



**SITE CLASSIFICATION
LOT 633 GREENWAY STREET
LLOYD NSW 2650**

September 2016

Project brief

At the request of Jo Creswell of the Diocese of Wagga Wagga, soil sampling, analysis and reporting was carried out to assess the site for a proposed residential development on 1 September 2016. The document provides information about the site and soil conditions from field observations and laboratory analysis.

Site identification

Address: Greenway Street Lloyd NSW 2650

Real property description: Lot 633 DP1196872

Centre co-ordinate: 530432 6109949 MGA GDA z55

Property size: 877 m² approximately

Owner: Diocese of Wagga Wagga


Local Council Area: Wagga Wagga City Council

Present use: Residential Block

Development Application Reference: not known

Site Classification: M-D - Moderately reactive clay or silt sites (Deep Drying)

Certification

Name	Signed	Date	Revision Number
David McMahon BAppSc GradDip WRM ASSSI		9/09/2016	0

Physical characteristics of the site

A desktop review and investigation of the topography, hydrology, soil, lithology, geology and hydrogeology of the site has been undertaken and are as follows:

Topography

The Lake Albert 1:25,000 Topographic Map (Sheet 8327-1-S) indicates that the site is located at an elevation of approximately 243m AHD. The site landform is classed as a Simple Slope and the slope class is Moderately Inclined.

Vegetation

The site is covered with annual grass and broadleaf species.

Hydrology

The nearest named waterway is the Murrumbidgee River located 5kms to the north of the site. Due to the relative incline of the site, rainfall is likely to both run off and infiltrate into the relatively permeable topsoil.

Weather

The average rainfall for Wagga Wagga is approximately 571.7 mm per annum, with the wettest months being July, August and October. Annual mean evaporation is 1861.5 mm with mean daily evaporation ranges from 1.2mm in July to 10.2mm in January. Wagga is characterised by cold wet winters and hot dry summers with mean maximum temperatures ranging from 12.7 °C in July to 31.6 °C in January and mean minimum temperatures ranging from 2.7 °C in July to 16.4 °C in February, Wagga Wagga AMO 072150 (www.bom.gov.au).

Soil & Landform

The site lies within the mapping unit Id from the Soil Landscapes of the Wagga Wagga 1:100 000 Sheet (DLWC, 1997). The map unit Id is described as:

Id - Lloyd (Erosional Landscapes)

Landscape—rolling low hills on Ordovician metasedimentary rocks. Local relief 30–90 m; slopes 10–20%. Broad crests and ridges; long waning mid to lower slopes; broad drainage depressions. Variable rock outcrop 0–50%. Extensively to completely cleared mid to high open-forest.

Soils—shallow (<0.5 m), moderately well-drained Paralithic Leptic Rudosols (Lithosols) on some crests, ridges and upper slopes; deep (1.0–1.5 m), imperfectly drained Red Kurosols (Red Podzolic Soils) on other crests and upper slopes; moderately deep (0.5–1.0m), moderately well-drained Red Chromosols and Kurosols (Red Podzolic Soils) on mid to lower slopes; and moderately deep (0.5–1.0 m), imperfectly drained Brown Kurosols (Yellow Podzolic Soils) in drainage lines.

Limitations—high erosion hazard; steep slopes (localised); localised rock outcrop; localised poor drainage; localised waterlogging; foundation hazard (localised); mass movement; shallow, stony and strongly acid soils (on ridges and upper slopes); localised aluminium toxicity; localised salinity.

Lithology and Geology

Undivided Ordovician metasedimentary rocks—thinly interbedded siltstones, shales and phyllites, with minorschists and minor quartzites. Lithology is highly variable

over a short distance. Relatively thick (1 m to several metres) colluvial and slopewash clayey sediments occur on lower slopes and in drainage depressions. There is generally no rock outcrop, but occasionally <50% (at sites usually underlain by sandstone).

Hydrogeology

From the Geoscience Australia hydrogeology dataset, the groundwater beneath the site is described as porous, extensive highly productive aquifers

Site Classification

Details of the conditions encountered with a field description of the soils and laboratory tests can be seen as follows.

Profile Description	Depth (m)	Soil Type	Engineering Properties
FILL	0-0.2	Brown Rocky Fine Sandy Clay	
B Horizon	0.2-0.4	Dark Red Light Clay	Ys Expansivity 20-40mm
C Horizon	0.4-0.6	Yellow Rocky Silty Sandy Clay Red Mottles	

Based on the field assessment and laboratory data and assumptions therein the site is classified as **MD – Moderately reactive clay or silt sites (deep drying), which may experience moderate ground movement from moisture changes** by reference to AS2870:2011.

Assumptions

Site investigation and classification was carried out by reference to AS2870:2011. At the time of the investigation the building type, foundation system or amounts of cut and fill are unknown.

This classification is based on the footings being founded into the B/C Horizon and an allowable bearing pressure of 100kPa may be adopted. If the footings are not into the specified material the site classification will need to be reassessed.

If more than 0.4m of uncontrolled fill is present or placed, or if depth of excavation within the building area extends more than 0.5m below the existing surface, the above classification will need to be reassessed.

Any earthworks on site will be carried out by reference to AS3798: 2007.

If any unconsolidated or saturated soils are encountered during excavation, or conditions that are not alike the above description, the site supervisor should be informed, the work stopped and this office be contacted immediately for further evaluation.

Where trees and large shrubs are removed from the site all roots are to be removed and voids replaced with compacted fill by reference to AS3798:2007.

The soils investigated are all natural ground and no free groundwater was encountered at the time of the investigation.

Site drainage and vegetation limitations are adhered to as per the attached CSIRO Foundation Management and Footing Performance: A Homeowner’s guide, BTF-2011.

Disclaimer

The information contained in this report has been extracted from field and laboratory sources believed to be reliable and accurate. DM McMahon Pty Ltd will not assume any responsibility for the misinterpretation of information supplied in this report. The accuracy and reliability of recommendations identified in this report need to be evaluated with due care according to individual circumstances. It should be noted that the recommendations and findings in this report are based solely upon the said site location and the ground level conditions at the time of testing. The results of the said investigations undertaken are an overall representations of the conditions encountered. The properties of the soil within the location may change due to variations in ground conditions outside of the tested area. The author has no control or liability over site variability that may warrant further investigation that may lead to significant design changes.

Reference

Chen X.Y. and McKane D.J., 1997, Soil Landscapes of the Wagga Wagga 1:100,000 Sheet map and report, Department of Land and Water Conservation, Sydney

Geeves GW, Craze B and Hamilton GJ 2007a. Soil physical properties. In 'Soils – their properties and management'. 3rd edn. (Eds Charman PEV and Murphy BW) pp. 168-191 Oxford University Press Melbourne

Geology information: Copyright Commonwealth of Australia (MDBC) 1999

Standards Australia AS 2870 – 2011 Residential Slabs and Footings - Construction

Standards Australia AS 1726 – 1993 Geotechnical Site Investigations

Standards Australia AS 3798 – 2007 Guidelines on earthworks for commercial and residential developments

Attachments

CSIRO Foundation Management and Footing Performance: A Homeowner's guide, BTF-2011

Foundation Maintenance and Footing Performance: A Homeowner's Guide



PUBLISHING
BTF 18-2011
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 2870-2011, 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, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

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 perpend).

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

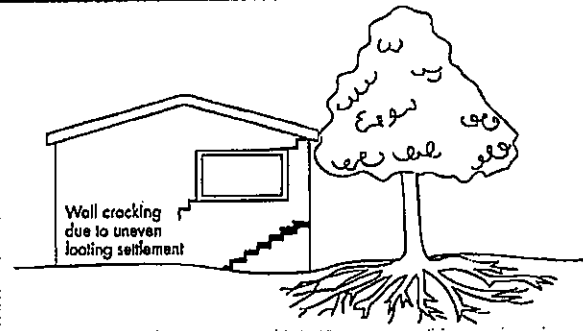
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the 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

Trees can cause shrinkage and damage



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 causes 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 2870-2011.

AS 2870-2011 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

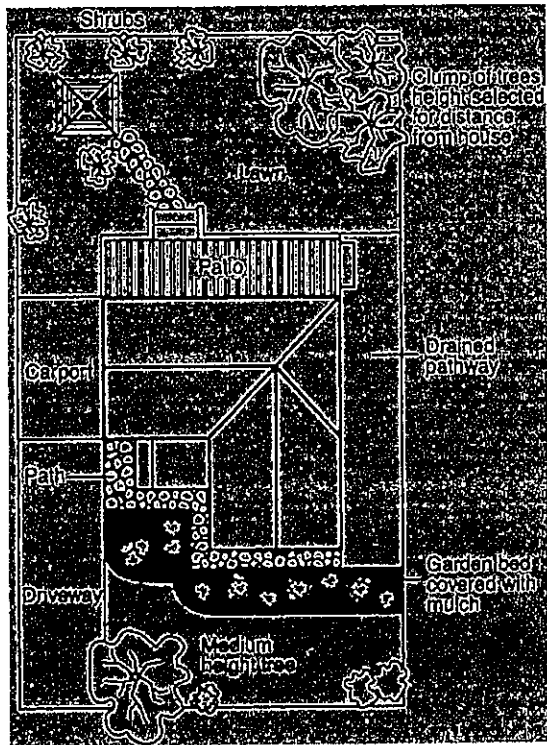
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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 should

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 depends on number of cracks	4

Gardens for a reactive site



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.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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7 June 2017

Reg. No.: FC16-15 (Revised)

Turners Excavations Pty Ltd
14 Blaxland Road
Wagga Wagga NSW 2650

Attention: Mr. Lew Turner

Dear Lew,

**CERTIFICATION OF FILL PLACEMENT – PROPOSED RESIDENTIAL DWELLING
BUILDING PADS, LOTS 630-635 GREENWAY STREET & 639-644 BONNER STREET,
LLOYD ESTATE - STAGE 6, WAGGA WAGGA, NSW**

Further to your request, we inspected the exposed subgrade and tested the fill placement at the above site between 15 June and 8 September 2016. We confirm that placement of fill at the above site was tested by Aitken Rowe Testing Laboratories Pty Ltd in accordance with AS 3798-2007 "Guidelines on earthworks for commercial and residential developments". The fill placement was inspected and tested in 150 to 300mm compacted layers for the depth ranging from 0 to 450mm across the site. The test reports are herewith attached.

The subject site is located at Lloyd Estate - Stage 6 Subdivision, Wagga Wagga, NSW and includes Lots 630-635 Greenway Street & 639-644 Bonner Street. We inspected the exposed subgrade prior to the placement of the new fill to ensure topsoil and unsuitable materials were removed and the exposed subgrade is properly proof rolled. It was noted that approximately 100mm of topsoil was removed across parts of the site at the time of the inspection (refer to "profile & test location plan"). We then witnessed the proof rolling of the exposed natural low to medium plasticity gravelly silty clay subgrade and no soft, loose or heaving areas were detected. We also witnessed proof rolling on the final fill layer and the exposed fill material was found to be firm and stable at the time of the inspection.

Four in-situ density tests carried out on the fill placement indicated that the low to medium plasticity gravelly silty clay fill material was placed throughout the site to the relative compaction ranging from 98.5% to 101.5%. The results show achievement of the required density throughout the subject site in accordance with the specification requirements.

It is considered that the fill is deemed "controlled fill" across the site in accordance with AS 3798. The controlled fill can then therefore be considered "suitable" to use as foundation/subgrade, for which an allowable bearing pressure of 100kPa may be adopted. It should be noted that this certification report is limited to parts of Lots 630-635 Greenway Street and 639-644 Bonner Street only and not for the entire lots (refer to proof roll reports for certification areas).

It is noted that the footings may be founded partly on fill and partly on natural material and therefore the footing system should be designed as such that it minimises differential settlement.

Should you have any queries, please do contact us.

Yours truly,



Jarrod Gornall
Geotechnical Engineer

Attachments:

- Addendum
- In-situ Density Test Report
- Proof Roll Test Reports
- Profile and Test Locations Plan

ADDENDUM

LIMITS OF INVESTIGATION

The recommendations made in this report are based on the assumption that the test results are representative of the overall subsurface conditions. However, it should be noted that even under optimum circumstances, actual conditions in some parts of the building site may differ from those said to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal all that is hidden by earth, rock and time.

The client should also be aware that our recommendations refer only to our test site locations and the ground level at the time of testing.

The recommendations in this report are based on the following: -

- a) The information gained from our investigation.
- b) The present "state of the art" in testing and design.
- c) The building type and site treatment conveyed to us by the client.
- d) Historical Information

Should the client or their agent have omitted to supply us with the correct relevant information, or make significant changes to the building type and/or building envelope, our report may not take responsibility for any consequences and we reserve the right to make an additional charge if more testing is necessary.

Notwithstanding the recommendations made in this report, we also recommend that whenever footings are close to any excavations or easements, that consideration should be given to deepening the footings.

Unless otherwise stated in our commission, any dimensions or slope direction and magnitude should not be used for any building costing calculations and/or positioning. Any sketch supplied should be considered as only an approximate pictorial evidence of our work.

AITKEN ROWE Testing Laboratories Pty Ltd

2 Riedell Street, Wagga Wagga NSW 2650

TEST REPORT DENSITY IN SITU

PAGE: 1

OF: 1

REQUEST NO: *

ORDER NO: *

CLIENT : TURNERS EXCAVATIONS PTY LTD - WAGGA WAGGA, NSW

PROJECT : LOTS 630-635 GREENWAY STREET & 639-644 BONNER STREET
LLOYD ESTATE - STAGE 6, WAGGA WAGGA, NSW
'CERTIFICATION'

TEST METHODS : AS1289.2.1.1

AS1289.5.4.1

AS1289.5.7.1

AS1289.5.8.1

SECTIONS REPRESENTED : PROPOSED RESIDENTIAL DWELLING BUILDING PADS

LOT No. : *

SAMPLING PROCEDURE: AS1289.1.2.1

CLAUSE: 6.4b

LAYER & MATERIAL : FILL - GRAVELLY SILTY CLAY

REGISTRATION No. : R12b FC16-15 (R)

SAMPLE OR SITE No.	1	2	3	4	*	*
CHAINAGE (m)	LAYER 1	LAYER 1	LAYER 1	LAYER 2	*	*
OFFSET (m)	LOT 643	LOT 640	LOT 639	LOT 641	*	*
DATE OF TEST	16/06/16	16/06/16	16/06/16	16/06/16	*	*
TIME OF TEST	1430	1435	1445	1455	*	*
DEPTH BELOW FINAL LEVEL (mm)	NIL	150	NIL	NIL	*	*
REDUCED LEVEL (m)	*	*	*	*	*	*
TESTED DEPTH (mm)	200	300	150	150	*	*
FIELD DRY DENSITY (0.01 t/m ³)	1.90	1.94	1.99	1.91	*	*
FIELD WET DENSITY (0.01 t/m ³)	2.14	2.16	2.20	2.15	*	*
PCWD. PEAK CONVERTED WET DENSITY (0.01 t/m ³)	2.17	2.17	2.16	2.17	*	*
APCWD. ADJ. PEAK CONVERTED WET DENSITY (0.01 t/m ³)	*	*	*	*	*	*
MAXIMUM DRY DENSITY (0.01 t/m ³)	*	*	*	*	*	*
OPTIMUM MOISTURE CONTENT (0.5 %)	15.0	14.0	13.5	15.0	*	*
FIELD MOISTURE VARIATION (0.5 %)	2.5	2.5	3.5	2.5	*	*
(WET/DRY):	DRY	DRY	DRY	DRY	*	*
CONTENT ACTUAL (0.5 %)	13.0	11.5	10.0	12.5	*	*
MOISTURE RATIO (0.5 %)	84.5	83.0	75.5	84.0	*	*
% OVERSIZE +37.5mm (0.1 %)	NIL	NIL	NIL	NIL	*	*
% OVERSIZE -37.5+19.0mm (0.1 %)	NIL	NIL	NIL	NIL	*	*
DENSITY OF OVERSIZE (if any) (0.01 t/m ³)	*	*	*	*	*	*
FRACTION TESTED (mm)	-37.5	-37.5	-37.5	-37.5	*	*
COMPACTIVE EFFORT	STANDARD	STANDARD	STANDARD	STANDARD	*	*
TIME FROM ADDITION OF ADDITIVE TO LAB. COMPACTION	*	*	*	*	*	*
MD DETERMINATION BEFORE/AFTER COMPACTION	After	After	After	After	*	*
DENSITY RATIO (0.5 %)	98.5	99.5	101.5	99.0	*	*
SPECIFIED DENSITY RATIO (%)	98.0	98.0	98.0	98.0	*	*

REMARKS: Report revised to add lots 630-365 Greenway Street.

*



ACCREDITED FOR
TECHNICAL
COMPETENCE

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Number: 4679

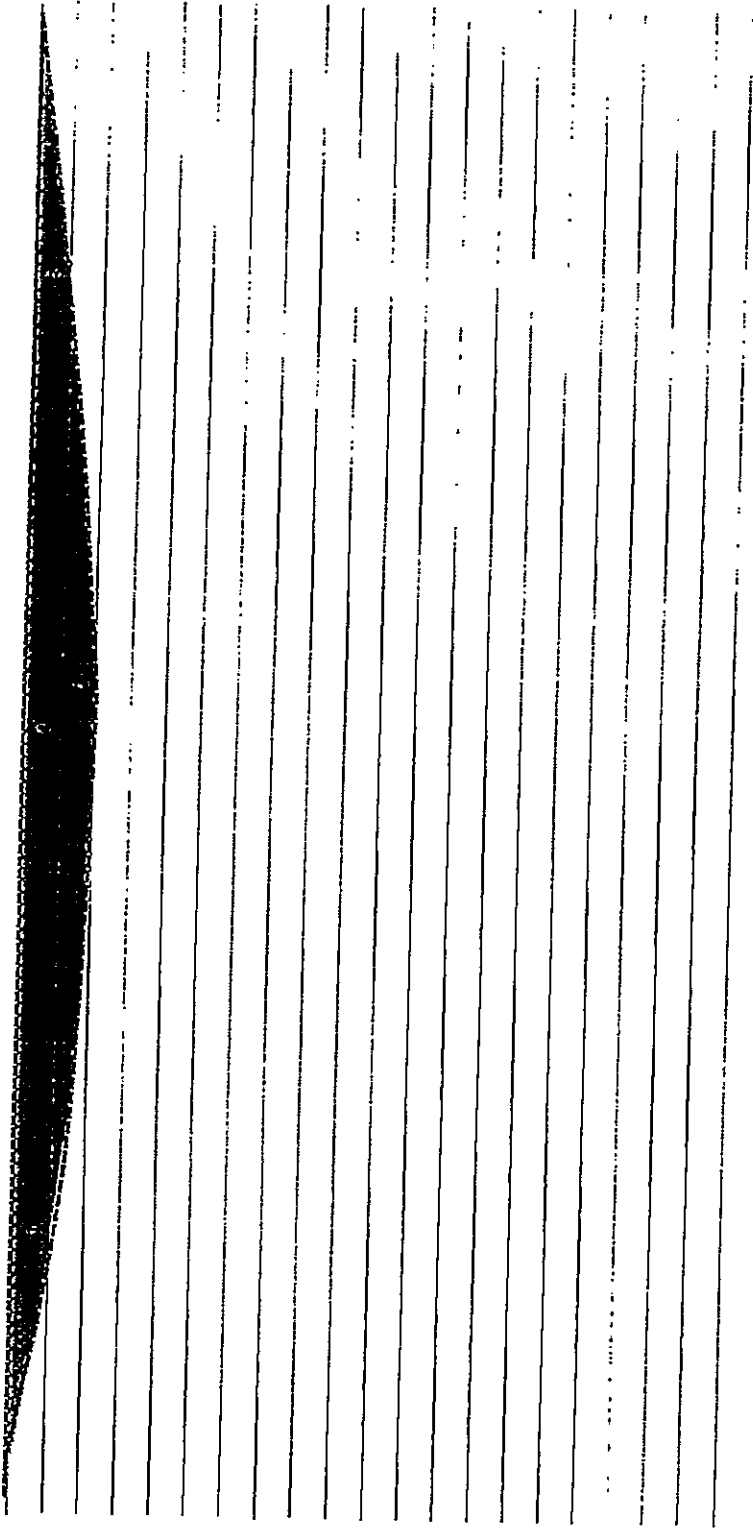
APPROVED SIGNATORY:  Jarrod Gornall

DATE: 7/06/2017

D.B.F (mm)

Nil
150
300

PROFILE SHOWN FROM



GRAVELLY SILTY CLAY @ 95% STD.

SOURCE: SITE WON

NB: DIAGRAMS NOT TO SCALE