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Geotechnical Investigation Report

Client: Bourke Aboriginal Corporation Health Service (BACHS)

Site Address: 88-96 Mitchell Street, Bourke NSW

3 November 2023

Our Reference: 42571-GR01_A

DISCLAIMER

This report has been prepared solely for Bourke Aboriginal Corporation Health Service (BACHS) in accordance with the scope provided by the client and for the purpose(s) as outlined throughout this report. Barnson Pty Ltd accepts no liability or responsibility for or in respect of any use or reliance upon this report and its supporting material by anyone other than the client.

The accuracy of the advice provided in this report may be limited by unobserved variations in ground conditions across the site in areas between and beyond test locations and by any restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints. These factors may lead to the possibility that actual ground conditions and materials behaviour observed at the test locations may differ from those which may be encountered elsewhere on the site. If the sub-surface conditions are found to differ from those described in this report, we should be informed immediately to evaluate whether recommendations should be reviewed and amended if necessary.

Project Name:	88-96 Mtchell Street, Bourke NSW
Client:	Bourke Aboriginal Corporation Health Service (BACHS)
Project Number:	42571
Report Reference:	42571-GR01_A
Date:	3.11.2023
Revision	Revision A

Prepared by:	Reviewed by:
Gareth Williams Laboratory Technician	**Richard Noonan** *BE(Hons) ME FIEAust CPEng NER* Director

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1. INTRODUCTION

The following is a report on the geotechnical assessment of a site in accordance with AS1726-2017 "Geotechnical Site Investigations".

The site investigation was carried out by Barnson Pty Ltd, on behalf of BACHS of Bourke NSW.

Plate 1 – Area of Investigation

BACHS is proposing to construct new medical centre at 88-96 Mitchell Street, Bourke NSW. The proposed site features that are covered by this investigation are as follows;

- Proposed Medical Centre

The investigation comprised of five (5) boreholes together with field mapping near the site. Details of the field work and laboratory testing are given in the report together with comments relevant to design and construction practice.

1.1. Terminology

The methods used in this report to describe the soil profiles, including visual classification of material types encountered, are in accordance with Australian standard AS1726-2017 "Geotechnical Site Investigations".

1.2. Limitations

The geotechnical section of Barnson Pty Ltd has conducted this investigation and prepared this report in response to specific instructions from the client to whom this report is addressed. This report is intended for the sole use of the client, and only for the purpose which it is prepared. Any third party who relies on the report or any representation contained in it does so at their own risk.

1.3. Geotechnical Testing

Representative samples from the site were subjected to the following range of tests in accordance with relevant method of Australian Standard AS1289:

- Linear Shrinkage
- PH

NATA endorsed reports are attached in *Appendix C*.

2. GENERAL DESCRIPTION OF SITE

The site is situated in a residential area of Bourke NSW.

The site has lightly scattered grass and weed cover, with mature trees scattered over the site.

The site is relatively flat. There are existing residential houses surrounding the area.

Any trees noted to be within the building zone, should be removed and the excavation remaining should be backfilled with natural material and reinstated in layers to a minimum of 95% Standard Maximum Dry Density.

Plate 2 – General view of site facing southeast.

Plate 3 – General view of site facing west.

Plate 4 – General view of site facing northwest.

3. SITE HISTORY

A review of Google Earth imagery of the site indicates that large trees have existed on the site since before an image taken in 2007. Also, during the onsite inspection, it was evident that residential dwellings had previously existed on the site. Fibreboard, brick, house footings and underground pipes were found onsite. The trees are still existing onsite, when removed the excavation should be backfilled with natural material and reinstated in layers to a minimum of 95% Standard Maximum Dry Density. See 2007 aerial image below:

Plate 5 – Aerial Image 2007, Courtesy Google Earth.

4. METHOD OF INVESTIGATION

On the 28th of September 2023, a geotechnical investigation was carried out at the site of the above-mentioned development. The field drilling was carried out by a geotechnical technician who logged the boreholes on site and undertook geological mapping of the nearby area.

A drilling rig with a 90mm auger and tungsten tip was used to excavate five (5) boreholes for the proposed Medical Centre to depths of 4.0m within the proposed building areas. These are identified as boreholes 1 through 5.

4.1. GPS Co-Ordinates

The boreholes were drilled as close as possible to the anticipated location of the proposed structures. GPS Co-ordinates of these were recorded on site to enable plotting of the borehole locations. The following Table 1 shows these co-ordinates.

Table 1: GPS Co-Ordinates of Boreholes

Location	Longitude	Latitude	Proposed Location
Borehole 1	145.946334	-30.090109	Medical Centre
Borehole 2	145.946293	-30.090337	Medical Centre
Borehole 3	145.946554	-30.090245	Medical Centre
Borehole 4	145.946933	-30.090225	Medical Centre
Borehole 5	145.946861	-30.090438	Medical Centre

The boreholes were recorded on site with a Garmin Oregon 550 handheld GPS, using GDA94 Datum. The co-ordinates have an accuracy of +/- 5m. These locations are also shown on site plan in *Appendix B*. The borehole logs of sub-surface profiles are attached in *Appendix C*

5. GENERAL SUB-SURFACE CONDITIONS

From the bore logs attached it can be seen that the soil encountered to the test end point was as follows:

5.1. Fill

Fill material was encountered at all borehole locations. The fill encountered was silty sand and sandy silt with traces of rubble to 0.3m as shown in the borehole logs attached in *Appendix C.*

5.2. Sub-Soils

Alluvial soils were encountered though out the boreholes. These generally comprised of slightly moist sandy silty clays, sandy clays and clayey sands to the depths as shown in the borehole logs attached in *Appendix C*. The clays and sands were noted to be of a low to medium plasticity, which was confirmed with laboratory testing.

5.3. Regional Geology

Reference to the Bourke 1:250,000 Geological Map indicates the surrounding area consists of "*Floodplains of clayey silt, sand and gravel*".

Rock was not encountered during this investigation.

6. NATA LABORATORY TESTING

Disturbed samples were taken during the field investigation. Laboratory testing was carried out on selected samples of all different material types, with details of the sampling and testing shown below:

Soil Index Properties testing was carried out on samples to aid in classification of the soils encountered and to assist in determining design parameters. This testing results are indicated below:

6.1. Linear Shrinkage Testing (L.S)

Table 2: Linear Shrinkage Results

Borehole No.	Depth (m)	Proposed Location	Linear Shrinkage (%)
Borehole 1	0.8	Medical Centre	6.5
Borehole 1	2.0	Medical Centre	1.5
Borehole 3	0.8	Medical Centre	10.0
Borehole 3	2.0	Medical Centre	1.5
Borehole 5	0.8	Medical Centre	4.0
Borehole 5	2.0	Medical Centre	1.5

The above test results confirm the material as low to medium plasticity.

6.2. Acidic Soils

Acidic ground conditions can be caused by dissolved "aggressive" carbon dioxide, pure and very soft waters, organic and mineral acids and bacterial activity. PH testing was conducted on the site samples to determine if any acidic conditions were present in the soils encountered.

Table 3: PH Testing Results

Borehole No.	Sample Depth (m)	Proposed Location	PH	Exposure Classification
Borehole 1	0.8	Medical Centre	6.5	A1
Borehole 3	0.8	Medical Centre	7.4	A1
Borehole 5	0.8	Medical Centre	7.3	A1

These results show the exposure classification as per Table 4.8.1 AS3600-2018. Groundwater was not encountered during this investigation.

6.3. Seasonal Surface Movement

From the laboratory test results, as shown attached, an estimated ground surface movement (Ys) was calculated in accordance with AS2870-2011 (using a change in suction at the soil surface $\Delta\mu$ = 1.2pF and a depth of design suction change, Hs = 4.0m) being:

Ys = 40 - 45mm

The site has trees, previous buiding removal and rubble fill of less than 400mm thus, it is our opinion that a Site Classification of 'P' should be adopted for the site in its present condition, with a soil classification of 'H1-D'.

Reference is made to Appendix 'H' of AS2870-2011, which gives guidance on the design of footings on reactive clay soils with the effect of trees. The footing design engineer will need to calculate the tree induced differential centre heave mound height (y_m) based on the tree height and distance of the proposed buildings from the tree or group of trees. This value should be used to design a suitable footing design in accordance with section 3 or 4 of the code.

The uncontrolled fill does not exceed 400mm depth and therefore the site can be classed as noted above, however this material should not be relied upon to support any proposed building loads unless confirmed as controlled fill.

Note: Clause 2.5.3 (b) (ii) of AS2870-2011 states "The classification of a site with uncontrolled fill not more than 0.8m deep for sand shall be Class "P" unless all footings are founded on natural soil through the filling.

7. SUB-SURFACE BEARING CAPACITIES

All the below soil strengths are applicable to the sites at the time of the investigation. They give an indication of in-situ strength of the soil as correlated from DCP testing. They should not be used for footing design purposes. Elevation of moisture content will cause a marked decrease in bearing capacity with soil types listed.

Table 4: In-Situ Bearing Capacities

Borehole No.	Soil Strata	Depth of Strata (m)	Ultimate Base Bearing Capacity (kPa)	Factored Limit State Ø = 0.52 (kPa)
Borehole 1	FILL	0.0-0.3	-	-
Borehole 1	Very Stiff CLAY	0.3-0.7	300	156
Borehole 1	Hard CLAY	0.7-3.0	>500	260
Borehole 1	Very Dense SAND	3.0-4.0	>500	260
Borehole 2	FILL	0.0-0.3	-	-
Borehole 2	Very Stiff CLAY	0.3-0.7	300	156
Borehole 2	Hard CLAY	0.7-1.1	>500	260
Borehole 2	Very Dense SAND	1.1-4.0	>500	260
Borehole 3	FILL	0.0-0.3	-	-
Borehole 3	Very Stiff CLAY	0.3-0.7	300	156
Borehole 3	Hard CLAY	0.7-1.3	>500	260
Borehole 3	Very Dense SAND	1.3-4.0	>500	260
Borehole 4	FILL	0.0-0.3	-	-
Borehole 4	Very Stiff CLAY	0.3-0.7	300	156
Borehole 4	Hard CLAY	0.7-1.6	>500	260
Borehole 4	Very Dense SAND	1.6-4.0	>500	260
Borehole 5	FILL	0.0-0.3	-	-
Borehole 5	Very Stiff CLAY	0.3-0.7	300	156
Borehole 5	Hard CLAY	0.7-1.0	>500	260
Borehole 5	Very Dense SAND	1.0-4.0	>500	260

A Geotechnical reduction factor of 0.52 has been applied to all listed ultimate bearing capacities (reference table 4.3.2 (i) AS2159-2009)

8. SITE EARTHWORKS RECOMMENDATIONS

8.1. Excavations

Excavations within the natural silt and clay will be achievable using conventional earthmoving equipment. The civil contractor should be responsible for selecting excavation equipment based on the proposed excavation depths and equipment capabilities.

8.2. General Construction Filling

All earthworks performed on site must be undertaken in a controlled manner, in accordance with a suitable earthwork's specification. Filling should be placed, compacted, inspected and tested in accordance with the Level 2 requirements of AS3798-2007.

8.3. General Bulk Fill Material

All general fill materials used shall be approved clean, hard material, deposited and compacted in the locations specified. Unless notified otherwise, general fill shall be sourced from excavations within the project area. The following conditions should also be satisfied:

- General filling must be compacted to a minimum dry density ratio of 98-100% relative to standard compaction at a moisture content of -2% to +2% of standard optimum moisture content.
- Filling should proceed in layers of 300mm maximum loose thicknesses.
- Layers of filling should be horizontal or benched to suit the surrounding topography.
- The existing subgrade should NOT be used as bulk fill, due to medium reactivity.

8.4. Temporary Batter Slopes

Temporary batter slopes in soil should be graded no steeper than 2 Horizontal (H) in 1 Vertical (V), and protected from erosion by re-directing any surface water flows from the batter face, revegetating etc.

8.5. Permanent Batter Slopes

Permanent Batter slopes in clay should be no steeper than 3 Horizontal (H) in 1 Vertical (V) and protected from erosion. Alternatively, fill embankments may be retained with properly designed and constructed retaining walls.

9. DESIGN PARAMETERS DISCUSSION

9.1. Building Foundation Recommendations

All foundations for buildings that are similar in size and structure to large residential buildings should be designed with guidance from AS2870-2011, for the site classification provided in section 6.3.

The existing rubble fill should be stripped and replaced with controlled fill compacted to a minimum 95% standard compaction, placed and tested per AS3798-2007, level 2. The fill material should be select imported fill of low reactivity and CBR of 10% or greater.

The additional surface movement, due to nearby trees, should be calculated by the footing designer once distance to the trees from the building is known, per APPENDIX H of AS2870-2011. The footing slab can then be designed for the calculated surface movement and a remediated site allowable bearing capacity of 100kPa.

9.2. Foundations General

The possibility of other abnormal and localised moisture changes must be minimised by adherence to general design and site management practises. These recommendations assume that all footings will be founded in the natural soil or controlled fill, and that no topsoil or poor and uncompacted fill occurs beneath the footing beams or slab.

Finally, it must be emphasised that the recommended design approach accepts that minor aesthetic cracking may occur. The design philosophy is thus a compromise between economy and performance.

10. CONCLUSION

The testing methods adopted are indicative of the site's sub-surface conditions to the depths excavated and to specific sampling and/or testing locations in this investigation, and only at the time the work was carried out.

The accuracy of geotechnical engineering advice provided in this report may be limited by unobserved variations in ground conditions across the site in areas between and beyond test locations and by any restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints.

These factors may lead to the possibility that actual ground conditions and materials behaviour observed at the test locations may differ from those which may be encountered elsewhere on the site.

If the sub-surface conditions are found to differ from those described in this report, we should be informed immediately to evaluate whether recommendations should be reviewed and amended if necessary.

APPENDIX A

General Notes

GEOTECHNICAL INVESTIGATION GENERAL NOTES

This report contains the results of a geotechnical investigation conducted for a specific purpose and client. The results should not be used by other parties, or for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where the test information is available (field and/or laboratory results). The borehole logs include both factual data and inferred information. Reference should be made to the relevant sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc).

GROUNDWATER

Unless otherwise indicated, the water levels presented on the borehole logs are the levels of free water or seepage in the bore hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeability's (i.e. depending on response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete borehole area. Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete borehole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to this firm for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process – investigation, construction verification and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels are required. There may be a requirement to extend foundation depths to modify a foundation system or to conduct monitoring as a result of this natural variability. Allowance for verification by geotechnical personnel accordingly should be recognised and programmed during construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommendation depth of any foundation (piles, caissons footings etc.) is an engineering estimate. The estimate is influenced and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions should include at least all of the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

Reports are the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm.

ROCK

Rock Strength

Rock strength is a scale of strength, based on point load index testing, or field testing.

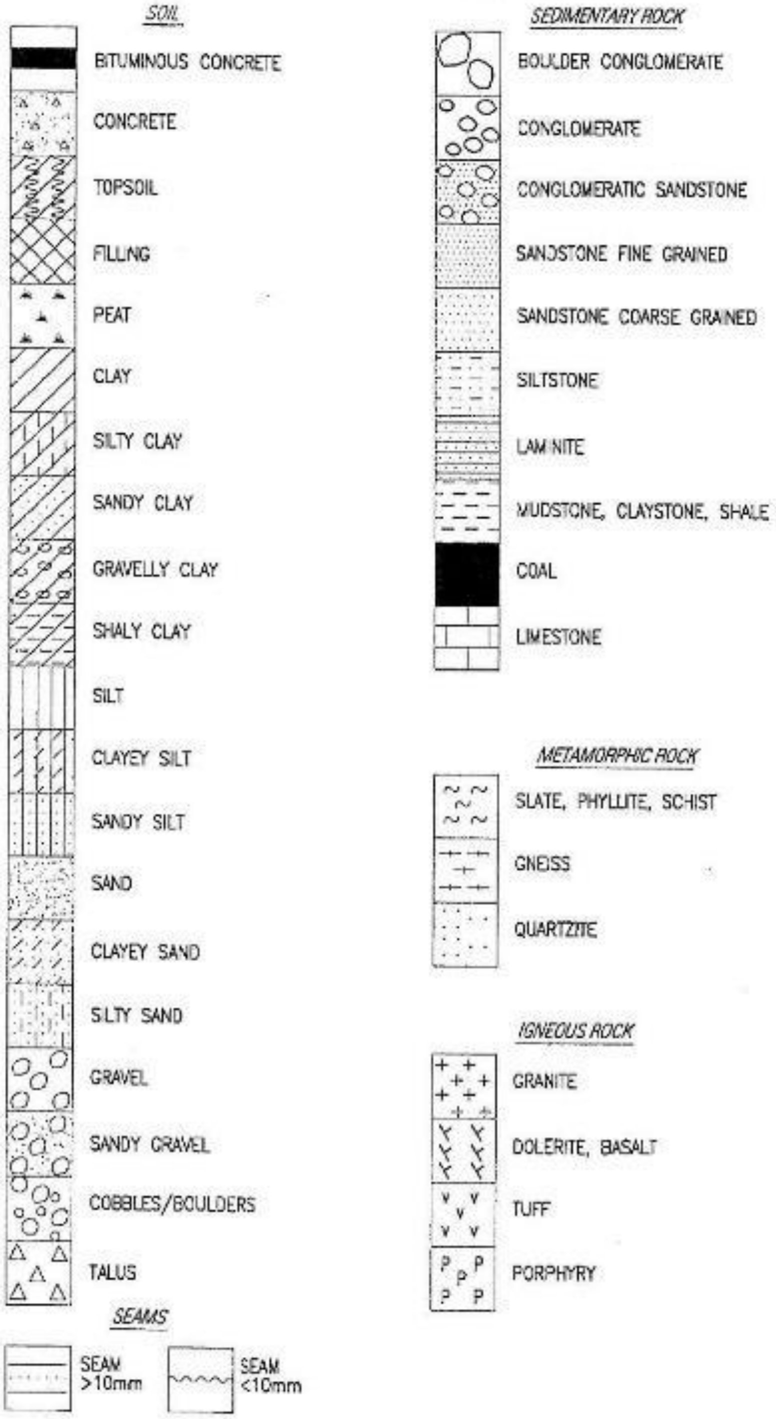
Term	Letter Symbol	Point load index (Mpa) Is (50)	Field guide to strength
Extremely low	EL	< 0.03	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1	Material crumbles under firm blows with sharp end of pick.
Low	L	0.1 – 0.3	Easily scored by knife, has dull sound under hammer.
Medium	M	0.3 – 1.0	Readily scored with knife, core pieces broken by hand with difficulty
High	H	1 – 3	Rock rings under hammer, core piece broken by pick only.
Very high	VH	3 – 10	Hand specimen breaks with pick after more than one blow.
Extremely high	EH	> 10	Hand specimen breaks with pick after several than one blow.

Rock Weathering

Rock weathering is the degree of rock weathering, determined in the field.

Term	Letter Symbol	Definition
Residual soil	RS	Soil developed on extremely weathered rock.
Extremely weathered rock	XW	Soil is weathered to such an extent that it has soil properties, i.e. it disintegrates or can be remoulded in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be discoloured, usually by iron staining, porosity is increased.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

GRAPHIC SYMBOLS FOR SOIL & ROCK



barnson.

APPENDIX B

Site Plan & Borehole Locations


BH1
BH4
BH3
BH2
BH5

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APPENDIX C

Borehole Logs

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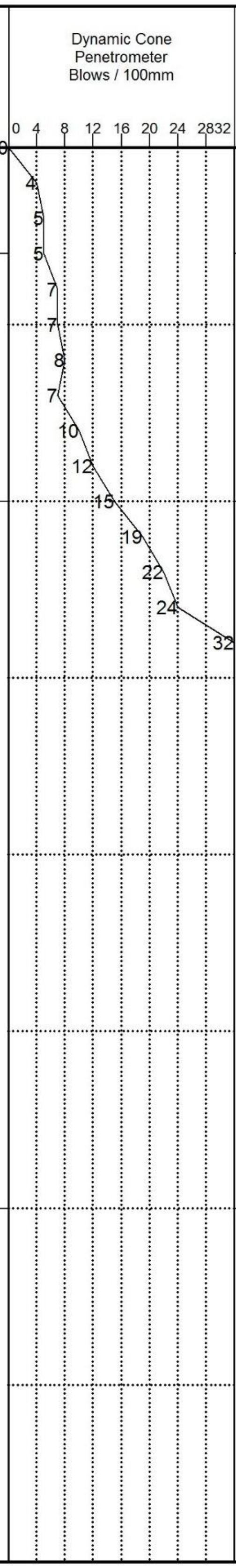
Barnson
1/36 Darling Street
NSW 2830
Telephone: 1300 BARNSON

BOREHOLE NUMBER 1

CLIENT Bourke Aboriginal Corporation Health Service (BACHS) **PROJECT NAME** Site Classification
PROJECT NUMBER 42571 **PROJECT LOCATION** 88-96 Mitchell Street, Bourke NSW

DATE STARTED 28/9/23 **COMPLETED** 28/9/23 **R.L. SURFACE** **LONGTITUDE** ---
DRILLING CONTRACTOR Barnson **SLOPE** 90° **LATITUDE** ---
EQUIPMENT GT-10 Drill Rig **HOLE LOCATION** Borehole 1
HOLE SIZE 90mm **LOGGED BY** NR **CHECKED BY** NR
NOTES

Method	Samples	Depth (m)	Classification Symbol	Material Description	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0–0.3		Silty SAND: brown: slightly moist: medium dense: low plasticity	FILL
	Disturbed Sample LS = 6.5%	0.3–1.0	CL	Sandy Silty CLAY: brown: slightly moist: very stiff to hard: medium plasticity	ALLUVIAL
	Disturbed Sample LS = 1.5%	1.0–3.0	CL	Sandy CLAY: orange: slightly moist: hard: low plasticity	ALLUVIAL
		3.0–4.0	SW	SAND: orange-pale brown: slightly moist: very dense: low plasticity	ALLUVIAL



Borehole 1 terminated at 4m

barnson.
Barnson
1/36 Darling Street
NSW 2830
Telephone: 1300 BARNSON

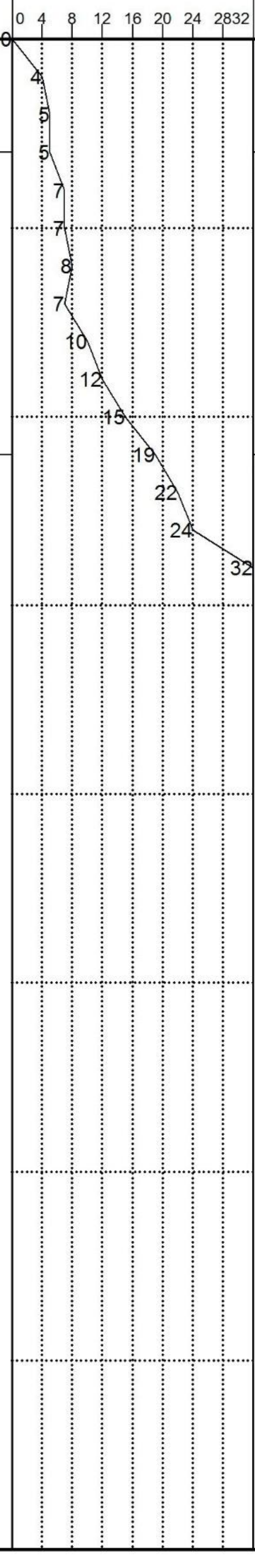
BOREHOLE NUMBER 2

CLIENT Bourke Aboriginal Corporation Health Service (BACHS) **PROJECT NAME** Site Classification
PROJECT NUMBER 42571 **PROJECT LOCATION** 88-96 Mitchell Street, Bourke NSW

DATE STARTED 28/9/23 **COMPLETED** 28/9/23 **R.L. SURFACE** **LONGTITUDE** ---
DRILLING CONTRACTOR Barnson **SLOPE** 90° **LATITUDE** ---
EQUIPMENT GT-10 Drill Rig **HOLE LOCATION** Borehole 2
HOLE SIZE 90mm **LOGGED BY** NR **CHECKED BY** NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0 – 0.3			Silty SAND: brown: slightly moist: medium dense: low plasticity	FILL
		0.3 – 1.1		CL	Sandy Silty CLAY: brown: slightly moist: very stiff to hard: medium plasticity	ALLUVIAL
		1.1 – 4.0		SC	Clayey SAND: orange: slightly moist: very dense: low plasticity	ALLUVIAL

Dynamic Cone Penetrometer Blows / 100mm



Borehole 2 terminated at 4m

BOREHOLE NUMBER 3

barnson.
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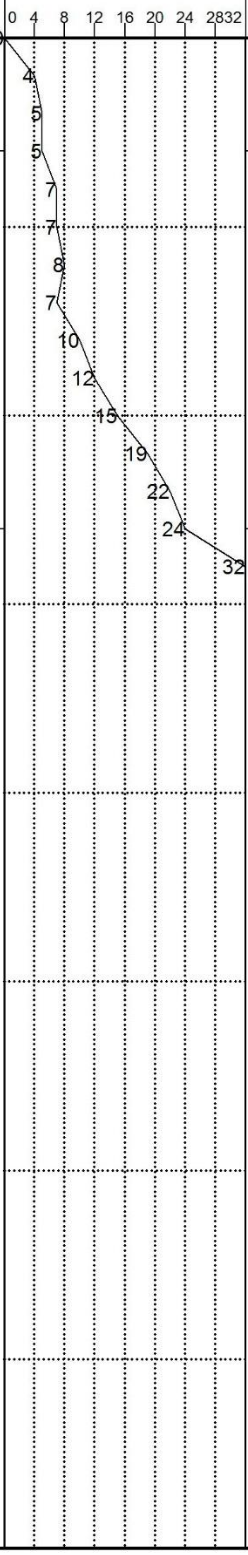
NSW 2830
Telephone: 1300 BARNSON

CLIENT Bourke Aboriginal Corporation Health Service (BACHS) **PROJECT NAME** Site Classification
PROJECT NUMBER 42571 **PROJECT LOCATION** 88-96 Mitchell Street, Bourke NSW

DATE STARTED 28/9/23 **COMPLETED** 28/9/23 **R.L. SURFACE** **LONGTITUDE** ---
DRILLING CONTRACTOR Barnson **SLOPE** 90° **LATITUDE** ---
EQUIPMENT GT-10 Drill Rig **HOLE LOCATION** Borehole 3
HOLE SIZE 90mm **LOGGED BY** NR **CHECKED BY** NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Dynamic Cone Penetrometer Blows / 100mm	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0–0.3			Silty SAND: brown: slightly moist: medium dense: low plasticity	0, 4, 5	FILL
	Disturbed Sample LS = 10.0% (approx. 0.7–0.9 m)	0.3–1.3		CL	Sandy Silty CLAY: brown: slightly moist: very stiff to hard: medium plasticity	5, 7, 7, 8, 7, 10, 12, 15, 19, 22	ALLUVIAL
	Disturbed Sample LS = 1.5% (approx. 1.9–2.1 m)	1.3–4.0		SC	Clayey SAND: orange: slightly moist: very dense: low plasticity	24, 32	ALLUVIAL



Borehole 3 terminated at 4m

BOREHOLE NUMBER 4

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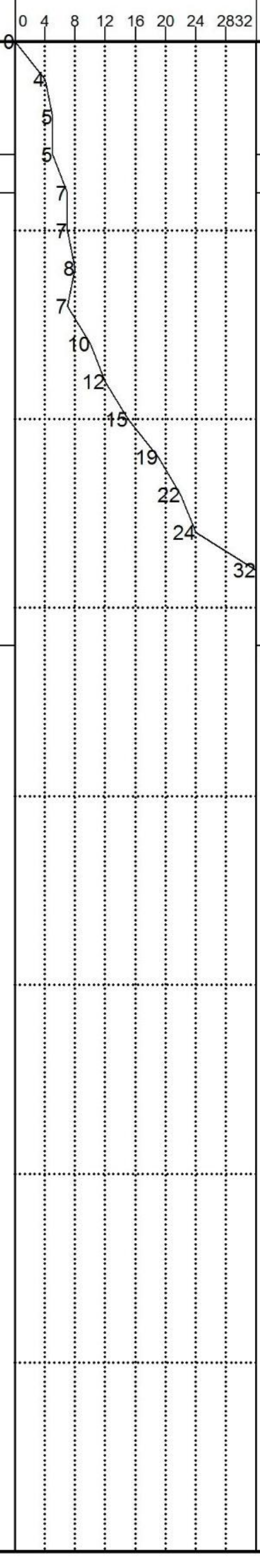
NSW 2830
Telephone: 1300 BARNSON

CLIENT Bourke Aboriginal Corporation Health Service (BACHS)
PROJECT NAME Site Classification
PROJECT NUMBER 42571
PROJECT LOCATION 88-96 Mitchell Street, Bourke NSW

DATE STARTED 28/9/23 **COMPLETED** 28/9/23
R.L. SURFACE
LONGTITUDE ---
DRILLING CONTRACTOR Barnson
SLOPE 90°
LATITUDE ---
EQUIPMENT GT-10 Drill Rig
HOLE LOCATION Borehole 4
HOLE SIZE 90mm
LOGGED BY NR
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0 – 0.3			Silty SAND: brown: slightly moist: medium dense: low plasticity	FILL
		0.3 – 0.4		ML	Clayey Sandy SILT: brown: slightly moist: very stiff: low plasticity	ALLUVIAL
		0.4 – 1.6		CL	Sandy CLAY: red-brown: slightly moist: hard: low to medium plasticity	ALLUVIAL
		1.6 – 4.0		SC	Clayey SAND: orange: slightly moist: very dense: low plasticity	ALLUVIAL

Dynamic Cone Penetrometer Blows / 100mm



Borehole 4 terminated at 4m

BOREHOLE NUMBER 5

barnson.
Barnson
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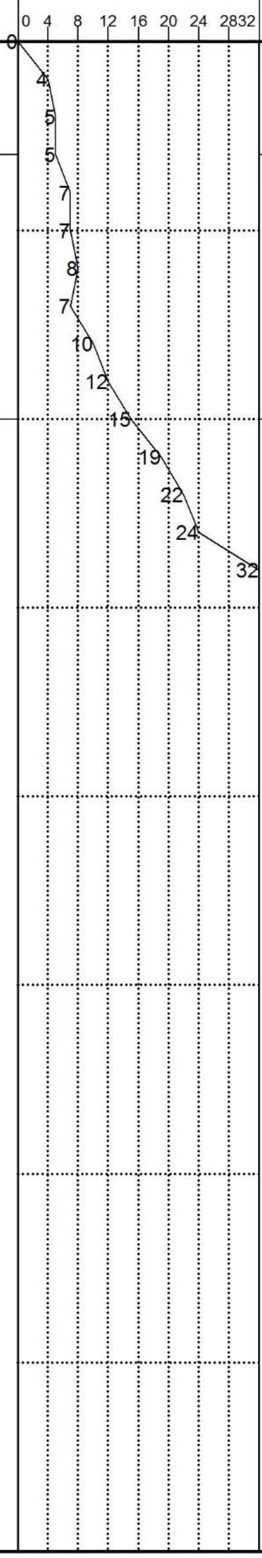
Telephone: 1300 BARNSON

CLIENT Bourke Aboriginal Corporation Health Service (BACHS)
PROJECT NAME Site Classification
PROJECT NUMBER 42571
PROJECT LOCATION 88-96 Mitchell Street, Bourke NSW

DATE STARTED 28/9/23 **COMPLETED** 28/9/23
R.L. SURFACE
LONGTITUDE ---
DRILLING CONTRACTOR Barnson
SLOPE 90°
LATITUDE ---
EQUIPMENT GT-10 Drill Rig
HOLE LOCATION Borehole 5
HOLE SIZE 90mm
LOGGED BY NR
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0–0.3			Sandy SILT: brown: slightly moist: stiff: low plasticity	FILL
	Disturbed Sample LS = 4.0%	0.3–1.0		CL	Sandy Silty CLAY: brown: slightly moist: very stiff to hard: medium plasticity	ALLUVIAL
	Disturbed Sample LS = 1.5%	1.0–4.0		SC	Clayey SAND: orange: slightly moist: very dense: low plasticity	ALLUVIAL

Dynamic Cone Penetrometer Blows / 100mm



Borehole 5 terminated at 4m

APPENDIX D

NATA Laboratory Reports

Material Test Report

Report Number:	**42571-1**
Issue Number:	1
Date Issued:	25/10/2023
Client:	Bourke Aboriginal Corporation Health Service (BACHS)
	Level 8, 124 Walker Street, North Sydney NSW 2060
Contact:	Jodie Crawford
Project Number:	42571
Project Name:	Site Classification
Project Location:	88-96 Mitchell Street, Bourke NSW
Work Request:	9076
Sample Number:	D23-9076A
Date Sampled:	28/09/2023
Dates Tested:	28/09/2023 - 24/10/2023
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 1, Depth: 800mm**
Material:	Brown Sandy Silty CLAY

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NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**6.5**		
Cracking Crumbling Curling	None		

Material Test Report

Report Number:	**42571-1**
Issue Number:	1
Date Issued:	25/10/2023
Client:	Bourke Aboriginal Corporation Health Service (BACHS) Level 8, 124 Walker Street, North Sydney NSW 2060
Contact:	Jodie Crawford
Project Number:	42571
Project Name:	Site Classification
Project Location:	88-96 Mitchell Street, Bourke NSW
Work Request:	9076
Sample Number:	D23-9076B
Date Sampled:	28/09/2023
Dates Tested:	28/09/2023 - 24/10/2023
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 1, Depth: 2.0m**
Material:	Orange Sandy CLAY

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**1.5**		
Cracking Crumbling Curling	None		

Material Test Report

Report Number:	**42571-1**
Issue Number:	1
Date Issued:	25/10/2023
Client:	Bourke Aboriginal Corporation Health Service (BACHS) Level 8, 124 Walker Street, North Sydney NSW 2060
Contact:	Jodie Crawford
Project Number:	42571
Project Name:	Site Classification
Project Location:	88-96 Mitchell Street, Bourke NSW
Work Request:	9076
Sample Number:	D23-9076C
Date Sampled:	28/09/2023
Dates Tested:	28/09/2023 - 24/10/2023
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 3, Depth: 800mm**
Material:	Brown Sandy Silty CLAY

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**10.0**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number:	**42571-1**
Issue Number:	1
Date Issued:	25/10/2023
Client:	Bourke Aboriginal Corporation Health Service (BACHS) Level 8, 124 Walker Street, North Sydney NSW 2060
Contact:	Jodie Crawford
Project Number:	42571
Project Name:	Site Classification
Project Location:	88-96 Mitchell Street, Bourke NSW
Work Request:	9076
Sample Number:	D23-9076D
Date Sampled:	28/09/2023
Dates Tested:	28/09/2023 - 24/10/2023
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 3, Depth: 2.0m**
Material:	Orange Clayey SAND

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**1.5**		
Cracking Crumbling Curling	None		

Material Test Report

Report Number:	**42571-1**
Issue Number:	1
Date Issued:	25/10/2023
Client:	Bourke Aboriginal Corporation Health Service (BACHS) Level 8, 124 Walker Street, North Sydney NSW 2060
Contact:	Jodie Crawford
Project Number:	42571
Project Name:	Site Classification
Project Location:	88-96 Mitchell Street, Bourke NSW
Work Request:	9076
Sample Number:	D23-9076E
Date Sampled:	28/09/2023
Dates Tested:	28/09/2023 - 25/10/2023
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 5, Depth: 800mm**
Material:	Brown Sandy Silty CLAY

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**4.0**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number: **42571-1**
Issue Number: 1
Date Issued: 25/10/2023
Client: Bourke Aboriginal Corporation Health Service (BACHS)
Level 8, 124 Walker Street, North Sydney NSW 2060
Contact: Jodie Crawford
Project Number: 42571
Project Name: Site Classification
Project Location: 88-96 Mitchell Street, Bourke NSW
Work Request: 9076
Sample Number: D23-9076F
Date Sampled: 28/09/2023
Dates Tested: 28/09/2023 - 24/10/2023
Sampling Method: AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location: **Borehole 5, Depth: 2.0m**
Material: Orange Clayey SAND

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Approved Signatory: Jeremy Wiatkowski
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NATA Accredited Laboratory Number: 9605

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**1.5**		
Cracking Crumbling Curling	None		

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APPENDIX E

CSIRO Guide

Foundation Maintenance and Footing Performance: A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

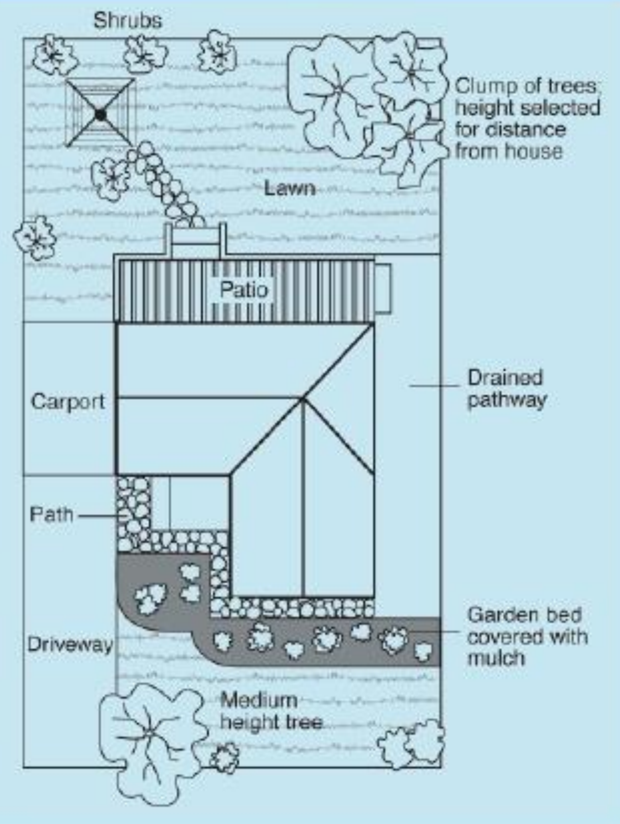
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation
In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden
The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees
Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs
State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation
Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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