Douglas Partners
Geotechnics | Environment | Groundwater

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**Geotechnical Desktop Study**
**HomeCo St Marys Project**
**243 Forrester Road, St Marys**

## 1. Introduction

This report presents the results of a desktop geotechnical assessment undertaken by Douglas Partners Pty Ltd (DP) for proposed alterations and additions at 243 Forrester Road, St Marys. The assessment was commissioned by David Gutwenger of Home Consortium, in an email dated 19 November 2020, and was undertaken in accordance with Douglas Partners' (DP) proposal SYD201028.P.001.Rev0 dated 18 September 2020.

It is understood that the proposed development at the site mostly involves changes to the internal fit-out of the existing building, with some minor changes to outdoor paved areas and the northern part of the existing building.

The proposed development was modified after preparation of DP's proposal and the intrusive geotechnical investigation originally outlined in the proposal was not required. This assessment has been based only on a review of existing information.

The aim of the assessment was to assess the subsurface conditions at the site in order to provide information on the expected geotechnical conditions, and to provide advice on geotechnical issues pertaining to the proposed development.

The assessment is based on

- information obtained during a geotechnical investigation completed by DP at the site in 2010 for the development of the existing building (DP reference: 71677);
- observations during construction inspections;
- earthworks testing undertaken by DP during construction (DP reference: 670669.00/.01); and
- published information relevant to the site.

## 2. Site Description

The site is a near rectangular shaped area of approximately 155 m by 225 m, mostly covered by on-grade parking areas along the northern, western, and southern boundaries and a large single storey warehouse building over the central and eastern parts of the site. The site is fairly flat with very gentle falls to drainage channels in the car parking areas.

The site is bounded by scrub and Forrester Road to the west and north, the St. Marys Leagues Stadium to the east, and on-grade parking for the St Marys Rugby League Club immediately to the south. Ropes Creek is located approximately 360 m east of the site and flows north-west into South Creek.


**Figure 1: Approximate Site Boundary and Location Plan**

## 3. Regional Mapping

The Penrith 1:100,000 Geological Series and Soil Landscape Series sheets indicate that the site is underlain by Quaternary sediments. These sediments are alluvial deposits which typically comprise fine grained sand, silt and clay. The soils are described as typically being very deep layered sediments over bedrock or relict soils with small areas of structured grey clays, leached clay and yellow solodic soils.

Solodic soils represent a former saline soil, associated with semi-arid tropical environments, in which the topsoil horizon has become slightly acidic, and the subsoil horizon is enriched with sodium-saturated clay. The presence of saline soils is indicated by the 2002 Salinity Potential in Western Sydney Map. The site is in an area of known salinity hazard. Localised salt scars are also known to occur in the area.

Based on the NSW acid sulphate soil risk map the site is within a region of no known occurrence of acid sulphate soils.

## 4. Background Information

In 2010 DP completed a geotechnical investigation at the site for the construction of the existing building and pavements. The investigation included the excavation of nine test pits to depths of 1-1.8 m, and six cone penetration tests (CPTs) to depths of 5-6 m.

The development of the site for the existing use involved raising of site levels by placing approximately between 0.6 m and 1.2 m of fill material to reach the design subgrade level, with the fill depth increasing towards the eastern half of the site. DP provided density testing and inspections during the earthworks operations, under Level 1 control as defined in AS3798-2007: "Guidelines on Earthworks for Commercial and Residential Developments" between March 2012 and May 2013. The majority of this testing was within the footprint of the existing building. Some additional testing under Level 2 control was undertaken around the site between April and May 2013.

Based on the results of the past investigation and earthworks testing, and DP's general understanding of the geology in the area, the anticipated sequence of subsurface materials likely to be encountered at the site, in increasing depth order, is summarised in Table 1.

**Table 1: Summary of Anticipated Subsurface Ground Profile**

| Unit | Material | Anticipated Depth Range to Top of Material | General Description |
|---|---|---|---|
| 1 | Fill | 0 m | Mostly controlled fill expected to typically comprise imported (shale) gravelly clay in the areas where site levels have been raised. May also comprise site-won re-compacted silty clays with gravel and sand.<br>Expected to be typically well compacted. |
| 2 | Alluvial Sediments | 0.5-3 m | Stiff to hard orange-brown silty clay with traces of gravel and some silty sand horizons which may be cemented in places |
| 3 | Residual Soil / Weathered Bedrock | 5-7 m | Hard clay grading into very low to low strength shale bedrock |

Groundwater was observed during the previous investigation in 2010 at depths of 2-2.5 m below original ground levels, equivalent to elevations between RL 22 m and RL 22.5 m relative to the Australian height datum. It is noted that groundwater levels are transient and may fluctuate significantly in response to climatic and seasonal variations.

## 5. Proposed Development

It is understood that the proposed development includes changes to the internal fit-out of the existing building, with some minor changes or extensions to outdoor paved areas and the northern part of the existing building.

It is expected that the development may include the construction of new on-grade slabs and shallow footings for the building extensions. Some minor earthworks may be required for excavation of new footings or services. No deep excavations are proposed.

## 6. Comments

The site is considered suitable for the proposed alterations from a geotechnical perspective and further investigation prior to construction is not considered necessary. However, validation of the expected subsurface conditions during construction should be undertaken by a geotechnical engineer as discussed in Section 6.2.

## 6.1 Excavations and Support

Excavations for footings and services are expected to be mainly within existing fill or alluvial soil. Excavation into these materials should be readily achieved with conventional earthmoving equipment, such as hydraulic excavators.

It is expected that some seepage may occur into open excavations, particularly following periods of wet weather. For excavations above the water table, it is expected that any seepage should be readily controlled by a pump.

All excavated materials to be removed from the site will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (EPA, 2014). This includes both fill and natural materials.

Any temporary excavations in the fill and alluvial soils more than 1.5 m deep should be battered at slopes no steeper than 1.5 Horizontal:1 Vertical, or supported by temporary shoring.

If shoring or retaining walls are proposed, they may be designed on the basis of the parameters in Table 2.

**Table 2: Retaining Wall Design Parameters**

| Unit | Material | Unit Weight ($kN/m^3$) | Active Earth Pressure Coefficient ($K_a$) | Passive Earth Pressure Coefficient ($K_p$) |
|---|---|---|---|---|
| 1 and 2 | Compacted Fill and Alluvial Clays | 20 | 0.3 | 2 |

Development of the 'active' earth pressure associated with $K_a$ requires some wall movement to occur. If movements behind retaining walls must be limited, an 'at-rest' earth pressure coefficient ($K_o$) of 0.5 is suggested for design. The passive earth pressure parameter given in Table 2 are ultimate values which can only occur if there is significant movement of the wall and should be factored during design to account for this.

Full hydrostatic pressure should be considered behind retaining walls unless adequate drainage is incorporated into the retaining wall design, and an allowance made for any surcharge loading behind the wall (e.g. existing structures or temporary construction loads).

## 6.2 Shallow Foundations

It is expected that the existing building footings are shallow spread footings (pads, strips and slabs) founded on either controlled fill or stiff to very stiff alluvial clay. The foundation system of the existing building should be confirmed, and any new footings should be of a similar type founded in the same stratum.

New footings founded in controlled fill or stiff to very stiff alluvial clay may be proportioned on the basis of an allowable bearing pressure of 150 kPa. Shallow footings proportioned on this basis are anticipated to experience settlements less than 1% of the footing width.

Footing excavations should be inspected and tested by a geotechnical engineer prior to construction of the footing to confirm that the subsurface conditions align with the design assumptions. This is particularly important where footings are to be founded in fill material, which despite earthworks control may vary locally (particularly outside the footprint of the existing building, where fill was placed outside Level 1 earthworks control).

## 6.3 Site Reactivity

Laboratory testing completed during the 2010 investigation indicated that the in-situ fill and alluvial clays were of moderate plasticity, and expected to have a moderate propensity for shrink-swell movements with variations in moisture content. As site levels have been raised with imported fill which has not been tested for shrink-swell properties, it is not possible to be certain of the reactivity of the imported fill.

However, as the site is mostly covered by pavements and concrete floor slabs, the potential for seasonal moisture variation should be limited. New footings founded at least 2.5 m away from any landscaped areas (e.g. garden beds) and at a minimum depth of 0.5 m below the finished surface levels should experience minimal shrink-swell movements associated with seasonal moisture variation. The depth of new footings founded within 2.5 m of any landscaped areas should be increased to at least 1.2 m to reduce the risk of shrink-swell movements.

Care should be taken during construction not to allow the foundation materials to dry out prior to the placement of the concrete. All the foundation materials should be at or close to the optimum moisture content of the soil to minimise the potential for later shrink/swell movements.

## 6.4 Pavements

The imported fill subgrade material supporting the existing pavements was tested during construction and found to have a California Bearing Ratio (CBR) value between 3% and 5%. It is recommended that a CBR value of 3% is adopted for design of any proposed pavements that will be supported on the existing fill subgrade. If the subgrade materials are altered by the importation of more, the CBR of the imported material should be confirmed prior to use.

## 6.5 Floor Slabs

Design of new concrete floor slabs will depend on the magnitude and distribution of floor loads. Designs undertaken in accordance with the Cement Concrete and Aggregates Australia (CCAA) "Guidelines to Industrial Floors and Pavements – design, construction and specification" (2009) require an assessment of the equivalent long-term Young's Modulus ($E_{sl}$) of the subgrade.

Based on the subgrade being compacted to a minimum dry density ratio of 98% Standard, within ±2% of the Optimum Moisture Content, then the design may assume an equivalent uniform soil layer of about 8 m depth with a modulus $E_{sl}$ = 15 MPa.

## 6.6 Salinity, Drainage and Aggressivity

The site is in an area of known salinity occurrence. The site is understood to be subject to periodic flooding, therefore groundwater levels may fluctuate allowing salts to reach foundation soils. In order to prevent adverse impacts from salinity, sufficient drainage should be incorporated into the design.

- Drainage should ensure it does not excessively concentrate surface runoff and lead to water-logging of pavement areas or result in additional recharge to the groundwater system;
- The subgrade should be sealed and pavements or slabs constructed as soon as possible;
- The installation of a damp-proof course should restrict damage from rising moisture;
- Landscaping and flowerbeds should not buttress walls as this may provide a conduit for saline water to bypass damp-proofing;
- Service trenches can provide conduits for water and therefore should be backfilled with compacted impermeable backfill, or with a clay plug every 2 m along the trench.

Saline soils can be aggressive to buried concrete foundations. The origin of the fill material is not known, and although it considered unlikely to be highly aggressive, the aggressivity of the subgrade material should be confirmed prior to the construction of new footings.

It would be prudent to assume that the subgrade material aggressivity classification is at least 'mild' for buried concrete and steel in accordance with AS2159-2009: "Piling-Design and Installation" in the design of new footings.

# 7. Limitations

Douglas Partners (DP) has prepared this report for this project at 243 Forrester Road, St Marys in accordance with DP's proposal SYD201028.P.001.Rev0 dated 18/09/2020 and acceptance received from David Gutwenger of Home Consortium, in an email dated 19 November 2020. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of RCP (NSW) Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DP's advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
**Douglas Partners Pty Ltd** Reviewed by

[redacted]

**Rhys McMillan** for **Fiona MacGregor**
Geotechnical Engineer Principal

Attachments: About this Report

# About this Report

Douglas Partners

## Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

## Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

## Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

# About this Report

## Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

## Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

## Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

## Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

## Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

| Type | Particle size (mm) |
|---|---|
| Boulder | >200 |
| Cobble | 63 - 200 |
| Gravel | 2.36 - 63 |
| Sand | 0.075 - 2.36 |
| Silt | 0.002 - 0.075 |
| Clay | <0.002 |

The sand and gravel sizes can be further subdivided as follows:

| Type | Particle size (mm) |
|---|---|
| Coarse gravel | 19 - 63 |
| Medium gravel | 6.7 - 19 |
| Fine gravel | 2.36 – 6.7 |
| Coarse sand | 0.6 - 2.36 |
| Medium sand | 0.21 - 0.6 |
| Fine sand | 0.075 - 0.21 |

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

| Term | Proportion of sand or gravel | Example |
|---|---|---|
| And | Specify | Clay (60%) and Sand (40%) |
| Adjective | >30% | Sandy Clay |
| With | 15 – 30% | Clay with sand |
| Trace | 0 - 15% | Clay with trace sand |

In coarse grained soils (>65% coarse)
- with clays or silts

| Term | Proportion of fines | Example |
|---|---|---|
| And | Specify | Sand (70%) and Clay (30%) |
| Adjective | >12% | Clayey Sand |
| With | 5 - 12% | Sand with clay |
| Trace | 0 - 5% | Sand with trace clay |

In coarse grained soils (>65% coarse)
- with coarser fraction

| Term | Proportion of coarser fraction | Example |
|---|---|---|
| And | Specify | Sand (60%) and Gravel (40%) |
| Adjective | >30% | Gravelly Sand |
| With | 15 - 30% | Sand with gravel |
| Trace | 0 - 15% | Sand with trace gravel |

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.



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# *Soil Descriptions*

## Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

| Description | Abbreviation | Undrained shear strength (kPa) |
|---|---|---|
| Very soft | VS | <12 |
| Soft | S | 12 - 25 |
| Firm | F | 25 - 50 |
| Stiff | St | 50 - 100 |
| Very stiff | VSt | 100 - 200 |
| Hard | H | >200 |
| Friable | Fr | - |

## Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

| Relative Density | Abbreviation | Density Index (%) |
|---|---|---|
| Very loose | VL | <15 |
| Loose | L | 15-35 |
| Medium dense | MD | 35-65 |
| Dense | D | 65-85 |
| Very dense | VD | >85 |

## Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

## Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

## Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).