



Application for Planning Approval

Land Use Planning and Approvals Act 1993

APPLICATION NO.

DA2025/117

LOCATION OF AFFECTED AREA

44 BRAEVIEW DRIVE, OLD BEACH

DESCRIPTION OF DEVELOPMENT PROPOSAL

OUTBUILDING

A COPY OF THE DEVELOPMENT APPLICATION MAY BE VIEWED AT www.brighton.tas.gov.au AND AT THE COUNCIL OFFICES, 1 TIVOLI ROAD, OLD BEACH, BETWEEN 8:15 A.M. AND 4:45 P.M, MONDAY TO FRIDAY OR VIA THE QR CODE BELOW. ANY PERSON MAY MAKE WRITTEN REPRESENTATIONS IN ACCORDANCE WITH S.57(5) OF THE LAND USE PLANNING AND APPROVALS ACT 1993 CONCERNING THIS APPLICATION UNTIL 4:45 P.M. ON **30/04/2026**. ADDRESSED TO THE CHIEF EXECUTIVE OFFICER AT 1 TIVOLI ROAD, OLD BEACH, 7017 OR BY EMAIL AT development@brighton.tas.gov.au. REPRESENTATIONS SHOULD INCLUDE A DAYTIME TELEPHONE NUMBER TO ALLOW COUNCIL OFFICERS TO DISCUSS, IF NECESSARY, ANY MATTERS RAISED.

JAMES DRYBURGH
Chief Executive Officer



Brighton
going places

- PROPOSED SHED AT 44 BRAEVIEW DRIVE, OLD BEACH



TASSIE HOMES

Unit 4/37 Ascot Drive, Huntingfield, Tasmania. 7055
Ph. (03) 62 833 273 www.tassiehomes.com.au

<i>Architectural Drawing No.</i>	<i>Description</i>
01	LOCATION PLAN
01a	SITE PLAN

PROTECTIVE COATINGS FOR STEELWORK

ENVIRONMENT	LOCATION	MINIMUM PROTECTION COATING	
		General structural steel members	Lintels in masonry
LOW mild steel corrosion rate 1.3 to 25 µm/year Typically remote inland areas or more than 1 km from sheltered bays	INTERNAL	No protection required	
	EXTERNAL	Option 1 Hot dip galvanising - HDG75 Option 2 Duplex system. See N.C.C. Table 6.3.9c Option 3 Paint. See N.C.C. Table 6.3.9b - ALC2, ACC2, IZS1, PUR2A	

NOTES:

1. Heavy industrial areas means industrial environments around major industrial complexes. There are only a few such regions in Australia, examples of which occur around Port Pirie and Newcastle.
2. The outer leaf and cavity of an external masonry wall of a building, including walls under open carports are considered to be external environments. A part of an internal leaf of an external masonry wall which is located in the roof space is considered to be in an internal environment.
3. Where a paint finish is applied the surface of the steel work must be hand or power tool cleaned to remove any rust immediately prior to painting.
4. All zinc coatings (including inorganic zinc) require a barrier coat to stop conventional domestic enamels from peeling.
5. Refer to the paint manufacturer where decorative finishes are required on top of the minimum coating specified in the table for protection of the steel against corrosion.
6. Internal locations subject to moisture, such as in close proximity to kitchen or bathroom exhaust fans are not considered to be in a permanently dry location and protection as specified for external locations is required.
7. For applications outside the scope of this table, seek specialist advice.

REVISION	DATE	SHEETS	DESCRIPTION
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Climate Zone - 7
 C.T. No. 160023/13
 Wind Speed - N2
 Soil Classification - A
 Corrosion Environment - LOW

FLOOR AREA = 150m²

BAL - N/A

- Preliminary drawings
- Development application drawings (DA)

- Preliminary construction drawings
Engineer not to sign this copy, only
provide notes, additions & amendments
- Final construction drawings (BA)

- Approved by Engineer
- Approved by Building Surveyor

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 Drafted by Cem Kali, Licence Number: 627300775

DRAWING: COVER SHEET

DATE: 25 March 2026
 FILE NAME: 44 Braeview - 250326
 DRAWN BY: CK
 DWG No:

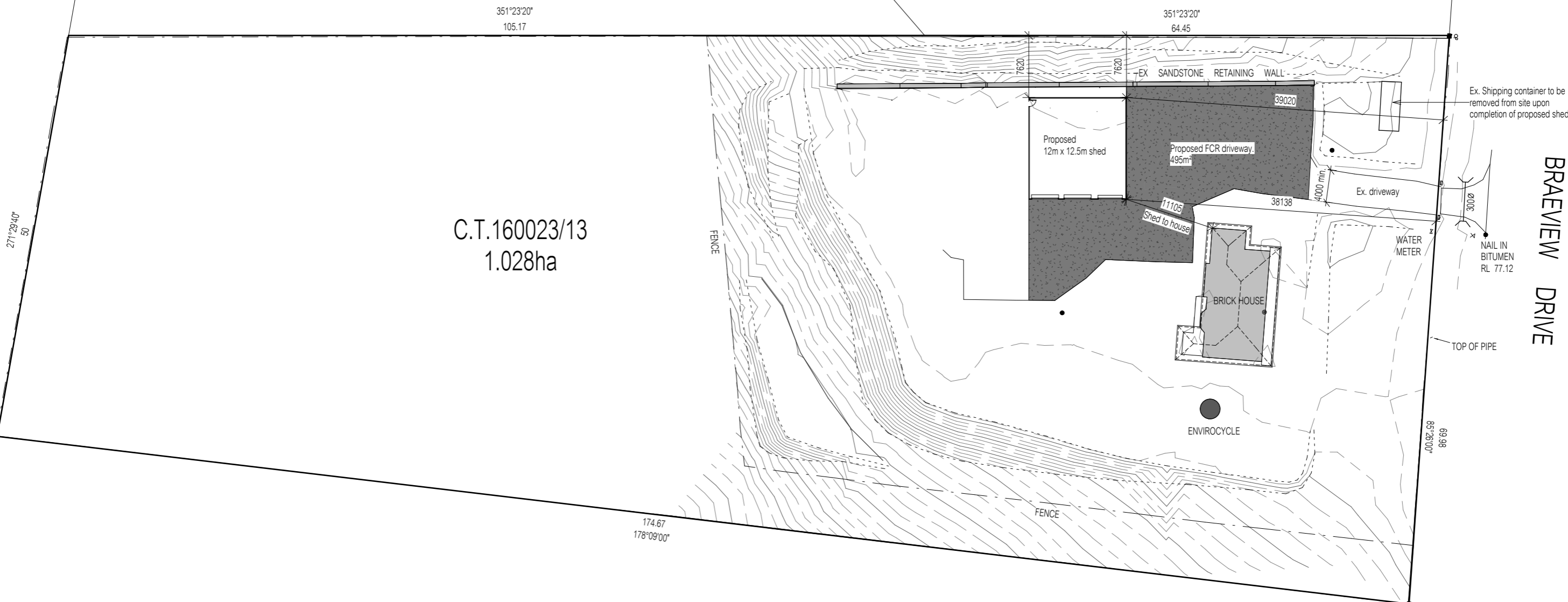
COVER SHEET



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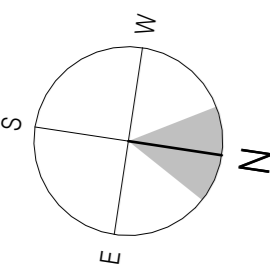
NOTES:
While all reasonable effort has been made to locate all visible above ground services, there may be other services which were not located during the field survey.
The title boundaries as shown on this plan were not marked at the time of the survey and have been determined by existing title dimensions and occupation (where available) only and not by field survey, and as a result are considered approximate only. This plan should not be used for building to boundary, or to prescribed set-backs, without further survey.
Prior to any demolition, excavation, final design or construction on this site, a full site inspection should be completed by the relevant engineers.
All survey data is 3D. The level (z-value) of any specific feature can be interrogated with a suitable CAD package. Spot heights of all features, including pipe inverts, are included in the model space but are not displayed on the PDF. Spot heights are organised into appropriate layers, and can be displayed as required.
DATUM - Vertical - AHD per MONDO PIN VRS
At the time of this survey, C.T.160023/13 was owned by CRAIG MICHAEL OSCAR LOVEGROVE & JUSTIN ANTHONY BROWNING
Date of Survey : 13-3-2026



C.T.160023/13
1.028ha

BRAEVIEW DRIVE

BAL - N/A



Scale 1 : 500

PROPOSED SHED
AT 44 BRAEVIEW DRIVE, OLD BEACH

REVISION	DATE	DESCRIPTION

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Drafted by Cem Kali, Licence Number: 627300775
DRAWING: LOCATION PLAN
DATE: 25 March 2026
FILE NAME: 44 Braeview - 250326
DRAWN BY: CK
DWG No:

C.T.160023/13
1.028ha

NOTE:
Gradients shown on driveway are approximate

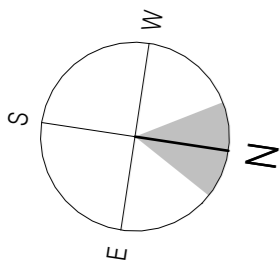


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DATUM - Vertical : AHD per MONDO PIN VRS
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Date of Survey : 13-3-2026

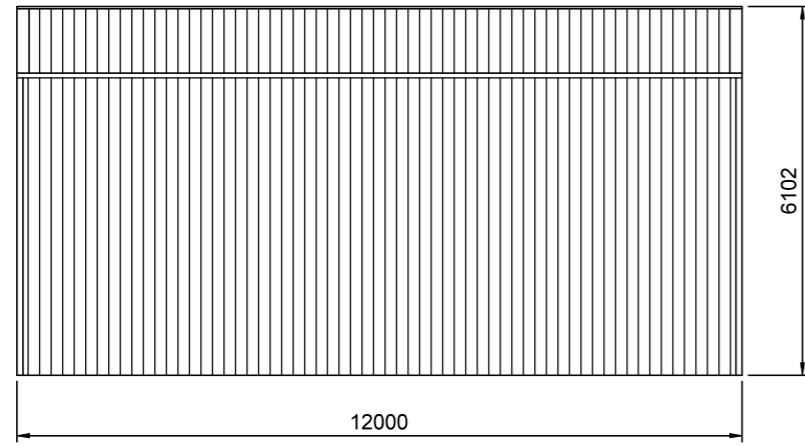


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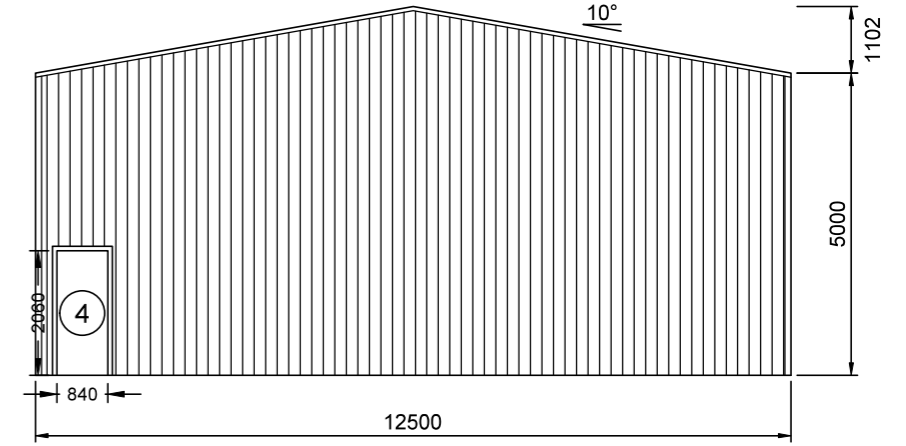
**PROPOSED SHED
AT 44 BRAEVIEW DRIVE, OLD BEACH**

REVISION	DATE	DESCRIPTION

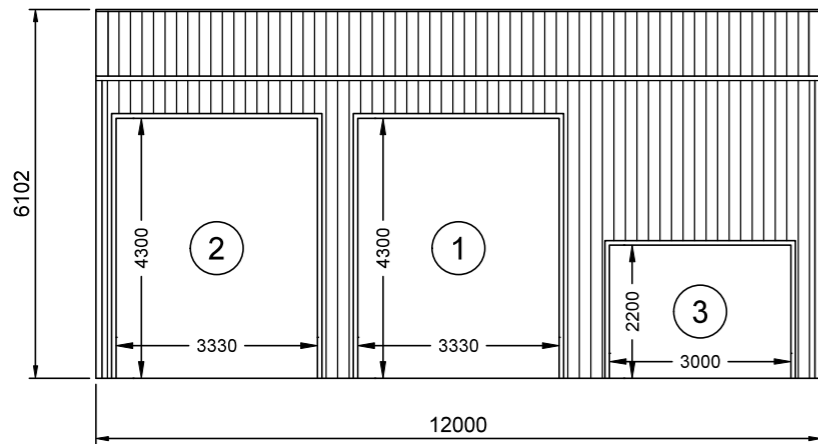
© This document is copyright and may not be reproduced without the written consent of Tassie Homes.
Drafted by Cem Kali, Licence Number: 627300775
DRAWING: SITE PLAN
DATE: 25 March 2026
FILE NAME: 44 Braeview - 250326
DRAWN BY: CK
DWG No:



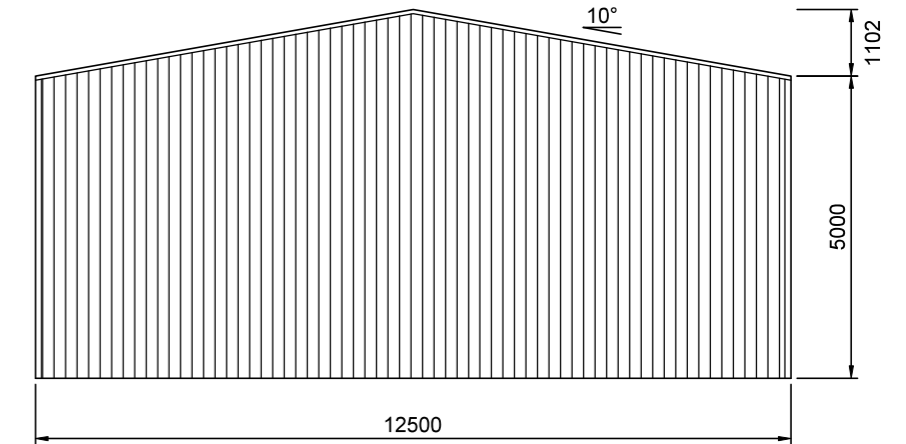
2 SIDEWALL B BUILDING ELEVATION
2 SCALE: 1:125



3 REAR BUILDING ELEVATION
2 SCALE: 1:125

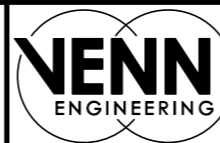


1 SIDEWALL A BUILDING ELEVATION
2 SCALE: 1:125



4 FRONT BUILDING ELEVATION
2 SCALE: 1:125

REV	DATE	DESCRIPTION
A	03-07-2025	-



PO Box 3084
THIRROUL NSW 2515
sheds@venn.engineering
ABN 39 626 802 257

Signed *[Signature]* Date 03-07-2025
Grant J Wood MIEAust CPEng NER RPEQ
Registered EA Chartered Professional Engineer (No. 2383009)
Registered Professional Engineer QLD (No. 14384)
Registered Civil Engineer Building Practitioner VIC (No. PE0002499)
Registered Certifying Engineer (structural) NT (No. 306371E5)
Building Services Provider (Engineer Civil) TAS (No. 696300425)

Customer Name: Craig Lovegrove
Site Address: 44 Braeview Dr
Old Beach,
TAS, 7017

DATE 03-07-2025
JOB NO. EALB1010041904
SHEET 2 of 10

GEOTECH 25-100

ROCK SOLID GEOTECHNICS PTY LTD
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peter@rocksolidgeotechnics.com.au

21/7/2025

GEOTECHNICAL ASSESSMENT / CLASSIFICATION
PROPOSED RESIDENTIAL DEVELOPMENT

44 Braeview Drive, Old Beach

CLIENT: Craig Lovegrove 0488509520
Via Keron Nichols keron@tassiehomes.com.au

SUMMARY 2
INVESTIGATION 2
CONDITIONS OF INVESTIGATION 6

FIGURE 1 Site Plan

APPENDIX 1 Certificate of Others (Building) – Form 55

APPENDIX 2 CSIRO 'Guide to home-owners on foundation maintenance and footing performance'

SUMMARY

A shed development is proposed by Craig Lovegrove at 44 Braeview Drive, Old Beach (Figure 1). Shallow Triassic mudstone/siltstone bedrock underlies the site.

The site is classified as Class 'A' in accordance with AS2870-2011.

Suitable upslope site drainage should be installed prior to the commencement of construction.

The following Wind Load Classifications (AS4055-2012: Wind Loads for Housing) are appropriate.

• Terrain Category Classification	TC2.5	Terrain with a few obstructions
• Shielding Classification	PS	Partial Shielding
• Topographic Classification	T1	
• Wind Load Classification	N2	

INVESTIGATION

The Tasmanian Geological Survey 1:25000 Digital Geological Atlas - *Richmond*, indicates that the site is underlain by Triassic sediments.

A site investigation was completed on Wednesday 9 July 2025. This included the augering of two test holes to assess the site for foundation conditions (4WD mounted SAMPLA25 mechanical auger with 100mm solid flight augers). The locations of the holes are marked on Figure 1.

It is proposed to install a new shed to the southwest of the residence (Plate 1). The site has been excavated, with Triassic aged siltstone and mudstone exposed in the cutting on the western side (Plate 2), and in the base of the western portion of the excavation. The development is now flat (after site preparation civil works). No seepages or springs were observed on the site.

Test Hole #1 (SE side of the shed site) encountered bedrock at 0.65m depth.

Test Hole #2 (NE side of the shed site) encountered bedrock at 0.30m depth.

Siltstone and mudstone bedrock encountered at the surface of the site on the western side of the shed site.

Groundwater was not encountered in either hole.

Dispersive soils were not encountered at the site.

Peter Hofto

ROCK SOLID GEOTECHNICS P/L

Plate 1 – Development site - looking across-slope to the southeast – Test Hole #1.



Plate 2 – looking to the northwest.



CONDITIONS OF INVESTIGATION

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This report should not be used for submission for Building or Development Application until RSG has been paid in full for its production. RSG accepts no liability for the contents of this report until full payment has been received.

The results & interpretation of conditions presented in this report are current at the time of the investigation only. The investigation has been conducted in accordance with the specific client's requirements &/or with their servants or agent's instructions.

This report contains observations & interpretations based often on limited subsurface evaluation. Where interpretative information or evaluation has been reported, this information has been identified accordingly & is presented based on professional judgement. RSG does not accept responsibility for variations between interpreted conditions & those that may be subsequently revealed by whatever means.

Due to the possibility of variation in subsurface conditions & materials, the characteristics of materials can vary between sample & observation sites. RSG takes no responsibility for changed or unexpected variations in ground conditions that may affect any aspect of the project. The classifications in this report are based on samples taken from specific sites. The information is not transferable to different sites, no matter how close (ie. if the development site is moved from the original assessment site an additional assessment will be required).

It is recommended to notify the author should it be revealed that the sub-surface conditions differ from those presented in this report, so additional assessment & advice may be provided.

Investigations are conducted to standards outlined in Australian Standards:

- AS1726-1993: Geotechnical Site Investigations
- AS2870-2011: Residential Slabs and Footings
- AS4055-2012: Wind Loads for Housing

& as specified in 'Guidelines for Geotechnical Assessment of Subdivisions and Recommended Code of Practise for Site Classification to AS2870 in Tasmania' - Institute of Engineers, Tasmanian Division.

All new developments should subject to strict site maintenance. Attention is drawn to the enclosed information reproduced with the permission from Standards Australia:

- CSIRO Information Sheet No. BTF18 – 'Guide to home-owners on foundation maintenance & footing performance'.

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PETER HOFTO

ROCK SOLID GEOTECHNICS PTY LTD



44 BRAEVIEW DRIVE
OLD BEACH
TEST HOLES



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CERTIFICATE OF QUALIFIED PERSON – ASSESSABLE ITEM

Section 321

Form **55**

To: Owner /Agent
 Address
 Suburb/postcode

Qualified person details:

Qualified person:
Address: Phone No:
 Fax No:
Licence No: Email address:

Qualifications and Insurance details: (description from Column 3 of the Director's Determination - Certificates by Qualified Persons for Assessable Items)

Speciality area of expertise: (description from Column 4 of the Director's Determination - Certificates by Qualified Persons for Assessable Items)

Details of work:

Address: Lot No:
 Certificate of title No:
The assessable item related to this certificate: (description of the assessable item being certified)
Assessable item includes –
- a material;
- a design
- a form of construction
- a document
- testing of a component, building system or plumbing system
- an inspection, or assessment, performed

Certificate details:

Certificate type: (description from Column 1 of Schedule 1 of the Director's Determination – Certificates by Qualified Persons for Assessable Items n)

This certificate is in relation to the above assessable items, at any stage, as part of – (tick one)

building work, plumbing work or plumbing installation or demolition work

OR

a building, temporary structure or plumbing installation

In issuing this certificate the following matters are relevant –

Documents:

Relevant calculations:

AS2870

References:

Substance of Certificate: (what it is that is being certified)

Scope and/or Limitations

I certify the matters described in this certificate.

Qualified person: *Signed:*



Certificate No:

GEOTECH
25-100

Date:

21/7/2025

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
I	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 pendants).

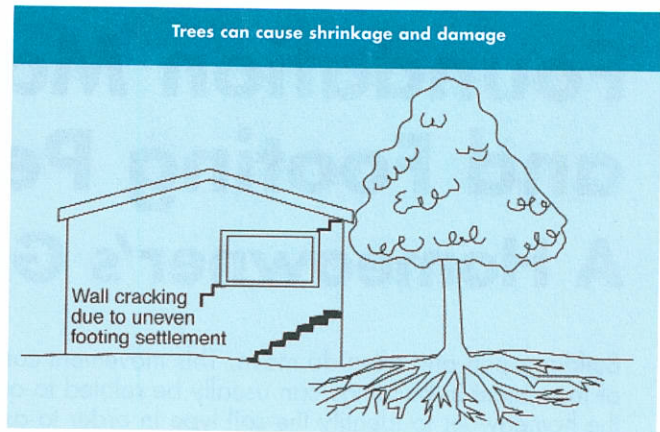
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

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.

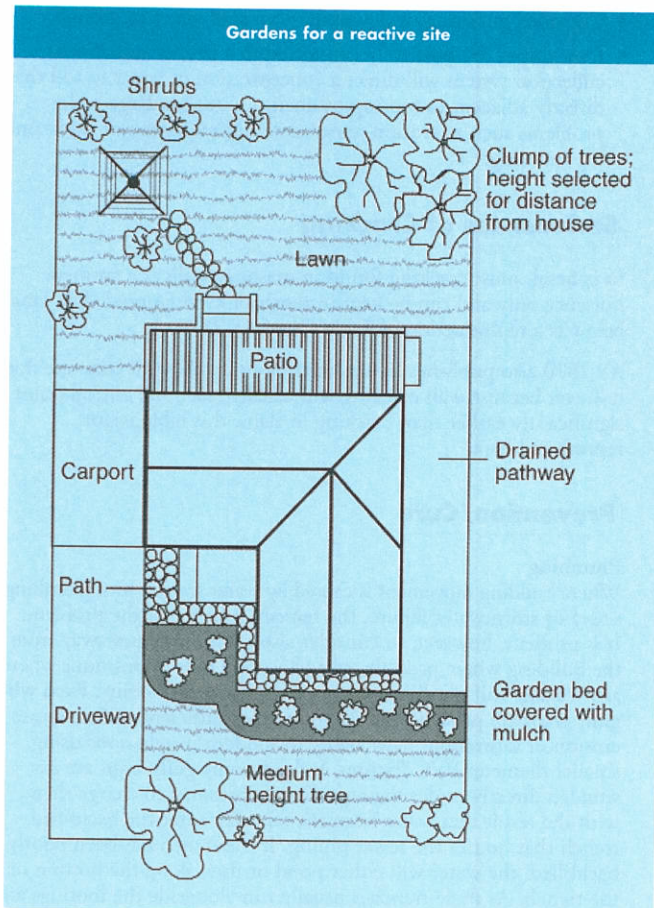
Protection of the building perimeter

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



- 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.

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:

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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DISPERSIVE SOIL ASSESSMENT



44 BRAEVIEW DRIVE - OLD BEACH **PROPOSED CUT AND FILL & OUTBUILDINGS**

Client: Tassie homes

Certificate of Title: 160023/13

Investigation Date: 06/11/2025

Refer to this Report As

Enviro-Tech Consultants Pty. Ltd. 2025. Foundation Classification Report for a Proposed Outbuildings, 44 Braeview Drive - Old Beach. Unpublished report for Tassie homes by Enviro-Tech Consultants Pty. Ltd., 06/11/2025.

Report Distribution

This report has been prepared by Enviro-Tech Consultants Pty. Ltd. (Envirotech) for the use by parties involved in the proposed development of the property named above.

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Limitations of this report

In some cases, variations in actual Site conditions may exist between subsurface investigation boreholes. This report only applies to the tested parts of the Site at the Site of testing, and if not specifically stated otherwise, results should not be interpreted beyond the tested areas.

The Site investigation is based on the observed and tested soil conditions relevant to the inspection date and provided design plans (building footprints presented in Attachment A). Any site works which has been conducted which is not in line with the Site plans will not be assessed. Subsurface conditions may change laterally and vertically between test Sites, so discrepancies may occur between what is described in the reports and what is exposed by subsequent excavations. No responsibility is therefore accepted for any difference in what is reported, and actual Site and soil conditions for parts of the investigation Site which were not assessed at the time of inspection.

This report has been prepared based on provided plans detailed herein. Should there be any significant changes to these plans, then this report should not be used without further consultation which may include drilling new investigation holes to cover the revised building footprint. This report should not be applied to any project other than indicated herein.

No responsibility is accepted for subsequent works carried out which deviate from the Site plans provided or activities onsite or through climate variability including but not limited to placement of fill, uncontrolled earthworks, altered drainage conditions or changes in groundwater levels.

Footing exposure classification is presented on a layer-by-layer basis. In practice, some layers may be removed during excavation or replaced as part of site cuts and fills, while others may be incorporated within the building envelope. The information should therefore be regarded as guidance only, and the designer must assess the actual founding conditions and make the final determination of concrete strength, curing and cover requirements.

At the time of construction, if conditions exist which differ from those described in this report, it is recommended that the base of all footing excavations be inspected to ensure that the founding medium meets that requirement referenced herein or stipulated by an engineer before any footings are poured.

Site Investigation

The Site investigation is summarised in Table 1.

Table 1 Summary of Site Investigation

Client	Tassie homes
Project Address	44 Braeview Drive - Old Beach
Council	Brighton
Planning Scheme	Tasmanian Planning Scheme
Inundation, Erosion or Landslip Overlays	None
Proposed	Outbuildings
Investigation	Fieldwork was carried out by an Engineering Geologist on the 6/11/2025
Site Topography	The Site is defined by the proposed building and works area which has a strong slope of approximately 20% (11°) to the south
Site Drainage	The Site receives overland flow runoff directly from the north (Figure 2).
Soil Profiling	Four investigation holes were direct push sampled from surface level around the proposed outbuildings (Appendix A):
Investigation Depths	The target excavation depth was estimated at 1.5 m. Borehole BH01 was direct push sampled to 2.1 m, borehole BH02 was direct push sampled to 1 m, borehole BH03 was direct push sampled to 0.9 m, and borehole BH04 was direct push sampled to 0.5 m. Borehole logs and photos are presented in Appendix B & C.
Soil moisture and groundwater	All recovered soil at the site ranged from slightly moist to wet. Groundwater was encountered at 0.1 to 1.4 m below ground surface.
Geology	According to 1:25,000 Mineral Resources Tasmania geological mapping (accessed through The LIST), the geology comprises of: Triassic Predominantly brown buff grey carbonaceous and green poorly-micaceous siltstone and mudstone, interbedded with lithic sandstone quartz sandstone and thin beds of silicified sandstone, horizons of crowded vertical burrows, siltstone palaeosols and plant fossils. and

Planning – DISPERSION

Brighton local provisions schedule - BRI-S7.0 East Baskerville Dispersive Soils

Objective

The objective of BRI-S7.0 East Baskerville Dispersive Soils is to minimise and/or mitigate adverse impacts from development occurring on land that contains potential dispersive soils.

Application

The specific area plan(BRI-S7) applies to:

- The area of land designated as East Baskerville Dispersive Soils Specific Area Plan on the overlay maps.
- In the area of land this plan applies to, the provisions of the specific area plan are in addition to the provisions of:
 - a) Rural Living Zone;
 - b) Agriculture Zone;
 - c) Landscape Conservation Zone; and
 - d) Environmental Management, as specified in the relevant provision.

Acceptable Solutions BRI-S7.7

Acceptable solutions are for developments

- works that do not involve the release of concentrated water or the disturbance soils; or
- additions or alterations to an existing building, or the construction of a non-habitable building, provided the development area is no more than 100m²; or
- forestry operations in accordance with a certified

Given the proposed development does not meet these acceptable solutions, the performance criteria (BRI-S7.7) must be addressed.

Findings

Soil Profiles

The geology of the site has been documented and described according to Australian Standard AS1726 for Geotechnical Site Investigations, which includes the Unified Soil Classification System (USCS). Soil layers, and where applicable, bedrock layers, are summarized in Table 2. Borehole locations are presented in Figure 1.

Table 2 Soil Summary Table

#	Layer	Details	USCS	BH01	BH02	BH03	BH04
1	Clayey GRAVEL	Clayey GRAVEL trace sand, trace silt, grey, mottled black, well sorted, medium to coarse grained sand; angular gravel	GC	0-0.1 0.1-0.3 DS@0.1			
2	Clayey Sandy SILT	Clayey Sandy SILT, dark greyish brown, well sorted, low plasticity, medium to coarse grained sand, trace roots, 5 % roots; sub-rounded gravel	ML		0-0.1 DS@0.0	0-0.1 DS@0.0	
3	CLAY	CLAY, greyish brown, mottled black, high plasticity, medium to coarse grained sand, with sand, trace charcoal, 5 % charcoal; angular gravel	CH				0-0.1 DS@0.0
4	Silty CLAY	Silty CLAY, light yellowish brown, medium plasticity, fine to medium grained sand, trace roots, 5 % roots	CI		0.1-0.5 DS@0.3		
5	CLAY	CLAY trace sand, yellowish brown, high plasticity, fine to medium grained sand	CH				0.1-0.3 DS@0.2
6	CLAY	CLAY, brownish yellow, high plasticity, fine grained sand	CH				0.3-0.5 DS@0.4
7	CLAY	CLAY trace gravel/sand, light olive brown, mottled olive yellow, high plasticity, medium to coarse grained sand; sub-rounded gravel	CH			0.4-0.8 DS@0.6	
8	CLAY	CLAY with gravel/sand, light yellowish brown, well sorted, high plasticity, medium to coarse grained sand; angular gravel	CH	0.3-0.6 DS@0.5		0.8-0.9 DS@0.8	
9	Gravelly CLAY	SANDSTONE Gravelly CLAY trace sand; angular gravel	CH	0.6-1 INF 1-1.4 DS@1.0	0.5-0.7 DS@0.6 0.7-1 INF REF		
10	CLAY	CLAY trace sand, light olive brown, high plasticity, medium to coarse grained sand	CH	1.4-1.6 DS@1.5		0.1-0.4 DS@0.3	
11	CLAY	CLAY trace sand, dark greyish brown, high plasticity, fine grained sand	CH	1.6-2.1 DS@2.0 REF			

Consistency¹ VS Very soft; S Soft; F Firm; St Stiff; Vst Very Stiff; H Hard. Consistency values are based on soil strengths AT THE TIME OF TESTING and is subject to variability based on field moisture condition

Density² VL Very loose; L Loose; MD Medium dense; D Dense; VD Very Dense

Rock Strength EL Extremely Low; VL Very Low; L Low; M Medium; H High; VH Very High; EH Extremely High

PL Point load test (lump)

DS Disturbed sample

PV Pocket vane shear test

FV Downhole field vane shear test

U50 Undisturbed 48mm diameter core sample collected for laboratory testing.

REF Borehole refusal

INF DCP has continued through this layer and the geology has been inferred.

¹ Soil consistencies are derived from a combination of field index, DCP and shear vane readings.

² Soil density descriptions presented in engineering logs are derived from the DCP testing.

Soil Exposure Classification

The soil has been tested for salinity impacts on footings in accordance with AS2870, as well as preliminary pH testing as a proxy to potential sulphate aggressivity.

- An A1 exposure classification is apparent at the Site.

Soil Dispersion (Emerson aggregate test) Findings

Select soil samples were tested for dispersion susceptibility using the Emerson Class number method according to AS1289.3.8.1. The results presented in Table 3 demonstrate that:

- Most of the soils at the Site are either only slightly dispersive (Emerson Class 3) or moderately dispersive (Emerson Class 2).
- A single soil layer (Layer 7) was analysed to be severely dispersive (Emerson Class 1) which was located near BH03 at 0.6m depth near the western boundary of the Site. Layer 7 ranges from 0.4 to 0.8 m depth (Table 3).
- Severely dispersive soil near S01 (cut near the entrance to the Site), S03 (cut along the western boundary of the Site), and S06 (filled area to the south - Table 4).

Table 3 Summary of the Emerson class results.

Layer	Soil	Depth	Sample ID	Emersion Class	Date Tested	Water	pH
1	Clayey GRAVEL trace sand, trace silt	0.1	BH01 0.1	Class 2	20/11/2025	DI 16°C	7.7
2	Clayey Sandy SILT	0	BH02 0.0	Class >4	20/11/2025	DI 16°C	6.2
2	Clayey Sandy SILT	0	BH03 0.0	Class 2	20/11/2025	DI 16°C	7.1
3	CLAY	0	BH04 0.0	Class 3	20/11/2025	DI 16°C	7.0
4	Silty CLAY	0.3	BH02 0.3	Class 3	20/11/2025	DI 16°C	6.7
5	CLAY trace sand	0.2	BH04 0.2	Class 2	20/11/2025	DI 16°C	7.1
6	CLAY	0.4	BH04 0.4	Class 2	20/11/2025	DI 16°C	7.4
7	CLAY trace gravel/sand	0.6	BH03 0.6	Class 1	20/11/2025	DI 16°C	6.4
8	CLAY with gravel/sand	0.5	BH01 0.5	Class 3	20/11/2025	DI 16°C	7.8
8	CLAY with gravel/sand	0.8	BH03 0.8	Class 2	20/11/2025	DI 16°C	6.7
9	SANDSTONE CLAY	1	BH01 1.0	Class 3	20/11/2025	DI 16°C	8.3
9	SANDSTONE CLAY	0.6	BH02 0.6	Class 3	20/11/2025	DI 16°C	6.8
9	SANDSTONE CLAY	0.9	BH02 0.9	Class 3	20/11/2025	DI 16°C	6.4
10	CLAY trace sand	1.5	BH01 1.5	Class 2	20/11/2025	DI 16°C	6.9
10	CLAY trace sand	0.3	BH03 0.3	Class 3	20/11/2025	DI 16°C	6.7
11	CLAY trace sand	2	BH01 2.0	Class 3	20/11/2025	DI 16°C	6.6

Table 4 Summary of the Emerson class results (grab samples from cut and fill areas)

Soil	Depth	Sample ID	Emersion Class	Date Tested	Water	pH
Silty CLAY with sand, trace gravel	0.4	S01 0.7	Class 1	20/11/2025	DI 16°C	7.6
Silty Gravelly CLAY with sand	0.7	S02 0.7	Class 3	20/11/2025	DI 16°C	7.5
CLAY trace gravel/sand	1.0	S03 0.7	Class 1	20/11/2025	DI 16°C	7.5
CLAY trace sand/gravel	0.6	S04 0.7	Class 2	20/11/2025	DI 16°C	8.7
CLAY with sand	1.5	S05 0.7	Class 3	20/11/2025	DI 16°C	6.6
Silty CLAY with sand/gravel	FILL	S06 0.7	Class 1	20/11/2025	DI 16°C	6.8

Dispersive Soil Management Overview

- Tunnel erosion is not apparent on the Site but there is evidence of riling of dispersive soils.
- Most of the soil at the Site is not classified as being severely dispersive.
- There are discrete soil layers which are severely dispersive which include soil layers which:
 - Are present between rock bedding
 - Are present below a topsoil nondispersive “capping” layer (all cut areas)
 - Comprise fill material
- It is important to manage cut and fill areas of the Site where drainage is naturally occurring, presenting risk of tunnel development.
- Not all areas need treatment if overland flow is not channelising and posing a risk of tunnel development
- Where water is channelising over cut and fill, it is important that severely dispersive soils are stabilised within the cut batter.
- Measures (applying gypsum and/or topsoil) are generally recommended for cut and fill areas of the Site where water is not concentrating

For further guidance, general recommendations are presented in Appendix G.

Recommendations

Site Drainage – Foundation Protection

Surface drainage shall be considered in the design of the footing system, and necessary modifications shall be included in the design documentation. The surface drainage of the site shall be controlled from the beginning of the preparation and construction of the site. The drainage system shall be completed after the completion of the building construction.

Ideally, the areas around the footprint of the building should be graded or drained so that the water cannot pond against or near the building. As soon as footing construction has been completed, the ground immediately adjacent to the building should be graded to a uniform fall of 50mm minimum away from the building over the first metre. The final provision of paving to the edge of the building can greatly limit soil moisture variations due to seasonal wetting and drying.

Filled Pad Preparation

Given the Site conditions, it is now considered that gypsum alone will likely be sufficient for stabilising the surface of the filled areas, and it should be applied uniformly across both the fill surfaces and the fill batters (Figure 3). The application of a gypsum treatment will help reduce soil dispersion, limit the initiation of tunnel erosion, and improve cohesion within the upper soil profile. Provided the gypsum is applied at an appropriate rate and lightly incorporated into the surface, this treatment is expected to offer adequate erosion control for the freshly prepared fill without the need for an additional high-clay gravel layer. Consistent application across all exposed fill batters remains important, as untreated dispersive soils present a high risk of tunnel development during periods of concentrated surface runoff.

Soil Batter Long-term erosion management

It is recommended that all soil batters be stabilised using gypsum applied at a rate of 0.5 kg/m², followed by placement of a mulch–topsoil blend to protect the surface and promote vegetation establishment. Given that all batters on the Site are relatively steep, jute matting is required across all exposed soil faces to provide immediate erosion control and to bind the surface while vegetation

develops. Following installation of the jute matting, the surface may be drill-seeded, broadcast-seeded, hydroseeded, or treated with an approved soil binder to achieve long-term stabilisation.

Cut & Filled Batter Drainage Chute

To manage overland flow across dispersive cut and fill batters, targeted interception works are required in the areas where tunnel erosion is most likely to initiate. A 45-degree wedge is to be excavated into the crest of the batter, with both sidewalls formed at matching 45-degree inclinations to create a controlled funnel-shaped cut. This excavation is to be progressively extended downslope along the same geometry until the bedrock surface is intercepted. The cut should terminate on the natural bedrock surface, rather than penetrating it, to provide a competent base for treatment. Once exposed, a 1-metre bench is to be formed on the bedrock to stabilise the treatment zone and provide a platform for rock placement. A geotextile (geofabric) blanket is then to be placed continuously over the prepared bedrock surface and the internal faces of the wedge excavation. The entire wedge is to be backfilled with engineered rock spalls to form a stable, non-erodible drainage path. This treatment prevents concentrated overland flow from entering dispersive soils and mitigates the development of tunnels within batter faces.

These works are to be conducted at BH02 and BH03 locations. An excavator with a long reach will be appropriate to instate the drainage stabilization works.

Management of Surface Water Flow Over Exposed Bedrock

Where bedrock is exposed along the downslope edge of the Site before transitioning into soil or fill, it is important to intercept and control surface water before it enters dispersive soil areas. A cut-off swale drain should be excavated directly along the bedrock surface, allowing all overland flow to move predictably toward a natural low point in the landscape. Once this swale has been established, an agricultural (ag) drain may be installed within the alignment and backfilled with aggregate, creating a stable, contiguous drainage surface and enhancing the capacity to safely collect and convey water. At the termination point of the exposed bedrock, a grated pit should be installed to capture the concentrated flow and direct it into a solid 100-mm stormwater pipe, enabling water to be transmitted away from the dispersive soil batters.

Diversion of Water Across the Fill Surface

Because the fill surface is relatively large, it is not appropriate to apply an impervious cover, as this would concentrate runoff and greatly increase the risk of tunnel initiation at the outflow point. Instead, initial infiltration into the freshly prepared fill surface is considered beneficial, particularly where gypsum has been applied to reduce dispersion and improve soil structure. In areas where overland flow is expected to travel across the fill surface, it is essential to divert water away from the filled batters and toward constructed swale drains. These drains should be over-excavated, treated with gypsum, and stabilised using a suitable liner—such as compacted non-dispersive soil, plastic membrane, or both—before being backfilled with geofabric, agricultural (agg) pipes, and drainage rock up to the surface level. Gypsum may need to be reapplied around the margins of the swale drain to further minimise dispersion and prevent surface erosion. Geofabric must be installed to protect the lining system and maintain separation between materials, ensuring water is conveyed safely without inducing erosion or tunnelling within the filled batters.

Filled Batter Drainage Chute

The swale drain may also intersect or ramp down the filled batter, provided it is a continuation of the plastic liner (ensuring top side of liner overlap is downgradient) and geofabric is used in combination with a layer of fine crushed rock (FCR) beneath the rock mattress to prevent liner damage. Ideally, the chute should terminate in a plastic, concrete or non-dispersive pit with a servicing 100mm pipe to collect water flow to be transmitted to the swale drain stormwater distribution area.

Redistribution of Water to Lower-Site Swale Drains

All water collected from bedrock cut-off drains and fill-surface diversion drains must ultimately be conveyed to a stable discharge point in a lower part of the Site where it can be redistributed in a non-erosive manner. The receiving drainage network should consist of engineered contour-aligned swale drains designed to spread flows evenly across the landscape rather than concentrate them. These swales will dissipate flow energy and reduce the likelihood of tunnel erosion developing within dispersive soils downgradient of the filled area. By distributing water uniformly along a broad swale, the system ensures that runoff is managed safely, reducing the hydraulic load on any single point and preventing the formation of preferential erosion paths.



Kris Taylor, BSc (hons)

Environmental & Engineering Geologist

Appendix A Mapping



Figure 1 Site Borehole Locations



Figure 2 Photos Locations

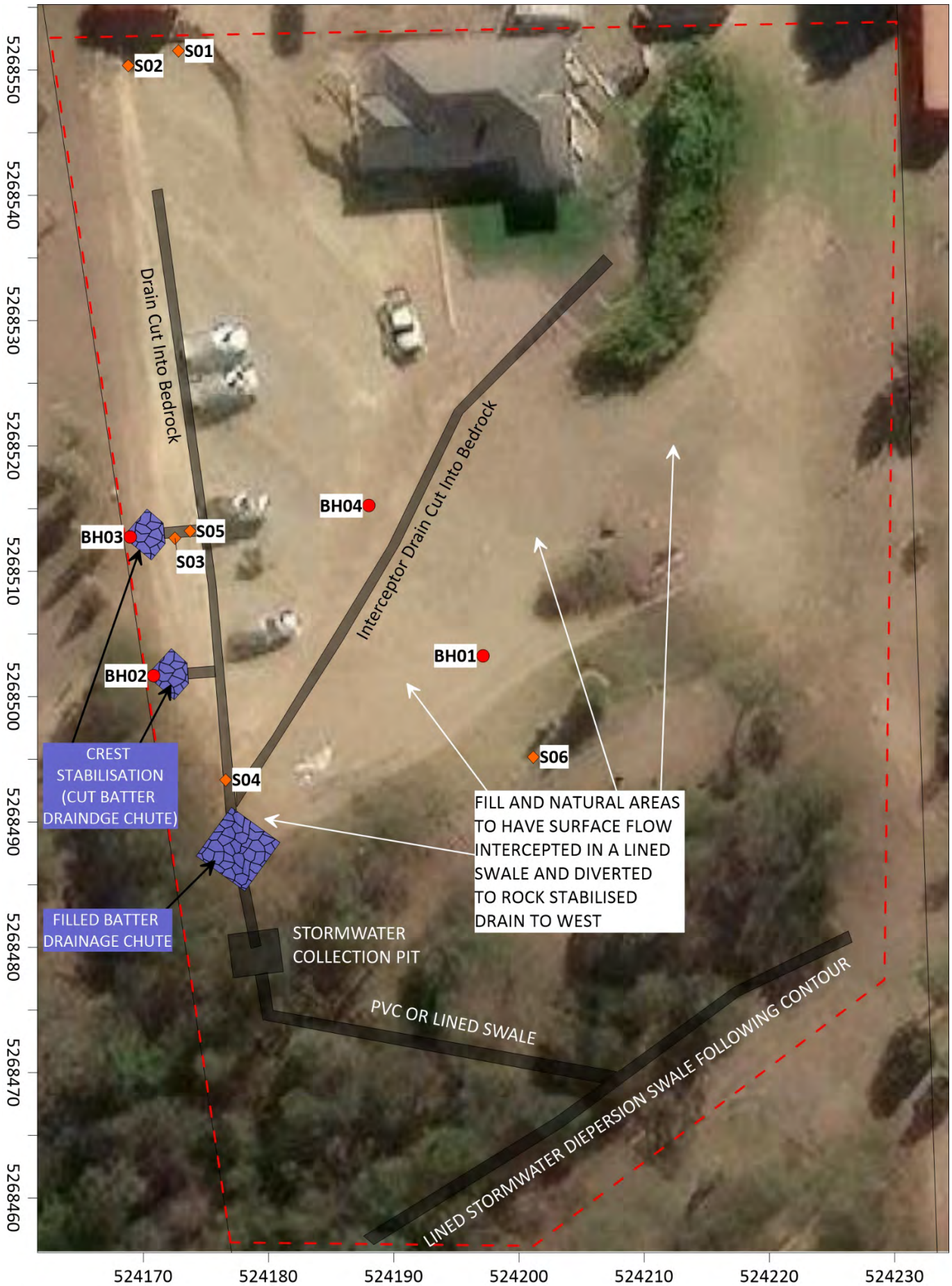
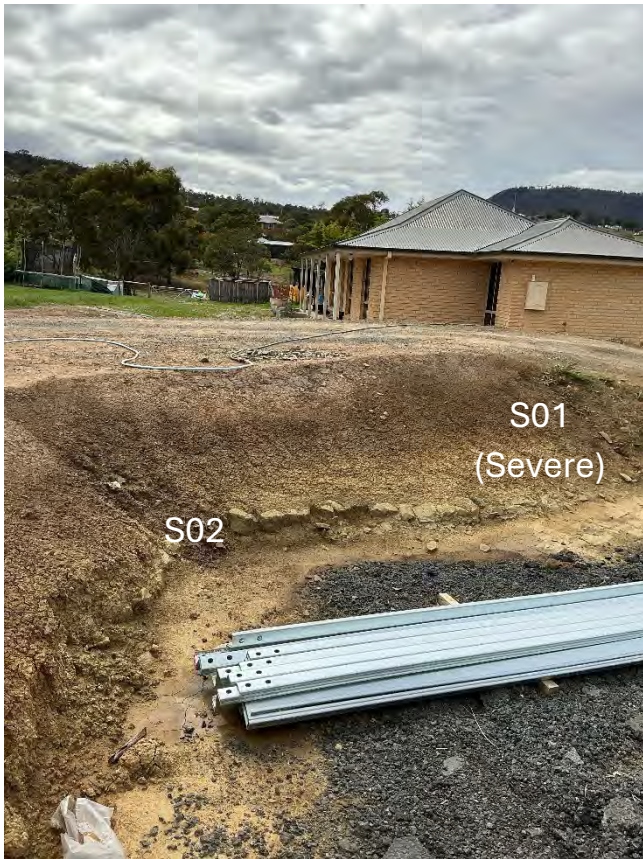


Figure 3 Dispersive Soil Management Plan

Appendix B Site photos

P#01 S01 & S02 locations



P#02



P#03



P#04



P#05



P#06



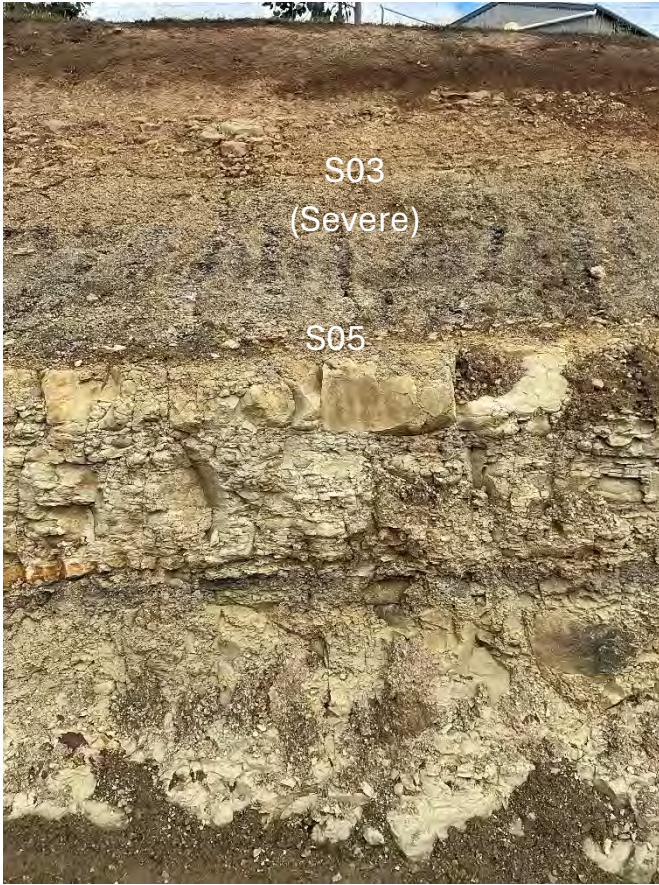
P#07



P#08



P#09 S03 & S04 locations



P#10 S03 & S04 locations



P#11



P#12



P#13



P#14



P#15



P#16



P#17



P#18



P#19



P#20



P#21



P#22



P#23



P#24



P#25



P#26



P#27



P#28



P#29



P#30



P#31



P#32



P#33



P#34




P#35



P#36



Appendix C Borehole Logs

		ASSESSMENT: Foundation Classification STRUCTURE: Outbuildings EAST GDA94: 524197.1 VERT & HORIZ NORTH GDA94: 5268503.3 ACCURACY: 0.12m				HOLE ID NO.: BH01 DATE TESTED: 6/11/2025 LOGGED BY: B. Addison ELEVATION: 78.00							
LOCATION: 44 Braeview Drive - Old Beach CLIENT: Tassie homes					EQUIPMENT: 50mm Christie Post Driver NATURAL SURFACE (RL):								
DEPTH (m)	GRAPHIC	DESCRIPTION	ELEVATION m/AHD	LAYER	DENSITY CONSISTENCY STRENGTH	MOISTURE INDEX %	SAMPLES	TEST	Cu (kPa)	UCS (kg/cm ²)	BLOW COUNT	blows/100mm	
0.0	GC	Clayey GRAVEL trace sand, trace silt, grey, mottled black, well sorted, medium to coarse grained sand	77.9	1		Moist	14	DS					
	GC		77.7	1		Moist							
0.5	CH	CLAY with gravel/sand, light yellowish brown, well sorted, high plasticity, medium to coarse grained sand	77.5	8		Moist	14	DS					
	CH	INFERRED SANDSTONE Gravelly CLAY trace sand	77.3	9		Slightly Moist							
1.0	CH	SANDSTONE Gravelly CLAY trace sand	76.9	9		Slightly Moist	9	DS					
	CH	CLAY trace sand, light olive brown, high plasticity, medium to coarse grained sand	76.7	10		Wet							
1.5	CH	CLAY trace sand, dark greyish brown, high plasticity, fine grained sand	76.5	11		Wet	21	DS					
	CH		76.3	11		Wet							
2.0			76.1				23	DS					
			75.9										
Borehole Ended At Target Depth End of borehole at 2.1m depth.													

GROUNDWATER: Encountered at 1.4 m Below Ground Surface

PAGE 1 of 1

TESTING:

Where blows per 100mm are less than 1, distance travelled per penetrometer blow is measured and converted to blows per 100mm

DS - Disturbed Sample; U50 - Undisturbed 50mm Core; FV - Field Vane (Ømm); PF - Pocket Penetrometer; CBR - California Bearing Ratio; PV - Pocket Vane



ASSESSMENT: Foundation Classification
 STRUCTURE: Outbuildings
 EAST GDA94: 524170.8 VERT & HORIZ
 NORTH GDA94: 5268501.7 ACCURACY: 0.13m

HOLE ID NO.: BH02
 DATE TESTED: 6/11/2025
 LOGGED BY: B. Addison
 ELEVATION: 81.00

LOCATION: 44 Braeview Drive - Old Beach
 CLIENT: Tassie homes

EQUIPMENT: 50mm Christie Post Driver
 NATURAL SURFACE (RL):

DEPTH (m)	GRAPHIC	DESCRIPTION	ELEVATION m AHD	LAYER	DENSITY CONSISTENCY STRENGTH	MOISTURE		SAMPLES	TEST	Cu (kPa)	UCS (kg/cm ²)	BLOW COUNT	blows/100mm					
						INDEX	%						0	5	10	15	20	
0.0	ML	Clayey Sandy SILT, dark greyish brown, well sorted, low plasticity, medium to coarse grained sand, trace roots, 5 % roots	80.8	2		Moist	13	DS										
	CI	Silty CLAY, light yellowish brown, medium plasticity, fine to medium grained sand, trace roots, 5 % roots	80.6	4		Moist	14	DS										
0.5	CH	SANDSTONE Gravelly CLAY trace sand	80.4	9		Slightly Moist	9	DS										
	CH	INFERRED SANDSTONE Gravelly CLAY trace sand	80.2	9														
1.0		Refusal in SANDSTONE CLAY End of borehole at 1m depth	80.0															

GROUNDWATER: Not Encountered

PAGE 1 of 1

TESTING:

Where blows per 100mm are less than 1, distance travelled per penetrometer blow is measured and converted to blows per 100mm

DS - Disturbed Sample; U50 - Undisturbed 50mm Core; FV - Field Vane (Ømm); PF - Pocket Penetrometer; CBR - California Bearing Ratio; PV - Pocket Vane



ASSESSMENT: Foundation Classification
 STRUCTURE: Outbuildings
 EAST GDA94: 524168.9 VERT & HORIZ
 NORTH GDA94: 5268512.7 ACCURACY: 0.13m

HOLE ID NO.: BH03
 DATE TESTED: 6/11/2025
 LOGGED BY: B. Addison
 ELEVATION: 81.00

LOCATION: 44 Braeview Drive - Old Beach
 CLIENT: Tassie homes

EQUIPMENT: 50mm Christie Post Driver
 NATURAL SURFACE (RL):

DEPTH (m)	GRAPHIC	DESCRIPTION	ELEVATION m/AHD	LAYER	DENSITY CONSISTENCY STRENGTH	MOISTURE		SAMPLES	TEST	Cu (kPa)	UCS (kg/cm ²)	BLOW COUNT	blows/100mm					
						INDEX	%						0	5	10	15	20	
0.0	ML	Clayey Sandy SILT, dark greyish brown, well sorted, low plasticity, medium to coarse grained sand, trace roots, 5 % roots	80.9	2		Moist	13	DS										
	CH	CLAY trace sand, light olive brown, high plasticity, medium to coarse grained sand	80.7	10		Wet	25	DS										
0.5	CH	CLAY trace gravel/sand, light olive brown, mottled olive yellow, high plasticity, medium to coarse grained sand	80.5	7		Moist	11	DS										
	CH	CLAY with gravel/sand, light yellowish brown, well sorted, high plasticity, medium to coarse grained sand	80.3	8		Slightly Moist	8	DS										
		Refusal in , light yellowish brown CLAY with gravel/sand End of borehole at 0.9m depth.	80.1															

GROUNDWATER: Encountered at 0.1 m Below Ground Surface

PAGE 1 of 1

TESTING:

Where blows per 100mm are less than 1, distance travelled per penetrometer blow is measured and converted to blows per 100mm

DS - Disturbed Sample; U50 - Undisturbed 50mm Core; FV - Field Vane (Ømm); PP - Pocket Penetrometer; CBR - California Bearing Ratio; PV - Pocket Vane



ASSESSMENT: Foundation Classification
 STRUCTURE: Outbuildings
 EAST GDA94: 524188 VERT & HORIZ
 NORTH GDA94: 5268515.2 ACCURACY: 0.12m

HOLE ID NO.: BH04
 DATE TESTED: 6/11/2025
 LOGGED BY: B. Addison
 ELEVATION: 78.00

LOCATION: 44 Braeview Drive - Old Beach
 CLIENT: Tassie homes

EQUIPMENT: 50mm Christie Post Driver
 NATURAL SURFACE (RL):

DEPTH (m)	GRAPHIC	DESCRIPTION	ELEVATION m AHD	LAYER	DENSITY CONSISTENCY STRENGTH	MOISTURE		SAMPLES	TEST	Cu (kPa)	UCS (kg/cm ²)	BLOW COUNT	blows/100mm					
						INDEX	%						0	5	10	15	20	
0.0	CH	CLAY, greyish brown, mottled black, high plasticity, medium to coarse grained sand, with sand, trace charcoal, 5 % charcoal	77.9	3		Wet	20	DS										
	CH	CLAY trace sand, yellowish brown, high plasticity, fine to medium grained sand	77.7	5		Wet	24	DS										
	CH	CLAY, brownish yellow, high plasticity, fine grained sand	77.5	6		Moist	18	DS										
0.5		Refusal in , brownish yellow CLAY End of borehole at 0.5m depth.																

GROUNDWATER: Not Encountered

PAGE 1 of 1

TESTING:

Where blows per 100mm are less than 1, distance travelled per penetrometer blow is measured and converted to blows per 100mm

DS - Disturbed Sample; U50 - Undisturbed 50mm Core; FV - Field Vane (Ømm); PP - Pocket Penetrometer; CBR - California Bearing Ratio; PV - Pocket Vane

Appendix D Core Photographs

BH01



BH02



BH03



* 1 metre core tray length

BH04



*** 1 metre core tray length**

Appendix E Explanatory Notes



USCS Soil Classification Methodology

Soil classification was undertaken in accordance with the Unified Soil Classification System (USCS) and AS 1726 – Geotechnical Site Investigations, using a combination of particle size distribution and plasticity assessment. This process was applied consistently to all soil layers encountered.

1. Particle Size Distribution (Wet Sieve Analysis)

Particle size analysis was performed by wet sieving in accordance with Australian Standard sieve sizes:

- Gravel fraction: >2.36 mm
- Sand fraction: 0.075 mm to 2.36 mm
- Fines fraction (silt + clay): <0.075 mm

Samples were soaked (often overnight) to fully disperse fines prior to sieving. Wet sieving is particularly effective for Tasmanian soils, which are often dispersive, ensuring accurate quantification of the fines fraction. The oversize fraction (>63 mm) was excluded from the mass percentages before classification.

2. Plasticity Assessment

Plasticity of the fines fraction was determined using:

- Laboratory Atterberg limits, where available, with liquid limit (WL) and plasticity index (PI) plotted on the Plasticity Chart (AS 1726) to determine the fines classification (silt vs clay) and plasticity level (low, medium, high).
- Field index tests (where Atterberg limits were not available), following Table 1 & Table 2:
 - Dry strength – resistance of dried soil to crushing.
 - Dilatancy – reaction of a moist soil pat to shaking.
 - Toughness – resistance of a soil thread near the plastic limit.

Table 1 Field Assessment of Fine-Grained Soils (adapted from AS 1726 Table 7)

Dry Strength		Dilatancy (reaction to shaking)		Toughness (consistency near plastic limit)	
None	The dry specimen crumbles into powder with mere pressure of handling.	None	No visible reaction or change in the specimen.	Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Low	The dry specimen crumbles into powder with some finger pressure.	Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear during squeezing.		Medium
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.			Rapid	
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.				
Very High	The dry specimen cannot be broken between the thumb and a hard surface.				

Table 2 Identification of Fine-Grained Soils by Visual–Tactile Methods (adapted from AS 1726 Table 8)

Soil description	Identification of inorganic fine-grained soils		
	Dry Strength	Dilatancy	Toughness and Plasticity
SILT	None to low	Slow to rapid	Low or thread cannot be formed
Clayey SILT — Clay/silt mixtures of low plasticity	Low to medium	None to slow	Low to medium
Silty CLAY — Silt/clay mixtures of medium plasticity	Medium to high	None to slow	Medium
High plasticity CLAY	High to very high	None	High

3. Classification Hierarchy

3.1 Fine- vs Coarse-Grained determination

- Fine-grained soils: More than 35% (by mass) passes the 0.075 mm sieve → classify using Table 3
- Coarse-grained soils: More than 65% (by mass) is retained on the 0.075 mm sieve → classify using Table 4.

3.2 Coarse-grained soils (Table 4):

1. Determine Gravel vs Sand:

- Gravel (G*) – more than 50% of the coarse fraction is retained on the 2.36 mm sieve.
- Sand (S*) – less than 50% of the coarse fraction is retained on the 2.36 mm sieve.

2. Assign fines modifiers:

- ≤5% fines: “Clean” gravels/sands (GW, GP, SW, SP).
- 5–12% fines: Dual classification (e.g., SP-SM, GW-GM).
- ≥12% fines: Silty or clayey modifiers (GM, GC, SM, SC) based on fines plasticity from Atterberg limits or field index tests.

3.3 Fines classification for coarse-grained soils

When coarse-grained soils contain ≥12% fines, the fines fraction is classified as silty or clayey based on:

- Atterberg limits where available; or
- Field index tests (Table 1 & Table 2) where Atterberg limits are not available.

3.4 Fine-grained soils (Table 3)

Fine-grained soils are those with >35% (by mass) passing the 0.075 mm sieve.

- With Atterberg limits available: WL and PI are plotted on the Plasticity Chart (AS 1726) to determine plasticity level (low, medium, or high) and USCS classification (ML, CL/CI/CH, MH, OL, OH).
- Where Atterberg limits are not available: The fines are classified directly in accordance with Table 3 by comparing field index test results (dry strength, dilatancy, toughness) to the criteria given for each USCS group. This allows direct assignment of ML, CL/CI/CH, MH, or OL/OH without reference to the A-line.

Organic soils (OL, OH) are identified based on colour, odour, and fibrous texture in addition to field index characteristics.

4. Integration of Results

The final USCS group symbol for each layer was determined by integrating:

- The proportion of gravel, sand, and fines from wet sieve analysis.
- The classification of the fines fraction using either Atterberg limits or field index methods.
- The classification hierarchy in Table 3 & Table 4.

This combined approach ensures that soil classification is both quantitatively accurate and fully compliant with AS 1726, while allowing consistent classification whether laboratory Atterberg limit testing is available.

Table 3 Classification of Fine-Grained Soils (adapted from AS 1726 Table 10)

Major Division	Group Symbol	Typical names	Field classification of silt and clay			Laboratory classification
			Dry strength	Dilatancy	Toughness	% <0.075
SILT and CLAY (low to medium plasticity, %)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
	CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
	OL	Organic silt	Low to medium	Slow	Low	Below A line
SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
	CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
	OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
Highly organic soil	Pt	Peat, highly organic soil	—	—	—	—

Table 4 Classification of Coarse-Grained Soils (adapted from AS 1726 Table 9)

Major Division	Group Symbol	Typical names	Field classification of sand and gravel	Laboratory classification
GRAVEL (more than half of coarse fraction is larger than 2.36 mm)	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤5% fines, $C_u > 4$, $1 < C_c < 3$
	GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤5% fines, fails to comply with above
	GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥12% fines, fines are silty

Major Division	Group Symbol	Typical names	Field classification of sand and gravel	Laboratory classification
	GC	Gravel–clay mixtures and gravel–sand–clay mixtures	‘Dirty’ materials with excess plastic fines, medium to high dry strength	≥12% fines, fines behave as clay
SAND (more than half of coarse fraction is smaller than 2.36 mm)	SW	Sand and gravel–sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤5% fines, $C_u > 6$, $1 < C_c < 3$
	SP	Sand and gravel–sand mixtures, little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤5% fines, fails to comply with above
	SM	Sand–silt mixtures	‘Dirty’ materials with excess of non-plastic fines, zero to medium dry strength	≥12% fines, fines are silty
	SC	Sand–clay mixtures	‘Dirty’ materials with excess plastic fines, medium to high dry strength	≥12% fines, fines are clayey

Standard Methodology for Determination of Soil Reactivity and Index of Shrink–Swell (Ips) for SIFE Investigations

1. Introduction

This methodology outlines the procedures adopted by Enviro-Tech Consultants Pty. Ltd. for determining soil reactivity and deriving the Index of Shrink–Swell (Ips) for each soil layer in accordance with the principles of AS 2870. The method combines Australian Standard testing procedures with enhanced correlation techniques developed from an extensive dataset of over 2,000 field and laboratory tests.

The approach ensures consistent, accurate classification of soil reactivity across a wide range of soil types. By combining standard and modified testing procedures, it enables calculation of profile movement for complex soil profiles, accounting for groundwater levels, bedrock depth, and particle size distribution.

2. Sampling and Preparation

2.1 Undisturbed Sampling

Undisturbed samples are collected using a thin-wall sampler to preserve natural soil structure and in-situ moisture conditions when performing shrink–swell testing. A 45 mm diameter core sampler is used for these tests to ensure uniformity and comparability between results. Most other laboratory testing is carried out on disturbed samples, which is one of the advantages of the linear shrinkage and modified linear shrinkage testing methods.

2.2 Sample Identification

All samples are assigned a Unified Soil Classification System (USCS) code using accurate laboratory and field identification techniques in accordance with AS 1726 (detailed procedure included herein). This classification underpins the correlation methods described in later sections.

2.3 Moisture Content Measurement

Field moisture content is recorded at the time of sampling, providing baseline data for correlation to laboratory shrink–swell results.

3. Standard Testing Procedures

3.1 Shrink–Swell Testing

Shrink–swell testing is performed on cohesive soils in accordance with the relevant Australian Standard method for determining the shrink–swell index. This test provides the primary Ips value for these soil types.

3.2 Linear Shrinkage Testing

Linear shrinkage testing is carried out in accordance with the Australian Standard method, which determines shrinkage from a soil prepared at its liquid limit. This standard approach typically excludes a proportion of the sandy fraction.

4. Secondary Modified Linear Shrinkage Method

4.1 Rationale

In practice, the relationship between shrink–swell test results and standard linear shrinkage results is often inconsistent, particularly for non-cohesive or marginally cohesive soils. To improve correlation, a secondary modified linear shrinkage method has been developed.

4.2 Modified Moisture Basis

Instead of preparing samples solely at the liquid limit, this method uses a “modified moisture” content representative of upper-range field moisture conditions for each USCS soil type. These values are derived from a dataset of over 2,000 samples collected predominantly during winter or immediately thereafter, representing the highest seasonal moisture levels without crossing into “abnormal moisture conditions” as defined in AS 2870.

4.3 Application to Non-Cohesive Soils

This approach enables reactivity assessment of sandy and silty soils that are unsuitable for shrink–swell testing due to their inability to remain intact during testing, but which still display measurable reactivity.

5. Gravel and Cobble Fraction Adjustments

5.1 Gravel Fraction

For all materials, the sand fraction is retained in testing, and the gravel fraction is re-added into the calculation. Because gravel has negligible moisture absorption, its proportion is used to adjust shrinkage values downwards.

5.2 Cobbles

Where cobbles are present:

- 0–35% cobbles: shrinkage is scaled according to the proportion of soil matrix between cobbles.
- 35% cobbles: shrinkage is considered negligible, as the soil matrix is insufficient to impart meaningful reactivity.

6. Correlation and Calibration

6.1 Dataset Development

Extensive correlation has been undertaken between:

- Standard shrink–swell results
- Standard linear shrinkage results
- Modified linear shrinkage results

6.2 USCS-Based Correlation

Accurate USCS classification is the key input variable. Once correlations are established for each USCS class, I_{ps} values can be assigned to future samples based solely on classification and moisture parameters, without requiring repeated shrink–swell testing.

7. Predictive Modelling and Database Search Method

Enviro-Tech Consultants maintains a large and continuously expanding database of soil test results, including shrink–swell, linear shrinkage, particle size distribution, USCS classification, and detailed field descriptions (e.g., colour, texture, structure).

When assessing a new Site, we search this database for comparable sites using multiple parameters:

- Geology – parent material type and origin
- USCS classification – precise laboratory classification

- Soil colour and descriptive features – matching field logging records
- Particle size distribution – percentage gravel, sand, and fines

This multi-parameter search allows us to identify highly similar soils and adopt Ips values from past testing at those sites with confidence. The approach reduces the need for repeated shrinkage or shrink–swell testing where soils are well represented in the database, while still meeting the requirements for reliable reactivity estimation.

8. Compliance with AS 2870 – Clause 2.3.2 (C2 & C3)

Our predictive approach aligns directly with the requirements of AS 2870 Clause 2.3.2:

c (ii): We maintain and utilise a database of past test results to estimate soil reactivity for sites with similar soil and geological conditions.

C (iii): Testing is repeated at regular intervals to ensure correlations remain valid. At minimum, reactivity testing is conducted once every 50 sites, but in practice we test far more frequently – typically at least once every 20 sites, and rarely more than six months between tests. On average, new verification testing is undertaken approximately monthly.

This compliance ensures that our methods are both technically robust and standards-compliant, providing clients with defensible, high-quality results.

9. Calculation of Profile Movement

9.1 Ips Values per Layer

An Ips value is determined for each soil layer based on test results or correlations.

9.2 Adjustment for Groundwater and Bedrock

Where groundwater or bedrock occurs within the profile, Ips values are reduced for the affected layers in accordance with AS 2870 principles.

9.3 Design Suction Change Depth (Hs)

Given the lack of statewide, high-resolution climatic data for Tasmania, a conservative Hs value of 3.0 m is adopted for all sites, in preference to regionalised values. This ensures a cautious approach where actual depth of suction change cannot be accurately modelled.

9.4 Surface Suction Change (Δu_s)

A standard surface suction change of 1.2 is applied in calculations, in line with AS 2870.

10. Advantages of the Modified Method

- Allows for reactivity assessment across all soil types, including non-cohesive sands and silts.
- Provides consistent correlation between laboratory and field methods.
- Enables accurate whole-profile movement estimation based on standardised USCS classification.
- Incorporates gravel and cobble fraction corrections for more realistic movement predictions.
- Reduces reliance on repeat laboratory shrink–swell testing for every sample.
- Fully compliant with AS 2870 Clause 2.3.2 (C2 & C3).

11. Limitations

- The method assumes accurate USCS classification and field moisture determination.
- The modified linear shrinkage method requires prior calibration for each USCS type.
- Adoption of a conservative Hs value may slightly overestimate movement in some locations.

12. Conclusion

This methodology blends rigorous Australian Standard test procedures with enhanced, data-driven correlation techniques, enabling Enviro-Tech Consultants Pty. Ltd. to deliver accurate, consistent, and site-specific soil reactivity assessments across Tasmania. The inclusion of >2,000 test results, gravel and cobble adjustments, predictive modelling from a comprehensive database, and modified moisture testing provides a robust basis for predicting profile movement in varied geological conditions, while maintaining strict compliance with AS 2870.

Appendix F Soil and Rock Testing

Soil Characterisation

Table 5 summarises the soil classification results for each layer encountered, including particle size distribution, plasticity assessment, and the assigned USCS group symbol.

Classifications were undertaken in accordance with AS 1726 – Geotechnical Site Investigations using the methodology provided in the Explanatory Notes section of this report.

Particle size distributions were determined by wet sieve analysis, and fines classifications were based on Atterberg limits where available, or on field index tests (dry strength, dilatancy, toughness) in accordance with AS 1726 Tables 7, 8, 9, and 10.

Full explanatory notes and reference tables are provided in Explanatory Notes section of this report.

Table 5 Summary of the Soil Characterisation

Layer	Soil	Borehole	Depth From (m)	Field Moisture %	Gravel %	Sand %	Fine %	Analysed Plasticity	Assigned USCS
1	Clayey GRAVEL	BH01	0.1	13.7	64.8	3.9	31.3	H	GC
2	Clayey Sandy SILT	BH02	0.0	13.3	7.8	37.6	54.6	L	ML
2	Clayey Sandy SILT	BH03	0.0	12.5	0.5	28.4	71.1	L	ML
3	CLAY	BH04	0.0	20.2	15.9	17.9	66.2	H	CH
4	Silty CLAY	BH02	0.3	13.9	0	5.7	94.3	M	CI
5	CLAY	BH04	0.2	24	0	2.5	97.5	H	CH
6	CLAY	BH04	0.4	17.9	0	1.8	98.2	H	CH
7	CLAY	BH03	0.6	10.7	10.8	10.1	79.1	H	CH
8	CLAY	BH01	0.5	14.2	33.8	19.2	47	H	CH
8	CLAY	BH03	0.8	7.6	31.3	20.5	48.2	M	CH
9	Gravelly CLAY	BH01	1.0	9.4	57.6	5.2	37.2	H	CH
9	Gravelly CLAY	BH02	0.6	9.2	56.7	7.6	35.7	M	CH
9	Gravelly CLAY	BH02	0.9	6.2	50.8	9.5	39.7	M	CH
10	CLAY	BH01	1.5	21.4	0.8	8.3	90.9	H	CH
10	CLAY	BH03	0.3	25.4	0	13.2	86.8	H	CH
11	CLAY	BH01	2.0	22.7	0	3.4	96.6	H	CH

Soil Aggressivity Testing (Footing Exposure Classification)

Soil samples from across the Site were assessed for potential aggressivity to concrete in accordance with the requirements of AS 2870:2011 – Residential Slabs and Footings (Clauses 5.5.1–5.5.3). Testing was undertaken to determine the salinity exposure class and provide an indicative assessment of sulphate soil potential.

The results are summarised in Table 6 which presents the sampling depth and location, soil texture classification, electrical conductivity (EC1:5), salinity factor (K), calculated saturated extract electrical conductivity (ECe), and the corresponding salinity exposure class (Table 5.1, AS 2870). Soil pH values were also measured and used as a conservative indicator of potential sulphate aggressivity, together with the assigned soil condition class, to derive an indicative sulphate exposure class (Table 5.2, AS 2870).

It is noted that the sulphate assessment has been undertaken on the basis of pH values only, and therefore represents a conservative assumption. Where soils exhibit pH < 5.5 or are otherwise classified within B or C exposure classes, confirmatory laboratory testing of sulphate concentrations may be warranted to refine the exposure classification and confirm appropriate concrete durability requirements.

Salinity testing has been undertaken in accordance with the relevant guidelines and provides a direct basis for assigning salinity exposure classification.

Where aggressive soils are discerned, detailed recommendations for the management of aggressive soils, including concrete strength, curing and reinforcement cover requirements, are presented in Table 6.

Table 6 Soil Aggressivity Assessment in Accordance with AS 2870:2011

Layer	Location	Depth From (m)	Saline Soil Determination				Sulphate Soil Potential [^]			
			USDA Soil Texture Class	EC1:5 mS/cm	K*	ECe dS/m	Exposure Class	pH1: 5	Soil Condition Class	Exposure Class
1	BH01	0.1	Clay	0.33	5.5	1.82	A1	7.7	B	A1
3	BH04	0.0	Clay	0.11	5.5	0.61	A1	7.0	B	A1
4	BH02	0.3	Silty clay	0.05	5.8	0.29	A1	6.7	B	A1
5	BH04	0.2	Clay	0.09	5.5	0.50	A1	7.1	B	A1
6	BH04	0.4	Clay	0.13	5.5	0.72	A1	7.4	B	A1
7	BH03	0.6	Clay	0.13	5.5	0.72	A1	6.4	B	A1
8	BH01	0.5	Clay	0.25	5.5	1.38	A1	7.8	B	A1
8	BH03	0.8	Clay	0.15	5.5	0.83	A1	6.7	B	A1
9	BH01	1.0	Clay	0.23	5.5	1.27	A1	8.3	B	A1
9	BH02	0.6	Clay	0.06	5.5	0.33	A1	6.8	B	A1
9	BH02	0.9	Clay	0.17	5.5	0.94	A1	6.4	B	A1
10	BH01	1.5	Clay	0.2	5.5	1.10	A1	6.9	B	A1
10	BH03	0.3	Clay	0.09	5.5	0.50	A1	6.7	B	A1
11	BH01	2.0	Clay	0.08	5.5	0.44	A1	6.6	B	A1

[^] Preliminary findings based on soil pH only. Further sulphate testing required to rule out sulphate soil exposure risks

*Electrical conductivity of the 1:5 soil–water extract (EC1:5) was measured at 25 °C and converted to an equivalent saturated paste extract (ECe) using texture-based conversion factors ($ECe = k \times EC1:5$) following Slavich, P.G. & Patterson, R.A. (1990). Estimating the electrical conductivity of saturated paste extracts from 1:5 soil:water suspensions and texture. Australian Journal of Soil Research, 28, 453–463.

Appendix G General Advice - Dispersive Soil Management

The Site may be susceptible to tunnel erosion if subsurface drainage is not adequately managed. Tunnel erosion typically initiates in excavated cuts; however, it can also develop where dispersive soils are exposed through excavation, leading to the release of pore water and concentrated groundwater discharge. Additional contributing factors may include broken pipes, ineffective stormwater infrastructure, or unmanaged surface flows. If left unaddressed, these conditions can result in progressive subsoil loss, potentially undermining footings or causing settlement-related damage to the structure.

Tunnel erosion typically progresses upslope, initiated by the dissolution and removal of highly dispersive Class 1 and Class 2 soil layers. As tunnels enlarge, they can undermine surrounding soils that may not be dispersive but are still susceptible to collapse due to loss of subsoil support. If unmanaged, tunnel erosion can extend beyond property boundaries, posing a risk to nearby infrastructure including buildings, roads, and underground services. For further background on the management of Emerson Class 1 soils, refer to the Department of Primary Industries, Parks, Water and Environment (DPIPWE, 2009) guidance document.

Dispersive soils should be managed through a combination of drainage control and ground treatment measures. These may include overland flow management, controlled cut and fill practices, and, in more severe cases, the installation of sand barriers to interrupt subsurface flow paths. Where dispersive soils are exposed—particularly on batters or in excavation faces—chemical treatment using gypsum or lime may be employed to improve soil cohesion and reduce erosion potential. Application rates should be guided by Emerson Class test results, as outlined in Table 7.

Gypsum and hydrated lime are proven effective in mitigating erosion in dispersive soils by displacing sodium ions on clay particles and replacing them with calcium. This cation exchange improves soil structure, increases shear strength, and enhances resistance to tunnel and surface erosion. The effectiveness of treatment is influenced by the soil's properties; higher application rates of gypsum are typically required for soils with greater cation exchange capacity, elevated pH, and lower Emerson Class numbers. Application guidelines should be based on laboratory test results, including Emerson Class assessment, to ensure appropriate treatment dosages.

Table 7 Prescribed gypsum and hydrated lime application rates – see Emerson soil testing results

Dispersive Emerson class	soil	Gypsum/Hydrated Lime Application Rate pH < 7.5	Gypsum Application Rate pH > 7.5
Class 3		0 to 0.3 kg/m ²	0.2 – 0.5 kg/m ²
Class 2		0.5 kg/m ²	1.0 kg/m ²
Class 1		1.0 kg/m ²	1.5 kg/m ²

Where practicable, vehicle driveways and parking areas should be located on level or gently sloping terrain to minimise the need for deep excavation and reduce disturbance to dispersive soils identified on Site.

General Recommendations

To minimise disturbance and erosion in areas where Class 1 dispersive soils have been identified, the following measures are recommended:

- **Drainage Control:** Construct soil cut-off mounds or shallow interceptor trenches in non-dispersive soils, no deeper than 0.2m above the interface with Class 1 dispersive soils. These should be positioned upslope of any proposed cuts to divert surface water before it reaches vulnerable areas.
- **Chemical Treatment:** Apply gypsum or hydrated lime to exposed dispersive soils where surface water movement is expected—particularly on freshly cut embankments, filled areas, service trenches, and zones where topsoil has been removed.
- **Surface Protection:** Cover all severely dispersive soils with either impermeable surfacing (e.g. paving) or a layer of non-dispersive topsoil to reduce erosion and limit moisture ingress.
- **Batter Stabilisation:** Place non-dispersive topsoil over freshly cut batters to protect against surface erosion and reduce the likelihood of tunnel initiation.
- **Remediation of Existing Tunnels:** Where tunnel erosion has already occurred, additional stabilisation of natural or constructed drainage gullies may be required. This may include the use of sand barriers and, in more severe cases, geotextile-wrapped drainage rock structures. When correctly designed, such barriers can intercept subsurface flow, promote controlled surface discharge, and direct water away from at-risk areas.

Key Management Measures for Dispersive Soils in Cut Embankments:

Surface water drainage can erode dispersive soils in embankment cuts. Groundwater discharge may worsen tunnel erosion by accelerating the development of secondary porosity—where subsurface flow progressively enlarges voids within the soil mass, leading to tunnel formation and internal instability. Management considerations:

- **Topsoil Removal Risks:** Earthworks commonly begin with the removal of non-dispersive topsoil, which often acts as a natural protective layer. Once removed, the underlying dispersive soils become highly vulnerable to erosion.
- **Barrier Construction in Cut Slopes:** Where excavation is necessary, erosion can be mitigated through immediate installation of physical barriers:
 - Place a sand layer (sand barrier) over exposed dispersive soil within the cut to interrupt flow paths.
 - Construct an earth retaining wall in front of the cut to contain soil and stabilise the slope face.
- **Timely Implementation:** All erosion control measures must be implemented immediately following excavation to prevent the initiation of tunnel erosion.
- **Use of Retaining Structures:** Low-height retaining walls (e.g., timber sleeper walls) constructed at the base of cut faces can assist in retaining eroding soils and maintaining the effectiveness of sand barriers.

Sand Barriers

To manage dispersive soils exposed in cut slopes, the following layered treatment is recommended:

- **Chemical Stabilisation:** Apply gypsum or hydrated lime at application rates specified in Table 29, based on Emerson Class testing.
- **Sand Layer:** Install a minimum 100 mm thick layer of clean, free-draining sand to act as a barrier and interrupt preferential flow paths.
- **Topsoil Cover:** Place a layer of non-dispersive, free-draining topsoil (such as loam) over the sand barrier to retain the sand in place and facilitate effective revegetation or application of surface treatments.
- **Erosion Control:** Implement surface erosion protection measures as outlined in the Erosion Control section to prevent wash-off and maintain system effectiveness.

Retaining Walls

The following measures are recommended when constructing retaining walls in areas with dispersive soils:

- Retaining walls should be founded on bedrock or non-dispersive soils to reduce the risk of tunnel erosion and structural instability.
- Where walls are constructed in Class 1 dispersive soils, freshly cut surfaces may be treated with gypsum or hydrated lime at application rates specified in Table 29 to reduce erosion potential.

Drainage

Effective drainage is critical in dispersive soil environments to prevent erosion, tunnel formation, and structural damage. The following measures are recommended:

- Divert surface water away from cut and fill slopes to reduce infiltration into dispersive soils.
- A sealed toe drain is essential to prevent water from soaking into freshly cut dispersive soils and migrating through dispersive fill layers beneath paved surfaces.
- For optimal surface drainage over Class 1 soils, install concrete spoon drains in preference to earthen swales to minimise erosion risk.
- Where earthen swale drains are used, stabilise Class 1 soils with gypsum or hydrated lime at a rate adjusted to soil pH. A liner (e.g. 20 mm bentonite layer) beneath topsoil and turf may be used to limit vertical water infiltration.
- Subsurface drains installed in Class 1 soils should be backfilled with a sand mix containing 2% gypsum or hydrated lime to inhibit dispersion and maintain flow pathways.
- Non-perforated drainage pipes should be used to divert water away from identified groundwater discharge points, limiting further erosion.

Filling

The use of dispersive soils as fill presents a significant risk for tunnel erosion, especially where water movement is poorly controlled. The following measures are recommended to reduce risk and ensure long-term stability:

- Dispersive soil used as fill is highly susceptible to tunnel erosion, particularly when exposed to concentrated surface or groundwater flow.
- Groundwater can migrate along the base of and within fill layers, initiating erosion of dispersive materials and undermining overlying structures.
- All proposed filling, especially within or near building footprints, should be carefully managed. This may involve either:
 - Removal of Class 1 dispersive soil from beneath the structure, or
 - Chemical treatment of dispersive fill using gypsum or hydrated lime, applied to the surface of each compacted lift.
 - Preventing water from intercepting dispersive soil by liming the fill or with careful drainage management
- When chemically treating fill:
 - Use 300 mm thick lifts with full application rates as specified in Table 29.
 - For 150 mm thick lifts, halve the application rate accordingly.
- Ensure compaction is achieved close to optimum moisture content, particularly in areas adjacent to footings and structures.
- Paved surfaces over filled areas significantly reduce the risk of tunnel erosion, if cut-off drains are installed to prevent water ingress at the fill base.
- Where feasible, spoon drains and pavement edges at the toe of cut batters should be founded on non-dispersive soil or bedrock to intercept all surface water and eliminate seepage pathways.
- If topsoil is removed prior to filling, and it is classified as slightly dispersive (Class 3) or non-dispersive (Class 4 or higher), it may be replaced with a liner or imported non-dispersive material to protect the dispersive fill beneath.

Roofed and Paved Area Stormwater Management

All captured water on-site, including roof runoff, must be managed to remain at the surface and be evenly dispersed downslope across the Site. Roof runoff must be directed to detention tanks, with overflow discharged via surface irrigation—not into soakage pits. Due to the absence of non-dispersive topsoil, imported loam is required in irrigation areas. Irrigation must either:

1. Be delivered just below the surface, draining directly into the imported loam without contact with dispersive soils; or
2. Be applied via above-ground sprinklers onto imported loam to prevent erosion and maintain surface stability.

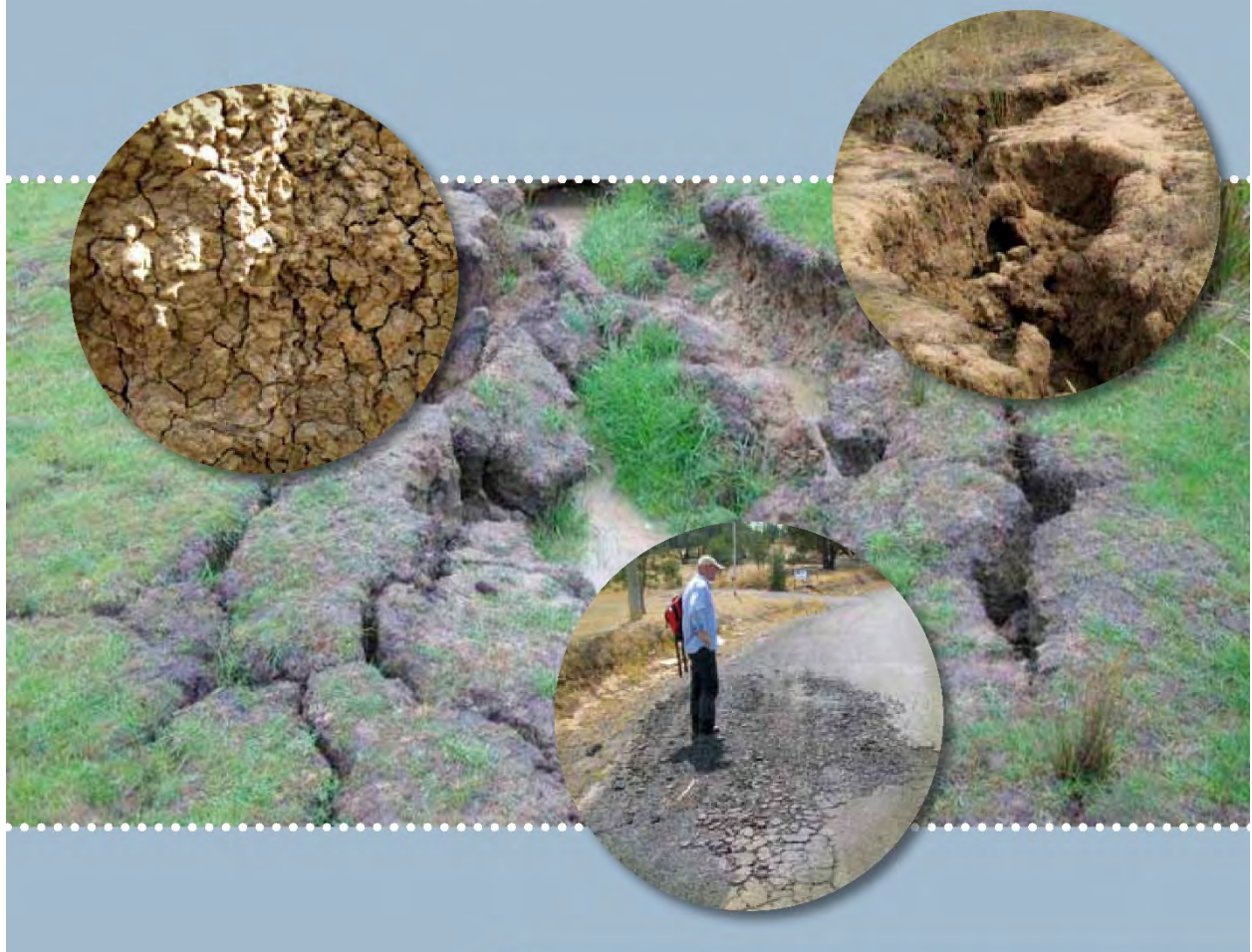
Runoff from pavements and other impervious surfaces must either be captured and redirected into detention tanks for controlled redistribution.

For driveways, runoff should be directed via cross-slope or in-slope alignment into lined side drains or swales. These must convey collected water to designated redistribution areas—such as detention tanks with surface irrigation or into distribution swales. Overflow must be dispersed across imported loam soils which is not located upgradient or downgradient of existing structures and ensuring water is not concentrated near foundations or fill. If distribution swales are used, they must be lined, constructed with low gradients, and designed to promote sheet flow rather than concentrated runoff. Distribution swale overflow must discharge onto non-dispersive imported loam soils.

Service Trenches

An effective measure to prevent stormwater ingress into backfilled service trenches is to ensure the trench surface is well sealed with non-dispersive soils or stable topsoil. As an additional site-specific recommendation, service trenches should be backfilled with compacted sand, which will help prevent water channelisation and reduce the risk of tunnel erosion along trench alignments.

DISPERSIVE SOILS *and* *their* MANAGEMENT



Technical Reference Manual

Sustainable Land Use
Department of Primary Industries and Water



4.1 MANAGEMENT OPTIONS FOR TUNNEL EROSION

Past efforts to repair tunnel erosion in agricultural landscapes have relied on mechanical destruction of the tunnel system by deep ripping, contour furrowing, and contour ripping. Unfortunately many of these techniques either failed or resulted in tunnel re-emergence in an adjacent areas (Floyd 1974, Boucher 1995). The use of these 'agricultural' techniques is inappropriate in peri-urban areas where tunnel repair requires a low incidence of re-failure due to the potential for damage to infrastructure. Experience with the construction of earth dams using dispersive clays, demonstrates that repair and prevention of tunnel erosion in urban and peri-urban environments is best achieved using a combination of,

- » Identification and avoidance of dispersive soils.
- » Precise re-compaction.
- » Chemical amelioration.
- » Sand blocks and barriers.
- » Topsoil, burial and revegetation.

4.2 IDENTIFICATION AND AVOIDANCE OF DISPERSIVE SOILS

The risk of tunnel erosion resulting from construction activities on dispersive soils can often be reduced or eliminated by identifying and avoiding areas containing dispersive soils. The presence and severity of dispersive soils can vary enormously over short distances (Figure 13). In many instances, large scale (ie 10 x 10 or 20 x 20 meter grid) soil survey and screening of soils for dispersion, (using the Emerson crumb test - section 3, Appendix I) can be used to site dwellings and infrastructure away from dispersive soils. Advice should be sought from a suitably qualified and experienced engineer or soil professional.



Figure 13. The severity (or sodium content) and depth of dispersive subsoils can vary considerably over short distances. (a). At this site highly dispersive subsoils exist meters away from (b) non-dispersive soils.

4.3 COMPACTION

Ritchie (1965) demonstrated that the degree of compaction within the dam wall was the single most important factor in reducing dam failure from piping (tunnel erosion). A high degree of compaction reduces soil permeability, restricting the movement of water and dispersed clay through the soil matrix, which decreases the severity of dispersion and restricts tunnel development (Vacher *et al.* 2004). However, dispersive soils can be difficult to compact as they lose strength rapidly at or above optimum moisture content, and thus may require greater compactive force than other soils (McDonald *et al.* 1981). Bell & Bryun (1997) and Bell and Maud (1994) suggest that dispersive clays must be compacted at a moisture content 1.5 -2% above the optimum moisture content in order to achieve sufficient density to prevent piping (Elges 1985).

Construction of structures such as earth dams and footings for buildings with dispersive soils require geotechnical assessment and advice from a qualified and experienced engineer, in order to determine compaction measures such as the optimal moisture content, number of passes, and maximum thickness of compacted layers.

Normal earth moving machinery including bull-dozers, excavators and graders do not provide sufficient compactive force to reduce void spaces or achieve adequate compaction in dispersive soils. A sheepsfoot roller of appropriate weight is usually required to compact dispersive soils. By comparison a D6 dozer applies only 0.6 kg/cm² pressure compared to 9.3 kg/cm² for a sheepsfoot roller (Sorensen 1995).

4.4 CHEMICAL AMELIORATION

Initiation of tunnel erosion is predominantly a chemical process, so it makes sense to use chemical amelioration strategies when attempting to prevent or repair tunnel erosion in dispersive soils. Despite the widespread use of gypsum and lime to treat sodic soils in agriculture, the use of gypsum and lime to treat tunnel affected areas has been relatively rare (Boucher 1990).

Hydrated lime (calcium hydroxide) has been widely used to prevent piping in earth dams. Rates of application have varied depending on soils and degree of compaction used in construction. Laboratory testing usually indicates that only around 0.5 – 1.0% hydrated lime is required to prevent dispersion, however difficulties with application and mixing necessitate higher rates of application (Moore *et al.* 1985). Moore *et al.* (1985) cite examples of the use of hydrated lime to control piping in earth dams at rates between 0.35% (N.S.W. Australia) and 4% (New Mexico). Elgers (1985), and McElroy (1987) recommend no less than 2% hydrated lime (by weight of the total soil material) to prevent dispersion within dam embankments, while Bell and Maud (1994) suggest that 3% - 4% by mass of hydrated lime should be added to a depth of 0.3m on the upper face of embankments. In alkaline (pH >7.0) soils (most sodic subsoils in Tasmania are neutral or alkaline) the effectiveness of hydrated lime is reduced by the formation of insoluble calcium carbonate (Moore *et al.* 1985), such that gypsum is preferred to hydrated lime. It is important to note that agricultural lime (calcium carbonate) is not a suitable substitute for hydrated lime due to its low solubility (McElroy 1987). Also note that excessive applications of lime may raise soil pH above levels required to sustain vigorous plant growth.

Gypsum (calcium sulphate) is more effective than lime for the treatment of dispersive soils as it increases the electrolyte concentration in the soil solution as well as displacing sodium with calcium within the clay structure (Raine and Loch 2003). Gypsum is less commonly used than hydrated lime in dam construction and other works due to its lower solubility, and higher cost. Elges (1985) recommends that in construction, a minimum of 2% by mass of gypsum be used. Bell and Maud (1994) present a means of calculating the amount of gypsum required to displace excess sodium and bring ESP values within desired limits (normally < 5). Be aware that application of excessive amounts of gypsum may cause soil salinity to temporarily rise beyond the desired level for plant growth.

NOTE:

- » Use of gypsum in Tasmania is covered under the Fertiliser Act 1993, which has established the allowable limit for cadmium and lead at 10 mg/kg and 5 mg/kg for mercury.
- » Gypsum is usually imported into Tasmania from Victoria or South Australia, which have different standards for allowable heavy metal content.
- » Purchasers of gypsum should check with suppliers to ensure that gypsum imported into Tasmania is compliant with current regulations.

Alum (aluminium sulphate) has been effectively used to prevent dam failure and protect embankments from erosion. Application rates are not well established. Limited data suggests mixtures of 0.6 – 1.0% (25% solution of aluminium sulphate) (Bell and Bruyn 1997, McElroy 1987) to 1.5% (Ouhadi, and Goodarzi 2006) of the total dry weight of soil may be appropriate. Alum is however highly acidic (pH 4-5), and thus alum treated soils will need to be capped with topsoil in order to establish vegetation (Ryker 1987). Soil testing is required to establish appropriate application rates for Tasmanian soils.

Long chain polyacrylamides have been shown to increase aggregate stability, reduce dispersion and maintain infiltration rates in dispersive soils (Levy *et al.* 1992, Raine and Loch 2003). However the effect is highly variable between various polyacrylamide products and the chemical and physical properties of the soil. The benefit of polyacrylamides is generally short due to their rapid degradation (Raine and Loch 2003). Further advice and laboratory testing should be conducted before using polyacrylamides to protect earth dams from piping failure.

Note that appropriate application rates for gypsum, hydrated lime, alum and polyacrylamides have not been established for dispersive soils in Tasmania. Extensive laboratory assessment of materials used for the construction of dams or embankments is required before locally relevant 'rules of thumb' can be established for the use of these products.

4.5 SAND BLOCKS AND SAND BARRIERS

Sand filters were first developed to prevent piping in earth dams. Sand filters prevent dam failure by trapping entrained sand and silt, blocking the exit of the tunnel and preventing further tunnel development (Sherard *et al.* 1977). Following the work of Sherard *et al.* (1977), Richley (1992 and 2000) developed the use of sand blocks to prevent tunnel erosion during installation of an optical fibre cable in highly dispersive soils near Campania, Tasmania. The sand blocks work slightly differently to the sand filters in that they allow the free water to rise to the surface through the sand. The use of sand blocks has recently been modified by Hardie *et al.*, (2007) to prevent re-initiation of tunnel erosion along an optical fibre cable near Dunalley. Modifications to the original technique developed by Richley (1992 and 2000) include (Figure 14 & 15);

- » Upslope curved extremities to prevent the structure from being by-passed.
- » Geotextile on the downslope wall to prevent collapse or removal of sand following settlement or erosion.
- » Application of gypsum (around 5% by weight) to ensure infiltrating water contains sufficiently electrolyte to prevent further dispersion.
- » Earth mound upslope of the structure to prevent run-on entering the sand blocks.



Figure 15. (a) Installation of sandblock perpendicular to a service trench. Note securing of geotextile to the optical fibre cable to prevent water flowing past the sand block. (b) Sandblock before final topsoiling.

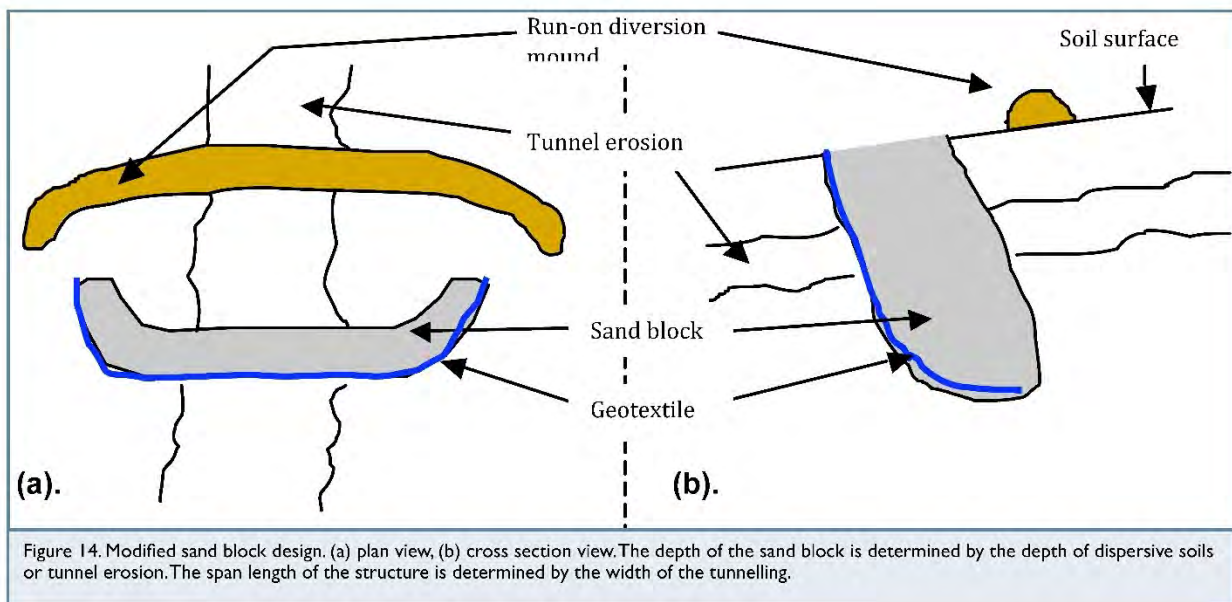


Figure 14. Modified sand block design. (a) plan view, (b) cross section view. The depth of the sand block is determined by the depth of dispersive soils or tunnel erosion. The span length of the structure is determined by the width of the tunnelling.

4.6 USE OF TOPSOIL / BURIAL AND REVEGETATION

Topsoil or burial of exposed dispersive soils reduces the likelihood of subsoil dispersion and initiation of tunnel erosion by;

- » Providing a source of salt to increase the electrolyte content of infiltration water;
- » Preventing desiccation and subsoil cracking;
- » Promoting even infiltration;
- » Providing a protective cover from raindrop impact;
- » Providing a suitable medium for revegetation.

Topsoil minimises the interaction between water and dispersive clays by providing both a physical and chemical barrier. Topsoil also reduces soil desiccation and development of surface cracks (Sorensen 1995). It is suggested that exposed dispersive subsoils be covered with at least 150mm of non dispersive topsoil and sown with an appropriate mix of grass species. In some cases it will be necessary to protect the topsoil from erosion with 'jute' cloth or similar product.

The suitability of planting trees in tunnel affected areas is influenced by the amount of annual rainfall and frequency of soil cracking resulting from desiccation. Boucher (1995) recommends the preferred option for revegetation of reclaimed tunnel erosion is a widely spaced tree cover in association with a combination of perennial and annual pastures, rather than a dense stand of trees or pasture alone. Experience in Tasmania suggests that in low rainfall areas, or areas in which existing trees or shrubs cause soil drying and cracking, the preferred option for revegetating tunnel affected land is a dense healthy pasture. In high rainfall areas, dense plantings of trees have been successfully used to repair or stabilise tunnel erosion for example Colclough (1973) successfully used *Pinus radiata* to stabilise tunnel-gully affected land in a moderate rainfall area near Tea Tree, Tasmania.

5.0 ACTIVITIES THAT INCREASE THE RISK OF EROSION ON DISPERSIVE SOILS

ACTIVITIES THAT INCREASE RISK OF INITIATING TUNNEL EROSION, INCLUDE;

- » Removal of topsoil.
- » Soil excavation or expose of subsoils to rainfall.
- » Supply of services via trenches.
- » Construction of roads and culverts in dispersive subsoils.
- » Installation of sewage and grey water disposal systems in dispersive subsoils.
- » Dam construction from dispersive soils.

OPTIONS FOR REDUCING THE RISK OF TUNNEL EROSION DURING CONSTRUCTION AND DEVELOPMENT WORKS ON DISPERSIVE SOILS INCLUDE,

- » Where possible do not remove or disturb topsoil or vegetation.
- » Ensure that dispersive subsoils are covered with an adequate layer of topsoil.
- » Avoid construction techniques that result in exposure of dispersive subsoils.
- » Use alternatives to 'cut and fill' construction such as pier and post foundations.
- » Where possible avoid the use of trenches for the supply of services ie water & power:
- » If trenches must be used, ensure that repacked spoil is properly compacted, treated with gypsum and topsoiled.
- » Consider alternative trenching techniques that do not expose dispersive subsoils.
- » Ensure runoff from hard areas is not discharged into areas with dispersive soils.
- » If necessary create safe areas for discharge of runoff.
- » If possible do not excavate culverts and drains in dispersive soils.
- » Consider carting non-sodic soil to create appropriate road surfaces and drains without the need for excavation.
- » Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive clays mixed with gypsum, topsoiled and vegetated.
- » Avoid use of septic trench waste disposal systems; consult your local council about the use of alternative above ground treatment systems.
- » Where possible do not construct dams with dispersive soils, or in areas containing dispersive soils.
- » If dams are to be constructed from dispersive clays, ensure you consult an experienced, qualified civil engineer to conduct soil tests before commencing construction.
- » Construction of dams from dispersive soils is usually possible, using one or a combination of: precise compaction, chemical amelioration, capping with non-dispersive clays, sand filters and adequate topsoiling.

With all forms of construction on dispersive soils, ensure you obtain advice and support from a suitably experienced and qualified engineer or soil professional before commencing work.

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 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 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.

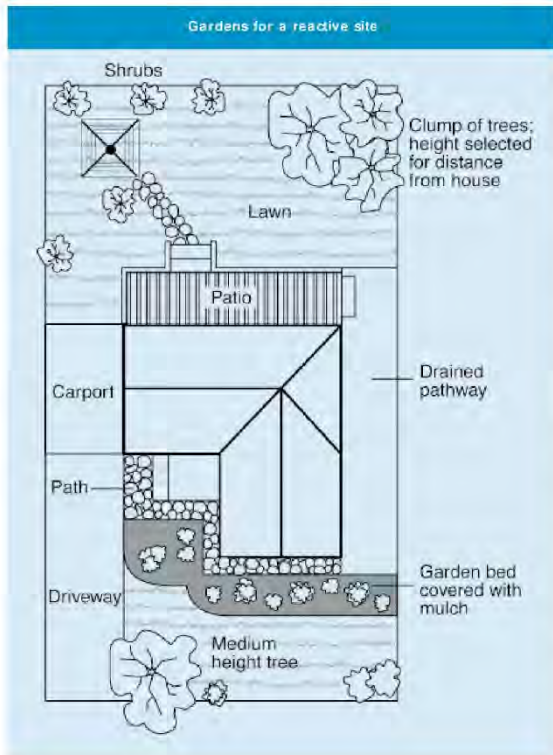
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

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



- 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.

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:

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.

Distributed by

CSIRO PUBLISHING PO Box 1139, Collingwood 3066, Australia

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