



SMEC Testing Services Pty Ltd

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May 8, 2009

Project No. 17055/6342B

Report No. 09/0435

LWI/ms

DeiCorp Pty Limited
Shop 5, 140-152 New Canterbury Road
PETERSHAM M NSW 2049

Attention: Mr. Greg Colbran

**SUBJECT: ACID SULFATE SOIL (ASS) ASSESSMENT
157 REDFERN STREET, REDFERN**

Dear Sir,

Introduction

This letter report presents the results of an ASS assessment for a proposed new commercial/retail/residential development to be constructed on the property. Site development will include a 15 metre deep basement excavation.

ASS are the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid. Natural processes formed the majority of acid sulfate sediments when certain conditions existed in the Holocene geological period (the last 10,000 years). Formation conditions require the presence of iron-rich sediments, sulfate (usually from seawater), removal of reaction products such as bicarbonate, the presence of sulfate reducing bacteria and a plentiful supply of organic matter. It should be noted that these conditions exist in mangroves, salt marsh vegetation or tidal areas, and at the bottom of coastal rivers and lakes.

The relatively specific conditions under which acid sulfate soils are formed usually limit their occurrence to low lying parts of coastal floodplains, rivers and creeks. This includes areas with saline or brackish water such as deltas, coastal flats, backswamps and seasonal or permanent freshwater swamps that were formerly brackish. Due to flooding and stormwater erosion, these sulfidic sediments may continue to be re-distributed through the sands and sediments of the estuarine floodplain region. Sulfidic sediment may be found at any depth in suitable coastal sediments – usually beneath the watertable.

Any lowering in the watertable that covers and protects potential ASS will result in their aeration and the exposure of iron sulfide sediments to oxygen. The lowering in the watertable can occur naturally due to seasonal fluctuations and drought or any human intervention, when carrying out any excavations during site development. Potential ASS can also be exposed to air during physical disturbance with the material at the disturbance face, as well as the extracted material, both potentially being oxidised. The oxidation of iron sulfide sediments in potential ASS results in ASS soils.



Successful management of areas with ASS is possible but must take into account the specific nature of the site and the environmental consequences of development. While it is preferable that sites exhibiting acid sulfate characteristics not be disturbed, management techniques have been devised to minimise and manage impacts in certain circumstances.

When works involving the disturbance of soil or the change of groundwater levels are proposed in coastal areas, a preliminary assessment should be undertaken to determine whether acid sulfate soils are present and if the proposed works are likely to disturb these soils.

Geology, Fieldwork Details and Subsurface Conditions

Reference to the Sydney geological series sheet at a scale of 1:100,000 shows Triassic Age Ashfield Shale underlies the site. Rocks within this formation comprise shale and laminite and weather to form reactive clays. The Ashfield Shale is underlain by Triassic Age Hawkesbury Sandstone. Rocks within this formation comprise medium to coarse grained quartz sandstone.

SMEC Testing Services Pty Limited has undertaken a geotechnical investigation for the site. As part of that investigation (Refer to our Report No. 09/0180) three boreholes were drilled to depths of between 20 to over 39 metres. The borehole locations are shown on Drawing No. 09/0435. The subsurface conditions encountered are shown on the attached borehole logs. Explanation sheets and notes relating to geotechnical reports are also attached.

When making an assessment of the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. The actual conditions at the site may differ from those inferred herein, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The subsurface conditions comprise fill overlying silty clays and weathered shale and sandstone. The fill is 0.6 to 0.8 metres thick. Natural silty clays were observed to depths of 2.7 to 5.5 metres. These were underlain by weathered shale to a depth of 28.8 metres. Weathered sandstone is present to the maximum depth of drilling, 39.48 metres.

Groundwater was observed at depths of 4.2 to 5.0 metres.

Presence of ASS

Reference to the Botany Bay ASS Risk Map indicates the property is an area where there are no known occurrences of ASS.

The following geomorphic or site criteria should be used to determine if acid sulfate soils are likely to be present:



- ❑ sediments of recent geological age (Holocene)
- ❑ soil horizons less than 5 in AHD
- ❑ marine or estuarine sediments and tidal lakes
- ❑ in coastal wetlands or back swamp areas

Assessment

The property location is underlain by Ashfield Shale and therefore is not consistent with the geomorphic criteria for the presence of ASS. The existing groundsurface has an elevation of about RL 31 metres. Based on our onsite observations and the subsurface conditions exposed in the boreholes, it is our opinion that the proposed construction will not intercept any ASS. The groundwater present appears to be located on the soil/rock interface, which is common in the Sydney area. Removal of this water during construction is likely to have minimal if any affect on the local groundwater level. As a consequence, construction will not result in the lowering of any groundwater that may be present in the ASS some 700 metres from the site.

Our assessment is the proposed construction will not require the preparation of an Acid Sulfate Soil Management Plan.

We trust this meets with your requirements. Should you have any questions, please contact us.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'L. Ihnativ', is written in a cursive style.

Laurie Ihnativ, BE, MEngSc, MBA
Manager, SMEC Testing Services Pty Limited

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by SMEC Testing Services Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, SMEC Testing Services Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, SMEC

Testing Services Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

Subsurface Information

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 18, 2009
 Logged: JK Checked By: JH

BOREHOLE NO.: BH 1
 Sheet 2 of 8

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES								
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
			0.0															
			1.0															
			2.0															
			3.0															
			4.0	START CORING AT 4.0 M														
			5.0	NO CORE 4.0 TO 5.78 M														
			6.0	SHALE: orange brown with light grey and occasional cark grey, fine grained	MW/ HW													5.78-6.0 m, Jt, 0-15 deg. Ir, Ro Cy, fe
Notes:																		
See explanation sheets for meaning of all descriptive terms and symbols																		
Contractor: Terratest Equipment: Edson 3000 Hole Diameter (mm): Angle from Vertical (°):																		

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 18, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 1
 Sheet 3 of 8

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES								
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N Q C O R E D I N G				SHALE: orange brown/light grey and occasional dark grey, fine grained	MW/ HW													6.0-6.2 m, Jt 0-15 deg. Ir, Ro, Cy, fe
				NO CORE 6.2 TO 6.73 M														
			79%	7.0	SHALE: dark brown/grey, fine grained, clay seams	MW												6.73-7.1 m, Jt, Ir, Ro, Cy
																		7.22 m, Jt, 0 deg. Pl, Ro 7.32 m, Jt, 0 deg. Pl, Sm 7.44 m, Jt, 0 deg. Pl, Ro, Cy opening upon drying 7.61 m, Jt, 0 deg. Pl, Sm
				8.0		MW/ SW												7.85-7.95 m, CZ, Cy
					NO CORE 8.5 TO 9.2 M													8.1-8.16 m, Sm, Cy
																		8.3 m, Jt, 0 deg. Pl, Ro, Cy 8.38 m, Jt, 0 deg. Pl, Ro 8.42-8.5 m, Sm, Cy
			61%	10.0	SHALE: dark grey with light grey, fine grained	Fr												9.28-9.34 m, Jt, 90 deg. Ir, Ro 9.39 m, Jt, 0 deg. Pl, Sm 9.46 m, Jt, 0 deg. Pl, Sm 9.54 m, Jt, 0 deg. Pl, Sm
					NO CORE 10.2 TO 10.85 M													9.74 m, Jt, 0 deg. Pl, Sm 9.79 m, Jt, 0 deg. Pl, Sm 9.89-9.92 m, Jt, 90 deg. Ir, Ro 9.93-10.32 m, numerous Jt, 0-90 deg. Ir, Pl, Cy
		↓ water loss	66%	11.0	SHALE: dark grey with light grey, fine grained	Fr												10.85-11.69 m, Numerous Jt, 0 deg. Pl, Ro
			12.0														11.7-11.9 m, Sm, Cy	

Notes: Contractor: Terratest
 Equipment: Edson 3000
 Hole Diameter (mm):
 Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 19, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 1
 Sheet 6 of 8

DRILLING			MATERIAL STRENGTH						DISCONTINUITIES									
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N Q C O R E D I N G		100%	24.03	SHALE: dark grey with light grey, fine grained	Fr												24.03 m, Pt, 0 deg. Pl, Sm	
			24.25														24.25 m, Jt, 0 deg. PL, Ro	
			24.32														24.32 m, Pt, 0 deg.. Pl, Sm	
			24.83														24.83 m, Pt, 0 deg. PL, Sm	
			25.46														25.46 m, Pt, 0 deg. Pl, Sm	
			25.59-25.7														25.59-25.7 m, Jt, -80 deg. Ir, Sm, open-tight	
			25.93														25.93 m, Pt, 0 deg. Pl, Sm	
			26.11														26.11 m, Jt, 45 deg. PL, Sm, cy veneer	
			26.36-26.39														26.36-26.39 m, Jt, 40 deg. Ir, Ro	
			26.44-26.51														26.44-26.51 m, Jt, 30-45 deg. Ir, Ro	
		26.9														26.9 m, Pt, 0 deg. Pl Sm		
		27.01-27.23														27.01-27.23m, numerous Jt, 0 deg Pl, Ro, minor cy		
		27.37	SHALE: light grey with dark grey, fine grained, occasional sandy interbeds	Fr												27.37 m, Jt, 0 deg. PL, Sm		
		27.83														27.83 m, Pt, 0 deg. Sm		
		28.12														28.12 m, Pt, 0 deg. Pl, Ro		
		28.33														28.33 m, Jt, 0 deg. Pl, Ro		
		28.76	SANDSTONE: light grey with dark grey bands fine to medium grained	Fr												28.76 m, Jt, 0 deg. PL, Ro		
		28.8														28.8m, Jt, 2 deg. PL, Ro		
		29.6														29.6 m, Pt, 0 deg. Pl, Sm		
		29.82														29.82 m, Jt, 0 deg. Pl, Ro		
Notes:													Contractor: Terratest Equipment: Edson 3000 Hole Diameter (mm): Angle from Vertical (°):					
See explanation sheets for meaning of all descriptive terms and symbols																		

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 19, 2009
 Logged: JK Checked By: JH

BOREHOLE NO.: BH 1
 Sheet 8 of 8

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES								
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N Q C O R E D I N G		100%	36.17	SANDSTONE: light grey with dark grey bands, fine to medium grained	Fr												36.17 m, Pt, 20 deg. Pl, Sm	
		100%	37.43														37.43 m, Pt, 20 deg. Pl, Sm	
			39.48	BOREHOLE DISCONTINUED AT 39.48 M														
			42.0															

Notes: Contractor: Terratest
 Equipment: Edson 3000
 Hole Diameter (mm):
 Angle from Vertical (°):
 See explanation sheets for meaning of all descriptive terms and symbols

W A T E R L E V E L		S A M P L E S		DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E				
Client: DeiCorp Pty Limited Project: 157 Redfern Street, Redfern Location: Refer to Drawing No. 09/0435		Project No.: 17055/5911B Date : February 19, 2009 Logged: JK							BOREHOLE NO.: BH 2 Sheet 1 of 5			
SPT 1.5-1.95 m 3, 6, 10 N = 16				ASPHALT/SANDY GRAVEL: (230 mm thick)	GW	DENSE	D					
				SILTY SANDY CLAY: dark brown, fine grained sand, low plasticity, trace of gravel		CL	VERY STIFF	M				
				FILL								
				SILTY CLAY: orange brown with light grey, medium plasticity		CL	STIFF	M				
				SILTY CLAY: light grey with red brown and occasional orange brown, medium plasticity, trace of ironstone gravel		CL	STIFF TO VERY STIFF	M				
				SPT 3.0-3.45 m 5, 11, 16 N = 27				SILTY CLAY: light grey with occasional red brown, low to medium plasticity, (CW shale)		CL	VERY STIFF	M-D
								SPT 4.5-4.95 m 3, 8, 12 N = 20				SHALE: dark brown/grey with occasional orange brown, fine grained
NOTES: D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT)						Contractor: Terratest Equipment: Explorer 2000 Hole Diameter (mm): 100 Angle from Vertical (°) 0						
See explanation sheets for meaning of all descriptive terms and symbols												

Client: DeiCorp Pty Limited
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Project / STS No.: 17055/5911B
 Date: February 19, 2009
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 Checked By: JH

BOREHOLE NO.: BH 2
 Sheet 3 of 5

DRILLING		MATERIAL STRENGTH						DISCONTINUITIES										
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N Q C O R E D I N G				START CORING AT 6.1 M (For non core details refer to non core log sheets)														
				NO CORE 6.1 TO 6.2 M														
			75%	SHALE: dark brown/grey with occasional orange brown, fine grained	HW													6.2-8.05 m, numerous Jt, fractured, cy, Ir, Ro
			100%															
			7.0															
			60%	SHALE: dark grey with occasional orange brown, fin grained, clay seams	MW/ SW													
			8.0															8.05 m, Jt, 0 deg. Pl, Sm
				SHALE: dark grey with light grey bands, fine grained	SW													8.14-8.22 m, Sm, Cy
																		8.41 m, Jt, 0 deg. Pl, Sm
						Fr												8.56 m, Jt, 0 deg. Pl, Sm
																	8.67 m, Jt, 0 deg. Pl, Sm	
																	8.7-8.92 m, Jt, - deg. Pl, Ro, minor cy, open-tight	
																	9.16-9.2 m, Sm, Cy	
				NO CORE 9.2 TO 9.76 M														
		100%																
			SHALE: dark grey with light grey bands, fine grained	Fr														9.83 m, Jt, 0 deg. PL, Sm
																	10.07 m, Pt, 0 deg. Pl, Ro	
																	10.2 m, Jt, 0 deg. Pl, Sm	
																	10.32 m, Pt, 0 deg. Pl, Ro	
																	10.37 m, Pt, 0 deg. Pl, Ro	
																	10.48 m, Jt, 0 deg. PL, Sm	
																	10.62 m, Pt, 0 deg. Pl, Sm	
																	10.72 m, Jt, 0 deg. PL, Sm, cy veneer	
																	10.8-11.26 m, numerous Jt, 0 deg. Pl, Ro tight-open	
																	11.32 m, Jt, 0 deg. PL, Ro	
																	11.4 m, Jt, 0 deg. PL, Ro	
																	11.5 m, Jt, 0 deg. Pl, Ro	
																	11.63 m, Jt, 2 deg. Pl, Ro	
																	11.68 m, Jt, 5 deg. Pl, Sm	
																	11.77 m, Jt, 0 deg. PL, Sm	
																	11.96 m, Jt, 0 deg. Pl, Sm	
			12.0															

Notes: Contractor: Terratest
 Equipment: Explorer 2000
 Hole Diameter (mm):
 Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 19, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 2
 Sheet 4 of 5

DRILLING			MATERIAL STRENGTH						DISCONTINUITIES									
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N Q C O R I N G		100%	12.0	SHALE: dark grey with light grey bands, fine grained	Fr												12.03 m, Pt, 0 deg. Pl, Sm	
			13.0														12.06 m, Pt, 0 deg. Pl, Sm	
																	12.13 m, Jt, 0 deg. PL, Sm	
																	12.21 m, Jt, 0 deg. PL, Sm	
																	12.31-12.4 m, numerous Jt/Pt, Pl, Ro	
																	12.54 m, Jt, 0 deg. Pl, Sm	
																	12.65-12.7 m, cz, Cy	
																	12.76-12.79 m, Jt, Ir, Ro	
																		13.05-13.93 m, Jt, 10-90 deg. Ir, Ro, occ. Cy
			100%	14.0														14.05 m, Jt, 0 deg. Pl, Sm
																		14.28-14.3 m, Jt, 30 deg. Pl, Sm
																		14.31 m, Jt, 20 deg. Pl, tight
																	14.34 m, Jt, 20 deg. Pl, tight	
																	14.54-14.58 m, Jt, 40 deg. Pl, Ro	
																	14.71 m, Jt, 0 deg. Pl, Ro	
																	14.77-14.9 m, Jt, 85 deg. Pl, Ro	
																	15.22 m, Jt, 0 deg. PL, Ro	
																	15.27-15.32 m, Jt, 35 deg. Pl, Sm	
																	15.43 m, Jt, 0 deg. Pl, Sm	
																	15.59 m, Jt, 0 deg. Pl, Sm	
																	15.83 m, Jt, 0 deg. Pl, Sm	
																	15.87 m, Jt, 0 deg. Pl, Sm	
																	16.1 m, Pt, 0 deg. Pl, Sm	
																	16.27 m, Jt, 5 deg. Pl, Ro	
																	16.37 m, Pt, 5 deg. Pl, Ro	
		100%															16.51 m, Jt, 0 deg. Pl, Sm	
																	16.8 m, Jt, 0 deg. Pl, Ro	
																	17.17 m, Pt, 0 deg. Pl, Ro	
																	17.3 m, Jt, 0 deg. Pl, Ro	
		100%															17.78 m, Jt, 0 deg. Pl, Sm	
Notes:													Contractor: Terratest Equipment: Explorer 2000 Hole Diameter (mm): Angle from Vertical (°):					
See explanation sheets for meaning of all descriptive terms and symbols																		

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 19, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 2
 Sheet 5 of 5

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES									
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)	
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300			1000
N Q C O R E D I N G		100%	18.17	SHALE: dark grey with light grey bands, fine grained	Fr												18.17 m, Pt, 0 deg. Pl, Ro		
			18.43															18.43 m, Jt, 0 deg. Pl, Sm	
			18.48																18.48 m, Jt, 0 deg. Pl, Sm
			18.56-18.64																18.56-18.64 m, Jt, Pl, Ro, cy infill
			18.8																18.8 m, Jt, 0 deg. Pl, Ro
			19.11																19.11 m, Pt, 0 deg. Pl, Sm
			19.23																19.23 m, Pt, 0 deg. Pl, Sm
			19.44																19.44 m, Jt, 0 deg. Pl, Sm
			19.95																19.95 m, Pt, 0 deg. Pl, Sm
			20.07																20.07 m, Jt, 0 deg. Pl, Sm
			20.23														20.23 m, Pt, 0 deg. Pl, Sm		
			20.44														20.44 m, Jt, 0 deg. Pl, Ro		
			20.47														20.47 m, Jt, 0 deg. Pl, Ro		
			21.0	BOREHOLE DISCONTINUED AT 20.74 M															
			22.0																
			23.0																
			24.0																

Notes: Contractor: Terratest
 Equipment: Explorer 2000
 Hole Diameter (mm):
 Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 20, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 3
 Sheet 3 of 5

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES								
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
			7.0															
			8.0	For non core details, refer to non core log sheets														
				START CORING AT 8.5 M														
N M L C C O R I N G			9.0	SHALE: dark grey with orange brown, fine grained, clay seams	MW												8.5-10.21 m, numerous Jt, Ir, Ro, Cy tight Jt opening upon drying	
		100%		SHALE: dark grey with light grey bands, fine grained	Fr/St													
					Fr													
			10.0															10.22 m, Jt, 0 deg. Pl Ro 10.35 m, Jt, 0 deg. Pl, Ro 10.38 m, Jt, 0 deg. PL, Ro 10.47 m, Jt, 0 deg. Pl, Ro 10.53-10.56 m, Jt, 30 deg. Ir, Ro
																		10.7 m, Jt, 0 deg. Pl, R 10.76 m, Jt, 0 deg. PL, Ro 10.86 m, Jt, 0 deg. Pl, Ro 10.94 m, Jt, 0 deg. Pl, Ro 11.1 m, Jt, 0 deg. Pl Ro 11.24 m, JT, 0 deg. PL, Ro 11.34 m, Jt, 0 deg. PL, Ro 11.41 m, Jt, 0 deg. PL, Ro 11.48 m, Jt, 0 deg. Pl, Ro 11.7-12.35 m, numerous Jt, 0 deg. Pl, Ro/Sm
			11.0															
			100%															
				12.0														

Notes: Contractor: Terratest
 Equipment: Edson 3000
 Hole Diameter (mm):
 Angle from Vertical (°):
 See explanation sheets for meaning of all descriptive terms and symbols

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 20, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 3
 Sheet 4 of 5

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES									
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)	
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300			1000
N M L C C O R I N G		100%	12.65	SHALE: dark grey with light grey bands, fine grained	Fr												12.65 m, Jt		
			13.0															13.22-13.33 m, Jt, 45 deg. Pl, Ro	
																		13.48 m, Jt, 0 deg. Pl, Sm	
																		13.63 m, Jt, 0 deg. PL, Sm	
																		13.84 m, Pt, 0 deg. Pl, Sm	
																		13.91 m, Jt, 0 deg. Pl, Sm	
																		14.05 m, Pt, 0 deg. Pl, Sm	
																		14.14 m, Jt, 0 deg. Pl, Sm	
																		14.29 m, Jt, 0 deg. Pl, Sm	
																			14.4 m, Jt, 0 deg. Pl, Ro
			100%																14.65 m, JT, 0 deg. Pl, Ro
																			14.89 m, Jt, 0 deg. Pl, Ro
																			15.03 m, Pt, 0 deg. PL, Ro
																			15.29 m, Jt, 0 deg. Pl, Sm
																			15.38 m, Jt, 0 deg. Pl, Ro
																			15.62 m, Jt, 0 deg. Pl, Ro
																			15.94 m, Pt, 0 deg. Pl, Sm
																			16.02 m, Pt, 0 deg. Pl, Ro
																		16.42 m, Pt, 0 deg. Pl, Sm	
																		16.73 m, Pt, 0 deg. Pl, Sm	
																		17.2 m, Pt, 0 deg. Pl, Sm	
		100%																17.44 m, Pt, 0 deg. Pl, Sm	
																		17.6 m, Jt, 0 deg. Pl, Sm	
																		17.74 m, Pt, 0 deg. Pl, Ro	
																		17.87 m, Pt, 0 deg. Pl, Sm	
Notes:												Contractor: Terratest Equipment: Edson 3000 Hole Diameter (mm): Angle from Vertical (°):							
See explanation sheets for meaning of all descriptive terms and symbols																			

Client: DeiCorp Pty Limited
 Project: 157 Redfern Street, Redfern
 Location: Refer to Drawing No. 09/0435

Project / STS No.: 17055/5911B
 Date: February 20, 2009
 Logged: JK
 Checked By: JH

BOREHOLE NO.: BH 3
 Sheet 5 of 5

DRILLING			MATERIAL STRENGTH							DISCONTINUITIES								
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength						Joint Spacing (mm)					Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
						Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300		
N M L C C O R E D I N G		100%	18.43	SHALE: dark grey with light grey bands, fine grained	Fr												18.43-19.08 m, Jt, 90 deg. Ir, Ro, fractured	
			19.0															19.24 m, Jt, 0 deg. Pl, Sm
			19.4														19.4 m, Jt, 0 deg. Pl, Sm	
			19.66														19.66 m, Jt, 0 deg. PL, Ro	
			19.95														19.95 m, Pt, 0 deg. Pl, Sm	
			20.0	BOREHOLE DISCONTINUED AT 20.0 M														
			21.0															
			22.0															
			23.0															
			24.0															

Notes: Contractor: Terratest
 Equipment: Edson 3000
 Hole Diameter (mm):
 Angle from Vertical (°):

See explanation sheets for meaning of all descriptive terms and symbols

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by SMEC in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour)

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

- (a) Soil Name and Classification Symbol

The USC system is summarized in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms "some" and "trace" as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - low to medium plasticity	H

(b) Grading

“Well graded”	Good representation of all particle sizes from the largest to the smallest.
“Poorly graded”	One or more intermediate sizes poorly represented
“Gap graded”	One or more intermediate sizes absent
“Uniformly graded”	Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as “rounded”, “sub-rounded”, “sub-angular” or “angular”.

Particle **form** can be “equidimensional”, “flat” or “elongate”.

Surface texture can be “glassy”, “smooth”, “rough”, “pitted” or “striated”.

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by “light” or “dark”. Borderline colours may be described as a combination of two colours, eg. red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 Soil Condition

(a) Moisture

Soil moisture condition is described as “dry”, “moist” or “wet”.

The moisture categories are defined as:

Dry (D) - Little or no moisture evident. Soils are running.
Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 – 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 – 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 – 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 – 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2 c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q_c (MPa)	DENSITY INDEX (%)
Very Loose	0 – 3	0 - 2	0 - 15
Loose	3 – 8	2 - 5	15 - 35
Medium Dense	8 – 25	5 - 15	35 - 65
Dense	25 – 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample

Lens - discontinuous with lenticular shape

Pocket - irregular inclusion

Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

“Residual Soil” - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

“Colluvium” - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

“Landslide Debris” - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

“Alluvium” - Material which has been transported essentially by water. Usually associated with former stream activity.

“Fill” - Material which has been transported and placed by man. This can range from natural soils which have been placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicated by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes “O” or “H” depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an “organic material” by classification.

Coal and lignite should be described as such and not simply as organic matter.

E2 CLASSIFICATION OF ROCKS

E2.1 Uniform Rock Description

The aim of a rock description for engineering purposes is to give an indication of the expected engineering properties of the material.

In a similar manner to soil materials, the assessment of site conditions where rock is encountered has to be based on the use of a descriptive method which is uniform and repeatable. Description has to:

- provide a clear identification of the rock substance and its engineering properties, and
- include details of the features which affect the engineering properties of the rock mass.

There is no internationally accepted system for rock description but SMEC Testing Services Pty Ltd has adopted a method which incorporates terminology defined by common usage in the engineering geological profession. Most feature definitions are as recommended by the International Society of Rock Mechanics and by the Standards Association of Australia.

For uniform presentation the different features are described in order:

Rock Substance

- NAME (in block letters)
- Mineralogy
- Grain Size
- Colour
- Fabric
- Strength
- Weathering/Alteration

Rock Mass

- Defect type
- Defect orientation
- Defect features
- Defect spacing

E2.2 Rock Substance

(a) Rock name

Each rock type has a specific name which is based on:

- mineralogy
- grain size
- fabric
- origin

The only method of determining the precise rock name is by thin section petrography.

Field identification of rocks for engineering purposes should be based on the use of common, easily understood, simple, geological names. In many cases knowledge of the precise name is of little consequence in the assessment of site conditions. If required the "field name" can be qualified by reference to a petrographic report. Reference to local geological reports often provides information on the rock types which may be expected.

(b) Mineralogy

The rock description should include the identification of the prominent minerals. This identification is usually restricted to the more common minerals in medium and coarse grained rocks.

(c) Grain Size

Rock material descriptions should include general grouping of the size of the predominant mineral grains as defined in Table E2.2.1. The maximum size, or size range, of the larger mineral grains or rock fragments should be recorded.

TABLE E2.2.1. - GRAIN SIZE GROUPS

TERM	GRAIN SIZE (mm)
Very Coarse	>60
Coarse	2 - 60
Medium	0.06 - 2
Fine	0.002 - 0.06
Very Fine	<0.002
Glassy	

(d) Colour

The colour of the rock should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by "light" or "dark". Borderline colours may be described by a combination of two colours, eg: grey-blue.

(e) Fabric

The fabric of a rock includes all the features of texture and structure, though the term refers specifically to the arrangement of the constituent grains or crystals in a rock. The fabric can provide an indication of the mode of formation of the rock:

- in sedimentary rocks bedding indicates depositional conditions,
- in igneous rocks the texture indicates the rate of cooling, and
- in metamorphic rocks the foliation indicates the stress conditions

Descriptions of fabric should include structure orientation, either with reference to North and horizontal, or to a plane normal to the core axis.

Tables E2.2.2, E2.2.3 and E2.2.4 list common textural features of sedimentary, igneous and metamorphic rocks with the subdivision of stratification spacing in Table E2.2.5.

TABLE E2.2.2 - COMMON STRUCTURES IN IGNEOUS ROCKS

STRATIFICATION (Planar)	STRATIFICATION (Irregular)
Bedding	Washout
Cross Bedding	Slump Structure
Graded Bedding	Shale Breccia
Lamination	
Cross Lamination	

TABLE E2.2.3 - COMMON STRUCTURES IN IGNEOUS ROCKS

Uniform Grain Size	FINE GRAINED ROCKS	COARSE GRAINED ROCKS
	Massive	Massive
	Flow Banded	Granitic
	Vesicular	Pegmatitic
Different Grain Size	Porphyritic	Porphyritic

TABLE E.2.2.4 - COMMON STRUCTURES IN METAMORPHIC ROCKS

FINE GRAINED ROCKS	COARSE GRAINED ROCKS
Slaty Cleavage	Granoblastic
Spotted	Porphyroblastic
Hornfelsic	Lincated
Foliated	Gneissic
Mylonitic	Mylonitic

TABLE E2.2.5 - STRATIFICATION SPACING

TERM	SEPARATION (mm)
Very Thickly Bedded	>2000
Thickly Bedded	600 - 2000
Medium Bedded	200 - 600
Thinly Bedded	60 - 200
Very Thinly Bedded	20 - 60
Laminated	6 - 20
Thinly Laminated	<6

(f) Strength

Substance strength is one of the most important engineering features of a rock and every description should include at least an estimate of the rock strength class of the material. This estimate can be calibrated by test results, either by Point Loan Strength Index or by Unconfined Compressive Strength.

The rock strength class in As 1726-1981 is defined by Point Loan Strength Index $I_s(50)$. The relationship between Point Loan and Unconfined Strength is commonly assumed to be about 20, but can range from 4 (in some carbonate rocks) to 40 (in some igneous rocks). It is necessary to confirm the relationship for each rock type and project. classification should be based on material at field moisture content, as some rocks give a significantly higher strength when tested dry.

Table E2.2.6 defines the rock strength classes, with indicative field tests listed in Table E2.2.7 which assist in classification when testing equipment is not available.

TABLE E2.2.6 - CLASSIFICATION OF ROCK STRENGTH

SYMBOL	TERM	POINT LOAD STRENGTH (MPa)	APPROX Qu (MPa)
EL	extremely low	<0.03	<1
VL	very low	0.03 - 0.1	1 - 3
L	low	0.1 - 0.3	3 - 10
M	medium	0.3 - 1	10 - 30
H	high	1 - 3	30 - 70
VH	very high	3 - 10	70 - 200
EH	extremely high	>10	>200

TABLE E2.2.7 - FIELD TESTS FOR ROCK STRENGTH CLASSIFICATION

STRENGTH CLASS	FIELD TEST
Extremely Low	Indented by thumb nail with difficulty
Very Low	Scratched by thumb nail
Low	Easily broken by hand or pared with a knife
Medium	Broken by hand or scraped with a knife
High	Broken in hand by firm hammer blows
Very High	Broken against solid object with several hammer blow
Extremely High	Difficult to break against solid object with several hammer blows

(g) Weathering/Alteration

In addition to the description of rock substance as examined, an assessment is required of the extent to which the original rock material has been affected by subsequent events. The usual processes are:

- Weathering - Decomposition due to the effect of surface or near surface activities
- Alteration - Chemical modification by the action of materials originating from within the mantle below.

The classification of weathering/alteration presented in Table E2.2.8 is based on the extent/degree to which the original rock substance has been affected. This classification has little engineering significance, as the properties of the rock as examined may bear no relationship to the properties of the fresh rock.

TABLE E2.2.8 - CLASSIFICATION OR ROCK WEATHERING/ALTERATION

TERMS	DEFINITION
Fresh (Fr)	Rock substance unaffected.
Fresh Stained (FR St)	Rock substance unaffected. Staining of defect surfaces.
Slightly (SW)	Partial staining or discolouration of rock substance.
Moderately (MW)	Staining or discolouration extends throughout the whole rock substance.
Highly (HW)	Rock substance partly decomposed.
Completely (CW)	Rock substance entirely decomposed.

E2.3 Rock Mass

The engineering properties of rock mass reflect the effect which the presence of defects has on the properties of the rock substance. Description of the rock mass properties consists of supplementing the description covered by Section E2.2 with data on the defects which are present.

(a) Defect type

The different defect types are described in Table E2.3.1.

(b) Defect orientation

Descriptions of defects should include orientation, either of individual fractures or of groups of fractures. Orientation should be with reference to North and horizontal, or to a plane normal to the core axis.

TABLE E2.3.1 - ROCK DEFECT TYPES

TYPE	SYMBOL	DESCRIPTION
Parting	Pt	A defect parallel or subparallel to a layered arrangement of mineral grains or micro-fractures which has caused planar anisotropy in the rock substance.
Joint	Jt	A defect across which the rock substance has little tensile strength and is not related to textural or structural features with the rock substance.
Sheared Zone	SZ	A zone with roughly parallel planar boundaries or rock substance containing closely spaced, often slickensided, joints.
Crushed Zone	CZ	A zone with roughly parallel planar boundaries of rock substance composed of disoriented, usually angular, fragments of rock.
Seam	Sm	A zone with roughly parallel boundaries infilled by soil or decomposed rock.

(c) Defect features

The character of a defect is described by its continuity, planarity, surface roughness, width, and infilling.

Continuity In outcrop the extent of a joint, bedding plane or similar defect both along and across the strike can be measured. In core, continuity measurement is restricted to defects nearly parallel to the core axis.

Planarity Described as "Planar", "Irregular", "Curved" or "Undulose".

Roughness Described as "Rough", "Smooth", "Polished" or "Slickensided".

Width Measured in millimetres normal to the plane of the defect

Infilling Described as "Clean", "Stained", "Veneer" (<1 mm) or "Infill" (>1 mm). The coating or infilling material should be identified.

(d) Defect spacing

The spacing of defects, particularly where they occur in parallel groups or sets, provides an indication of the rock block sizes which:

- have to be supported in the face or roof of an excavation
- will be produced by the excavation operation.

It is preferable to provide measured data but discontinuity spacing is grouped as shown in Table E2.3.2.

TABLE E2.3.2 - DISCONTINUITY SPACING

DESCRIPTION	SPACING (mm)
Extremely Widely Spaced	>6000
Very Widely Spaced	2000 - 6000
Widely Spaced	600 - 2000
Medium Spaced	200 - 600
Closely Spaced	60 - 200
Very Closely Spaced	20 - 60
Extremely Closely Spaced	<20