HARDROCK
GEOTECHNICAL
CONSULTING GEOTECHNICAL ENGINEERS

Geotechnical Site Investigation Report

No. 6 Wests Road, Maribyrnong

Client: Maribyrnong City Council
Attention: Sze-Lay Ng
No. 95 Sunshine Road
West Footscray
Vic. 3011

Distribution: - Maribyrnong City Council
- K20 Au Pty Ltd

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Introduction

A site investigation was conducted by an experienced geotechnical engineer at this site on the 30th of May, 2015. The purpose of the investigation was to provide foundation recommendations for the proposed alternations and additions to the existing childcare centre, incorporating a single storey extension.

Site Description

The site is currently occupied by the existing day care centre. The property is bounded by roads and tram lines to the west and east and residential apartments to the north and south. The site has a ground cover of asphalt pavement, comprising play areas and car parking, tan-barked play grounds and grassed areas. Garden beds with small, medium and large trees are present along the property boundaries with some isolated garden beds along the existing building. The site is relatively flat with poor natural surface drainage.

View of the front of the site

Scope of the Investigation

The site investigation included the drilling of 7 boreholes using hand auger, incorporating the exposure of 4 existing footings. The presence of concrete paving along the playroom 1 exterior wall prevented the exposure of that footing. The subsurface profile was logged and bulk sampled using visual-tactile methods as per AS2870-2011.

Borehole logs and locations are shown on pages 10 to 14 of this report.

Subsurface Conditions

Regional geology

The site is identified on the 'Geological Survey of Victoria' Melbourne Sheet (1:63,360) as being in the province of Quaternary 'Newer Volcanics'. Weathering of these olivine basalt flows typically result in shallow surface residual silts, underlain by highly reactive silty clays which grade to variably weathered basalt at depth.

Subsurface profile

See borehole logs pages 10 to 13.

The boreholes encountered:

- FILLING to depths of between 0.30m to 0.70m, underlain by;
- a thin veneer of natural medium dense clayey SILT of medium plasticity in borehole 1 only to a depth of 0.60m, underlain by;

- stiff silty CLAY of high plasticity to depths of between 0.90m and 1.60m, underlain by;
- weathered BASALT ROCK, intersected in boreholes 1, 2, 3, and 4.

The existing fill material can be considered the equivalent of rolled non sand fill in accordance with AS2870 – 2011 clause 6.4.2.

Depth to bedrock

Basalt rock was intersected at the southern side of the site at depths between 0.9-1.6m. The depth to rock appears to increase towards the north with borehole 6 drilled to 2.7m depth with no rock intersected.

Soil moisture & groundwater

No groundwater was encountered in the boreholes. Filling and natural soils were in a moist condition.

Site Classification

The site is classified as **CLASS H2** in accordance with AS2870-2011.

Earthquake - Site Sub-Soil Class

With reference to AS1170.4-2007, Section 2.4, a site sub-soil class of **CLASS C_e – Shallow Soil Site** can be assumed.

Details of Existing Footings

The existing slab footings were exposed at boreholes 2, 3,4 and 5 (see figure 1). Dimensions and founding material are shown below, depths are relative to the existing surface levels at the time of the investigation.

Location:	**Borehole 2**	**Borehole 3**
		South face of MCH building
Type:	Concrete Slab	Concrete Slab
Founding depth:	750mm	600mm
Depth of footing:	750mm	300mm
Projection:	Variable: 100mm – 0mm	400mm
Founding material:	natural stiff silty CLAY	natural stiff silty CLAY

Location:	**Borehole 4**	**Borehole 5**
	South West corner of Multipurpose Hall	**North East corner of Playroom 3**
Type:	Concrete Slab	Concrete Slab
Founding depth:	900mm	900mm
Depth of footing:	850mm	750mm
Projection:	300mm	90mm
Founding material:	natural stiff silty CLAY	natural stiff silty CLAY

Rear of the existing building, footing exposure as requested could not be conducted here without concrete cutting.

Foundation Recommendations

Where the proposed buildings conform with the scope of AS2870-2011, a conventional foundation may be incorporated into the design (as per the recommendations below).

Where the proposed buildings exceed the scope of the code, the design should either be:

- based on engineering principles to accommodate a design surface movement of 60mm<y_s<75mm; or alternatively;
- deepened to the underlying BASALT ROCK or suspended to an engineer design incorporating mass pads or bored piers or piles.

Concrete floor slab

Site preparation

The site shall be prepared either in accordance with the:

- subgrade preparation requirements provided below; or alternatively
- section 6 of AS2870-2011.

Particular attention should be given to the stripping of all vegetation and root zone material. In addition any soft or loose material that does not respond to compaction should be excavated to achieve a firm working base.

Any filling placed across the site to assist in levelling prior to slab construction should conform with requirement for either Controlled or Rolled fill as outlined in clause 6.4.2 AS 2870-2011.

Slab-on-ground

The slab should be designed in accordance with a **CLASS H2** classification, or designed using engineering principles to accommodate a design surface movement of 60mm<y_s<75mm, and:

- slab edge beams and heavily loaded internal beams should penetrate through any fill material and be founded a minimum of 100mm into the natural stiff silty CLAY; and
- founding depths for slab edge beams should not be reduced to less than 300mm below finished ground level.

Borehole No.	Minimum Founding Depth (m)	Founding material.
	Slab edge beams & heavily loaded internal beams.	
1	0.70	natural stiff silty CLAY
2, 4, 7	0.80	natural stiff silty CLAY
3, 5	0.60	natural stiff silty CLAY
6	0.40	natural stiff silty CLAY

Founding depths for slab edge beams are relative to surface levels at the time of the site investigation. Site cutting or filling will alter the founding depths estimated.

An allowable bearing pressure of 150kPa may be adopted beneath slab edge beams founding in the natural stiff silty CLAY.

Slab panels and non-heavily loaded internal beams can be founded in the natural soil profile or in compacted surface filling. Compacted filling used to raise levels beneath panels must be placed and compacted as per specifications for Controlled or Rolled fill in accordance with section 6.4.2 AS2870-2011. Total fill depths (including any existing filling on site) must not exceed that specified in clause 6.4.2 AS 2870-2011.

Trees

Trees/shrubs can induce 'drying' of foundation zone soils, resulting in shrinkage and consequent foundation movement and cracking. Conversely, trees/shrubs can also block or crack service pipes, resulting in leaking and wetting of foundation zone soils, with similar undesirable consequences.

Trees should therefore be prohibited a minimum distance equal to the mature height of the tree from structures for sites of high reactivity, AS2870-2011 B2.3 (c) tree restrictions. There generally has to be a compromise between the presence of trees and foundation movement and associated cracking.

Should significant trees exist or proposed within this 'zone of influence' from the proposed structure(s), slab edge beams should be suspended to an engineer design (as per the recommendations below).

Tree roots are attracted to moist ground conditions. If a relatively low and constant ground moisture condition can be maintained in the vicinity of the foundations, tree roots, which may cause volumetric changes in the foundation zone soils and/or cracking in later dry periods, will be attracted to other areas.

This office specialises in GEOTECHNICAL ENGINEERING, and not arbiculture/horticulture and tree identification. Any trees/shrubs shown on Figure 1 are schematic and not intended to be utilised in the footing design. To ensure the performance of the foundations, we recommend that once clearing (and/or demolition) is complete, any trees and shrubs remaining or removed are identified and the structural engineer informed to modify the structural design accordingly. Identification may require a professional arborist or similar.

Removal of trees

Trees should be carefully removed and 'grubbed'; the resulting open excavations should be appropriately backfilled with tamped clay or stabilised soils where close to the proposed building envelope.

Footing trenches and open excavations must take care to penetrate through any significant tree root matter; additional blinding should be anticipated.

Engineer Designed Footing System

Where the proposed building exceeds the scope of the code and/or is a raft slab on ground is impracticable, the design should either be:

- based on engineering principles to accommodate a design surface movement of 60mm<y_s<75mm; or alternatively;
- founded on the underlying confirmed continuous BASALT ROCK (bedrock), throughout. The foundation may be continuously deepened, or alternatively suspended to an engineer design incorporating mass pads or bored piers or piles.

Where the footing are based on engineering principles for a design surface movement all footing should be founded in the natural stiff silty CLAY and proportioned for a maximum allowable bearing pressure of 180kPa. Good foundation maintenance practices are required for this foundation.

Suspended footings

The depth to BASALT ROCK should ideally be confirmed with test pit(s) (or indicative depths with boreholes) to validate the recommendations in this report. This should be conducted at the first possible opportunity once site access is readily available to avoid future delays and redesign.

Bored piers/mass pads would be better suited to areas of the site characterised by shallow and variable BASALT ROCK, screw or driven piles will be better suited to areas of the site where the depth to BASALT ROCK is deeper.

Bored piers/mass pads must penetrate through any filling and natural soils and founded at refusal on confirmed continuous weathered BASALT ROCK.

An allowable bearing pressure of 1000kPa is available beneath bored piers founded at refusal on confirmed continuous weathered BASALT ROCK.

Should a basalt floater be intersected before a founding depth is achieved, that pile should be cored to bedrock, abandoned or the pile moved until the floater is avoided.

Screw piles

Screw piles should be founded at refusal on confirmed continuous weathered BASALT ROCK.

An allowable bearing pressure of 1000kPa is available beneath screw piles founded at refusal on confirmed continuous weathered BASALT ROCK.

Should a basalt floater be intersected before a founding depth is achieved that pile should be removed or abandoned and the pile moved until the floater is avoided.

Pile cap

If a slab on ground is to be adopted for the pile cap then we recommend that a void former is placed under the slab panels (but not the beams) to prevent heave and uplift forces.

If a strip footing is be the pile cap, then no void former is needed and as a guide to design we recommend that the pile cap (strip footings) are gridded at approximately 6m centres as per the requirement for a CLASS H1 strip footing (at the discretion of the Structural Engineer) to prevent lateral movements of the pile cap.

Construction & Maintenance

Strict adherence to normal foundation maintenance practices is not required for a footings founded entirely on weathered BASALT ROCK.

Site conditions

Basalt floaters may be intersected in the soil profile, and may make foundation excavations problematic. Where practical placement of the footing directly over a floater should be avoided, the floater removed and the resulting void backfilled with concrete.

Details for a partial rock foundation are provided in AS2870-2011, section 3.1.7.

Disturbance of the filling and natural soils will result from previous land use, demolition and site works. Disturbed natural soils will constitute fill material and deeper isolated areas of filling should therefore be anticipated.

Where footings/edge beams are to be additionally deepened, we recommend blinding concrete should first be poured in the base of the excavation upon which the footing/edge beam can be constructed.

Articulation

Articulation of pavements and floor slabs where they abut walls should be provide to allow for differential movement.

Articulation of masonry walls should be provided at the discretion of the structural engineer or as per details contained in reference (3) below. Spacing between articulation joints should not exceed a maximum of 6.0m, and should be provided at/or between:

- any new walls abutting the existing building walls (as per AS 2870-2011, clause 3.1.5);
- different foundation types;
- footings founding at significantly different founding depths, or founding material; and
- points of high stress ie above door and window openings, changes in storey height, or above large spanning lintels.

Service trenches/easements

The presence of service trenches and easements is a common cause of unsatisfactory performance of foundations through either direct undermining or through the introduction of undesirable levels of soil moisture. For this reason, we recommend:

- Where footings are located in close proximity or adjacent to a backfilled service trench or easements, the footing must be deepened and founded at a depth 500mm below the level of plane of inclination of 45° above horizontal extending outwards from the base of the trench or filling (as illustrated by figure C6.1 AS 2870-2011). This includes service trenches which may be present on adjacent sites or on site prior to the current development (such as abandoned stormwater and sewer trenches);
- Significant additional deepening (greater than nominal depth of 1.50m) may necessitate the footing/edge beam to be suspended to an engineer design, and this office should be contacted for further advice;
- All service trenches should be sloped away from the building as per AS2870-2011 section 5.6.3(b, c and d) and be backfilled with non-permeable material as per AS2870-2011 section 5.6.3 (b).
- Backfill material should ideally comprise weak mix concrete, mortar or (preferably) cement stabilised soil, or clean adequately tamped/compacted clay placed marginally wet of optimum. Permeable or granular material such as sand, gravel, ¼ minus, or building rubble, should not be used to backfill service trenches in proximity to building foundations.

Construction

To ensure the satisfactory long term performance of foundations, it is absolutely imperative that:

- no water shall be allowed to pond or pool at the base of the foundation excavations,
- the stormwater be connected as soon as the roof is sealed. This will normally require the installation of a temporary system ‘above ground’ until permanent drainage is connected and operational, and

- the ground surface and pavements adjacent to the building be graded away from the building, as per the drainage requirements C5.2 AS2870-2011.

The recommendations contained in:
- AS2870-2011 Section 5.6 and 6.6 'Additional requirements for classes M, H1, H2 and E sites'; and
- Appendix B (Performance requirements and foundation maintenance), Section C5 AS2870-2011 (Detailing requirements);

should be adopted, where applicable for this site.

All contractors must be well **briefed** as to the requirements and specifications in this report. To minimise the likelihood of misinterpretation, this report must not be reproduced unless in full and contractors given ready access to the complete report.

This report is based on the assumptions that conditions revealed through selective sampling are indicative of the actual conditions throughout the site, i.e. correlation between boreholes. Variations between boreholes may exist due to previous land use or natural geologic processes. Additional deepening of the foundations, deeper than the minimum specified founding depths in this report, may be required. The actual subsurface conditions can be discerned only during earthworks when the subsurface profile can be directly observed.

For further information regarding geotechnical site investigation reports, refer to reference (5) below.

Inspection of all foundation excavations, site works and compaction must be conducted by a suitably qualified, experienced engineer, engineering geologist, building surveyor or similar to ensure that the founding material and site works are in accordance with this report. Should there be any doubt, this office should be immediately contacted.

Maintenance

The clay soils at this site are highly reactive, and may experience appreciable volumetric changes with changes in moisture content (i.e. shrink upon drying and swell upon wetting).

Conventional foundations are designed to accommodate normal reactivity induced seasonal surface movements, but require that a good foundation maintenance program be implemented.

A good foundation maintenance program should be aimed at keeping foundation zone soils at a low and constant moisture content. To this end we recommend that the notes contained in AS2870-2011 Appendix B and the CSIRO Information Sheet BTF 18 (references 1 and 3) be implemented, and that particular attention be given to the points discussed below.

Site drainage

The site should be graded or drained to prevent water from ponding against or near the building. Monitoring of surface drainage paths should be ongoing. In any areas where ponding or pooling of water does occur, the surface should be regraded to direct water away from the building or to stormwater discharge points.

Garden restrictions

Garden beds should not compromise site drainage or be located directly adjacent to the building and should not be over-watered where they are near the building foundations.

Maintenance of plumbing, services and stormwater system

All services and plumbing must be well maintained and periodically checked for leaks. Guttering must be kept clean at all times and downpipes discharge all roof water into the storm water system (or rainwater tank).

Foundation performance

It should be noted that the conventional foundations specified in AS2870-2011 may still experience some minor (non-structural) foundation movement and cracking, even where good foundation maintenance practices are undertaken, depending on environmental factors and local conditions (refer to AS2870-2011 Section 1.3.1 and Table C1 and C2 Appendix C). This reflects the necessity of achieving a balance between cost, safety and serviceability.

Alternatives to conventional foundations can be 'tailored' to suit the desired level of performance of the foundation system. Should minor foundation movements be intolerable, or on-going maintenance be undesirable, the foundation may be engineered accordingly. This will be a matter for the proponent to decide based on the required level of serviceability and desired performance criteria, and cost. Further advice with regard to an alternative foundation design may be obtained from this office, if required.

Please do not hesitate to contact this office, should there be any further queries.

Yours Faithfully,
HardRock Geotechnical Pty Ltd

James Harrison B.E. (Geo.) M.E. (Env.)
(Geotechnical Engineer)

References

1. AS2870-2011. "Residential slabs and footings- Construction."
2. The Cement and Concrete Association of Australia. Technical Note: TN61.
3. CSIRO Information Sheet BTF 18: "Foundation Maintenance and Footing Performance: A Homeowners Guide".
4. Institution of Engineers, Australia. 1987. "Guidelines for the Provision of Geotechnical Information in Construction Contracts".
5. AS1726-1993. "Geotechnical Site Investigations".
6. AS2159- 2009. "Piling – Design and Installation".
7. AS2159 Supp1 - 1996. "Piling – Design and Installation Guidelines".
8. AS 3798-1996 "Guidelines on Earthworks for commercial and residential developments".
9. AS2159 – 1978 "SAA Piling Code"
10. Brinch Hansen, J (1961) " The ultimate resistance of rigid piles against transverse forces" -Danish Geotechnical Institute Bulletin no.12 pp5-9.
11. Broms (1964a) 'The lateral resistance of piles in cohesive soils' Journal of the soil Mechanics and Foundations Division, American Society of Civil Engineer, vol. 90, no. SM3 pp 27-63
12. Broms (1964b) 'The lateral resistance of piles in cohesionless soils' Journal of the soil Mechanics and Foundations Division, American Society of Civil Engineer, vol. 90, no. SM3 pp 79-99.
13. BS 8002-1994 "Earth Retaining Structures".
14. AS 4678-2002 "Earth Retaining Structures".

HardRock Geotechnical P/L

Consulting geotechnical engineers.

Borehole Logs

File: 150688
Date: 30/5/15
Supervisor: MB/ TB

Client: Maribyrnong City Council

Project: No. 6 Wests Road, Maribyrnong

Borehole No. 1 **Drilling method**: A **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
		tanbark/ silty SAND			
0.20	Fill				
		silty CLAY, red/ brown	ST	M	
0.40					
	SP	clayey SILT (ML), grey	MD	M	
0.60					
		silty CLAY (CH), high plasticity, grey	ST	M	
1.40					
		Refusal on basalt rock at 1.40m			

Borehole No. 2 **Drilling method**: HA **Location:** see figure 1.

	Fill	tanbark, silty CLAY, red/ brown, gravel	L	M	
0.70					
	SP	silty CLAY (CH), low plasticity, grey	ST	M	
1.10					
		Refusal at 1.10m on basalt rock			

Legend:

Density	**Cohesion**	**Moisture**	**HA-**hand auger **A-** Flight auger drill rig.
VL-very Loose	Soft- Soft	W - wet	Unified soil Classification symbols: CL, SM, SW
L-Loose	F- Firm	M- moist	SP- Soil profile
MD- Medium Density	ST- stiff	D- dry	Some< 15%
D - dense	VST- Very Stiff		Trace< 5%

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Borehole No. 3 **Drilling method**: HA **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
	Fill	tanbark/ silty SAND silty CLAY, red/ brown some gravel	ST/ MD	M	
0.50					
	SP	silty CLAY (CH), low plasticity, grey	ST	M	
0.90					
		Refusal at 0.90m on basalt rock			

Borehole No. 4 **Drilling method**: HA **Location:** see figure 1.

	Fill	silty SAND, gravel ≈ 50mm silty CLAY, high plasticity, red/ brown, some gravel	ST	M	
0.50					
	SP	silty CLAY (CH), low plasticity, grey	ST	M	
		some calcrete sand and gravel below 1.0m	ST	M	
1.60					
		Refusal at 1.60m on basalt rock			

Legend:

Density	**Cohesion**	**Moisture**	**HA-**hand auger **A-** Flight auger drill rig.
VL-very Loose	Soft- Soft	W - wet	Unified soil Classification symbols: CL, SM, SW
L-Loose	F- Firm	M- moist	SP- Soil profile
MD- Medium Density	ST- stiff	D- dry	Some< 15%
D - dense	VST- Very Stiff		Trace< 5%

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Borehole Logs

File: 150688
Date: 30/5/15
Supervisor: MB/ TB

Client: Maribyrnong City Council

Project: No. 6 Wests Road, Maribyrnong

Borehole No. 5 **Drilling method**: HA **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
	Fill	packing sand 100mm silty CLAY, high plasticity, red/ brown, some gravel	ST/ MD	M	
0.50	SP	silty CLAY (CH), low plasticity, grey	ST	M	
1.80		Borehole terminated at 1.80m depth			

Borehole No. 6 **Drilling method**: HA **Location:** see figure 1.

	Fill	tanbark/ geofabric	L	M	
0.10		scoria/ silty CLAY/ sand	MD	M	
0.30	SP	silty CLAY (CH), low plasticity, grey	ST ST	M M	
2.70		Borehole terminated at 2.70m in clay			

Legend:

Density	**Cohesion**	**Moisture**	**HA-**hand auger **A-** Flight auger drill rig.
VL-very Loose	Soft- Soft	W - wet	Unified soil Classification symbols: CL, SM, SW
L-Loose	F- Firm	M- moist	SP- Soil profile
MD- Medium Density	ST- stiff	D- dry	Some< 15%
D - dense	VST- Very Stiff		Trace< 5%

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Borehole Logs

File: 150688
Date: 30/5/15
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Client: Maribyrnong City Council

Project: No. 6 Wests Road, Maribyrnong

Borehole No. 7 **Drilling method**: HA **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
		packing sand (in sand pit)	L	M	
0.60	Fill	geofabric scoria	MD	M	
0.70	SP	silty CLAY (CH), low plasticity, grey	ST	M	
0.80		Borehole terminated at 0.80m			

Legend:

Density	**Cohesion**	**Moisture**	**HA-**hand auger **A-** Flight auger drill rig.
VL-very Loose	Soft- Soft	W - wet	Unified soil Classification symbols: CL, SM, SW
L-Loose	F- Firm	M- moist	SP- Soil profile
MD- Medium Density	ST- stiff	D- dry	Some< 15%
D - dense	VST- Very Stiff		Trace< 5%

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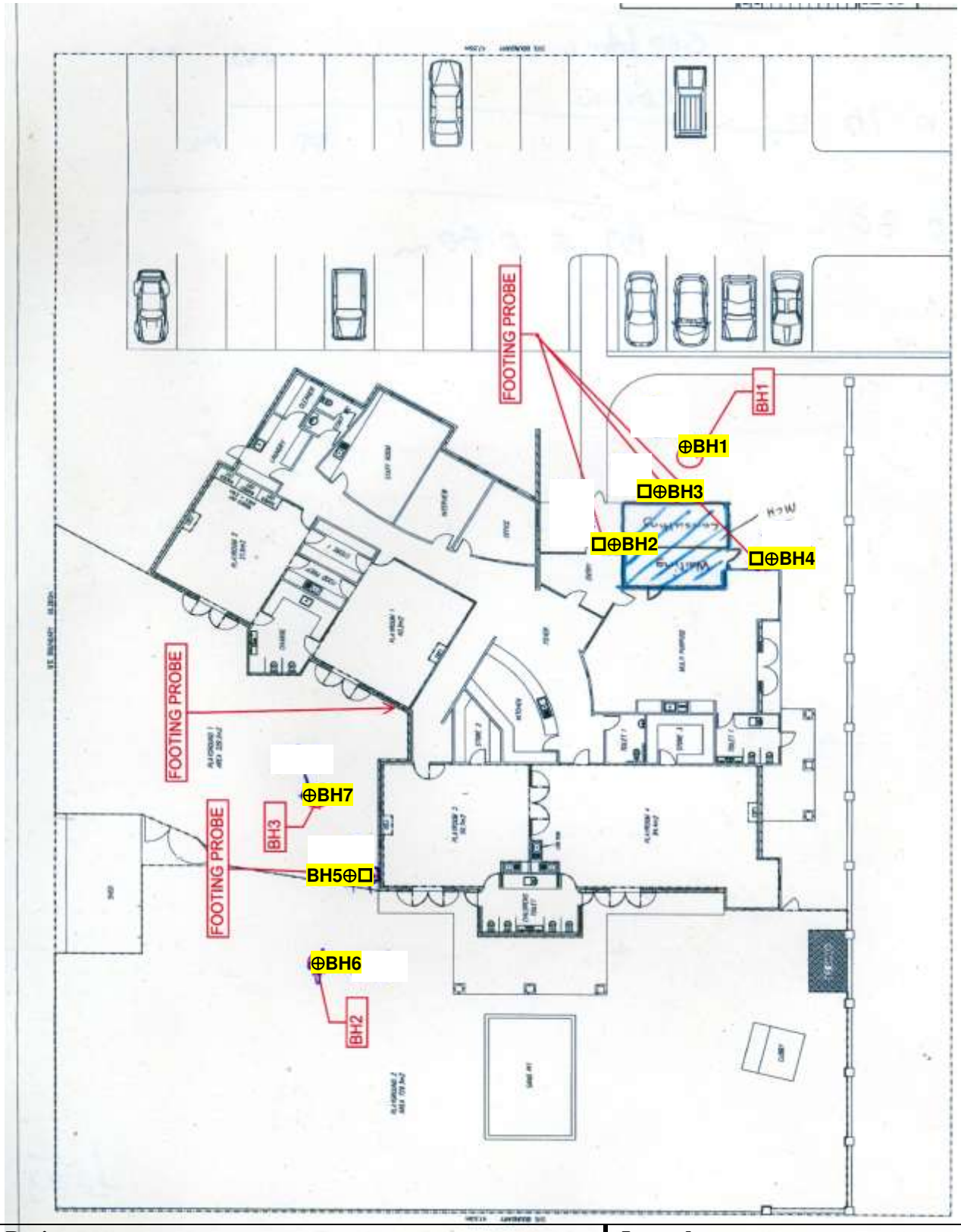
LOCATION PLAN

File: 150688
Date: 30/5/15

Figure No. 1



Project:
No. 6 Wests Road, Maribyrnong
Scale.
Not to Scale (sketch for borehole locations).

Legend:
⊕ Borehole
□ Footing inspection