Preliminary Geotechnical site investigation report

Proposed development at Young High School, Campbell Street
Young NSW 2594

Ref: R9966g1
Date: 22 August 2019

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Environmental
Geotechnical
Asbestos
Services

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Interested authorities:	Hilltops Council
Report number:	R9966g1
Date:	22 August 2019

Executive Summary

Background

New development is proposed for Young High School, Campbell Street, Young NSW. The development will consist of upgrades to existing buildings, new buildings and pavement areas (driveways and carparks).

A preliminary geotechnical investigation of the site is required to enable planning of civil works, design footings, design of pavements and provide advice on fill and earthworks.

Scope

Undertake a preliminary geotechnical investigation to determine site classification, pavement parameters, evidence of fill and other site limitations.

Investigation

A site inspection and sampling was undertaken on 12 July 2019 to determine soil engineering properties. Boreholes were drilled to depths of up to 3 metres at six representative locations (BH1-BH6). The boreholes were constructed with a truck mounted EVH drilling rig fitted with a solid auger. The profile of each borehole was described along with moisture, consistency, density and plasticity.

Four samples were collected for laboratory analysis of liquid limit, plastic limit, plasticity index and linear shrinkage. The soil profile and laboratory testing data will enable the building site to be classified for reactivity.

Potential corrosive soils were assessed by soil analysis of a sample for pH and electrical conductivity.

The soil was investigated at the proposed pavement areas. Soil was sampled and the Californian Bearing Ratio (CBR) determined by the four day soak method. The CBR is a parameter used in pavement design.

Evaluation of engineering properties was undertaken to enable site classification, bearing capacity, soil aggressiveness and pavement parameters.

Conclusions and recommendations

The investigation area is within the school grounds including existing paved areas. Existing buildings may require removal. The site occurs on a mid-slope.

The natural soil profile consists of brown sandy silt topsoil over yellowish brown, brown, reddish brown and red sandy clay and greyish yellow fine gravelly clay with increasing weathered gravels. Ironstone gravel is present in the soil profile.

Fill material was identified to depths of up to 0.4m beneath paved surfaces (Boreholes 1, 3 and 5) and comprised sand, sandy gravel and sandy clay.

The drilling consistency was firm to very stiff.

The soil was moist to dry to the drilling depth.

The site is not located in a mapped acid sulphate soil prone area. The soil is not aggressive to foundations. No obvious signs of salinity were observed on the site surface or within the subsoil. The laboratory results indicate all the soil samples collected were non-saline and the soil pH was neutral.

An estimation of design surface movement (Ys) of the natural soil was determined from the shrink swell index (AS7289.7.1.1-2011), soil index tests and soil profile identification as recommended in AS 2870.

The soils on the site had a moderate to high liquid limit, linear shrinkage and plastic limit. The natural soils have a maximum surface movement (Ys) of 45-50mm.

The site has a classification of **Class P** due to potential for differential settlement in areas of removed or existing structures. Some existing structures were identified at the locations of the proposed development and will require removal. Removal details of the structures are not known.

Uncontrolled fill was used to backfill excavations created during the construction of the existing structures. Fill material is present to the depth of the structures and the surrounding zone of influence. Differential settlement is possible in the areas of existing or removed structures.

Footings should be founded on natural soil or controlled fill and any excavations should be backfilled and compacted to a minimum of 95% standard compaction (density ratio) in accordance with AS3798 (*Guidelines on Earthworks for Commercial and Residential Developments*).

The subsoils are firm to very stiff consistency and are expected to be excavated with an excavator and tined bucket. Granite is known to occur in the area which is potentially extremely high strength and difficult to excavate.

Subsoils on the site are suitable for use as general fill. Subsoil used for fill should not contain high moisture content, high silt content or rock greater than 70mm diameter.

The CBR result for sample analysed from the subgrade depth was moderate at 5.0%.

Contents

1. Introduction

New development is proposed for Young High School, Campbell Street, Young NSW. The development will consist of new buildings and upgrades to existing buildings. New pavement and parking areas will be located on-site. Existing tructures will be removed in some areas.

A preliminary geotechnical investigation of the site is required to enable planning of civil works, design footings, design of pavements and provide advice on fill and earthworks.

2. Objectives

Envirowest Consulting Pty Ltd was commissioned by Hayball to undertake geotechnical investigations for the proposed development of Young High School, Campbell Street, Young NSW.

The investigation includes:

- Summary of surface and subsurface conditions
- Groundwater conditions and potential influences on structures
- Site classification including characteristic surface movement
- Assessment of soil aggressiveness
- Suitability of subsoil for reuse as fill
- Excavation limitations
- Subgrade assessment / pavement parameters

3. Site location

The investigation area is located at Young High School, Campbell Street, Young NSW. The investigation area is within the school grounds including existing paved areas.

4. General site description

The investigation area is Young High School comprising buildings, hardstand paved areas and landscaped areas consisting of lawns with trees and gardens.

5. Site condition and environment

5.1 Surface cover

The investigation area comprised paved and grassed areas with scattered large eucalyptus trees and deciduous trees.

5.2 Topography

The site is located on a mid-slope. Aspect is predominantly north and slopes are very gently inclined and less than 5%. Elevation ranges between 444 and 452 metres above sea level. No groundwater seepage or discharge areas were observed on the site.

5.3 Soils and geology

The site is located within the Young Soil Landscape (Espade, 2019). The soil landscape consists of red dermosols (euchrozems), red kandosols (red earths) and red chromosols on mid to upper slopes and crests. Yellow and brown chromosols are found on lower slopes and yellow solodic soils are found along drainage lines. Salinity outbreaks have occurred in drainage depressions and on lower slopes.

The geological unit is Silurian Young Formation granodiorite and granite, often porphyritic in quartz, plagioclase and more rarely K-feldspar and biotite. Colluvium and alluvium derived from these materials occur on lower slopes.

5.4 Surface water

No dams or drainage lines are located within the proposed investigation area. Surface water flows north into the local storm water system.

5.5 Groundwater

There was no evidence of seasonal groundwater identified from soil profile to the drilling depth.

A search of the Water NSW groundwater database located nine bores within 500m of the site. The bores are used for recreational, monitoring and domestic purposes. Standing water levels were located from a depth of 3.22m and water bearing zones from a depth of 18.3m in granite.

6. Investigation methods

A site inspection and field assessment was conducted on 12 July 2019. A total of six boreholes (BH1 to BH6) were drilled on the site to depths of up to 3m and sampling undertaken to determine soil engineering properties. The boreholes were in the location of the proposed buildings and pavement areas. The profile of each borehole was described along with moisture, consistency, density, plasticity and rock weathering if applicable.

Allowable bearing capacities were estimated from drilling auger resistance and soil type.

Four representative soil samples were collected from three boreholes (BH1, BH2 and BH4) for laboratory analysis of liquid limit, plastic limit, plastic index and linear shrinkage. The soil profile and laboratory testing data enabled the site to be classified for reactivity.

Samples were collected from boreholes and analysed for electrical conductivity (EC) and pH to determine the soil aggressiveness.

The soil was investigated for engineering parameters to enable pavement design for driveway and parking areas. Soil was collected from the subgrade depth and the California Bearing Ratio (CBR) was determined on the sample by the 4 day soak method. The CBR parameter assists in pavement design.

All testing depths undertaken for the assessment were relative to existing ground level on the day of investigation.

A schedule of sampling locations and the tests undertaken are given in Table 1 and Figure 2.

Soil sampling was undertaken according to the Australian Standards 2870, by qualified field and laboratory personnel. All soil analysis was undertaken at the NATA accredited laboratory of Envirowest Testing Services.

Table 1. Sampling location and tests undertaken

Sampling location (Figure 2)	Location	Tests undertaken	Testing depths (m)	Investigation total depth (m)
Borehole 1	Proposed canteen	Soil properties description	0 to 3.0	3.0
		Index tests	1.2	
Borehole 2	Proposed library	Soil properties description	0 to 3.0	3.0
		Index tests	1.3 and 1.9	
Borehole 3	Proposed library	Soil properties description	0 to 3.0	3.0
		Electrical conductivity and pH	0.6	
Borehole 4	Proposed block MM	Soil properties description	0 to 3.0	3.0
		Index tests	1.5	
		Electrical conductivity and pH	0.8	
Borehole 5	Existing parking off Campbell Street	Soil properties description	0 to 3.0	3.0
Borehole 6	Existing parking off Caple Street	Soil properties description	0 to 1.5	1.5
		CBR tests	0.3 to 1.2	

7. Results

7.1 Surface condition

The site is Young High School comprising buildings and landscaped areas consisting of lawns with trees and gardens.

7.2 Soil profile and subsurface conditions

The natural soil profile consists of brown sandy silt topsoil over yellowish brown, brown, reddish brown and red sandy clay and greyish yellow fine gravelly clay with increasing weathered gravels. Ironstone gravel is present in the soil profile.

Fill material was identified to depths of up to 0.3m beneath paved surfaces (Boreholes 1, 3 and 5) and comprised sand, sandy gravel and sandy clay.

The drilling consistency was firm to very stiff.

The soil was moist to dry to the drilling depth.

7.3 Soil index tests

Soil on the site had a moderate liquid limit and moderate to high linear shrinkage (Table 2). The soil index properties laboratory report is presented in Appendix 2.

Table 2. Soil index test summary

Sampling location (Figure 2)	Proposed location (Figure 2)	Sample depth (m)	Plastic index %	Plastic limit %	Liquid limit %	Linear shrinkage %	Soil description
BH1	Proposed canteen	2.7	12	24	36	7.0	Fine gravelly clay
BH2	New library	1.3	19	18	37	12.0	Sandy clay
BH2	New library	1.9	23	20	43	15.5	Sandy clay
BH4	Block MM	1.5	25	18	43	13.5	Sandy clay

7.4 Soil aggressiveness

No obvious signs of salinity were observed on the site surface or within the subsoil. The laboratory results indicate all the soil samples collected were non-saline and less than 4dS/m (Table 3).

The pH of the soil sample tested was neutral (Table 3).

The site is not located in a mapped acid sulphate soil prone area.

Table 3. pH and electrical conductivity analysis results and salinity rating

Sampling location (Figure 2)	Sample depth (m)	pH	Electrical conductivity of a saturated extract (dS/m)	Salinity rating
BH3	0.6	7.6	0.38	Non-saline
BH4	0.8	7.4	0.80	Non-saline

7.5 California bearing ratio (CBR)

The CBR for the soil sample collected from Borehole 6 was 5% (Table 4). The CBR laboratory report is presented in Appendix 5.

Table 4. CBR test results

Borehole (Figure 2)	Sample ID	Location	Sample depth (mm)	Sample description	CBR(%)
BH6	S19-535	Car park off Caple Street	300-1200	SILTY CLAY	5

7.6 Groundwater

No wet soil or groundwater indicators were encountered at the borehole locations on day of inspection. Ironstone gravel was encountered from a depth of 0.5m indicating poorly drained soil.

7.7 Trees

Trees were located adjacent to the proposed development areas.

7.8 Removal of existing structures

Some existing structures on the site will require removal in preparation for the new buildings.

7.9 Fill material

Uncontrolled fill was used to backfill excavations created during the construction of the existing structures. Fill material is present to the depth of the structures and the surrounding zone of influence.

8. Recommendations

8.1 Foundations

8.1.1 Soil reactivity

An estimation of design surface movement (Ys) of the natural soil was determined from the shrink swell index (AS7289.7.1.1-2011), soil index tests and soil profile identification as recommended in AS 2870.

The soils on the site had a moderate to high liquid limit, linear shrinkage and plastic limit. The natural soils have a maximum surface movement (Ys) of 45-50mm.

The site has a classification of **Class P** due to potential for differential settlement in areas of removed or existing structures. Some existing structures were identified at the locations of the proposed development and will require removal. Removal details of the structures are not known.

Uncontrolled fill was used to backfill excavations created during the construction of the existing structures. Fill material is present to the depth of the structures and the surrounding zone of influence. Differential settlement is possible in the areas of existing or removed structures.

Footings should be founded on natural soil or controlled fill and any excavations should be backfilled and compacted to a minimum of 95% standard compaction (density ratio) in accordance with AS3798 (*Guidelines on Earthworks for Commercial and Residential Developments*).

8.1.2 Exposure classification

Soil saturated extract electrical conductivity (EC_e) was determined to be <4dS/m in the soil samples tested. Soil pH was neutral for the soil samples analysed. Exposure classification for concrete is A1. Minimum design characteristic strength for concrete is 20MPa and minimum curing requirement is continuous curing for at least 3 days (Appendix 3). Minimum reinforcement cover for concrete in soils is 40mm (Appendix 3).

8.1.4 Footing design parameters

The development will have an impact on underlying soils and would need to take into account of potential settlement and consolidation of up to 20mm.

Footings are not recommended to be founded in fill material. Footings should be founded into natural soil or fill compacted in layers less than 200mm and a minimum standard compaction density ratio of 98%.

8.2 Earthworks

8.2.1 Excavations

The subsoils on the site are firm to very stiff and are expected to be excavated with an excavator and tined bucket.

8.2.2 Filling

Subsoils with high moisture content on the site are not recommended for reuse as fill.

Fill material should be compacted close to optimum moisture content in layers less than 200mm and a minimum standard compaction density ratio of 98% in accordance with AS3798.

Site inspections by a suitably qualified person are recommended during and after earthworks to confirm strata and subsurface conditions.

8.3 Trees

Several trees were located adjacent to the proposed extensions. Site classification allowances were made for suction changes attributed to the trees. Tree roots at the building location have the potential to degrade and cause differential settlement. Tree roots identified during excavations at the building location should be removed. Tree removal and subsequent backfill shall be undertaken in accordance with AS3798.

8.4 Removed structures

Excavations of removed structures and associated foundations will require backfilling in accordance with AS3798.

8.5 Footing design parameters

The development will have an impact on underlying soils and would need to take into account of potential settlement and consolidation of up to 20mm.

A summary of shallow footing parameters (natural soil) is outlined in Table 5.

Table 5. Expected allowable bearing capacity for shallow footing 0.5m

Founding stratum (0.5m depth)	Bulk unit weight (γ) kN/m^3	Soil friction angle (Ø) degrees	Allowable bearing capacity[a] (kPa)
Sandy silt (natural soil)	16	21	100
Compacted fill	17	20	100

[a] strip footing minimum 0.5m embedment and less than 1.2m wide

Deep raft and pile type foundation parameter recommendations are outlined in Table 6.

Lateral restraint from the soils in the top 0.6m should be ignored in design.

Pile foundation allowable bearing capacity was determined in accordance with AS 2159 with a geotechnical reduction factor of Φ_g = 0.33. All foundations and piers should be inspected by a suitably qualified person to confirm geotechnical properties.

Table 6. Soil parameter for engineering design for deep footings

Material (natural soil)	Depth (m)	Geotechnical design parameters									
		γ kN/m³	Cu kPa	Ø deg	E_s MPa		c kPa	Ultimate shaft adhesion kPa	Allowable shaft adhesion kPa	Ultimate bearing capacity kPa	Allowable bearing capacity kPa
					E_{ss}	E_{sl}					
Firm sandy clay	1.0	17.0	80	22.0	14	10	15	-	-	375	125
Stiff sandy clay	1.5	17.5	100	23.0	16	10	15	51	17	510	170
Stiff sandy clay	2.0	17.8	140	23.0	20	12	15	60	22	660	220
Stiff to very stiff sandy clay	2.5	18.0	180	24.0	20	12	10	82	27	825	275
Very stiff sandy clay and gravelly clay	3.0	19.0	200	28.0	31	25	5	35	35	1050	350
Engineered compacted fill	-	17.0	100	20	14	10	10	30	10	300	100

γ - Bulk unit weight, Cu - undrained shear strength, Ø – soil friction angle, c – Cohesion, E_s – Young's modulus (E_{ss} short term, Esl long term)

8.6 Retaining wall design parameters

Retaining walls should be designed in accordance with AS 4678. Earth pressure coefficients for retaining walls are outlined in Table 7.

Table 7. Earth pressure coefficients (non-sloping crest backfill)

Stratum	γ kN/m³	Ø (deg)	Active K_a	At Rest K_o	Passive K_p
Compacted fill	17.0	20.0	0.490	0.658	2.040
Firm clay	17.0	22.0	0.455	0.625	2.198
Stiff clay	18.0	23.0	0.438	0.609	2.283
Very stiff clays	19.0	28.0	0.361	0.531	2.770

γ - Bulk unit weight, Ø – soil friction angle

Full height drainage is recommended for retaining walls to minimise hydrostatic pressure build-up.

Allowances should be made for surcharge load pressures in the material behind the retaining wall.

The use of heavy compaction equipment on backfill material against the retaining wall will result in earth pressures at levels greater than Table 7. Temporary wall propping should be undertaken if heavy compaction equipment is required.

Site inspections by a suitably qualified person are recommended during and after earthworks to confirm strata and subsurface conditions.

8.7 Batter stability

Temporary excavation batters and areas of fill on the site should be graded no steeper than 2 horizontal (H) to 1 vertical (V) where excavation depths are less than 1 metre (Landcom 2004). Excavation depths of greater than 1 metre should be graded as per Table 8.

Permanent excavation batters in the natural soil on the site should be graded no steeper than 2H: 1V where excavation depths are less than 1 metre. Deep excavation will require engineered retaining walls. Appropriate drainage, topsoil and vegetation application is required to reduce erosion.

Maximum temporary and permanent batter grades for excavation greater than 1m are outlined in Table 8.

Table 8. Batter grades for excavation greater than 1m

Material	Maximum temporary batter	Maximum permanent batter
Topsoil, fill material	2H : 1V	2H : 1V
Firm to stiff clay	1.5H : 1V	2H : 1V
Very stiff clays	1.5H : 1V	2H : 1V

9. Pavement design

9.1 Subgrade preparation

Subgrade preparation in the pavement areas should include:

- Uncompacted loose fill is not suitable for use as subgrade or foundation. Compacted fill will require passing a proof roll prior to use as subgrade.
- Topsoil, vegetation, soft soil, wet material, debris and other foreign matter should be removed from the location of the proposed development.
- Adjust the in-situ moisture of the subgrade to close to optimum moisture content.
- The exposed subgrade should be compacted to 98% of the dry density ratio. The exposed compacted surface should be rolled with a minimum 12 tonne roller to detect soft spots.
- Any soft, weak or saturated material should be removed and replaced by suitable fill material and compacted in layers less than 200mm close to optimum moisture content and to within 98% of the dry density ratio.
- All service trenches, select fill and other excavations should be backfilled with suitable material and compacted in layers less than 200mm close to optimum moisture content and to within 98% of the dry density ratio.
- Adequate drainage will be required to ensure water does not migrate into the subgrade layer.

9.2 Subgrade strength

The CBR sample was collected for natural soil. The samples collected had a moderate CBR of 5.0%. The design subgrade is a CBR of 5.0%. The subgrade is not expansive.

9.3 Pavement thickness

Pavements, based on information contained within the project brief, are expected to contain minimal heavy vehicle movement.

The design CBR strength of the natural soil in the pavement areas is 5.0%. The design CBR strength is based on the limiting factor from the CBR results.

The pavement parameters for flexible pavement are outlined in Table 5 and rigid pavement outlined in Table 6.

9.4 Design traffic

Flexible pavement traffic design is $8x10^4$ ESA which is local access with buses. Rigid pavement traffic design is $8x10^4$ HVAG.

Table 9. Pavement parameters for design traffic of **$8x10^4$ ESA**

Pavement parameter	Natural subgrade (CBR 5.0%)
Surface layer	Sealed pavement: • AC wearing layer minimum 50mm
Base	• 100mm granular material such as DGB20 or equivalent • The base material shall be compacted in layers with moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC).
Sub-base	250mm granular material such as DGS40 or equivalent • The subbase material shall be compacted in layers with moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC). Each layer shall pass a proof roll.
Total granular material	350mm
Design subgrade CBR	• Natural subgrade CBR 5.0%

Table 10. Rigid pavement parameters for traffic design of **$8x10^4$ HVAG**

Pavement parameter	Natural subgrade (CBR 5.0%)
Concrete base	Sealed pavement: • 150mm thickness jointed reinforced
Subbase	• 200mm crushed rock / DGS40 or equivalent • The subbase material shall be compacted in layers with moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC). Each layer shall pass a proof roll.
Design subgrade CBR	• Natural subgrade CBR 5.0% • The subgrade material shall be compacted with moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC). Each layer shall pass a proof roll. • Uncompacted or loose fill is not suitable for use as subgrade or foundation. Compacted fill will require passing a proof roll prior to use as subgrade.

Rigid pavement design is based on:

- Load safety factor (LSF) of 1.05
- Provision of concrete shoulders

9.5 Pavement material

Pavement materials shall be in accordance with council construction guidelines.

9.6 Surface water and groundwater mitigation

Drainage may be recommended to divert surface and groundwater from upslope around the buildings and pavement areas.

9.7 Geotechnical testing

Site inspections by a suitably qualified person are recommended during and after earthworks to confirm strata and subsurface conditions.

Foundations and pavement layers should be inspected by a suitably qualified person at the time of excavation and placement to confirm accordance with design parameters. The specification, execution and control testing of earthworks and site preparation should be undertaken according to AS3798.

Subgrade and subbase should be compacted to a minimum 98% of the dry density ratio and no deflection with a 12 tonne roller (proof roll).

Trenches should be compacted to a comparable condition as the surrounding ground.

Imported fill should be in accordance with AS3798.

10. Limitations of the investigation

The engineering logs describe subsurface conditions only at a specific borehole location and inferred boundaries between geotechnical units may vary.

Ground conditions can vary over relatively short distances and it may be necessary to carry out additional investigations for specific excavation and building sites. Once specific proposals are known a geotechnical review should be undertaken and if necessary additional investigations commissioned to provide the level of information required for assessing design parameters. A geotechnical engineer should be engaged to review subsurface condition during construction stages to confirm that subsurface conditions are consistent with design assumptions.

This report has been prepared for the use of the client to achieve the objectives given the client requirements and cost constraints. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists who then render an opinion about overall subsurface conditions, the nature and extent of the investigation and its likely impact on the proposed buildings Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus important to understand the limitations of the investigation and recognise that Envirowest Consulting Pty Ltd are not responsible for these limitations.

11. References

AS 2870 (2011) *Residential Slabs and Footings - Construction* (Standards Australia: Homebush)

AS 3727 (1993) *Guide to residential pavements* (Standards Australia: Homebush)

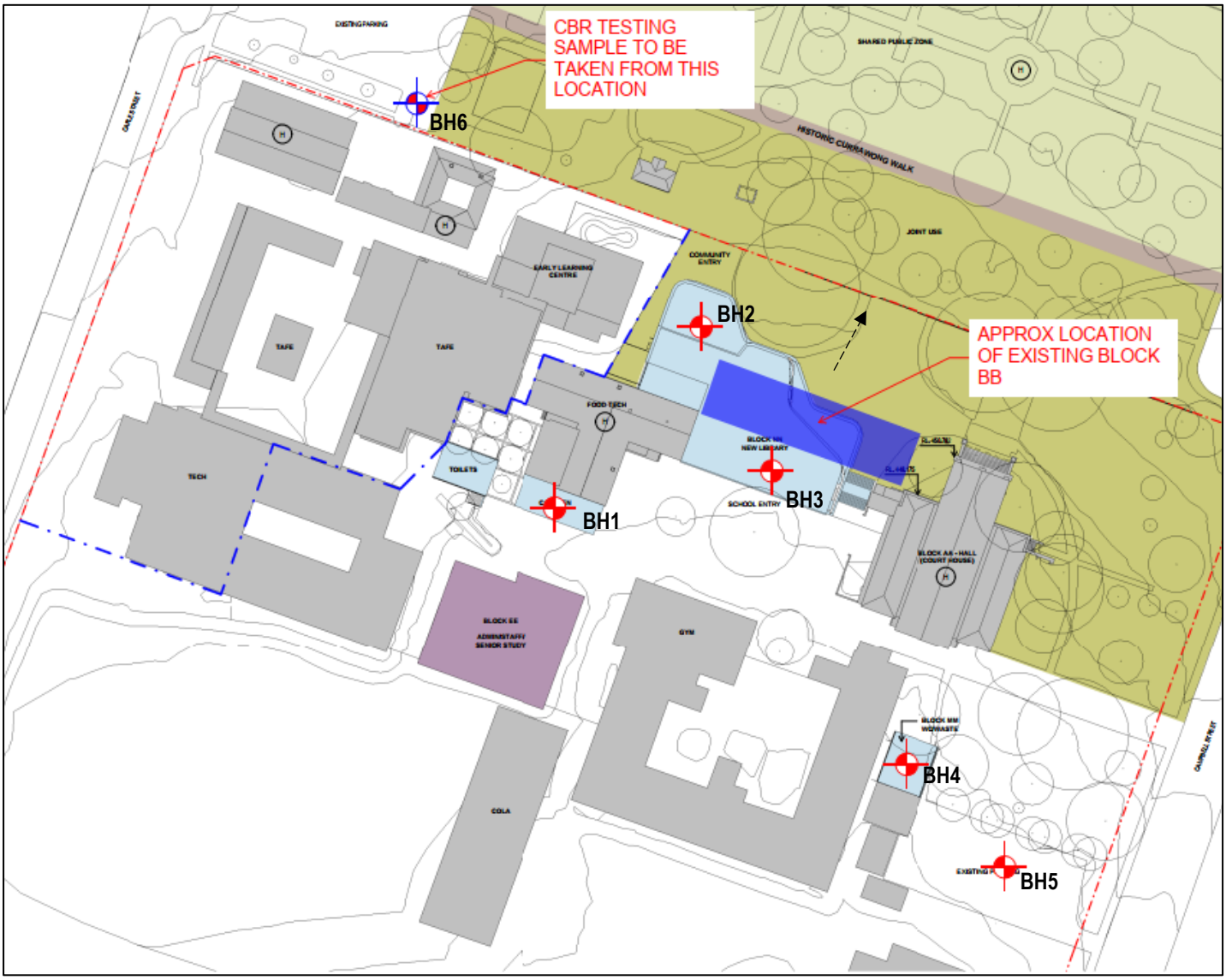
AS 3798 (2007) *Guidance on earthworks for commercial and residential buildings* (Standards Australia: Homebush)

Austroads (2012) *Pavement design-A guide to the structural design of road pavements* (Austroads Inc, Sydney)

Austroads (2012) *Pavement design for light traffic-A supplement to the Austroads Pavement Design Guide* (Austroads Inc, Sydney)

Environment.nsw.gov.au, *'Espade | NSW Environment & Heritage*' Version 2. N.p., 2015. Web. 19 July 2019.

Figure 1. Locality map		
Young High School, Campbell Street, Young NSW		
	Envirowest Consulting Pty Ltd	
Job: R9966g	Drawn by: JG	Date: 30/072019



Legend

⊗ Borehole locations

Slope

Figure 2. Site plan and borehole locations		
Young High School, Campbell Street, Young NSW		
	Envirowest Consulting Pty Ltd	
Job: R9966g	Drawn by: Northrop	Date: 30/072019

Appendix 1.

Bore Log Sheet

Job: R9966g1	Borehole No: 1	Sampling method: EVH auger drill
Client: Hayball	Location: Proposed canteen	Logged by: JG
Site: Young High School, Campbell Street, Young NSW		Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
		FILL, sand, yellow with pavement tiles on soil surface	SP		M	F	M	L	-
0.5		SANDY CLAY, reddish brown with ironstone gravel and fine gravel	Cl		M	St	M	M	-
1.0		SANDY CLAY, brownish yellow	Cl		M	VSt	M	M	-
1.5		Increasing clay content			D	VSt			
2.0									
2.5		GRAVELLY CLAY, yellowish grey	Cl	D	D	VSt	M	M	-
3.0									
3.5		End of hole at investigation depth							
4.0									

Slope/nature of surface:0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Fill to a depth of 400mm

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed	*D* - Dry	Shear strength (kPa)	*VL* - very loose	*NP* - non plastic	Point load (mPa)
D - disturbed	*M* - Moist, can be moulded	*VS* - very soft,	*L* - loose	*T* – trace	*EL* – extremely low (<0.03)
SPT-standard penetrometer test	*W* - Wet, free water on hands	*S* – soft	*M* - medium	*VL* – very low	*VL* – very low (<0.1)
CBR-California Bearing Ratio	*Wp* - plastic limit	*F* – firm	*D* - dense	*L* – low	*L* – low (<0.3)
DCP-Dynamic cone penetrometer	*Wl* - liquid limit	*St* – stiff	*VD* - very dense	*M* – medium	*M* – medium (<1.0)
		VSt - very stiff		*H* – high	*H* – high (<3.0)
		H – hard		*VH* – very high	*VH* – very high (<10)
					EH – extremely high (>10)

Bore Log Sheet

Job: R9966g1 Client: Hayball Site: Young High School Campbell Street, Young NSW	Borehole No: 2 Location: New Library (north side)	Sampling method: EVH auger drill Logged by: JG Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
		SANDY SILT, brown	SM		M	F	M	L	-
0.5		SANDY CLAY, yellowish brown with fine gravel	Cl		D	F	M	M	-
		SANDY CLAY, reddish brown with fine gravel	Cl		D	St	M	M	-
1.0		SANDY CLAY, red	Cl	D	D	VSt St	M	M	-
1.5		SANDY CLAY, brownish yellow	Cl	D	D	St	M	M	-
2.0				D					
		GRAVELLY CLAY, greyish yellow	Cl		D	VSt	M	M	-
2.5									
3.0									
		End of hole at investigation depth							
3.5									
4.0									

Slope/nature of surface: 0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Nil

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed *D* - disturbed SPT-standard penetrometer test CBR-California Bearing Ratio DCP-Dynamic cone penetrometer	*D* - Dry *M* - Moist, can be moulded *W* - Wet, free water on hands *Wp* - plastic limit *Wl* - liquid limit	Shear strength (kPa) *VS* - very soft, *S* – soft *F* – firm *St* – stiff *VSt* - very stiff *H* – hard	*VL* - very loose *L* - loose *M* - medium *D* - dense *VD* - very dense	*NP* - non plastic *T* – trace *VL* – very low *L* – low *M* – medium *H* – high *VH* – very high	Point load (mPa) *EL* – extremely low (<0.03) *VL* – very low (<0.1) *L* – low (<0.3) *M* – medium (<1.0) *H* – high (<3.0) *VH* – very high (<10) *EH* – extremely high (>10)

Bore Log Sheet

Job: R9966g1 Client: Hayball Site: Young High School Campbell Street, Young NSW	Borehole No: 3 Location: New Library (south side)	Sampling method: EVH auger drill Logged by: JG Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
		FILL, SANDY GRAVEL with bitumen surface	GM		D	VSt	M	L	-
0.5		SANDY SILT, brown	ML		D	VSt	M	L	-
1.0		SANDY CLAY, reddish brown	Cl		D	St	M	M	-
1.5									
2.0		SANDY CLAY, yellowish brown	Cl		D	St	M	M	-
2.5									
3.0		GRAVELLY CLAY, greyish yellow Yellow	Cl		D	VSt	M	M	-
3.5		End of hole at investigation depth							
4.0									

Slope/nature of surface: 0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Fill to 300mm

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed *D* - disturbed SPT-standard penetrometer test CBR-California Bearing Ratio DCP-Dynamic cone penetrometer	*D* - Dry *M* - Moist, can be moulded *W* - Wet, free water on hands *Wp* - plastic limit *Wl* - liquid limit	Shear strength (kPa) *VS* - very soft, *S* – soft *F* – firm *St* – stiff *VSt* - very stiff *H* – hard	*VL* - very loose *L* - loose *M* - medium *D* - dense *VD* - very dense	*NP* - non plastic *T* – trace *VL* – very low *L* – low *M* – medium *H* – high *VH* – very high	Point load (mPa) *EL* – extremely low (<0.03) *VL* – very low (<0.1) *L* – low (<0.3) *M* – medium (<1.0) *H* – high (<3.0) *VH* – very high (<10) *EH* – extremely high (>10)

Bore Log Sheet

Job: R9966g1 Client: Hayball Site: Young High School Campbell Street, Young NSW	Borehole No: 4 Location: Building MM	Sampling method: EVH auger drill Logged by: JG Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
0.5		SANDY SILT, brown	ML		M	F	M	L	-
1.0		SANDY CLAY, reddish brown with fine gravel and ironstone gravel	CI		M	VSt	M	M	-
1.5		SANDY CLAY, brown with fine gravel	CI	D	M	St	M	M	-
2.0		SANDY CLAY, yellowish brown with fine gravel	CI		D	VSt	M	M	-
2.5		GRAVELLY CLAY, greyish brown	CI		D	VSt	M	M	-
3.0		Yellow							
3.5		End of hole at investigation depth							
4.0									

Slope/nature of surface: 0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Fill to 300mm

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed *D* - disturbed SPT-standard penetrometer test CBR-California Bearing Ratio DCP-Dynamic cone penetrometer	*D* - Dry *M* - Moist, can be moulded *W* - Wet, free water on hands *Wp* - plastic limit *Wl* - liquid limit	Shear strength (kPa) *VS* - very soft, *S* – soft *F* – firm *St* – stiff *VSt* - very stiff *H* – hard	*VL* - very loose *L* - loose *M* - medium *D* - dense *VD* - very dense	*NP* - non plastic *T* – trace *VL* – very low *L* – low *M* – medium *H* – high *VH* – very high	Point load (mPa) *EL* – extremely low (<0.03) *VL* – very low (<0.1) *L* – low (<0.3) *M* – medium (<1.0) *H* – high (<3.0) *VH* – very high (<10) *EH* – extremely high (>10)

Bore Log Sheet

Job: R9966g1 Client: Hayball Site: Young High School Campbell Street, Young NSW	Borehole No: 5 Location: Existing carpark off Campbell Street	Sampling method: EVH auger drill Logged by: JG Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
		FILL, sandy gravel, yellow with bitumen	GM		M	St	M	L	-
0.5		SANDY CLAY, reddish brown with gravel	Cl		M	St	M	M	-
1.0		SANDY CLAY, brownish yellow with gravel	Cl		M	VSt	M	M	-
1.5									
2.0		GRAVELLY CLAY, brown	Cl		D	VSt	M	M	-
2.5									
3.0		GRAVELLY CLAY, greyish brown Yellow	Cl		D	VSt	M	M	-
3.5		End of hole at investigation depth							
4.0									

Slope/nature of surface: 0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Fill to 200mm

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed *D* - disturbed SPT-standard penetrometer test CBR-California Bearing Ratio DCP-Dynamic cone penetrometer	*D* - Dry *M* - Moist, can be moulded *W* - Wet, free water on hands *Wp* - plastic limit *Wl* - liquid limit	Shear strength (kPa) *VS* - very soft, *S* – soft *F* – firm *St* – stiff *VSt* - very stiff *H* – hard	*VL* - very loose *L* - loose *M* - medium *D* - dense *VD* - very dense	*NP* - non plastic *T* – trace *VL* – very low *L* – low *M* – medium *H* – high *VH* – very high	Point load (mPa) *EL* – extremely low (<0.03) *VL* – very low (<0.1) *L* – low (<0.3) *M* – medium (<1.0) *H* – high (<3.0) *VH* – very high (<10) *EH* – extremely high (>10)

Bore Log Sheet

Job: R9966g1 Client: Hayball Site: Young High School Campbell Street, Young NSW	Borehole No: 6 Location: Existing carpark off Caple Street	Sampling method: EVH auger drill Logged by: JG Date: 12/07/2019

Depth (m)	Graphic log	DESCRIPTION. Soil type/rock, grain size, structure, colour, minor components	Unified symbol	Samples	Moisture	Consistency	Density	Plasticity	Rock description
		SANDY SILT, dark brown	ML		M	F	M	L	-
0.5		SILTY CLAY, reddish brown	CI	D	M	F	M	M	-
1.0				D					
1.5		SILTY CLAY, brown	CI		M	F	M	M	-
2.0		End of hole at investigation depth							
2.5									
3.0									
3.5									
4.0									

Slope/nature of surface: 0-2%
Ground water: Nil
Soil salinity: No evidence observed

Remarks (fill, odour, root holes): Fill to 200mm

Samples	**Moisture**	**Consistency**	**Density**	**Plasticity**	**Rock strength**
U - undisturbed *D* - disturbed SPT-standard penetrometer test CBR-California Bearing Ratio DCP-Dynamic cone penetrometer	*D* - Dry *M* - Moist, can be moulded *W* - Wet, free water on hands *Wp* - plastic limit *Wl* - liquid limit	Shear strength (kPa) *VS* - very soft, *S* – soft *F* – firm *St* – stiff *VSt* - very stiff *H* – hard	*VL* - very loose *L* - loose *M* - medium *D* - dense *VD* - very dense	*NP* - non plastic *T* – trace *VL* – very low *L* – low *M* – medium *H* – high *VH* – very high	Point load (mPa) *EL* – extremely low (<0.03) *VL* – very low (<0.1) *L* – low (<0.3) *M* – medium (<1.0) *H* – high (<3.0) *VH* – very high (<10) *EH* – extremely high (>10)

Appendix 2. Soil index properties

Envirowest Consulting Pty Ltd ABN 18 103 955 246 trading as
Envirowest Testing Services
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

Rec 51002 Soil Index Properties - Test Report

Client	Hayball	Report no.	R9966g1
Address	11-17 Buckingham Street Surry Hills NSW 2010	Site location	Young High School Campbell Street, Young NSW

Borehole		BH1	BH2	BH2	BH4
Depth (mm)		2700	1300	1900	1500
Tests	***Methods***				
Liquid Limit (%)	AS 1289.3.1.2	36	37	43	43
Plastic limit (%)	AS 1289.3.2.1	24	18	20	18
Plasticity index (%)	AS 1289.3.3.1	12	19	23	25
Linear Shrinkage (%)	AS 1289.3.4.1	7.0	12.0	15.5	13.5
-characteristics (curling or crumbling)		curling	curling	curling	curling
Field Moisture (%)	AS 1289.2.1.1	-	-	-	-
I_{SS}	AS 1289.7.1	-	-	-	-
USCS	AS 1726 *	CI	CI	CH	CI
Description	AS 1726 *	GRAVELLY CLAY	SANDY CLAY	SANDY CLAY	SANDY CLAY
Colour	AS 1726 *	Yellowish grey	Red	Brownish yellow	Brown

Disturbed samples

Sample preparation:	-drying	-	Air	x	Oven	-	Natural state
	-sieving	-	Wet			x	Dry
	-material	-	Pass 2.36 mm			x	Pass 425 µm
Linear shrinkage:	-mould	x	250 mm			-	125 mm
Liquid Limit:	-method	-	Standard			x	One Point

Undisturbed samples

Inert inclusions in specimen	-	%				
Soil crumbling during shrinkage affecting mass	-	Yes	-	No		
Extent of cracking of sample	-	Major	-	Minor	-	Nil

Samples tested as received
* Not NATA test

Test authorised by:

G. Madafiglio PhD
Date: 01/08/2019

NATA

Accredited for compliance with ISO/IEC 17025

Accred. No. 15372

Appendix 3. Aggressive soils, extract from Australian Standards, *AS 2870*

Exposure classification for concrete in saline soils

Saturated extract electrical conductivity (EC_e), *dS/m*	Exposure classification
<4	A1
4-8	A2
8-16	B1
>16	B2

Notes:

1. Guidance on concrete in saline soils can be found in CCAA T56
2. Exposure classifications are from AS 3600
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (*EC*) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture, to determine the saturated extract electrical conductivity (EC_e)
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4dS/m, therefore no increase in the minimum concrete strength is required below this value

Exposure classification for concrete in sulphate soils

Exposure conditions			Exposure classification	
Sulphates (expressed as SO_4)*		pH	Soil conditions A**	Soil conditions B†
In soil (ppm)	In groundwater (ppm)			
<5,000	<1,000	>5.5	A2	A1
5,000-10,000	1,000-3,000	4.5-5.5	B1	A2
10,000-20,000	3,000-10,000	4-4.5	B2	B1
>20,000	>10,000	<4	C2	B2

* Approximately 100ppm SO_4 = 80ppm SO_3

** Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater

† Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

Minimum design characteristic strength (f_c') and curing requirements for concrete

Exposure classification	Minimum f_c' MPa	Minimum initial curing requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

Minimum reinforcement cover for concrete

Exposure classification	Minimum cover in saline soils * mm	Minimum cover in sulfate soils ** (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	†	70
C2	†	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30mm.

** Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10mm.

† Saline soils have a maximum exposure classification of B2 as per Table 5.1.

Appendix 4. Important information about the report

Background

The intention of the Australian Standard 2870-1996, Residential slabs and footings, is to provide guidance in the design of slabs and footings of residential building on commonly encountered foundations. The standard is also considered to provide useful guidance for commercial and industrial buildings. This involves (1) site classification, (2) structural design and construction and (3) site maintenance after construction. The classification assessment in this report is the first step in providing a footing system for a building, which will have a low risk of inadequate performance (Appendix B AS2870-1996). Even significant cracking to widths of over 3 mm usually presents only aesthetic rather than structural problems. Some minor problems should be expected during settlement or in periods of drought.

Classification

AS2870-1996 establishes a classification system whereby reactive sites (unaffected by filling) are designated slightly, moderately, highly or extremely reactive based on the range of ground surface movements anticipated and which are likely to have a less than 5% chance of being exceeded in the design life of the structure. Where the foundation conditions at a site need to consider aspects in addition to, or other than soil reactivity, the site is classified P.

It is neither possible nor economical to design for the extreme conditions that could occur in the foundation if a site is not properly maintained. The recommended foundation maintenance is described below. Some minor cracking and movement will occur in a significant proportion of houses, especially on reactive clays.

The method of subsurface investigation has been described in the attached report and it usually involves one or more boreholes or test pits in each lot. It may also involve the inspection of exposures in road cuttings and trenches. In making the assessment there is a risk that variations which may occur between tests or exposure locations may not be detected. The number of test pit locations undertaken is a professional estimate to provide a description of the general soil profile at the site. No subsurface investigation, no matter how comprehensive, can reveal all details and anomalies. Small local variations such as deep topsoil, fill associated with local grubbing of tree stumps and previous trenches or pits may be undetected. If subsoil conditions encountered during the footing excavation are different from those described in the report, reclassification may be necessary. The site should be reassessed and may require revision of the classification and footing design.

Most sites are not level and often require cutting and filling to provide a level platform for construction. AS2870-1996 specifies the classification should be revised if (a) the depth of the cut exceeds 0.5m, or (b) the depth of compacted fill exceeds 0.4 m for clay or 0.8 m for sand.

Foundation maintenance

All soils are affected by water. Silts are weakened by water and some sands can settle if heavily watered, but most problems arise on clay foundations. Clays swell and shrink due to changes in moisture. Sands, silts and clays should be protected from becoming extremely wet. Sites classified as M, H or E shall be maintained at essentially stable moisture conditions and extremes of wetting and drying prevented. This requires attention to the following:

(a) Drainage of the site. The site shall be graded and drained so that water cannot pond against or near the house. The ground immediately adjacent to the house shall be graded to a uniform fall of 50mm minimum away from the house over the first metre. The sub floor space for houses with suspended floors shall be graded or drained to prevent ponding, where this may affect the performance of the footing system. The site drainage requirement shall be maintained for the economic life of the building.
(b) Limitation on gardens. The buildings shall not interfere with the drainage requirements or the sub floor ventilation and weep hole drainage systems. Garden beds adjacent to the house should be avoided. Care should be taken to avoid over watering of gardens close to the house footings.
c) Restrictions on trees and shrubs. Planting of trees and shrubs should be avoided near the foundations of a house on reactive sites as they can cause damage, even at substantial distances, due to the drying of the clay. To reduce, but not eliminate the possibility of damage, trees should be restricted to a distance of 1 times the mature tree height for Class H and M, and 1.5 times mature tree height for Class E. Where groups of trees are involved, distances should be increased. Removal of trees from the site can also cause similar problems.
(d) Repair of leaks. Leaks in plumbing, including storm water and sewage should be repaired promptly.

Class P sites

The presence of fill, compressible soils at depth or slope may influence footing performance and these need to be considered in foundation design.

Appendix 5. CBR laboratory report