling operations, which was measured to be at about Elevation 227 m. It is understood that SWM Pond 9 will be lined with a relatively impermeable liner at the base and along the interior side-slopes. For Stockpile B, considering the pond will be lined and the fact that the proposed Stockpile is essentially an extension of the pond berm fill, the effect of the water level in the pond is not considered to impact the global stability of the stockpile.

The results of the analyses indicate that a Factor of Safety greater than 1.3 for deep seated, global failure surfaces that would impact operation of the nearby roadways, pond or drainage system is calculated for the proposed long-term configuration of Stockpile A and B. Example results of two analyses performed at critical sections of Stockpile A and Stockpile B are shown on Figures 1 and 2, respectively.

[1] Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA-S6-06. 2006. CSA Special Publication, S6.1-06. Canadian Standard Association.

Settlement

Based on the typical design sections, soil material stockpiles up to 4 m and 3 m high are to be placed at Stockpile A and Stockpile B, respectively. Settlement analyses were performed using the commercially available software program "Settle 3D" produced by Rocscience Inc. and checked with hand calculations to estimate the settlement of the foundation soils underlying the proposed stockpiles.

A bulk unit weight of 20 kN/m^3 has been assumed for the stockpile materials in calculating the stockpile loading on the founding subsoils. The foundation soil parameters are based on field and laboratory test data and accepted correlations (CHBDC, 2006)[1]. It is assumed that all topsoil will be removed from below the footprint of each stockpile area prior to stockpile material placement. Based on the results of the settlement analyses, the total settlements are comprised of immediate settlement (i.e., occurring during or shortly after construction) and consolidation settlement (i.e., time-dependant settlement after-construction) of the over-consolidated cohesive deposits. The estimated maximum settlements of the stockpiles constructed at each of the areas are summarized below.

Stockpile	Total Estimated Settlement (mm)	Primary Settlement Component (mm)	Consolidation Settlement Component (mm)
Stockpile A	50	45	5
Stockpile B	40	35	5

It is noted that the total settlement will be differential relative to other areas of the stockpiles where fill heights are less than the values assumed in the analysis. Consideration could be given to leaving the topsoil in place; however settlements (up to an additional 50 mm) could be expected assuming about 0.3 m of topsoil is present. Settlements are not anticipated to be a concern in most areas if regular maintenance is provided to ensure proper drainage. However if the topsoil is left in place below the future Woodbine N/S-Highway 404 S ramp, then settlements in the northern half of Stockpile A may be a concern as it would affect the performance of the ramp.

Provided that the stockpile material is properly placed and compacted to at least 90 per cent of the SPMDD of the material in accordance with SP206S03 (Earth Excavation and Grading), the settlement of the stockpile material itself is expected to be less than 25 mm, and the majority of settlement will occur during or shortly after construction.

Subgrade Preparation and Stockpile Material Placement

Prior to the placement of any stockpile material, all topsoil (estimated to be up to about 0.3 m thick) should be stripped from below the proposed stockpile footprints in accordance with SP206S03 (Earth Excavating, Grading) and temporarily stockpiled so that it can be re-used as cover for the long-term stockpiles. Alternatively, in non-settlement sensitive areas, the topsoil can be left in place but should be scarified prior to the placement of stockpile material.

After stripping or scarification, the subgrade soils should be inspected by the Quality Verification Engineer prior to placement of stockpile material, and any poorly performing areas in settlement sensitive areas (i.e. below the proposed Woodbine Ave N-Hwy 404 N Ramp) should be sub-excavated and replaced with suitable fill.

All stockpile fill should be placed and compacted in accordance with SP206S03 (Earth Excavation, Grading). Standard Proctor testing (ASTM D698) should be carried out on bulk samples of the proposed stockpile material

to determine the SPMDD and optimum moisture content (OMC). The stockpile material should be compacted to not less than 90 per cent of the SPMDD for general fill purposes at not more than +/- 4 percent of the OMC. For settlement sensitive areas, stockpile fill should be compacted to at least 98 per cent of the SPMDD.

Surface water should be directed away from the stripping/stockpiling areas at all times. Temporary erosion control (i.e. silt fences and/or check dams) should be put in place prior to and maintained during construction to control surface water run-off and sediments.

To reduce surface water erosion on the permanent stockpile exterior side-slopes, topsoil and seeding should be placed as soon as possible in accordance with OPSS 572 (Construction Specification for Seed and Cover). Construction of the stockpiles should be completed in the summer months to allow for protective growth on the side slopes to occur. If protection is not in place before Winter, remedial works on the side slopes in the Spring may be required prior to topsoil and seeding as a result of erosional damage. The surrounding ditches may also require remediation due to the influx of eroded stockpile materials during and shortly after construction, and during regular maintenance activities.

Closure

We trust that this technical memorandum satisfies your current requirements. If you have any questions, please do not hesitate to contact us.

Matt Soderman, E.I.T.
Geotechnical Engineering Group

Kevin Bentley, P. Eng.
Associate

Jorge Costa, P.Eng.
Designated MTO Contact, Principal

MAS/KJB/JMAC/jl

Attachments:
Drawing 1 – Borehole Location Plan
Drawing 2 – Cross-sections Provided by AECOM
List of Symbols and Abbreviations
Record of Boreholes SWM9-BH1 and SWM9-BH2
Figure 1 – Stockpile A – Static Global Stability at Section A-A'
Figure 2 – Stockpile B – Static Global Stability at Section B-B'

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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

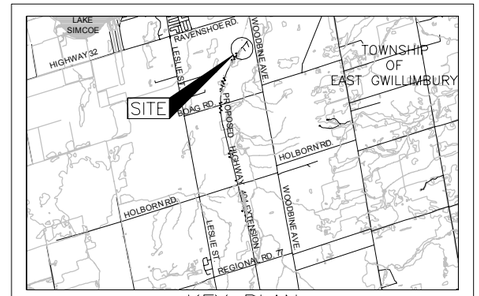
CONT No. 2010–2055
WP No. 2005–07–00

HIGHWAY 404 EXTENSION
PROPOSED PERMANENT STOCKPILES
BOREHOLE LOCATION PLAN

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

PLAN
SCALE
20 0 20 40 m



KEY PLAN
SCALE
1.5 0 1.5 3 km

LEGEND

● Borehole – Golder, 2010 (GEOCRES No. 31D–499)

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
SWM9–BH1	229.6	4894410.5	309619.3
SWM9–BH2	228.8	4894488.0	309651.5

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by AECOM, drawing file "2538–199–00_CT–XDesign.dwg", received April 16, 2013.

DRAFT

NO.	DATE	BY	REVISION

Geocres No.

HWY. 404	PROJECT NO. 08–1111–0022		DIST.
SUBM'D. MAS	CHKD. MAS	DATE: May 2013	SITE:
DRAWN: MR	CHKD. KJB	APPD. JMAC	DWG. 1

PLOT DATE: May 23, 2013
FILENAME: I:\Projects\2008\08-1111-0022 (GWA, York)\-MA- (Stockpiles)\08111100229A001.dwg

METRIC

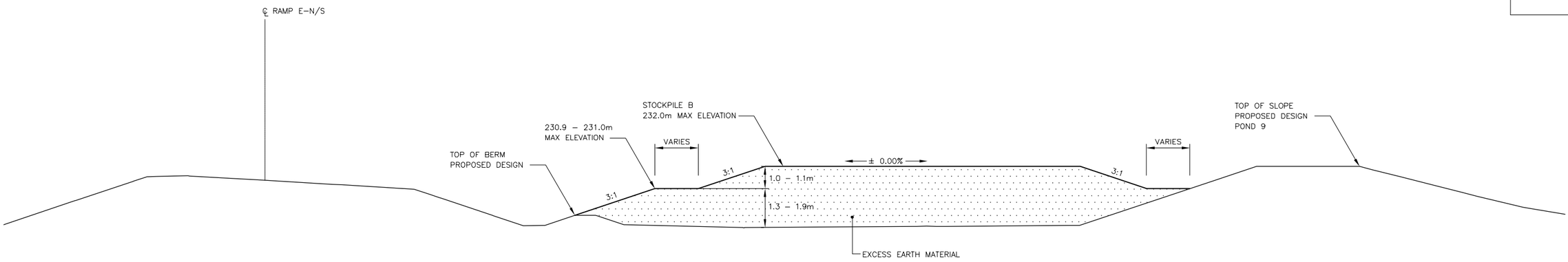
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT 2010–2055
WP 2005–07–00

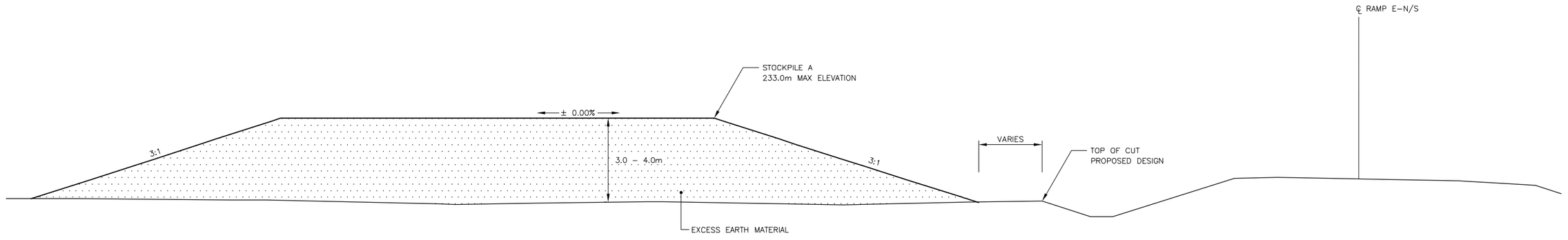
SHEET

TYPICAL SECTIONS

AECOM



STOCKPILE B



STOCKPILE A

Drawing 2

Cross-sections Provided by AECOM

N.T.S.

DRAFT

MINISTRY OF TRANSPORTATION, ONTARIO PR–D–707 88–05

DRAWING NAME: 2538–199–00_CT–TYP.dwg PLOT DATE: 4/9/2013 4:00 PM
SAVED BY: smallwoodw SAVE DATE: 4/9/2013 2:42 PM

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:
The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)
A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index / Relative Density	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Percent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (cohesionless) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

Golder Associates

RECORD OF BOREHOLE No SWM9-BH1 SHEET 1 OF 1 METRIC

PROJECT 08-1111-0022
G.W.P. 2005-07-00 LOCATION N 4894410.5 ;E 309619.3 ORIGINATED BY NS
DIST HWY 404 BOREHOLE TYPE 108 mm Dia. Solid Stem Augers COMPILED BY SC
DATUM Geodetic DATE March 13, 2009 CHECKED BY XW/KJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.6	GROUND SURFACE										
0.0 / 229.3	TOPSOIL										
0.3	SILTY CLAY to CLAYEY SILT, trace sand, trace gravel (TILL) Stiff Light brown Moist		1	AS	-		229				
228.2			2	SS	15						
1.4	Sandy SILT to SAND and SILT, some clay, trace gravel (TILL) Compact Brown Moist		3	SS	16		228				7 33 46 14
227.5 / 2.1	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to very stiff Light brown to grey Moist to wet		4	SS	28		227				
			5	SS	10						
			6	SS	14		226				
225.3											
4.3	END OF BOREHOLE										

NOTES:

1. Borehole open and dry upon completion of drilling.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No SWM9-BH2 SHEET 1 OF 1 METRIC

PROJECT 08-1111-0022
G.W.P. 2005-07-00 LOCATION N 4894488.0 ;E 309651.5 ORIGINATED BY NS
DIST HWY 404 BOREHOLE TYPE 108 mm Dia. Solid Stem Augers COMPILED BY SC
DATUM Geodetic DATE March 12, 2009 CHECKED BY XW/KJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
228.8	GROUND SURFACE										
0.0 / 228.5	TOPSOIL										
0.3	SILTY CLAY to CLAYEY SILT, trace sand, trace gravel (TILL) Sitff to very stiff Light brown Moist		1	AS	-		228				
			2	SS	18						
			3	SS	10	▽	227				
			4	SS	25		226				
			5	SS	12						
			6	SS	21		225				
224.5											0 2 62 36
4.3	END OF BOREHOLE										

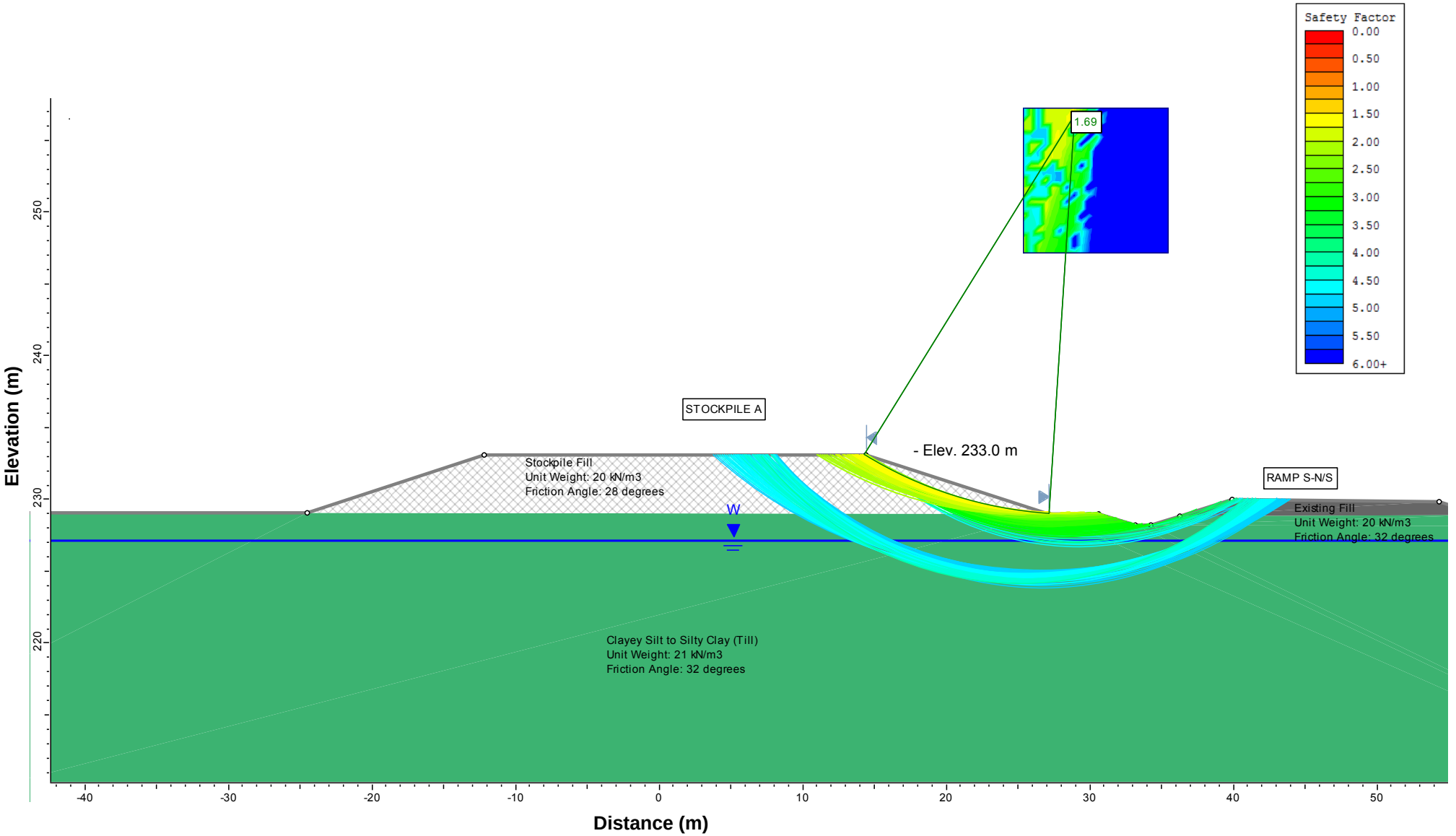
NOTES:

1. Water level in open borehole at a depth of 1.8 m below ground surface (Elev. 227.0 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Stockpile A – Static Global Stability for A-A'
Highway 404 Extension

Figure 1



Date: May 2013
Project No: 08-1111-0022

Analysis By: MAS **Reviewed By:** KJB

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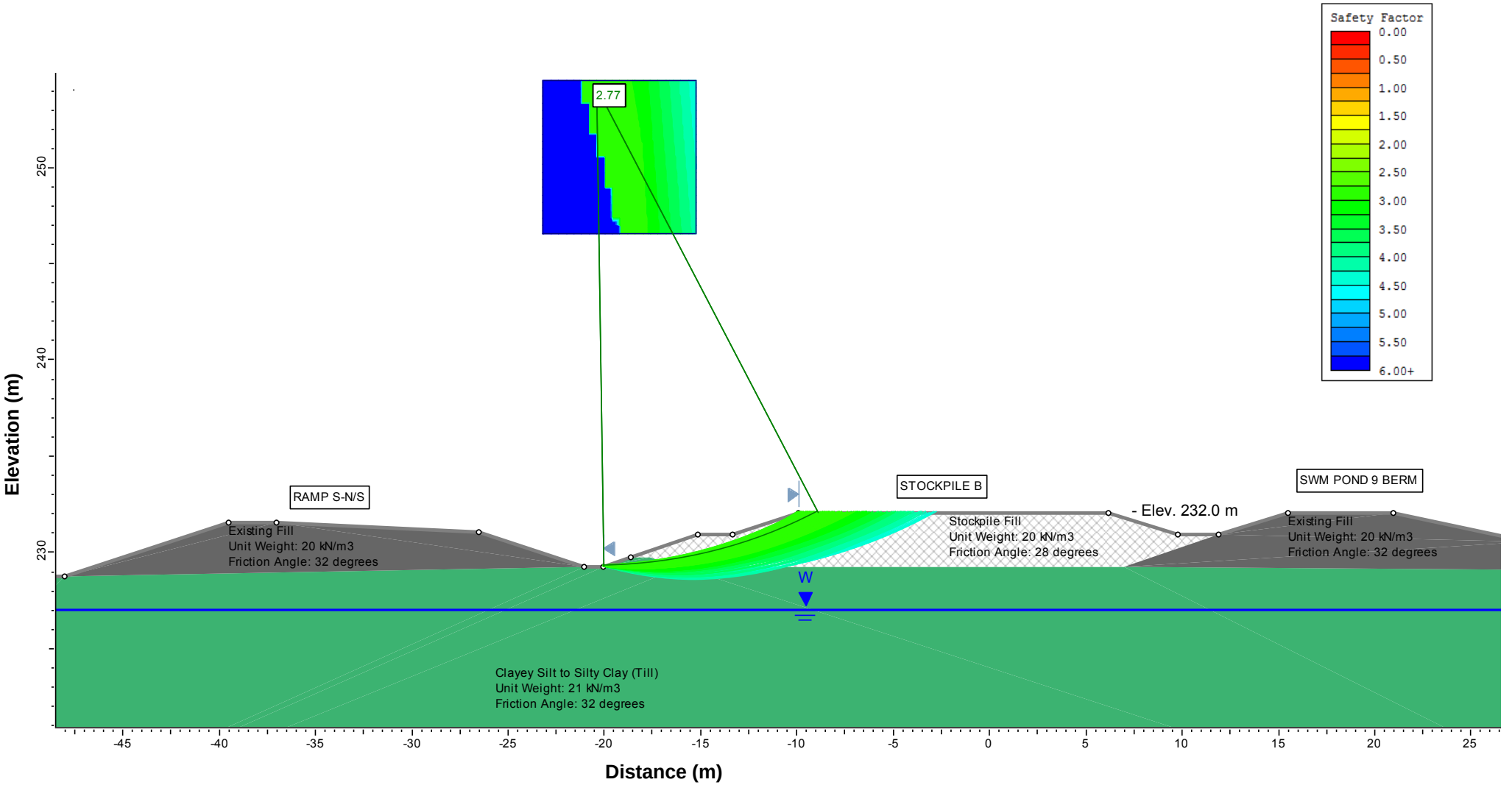
Stockpile B – Static Global Stability for B-B'
Highway 404 Extension

Figure 2



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Analysis By: MAS **Reviewed By:** KJB

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