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Services completed for this site

- ☑ Lot Classifications
- ☐ Salinity Test
- ☐ In-situ Permability Test
- ☐ Acid Sulphate Report
- ☐ Exposure Classification
- ☐ Contamination Report
- ☐ Wastewater Management Report
- ☐ Level 1/2 Compaction Test
- ☐ Contour Survey

LOT CLASSIFICATION REPORT

Prepared for: Wincrest Homes - Wincrest Group P/L
Site Address: Lot 1 (98) Elimatta Road, MONA VALE

Revision:
Site Test: 25/01/2019
Lab Test: 01/02/2019
Customer Job: 17271/080/X02
Ideal Job: 37822
Technician: JK

Site Classification
P

Soil Classification
H1
Ys = 40 - 60

Wind Classification
N1 (W28)

Standards

Test results completed in this report are in accordance with the following standards:

- AS 2870-2011 Residential slabs and footings
- AS 4055-2012 Wind loads for housing
- AS 1726-1993 Geotechnical site investigations
- AS 3798-2007 Guidelines on earthworks for commercial and residential developments

2.0 SITE ANALYSIS

Is there current evidence of the following that would likely affect this site?
NB: * denotes relevant to PROBLEM SITE

2.1*	Existing fill (>400mm onsite)	No
2.2*	Fill containing wood, metal, plastic or other deleterious materials	No
2.3*	Residential allotment (<1000m2) with over 1.6m fill	No
2.4*	Rural allotment (>1000m2) with over 2.4m fill	No
2.5*	Soft or collapsing soils	No
2.6*	Are there any trees (or removed trees) on site or adjoining site? If Yes show locations at 6.0	Yes
2.7	Is the project a knock down rebuild?	No
2.8	Floating boulders	No
2.9	Rock (difficult excavation)	No
2.10	Underground flowing water and/or seepage evidence	No
2.11	Marine environment or other risk of corrosion (within 1km from water with surf)	No
2.12	Erosion	No

3.0 INSPECTION OF SITE

3.1	Site status - platform slope is: **Slope:** 9 Degrees **Fall direction:** S	
3.2	Slope stability assessment recommended (> 11 Degrees)	No
3.3	Are there any Retaining Walls supporting this site? (if Yes, see attached plan drawing 6.0)	No

4.0 VISUAL OBSERVATION OF NEIGHBOURHOOD

4.1	Presence of rock Is surface rock visible on this site or on adjoining lots, or is rock visible in nearby excavations?	No
4.2	Existing masonry buildings Is there significant cracking of existing masonry walls? Building Type:	No
4.3	Indicators of movement in the following: Roads, Kerbs, Pavements, Masonry Fences, and/or Ground Surfaces Is there significant movement in any of the above?	No

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5.1 FIELD LOG

Date: 25/01/2019
Customer Job: 17271/080/X02
Ideal Job: 37822
Site Address: Lot 1 (98) Elimatta Road, MONA VALE, NSW, 2103

Borehole: BH1
Surface RL:
Easting:
Northing:

Water	Depth (m)	DCP	PP	Sample	Classification Code	Material Description	Moisture	Density / Consistency	Fill
	0.1				CI	Silty Clay with trace Gravel	Moist	VSt	↓
	0.2					brown			
	0.3		137 kPa		CH	Silty Clay	Moist	VSt - Very Stiff	
	0.4					brown			
	0.5			Soil Sample 1					
	0.6		172 kPa						
	0.7								
	0.8								
	0.9		162 kPa						
	1.0								
	1.1								
	1.2		196 kPa						
	1.3								
	1.4				CI	Residual Soil Silty Clay with trace Gravel	Moist	H - Hard	
	1.5		216 kPa			grey brown			
	1.6								
	1.7								
	1.8								
	1.9					End Bore 1.8m			
	2.0								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	2.9								
	3.0								
	3.1								
	3.2								
	3.3								

Water Table **UTP** - Unable to penetrate **DCP** - 9kg Dynamic Cone Penetrometer **PP** - Pocket Penetrometer

AND – Density Index vs Approx. Penetrometer results				**SILTS & CLAY** – Cu vs Approx. Penetrometer results					**MOISTURE**	
DENSITY		**Density Index**	**DCP Blow Count** (blows/100mm)	**CONSISTENCY**		**Undrained Shear Strength** (kPa)	**DCP Blow Count** (blows/100mm)	**PP Dial Indicator**		
VL	Very Loose	< 15 %	< 1	VS	Very Soft	0 – 12	< 1	0 – 0.2	D	Dry
L	Loose	15 – 35 %	1 – 3	S	Soft	12 – 25	1 – 2	0.2 – 0.5	M	Moist
MD	Medium Dense	35 – 65 %	3 – 9	F	Firm	25 – 50	2 – 3	0.5 – 1.0	W	Wet
D	Dense	65 – 85 %	9 – 15	St	Stiff	50 – 100	3 – 5	1.0 – 2.0	W_P	Plastic Limit
VD	Very Dense	> 85 %	> 15	VSt	Very Stiff	100 – 200	5 – 8	3.0 – 4.0	W_L	Liquid Limit
				H	Hard	> 200	> 8	> 4.0		

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5.2 FIELD LOG

Date:	25/01/2019	**Borehole:**	**BH2**
Customer Job:	17271/080/X02	**Surface RL:**	
Ideal Job:	37822	**Easting:**	
Site Address:	Lot 1 (98) Elimatta Road, MONA VALE, NSW, 2103	**Northing:**	

Water	Depth (m)	DCP	PP	Sample	Classification Code	Material Description	Moisture	Density / Consistency	Fill
	0.1				CI	Silty Clay with trace Gravel	Moist	VSt	
	0.2					brown			
	0.3		294 kPa						
	0.4								
	0.5				CH	Silty Clay	Moist	VSt - Very Stiff	
	0.6		147 kPa			brown			
	0.7								
	0.8								
	0.9		191 kPa						
	1.0								
	1.1								
	1.2		294 kPa						
	1.3				CI	Residual Soil Silty Clay with trace Gravel	Moist	H - Hard	
	1.4					grey brown			
	1.5		294 kPa						
	1.6								
	1.7								
	1.8								
	1.9					End Bore 1.8m			
	2.0								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	2.9								
	3.0								
	3.1								
	3.2								
	3.3								

Water Table **UTP** - Unable to penetrate **DCP** - 9kg Dynamic Cone Penetrometer **PP** - Pocket Penetrometer

AND – Density Index vs Approx. Penetrometer results				**SILTS & CLAY** – Cu vs Approx. Penetrometer results					**MOISTURE**	
DENSITY		**Density Index**	**DCP Blow Count** (blows/100mm)	**CONSISTENCY**		**Undrained Shear Strength** (kPa)	**DCP Blow Count** (blows/100mm)	**PP Dial Indicator**		
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L	Loose	15 – 35 %	1 – 3	S	Soft	12 – 25	1 – 2	0.2 – 0.5	M	Moist
MD	Medium Dense	35 – 65 %	3 – 9	F	Firm	25 – 50	2 – 3	0.5 – 1.0	W	Wet
D	Dense	65 – 85 %	9 – 15	St	Stiff	50 – 100	3 – 5	1.0 – 2.0	W_P	Plastic Limit
VD	Very Dense	> 85 %	> 15	VSt	Very Stiff	100 – 200	5 – 8	3.0 – 4.0	W_L	Liquid Limit
				H	Hard	> 200	> 8	> 4.0		

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5.3 FIELD LOG

Date: 25/01/2019
Customer Job: 17271/080/X02
Ideal Job: 37822
Site Address: Lot 1 (98) Elimatta Road, MONA VALE, NSW, 2103

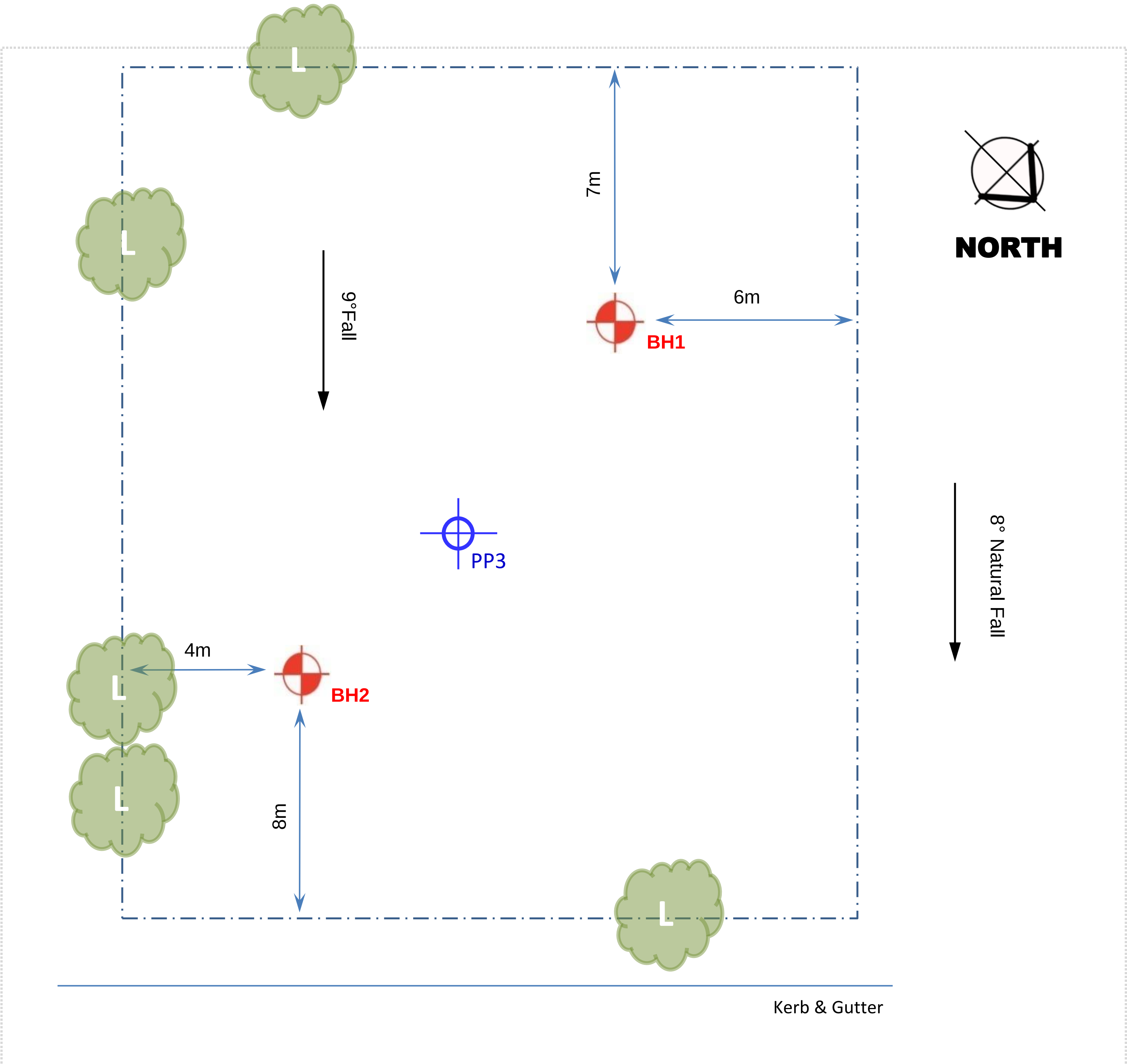
Borehole: **BH3**
Surface RL:
Easting:
Northing:

Water	Depth (m)	DCP	PP	Sample	Classification Code	Material Description	Moisture	Density / Consistency	Fill
	0.1								
	0.2								
	0.3		294 kPa						
	0.4								
	0.5								
	0.6		137 kPa						
	0.7								
	0.8								
	0.9		172 kPa						
	1.0								
	1.1								
	1.2		206 kPa						
	1.3								
	1.4								
	1.5		294 kPa						
	1.6								
	1.7								
	1.8								
	1.9								
	2.0								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	2.9								
	3.0								
	3.1								
	3.2								
	3.3								

Water Table **UTP** - Unable to penetrate **DCP** - 9kg Dynamic Cone Penetrometer **PP** - Pocket Penetrometer

AND – Density Index vs Approx. Penetrometer results				**SILTS & CLAY** – Cu vs Approx. Penetrometer results					**MOISTURE**	
DENSITY		**Density Index**	**DCP Blow Count** (blows/100mm)	**CONSISTENCY**		**Undrained Shear Strength** (kPa)	**DCP Blow Count** (blows/100mm)	**PP Dial Indicator**		
VL	Very Loose	< 15 %	< 1	VS	Very Soft	0 – 12	< 1	0 – 0.2	D	Dry
L	Loose	15 – 35 %	1 – 3	S	Soft	12 – 25	1 – 2	0.2 – 0.5	M	Moist
MD	Medium Dense	35 – 65 %	3 – 9	F	Firm	25 – 50	2 – 3	0.5 – 1.0	W	Wet
D	Dense	65 – 85 %	9 – 15	St	Stiff	50 – 100	3 – 5	1.0 – 2.0	W_P	Plastic Limit
VD	Very Dense	> 85 %	> 15	VSt	Very Stiff	100 – 200	5 – 8	3.0 – 4.0	W_L	Liquid Limit
				H	Hard	> 200	> 8	> 4.0		

6.0 LOCATION SKETCH



7.0 COMMENTS & RECOMMENDATIONS

Site Notes:

8.0 CERTIFICATION

The attachment of the signature below is to certify that this report has been compiled in accordance with Australian Standards AS2870-2011, AS1726-1993 and AS3798-2007.

Yours Faithfully,

Miles Opacic BE (Civil)

9.0 REPORT CONDITIONS & LIMITATIONS

CONDITIONS OF THE RECOMMENDATIONS

- This is a site classification report generally in accordance with AS-2870-2011 and should be sufficient for a qualified person to design footings for structures covered under the scope of this standard.

- This site classification was completed by an experienced soil technician and does not make any allowance for any possible mine subsidence within the building envelope.

- The advice given in this report is based on the assumption that the test results are representative of the overall subsurface conditions. However, it should be noted that actual conditions in some parts of the building site may differ from those found in the boreholes. If excavations reveal soil conditions significantly different from those shown in our attached Borehole Log(s), Ideal Geotech must be consulted and excavations stopped immediately.

- Any sketches in this report should be considered as only an approximate pictorial evidence of our work. Therefore, unless otherwise stated, any dimensions or slope information should not be used for any building cost calculations and/or positioning of the building. Dimensions on logs are correct.

REPORT LIMITATIONS

The investigations addressed in this report are not intended nor designed to locate all possible ground conditions on the site. It is not possible to identify all possible ground conditions. Further, one site may have a variety of ground conditions and, the ground conditions actually identified by the testing articulated in this report may change, even over very short periods of time.

The advice and recommendations contained in this report are based on the test results obtained from the samples tested, and on the assumption that those test results are representative of the overall ground conditions of the entire site. The actual conditions in some parts of the site might differ from those tested. If excavation reveals ground conditions that vary from those outlined in our findings in this report and the advice contained in this report may differ significantly and must be revisited. If this occurs, Ideal Geotech must be consulted before any further work is carried out on the site, Ideal Geotech should be engaged for a supplementary report and updated recommendations.

The scope and relevance of the advice provided in the report is subject to restrictions and limitations. Ideal Geotech did not perform a complete assessment of all possible conditions or circumstances that may exist on the site. If a service is not expressly indicated that means it has not been provided, and and the reader should not assume that it has been. If a matter is not specifically addressed then Ideal Geotech has not made a determination in relation to it, and the reader should not assume that it has.

Where data and information has been supplied by the client or a third party, the accuracy of the advice and recommendations in this report is dependant upon the accuracy of that data and information. Ideal Geotech is not responsible for verifying the accuracy of data or information provided to it by third parties. Ideal Geotech is not liable nor responsible for inaccurate advice provided upon reliance of incomplete or inaccurate data supplied by third parties.

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).

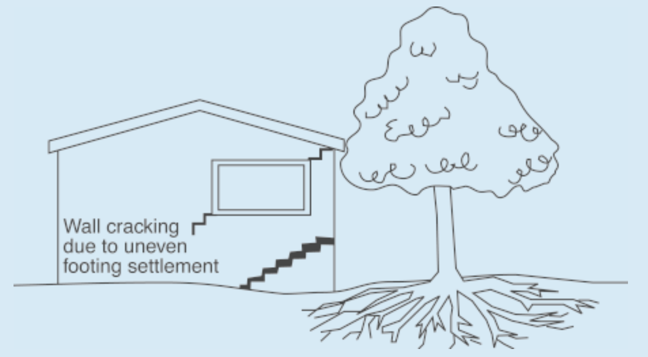
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

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.

Trees can cause shrinkage and damage



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.

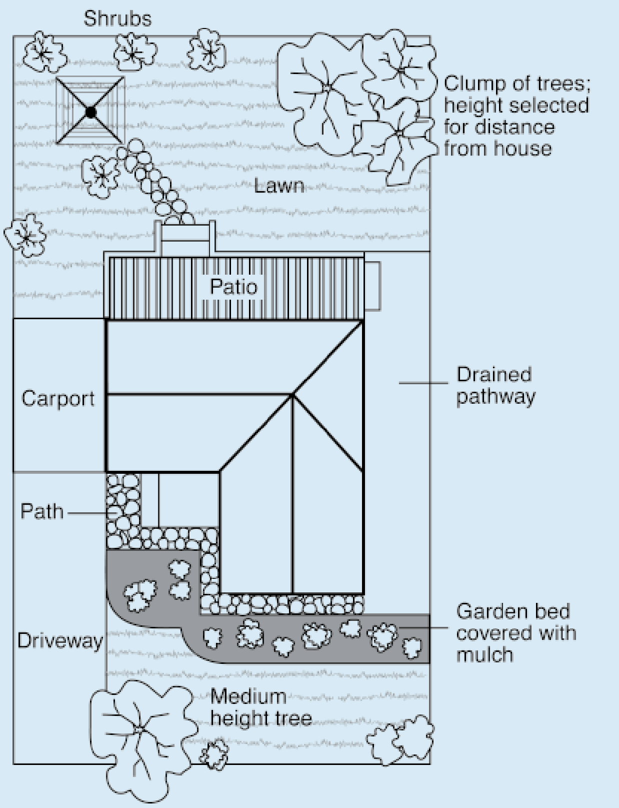
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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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Liquid Limit and Linear Shrinkage Test Results

Customer:	**Wincrest Homes**	Ideal Job No:	**37822-WIN**	Report No	**37822 L1**
Address:	**Lot 1 (98) Elimatta Road, MONA VALE**			Test Date:	**30/01/19**

Test No:	L1	Depth (m):	0.5m	Borehole No:	1

Sample No	Depth (m)	Material Description (visual)	Codes	Liquid Limit %	Linear Shrinkage %
L1	0.5m	Red Orange Silty Clay	1,6,**	71%	14.0%

CODES/LEGEND

NO - Not Obtainable

Sample History

1 - Air Dried 2 - Low Temperatures (<50C) Oven Dried 3 - Oven (105C) Dried 4 - Unknown 5 - Natural

Method of Preparation

6 - Dry Sieved 7 - Wet Sieved

Shrinkage sample

(CR) - Crumbled (CU) - Curled

** Mould Length is 125mm *** Mould Length is 150mm

Test Methods

Linear Shrinkage AS1289.3.4.1 & Liquid Limit AS1289.3.1.2 & Sampling AS1289 1.2.1 (Power/ Hand Auger)

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Accredited for compliance
with ISO/IEC 17025-Testing
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Checked By D.Dwyer
Dated 01-Feb-19

Approved Signatory D.Dwyer