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CONSULTING ENGINEERS AND
BUILDING SURVEYORS
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EMAIL: office@mamic.com.au
Office: GROUND LEVEL: 421 ELIZABETH ST NORTH HOBART
PO BOX 143 NORTH HOBART TAS 7002

ON SITE WASTE DISPOSAL REPORT

FOR A CRACK

AT 245 ALLENS RIVULET ROAD, ALLENS RIVULET

NOVEMBER 2020

INTRODUCTION

The report investigates the suitability for onsite effluent disposal at 245 Allens Rivulet Road, Allens Rivulet. Existing house has four bedrooms and ancillary has one bedroom.

The proposed house and ancillary are situated on 18100m² of land. There are no sewage services in the whole area and neighbouring houses rely on onsite waste disposal systems.

SITE INSPECTION

The site was inspected on 5th October 2020. Test holes were drilled with drill rig. The soil was tested for permeability with an outcome of 0.01m /day. The day of the test was fine.

SURFACE CONDITIONS

The site has grass covering and is almost level. There was no water ponding observed on the site.

SOIL PROFILE

The soil profile has been determined from the test holes dug on 5th October 2020. The soil profile consists of:

- Layer of top soil approximately 0.10m thick.
- Layer of soft moist, light brown Highly weathered mudstone derived plastic clay Approximately 0.65m thick. (CL)
- Layer of moist soft reddish plastic clay approximately 0.25m thick. (CL)
- Layer of moist light brown plastic clay with small mudstone fragments approximately 0.30 thick (CL)

PERMEABILITY MEASUREMENTS

The permeability of this soil was tested utilizing the constant head permeability method. An average permeability of 0.01m /day was obtained for the soil.

GROUNDWATER

The groundwater table was not struck in the bore holes which were dug to a depth of approximately 1.30m below natural surface level.

DESIGN

Manual design in accordance with AS/NZ 1547.2012 was undertaken.

CONCLUSION

We recommend the use of an AWTS with drip irrigation pad.

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SITE AND SOIL EVALUATION REPORT

Site and soil evaluation reports must be submitted with all applications for on-site wastewater management systems. Evaluation reports must be completed by: soil scientists, Engineering geologists, engineers or environmental health officers. Site evaluators should use their professional judgment to determine if issues outlined in the site evaluation report are relevant or if additional information is required.

For further information on site evaluation please consult AS/NZS 1547-2012 on-site domestic wastewater management.

Using the Trench™ site assessment program instead of using this form, also meets Council's information and design requirements in respect of addressing the performance requirements of the Tasmanian Plumbing Code.

SITE INFORMATION

Location: 245 Allens Rivulet Road, Allens Rivulet

Owner: A CRACK

Site Plan: See attached

Soil Category:
(as stated in AS/NZS 1547-2012) Modified Emerson Test Required: **No**

1,…2,…3,…4,…**5**,…6 If Yes, Emerson Class No

Soil Profile:
(Attach a soil profile and description of the soil in the test pits.
Location of pits should be nominated on the site plan)

Measured or Estimated Soil Permeability (m/d) **<0.01 m/day**

Design Irrigation Rate (mm/d)
(This is a recommendation to the designer advising how many liters of effluent should be applied to the soil for every square meter of absorption trench or other land application system.)

3mm/DAY

NOTE: The accompanying engineering log describes the soil profile encountered at 245 Allens Rivulet Road, Allens Rivulet.

Geology: Permian: Fine sandstone, coarse siltstone, and fossiliferous mudstone at undetermined depths. Dominant soils: Variable from thin yellow grey silty sand to gravel overlies thick yellow clayey gravel/clay.

Soil properties (typical):
Liquid Limit …………….. 21% – 68%
Plasticity Index ………….. 3% – 49%
Linear Shrinkage ……….. 1% – 17%
(see local geological map)

Topography *(include relevant information on the site plan)*

Slope: Slope of 2^0 to 3^0

Drainage lines / water courses: Allens Rivulet is more than 200m away.

Vegetation: Cleared grassed with trees.

Indicate the location of any of the following features on site plan:

- Waterways or drainage lines
- Embankments (on this lot or on surrounding land)
- Buildings
- Wells or bores

Site History (Land use) Forestry. **N/A**

……………………………………………………………………………………………………

Site Exposure

Aspect: **Land**

Pre-dominant wind direction: **Northwest to Southwest**

Environmental Issues

Location of sensitive vegetation, high water table, swamps, waterways etc.

Site Stability

Will on-site wastewater disposal affect site stability? **NO**

Is geological advice required? **NO**

Drainage/Groundwater

Depth to the seasonal groundwater (m) **1.3m.**
(including perched water table)

Are surface or sub-surface drains required upslope of the land application area? **NO**
(Nominate location of drains on the site plan)

Primary and Reserve Land Application Area The suitable land application area does not vary much over the whole site , it is fairly consistent.

Water Supply *Please tick appropriate*

- [ ] Public Supply
- [X] Rainwater Tanks
- [ ] Bore, Well or Dam

Date of Site Evaluation: 5th October 2020

Weather conditions:
(on the day of evaluation and during the last week) ***Fine***

Conclusion: The site is suitable for a AWTS with drip irrigation pad.

....

Site Evaluator:

Name: Joe Mamic

The Institution of Engineers, Australia
Joseph Mamic
MIEAust CPEng
Chartered Professional Engineer
Membership No. 619436

Signed:

Company: Joe Mamic & Associated P/L

Address: 421 Elizabeth St, North Hobart.

Phone: 62 314422

Fax: 62 319277

Email: office@mamic.com.au

Qualifications: BE MASc MIABS MIE Aust

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Project	245 Allens Rivulet Road, Allens Rivulet
Subject	On site waste disposal calculations
Date	04th November 2020

Using AS 1547.2012

Soil Category = 5
Permeability measured on site (constant head) = <0.01m/day
DIR = 3mm/day = 21mm/week

Q = design daily flow rate based on number of bedrooms. Therefore, number of people (Table I, Section 4.3 Directors Guidelines) = 7 @120 l/person.

From Table H1 = 120 litres/person (tank water)

$\therefore$ Q = 7 x 120 = 840 litres

The area for spray irrigation required is:

$$\text{Area} = \frac{7 \times Q}{DLR}$$

Q = 840 litres
DIR from Table M1 = 3mm/day

$$\therefore \text{Area} = \frac{7 \times 840}{21}$$

$$= 280 \text{ m}^2$$

Need an area of 280 m^2 of spray irrigation pad for an AWTS.

JOE MAMIC & ASSOCIATES P/L

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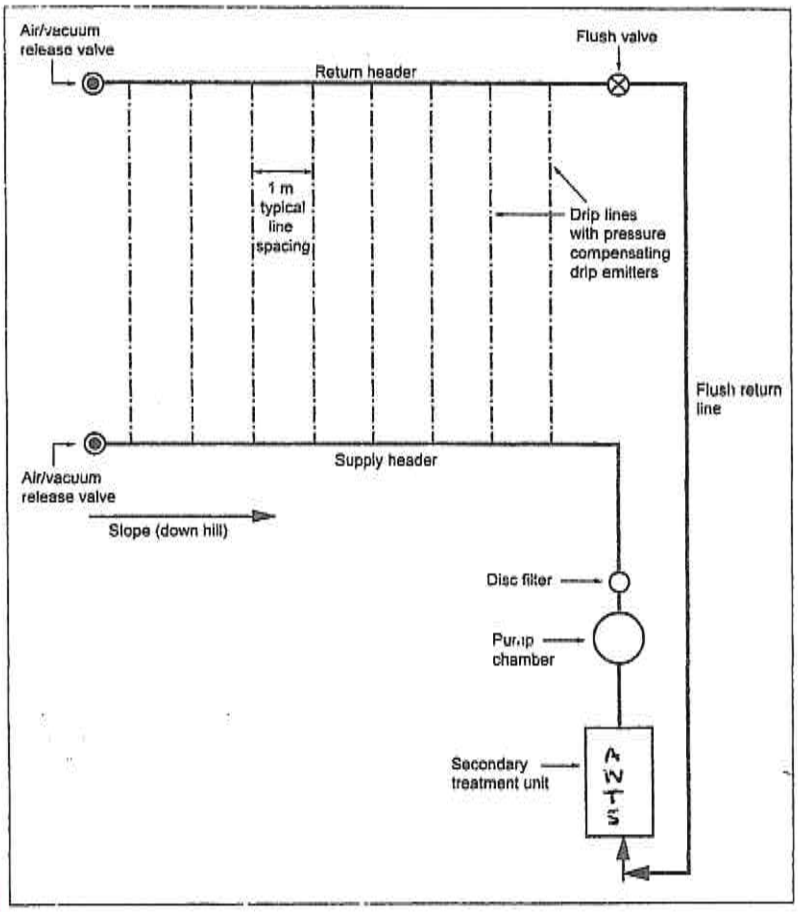
ENGINEERS INSTRUCTION REPORT

PROJECT: 245 Allens Rivulet Rd Allens Rivulet

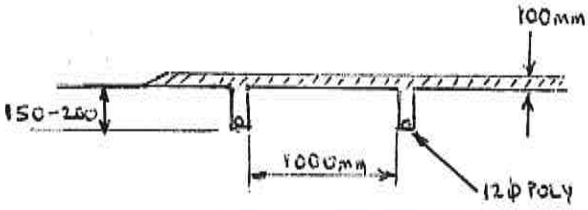
SUBJECT: Drip irrigation Specifications

COMMENTS:

Provide 280 m^2 of drip area, grassed with a distribution system as shown below and as indicated on accompanying site plan the imported topsoil is to consist of a mix of sandy loam soil and saw dust at a ratio of 1 to 2.



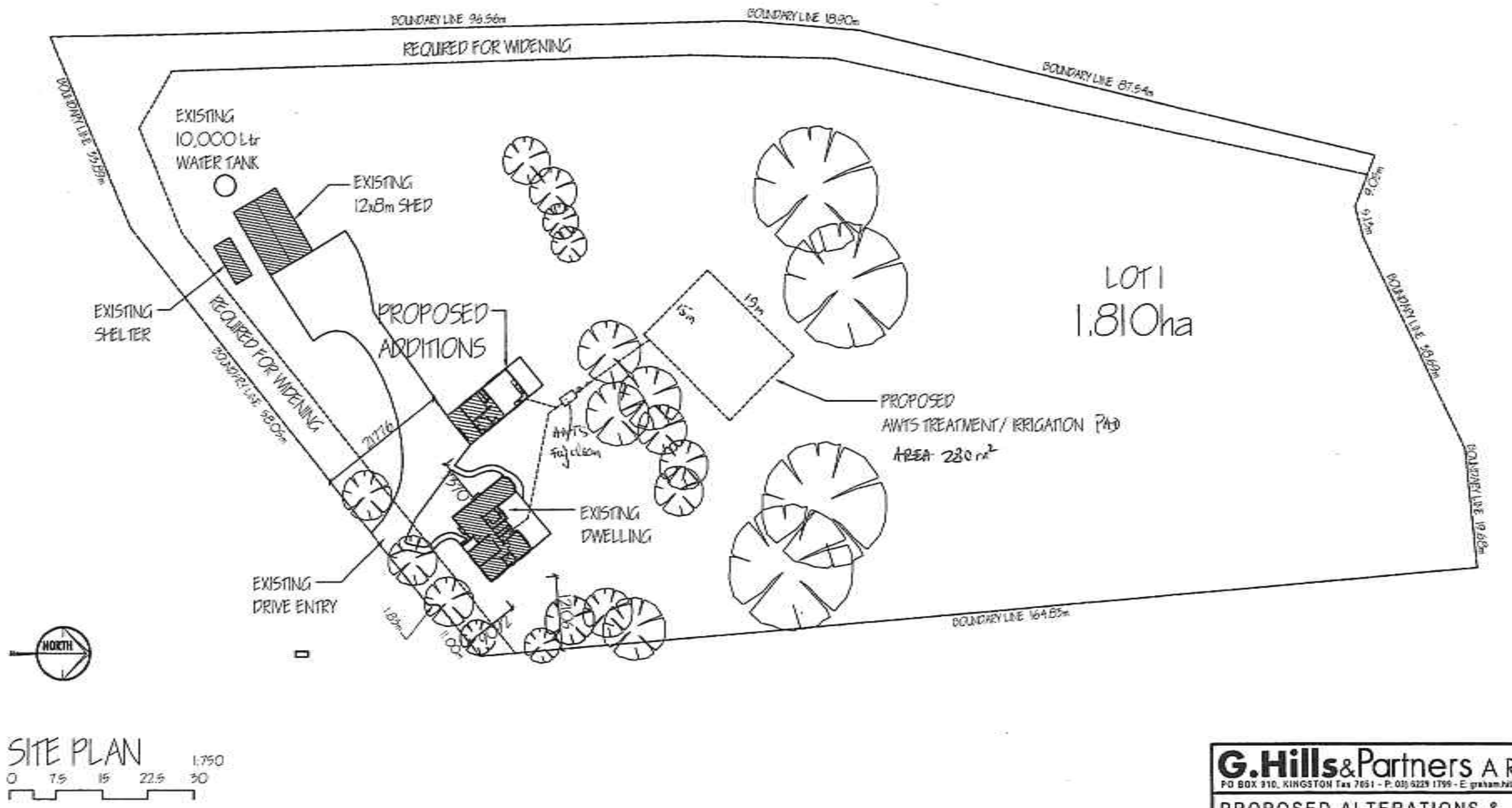
DRIP IRRIGATION SYSTEM – EXAMPLE LAYOUT OF COMPONENTS



SIGNED:

Joseph Mamic
MIEAust CPEng
Chartered Professional Engineer
Membership No. 619436

Should a cost variation arise from this inspection the contractor shall inform the Engineer or Architect prior to prior to proceeding.

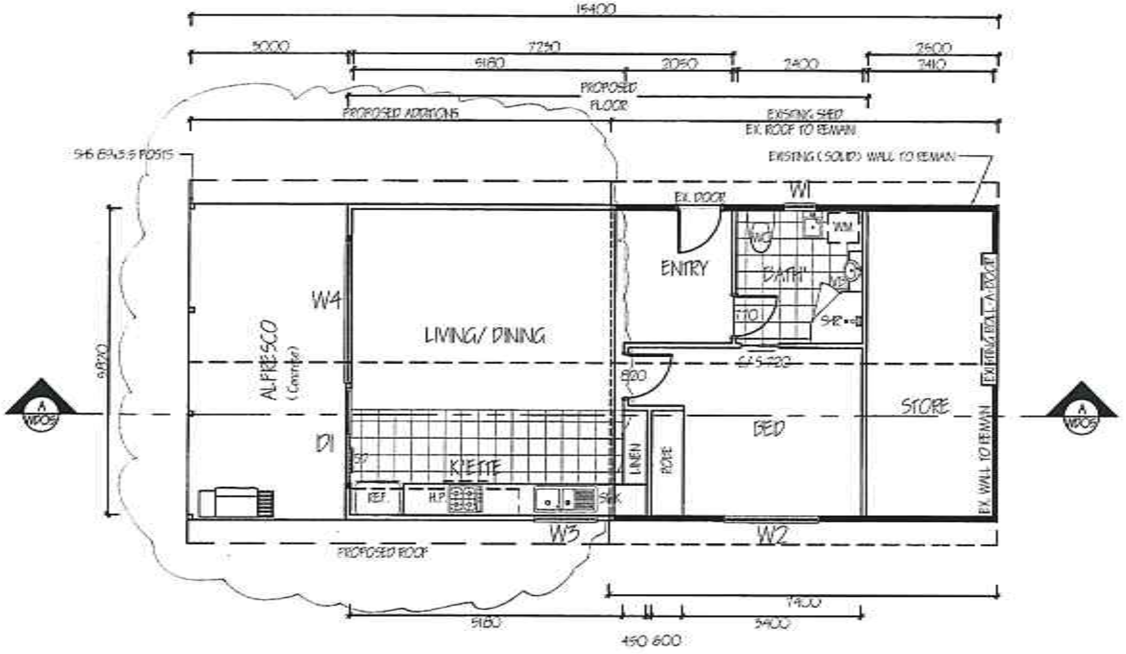


Joseph Mentic
MIEAust CPEng
Chartered Professional Engineer
Membership No. 619436
10 DEC 2020

G.Hills&Partners ARCHITECTS
PO BOX 310, KINGSTON Tas 7051 - P: 03) 6229 1799 - E: graham.hills@bigpond.com - E: josh.hills26@gmail.com

PROPOSED ALTERATIONS &
ADDITIONS TO SHED AS ANCILLARY
For : A. Crack & M. Bromley
At : 245 Allens Rivulet Road, ALLENS RIVULET

DRAWING TITLE:			
SITE PLAN			SCALE: 1:750 @ A3
			DESIGNER: G. & J. Hills
			DRAWING: J. Hills
			DATE: Oct. 2020
PROJECT No: 22076	DWG. No: WD01	No. IN SET: 10	PRINTED: 09/12/2020
			ISSUE: A



EXISTING & PROPOSED FLOOR PLAN

1:100

0 1 2 3 4

WINDOW & DOOR SCHEDULE

	HEIGHT	WIDTH	DESCRIPTION
W1	900	600	OBSCURED AWNING
W2	600	1800	AWNING, FIXED
W3	900	1200	AWNING
W4	1500	2700	AS STOCKED
D1	2100	1800	EXTERNAL GLASS SLIDING DOOR

AREA:

Existing Floor = 44m²

Proposed Floor = 59.4m²

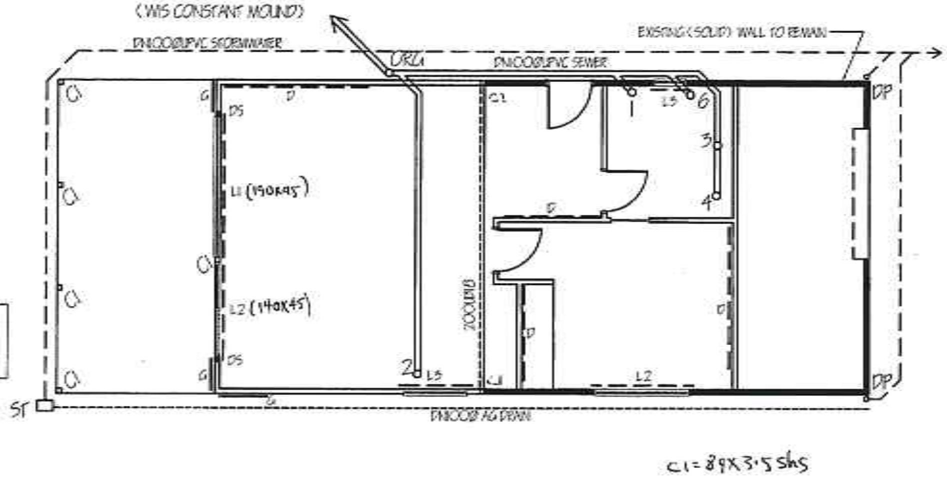
SEWERAGE CONNECTION TO NEW AWTS TREATMENT/ IRRIGATION SYSTEM. REFER TO ENGINEERS REPORT (W/S CONSTANT MOUND)

STORMWATER CONNECTED TO EXISTING LINE - TO HOUSE CONNECTION POINT.

DRAINAGE SCHEDULE

1 - WC
2 - SINK
3 - VANITY BASIN - 50mm vent to air
4 - SHOWER
6 - TROUGH
ORG - TAP OVER FLOW RELIEF GULLY
ST - SILT TRAP
DP - DOWN PIPE

NOTE: ALL PLUMBING AND DRAINAGE IS TO BE CARRIED OUT IN ACCORDANCE WITH AS3500 AND AS DIRECTED BY COUNCIL AUTHORITIES.



BRACING & DRAINAGE PLAN

1:100

0 1 2 3 4

BRACING:

G = BRACING PLY SHEET (0.9 m LONG U.N.O.)
3.4 KN/ m

D = METAL TENSIONED CROSS BRACING (2.4m LONG U.N.O.)
3.0 KN/ m

BRACING TO COMPLY WITH AS1684.2 2010 REFER TABLE 8.18 FOR INSTRUCTION DETAILS TIE DOWN TO COMPLY WITH AS 1684.2 1999. REFER TO ENGINEERS' SOIL REPORT FOR CLASSIFICATION

LINTEL SCHEDULE (SINGLE / UPPER LEVEL)

LINTEL SIZE F17	SPAN mm
90X45	1500
140X45	2000
190X45	2500
240X45	3000
290X45	3500

G.Hills&Partners ARCHITECTS
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PROPOSED ALTERATIONS & ADDITIONS TO SHED AS ANCILLARY
For : A. Crack & M. Bromley
At : 245 Allens Rivulet Road, ALLENS RIVULET

DRAWING TITLE:
EXISTING & PROPOSED ANCILLARY FLOOR PLAN & BRACING & DRAINAGE PLAN

SCALE:	1:100 @ A3
DESIGNER:	G. & J. Hills
DRAWING:	J. Hills
DATE:	Oct. 2020
PRINTED:	09/12/2020
ISSUE:	A

PROJECT No:	DWG. No:	No. IN SET:
22076	WD03	10

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LOADING CERTIFICATE TO AS1547- 2012 7.4.2 (d) REQUIREMENTS

PROJECT: 245 ALLENS RIVULET ROAD, ALLENS RIVULET

(i) System capacity number of persons and daily flow

Four Bedrooms and an ancillary bedroom (7 Persons)
Daily flow = 840lts

(ii) Summary of design criteria

Soil Category = 5
Spray Irrigation Rate (SIR) = 3mm/day

(iii) The location of and use of the 'reserve area'

The site has a site area of 18100m^2 therefore plenty of area to reserve
Bed.

(iv) Use of water efficient fitting, fixture or appliances

These days water efficient fittings, fixtures and appliances are common.
Design was not based on use of such water saving devices.

(v) Allowable variation from design flows (peak loading events)

An allowable variation of 20% is acceptable for a period not longer than 2 weeks.

(vi) Consequences of changes in loading (due to varying waste water characteristics)

Unlikely waste water characteristics will change due to its use, but if they did the plants may not fare well.

(vii) Consequences of overloading the system

Over saturation to be investigated and irrigation pad are increased.

(viii) Consequences of under loading the system

NIL – The vegetation may not fair well

(ix) Consequences of lack of operation, maintenance, and monitoring attention, and

Unlikely as will be maintained by installer due to contractual agreement

(x) Any other relevant considerations related to use of the system; and

Nil

CERTIFICATE OF THE RESPONSIBLE DESIGNER

Section 94
Section 106
Section 129
Section 155

Form **35**

To:	A Crack	*Owner name*
	245 Allens Rivulet Road	*Address*
	Allens Rivulet Tas. 7150	*Suburb/postcode*

Designer details:

Name:	Joe Mamic	Category:	Engineer
Business name:	Joe Mamic & Associates Pty Ltd	Phone No:	03 6231 4422
Business address:	PO Box 143		
	North Hobart Tas. 7000	Fax No:	03 6231 9277
Licence No:	CC411N	Email address:	office@mamic.com.au

Details of the proposed work:

Owner/Applicant	A Crack	Designer's project reference No.	
Address:	245 Allens Rivulet Road	Lot No:	
	Allens Rivulet Tas. 7150		

Type of work: Building work X Plumbing work X *(X all applicable)*

Description of work:

On Site Waste Water

(new building / alteration / addition / repair / removal / re-erection water / sewerage / stormwater / on-site wastewater management system / backflow prevention / other)

Description of the Design Work (Scope, limitations or exclusions): *(X all applicable certificates)*

Certificate Type:	**Certificate**	**Responsible Practitioner**
	☐ Building design	Architect or Building Designer
	☐ Structural design	Engineer or Civil Designer
	☐ Fire Safety design	Fire Engineer
	☐ Civil design	Civil Engineer or Civil Designer
	X Hydraulic design	Building Services Designer
	☐ Fire service design	Building Services Designer
	☐ Electrical design	Building Services Designer
	☐ Mechanical design	Building Service Designer
	☐ Plumbing design	Plumber-Certifier; Architect, Building Designer or Engineer
	☐ Other (specify)	

Deemed-to-Satisfy: ☐ Performance Solution: X *(X the appropriate box)*

Other details:

Design documents provided:

The following documents are provided with this Certificate –

Document description:

Drawing numbers: G Hills	Prepared by: J Mamic	Date: 10/12/2020
Schedules:	Prepared by:	Date:
Specifications:	Prepared by:	Date:
Computations:	Prepared by:	Date:
Performance solution proposals:	Prepared by:	Date:
Test reports:	Prepared by:	Date:

Standards, codes or guidelines relied on in design process:

AS 1547

Any other relevant documentation:

NIL

Attribution as designer:

I Joe Mamic .... am responsible for the design of that part of the work as described in this certificate;

The documentation relating to the design includes sufficient information for the assessment of the work in accordance with the *Building Act 2016* and sufficient detail for the builder or plumber to carry out the work in accordance with the documents and the Act;

This certificate confirms compliance and is evidence of suitability of this design with the requirements of the National Construction Code.

	Name: (print)	*Signed*	*Date*
Designer:	Joe Mamic		10/12/2020
Licence No:	CC411N		

Assessment of Certifiable Works: (TasWater)

Note: single residential dwellings and outbuildings on a lot with an existing sewer connection are not considered to increase demand and are not certifiable.

If you cannot check ALL of these boxes, LEAVE THIS SECTION BLANK.

TasWater must then be contacted to determine if the proposed works are Certifiable Works.

I confirm that the proposed works are not Certifiable Works, in accordance with the Guidelines for TasWater CCW Assessments, by virtue that all of the following are satisfied:

- [X] The works will not increase the demand for water supplied by TasWater
- [X] The works will not increase or decrease the amount of sewage or toxins that is to be removed by, or discharged into, TasWater's sewerage infrastructure
- [X] The works will not require a new connection, or a modification to an existing connection, to be made to TasWater's infrastructure
- [X] The works will not damage or interfere with TasWater's works
- [X] The works will not adversely affect TasWater's operations
- [X] The work are not within 2m of TasWater's infrastructure and are outside any TasWater easement
- [X] I have checked the LISTMap to confirm the location of TasWater infrastructure
- [X] If the property is connected to TasWater's water system, a water meter is in place, or has been applied for to TasWater.

Certification:

I ..Joe Mamic.. being responsible for the proposed work, am satisfied that the works described above are not Certifiable Works, as defined within the *Water and Sewerage Industry Act 2008*, that I have answered the above questions with all due diligence and have read and understood the Guidelines for TasWater CCW Assessments.

Note: the Guidelines for TasWater Certification of Certifiable Works Assessments are available at: www.taswater.com.au

	Name: (print)	*Signed*	*Date*
Designer:	Joe Mamic		10/12/2020

The Institution of Engineers, Australia
Joseph Mamic
MIEAust CPEng
Chartered Professional Engineer
Membership No. 819436

JOE MAMIC & ASSOCIATES P/L

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Plants Suitable for Aerobic Waste Water Treatment Systems

Soil type, rainfall, nutrients, amount of water used, altitude can all play a significant role in the health of plants and the landscape.

For residents living in non sewered areas there are a number of landscape designs that reuse waste water. By reuse, the water is further cleansed through filtration in a number of ways;

- sub-surface and covered surface irrigation – drip irrigation
- absorption trenches and absorption beds
- evapotranspiration/absorption/seepage beds/trenches
- mounds

There are three general soil types found

- Sandy = free draining feels grainy
- Loam = combination soil that holds water and nutrients well
- Clay = does not drain well, forms a ball or clod if dampened with water

This is a simple guide and by no means is exhaustive in its information. If you would like to plant alternative types of plants it is recommended to seek professional advice for your particular circumstance.

Frequently Asked Questions.

Q: Can I plant fruit trees in my irrigation area?
A: Treated/recycled wastewater may be used to irrigate the base of fruit trees but must not come into contact with the edible parts of a plant. It is not recommended that fruit trees be used in an irrigation area because most fruit trees are deciduous in winter and do not absorb much waste water during this period. Remember, irrigation areas are part of the treatment process and are required to absorb and cleanse the waste water.

Q: Will the high nutrient content of the reclaimed water affect the plants?
A: It all depends on the type of system and what is put down your drain. Tasmanian soils lack phosphorous, consequently any additional Phosphorous can cause some native plants to die, especially Grevillea's. Native plants are generally sensitive to higher nutrient loads but are able to tolerate low doses.

Q: Can I plant large trees?
A: Large trees are not recommended as they can have an impact on surrounding growth of other plants. You need to be aware of the impact it may have on your neighbours including how big the trees will grow in the future. Large eucalypts and other larger trees will need to be kept well pruned to continue to bush out rather than grow tall which can affect their structural integrity.

Q: Can I plant conifers?
A: Conifers need a drier environment and are unlikely to survive.

Q: Can I plant perennials, roses, maples, delphiniums, Hosta or fox gloves?
A: In general all of these plants have a dormant phase where they do not grow. Therefore they do not absorb water during this phase and will cause the waste water area to become a public health risk.

Further information can be obtained through your local nursery, landscape gardener or environmental consultant. Following is a list of plants recommended by Tasmanian plants specialists. Tasmanian natives are preferred over mainland species as they are better suited to local conditions and will grow on most soil types.

Table 1 suggested plant list with common and botanical name with matching soil type.
Compiled by TASFLORA

Common plant name	*soil type*							*Botanical name*
Common plant name	Wet	Dry	Margin	Clay	Sand	Loam	Salt tolerant	Genus and species
Grasses & sedges								Grasses & sedges
southern cordrush	✓		✓	✓	✓	✓		*Baloskion australe*
tassel cordrush	✓		✓	✓	✓	✓		*Baloskion tetraphyllum*
tall sedge	✓		✓	✓		✓		*Carex appressa*
tassell sedge	✓		✓	✓		✓		*Carex fascicularis*
curly sedge		✓	✓	✓		✓		*Carex tasmanica*
spreading flaxlily		✓	✓	✓	✓	✓		*Dianella revoluta*
forest flaxlily	✓	✓	✓	✓	✓	✓		*Dianella tasmanica*
western flag-iris	✓		✓	✓	✓	✓		*Diplarrena latifolia*
white flag-iris	✓	✓	✓	✓	✓	✓		*Diplarrena moraea*
knobby clubsedge	✓	✓	✓	✓	✓	✓	✓	*Ficinia nodosa*
cutting grass	✓		✓	✓		✓		*Gahnia grandis*
sea rush	✓		✓	✓	✓	✓	✓	*Juncus kraussii*
pale rush	✓		✓	✓	✓	✓		*Juncus pallidus*
sage		✓	✓	✓	✓	✓		*Lomandra longifolia*
silver tussockgrass	✓	✓	✓	✓	✓	✓		*Poa labillardierei*
velvet tussockgrass		✓	✓	✓		✓		*Poa rodwayi*
Low shrubs (up to 1.5m)								Low shrubs (up to 1.5m)
wiry bauera			✓			✓		*Bauera rubioides*
hop native-primrose	✓	✓	✓	✓	✓	✓		*Goodenia ovata*
slender honeymyrtle	✓		✓	✓		✓		*Melaleuca gibbosa*
Tall shrubs/trees (2-5m)								Tall shrubs/trees (2-5m)
silver wattle		✓	✓		✓	✓		*Acacia dealbata*
blackwood	✓		✓	✓		✓		*Acacia melanoxylon*
arching wattle	✓		✓	✓		✓		*Acacia riceana*
prickly moses			✓	✓	✓	✓		*Acacia verticillata*
yellow bottlebrush		✓	✓	✓		✓		*Callistemon pallidus*
prickly bottlebrush	✓		✓	✓		✓		*Callistemon viridiflorus*
native hop		✓	✓	✓	✓	✓		*Dodonaea viscosa*
smoky teatree		✓	✓		✓	✓		*Leptospermum glaucescens*
woolly teatree	✓	✓	✓	✓		✓		*Leptospermum lanigerum*
shiny teatree	✓		✓	✓		✓		*Leptospermum nitidium*
river teatree	✓		✓	✓		✓		*Leptospermum riparium*
common teatree		✓	✓	✓	✓	✓		*Leptospermum scoparium*
warty paperbark	✓		✓	✓		✓		*Melaleuca pustulata*
swamp honeymyrtle	✓		✓	✓		✓		*Melaleuca squamea*
scented paperbark	✓		✓	✓		✓		*Melaleuca squarrosa*
common dogwood	✓		✓	✓		✓		*Pomaderris apetala*
Trees (>10m)								Trees (>10m)
black gum	✓		✓	✓		✓		*Eucalyptus ovata*
Exotics								
Pittosporum bicolor								
Pittosporum Tenuifolium								
coleonema								
acemena (lillypilly)								
ceanothus								
hebe all varieties are very good with the exception of hebe emerald green								
penstemon								
abelia								
buxus sempervirens								
*Fruit trees are not recommended in an irrigation area.								

Document Set ID: 4818445
Version: 1, Version Date: 12/08/2026

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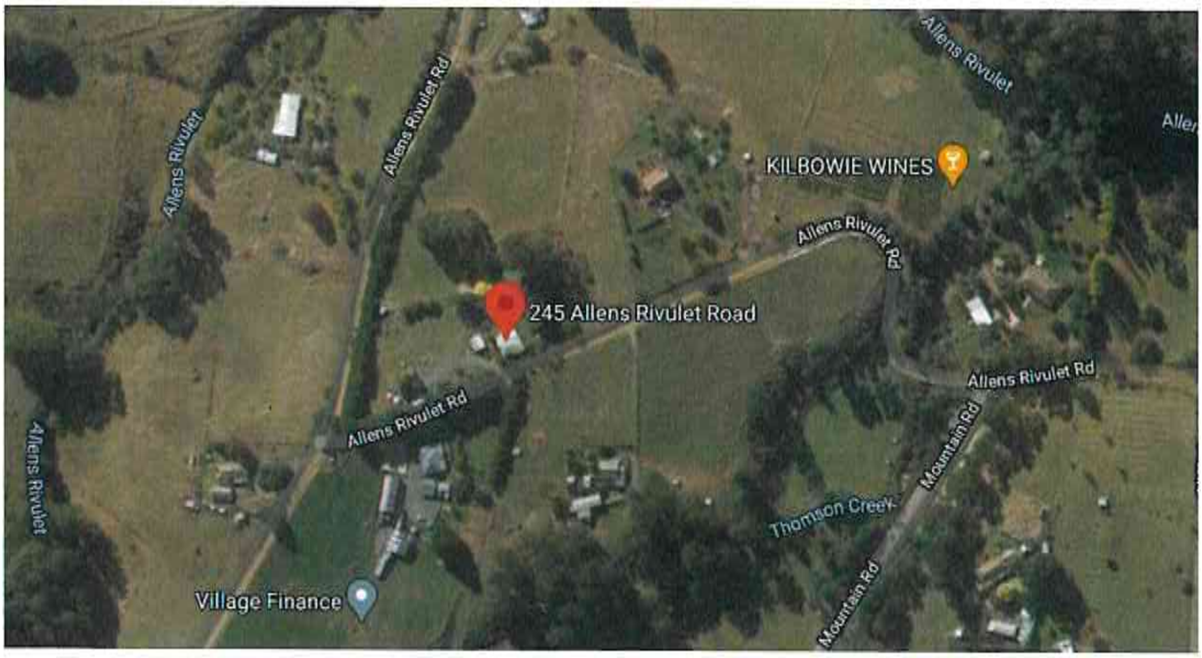
AS2870 SITE CLASSIFICATION REPORT

SR 2171

ANDREW CRACK

245 ALLENSRIVULET ROAD, ALLENS RIVULET

OCTOBER 2020



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REF NO: SR2171

DATE : 5TH OCTOBER 2020

AS2870 SITE CLASSIFICATION REPORT

PROJECT: 245 ALLENS RIVULET ROAD, ALLENS RIVULET

CLIENT : Andrew Crack - (Graham Hills)

GENERAL OBSERVATIONS

The site has a gentle slope of 2^0 to 3^0.
The site cover is grass and trees.
The weather on the day was fine.

CORE LOG

Soil profile for natural ground is:
Four types of soil were found.
Type A – Layer of top soil approximately 0.10m thick.
Type B – Layer of soft moist, light brown highly weathered mudstone derived plastic clay approximately 0.65m thick.(CL).
Type C – Layer of moist soft reddish plastic clay approximately 0.25m thick. (CL)
Type D – Layer of moist light brown plastic clay with small mudstone fragments approximately 0.30 thick. (CL)

Our bores terminated on highly weathered mudstone approximately 1.30m below surface level.

GEOLOGY – PERMIAN : Fine sandstone, coarse siltstone , and fossiliferous mudstone at undetermined depths. Dominant Soils – Variable from thin yellow grey silty sand to gravel overlies thick yellow clayey gravel/clay.

SOIL PROPERTIES
LIQUID LIMIT.................21 – 68 %
PLASTICITY INDEX......... 3 – 49 %
LINEAR SHRINKAGE....... 1 – 17 %

CLASSIFICATION

We classify the site in accordance with AS 2870 to be class M

PERMEABILITY Constant head permeability result yielded <0.01m/day.

WIND CLASSIFICATION

The site is classified in accordance with the AS 1170 part 2 and the residential wind code AS4055 to be class N3 with a design wind velocity of 41 m/s.

GEOGRAPHIC REGION – A
TERRAIN CATEGORY – TC2.5
SHIELDING –NS
TOPOGRAPHIC CLASSIFICATION – T1

SLOPE STABILITY

I have checked the publicly available records and have found no information concerning reported instability problems for this site.

EROSION

The clay materials which underline the site are not dispersive in nature and therefore are not susceptible to erosion. Also the site in general has a good grass covering. No evidence of erosion was observed at the proposed house site. If vegetation is stripped erosion will take place.

SITE MAINTENANCE RECOMMENDATION

The future performance of the structure can be affected by unsuitable garden practices. Please refer to the enclosed copy of the C.S.I.R.O Information Services Brochure No 10-91 - Trees and Foundations, for information.
We recommend a cut off drain be provided around the proposed structure.

CAUTION

This report is based on site as inspected. Changes to the site such as major excavation or fill will alter its classification.
Representative samples of the soil were taken for assessment. However, it is possible for significant site variation to be encountered during construction. If such does occur, further assessment will be required. Consult the writer if any of the above occur.

CONCLUSION

The subject land is suitable from stability point of view for the proposed development subject to the recommendations included in this report being carried out.

This site classification is valid for one year from date of issue only.

The Institution of Engineers, Australia
Joseph Mamic
MIEAust CPEng
Chartered Professional Engineer
Membership No. 619436

J.Mamic
B.E. MASc M.I.E.Aust. M.I.A.B.S

REFERENCES:
AS 1726 – 1993 Geotechnical site investigation
AS2870 – 2011 Residential slabs & footings
AS4055 – 2006 Wind loads for housing
AS1170 – 2011 Part 2 Wind loads
Institution of Engineers Australia (Tasmanian Branch) publication – Recommended Practice for Site Classification to AS2870 in Tasmania.


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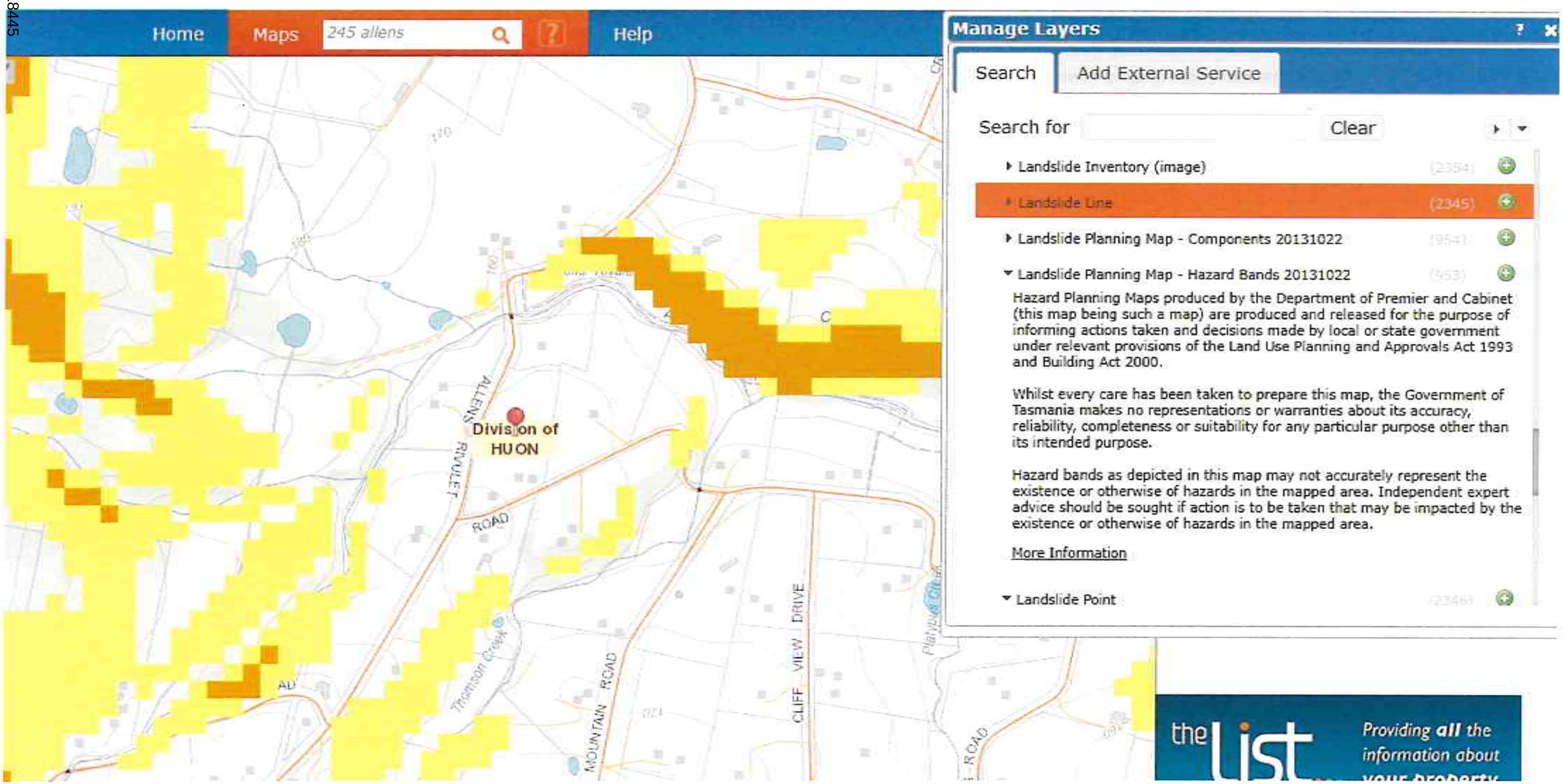
Home
Maps
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Manage Layers
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Add External Service
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Landslide Inventory (image)
Landslide Line
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Landslide Planning Map - Components 20131022
Landslide Planning Map - Hazard Bands 20131022
Hazard Planning Maps produced by the Department of Premier and Cabinet (this map being such a map) are produced and released for the purpose of informing actions taken and decisions made by local or state government under relevant provisions of the Land Use Planning and Approvals Act 1993 and Building Act 2000.
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Hazard bands as depicted in this map may not accurately represent the existence or otherwise of hazards in the mapped area. Independent expert advice should be sought if action is to be taken that may be impacted by the existence or otherwise of hazards in the mapped area.
More Information
Landslide Point
Division of HUON
ALLENS RIVULET ROAD
MOUNTAIN ROAD
CLIFF VIEW DRIVE
Thomson Creek
ROAD
the list
Providing all the information about

Foundation Maintenance and Footing Performance: A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

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

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

Soil Types

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

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

Causes of Movement

Settlement due to construction

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

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

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

Erosion

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

Saturation

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

Seasonal swelling and shrinkage of soil

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

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

Shear failure

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

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

GENERAL DEFINITIONS OF SITE CLASSES

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

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

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

Unevenness of Movement

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

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

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

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

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

Effects of Uneven Soil Movement on Structures

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

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

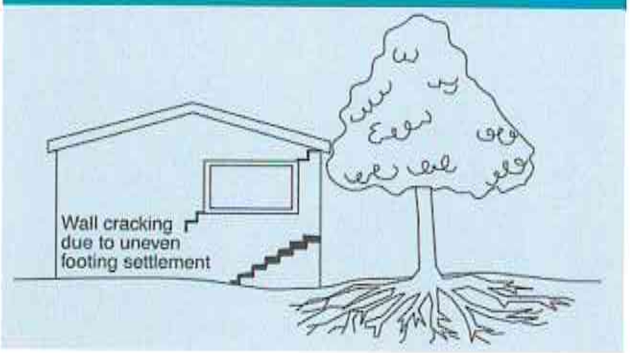
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

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

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

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

Trees can cause shrinkage and damage



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

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

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

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

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

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

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

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

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

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

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

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

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

Water Service and Drainage

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

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

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

Seriousness of Cracking

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

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

Prevention/Cure

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

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

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

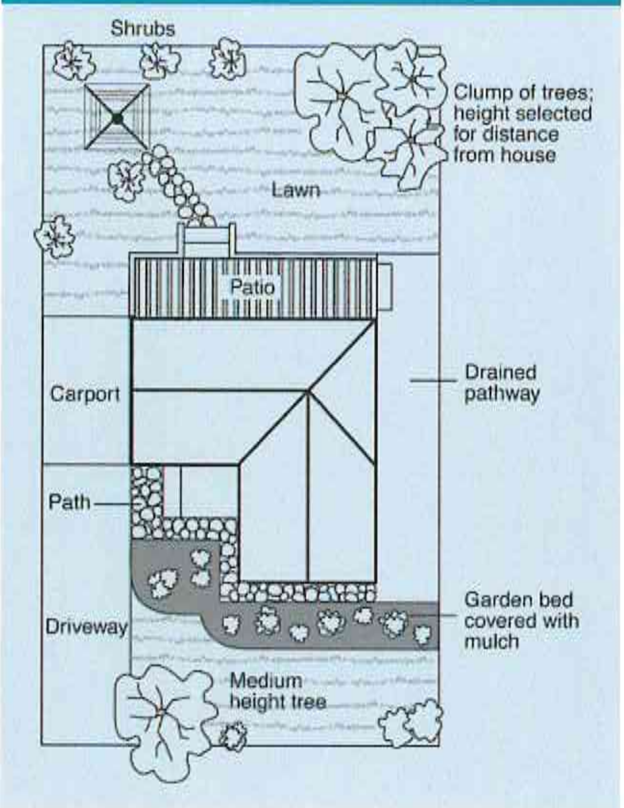
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

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

Gardens for a reactive site



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

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

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

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

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

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

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

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

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

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

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

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

Remediation

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

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

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

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Soil Description Explanation Sheet(1of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Classification System (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	Fine	75 μm to 200 μm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

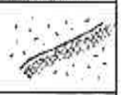
Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of Material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
			DRY STRENGTH		DILATANCY	TOUGHNESS		
		SILTS & CLAYS Liquid limit less than 50	None to Low		Quick to slow	None	ML	SILT
			Medium to High		None	Medium	CL	CLAY
			Low to medium		Slow to very slow	Low	OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium		Slow to very slow	Low to medium	MH	SILT
			High		None	High	CH	CLAY
			Medium to High		None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT
• Low plasticity – Liquid Limit WL less than 35%. • Medium plasticity – WL between 35% and 50%.								

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Borehole Log Explanation Sheet

Method

TERM	Description
AS	Auger Screwing*
AD	Auger Drilling*
RR	Roller / Tricone
W	Washbore
CT	Cable Tool
HA	Hand Auger
DT	Diatube
B	Blank Bit
V	V Bit
T	TC Bit

* Bit shown by suffix e.g. ADT

Support

TERM	Description
M	Mud
N	Nil
C	Casing

Notes, samples, tests

TERM	Description
U_{50}	Undisturbed sample 50 mm diameter
U_{63}	Undisturbed sample 63 mm diameter
D	Disturbed sample
N	Standard Penetration Test (SPT)
N*	SPT – sample recovered
N_c	SPT with solid cone
V	Vane Shear
PP	Pocket Penetrometer
P	Pressumeter
B_s	Bulk sample
E	Environmental Sample
R	Refusal

Penetration

1	2	3	4	
				No resistance ranging to refusal

Water

Symbol	Description
	Water inflow
	Water outflow
	17/3/08 water on date shown

Classification symbols and soil description

Based on unified classification system

Moisture

TERM	Description
D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Consistency/Density index

TERM	Description
VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	Very dense

DISPERSIVE SOILS *and their* MANAGEMENT

Guidelines for Landholders, Planners and Engineers

1.0 WHY MANAGEMENT OF DISPERSIVE SOILS IS IMPORTANT

In recent years, urban expansion has occurred in areas with dispersive soils. Disturbance of dispersive soils has resulted in tunnel erosion, damage to infrastructure, and environmental harm. Greater awareness of the difficulties posed by development on dispersive soils is required to prevent future damage. Tunnel erosion results in the formation of underground cavities that can collapse causing gully erosion and damage to infrastructure such as optical fibre cables, septic systems, roads, culverts and dwellings. Unlike other forms of erosion, tunnel erosion involves both chemical and physical processes associated with the dispersion of sodic clays. Given the difficulty of repairing tunnel erosion, management effort is focused on prevention of tunnel formation through increased understanding and awareness of the issues associated with construction and development on dispersive soils.

Figure 1. Tunnel and gully erosion resulting from construction of a stormwater culvert in dispersive clay.

2.0 WHERE DO DISPERSIVE SOILS OCCUR?

Dispersive soils and tunnel erosion occur in all municipalities in southern Tasmania, as well as parts of the Northern Midlands, Tamar Valley and Break O'Day municipalities. Dispersive soils are generally associated with soils derived from Triassic sandstone, or Permian mudstone. The location and extent of dispersive soils has not been specifically mapped in Tasmania, although broad scale land systems mapping indicates that approximately 103,000 ha of private freehold land in Tasmania contains a tunnel erosion hazard.

Tunnel erosion mostly occurs on;

- Dispersive, or sodic soils.
- Soils derived from Triassic sandstone and Permian mudstone.
- Deep sedimentary soils.
- North and northeast facing slopes.
- Drainage lines.
- Areas in which vegetation, soils or hydrology have been disturbed.
- Areas with less than 700 mm annual rainfall.

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Tasmania
Explore the possibilities

3.0 IDENTIFICATION OF DISPERSIVE SOILS

- Dispersive soils can be identified by dribble patterns and pitting (Figure 2).
- Early stages of tunnel erosion can be identified by the development of 'spew holes' and fans of dispersed material ejected from tunnels (Figure 3).
- Simple field tests can be used to identify the presence of dispersive soils.
- For engineering works or infrastructure development, a combination of analytical and physical tests may be required to predict dispersive behaviour in soils.

Figure 2 (a). Example of dribble pattern on an exposed subsoil, the photograph was taken from within an actively eroding tunnel system. (b) Dribble patterns on sodic soil ped.

Figure 3. Sediment fans or 'spew holes' are often the first obvious sign of tunnel erosion

SIMPLE TEST FOR IDENTIFYING DISPERSIVE SOILS.

Field testing for dispersive soils can be conducted by observing the behaviour of air dried soil aggregates in distilled water or rainwater.

1) Collect soil aggregates (1-2 cm diameter) from each layer in the soil profile.
2) If moist, dry the aggregates in the sun for a few hours until approximately air dried.
3) Place the aggregates in a shallow glass jar or dish of distilled water or rainwater (not tap water). It may help to place the jar on black card or a dark surface. (Distilled water can be purchased at most supermarkets).
4) Leave the aggregates in water without shaking or disturbing them for 1 hour.
5) Observe and record if you can see a milky ring around the aggregates. Don't worry if the soil collapses or bubbles (figure 4).

Caution: Aggregates may not disperse when they should if they haven't been sufficiently dried. Importantly, while the presence of a milky halo indicates the presence of dispersion, the absence of a milky halo does not necessarily mean that soil will not disperse, especially after disturbance. Further testing using an approved Australian Standard technique may be required.

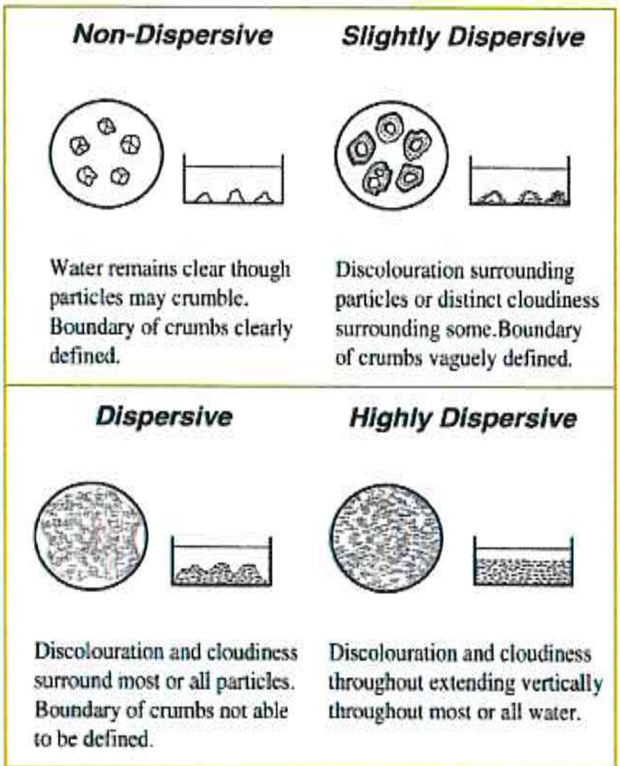

Figure 4. Field test for aggregate dispersion (Sorensen 1995).

4.0 ACTIVITIES THAT INCREASE THE RISK OF INITIATING TUNNEL EROSION

In almost all cases tunnel erosion results from some form of disturbance which allows rainwater to come into direct contact with dispersive subsoils. Activities that increase the risk of exposing dispersive subsoils to rainfall include;

- Removal of topsoil.
- Subsoil excavations (cut and fill).
- Supply of services by trenches.
- Construction of roads and culverts in dispersive soils
- Sewage and grey water disposal systems in dispersive soils
- Dam construction from dispersive clays.

Changes to hydrology, such as concentration of flow in culverts, runoff from hardened areas and ponding of rainfall may also increase the likelihood of tunnel erosion.

Figure 5. Piping failure or tunnel erosion in a dam constructed from soils derived from Permian mudstone. This dam is known to have failed on first filling. The image was taken from the dam floor.

5.0 STRATEGIES TO REDUCE RISK ASSOCIATED WITH DISTURBANCE OF DISPERSIVE SOILS

In order to prevent or repair tunnel erosion it is important to understand that unlike other forms of erosion, tunnel erosion results from chemical processes associated with dispersion of sodic subsoils. The risk of initiating tunnel erosion during construction or development of land containing dispersive soils can be minimised by;

- Identifying and avoiding disturbance to areas with dispersive subsoils.
- Minimising excavation of dispersive soils.
- Not allowing water to pond on the soil surface, or exposed subsoils.
- Keeping dispersive soils buried under topsoil.
- Maintaining vegetation cover.
- Use of gypsum or hydrated lime at appropriate rates.

Figure 6 (a). Tunnel erosion resulting from construction of a culvert in dispersive clay (b). Tunnel erosion caused by installation of optical fibre cable in dispersive soil.

RECOMMENDATIONS FOR REDUCING THE RISK OF TUNNEL EROSION IN PERI-URBAN AREAS

- 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.
- Do not allow rainwater to pond or sit on exposed 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 i.e., 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 exposed dispersive soils.
- If necessary create safe areas for discharge of runoff.
- If possible do not excavate culverts and drains in dispersive soils.
- Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive soil / spoil mixed with gypsum and vegetated.
- Avoid use of septic trench waste disposal systems. Consult your local council about the use of above ground treatment systems.
- Where possible do not construct dams from 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 or soil specialist before commencing construction.

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

6.0 FURTHER INFORMATION

Comprehensive information on the management of dispersive soils in Tasmania is available in the companion document '*Dispersive Soils and Their Management : Technical Reference Manual*'. Hardie 2008, DPIW, Tasmania

Dispersive soils - high risk of tunnel erosion. Fact Sheet 2. Soil and water management on construction sites series, Department of Tourism, Arts and the Environment (DTAE).

Seek advice from your local council, the Department of Primary Industries and Water (DPIW), a suitably qualified and experienced soil specialist, or a civil engineer.

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ISBN 978-0-7246-6773-4

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