PP33/2019-1

2010 Colac Lavers Hill Road GELLIBRAND

Lot: 2 LP: 120918

Construction of Dwelling

G A De La Rue

Officer – Julia Repusic

EXHIBITION FILE

Submissions to this planning application will be accepted until a decision is made on the application.

If you would like to make a submission relating to a planning permit application, you must do so in writing to the Planning Department

Office Use Only					
Application No.:			Fee:	$	
Date Lodged:	/	/	Receipt No.:		
Date Allocated:	/	/	Ward:		
Allocated to:			Zone(s):		
			Overlay(s):		

Planning Enquiries
Phone: (03) 5232 9412
Web: www.colacotway.vic.gov.au

Application for **Planning Permit**

Use this form to make an application for a planning permit and to provide the information required by section 47 of the *Planning and Environment Act 1987* and regulations 15 and 38 of the Planning and Environment Regulations 2005.

Supplementary information requested in this form should be provided as an attachment to your application. Please print clearly or complete the form electronically (refer to How to complete the Application for Planning Permit form).

Privacy notice

⚠ Information collected with this application will only be used to consider and determine the application. It will be made available for public inspection in accordance with section 51 of the *Planning and Environment Act 1987*.

Need help with the application?

If you need help to complete this form, read *How to complete the Application for Planning Permit form*. For more information about the planning process, refer to *Planning: a Short Guide*. These documents are available from your local council, the Planning Information Centre (Ph: 03 9637 8610, 8 Nicholson Street, Melbourne), or www.dse.vic.gov.au/planning.

Contact council to discuss the specific requirements for this application and obtain a planning permit checklist. Insufficient or unclear information may delay your application.

(1) Has there been a pre-application meeting with a council officer?

☑ Yes ☐ No

If yes, with whom?: Helen Evans

Date: 18 / 02 / 2019

The land

(2) Address of the land. Complete the Street Address and one of the Formal Land Descriptions.

Street Address

Street No.: 2010

Street Name: Colac Lavers Hill Road

Suburb/Locality: Kawarren

Postcode: 3249

Formal Land Description

⚠ This information can be found on the certificate of title.

Lot No.: 2

on Lodged Plan, Title Plan or Subdivision Plan No.: LP120918

OR

Crown Allotment No.:

Section No.:

Parish Name:

(3) Title information.

☑ Attach a full, current copy of title information for each individual parcel of land, forming the subject site.

(4) Describe how the land is used and developed now.

eg. single dwelling, three dwellings, shop, factory, medical centre with two practitioners, licensed restaurant with 80 seats.

Vacant farmland with Hay Shed

(5) Plan of the land.

☑ Attach a plan of the existing conditions. Photos are also helpful.

The proposal

⚠ You must give full details of your proposal and attach the information required to assess the application.

If you do not give enough detail or an adequate description of the proposal you will be asked for more information. This will delay your application.

(6) For what use, development or other matter do you require a permit?

Read *How to complete the Application for Planning Permit form* if you need help in describing your proposal.

Add a residence, with the existing sheds

(7) Additional information about the proposal.

Contact council or refer to council planning permit checklists for more information about council's requirements.

☑ Attach additional information providing details of the proposal, including:

- ☐ Any information required by the planning scheme, requested by council or outlined in a council planning permit checklist.
- ☑ Plans showing the layout and details of the proposal.
- ☐ If required, a description of the likely effect of the proposal (eg. traffic, noise, environmental impacts).

(8) Encumbrances on title.

Encumbrances are identified on the certificate of title.

Is the land affected by an encumbrance such as a restrictive covenant, section 173 agreement or other obligation on title such as an easement or building envelope?

- ☑ No, go to 9.
- ☐ Yes, ☑ Attach a copy of the document (instrument) specifying the details of the encumbrance.

  Does the proposal breach, in any way, the encumbrance on title?

  - ☐ No, go to 9.
  - ☐ Yes, contact council for advice on how to proceed before continuing with this application.

⚠ Note

Council must not grant a permit that authorises anything that would result in a breach of a registered restrictive covenant (sections 61(4) and 62 of the *Planning and Environment Act 1987*).

Contact council and/or an appropriately qualified person for advice.

Costs of buildings and works/permit fee

Most applications require a fee to be paid. Where development is proposed, the value of the development affects the fee. Contact council to determine the appropriate fee.

(9) Estimated cost of development for which the permit is required.

Cost $ 190,000.00 ⚠ You may be required to verify this estimate.

Write 'NIL' if no development is proposed (eg. change of use, subdivision, removal of covenant, liquor licence)

(10) Do you require a receipt for the permit fee?

☑ Yes ☐ No

Contact, applicant and owner details

(11) Provide details of the contact, applicant and owner of the land.

Contact

The person you want Council to communicate with about the application.

Name: G A De la Rue

Organisation (if applicable): Architect

Postal address: PO Box 92,

Colac Postcode: 3 2 5 0

Contact phone: 5231 4787 ☐

Mobile phone: 0419 351 185 ☑

Email: gdelarue@iinet.net.au ☑

Fax: - ☐

Indicate preferred contact method

Applicant

The person or organisation who wants the permit.

☑ Same as contact. If not, complete details below.

Name:

Organisation (if applicable):

Postal address:

Postcode:

Owner

The person or organisation who owns the land.

☐ Same as contact ☐ Same as applicant

Where the owner is different from the applicant or contact, provide the name of the person or organisation who owns the land.

Name (if applicable): Mr Graeme Sutherland

Organisation (if applicable):

Postal address: Colac Lavers Hill Road

Kawarren Postcode: 3 2 4 9

Checklist

(12) Have you?

☑ Filled in the form completely?

☑ Paid or included the application fee?

☑ Attached all necessary supporting information and documents?

☐ Completed the relevant council planning permit checklist?

☑ Signed the declaration on the next page?

Declaration

(13) This form must be signed. Complete one of A, B or C

⚠ Remember it is against the law to provide false or misleading information, which could result in a heavy fine and cancellation of the permit.

A Owner/Applicant

I declare that I am the applicant and owner of the land and all the information in this application is true and correct.

Signature

Date: D D / M M / Y Y Y Y

B Owner

I declare that I am the owner of the land and I have seen this application.

Signature

Date: D D / M M / Y Y Y Y

Applicant

I declare that I am the applicant and all of the information in this application is true and correct.

Signature

Date: D D / M M / Y Y Y Y

C Applicant

I declare that I am the applicant and:

- I have notified the owner about this application;
- and all the information in this application is true and correct.

Signature

Date: 18 / 02 / 2019

Lodgement

Lodge the completed and signed form and all documents with:

Colac-Otway Shire □□

PO Box 283, □COLAC VIC 3250□

2-6 Rae Street, COLAC VIC 3250□□

Telephone: (03) 5232 9412 □□

Fax: (03) 5232 1046 □□

For help or more information

Email: inq@colacotway.vic.gov.au □□

TTY: (03) 5231 6787□□

REGISTER SEARCH STATEMENT (Title Search) Transfer of Land Act 1958

VOLUME 09204 FOLIO 716 Security no : 124076195555X
Produced 18/02/2019 05:03 PM

LAND DESCRIPTION

Lot 2 on Plan of Subdivision 120918.
PARENT TITLE Volume 08100 Folio 822
Created by instrument LP120918 27/05/1977

REGISTERED PROPRIETOR

Estate Fee Simple
Joint Proprietors
GRAEME PETER SUTHERLAND
STEPHANIE SUTHERLAND both of GELLIBRAND
G730834 02/08/1977

ENCUMBRANCES, CAVEATS AND NOTICES

Any encumbrances created by Section 98 Transfer of Land Act 1958 or Section 24 Subdivision Act 1988 and any other encumbrances shown or entered on the plan or imaged folio set out under DIAGRAM LOCATION below.

DIAGRAM LOCATION

SEE LP120918 FOR FURTHER DETAILS AND BOUNDARIES

ACTIVITY IN THE LAST 125 DAYS

NIL

----------END OF REGISTER SEARCH STATEMENT----------

Additional information: (not part of the Register Search Statement)

Street Address: 2010 COLAC-LAVERS HILL ROAD GELLIBRAND VIC 3239

DOCUMENT END

Imaged Document Cover Sheet

The document following this cover sheet is an imaged document supplied by LANDATA®, Land Use Victoria.

Document Type	**Plan**
Document Identification	**LP120918**
Number of Pages (excluding this cover sheet)	**1**
Document Assembled	**18/02/2019 17:17**

LP120918
EDITION 2
APPROVED 6/10/77

M.

PLAN OF SUBDIVISION

OF PARTS OF CROWN ALLOTMENTS 25D, 25E & 25F

SECTION A

PARISH OF YAUGHER

COUNTY OF POLWARTH

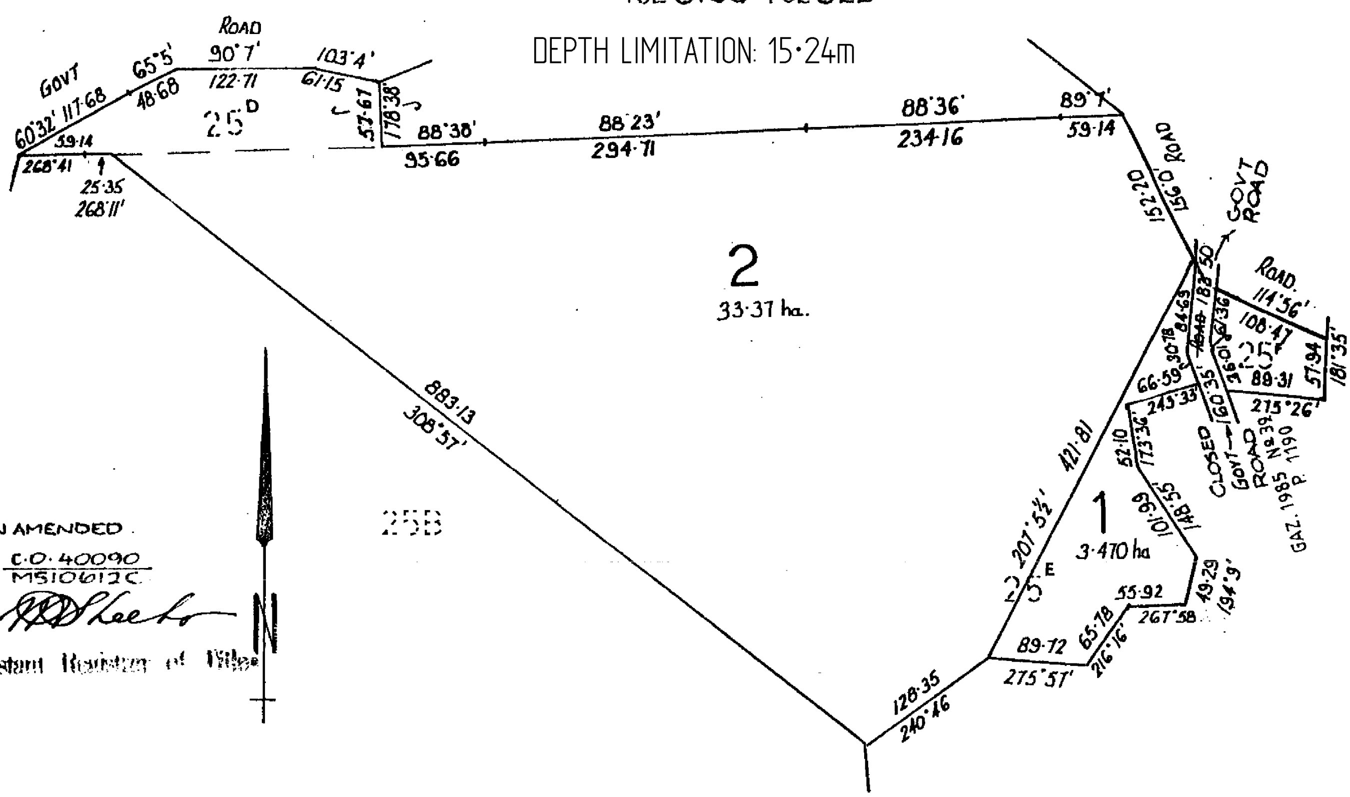
Scale 100 50 0 100 200 300

lengths are in metres

NOTATIONS
WATERWAY NOTATION:
LOT 1 IN THIS PLAN MAY ABUT CROWN LAND THAT MAY BE SUBJECT TO A CROWN LICENCE TO USE

VOL 8100 FOL 822

DEPTH LIMITATION: 15·24m



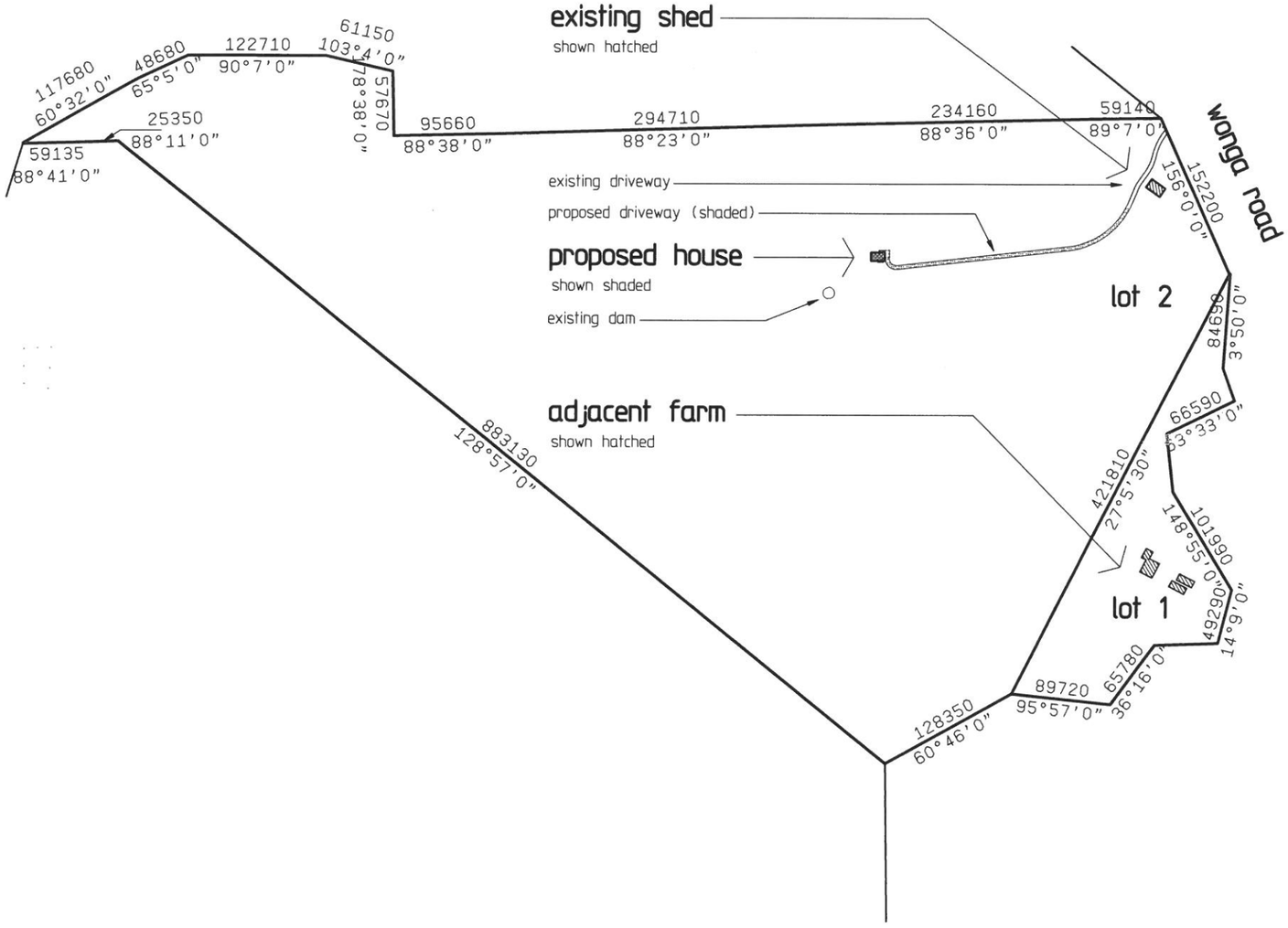
PLAN AMENDED VIDE C.O. 40090 M510612C

Assistant Registrar of Titles

LIST OF MODIFICATIONS

LAND	MODIFICATION	DEALING No.	A.R.T	EDN. No.
	CROWN BOUNDARY ADDED	———		2

SEAL AND ENDORSEMENT OF COUNCIL	SURVEYORS CERTIFICATION
Twentieth October, 76	I certify that this plan has been prepared by me, accords with Certificate of Title Volume 8100 Folio 822, is mathematically correct, and is not based on survey. Signed [signature] L.S. Dated 27-8-76
[signatures]	Greg Speirs Licensed Surveyor Box 248. P.O Colac Phone Colac 314475.



new driveway and turning area shown shaded, allow to cut & fill as req'd. to achieve the desired levels

outline of area set aside for effluent disposal field

refer to the geotech report for reference to the best effluent disposal field location

locate the effluent disposal field above the wetter, lower section of the site, after liaising with the COS health surveyor

bush fire rating:

BAL has been .....TBC

Geoff De La Rue
b arch, raia, bdav

architect

26 murray street colac
po box 92 colac 3250
telephone 03 52314787
mobile 0419 351 185
email gdelarue@iinet.net.au

site plan

scale: 1:5,000

REVISIONS:

NOTES:
DO NOT SCALE OFF THE DRAWINGS
REFER TO FIGURED DIMENSIONS ONLY
BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - site plan

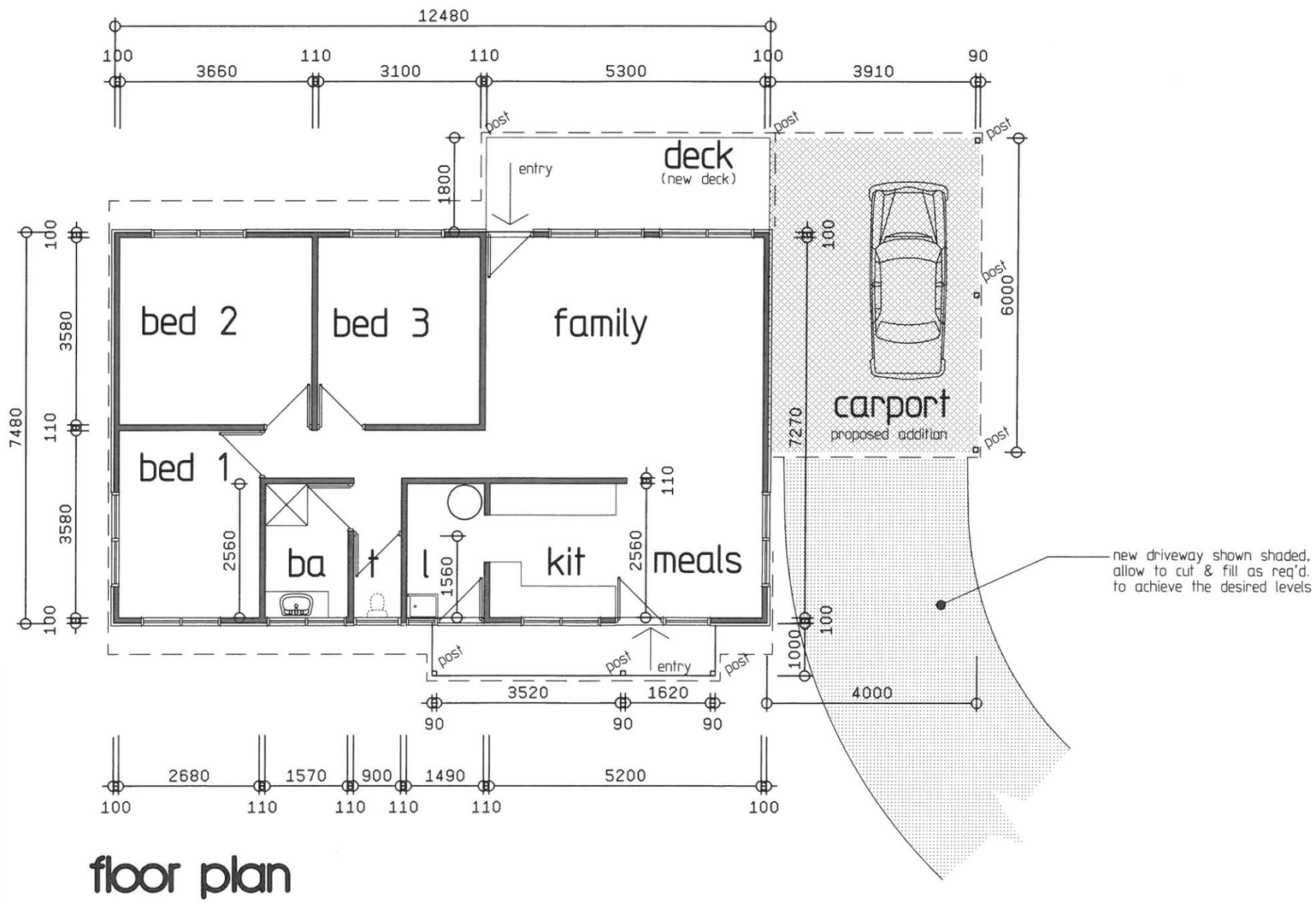
DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD.....
DATE: 20-09-18

SCALE: AS SHOWN
ISSUED: .....
TO: .....
FOR: .....

18:34
PROJECT NUMBER:

01 3 -
SHEET: OF: REV:

A3
FORMAT



floor plan

scale: 1:100

Geoff De La Rue
b arch, raia, bdav

architect

26 murray street colac
po box 92 colac 3250
telephone 03 52314787
mobile 0419 351 185
email gdelarue@iinet.net.au

REVISIONS:

NOTES:
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BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

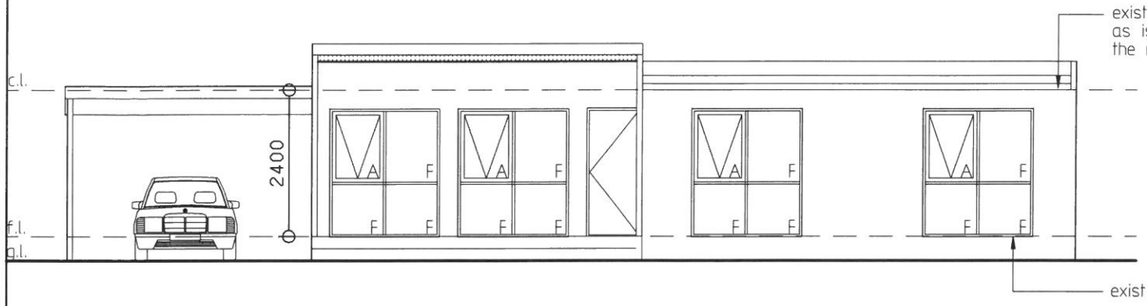
NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - proposed plan

DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD.....
DATE: 20-09-18

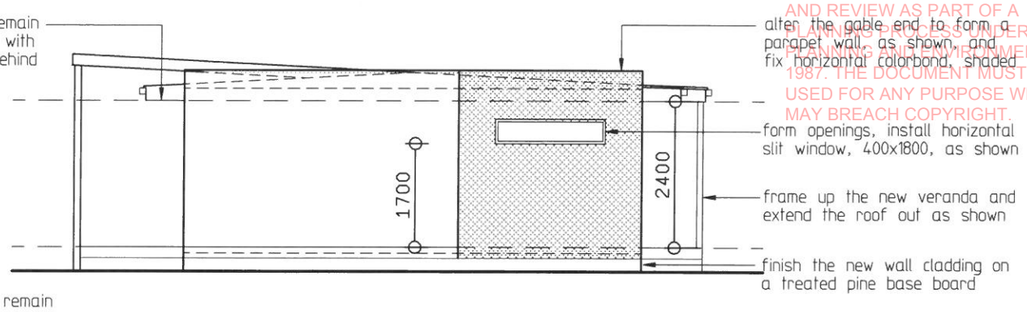
SCALE: AS SHOWN
ISSUED: .....
TO: .....
FOR: .....

18:34
PROJECT NUMBER:
02 3 -
SHEET: OF: REV:
A3
FORMAT



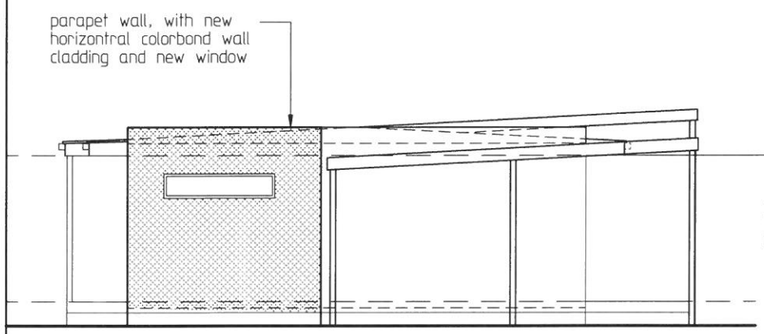
north elevation

scale: 1:100



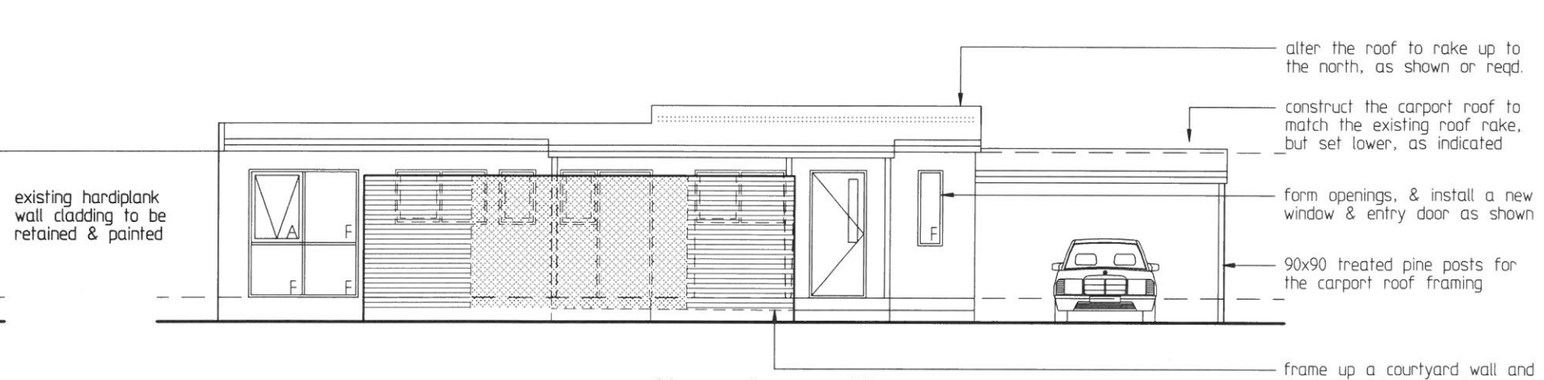
west elevation

scale: 1:100



east elevation

scale: 1:100



south elevation

scale: 1:100

general construction notes:

existing colorbond deck roof to be removed and re-used

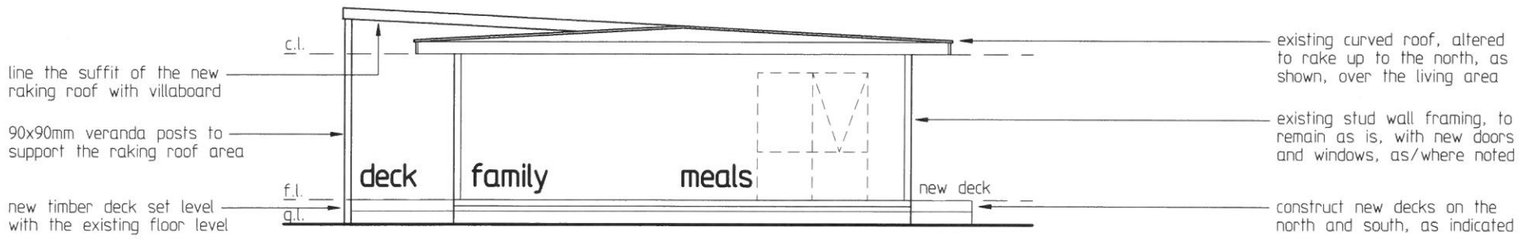
existing hardiplank cladding to be retained, generally

replace existing cladding with colorbond, where indicated

install new door and windows, & retain exg. where indicated

add carports and decking where indicated, as noted

concrete stumps to support the exg., relocated buildings



section 1

scale: 1:100, (typical)

Geoff De La Rue
b arch, raia, bdav

architect

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po box 92 colac 3250
telephone 03 52314787
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BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

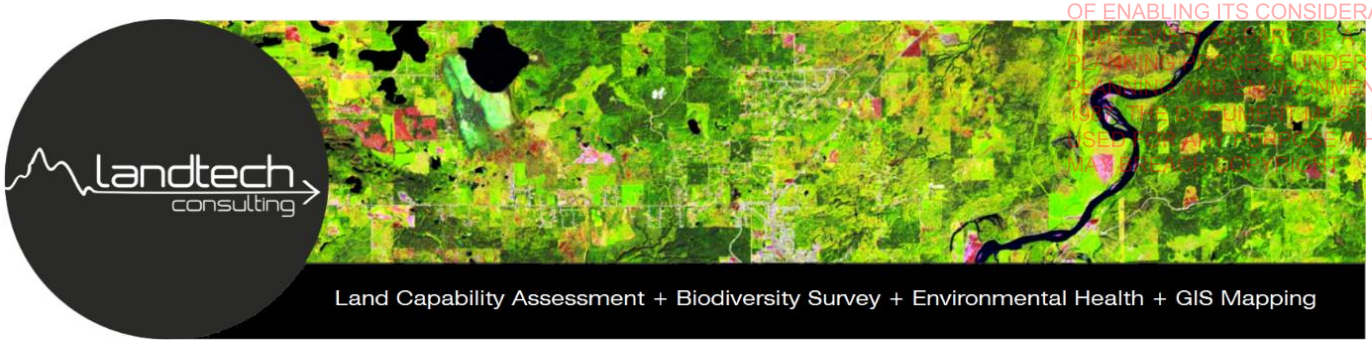
NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - proposed elevations

DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD
DATE: 20-09-18

SCALE: AS SHOWN
ISSUED:
TO:
FOR:

18-34 PROJECT NUMBER:
03 SHEET: 3 OF: - REV:
A3 FORMAT



LAND CAPABILITY ASSESSMENT
ONSITE DOMESTIC WASTEWATER SYSTEM MANAGEMENT REPORT
2010 COLAC-LAVERS HILL ROAD GELLIBRAND VIC 3239

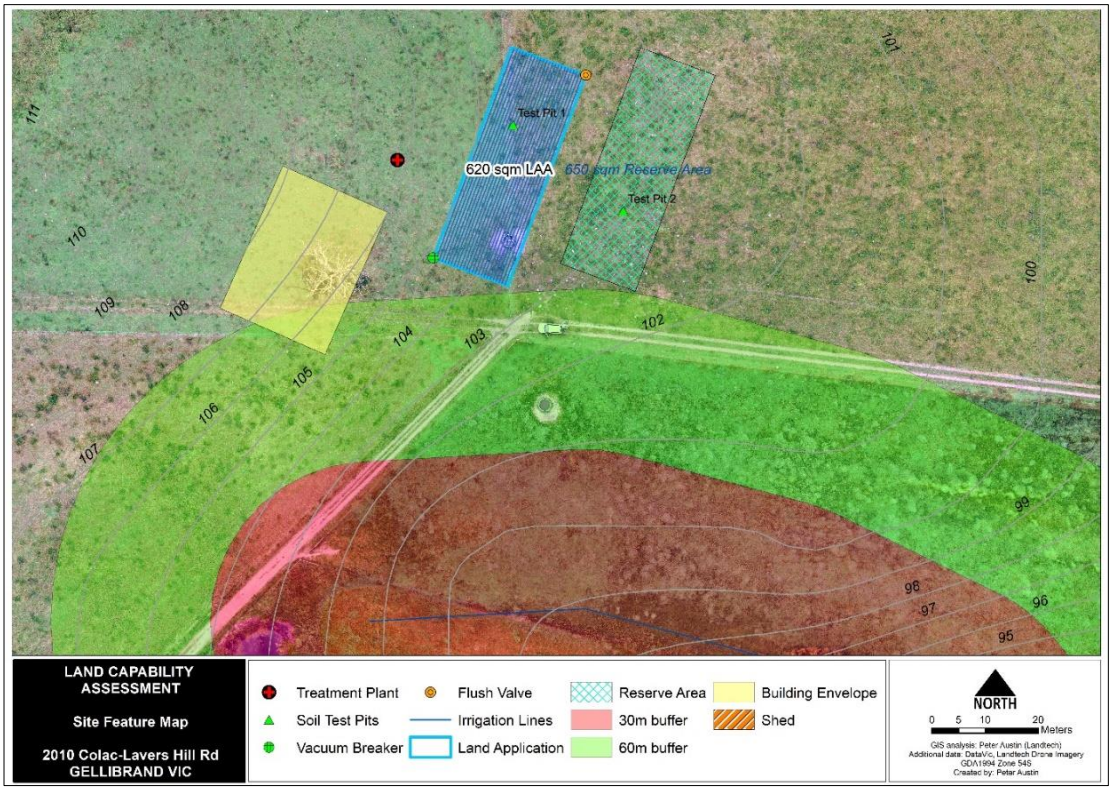


FIGURE 1 – Land Capability Assessment site consisting of evenly sloping former farmland/pasture.

1.0 INTRODUCTION

Landtech Consulting has been engaged to undertake a Land Capability Assessment (LCA) for the development of a proposed 4-bedroom dwelling at 2010 Colac-Lavers Hill Road GELLIBRAND VIC (Colac Otway Shire Council) (see *Figures 1* - 9).

This report will accompany a *Planning Permit* to be submitted to Council for such a development and the requirement for a compliant onsite wastewater system.

The site is a 10-15% east-west sloping 32.01ha *Farming Zone* lot proximal to the Gellibrand River, on former farming operations-based land where the dwelling will be developed.

The report will be based on wastewater load and best-practice onsite wastewater system for the potential 4-bedroom dwelling, with reduced relative land application size due to annual rainfall, soil texture, slope, and watercourse setback constraints (see *Figures 1-9*).

This LCA report provides information regarding site and soil conditions and recommendations for the proposed treatment system and land application method (LAA). The owner can provide Council further specific information regarding future site intentions.

The LCA includes a conceptual design for a suitable onsite wastewater system to meet *EPA guidelines (891.4:2016)*, including recommendations for system monitoring and management.

The field investigation and report has been undertaken and prepared by suitably qualified and experienced staff.

Landtech Consulting has appropriate qualifications, experience, and professional indemnity insurance for this type of work, and certification documents are available on request.

The assessment was completed in accordance with the *Environment Protection Authority's Code of Practice – Onsite Wastewater Management (EPA 891.4 - 2016)*, and guidelines such as *Land Capability Assessment for On-Site Wastewater Management (EPA Publication No. 746.1*, March 2003), and *On-Site Domestic Wastewater Management (AS/NZS 1547:2012)*.

FIGURE 2 – Lot with significant coverage of both strongly-growing pasture grass and patches of remnant vegetation.

1.1 REPORT SUMMARY

- Due to the requirement for the owner to gain a *Planning Permit* for the development of a proposed 4-bedroom dwelling on an essentially vacant lot, and for an onsite wastewater system, an LCA is additionally required to support such a process.
- The report is based on the owner's desire for a proposed 4-bedroom dwelling on the largely sloping *Farming*-zoned lot.
- The main constraining feature of the proposed dwelling and wastewater treatment is reduced relative land application size due to watercourse setback constraints, high relative annual rainfall, minor soil texture, and slope constraints (see *Figure 2*); which could be managed using secondary treatment and sub-surface irrigation, wick trenches etc., although with potentially large effluent disposal areas required (due primarily to higher relative annual rainfall totals and COS requirements).
- Due to the proposed location of the effluent disposal area and moderate slope constraints, an upslope diversion drain must be installed and configured to protect the disposal area from upslope run-on rain events.
- With the above varied constraints in mind, a conservative approach is taken to wastewater treatment system type and effluent disposal area type and sizing.
- It is recommended that secondary treatment (treated to '10/10/10' or 20/30/10 standard) is used allowing potential re-use of effluent to soil absorption, wick trenches etc.
- The proposed location of the effluent disposal area(s) meet required setbacks to the ephemeral watercourse and 1 in 20 and 1 in 100-year flood-level (although definitive data on such flood levels is lacking).
- Operation, maintenance, and management of the treatment and disposal system must be in accordance with the manufacturer's recommendations, the *EPA Certificate of Conformity*, the *EPA Code of Practice 891.4 (2016),* and the recommendations made in this report.
- With prescriptions built into the Council Permit conditions such as; strict quarterly servicing of the treatment plant and effluent disposal area; the required use of WELLS & AAA-rated appliances and plumbing fixtures (see *Appendix 4*).

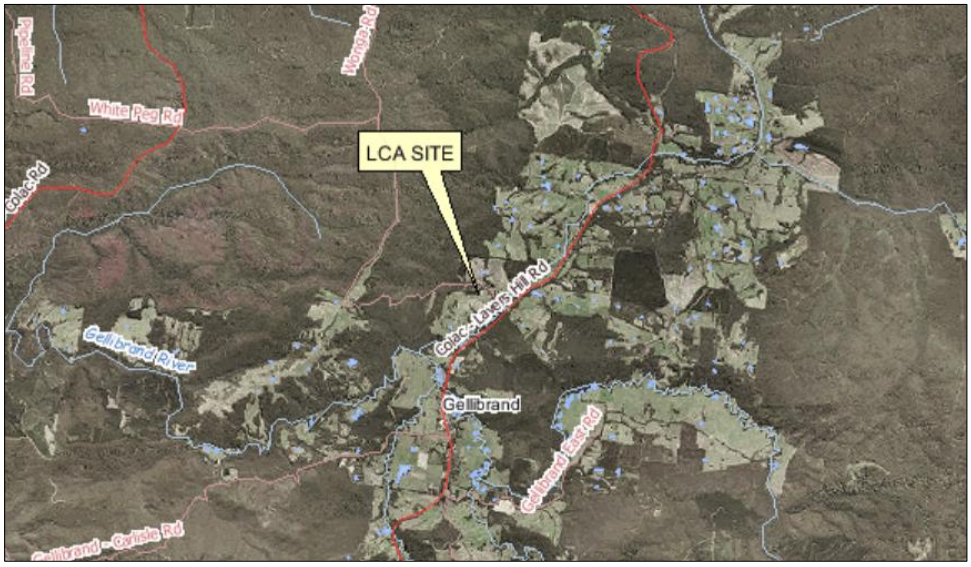


FIGURE 3 – Watercourses are numerous within the floodplain and hillslope landscape (Source: DELWP 2018).

2.0 DESCRIPTION OF THE DEVELOPMENT

The LCA site is located within rural agricultural operations and bushland acreage 'lifestyle' sites, with surrounding areas of fringing and former grazing land and forested sites, 2km north-east of the Gellibrand township.

The site shares an eastern boundary to the Gellibrand River although the proposed dwelling site is over 300m from this receptor.

The *Farming-zoned* lot exists within existing with adjoining remnant vegetation areas, with increased fire risk, but enhanced effluent disposal via productive pasture evapotranspiration.

Site constraints include increased site annual rainfall, reduced relative land application size due to soil, slope, and watercourse setback constraints. This reduces the range of potentially sustainable onsite wastewater treatment options.

However, with strict adherence to system maintenance, monitoring, and effective effluent disposal design, sustainable outcomes can result.

The lot contains adequate open areas facing east-south-east (see *Figures 4-5*), while maintaining excellent pasture cover within sites proximal to the dwelling, for enhanced effluent disposal.

The lot is moderately constraining for wastewater treatment however based on the use of secondary treatment, effective treatment can result.

Cost-effective use of tubestock indigenous local grasses, rushes, and sedges would form an effective evapotranspiration tool in multi-rowed plantings (below) bordering the effluent disposal area (for the proposed wastewater system).

By nature of the site's location it has an open and exposed easterly aspect to assist in effluent evaporation, in an area of relatively elevated annual rainfall.

The site sits relatively high in the immediate landscape and forms part of the foothill sub-catchment of the Gellibrand *River* (see *Figure 3*).

The lot is 32.01ha in size and includes agricultural infrastructure such as fencing and sheds (see *Figures 4 - 5 & 18*).

The lot is outside the 1 in 20 & 100-year flood coverage however is within a *Declared Water Supply Catchment Area*.

The lot includes sufficient land available for sustainable onsite effluent management that maintains appropriate buffers to such constraints.

Key site factors and proposed development descriptors are listed in *Table 1*.

FIGURE 4 – The LCA site slopes west to east with the Gellibrand River bordering the eastern boundary.

Table 1 - Site Description

<table>
<tr><td>Site address</td><td>Address: 2010 COLAC-LAVERS HILL ROAD GELLIBRAND 3239
Lot and Plan Number: This property has 6 parcels. See table below.
Standard Parcel Identifier (SPI): See table below.
Local Government (Council): COLAC OTWAY Council
Property Number: 20894
Directory Reference: VicRoads 101 A2

<table>
<tr><th>Lot/Plan or Crown Description</th><th>SPI</th></tr>
<tr><td>Lot 2 LP120918</td><td>2\LP120918</td></tr>
<tr><td>Lot 1 TP597868</td><td>1\TP597868</td></tr>
<tr><td>Lot 2 TP597868</td><td>2\TP597868</td></tr>
<tr><td>Lot 1 TP899907</td><td>1\TP899907</td></tr>
</table>
<table>
<tr><th>Lot/Plan or Crown Description</th><th>SPI</th></tr>
<tr><td>PARISH OF YAUGHER</td><td></td></tr>
<tr><td>Allot. 21S Sec. A</td><td>21S~A\PP3978</td></tr>
<tr><td>Allot. 25B Sec. A</td><td>25B~A\PP3978</td></tr>
</table>
</td></tr>
<tr><td>Owner / Developer</td><td>C/- Geoff De La Rue</td></tr>
<tr><td>Postal address</td><td>2010 COLAC-LAVERS HILL ROAD GELLIBRAND 3239</td></tr>
<tr><td>Contact</td><td>C/- Geoff De La Rue</td></tr>
<tr><td>Council area</td><td>Colac-Otway Shire Council</td></tr>
<tr><td>Zoning/Overlays</td><td>Planning Zone Summary
Planning Zones: FARMING ZONE (FZ)
SCHEDULE TO THE FARMING ZONE (FZ)
PUBLIC CONSERVATION AND RESOURCE ZONE (PCRZ)
SCHEDULE TO THE PUBLIC CONSERVATION AND RESOURCE ZONE (PCRZ)
Planning Overlays:
BUSHFIRE MANAGEMENT OVERLAY (BMO)
ENVIRONMENTAL SIGNIFICANCE OVERLAY (ESO)
ENVIRONMENTAL SIGNIFICANCE OVERLAY - SCHEDULE 2 (ESO2)
ENVIRONMENTAL SIGNIFICANCE OVERLAY - SCHEDULE 3 (ESO3)
EROSION MANAGEMENT OVERLAY (EMO) EROSION MANAGEMENT OVERLAY - SCHEDULE 1 (EMO1)
LAND SUBJECT TO INUNDATION OVERLAY (LSIO)
LAND SUBJECT TO INUNDATION OVERLAY SCHEDULE (LSIO)
Areas of Aboriginal Cultural Heritage Sensitivity: All or part of this property is an 'area of cultural heritage sensitivity'.</td></tr>
<tr><td>Key regulatory site constraints</td><td>FARMING ZONE (FZ)

To ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture.
To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.

35.07-2 Use of land for a dwelling

-The dwelling must be connected to a reticulated sewerage system or if not available, the waste water must be treated and retained on-site in accordance with the State Environment Protection Policy (Waters of Victoria) under the Environment Protection Act 1970.

PUBLICCONSERVATIONANDRESOURCEZONE
To protect and conserve the natural environment and natural processes for their historic, scientific, landscape, habitat or cultural values.

ENVIRONMENTAL SIGNIFICANCE OVERLAY (ESO) 42.01-5 31/07/2018 VC148

Decision guidelines

The statement of environmental significance and the environmental objective contained in a schedule to this overlay.

The need to remove, destroy or lop vegetation to create a defendable space to reduce the risk of bushfire to life and property. Any other matters specified in a schedule to this overlay.

EROSIONMANAGEMENTOVERLAY

Any proposed measures to manage concentrated runoff and site drainage.
Any proposed measures to minimise the extent of soil disturbance.</td></tr>
</table>

	Whether the removal of vegetation will increase the possibility of erosion, the susceptibility to landslip or other land degradation processes, and whether such removal is consistent with sustainable land management. The need to stabilise disturbed areas by engineering works or revegetation. Whether the land is capable of providing a building envelope which is not subject to high or severe erosion concern. LANDSUBJECTTOINUNDATIONOVERLAY To protect water quality in accordance with the provision relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and3 5 of the State Environment Protection Policy(Waters of Victoria). To ensure that development maintains or improves river and wetland health, waterway protection and floodplain health.
Allotment size	32.01ha
Domestic water supply	Reticulated supply not available.
Proposed development	Planning Permit for development of proposed 4-bedroom dwelling; requiring the provision of a Land Capability Assessment and related domestic wastewater system.
Anticipated wastewater load[1] [2]	A wastewater load of 900L/day ((4+1) x 180L/day) (AS/NZ1547) has been used in wastewater calculations to allow for a potential 4-bedroom dwelling.
Availability of sewer	The area is unsewered and is unlikely to be sewered in the medium term.
Treatment system required	Secondary treatment (such as OzziKleen RP10 – 10/10/10 standard).
Disposal system required	813m² subsurface irrigation calculated using the MAV Irrigation; Victorian Land Capability Assessment Framework (DIR 3.5mm/day – subsurface irrigation 4a category Silty Clay Loam soil). 33m² wick-trench basal area (COS Gellibrand Township sizing table). 112.5m lineal – Wick-trench sizing – 6 x 19m length (MAV Trench-sizing spreadsheet). Primary Treatment and Soil Absorption Trenches could not be considered due to rainfall, effluent sizing, soil depth and textural constraints.

[1] Victorian EPA Code of Practice – Onsite Wastewater Management (publication 891.4:2016).
[2] AS/NZS 1547:2000 – Onsite Domestic Wastewater Management (Appendix 4.2D) for standard water reduction fixtures.

3.0 SITE KEY FEATURES

Site investigation was undertaken by Peter Austin on the 3rd of November 2018.

A range of site features were assessed in terms of the degree of limitation they present for a range of onsite wastewater management systems.

Reference is made to features described in Table 1 of EPA (2003).[3]

-*Table 2* summarises the key features in relation to effluent management at the site.

-*Figures 1*- 9 provide site and locality plans indicating the location of the site/proposed development.

-*Figures 9 & 18* provide site plans describing the physical site features, location of proposed buildings, and proposed wastewater management system components.

FIGURE 5 – Localised site features including location of site and proximity to within-site ephemeral watercourse (Source: Google Earth 2018).

NOTE:

- The site is within a *Special/Declared Water Supply Catchment Area*.
- The proposed area available to contain effluent is not constraining if mitigatory measures detailed within this report/conclusion are considered actions.
- The site proposed for the effluent disposal areas (LAA) have the potential to be impacted by moderate stormwater run-on due to upslope catchment requiring pre-system diversion drainage, and/or raised/mounded subsurface irrigation fields.
- There is no evidence of a shallow watertable (14-45m *VVG Groundwater Data; Bore: 115281; 2018*) or other significant constraints.
- The site is above 1 in 20 & 100-year flood coverage.
- The risk of effluent transport off-site is moderate.

[3] Land Capability Assessment for On-Site Wastewater Management (EPA Publication No. 746.1, March 2003); Table 1 of EPA (2003a).

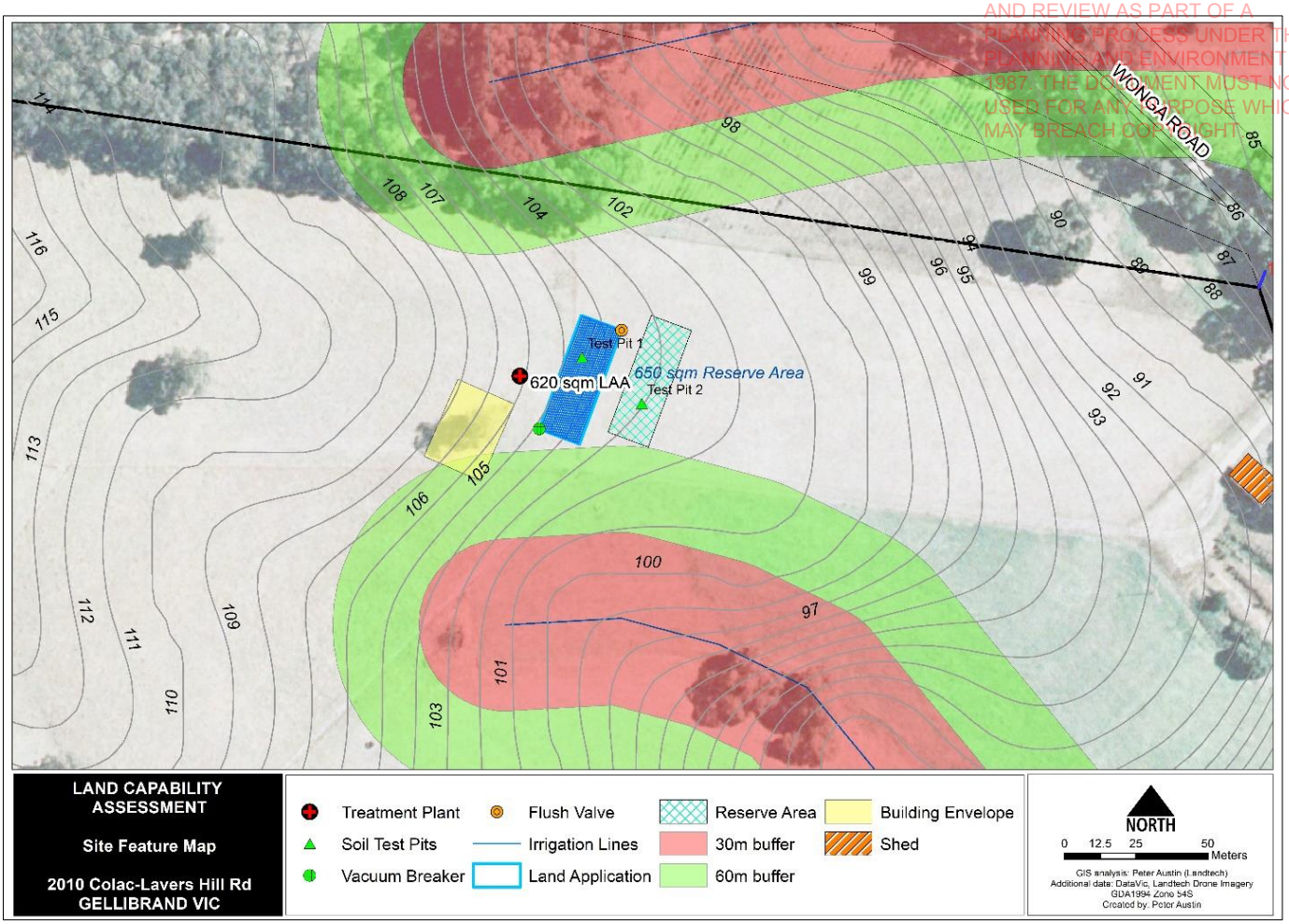


FIGURE 6 – Key site features indicating irrigation fields, soil test pits and proposed treatment plant location.

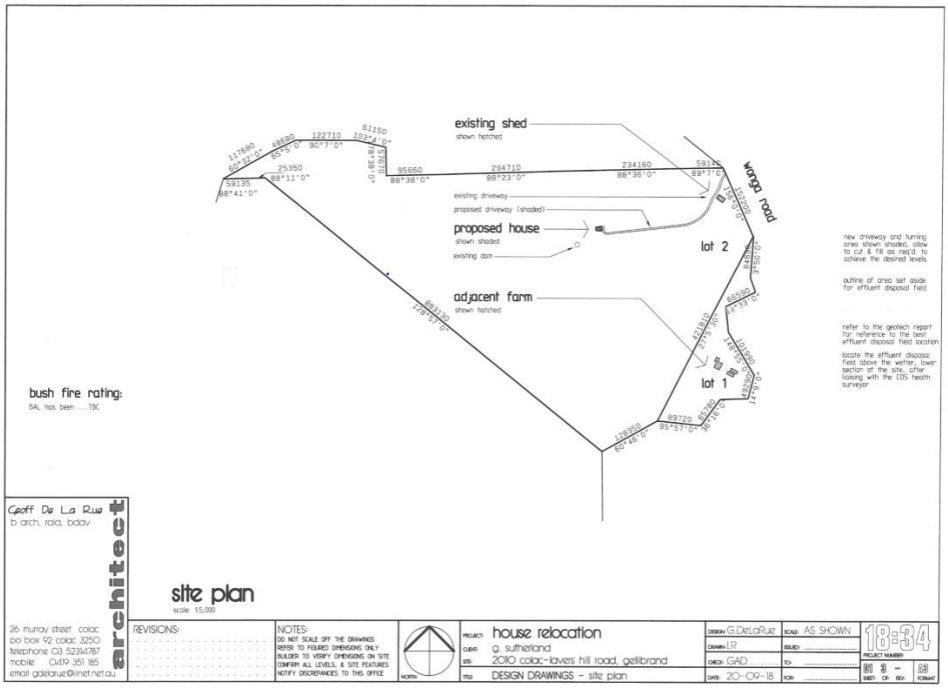


FIGURE 7 – Site features indicating proposed house site location within a large allotment (Source: Geoff De La Rue 2018).

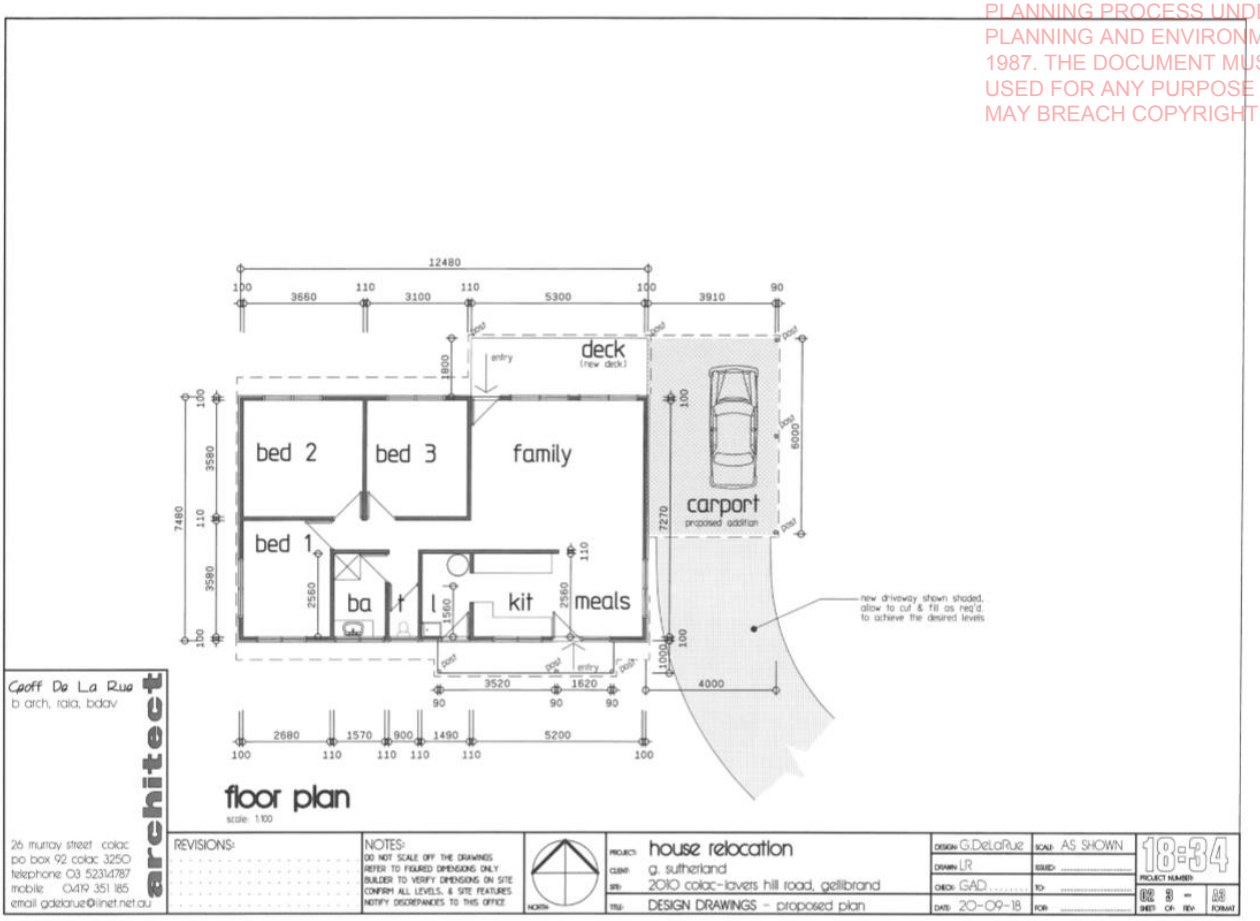


FIGURE 8 – Floor plan indicating a potential 3-bedroom home (Source: Geoff De La Rue 2018).

Colac Otway *Shire – Gellibrand Township Wastewater Summary*[4]

Climate Zone

Zone 3.

Gellibrand is located approximately 21km south of Colac. It is located on elevated and dissected terraces or deeply dissected hills, abutting the Gellibrand River. Gellibrand is located on relatively flat land gently slopes in a northerly direction to the convergence of Charleys Creek and Lardner Creek. Notably, the entire locality is located within the Gellibrand River DWSC.

Refer to the following documents for additional detail regarding the locality:

- Gellibrand River Township Master Plan Report (October, 2005);
- Colac Otway Domestic Wastewater Management Plan (2007);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

Land use comprises of a range of land uses, including dairy, forestry, rural living and tourism. Occupancy rates 2.3 (ABS Census, 2011).

Typical soils

Duplex profile. Very dark grey brown sandy clay loam surface soil overlying abruptly at 35cm a strongly mottled yellow brown, grey, strong brown silty clay, overlying a stratum of white and yellow coarse gravelly sand with rounded quartz pebbles between 140-170cm, overlying strongly mottled clay to at least 200cm. Drainage and permeability are variable depending on slope and position. AS/NZS 1547:2012 5 (Light Clays).

Surface waterways & catchments

The locality is located entirely within the Gellibrand River DWSC. There is an extensive drainage network surrounding the town; including Gellibrand River traversing southeast to northwest, Love Creek, Charleys Creek, Lardner Creek and Asplin Creek.

Groundwater

Proximity to groundwater bores: significantly dense distribution throughout the town and along the river, similar to Kawarren. Groundwater depth: 1.5 – 2m below surface.

Land subject to inundation

Extensive along Gellibrand River, Charleys Creek, Lardner Creek and Love Creek; envelopes the town.

Geology

Various underlying geology. Majority of town is a river terrace with clay and sand which is moderately sorted and poorly consolidated.

Northern tip is alluvial floodplain with silt, sand, and gravel deposits which are also moderately sorted and poorly consolidated.

South – Eumeralla Formation of the Otway Group. Dilwyn Formation of Wangeripp Group is directly south of town.

[4] Colac Otway Shire Council. Colac Otway Shire Council Domestic Wastewater Management Plan 2016. *Gellibrand Township Wastewater Summary*; Accessed from: http://www.colacotway.vic.gov.au/files/assets/public/trimfiles/my-property/domestic-wastewater-management-plan/dwmp-webpage-locality_info_forrest.pdf

Older Volcanic Group (volcanic plugs, sills, dykes, pillow and pyroclastic deposits) to the east and north of town.

Wiridjil Gravel Member of Pebble Point Formation to west of town towards Carlisle River. South eastern edge is a shallow marine deposit with sand, clay and silt.

The majority of the town is classified as having a high soil suitability constraint. The dominant soil landscape unit of the town consists of '67' which forms on deeply dissected hills abutting the Gellibrand River to the west of Love Creek.

The soils consist of brown gradational soils, strongly structured sandy clay loam over weakly structured light clay, to 0.9m depth. Limitations include acidity. The western and southern regions of the town consist of soil landscape unit '94' which forms on elevated, and in parts, uplifted and dissected system of ancient cut and depositional terraces of Gellibrand River.

The soils consist of grey sand soils with structured clay underneath; strongly structured sandy loam over moderately structured medium clay; to depths of more than 2m. Limitations include low fertility and restricted drainage.

The northern region of the locality consists of soil landscape unit '90' which forms on the rolling hills in the northern upper reaches of the Gellibrand catchment and consists of mottled gradational soil to more than 2m depth.

The soil consists of apedal fine sandy loam over weakly structured silty clay loam. Limitations include low p-sorb, low fertility and restricted drainage.

The southern half of the locality consists of soil landscape unit '61' which forms on the deeply dissected hills of the Otway Ranges and consist of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage. Predominant soil is yellow sandy gravel fill over brown clayey sandy silt overlying dark brown silty fine sand. Soil capacity for good drainage but waterlogged during wetter months.

Landslip: excessive, particularly to northwest of town. Vegetation: Otway Forest Park in southeast corner.

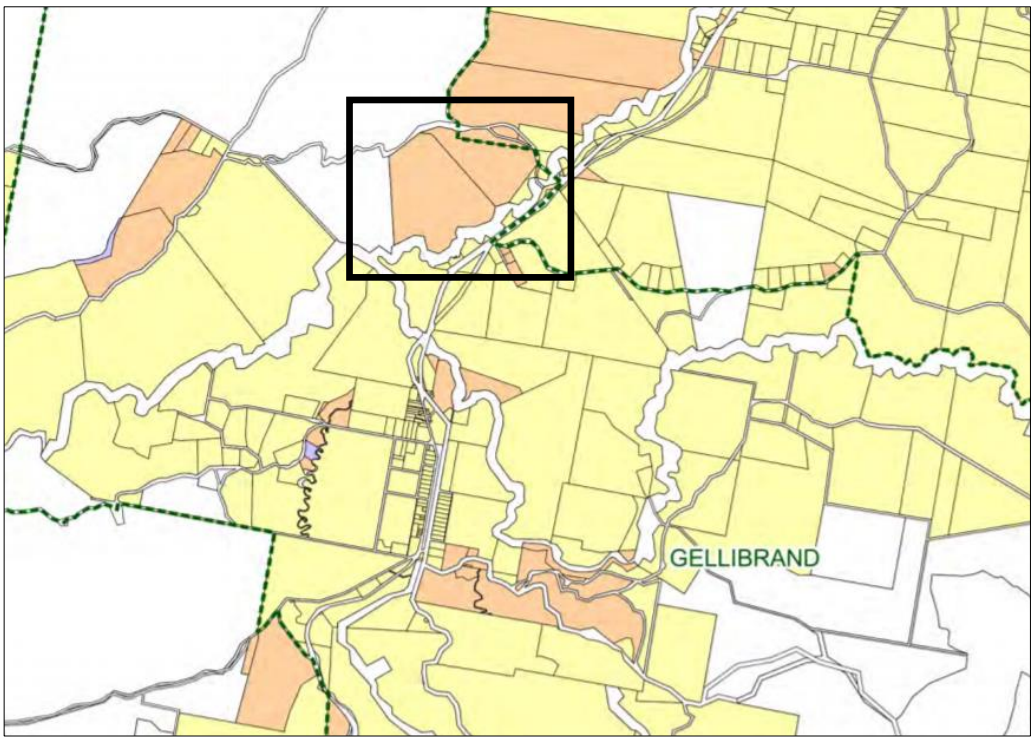


FIGURE 9 – COS Site Sensitivity Map indicating the LCA site is within HIGH sensitivity and a DWSC (Source: COS 2018).

System Selection

Due to the dominance of heavy-textured soils in the Gellibrand locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged.

Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development.

Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs.

Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Gellibrand was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables.

Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained properties/parcels.

System Selection

The Rural Living Strategy (2011) identified Gellibrand as having 'deferred' growth potential, dependent on water catchment constraints and bushfire hazard being satisfactorily addressed. The Sensitivity Analysis concludes that development is feasible given its predominantly Moderate Sensitivity to DWM, particular within the town.

Particular attention needs to be directed towards ensuring that appropriate setbacks to surface waterways, groundwater bores and flood prone areas are maintained, that the DWM systems are sized based on the limiting soil horizon and that the depth to groundwater during site-specific LCAs is ascertained. It is imperative that there is sufficient useable area to sustainably manage wastewater on-site.

Some areas within the locality are considered to be extensively prone to landslip; a geotechnical report by a suitably qualified person will need to be conducted to address this constraint. Predominantly, Standard and Detailed LCAs will be required, with the use of System Sizing Tables deemed appropriate for the properties/parcels assigned a Moderate Sensitivity Rating.

Table 2 – Key Site Features

	FEATURE	DETAIL	Nil or Minor	Moderate	Major	Level of constraint	MITIGATION MEASURES
1	**Aspect**	The site has an easterly aspect.	*N NE NW*	*E W SE SW*	*South*	Nil	NN*
2	**Exposure**	The site has high sun and wind exposure.	*Full sun, high wind, minimal shading*	*Dappled light*	*Limited patches of light to heavily shaded all day*	Nil	NN*
3	**Climate**	The site has a temperate climate with a warm to hot summers and cold winters with rainfall exceeding evaporation annually. The site experiences an average annual rainfall of 968mm (Wyelangta 70th% (90087) and an average of 89.1 rain days per year (>=0.1mm). Annual pan evaporation is taken as 907mm; Silo COS DWMP (Yeodene).	*Excess of evaporation over rainfall in the wettest months*	*Rainfall equal to evaporation*	*Excess of rainfall over evaporation in the wettest months*	Moderate	Secondary Treatment & Subsurface Irrigation, raised effluent disposal area
4	**Erosion potential**	No evidence of sheet or rill erosion however vegetation cover must be maintained as much as possible for reducing erosion. The soil profile is clear of obstructions for at least the surface 1200mm.	*Nil or minor*	*Moderate*	*Severe*	Nil	Maintain vegetation cover
5	**Fill**	Natural soil profiles were observed throughout the site. No fill was observed and no filling is proposed in the effluent management area.	*No fill or minimal fill, or fill is good topsoil*	*Moderate coverage, fill is good quality*	*Extensive poor quality fill*	Nil	NN*
6	**Flood potential**	The house site and area available for application of treated effluent lies above the 1:20 & 1:100-year flood level (Source: DataVic 1%AEP).	*Less than 1 in 100 years*	*Between 100 and 20 years*	*More than 1 in 20 years*	Nil	Site system as high in the landscape as possible
7	**Groundwater**	There are no signs of shallow groundwater tables above 1.5m depth. References suggest groundwater depth is 14-45m *VVG Groundwater Data; Bore: 115281; 2018* – DELWP Bore Details: 334081). There are 2 bores within 500 metres of the site however no use of groundwater bore for domestic purposes exist with compliant setback distances to the proposed effluent management area (VVG 2017).	*No bores onsite or on neighbouring properties*	*Setback distance from bore complies (EPA 891.4)*	*Setback distance from bore does not comply with (EPA 891.4)*	Nil	NN*
8	**Land suitability - available land application area**	All buffer distances recommended in *Table 5 of EPA 891.4* are achievable and do not significantly limit siting of the LAA in this case. Considering watercourse and slope constraints, the site has land that is suitable and available for land application of treated effluent.	*Exceeds LAA, duplicate LAA, buffer distance requirements*	*Meets LAA, duplicate LAA, buffer distance requirements*	*Insufficient area for LAA*	Nil	NN*
9	**Landform**	The site is generally convex in form with a concave area within the drainage line with the site including variably sloping areas between 10 and 15% slope from west to east.	*Convex or divergent side-slopes*	*Straight side-slopes*	*Concave or convergent side-slopes*	Minor	NN*
10	**Rocks and rock outcrops**	No surface rocks or outcrops evident at the immediate site.	*<10%*	*10-20%*	*>20%*	Nil	NN*
11	**Recommended buffer distances**	All buffer distances recommended in *Table 5 of EPA 891.4* buffer requirements are achievable and do not limit the siting of the LAA.	*Setback distance complies*		*Setback distance does not comply*	Nil	NN*
12	**Site drainage and subsurface drainage**	The proposed house site and effluent management area are expected to receive stormwater run-on in average rainfall events but moderate to high in intense rainfall events (large catchment above site) which must be mitigated by upslope diversion drainage. There is no evidence of groundwater seepage, soaks or springs nearby. There is a watercourse >100m from the LAA site.	*Rapidly drained. No visible signs or likelihood of dampness*	*Moderately well drained. Some signs or likelihood of dampness*	*Very poorly drained. Sedges, mosses, surface water ponding*	Nil	Use of raised upslope diversion drainage, effluent

	FEATURE	DETAIL	*Nil or Minor*	*Moderate*	*Major*	Level of constraint	MITIGATION MEASURES
13	**Stormwater run-on, upslope seepage**	The house site and proposed effluent management area may receive stormwater run-on in average rainfall events.	*Low likelihood of stormwater run-on*		*High likelihood stormwater run-on*	Nil	Upslope diversion drainage
14	**Slope**	The overall site has sloping surfaces with an overall slope variation of 10-15% (based on DELWP 1:25000 elevation data – DataVic).	*<6%*	*6-15%*	*>15%*	Nil	Upslope diversion drainage, careful effluent disposal design
15	**Surface water**	The overall site is over 60m to a watercourse. Primary treatment setback distances (60m) can be complied with but is not preferred.	*Setback distance complies with 891.4*		*Setback distance does not comply with 891.4*	Nil	NN*
16	**Vegetation**	The site contains exotic pasture for most of the site with bordering indigenous vegetation. The existing vegetation provide soil profile moisture and effluent removal services to support the proposed effluent disposal. Additional plantings of native grasses (Poa sp.) would be useful effluent disposal area border plantings for enhanced evapotranspiration and utilisation of subsurface irrigation (applied 10/10/10 quality effluent).	*Plentiful vegetation, good potential for nutrient uptake*	*Limited variety of vegetation*	*Sparse or no vegetation*	Nil	NN*
17	**Landslip potential**	Published (DataVic – Land Systems Victoria 2015) mapping data indicates minor-moderate landslip potential within the site.	*Nil*	*Minor to moderate*	*High or Severe*	Nil	Maintain vegetation cover

Key resources used for this assessment include the following:
http://www.bom.gov.au/climate/data/, http://nremap-sc.nre.vic.gov.au/MapShare.v2/imf.jsp?site=water, http://maps.cerdi.com.au/vvg.php, http://data.water.vic.gov.au/monitoring.htm, http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim, http://services.land.vic.gov.au/maps/pmo.jsp#Planning%20maps%20online

*NN: not needed

3.1 SITE ASSESSMENT RESULTS

Based on the set of constraining site features (minor soil texture, slope, and watercourse setbacks), the overall land capability of the site to sustainably manage all effluent onsite is satisfactory due to the large potential land application area to the east north-east of the dwelling.

The proposed effluent management area is located above the 1 in 20 and 1 in 100-year flood level, and includes satisfactory soil characteristics for wastewater disposal and protection of surface and groundwaters.

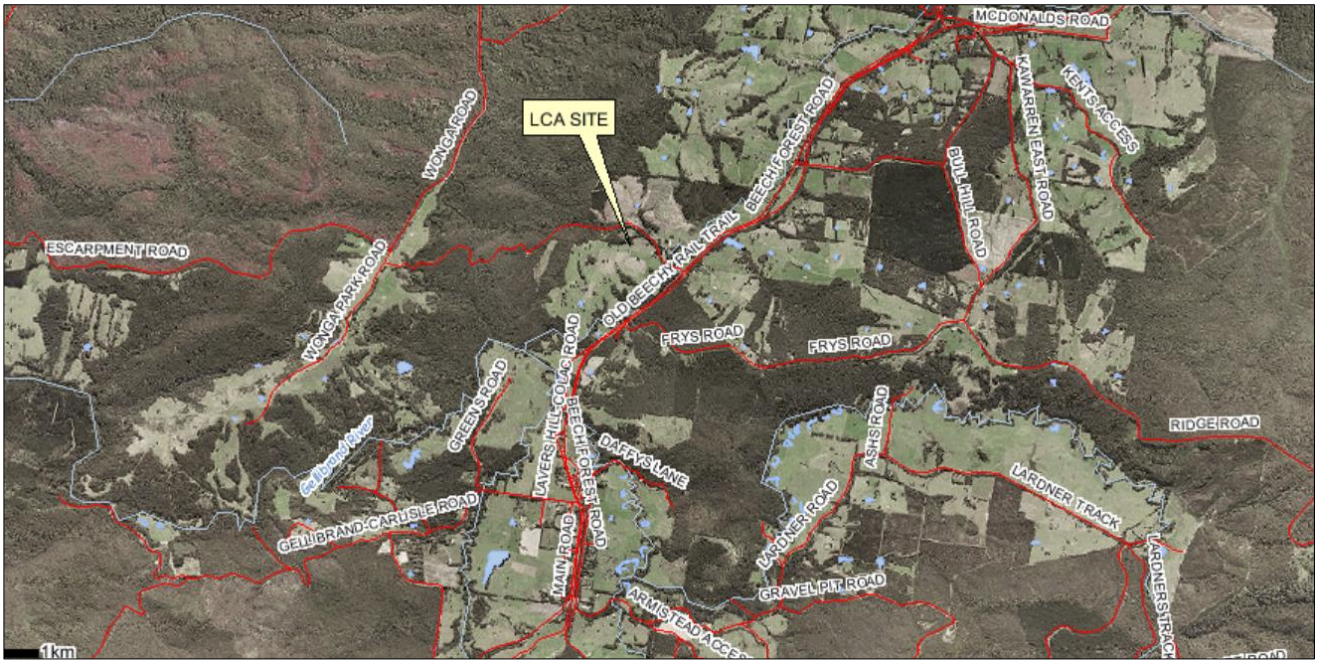


FIGURE 10 – Regional location of the LCA site lying above the Gellibrand River and surrounding ridge-country (Source: DELWP 2018).

FIGURE 11 – Image depicting proposed house site area to the left of the view.

4.0 SOIL ASSESSMENT AND CONSTRAINTS

The site's soils have been assessed for their suitability for onsite wastewater management by a combination of soil survey and desktop review of published soil survey information as outlined below.

4.1 PUBLISHED SOILS INFORMATION

Soils of the site have been mapped and described in the Colac (1:250000 - 11614) map series (Geological Survey of Victoria)[5] (see *Figure 12*) and the applicable reports;

1. *A Land Resource Assessment of the Corangamite Region*[6] *(DPI 2003)*
2. *Soils and Landforms of south-western Victoria. Part 1. Inventory of Soils and their Associated Landscapes (1987),* [7]
3. Colac 1:250000 Map Geological Report.[8]

Soils within the localised area are of part of the *Otway Group* and *Eumerella Formation* origin, non-marine sedimentary soils. [9]

Underlain by *Eumeralla Formation* of *Otway Group* which consist of fluvial and braided stream sedimentary deposits.

Typical soils include grey brown fine sandy loam to fine sandy clay loam becoming mottled at 15cm, abrupt change at 30cm to mottled light yellow and grey brown silty clay loam, grading to increasing mottling with depth to bright dark yellow brown, strong brown silty clay loam with some black small concretions below 80cm depth.

Soil categories include AS/NZS 1547:2012 categories 4 (Clay Loams) to 5 (Light Clays).

Drainage and permeability are variable depending on slope and position.[10]

The immediate area includes a range of land uses, including dairy, forestry, rural living and tourism.

Gellibrand Marl of Heytesbury Group (continental shelf deposits) is dominant with Older Volcanic Group to the west and north of settlement.

The Clifton Formation of Heytesbury Group straddles the Older Volcanic Group and alluvial flood plain deposits. Demons Bluff Formation of the Nirranda Group is to the north of locality. [11]

The settlement and the majority of the locality consists of soil landscape unit '90' which forms on the rolling hills in the northern upper reaches of the Gellibrand catchment and consists of mottled gradational soil to more than 2m depth.[12]

The soil consists of apedal fine sandy loam over weakly structured silty clay loam. Limitations include low p-sorb, low fertility and restricted drainage.

The settlement and to the east of the locality consists of soil landscape unit '76' which forms on undulating plains. The soil consists of grey sand soils to more than 2m depth with weak loamy sand overlying apedal sand. Limitations include low fertility.

[5] DELWP Colac (1:250000 - 11614) map series (Geological Survey of Victoria). Accessed from: http://earthresources.efirst.com.au/product.asp?pID=152&cID=32&c=232933

[6] Maher, J.M. and Martin, J.J. (1987). Soils and landforms of south-western Victoria. Part 1. Inventory of soils and their associated landscapes. Research Report Series No. 40. Department of Agriculture and Rural Affairs.

[7] Robinson et al., (2003). *A land resource assessment of the Corangamite region (DPI 2003).*

[8] Edwards JG (1996). Colac 1:250000 Map Geological Report.

[9] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.

[10] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.

[11] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.

[12] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.

The area is part of the deeply dissected hills of the Otway Range (to 600m elevation). Soil groups include feldspathic sandstone and mudstone[13] resulting from in-situ weathered rock, giving rise to brown gradational fine sandy clay loam soils.

Steep slopes and weakly structured surfaces lead to sheet erosion. Clay subsoils on steep slopes subject to periodic saturation are prone to landslips.

Fluvial braided stream deposits include volcanolithic sandstone, siltstone, mudstone, mud-clast conglomerate with feldspar and quartz grains.[14]

The central region of the locality, including the town, consists of soil landscape unit '60'[15] which form on rolling hills along the top of the Otway Ranges.

The soil consists of brown friable gradational soils with weakly structured clay loam over light clay to 0.9m depth. Limitations include restricted drainage. [16]

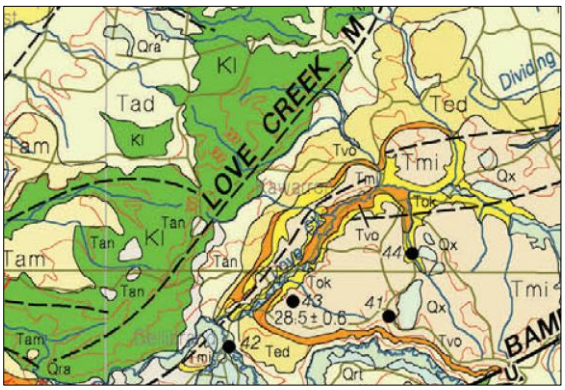


FIGURE 12 – Soils within the localised area are of part of the Otway Group and Eumerella Formation origin, non-marine sedimentary soils. Underlain by Eumeralla Formation of Otway Group which consist of fluvial and braided stream sedimentary deposits.

The remainder of the locality consists of soil landscape unit '61' which forms on the deeply dissected hills of the Otway Ranges and consists of brown gradational soils to 1.2m depth.

The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage. Gradational profile of dark grey brown sandy clay loam grading to dark brown silty clay loam between 10-25cm, grading to dark brown to dark reddish brown sandy clay loam with excellent structure and fairly common small rock fragments.

The fluctuation in sea level and the associated uplift of the Otway Ranges has resulted in the rapid erosional processes that has resulted in numerous large landslides, with probably more activity in the past 6000 years since the slight drop in stream base levels (renewed erosion) and warmer (and therefore wetter) climates have prevailed (Dahlhaus & Miner 2002).

The streams flowing south are mostly short and enter the sea directly, whereas those to the north join the larger Barwon and Gellibrand river systems.

The northern half and the south-eastern corner of the locality are located within the Gellibrand River DWSC and Barham River DWSC, respectively.

The DWSC boundary runs along the ridgeline, which forms the major road running through the middle of the town.

The drainage network is extensive, with West Gellibrand Dam located in the northeast of the locality along the Gellibrand River.

Waterways located within the DWSC are: Asplin Creek, Larder Creek East and West Branches, Little Larder Creek, McDonald Creek, Charleys Creek, Barham River East Branch, Falls Creek, and Seaview Creek.[17]

[13] VRO Lorne Land Systems (2018). Geomorphology Map.
[14] DELWP Colac (1:250000 - 11614) map series (Geological Survey of Victoria). Accessed from: http://earthresources.efirst.com.au/product.asp?pID=152&cID=32&c=232933
[15] Whitehead and Associates Environmental Consultants (2016).Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Colac Otway Shire.
[16] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.
[17] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document; Kawarren Locality Report.

4.2 SOIL SURVEY AND ANALYSIS

A soil survey was carried out at the site to determine suitability for application of treated effluent.

Subsoil investigations were conducted at two locations in the vicinity of the proposed land application envelope using hand dug test pits/bore holes (TP1 and TP2) to 1.2m depth (see *Figures 13,14 & 20*).

This was sufficient to adequately characterise the soils as only minor variation would be expected, and resulted, throughout the area of interest.

Full profile descriptions are provided in *Appendix 1*. Samples of all discrete soil layers for each soil type were collected for subsequent laboratory analysis of pH, Electrical Conductivity, and Emerson Aggregate Class.

Table 3 describes the soil constraints in detail for the soils encountered and provides an assessment of the physical and chemical characteristics at both test pit locations.

Soils in the vicinity of the proposed effluent envelope (TP1 & TP2) are characterised as Sandy Loam topsoils overlying Silty Clay Loam subsoils.

Subsoils of the A1 horizon exhibited a grey/light brown colouration (with minor <2% coarse fragments), with colour changing progressively to a light brown/orange A2/3 horizon.

The soil sample contained no mottling within the lower portions of the A2/3 horizons and appears to provide a relatively free-draining soil profile (0.5-1.2m depth) for wastewater application.

The soils (within TP1 & TP2) are classified as graditional Yellow/Brown Chromosols using the Australian Soil Classification.[18]

After analysis of the most limiting soil texture and structure (most limiting 0.5-1m depth) the soil category has been determined as a Category 4a moderately-structured Silty Clay Loam (in accordance with *Table 5.1 AS/NZS1547:2012 and Table 9 of the EPA Code of Practice: 891.4)*.

Secondary treatment incorporating two split sub-surface irrigation fields (effluent disposal) or wick trenches are suggested for Category 4a type soils observed at this site.

For the soil in the proposed land application area, no soil characteristics present major constraints providing various options within compliant (*EPA Code of Practice 891.4*) wastewater management solutions.

FIGURES 13 & 14 – Both samples consisted of sand/silt-based topsoils to 900mm with light clay subsoils; suiting the use of subsurface irrigation to maximise use of this 700mm zone.

[18] Isbell, R.F. (1996). The Australian Soil Classification. CSIRO Publishing, Melbourne.

Table 3 - Soil Survey - Risk Assessment Identification[19]

TEST PITS 1 & 2 – LIGHT BROWN/YELLOW CHROMOSOL *(both test pits: uniform soil types across disposal area – see Appendix 1)*			**Nil or Minor**	**Moderate**	**Major**	**Assessed Level of Constraint**
Soil Depth	Soil depth greater than 1200mm and no hardpans occur. Topsoil: <600mm; Subsoil: 900mm to >1200 mm.		>1.5 m	1.5 – 1 m	<1 m	Nil
Depth to watertable	Groundwater not encountered, test hole terminated at 1.2m. Mapping indicates groundwater depth 14-45m (VVG 2018).		>2 m	2 – 1.5 m	<1.5 m	Nil
Coarse Fragments (%)	Minor coarse fragments occur within the soil profile.		0 – 10%	10 – 20 %	>20%	Nil
	TOPSOIL	**SUBSOIL**				
Soil texture AS/NZS/1547:2012	Sandy Loam (2b)	Silty Clay Loam (4a)	Cat. 2b, 3a, 3b, 4a	Cat. 4b, 4c, 5a, (5b)	Cat. 1, 2a, 5c, 6	Nil
Soil colour	Grey/Light Brown 7.5YR/5/1	Orange Brown 5YR/5/8				
Soil structure	Moderately structured	Moderately structured	Highly or Moderately structured	Weakly-structured	Structureless, Massive or hardpan	Nil
Soil Permeability AS/NZS1547:2012	1.4 - 3m/day saturated conductivity (K_{sat})	0.5 – 1.5m/day saturated conductivity (K_{sat})	0.5 – 3m/day	0.06 – 0.5m/day	>3 or <0.06m/day	Nil
Gleying (see Munsell Soil Colour Chart)	Nil	Nil	Nil	Some evidence greenish grey / black or bluish grey / black soil colours	Predominant greenish grey / black, bluish grey / black colours	Nil
Mottling (Munsell Soil Colour Chart)	Nil	Nil	Very well to well-drained soils - uniform brownish or reddish colour	Moderately well to imperfectly drained soils - grey and/or yellow brown mottles higher in the profile	Poorly drained soils, dominant grey colours, yellow brown or reddish brown mottles	Nil
Soil Category (Table 9, EPA Code of Practice 891.4)	2b	4a	Cat. 2b, 3a, 3b, 4a	Cat. 4b, 4c, 5a, (5b)	Cat. 1, 2a, 5c, 6	Nil
Design Irrigation Rate	5 (DIR mm/day) for Subsurface Irrigation	3.5 (DIR mm/day) for Subsurface Irrigation	*(Table 9 – Vic EPA COP 891.4) Inferred with reference to Table 4 Vic EPA – Code of Practice 891.4; describes conservative design loading rates (DLRs) and Design Irrigation Rates (DIRs) for various effluent application systems according to soil texture. Reduced loading rates applies to primary treatment systems.*			
Design Loading Rate	15 (DLR mm/day) for Soil Absorption Trenches	10 (DLR mm/day) for Soil Absorption Trenches				
pH The pH of 1:5 soil/water using a *Hanna* hand-held pH/EC meter.	6.9 - slightly acid. Soil conditions do not appear to be affecting plant growth.	7.7 - slightly acid. Soil conditions do not appear to be affecting plant growth.	5.5 - 8	4.5 - 5.5	<4.5, >8	Nil
Electrical Conductivity (Ec) (dS/m) measure of soil salinity.	0.319 deciSiemens per metre. Negligible salinity exists and will therefore not impact long-term operation of the system.	0.328 deciSiemens per metre. Negligible salinity exists and will therefore not impact long-term operation of the system.	<0.8	0.8 - 2	>2	Nil
Emerson Aggregate Class	EA Class 4 (some slaking, no dispersion or swelling)	EA Class 5 (some slaking, no dispersion or swelling)	4, 5, 6, 8	7	1, 2, 3	Nil

[19] Municipal Association of Victoria, Department of Environment and Sustainability and EPA Victoria (2013) Victorian Land Capability Assessment Framework.

5 LAND CAPABILITY ASSESSMENT MATRIX

The land capability assessment matrix has been developed for the site and using the soils within the vicinity of the proposed effluent (LAA) envelope.

Table 4: Land Capability Assessment Matrix[20]

Land features	Land Capability Class Rating					Site rating
	Very good (1)	Good (2)	Fair (3)	Poor (4)	Very poor (5)	
General characteristics						
Site drainage	No visible signs of dampness	Moist soil but no standing water		Visible signs of dampness such as moisture-tolerant plants	Water ponding on surface	1
Run-off	None	Low	Moderate	High – need for diversionary structures	Very high – diversion not practical	3
Flood levels (1 in 100 year)	Never		<1 in 100	<1 in 100 and <1 in 20	<1 in 20	1
Proximity to watercourses	>60m				<60m	1
Slope %	0-2	2-8	8-12	12-20	>20	3
Landslip	No actual or potential failure		Low potential for failure	High potential for failure	Present or past failure	1
Groundwater (seasonal water-table depth in m)	>5	5-2.5	2.5-2	2-1.5	<1.5	1
Rock outcrop (% of land surface containing rocks > 200mm)	0	<10%	10-20%	20-50%	>50%	1
Erosion potential	No erosion	Minor	Moderate	High	Severe erosion potential	1
Exposure	High sun and wind exposure		Moderate	Low sun and wind exposure		2
Landform	Hill crests, convex side slopes and plains		Concave side slopes and foot slopes		Floodplains and incised channels	1
Vegetation type	Turf or pasture				Dense forest with little understorey	2
Average rainfall (mm/year)	<450	450-650	650-750	750-1000	>1000	4
Pan evaporation (mm/year)	>1500	1250-1500	1000-1250		<900	2
Fill	No fill		Fill present			1
Soil profile characteristics						
Soil permeability category	2 and 3	4		5	1 and 6	2
Profile depth (m)	>2m	1.5m-2m	1.5m-1m	1m-0.5m	<0.5	1
Presence of mottling	None	Minor	Moderate		Extensive	3
Coarse fragments %	<10	10-20	20-40		>40	1
pH	6-8		4.5-6		<4.5, >8	1
Emerson aggregate	4,6,8	5	7	2,3	1	2
Electrical conductivity (Ec/dS/m)	<0.3	0.3-0.8	0.8-2	2-4	>4	2
OVERALL SITE RATING						**4**

As a guide, remedial measures should be considered whenever ratings of 3, 4, or 5 occur and this might involve land improvement works, soil amelioration, or simply adoption of higher-level technologies to ensure environmental protection. The rating consists of the highest (most limiting) single rating and not the average.

The assessed site has been determined to have an overall land capability assessment risk rating of 4 (*Table 4*). See *Table 5* for Rating 4 wastewater management prescriptions.

[20] Standards Australia / Standards New Zealand (2012). AS/NZS 1547:2012 On-site Domestic Wastewater Management.

Table 5: Land Capability Assessment Risk Matrix[21]

Rating	Degree of limitation	Detail
Rating 1	None to very slight	The effluent envelope is suitable for on-site disposal of septic discharge. The limitations or environmental hazard from long-term use is considered very slight. Standard performance measures for design, installation and management should prove satisfactory.
Rating 2	Slight	The site has been identified as generally suitable for on-site effluent disposal but there is a slight associated environmental hazard expected. One or more land limitations are present, which may not be compatible with straight forward conventional on-site disposal. The wastewater management program will require careful planning, adherence to specifications and adequate supervision.
Rating 3	Moderate	The site has only a fair capability for on-site effluent disposal with a moderate associated environmental risk always present. Very careful site selection, preparation and specialised design will be required to address the identified land constraints. A management program should be delivered to the responsible authority with the development application and prior to earthworks commencing. It is recommended that in order to achieve BPEM, wastewater processing systems which can attain a higher level of treatment with basic monitoring should be considered as an alternative to standard conventional trench disposal.
Rating 4	High	Areas have poor capability rating with a high associated environmental risk. Considerable difficulties are expected during siting and installation of the wastewater treatment system and during routine operation. A very high engineering input and close supervision would be needed to minimise the environmental impact. Alternative wastewater processing systems capable of consistently producing high quality secondary effluent (such as aerated wastewater treatment plants) together with a close monitoring program should be seriously investigated and adopted.
Rating 5	Severe	Areas have a very poor capability and there is a severe associated environmental risk. The areas are not generally considered suitable for disposal of septic tank effluent by trench systems. The high levels of engineering input and management needed at all stages are unlikely to adequately address the identified land constraints and achieve a sustainable outcome.

[21] Standards Australia / Standards New Zealand (2012). AS/NZS 1547:2012 On-Site Domestic Wastewater Management.

6 WASTEWATER MANAGEMENT SYSTEM

This LCA has been prepared to accompany a *Planning Permit* application to be submitted to the *Colac Otway Shire Council*, and the included requirement for a compliant onsite wastewater system.

As such, this report provides recommendations for treatment and land application systems that are appropriate to the land capability, including sizing, design considerations, and justification for selection.

Detailed design for the system should be undertaken at the time of the building application and submitted to Council.

It should be noted that the site has slope, watercourse setback, annual rainfall and minor soil textural constraints, and therefore reduced flexibility with locating the proposed treatment system and land application areas. A reserve field has also been included in the suggested design (see *Figure 18*).

Reductions in wastewater output can and should be achieved in the proposed dwelling by the use of high water efficiency fittings such as with WELS-rated 3-star appliances and 4-star fittings and fixtures.

Other suggested measures include; water-efficient front or top-loading washing machines, dual-flush toilets, water-efficient shower roses, water-efficient dishwashers, aerated taps, hot/cold water mixing taps, flow restrictors, hot water system with 'cold water diverter' (recirculates initial cold water flow when hot water tap used).

6.1 TREATMENT SYSTEM

To treat domestic wastewater and allow evapotranspiration with some soil absorption of treated effluent, we recommend installing a system that provides secondary treatment (AWTS, Reed-bed, and Sand Filter).

A Reedbed and Sand Filter would require additional area lost from much-needed effluent disposal areas and potentially be more costly options.

Primary treatment could be considered with the support of COS but must be disposed of to wick trenches via a pump-well (dosed).

Refer to *Appendix 12* and the EPA website for the list of approved options available: http://www.epa.vic.gov.au/en/your-environment/water/onsite-wastewater.

Any of the treatment system options are capable of achieving the desired level of performance however the author recommends an AWTS such as the *OzziKleen RP10*, capable of treating effluent to 10/10/10 standard. Further information can be provided on this option.

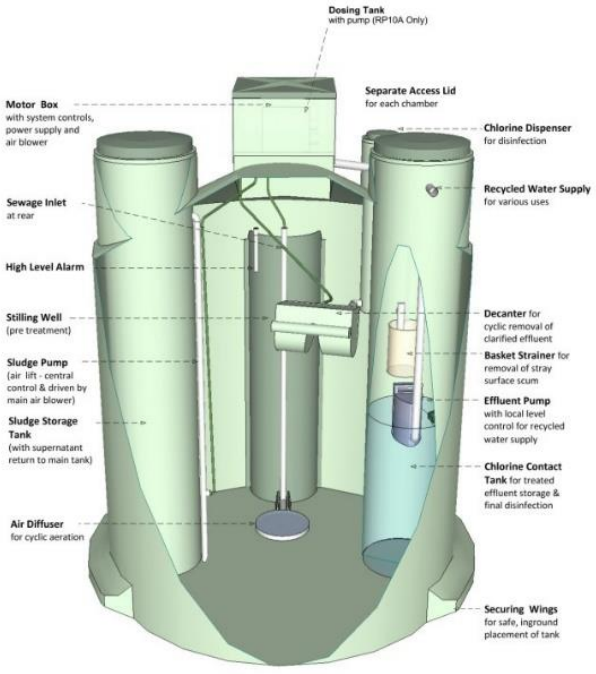


FIGURE 15 – Internal profile of OzziKleen treatment system (Source: OzziKleen 2018).

6.2 LAND APPLICATION SYSTEM (EFFLUENT DISPOSAL)

A range of possible land application systems have been considered such as Soil Absorption Trenches, Subsurface Irrigation, Evapotranspiration-absorption (ETA) beds, and Wick-Trenches.

Subsurface irrigation, to maximise evapotranspiration is the preferred effluent disposal method (within the area shown in *Figure18*).

Such systems will provide potential beneficial sub-surface reuse of effluent, which is desirable given rainwater tanks are relied upon for water supply.

It will also ensure that the risk of effluent being transported off-site and to groundwater will be negligible.

The land application areas are well-suited to subsurface irrigation due to gradual slope of the landscape.

Setback buffer distances from effluent land application areas and treatment systems are required to help prevent human contact, maintain public amenity, and protect sensitive environments.

The owner is encouraged to plant indigenous vegetation perhaps surrounding the effluent disposal area (such as *Poa, Lomandra sp*. etc) to assist in effluent uptake.

The proposed land application area (see *Figure 18*) should be protected from stock or compacting machinery, vehicles etc. Failure to complete this will inevitably reduce the long-term sustainability of the system.

Wick trenches could also be used with either primary or secondary treatment systems however will require a pump-well if a septic tank/worm farm used.

6.3 BUFFER DISTANCES

All buffer distances are achievable.
The relevant buffer distances for this site, taken from *Table 5* of the Code (2016) are:

- *50 metres from groundwater bores in sandy soils; and*
- *30-60 metres from non-potable watercourses; and*
- *100m from potable watercourses (declared water supply catchment area); and*
- *3 metres if area up-gradient and 1.5 metres if area down-gradient of property boundaries, swimming pools and buildings (secondary treatment).*

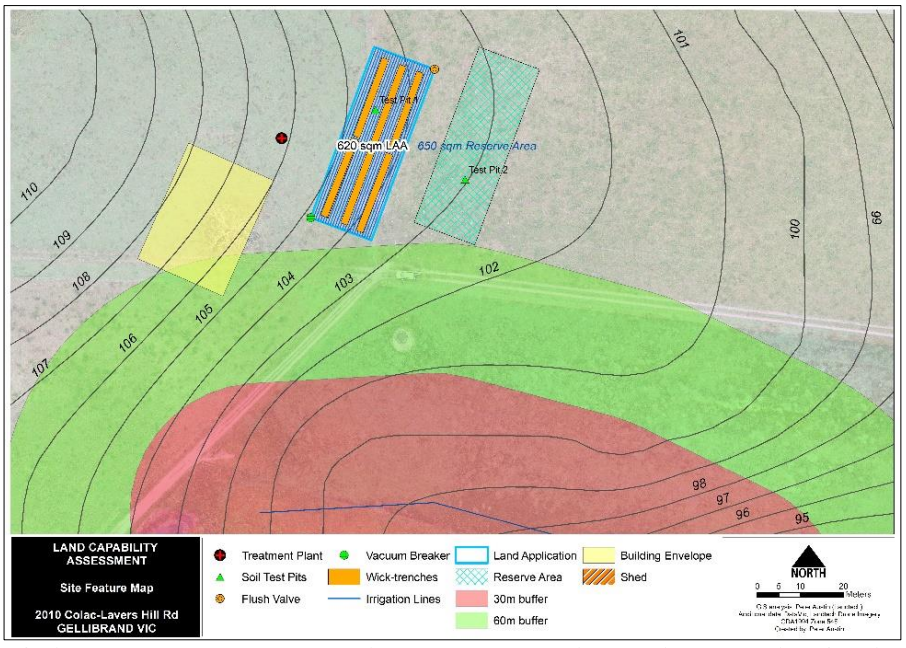


FIGURE 16 – If primary or secondary treatment is used there are various available locations for wick-trenches.

6.4 SIZING THE EFFLUENT DISPOSAL SYSTEM

To determine the necessary size of the land application/effluent disposal area, water and nutrient balance modelling has been undertaken in accordance with *EPA Publication 168 (1991): Guidelines for Wastewater Irrigation*[22] and the *Victorian Land Capability Assessment Framework (MAV Victoria)*.

The results show that the required irrigation area is 620m², the larger of the areas calculated by the water and nutrient (nitrogen, phosphorous) balance calculations.

The calculations are summarised in *Appendix 2 & 3*.

- DIR – Design Irrigation Rate of 3.5mm has been used in effluent disposal calculations (used as conservative approach based on Cat. 4a *Silty Clay Loam* soil texture).
- From the nutrient balances in the absence of site-specific data, conservative estimates of crop nutrient uptake rates and total nitrogen lost to soil processes have been adopted.
- The required land application area is based on the highest value of the water and nutrient balance (nitrogen/phosphorous) calculations (see *Appendix 2 & 3*).

An area of at least 620m² (water balance: 620m² - nitrogen 299m² - phosphorous 397m²) must therefore be provided for land application of effluent.

It is worth noting that the modelling includes several significant factors of conservatism:

Hydraulic load (900 L/day) – based on *EPA Code of Practice (891.4)* and is a conservative estimate of hydraulic load;

The site plan in *Figure 18* shows the location of the proposed wastewater management system components and other relevant features

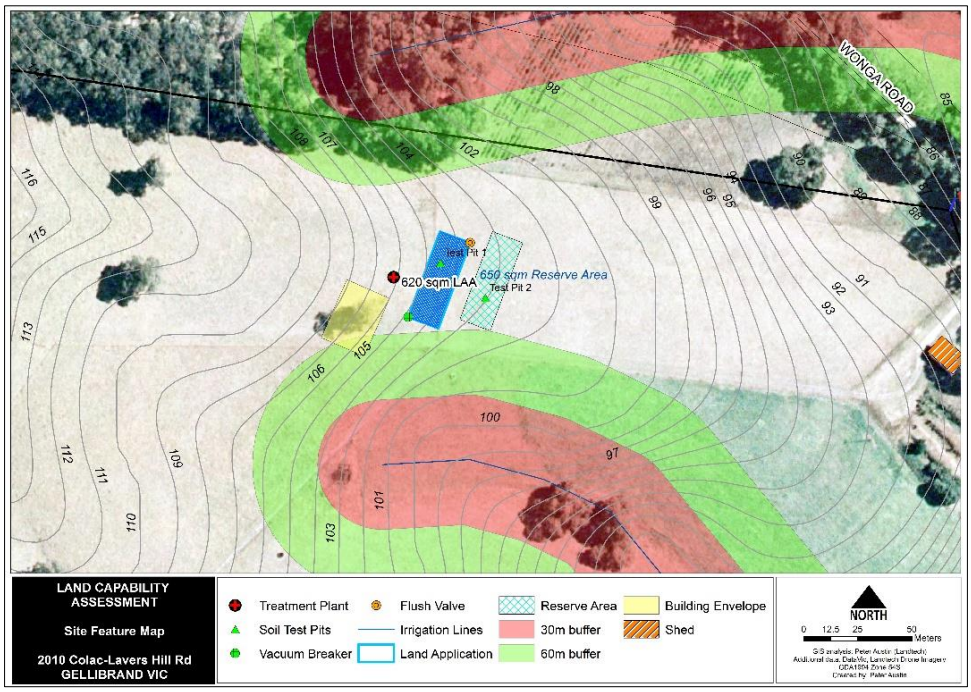


FIGURE 17 – Localised site feature overview depicting slope across the site and location of drainage line.

[22] Environment Protection Authority (1991). Guidelines for Wastewater Irrigation Publication 168.

6.5 SITING AND CONFIGURATION OF THE EFFLUENT DISPOSAL SYSTEM

Notwithstanding relatively high site rainfall, slope, watercourse setback, and minor soil textural limitations, there is adequate area for location and configuration of effluent disposal systems.

Figure 18 shows an envelope of land (LAA – 620m²) that is suitable and required for effluent management. Reserve areas are a regulatory default due to the site being within a DWSC. The LAA can incorporate a reserve land application area.

The location of the system is based on plans, previous technical assessement documents and advice provided by the owner, including location of the proposed house.

Final placement and configuration of the effluent system will be determined by the client and/or plumber, with prescriptive input from Council, and advice and guidance from Landtech if required.

Land application of treated effluent to a 620m² area (includes required buffers) via (0.6m spaced laterals) subsurface irrigation (is recommended).

Figure 18 shows the minimum area required according to the water and nutrient balance calculations.

Whilst there is area for application of the effluent, it is important that appropriate buffer distances to boundaries and proposed built structures such as dwellings, embankments, driveways, rainwater tanks, dwelling, and sheds (refer *Table 5 EPA Code of Practice 891.4: 2016*).

It is recommended that the owner consult an appropriately registered plumbing/drainage practitioner to install the system.

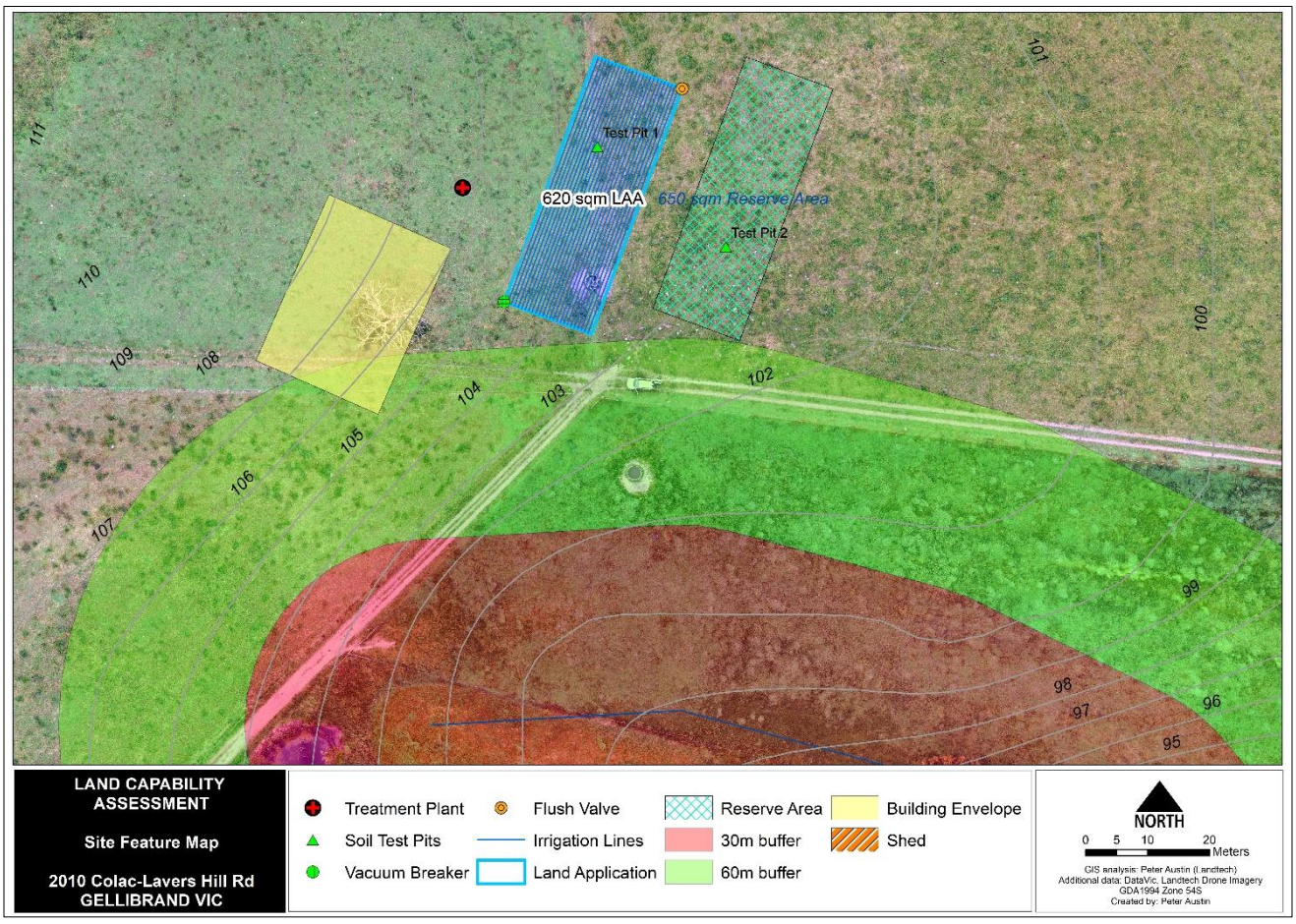


FIGURE 18 – Proposed wastewater system design specifications using preferred subsurface irrigation.

6.6 DESCRIPTION OF THE TREATMENT SYSTEM

To treat domestic wastewater and allow soil absorption and plant uptake of treated effluent, we recommend installing a system that provides secondary treatment (Aerated Wastewater Treatment System AWTS, Septic Tank/Sand Filter, Septic Tank/Reed-bed).

Refer to the EPA website for the list of approved options that are available: http://www.epa.vic.gov.au/en/your-environment/water/onsite-wastewater. Any of the treatment system options are capable of achieving the desired level of performance.

The author recommends an AWTS such as the *OzziKleen RP10*, capable of treating effluent to 10/10/10 standard. Further information can be provided on this option.

The owner will gain the benefit of wastewater re-use via plant/pasture uptake, useful in periods of low rainfall and the requirement on the sites slope to retain erosion-inhibiting vegetation cover.

Domestic AWTS are pre-fabricated, mechanically aerated wastewater treatment systems designed to treat wastewater flows of <2,000L/day. They are tank-based systems, comprising either one or two discrete tanks that typically employ the following processes see *Figure 20*): [23]

1. Settling of solids and flotation of scum in an anaerobic primary chamber or separate primary tank (effectively operating as a septic tank). This stage is omitted in some models.
2. Oxidation and consumption of organic matter through aerobic biological processes using (active or passive) mechanical aeration.
3. Clarification – secondary settling of solids.
4. Disinfection – usually by chlorination but occasionally using ultraviolet irradiation.
5. Regular removal of sludge to maintain the process.

FIGURE 19 – OzziKleen systems are simple, cost-effective to install and maintain, and have enhanced (10/10/10) effluent quality standards.

[23] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document, Barongarook Locality Report. Accessed from: http://www.colacotway.vic.gov.au/files/assets/public/trimfiles/my-property/domestic-wastewater-management-plan/dwmp-webpage-locality_info_barongarook.pdf

AWTS's treat wastewater through a combination of biological treatment and aeration, resulting in a higher standard of wastewater effluent. This provides greater options for the disposal of treated effluent, although AWTS will require power to operate, and be subject to regular quarterly maintenance. Treated effluent is normally disposed of via pressure-compensating sub-surface irrigation or dosed soil absorption trenches to a suitably sized and vegetated area.

The AWTS system consists of two tanks (sometimes within a single larger tank). The first is a basic septic tank where solids settle and anaerobic digestion occurs.

In the second tank, oxygen is bubbled through the effluent to encourage aerobic bacteria to digest the waste. Finally, the effluent is disinfected using chlorine or ultra-violet light before being pumped to an irrigation area.

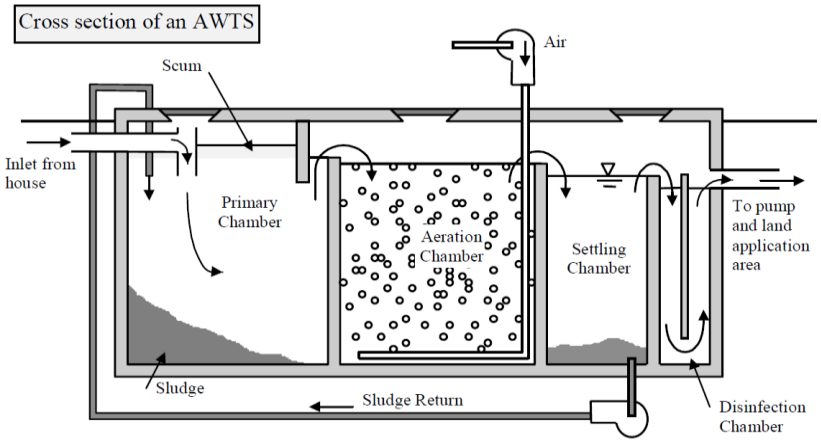


Figure 20 – Cross-sectional view of an aerated wastewater treatment system (Source: EHPA 2015).

Treated effluent is normally disposed of via pressure compensating sub-surface irrigation to a suitably sized and vegetated area, although dosed soil absorption trenches can be used in certain situations.

The extra treatment provided by an aerated septic tank reduces pathogen levels, (and can sometimes reduce nutrients) as long as the system is kept well maintained, and the disinfection unit is functioning properly. AWTS may also be used to treat greywater to a standard suitable for garden watering of non-food plants.

AWTS are typically supplied as stand-alone, proprietary systems. They require regular maintenance in accordance with the EPA Certificate of Approval for the specific model (usually quarterly) to ensure satisfactory performance and adequate disinfection.

The operating (power) costs of AWTS are relatively high compared to more passive systems such as trickling filters and reed beds, as the aerobic treatment phase requires air blowers to be run for several hours each day. [24]

AWTS are generally **not** suitable for premises with intermittent use or surge loads, such as holiday homes and commercial premises with very low flow/high flow wastewater cycles.

AWTS must not be switched off when not in use as the deprivation of oxygen will kill the aerobic bacteria within a few days and populations can take weeks to be re-established when the system is turned on and wastewater supply resumes. Some AWTS models have a low-flow switch which re-circulates effluent to keep aerobic bacteria alive when not in use.

AWTS are subject to AS/NZS1546.2:2008 ('On-site domestic wastewater treatment units – waterless composting toilets') as well as the current EPA Code of Practice and current EPA Certificate of Approval for the specific AWTS model.

[24] Colac Otway Shire (2016). Colac Otway Shire Council Domestic Wastewater Management Plan - Technical Document, Barongarook Locality Report. Accessed from: http://www.colacotway.vic.gov.au/files/assets/public/trimfiles/my-property/domestic-wastewater-management-plan/dwmp-webpage-locality_info_barongarook.pdf

6.7 INSTALLATION OF THE EFFLUENT DISPOSAL SYSTEM

A suitably qualified, licensed plumber must carry out installation of the effluent disposal system as per AS/NZS 1547.

The effluent disposal area must be vegetated or revegetated immediately following installation of the system, preferably with turf or native sedges and grasses (border of the effluent area).

The area should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access; and signs should be erected to inform householders and visitors of the extent of the effluent irrigation area, and to limit their access and impact on the area (see *Appendix 14*).

7 MONITORING, OPERATION AND MAINTENANCE

Maintenance is to be carried out in accordance with the *EPA Certificate of Approval/Conformity* of the selected wastewater system, manufacturer's warranty, and Council's permit conditions.

The system will only function adequately if appropriately and regularly maintained (see *Appendix 4-13*).

To ensure the system functions adequately, residents must:

- Use household cleaning products that are suitable for wastwater systenms;
- Keep as much fat and oil out of the system as possible; and
- Conserve water (AAA rated fixtures and appliances ar recommended).

To ensure the land application system functions adequately, residents must:

- Regularly harvest (mow) vegetation within the Land Application Area (LAA) and remove this to maximise uptake of water and nutrients;
- Not erect any structures and paths over the LAA;
- Avoid vehicle and livestock access to the LAA, to prevent compaction and damage; and
- Ensure that the LAA is kept level by filling any depressions with good quality topsoil (not clay).

7.1 WATER CONSERVATION AND IMPROVING WASTEWATER QUALITY

Good water conservation is an important aspect in the overall management of onsite systems.

It will be important for the ongoing performance of both the treatment and land application system that they are not overloaded hydraulically.

AAA-rated plumbing is recommended for all future water fixtures (see *Appendix 4*).

7.2 STORMWATER MANAGEMENT

Stormwater run-on may be a moderate concern for the proposed land application area.

An upslope (of LAA) diversion drain may be constructed if this is deemed to be necessary during installation of the system, or in the future.

Stormwater from roofs and other impervious surfaces must not be disposed of into the wastewater treatment system or onto the effluent management system.

8 CONCLUSION

As a result of EPA Code-compliant (891.4) investigations, we conclude that sustainable onsite wastewater management is feasible with appropriate key mitigation measures as detailed below.

A wastewater load of 900L/day has been conservatively used in wastewater calculations to allow for the potential 4-bed dwelling (4 + 1) x 150L/day, (based on *Section 3.4.1(b)* from EPA Code of Practice 891.4 (2016).

Based on the surveyed *Silty Clay Loam Category 4a* subsoil texture (most limiting layer), and requirements detailed in *Appendix A* and *Table 9* of the *EPA Code of Practice 891.4 (2016)*, the recommended system includes 620m² of subsurface irrigation coverage/area (includes setbacks).

Specifically we recommend the following:

- Due to the proposed location of the effluent disposal area and slope constraints, an upslope diversion drain will be required to be configured to protect the disposal area from upslope run-on.
- The exact location of the proposed land application areas could be modified slightly in consultation with COS, the owner, and plumber.
- Strict system maintenance and report to Council regime should be required due to watercourse receptor proximity.
- The operation, quarterly maintenance and management of the treatment and disposal system must be in accordance with the manufacturer's recommendations, *EPA Certificate of Conformity*, the *EPA Code of Practice 891.4 (2016),* and recommendations made in this report.
- With prescriptions built into the Council Permit conditions such as; strict quarterly servicing of the treatment plant and effluent disposal area; the required use of WELLS & AAA-rated appliances and plumbing fixtures etc., (see *Appendix 4*);
- Installation of secondary treatment system (such as OzziKleen RP-10 to 10/10/10 effluent quality) and subsurface irrigation system (*Figure 18*).
- Land application of treated effluent to 620m² (includes required watercourse setback buffers) area via subsurface irrigation; potentially split into two fields (2 x 310m²); and sequentially dosed via a Rotavalve (see *Figure 18*).
- It is suggested that a 25-50m head pump is used to pump effluent across the drainage line. A plumber should check pump size requirements based on site slope/distance to be pumped, prior to install of new systems; the pump-well should have alarms installed as per EPA Code of Practice 891.4;
- Utilising avalilable land for maximising vegetation uptake of effluent to reduce cumulative wastewater impact to localised area is critical to reducing soil moisture loading.
- Other wastewater treatment systems and effluent disposal methods could be considered if desired by the owner or Council and could include: Septic Tank/Sand Filter, Septic Tank/Reedbed for treatment; however most would have increased footprint/cost for disposal in a reduced land application area;
- Installation of secondary treatment system (such as OzziKleen RP-10 to 10/10/10 effluent quality) and subsurface irrigation system; Wick-trenches of 112m lineal (6 x 19m);
- Wick-trenches could be used with primary treatment so long as a pump-well is used to dose the effluent field.

- Future dwelling development must include the installation of water-saving fixtures and appliances to minimise effluent load (see *Appendix 4*);
- It is critical that careful selective removal of vegetation only occurs during irrigation and treatment plant installation. All areas disturbed must be protected during construction and revegetated immediately after disturbance if possible.
- It is strongly recommended that *Poa, Lomandra, Dianella* indigenous grass/sedge species be planted in 3-4 rows below the effluent disposal area to act as a secondary effluent absorption mechanism and protect neighbouring properties;
- Reserve areas are required (DWSC); this proposal has been able to include potential reserve areas.

- An all-waste wastewater system/disposal system is to be constructed concurrently with the renovation, such that all liquid waste shall at all times be contained within the allotment. Such systems shall be designed and installed to the satisfaction of the Responsible Authority.
- A *Permit to Install* an all waste system must be lodged and approved by the Responsible Authority prior to the commencement of works. Such system shall be designed and installed to the satisfaction of the Responsible Authority before a *Permit to Use* the system can be issued.
- The proposed wastewater system shall not be located within 30m of the bank of any surface waters.
- Use of low phosphorus and low sodium (liquid) detergents to improve effluent quality and maintain soil properties for growing plants.

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APPENDIX 1: SOIL BORE LOGS

SOIL BORE LOG		LANDTECH CONSULTING	
Client	C/- Geoff De La Rue	**Test pit no.**	1 – 2
Site	2010 Colac-Lavers Hill Rd GELLIBRAND VIC	**Excavated by**	Landtech Consulting
Date	3 November 2018	**Excavation type**	Hand-auger
Notes	Refer *Figure 18* for position of Test Pits		

PROFILE DESCRIPTION

Depth mm	Graphic log	Sample name	Horizon	Texture	Structure	Colour	Mottles	Coarse fragments	Moisture condition	COMMENTS
0-200		TP1 & TP2	A1	Sandy Loam	Moderate	Light Brown / Grey	Nil	Nil	Moist	Nil
200-900		TP1 & TP2	A2	Silt Loam	Moderate	Brown	Nil	Minor	Moist	Nil
900-1200		TP1 & TP2	A3	Sandy Clay Loam	Moderate	Orange Brown	Nil	Nil	Moist	Nil

KEY TO SOIL BORELOGS

Watertable depth	W	Depth of refusal	X	Sample collected	.
S - Sand **LS** - Loamy sand **CS** - Clayey sand		**CL** – Clay loam **SCL** – Sandy clay loam **SiCL** – Silty clay loam		Gravel (G)	
SL – Sandy loam		**LC** - Light clay **SC** - Sandy clay		Parent material (stiff)	
L – Loam **LFS** – Loam fine sand **SiL** – Silty loam		**MC** – Medium clay **HC** – Heavy clay		Parent material (weathered)	

APPENDIX 2 THE WATER BALANCE

The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation

Based on the use of secondary treatment and subsurface irrigation and site soil texture, the design loading rate based on Table 9 of the *EPA Code of Practice 891.4 (2016)* is 3.5mm/day.

A conservative approach has been taken in this instance where higher rainfall totals have been used in water and nutrient balance calculations to maximise buffering of the selected treatment system.

Data used in the water balance includes:

- Mean monthly rainfall (Silo COS DWMP Wyelangta 70th%) and mean monthly pan evaporation (Silo COS DWMP (Yeodene 70th%) data;
- Average daily effluent load – 900L/day (from Table 4 of the *Code 891.4*);
- Design loading rate (DLR) – 3.5mm/day used (from Table 9 of the *Code 891.4*);
- Crop factor – 0.8;
- Retained rainfall – 80% due to slope

The nominated area method is used to calculate the area required to balance all inputs and outputs to the water balance.

As a result of these calculations at least; 860m^2 of land application area (based on secondary treatment and subsurface irrigation) is required to achieve zero wet weather storage (see *Figure 21* below).

Victorian Land Capability Assessment Framework

Please read the attached notes before using this spreadsheet

Irrigation area sizing using Nominated Area Water Balance for Zero Storage

Site Address:	**2010 Colac Lavers Hill Road GELLIBRAND VIC**		
Date:	3.11.2018	**Assessor:**	Landtech Consulting

INPUT DATA

Design Wastewater Flow	Q	900	L/day	Based on maximum potential occupancy and derived from Table 4 in the EPA Code of Practice (2013)
Design Irrigation Rate	DIR	3.5	mm/day	Based on soil texture class/permeability and derived from Table 9 in the EPA Code of Practice (2013)
Nominated Land Application Area	L	267	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	0.7	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	(Wyelangta 70th% (90087)			BoM Station and number
Mean Monthly Pan Evaporation Data	Silo COS DWMP (Yeodene)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	45.8	46.5	59.2	76.3	92.0	107.6	107.7	118.5	100.8	89.5	68.2	56.6	968.8126
Evaporation	E		mm/month	139.2	114.5	94.4	57.9	35.2	23.9	26.9	40.3	58.4	85.6	103.3	127.8	907.4
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	111	92	66	41	21	14	16	24	41	68	83	102	679.59
Percolation	B	DIRxD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		ET+B	mm/month	219.9	189.6	174.6	145.5	129.6	119.3	124.6	132.7	145.9	177.0	187.6	210.7	1957.1
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	32.08114	32.58059	41.42719	53.40608	64.40329	75.3445	75.4166	82.9661	70.5572	62.63943	47.71725	39.62945	678.1688
Applied Effluent	W	(QxD)/L	mm/month	104.5	94.4	104.5	101.1	104.5	101.1	104.5	104.5	101.1	104.5	101.1	104.5	1230.3
Inputs		RR+W	mm/month	136.6	127.0	145.9	154.5	168.9	176.5	179.9	187.5	171.7	167.1	148.8	144.1	1908.5
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	9.0	48.3	105.4	160.7	215.5	241.3	231.4	192.6	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-83.3	-62.6	-28.7	9.0	39.3	57.1	55.3	54.8	25.8	-9.8	-38.8	-66.6	
Cumulative Storage	M		mm	0.0	0.0	0.0	9.0	48.3	105.4	160.7	215.5	241.3	231.4	192.6	126.0	
Maximum Storage for Nominated Area	N		mm	241.26												
	V	NxL	L	64416												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	149	160	210	293	428	614	567	561	358	244	193	163	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 614.0 m^2

FIGURE 21 – Water balance calculations (MAV 2016).

APPENDIX 3 THE NUTRIENT BALANCE

A nutrient balance (nitrogen / phosphorous) has been undertaken to check that the LAA(s) are of sufficient size to ensure nutrients are assimilated by soils and vegetation (see *Figure 22* below).

Within the lot, 299m² (nitrogen) and 397m² (phosphorous) of effluent disposal / land application area is required.

The model used here is based on a simplistic methodology but improves on this by incorporating more variables in the respective nutrient cycles to more accurately model actual processes.

It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as mineralisation (the conversion of organic nitrogen to ammonia) and volatilisation.[25] It also accounts for crop growth rates (and hence nutrient uptake rates) for a typical pasture.

Some assumptions used in the modelling follow:

- Hydraulic loading – 900 L/day
- Nitrogen concentration in effluent – 30 mg/L
- Nitrogen percentage lost to soil processes – 20%
- Phosphorus concentration in effluent – 8 mg/L (use of no-phosphorous products, weekend house use)
- Critical nutrient loading rates – 220 kg/ha/year (60 mg/m²/day) for nitrogen and 50 kg/ha/year (14mg/m²/day) for phosphorus
- Soil phosphorus sorption capacity – 3375 kg/ha of soil
- Proportion of phosphorus sorption capacity utilised – 50%
- Design life of system - 50 years

Victorian Land Capability Assessment Framework

Please read the attached notes before using this spreadsheet

Nitrogen Balance

Site Address:	**2010 Colac Lavers Hill Road GELLIBRAND VIC**								
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE								299	m^2
INPUT DATA[1]									
Wastewater Loading				**Nutrient Crop Uptake**					
Hydraulic Load	900	L/day		Crop N Uptake	220	kg/ha/yr	which equals	60.27	mg/m²/day
Effluent N Concentration	25	mg/L							
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal							
Total N Loss to Soil	4500	mg/day							
Remaining N Load after soil loss	18000	mg/day							
NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES									
Minimum Area required with zero buffer			**Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)**						
Nitrogen	299	m^2	Nominated LAA Size			267	m^2		
			Predicted N Export from LAA			0.70	kg/year		
			Minimum Buffer Required for excess nutrient			32	m^2		

FIGURE 22 - Nutrient balance calculations (MAV 2016).

PHOSPHOROUS BALANCE	
1 Determine the daily P load	Effluent concentration P – 10mg/L Daily hydraulic load – 900 L/day 10 x 900 = 9000 mg/day
2 Determine the annual P load	9000 mg/day x 365 days = 3285000 mg - Annual P load = 3.285 kg
3 Allow for an uptake by plants (application rate) of 50 kg P/ha/year	This figure is suitable for a regularly maintained grass cover.
4 Determine P sorption each year for 50 years	3285 / 50 x 0.5 (actual field sorption multiplier) = 32.85 kg/ha/yr
5 Determine total annual application rate	Plant uptake + P sorption = 32.85 + 50 (Total P application rate) = 82.85 kg/ha/yr
6 Divide the annual P load by the application rate	3.285 / 82.85 = 0.03964 ha - multiply by 10 000 m²
Minimum area required for P assimilation over 50 years =	The area required for phosphorous assimilation requires 396.4 **(397m²).**

[25] Geary, P. and Gardner, E. (1996). On-site Disposal of Effluent. In Proceedings from the one day conference Innovative Approaches to the Management of Waste and Water, Lismore 1996.

APPENDIX 4 - REDUCE THE VOLUME OF WASTEWATER GENERATED BY INSTALLING: [26]

1. High 'Water Efficiency Labelling Scheme' (WELS)-rated water-efficient fittings (minimum '3 Stars' for appliances and minimum '4 Stars' for all fittings and fixtures):
2. Water-efficient clothes washing machines (front or top loading)
3. Dual-flush (6.5/3.5L or less) toilets
4. Water-efficient shower roses
5. Water-efficient dishwashers
6. Aerated taps
7. Hot and cold water mixer taps (especially for the shower)
8. Flow restrictors
9. Hot water system fitted with a 'cold water diverter' which recirculates the initial flow of cold water until it is hot enough for a shower.

APPENDIX 5 - IRRIGATION SYSTEMS[27] (EPA COP 891.4 – Section 3.10.2)

A reserve area is not required for a surface or sub-surface pressure-compensating irrigation system where the size of the system has been calculated and designed using the latest version of the Model LCA Report and the recommended Design Irrigation Rates in Tables 3 and 9, unless Council considers the site maybe subject to environmental or operational risks.

The low application rates are designed to create irrigation systems that are sustainable over the life of the system. If a fault occurs with a pressure-compensating irrigation system it is an equipment fault that needs maintenance, it is not a soil degradation problem.

Pumps and disc/mesh filters will fail before the soil is overloaded.

APPENDIX 6 - SYSTEM INSTALLATION, USE AND MAINTENANCE[28] (EPA COP 891.4 – Section 3.11)

A Council Permit to Install is required before the installation of any treatment system and the associated effluent recycling/disposal system. Once installed, the onsite wastewater management system may not be used until Council has issued a Certificate to Use.

Before commissioning, Council must be given suitable notice (the required timeframe will vary between Councils) that the treatment and irrigation systems have been installed (but not buried) and are ready for Council inspection.

The Certificate to Use is issued after Council has received the Plumbing Compliance Certificate and is satisfied the treatment and irrigation systems were installed in accordance with the Permit to Install and this Code.

[26] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4
[27] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4
[28] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4

APPENDIX 7 - SERVICE CONTRACTS[29] (EPA COP 891.4 – Section 3.11.1)

The treatment and irrigation/disposal systems must be operated and maintained in accordance with the conditions in the Council Permit to Install/Alter and this Code to ensure that human health and the environment are protected.

Where a property is served by a treatment system other than a gravity-flow primary treatment and land application system, it is mandatory that the property owner has a service contract with an accredited and trained service technician who will routinely service and maintain the treatment unit and land application system in accordance with the Permit conditions.

Council may fine a property owner under section 53N and Schedule A of the Act for failing to have the treatment system *regularly serviced* on an ongoing basis in accordance with the conditions on the Council Septic Tank Permit.

APPENDIX 8 - MAINTAINING LAND APPLICATION AREA (LAA)[30] (EPA COP 891.4 – Section 3.11.2)

To ensure that a LAA functions efficiently long-term, all the following actions should be undertaken by the land application designer and/or property owner:

• Realistic estimates of water, salt and sodium balances should be made to ensure that sufficient leaching occurs and no salts or sodium can accumulate in the root zone of vegetation. Sufficient gypsum should be applied to the garden to displace sodium from the soil particles and replace lost calcium.

• New land application areas should be vegetated immediately after installation (see list of suitable plants).

• Care should be taken to protect the vegetation growing across soil absorption trenches because plants, together with sunlight and wind, play a vital role in supporting the utilisation and dispersal of wastewater.

• Effluent recycling/disposal areas should be isolated as much as possible from other domestic facilities and activities to protect people and pets from potential contamination with wastewater and to protect the land from disturbance.

• Signs should be erected to inform householders and visitors of the proximity of the LAA and to limit their access and impact on the area.

• Paving, driveways, patios, fences, building extensions, sheds, children's playgrounds, utility service trenching must not be built over or encroach on the disposal/recycling area.

• The long-term functionality of the LAA will depend on the actual (as distinct from the proposed) hydraulic loading, the composition of the wastewater, and the ongoing maintenance of the treatment plant and LAA system.

[29] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4

[30] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4

APPENDIX 9 - SUBSURFACE OR COVERED-SURFACE DRIP IRRIGATION

Subsurface drip irrigation or covered-surface drip irrigation systems are becoming more popular in recent years. Properly designed systems apply effluent at much lower volumetric rates and over larger areas than absorption or ETA trenches/beds or mounds. Coverage is often better than can be achieved by surface irrigation.

Effluent is applied in the root zone of plants (100-150mm below the surface) at a rate that more closely matches plant and soil requirements (evapotranspiration), leading to more effective effluent reuse. The reliance on soil absorption is relatively low and hence the risk of contaminants accumulating in the soil or leaching to groundwater is also low.

Subsurface drip irrigation typically comprises a network of proprietary, pressure-compensating drip-irrigation line that is specially designed for use with effluent and contains specially designed emitters that reduce the risk of blockage, biofilm development and root intrusion.

Subsurface irrigation virtually eliminates the risk of people inadvertently coming into contact with effluent and also minimises the risk of effluent being transported off-site, even during rain.

Subsurface irrigation may be installed on sloping properties/parcels, provided the application rate is reduced accordingly to ensure that effluent migration down slope is taken up adequately within the root system (as per Table M2 of AS/NZS 1547:2012).

When properly designed, installed and operated, the system will ensure good distribution of effluent at uniform, controlled application rates. By properly sizing the land application areas to ensure sustainable hydraulic and nutrient loading rates, water and nutrients can be effectively utilised and are unlikely to seep to groundwater or run-off to surface waters.

Care must be taken in designing and installing irrigation systems in areas that experience temperatures below freezing. Table 9 of the EPA Code of Practice (2013) and Table 5.2 of AS1547:2012 provide Design Irrigation Rates (DIRs) for subsurface irrigation systems.

APPENDIX 10 - ISSUES TO CONSIDER WHEN SELECTING WASTEWATER TREATMENT SYSTEM

- The sustainability of the proposed system;
- The expectations of the owners of the development;
- Current property owners' ability to adequately manage the system;
- Site suitability, including environmental sensitivity;
- The availability of service agents in the area;
- System costs (both capital and on-going);
- The need for the proposed system to be replaced or refurbished at some later date;
- The development of contingency plans in the event of system failure
- The impact of the system on the amenity of the area

APPENDIX 11 - MITIGATION MEASURES FOR LAND APPLICATION AREAS

This information may be required for sites or LAAs requiring specific measures to mitigate observed constraints, usually prior to or during installation/construction of the effluent management system.

Examples of mitigation measures include (but are not limited to):

- Terracing for steep slopes;
- Imported topsoil fill to increase soil quality and depth;
- Application of gypsum or lime to improve soil condition;
- Construction of stormwater diversion berms or swales upslope of the LAA;
- Flood mitigation – such as installing seals, access risers and backflow prevention devices on treatment systems (in accordance with manufacturers' requirements), raising or bunding LAAs;
- Ripping of compacted or low-permeability soils (particularly for mound systems)
- Vegetation clearing over LAA; and
- Manual removal of coarse rock fragments or unsuitable fill materials.

APPENDIX 12 - APPROVED TYPES OF WASTEWATER & GREYWATER TREATMENT SYSTEMS

Table 2 of the Code of Practice (891.4: 2016)[31] specifies the approved types of wastewater and greywater treatment systems and effluent reuse and disposal systems for both sewered and unsewered areas.

Any wastewater treatment system proposed for installation in Victoria must have a current CA (*Certificate of Conformity*) issued by EPA and displayed on the EPA website. There is a broad range of treatment systems with current *Certificates of Conformity* including:

- Wet or dry composting toilets (greywater treatment system also required);
- Septic tanks;
- Aerobic biological filters (wet composting, vermiculture);
- Aerated wastewater treatment systems (AWTS);
- Ozonation;
- Textile filters;
- Sand filters (following primary treatment);
- Trickling aerobic filters (using foam, plastic or similar media);
- Membrane filtration;
- Reed beds (following primary treatment);
- Sand mounds (following primary or secondary treatment).

The default for recycling secondary quality effluent is sub-surface irrigation[32] because water is not wasted by evaporation or runoff, flexible garden designs are possible, water is delivered to the plants' roots in the topsoil layer, and it provides the highest protection for environmental and public health.

The setback distance to a groundwater bore in Category 1 and 2a soils can be reduced to 20 m where treated and disinfected greywater or sewage (20/30/10 or better standard) is applied and the property owner has a service contract with an appropriately qualified technician to regularly maintain the treatment system. [33]

[31] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4
[32] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4
[33] Environment Protection Agency Victoria (2016). EPA Code of Practice; Onsite Wastewater Management; 891.4. Accessed from: http://www.epa.vic.gov.au/our-work/publications/publication/2016/july/891-4

APPENDIX 13 – DWICK-TRENCH SUGGESTED SPECIFICATIONS[34]

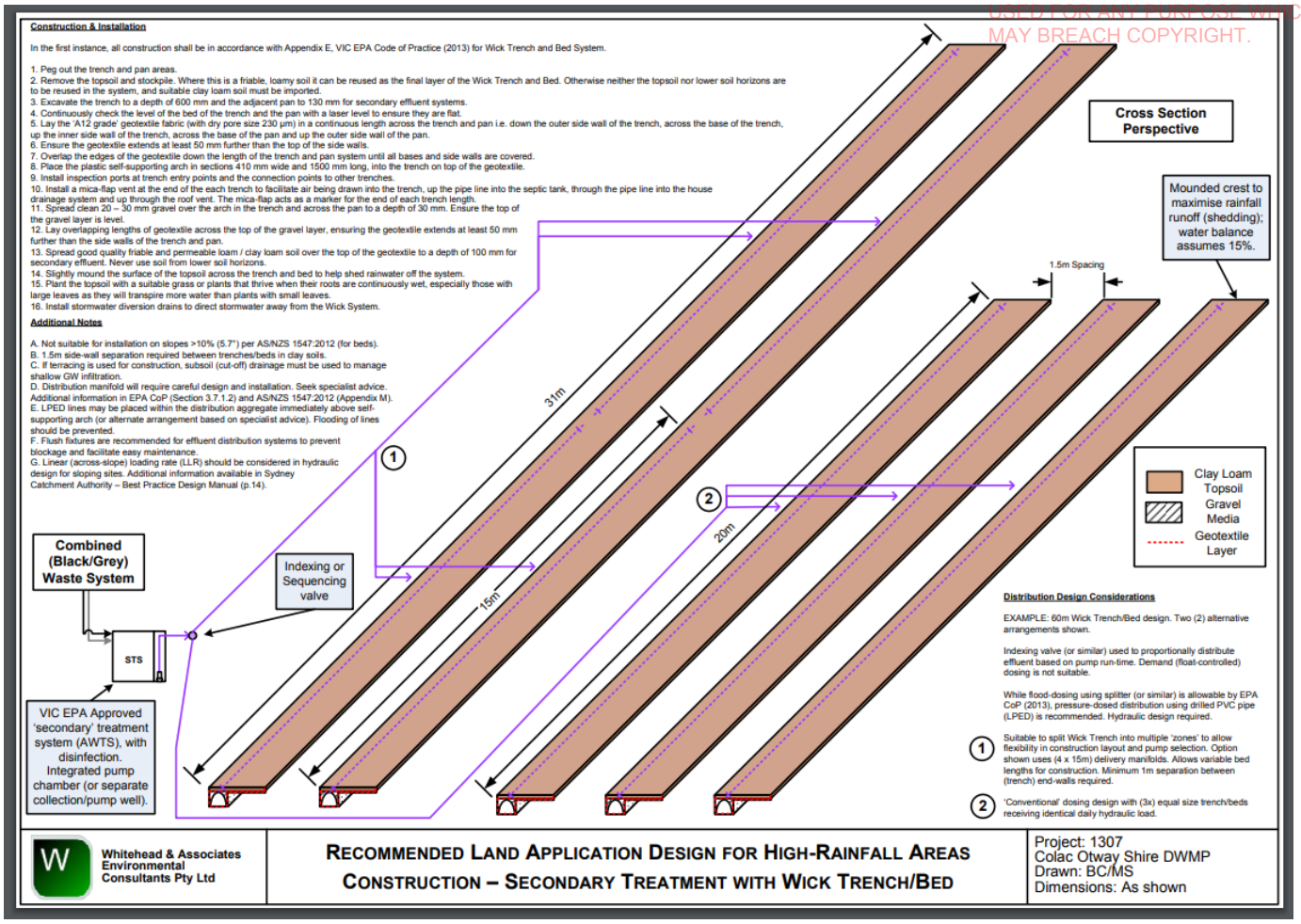


Figure 23 – Wick trenches are a high-rainfall effluent disposal option (Source: Whitehead & Associates 2016).

[34] Whitehead & Associates 2016. Colac Otway Shire Domestic Wastewater Management Plan 2016. Wick Trench Design Specifications. Accessed from: http://www.colacotway.vic.gov.au/files/assets/public/trimfiles/my-property/waste-water-management-2016-2017/wick_trench_construction-sheet_final.pdf

SUB-SURFACE IRRIGATION

These requirements are not exhaustive but summarise the main requirements under the *EPA Code of Practice Onsite Wastewater Management and AS/NZS 1547:2012*. For exact requirements go to http://www.epa.vic.gov.au/your-environment/water/onsite-wastewater

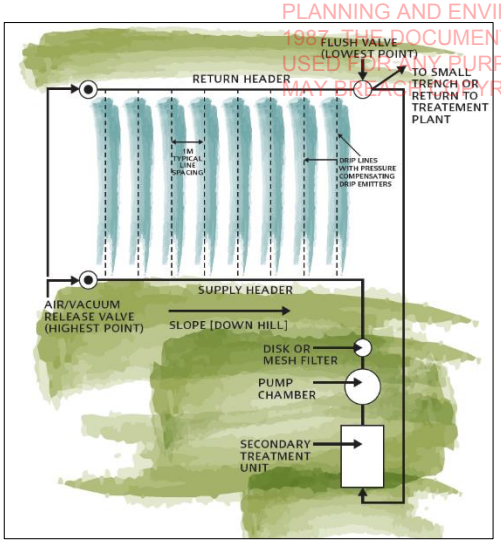
The default land application system for sustainably recycling secondary treated sewage or greywater effluent to land is pressure-compensating sub-surface irrigation (with disc or mesh filters and scour and vacuum valves), which evenly distributes effluent throughout the irrigation area.

A detailed irrigation system design is beyond the scope of this report, however a general description of subsurface irrigation is provided here for the information of the client and Council (see *Figures 24-28*).

Subsurface irrigation comprises a network of drip-irrigation lines that is specially designed for use with wastewater. The pipe contains pressure compensating emitters (drippers) that employ a biocide to prevent build-up of slimes and inhibit root penetration.

The lateral pipes are usually 0.6 apart, installed parallel along the contour. Installation depth is 100-150 mm in accordance with *AS/NZS 1547:2012*. It is critical that the irrigation pump be sized properly, to ensure adequate pressure and delivery rate to the irrigation network.

The distribution pipes (drip-lines) fill up with effluent until a certain pressure is reached which opens the emitter valves. For a 450m² irrigation field with 13mm diameter pipes, at least 60L may be required to be pumped into the pipes to reach the required pressure to open the emitters.
More controlled pressure can be applied when the field is divided into two or more zones with alternate areas intermittently dosed using a sequencing valve.



Figures 24-25 – Technical specifications for subsurface irrigation; recently completed irrigation field (Source: EHPA 2012).

A filter is installed in the main line to remove fine particulates that could block the emitters. This must be cleaned regularly (typically monthly) following manufacturer's instructions.

Vacuum breakers should be installed at the high point/s in the system to prevent air and soil being sucked back into the drippers when the pump shuts off.

Flushing valves are an important component and allow periodic flushing of the lines, which should be done at six monthly intervals. Flush water can be either returned to the treatment system, or should be released to a small dedicated gravel-based trench.

All trenching used to install the pipes must be backfilled properly to prevent preferential subsurface flows along trench lines.

Irrigation areas must not be subject to high foot traffic movement, and vehicles and livestock must not have access to the area otherwise compaction around emitters can lead to premature system failure.

Gravity-flow effluent irrigation systems are not allowed, due to the lack of even distribution. Irrigation distribution pipes must not have dripper-holes drilled or cut into them after purchase because the effluent will flow out of the holes in the first few metres of pipe at a far higher rate than the system is designed for, and higher than the soil is capable of sustainably absorbing.

Figures 26-27 – Flush valve, subsurface irrigation trenches; filter
(Source: Mornington Shire Council 2014).

Secondary treated effluent should be applied using the *Design Irrigation Rates* specified as a maximum. Secondary quality effluent is a valuable water and nutrient resource and should be used beneficially to support vegetation growth, and not be discharged deep in the soil profile where it provides very little beneficial use to the land or vegetation.

The default for recycling secondary quality effluent is sub-surface irrigation because water is not wasted by evaporation or runoff, flexible garden designs are possible, water is delivered to the plants' roots in the topsoil layer, and it provides the highest protection for environmental and public health.

Subsurface irrigation can be flexibly used and for example run (1.5m setback) along fence lines to water trees and shrubs. Trenches only required to be dug to 150-200mm in depth (as compared to soil absorption trenches 450mm).

All irrigation pipe must be laid in 3-8mm gravel/aggregate, and covered with strips of geotextile fabric. This is also required due to the high failure rate experienced by systems installed directly into topsoil.

• The international colour-coded pipe for plumbing installations for recycled water is lilac, but it is generally referred to as purple in Victoria (i.e. 'purple pipe') for pipework connecting the treatment unit and irrigation area.

The new irrigation field must have appropriate signage in accordance with the most recent version of *AS/NZS 3500: Drainage and Plumbing*.

Where a treatment system is retrofitted to existing irrigation pipes that are not purple-coloured, the above-ground fixtures such as taps, pumps and hatches, must be covered with purple paint or tape.

• If the permeability of the soil is very low (i.e. heavy clay), the soil in the irrigation area must be improved by rotary hoeing and adding gypsum to the dedicated wastewater disposal area.

• The irrigation area must be a permanent dedicated area for effluent disposal and must not be parked or driven on.

• For pressure compensating pipe vacuum breakers (air valve) must be installed at the high point of the disposal area and a flushing valve must be installed at the low point of the disposal area.

This allows for the disposal area to be flushed out preventing any blockages from sludge/scum build-up and therefore prolonging the life of the system.

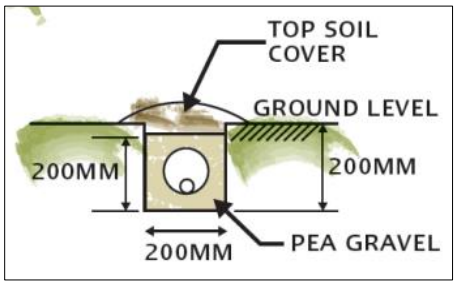


Figure 28 – Preferred method of laying subsurface irrigation.

The flushing valve must either be connected so the wastewater is returned to the system (preferable option), or disposed of via sub-soil absorption trenches.

A suitably qualified, licensed plumber must carry out installation of the effluent disposal system as per AS/NZS 1547. The effluent disposal area must be vegetated or revegetated immediately following installation of the system, preferably with turf or native sedges and grasses (planted surrounding the border of the effluent area).

The area should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access; and signs should be erected to inform householders and visitors of the extent of the effluent irrigation area, and to limit their access and impact on the area. Installation of the irrigation system must be carried out by a suitably qualified, licensed plumber or drainer experienced with effluent irrigation systems.

To ensure even distribution of effluent, it is essential that the pump capacity is adequate for the size and configuration of the irrigation system, taking into account head and friction losses due to changes in elevation, pipes, valves, fittings etc. An additional, optional measure to achieve even coverage is to divide the irrigation area into two or more separate sub-zones of minimum 300m² each; dosed alternately using an automatic indexing or sequencing valve.

The irrigation area and surrounding area must be vegetated or revegetated immediately following installation of the system, preferably with turf or native sedges and grasses (planted surrounding the border of the effluent area).

The area should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access; and signs should be erected to inform householders and visitors of the extent of the effluent irrigation area, and to limit their access and impact on the area.

Irrigation Construction Specifics[35]

1. Design for relatively uniform slope. Additional design work may be required where slope exceeds 12% or if system is to be installed over undulating ground.
2. An earth bank diversion drain must be constructed upslope of the area to divert stormwater run-on if this is appreciable.
3. Secondary treatment system – the irrigation pump must provide a minimum 25 m head and a flow rate that matches the design output of the selected dripline. Flow rate will vary depending on emitter spacing, flow rate and lineal metres of line. A full hydraulic design must be carried out. Each area should be capable of discharging a minimum of 80 L/min.
4. Filtration and flushing mechanism (see Inset A) – a field flush valve must be installed on the return line to facilitate periodic flushing to the treatment tank. An additional filter flush valve should be installed downstream of the field flush valve. A 100-150-micron cylindrical filter should be installed and cleaned regularly. Where there are potential problems in returning irrigation field flush back to the treatment tank, a small (approximately 3 m x 0.6 m) absorption area sited below the effluent irrigation area can be used to accommodate the flushed effluent.
5. An automatic, hydraulically operated sequencing valve should be installed to deliver effluent evenly to the two areas.
6. Air release valves must be installed at high points in each area. Additional air release valves may be required in undulating terrain.
7. Check valves are required for each irrigation field to facilitate periodic flushing.
8. Distribution manifolds should be 25 mm uPVC or polyethylene pipe buried 300 mm below the ground surface. I Flushing return manifold should be 25 mm uPVC or polyethylene pipe buried 100- 150 mm below the ground surface within the irrigation area. Outside this area, the pipe must be buried at a minimum of 300 mm depth.
9. Pressure compensating (PC) subsurface drip line laterals (typically 16 mm) with emitters and laterals at approximately 600 mm spacings (maximum 1,000 mm spacings) and buried to a depth 100-150 mm. Only subsurface dripline specifically designed for effluent irrigation must be used.

[35] WaterNSW (2018). Sydney Catchment Authority; Design and Installation of On-site Wastewater Systems, Section 13: Subsurface Irrigation. Accessed from: https://www.waternsw.com.au/__data/assets/pdf_file/0005/114818/Section-13-Subsurface-Irrigation.pdf

GEOTECHNICAL ASSESSMENT

AT: **2010 COLAC-LAVERS HILL ROAD GELLIBRAND**

PREPARED FOR: **Geoff De La Rue**
26 Murray Street
COLAC VIC 3250

REPORT NO.: **23156**

FEBRUARY 2019

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GEOTECHNICAL ASSESSMENT AT:
2010 COLAC-LAVERS HILL ROAD, GELLIBRAND
REFERENCE NO: 23156

1.0 INTRODUCTION

P.J. Yttrup & Associates Pty Ltd (Yttrup) was commissioned by Geoff De La Rue to carry out a geotechnical assessment at the above address in accordance with the requirements of the Australian Geomechanics Society (AGS) Guidelines on Landslip Risk Assessment (AGS, 2007) and the Colac Otway Shire (COS) Erosion Management Overlay (EMO).

The report details findings of the investigation carried out on this site, and makes comments and recommendations in regards to slope stability, footings and effluent disposal at the site.

1.1 Landslide Susceptibility

The COS EMO indicates that a Landslide Risk Assessment (LRA) must be included as part of a planning permit application should a geotechnical assessment (GA) indicate that natural slopes are steeper than 9 degrees in the Gellibrand Marl or where landslide features are present.

The Corangamite Catchment Management Authority (CCMA) has undertaken assessment and strategies as part of its Soil Health Strategy, including Landslide Susceptibility Mapping (Miner, 2007).

Reference to the 1:125,000 Colac-Otway Shire Landslide Susceptibility Map indicates that the site is categorised as Low to Moderate Landslide Susceptibility (Miner, AS (2007) in the area of the proposed development.

2.0 PROPOSED DEVELOPMENT

The location and layout of the existing dwelling is shown on Figure 1.

The proposed development includes:

1. Construction of a one storey dwelling. Construction materials to include a timber clad frame. It is likely that pad footings will be adopted for the residence.
2. No cuts are proposed. No retaining walls are proposed.

3.0 GEOTECHNICAL INVESTIGATION

Fieldwork was completed on 29 November 2018. Fieldwork comprised investigation using a mechanical auger.

Two geotechnical boreholes were advanced at the location of the proposed dwelling to depths of up to 5.0 m below ground level (BGL). Borehole locations are provided in Figure 1. Hand Vane testing and Uniaxial Compressive Strength (UCS) was completed in soils to assess shear strength. Core photos are presented in Appendix B.

Borehole log reports and explanatory notes are provided in Appendix B.

4.0 SITE CONDITIONS

4.1 Geological Setting

Reference to the 1:250,000 Colac geological map (Edwards et al, 1996) indicates the site lies within deposits of the Gellibrand Marl Group.

The Gellibrand Marl group is composed mainly of marlstone, siltstone, calcarenite and calcareous silty clay.

Edwards et al (1996) outline the broad physiography of the Otway Ranges as follows:

- The ranges are comprised of uplifted and eroded Cretaceous Eumeralla Formation.
- Miocene compression activity has produced northeast trending anticlinoria.
- Numerous folds are offset by east trending faults. Typically streams run sub-parallel to these fault systems.

4.2 Geomorphology

Dahlhaus et al, (2003) have described the significant geomorphological processes that affect the Otway Ranges in detail. Dahlhaus et al, (2003) state that:

- Coastal flanks of the Otway Ranges comprise rugged topography of ridges and spurs separated by deeply dissected and steep valleys.
- Erosion processes are driven by –
  - Significant uplift of the Otway Ranges.
  - Relatively recent fluctuations of the sea level and warmer and wetter climates.
- Due to the current erosion processes and the significant number of landslides in the region, colluvium and landslide debris is often encountered.

4.2.1 Documented Landslides

The Silty CLAY of this group can be extremely reactive and is known to form low strength fissures in the clay fabric. These can approach residual strengths and therefore moderate slopes or those with shallow groundwater tables may be susceptible to instability. This is often observed as hummocky ground.

The nearest documented landslides (**N.B.** inferred from aerial photography by others) are on the property. Refer to the CCMA mapping in Plate 1.

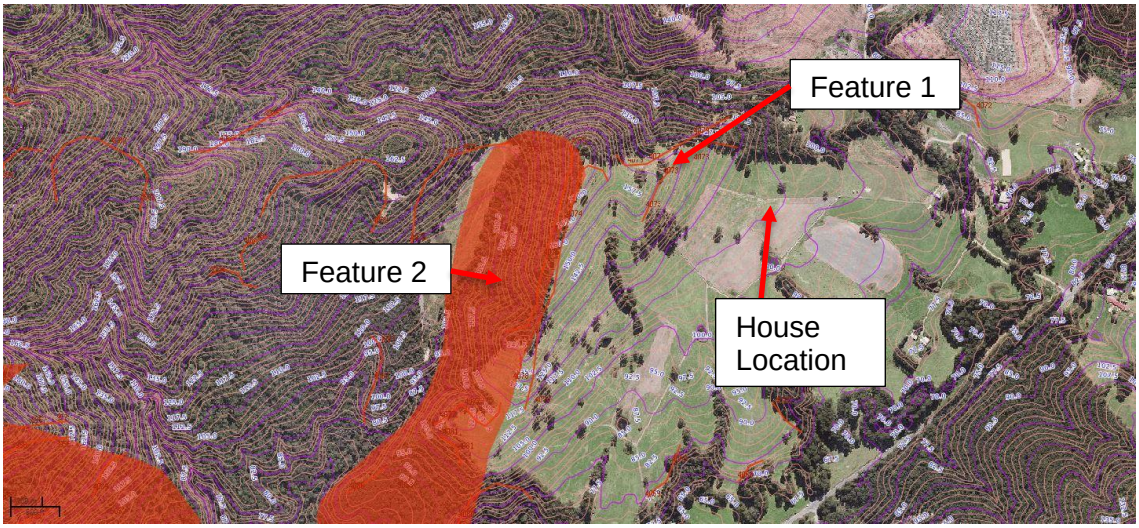


Plate 1 – CCMA landslide mapping.

Field mapping and review of aerial photography (1947 to current) indicates that no significant landslide features exist in the area of the proposed development. Two significant features are present on the property and are discussed as follows:

1. Feature 1 – represents the crest of the 20° slopes to the north west of the development. The area may be susceptible to creep. No major terraces were observed on this slope, Photo 1.
2. Feature 2 – a large area interpreted as potentially unstable. The slopes in this area fall to the south west and are inferred to be controlled by the incised gully of similar strike. Although this is a large area of potential instability, no gullies strike through the proposed development and the slopes are significantly flatter than this area of the property.

4.2.2 Site slope detail

Gentle slopes (AGS LR2, 2007) fall across the area of the proposed development in the order of 1 to 3 degrees to the south-east. Slopes increase to 8 to 9 degrees further south-east, Photo 2, over an elevation change of 7.5 m. Although 9° slopes are typically a trigger for a Landslide Risk Assessment, the distance from the proposed dwelling to the break in slope is greater than 15 m (twice the height of the slope) which is a significant stand-off to the crest.

The range to the north west of the property has slopes in the order of 20° over an elevation change of 40 m. There is at least a 125 m buffer between the development and the base of this slope, Figure 1.

Numerous incised gullies are present to the south east of the proposed development, Figure 1.

4.2.3 Surface water

Drainage on the block is currently good with slopes falling towards gullies towards the east of the proposed development, Figure 1.

The site is at risk of storm water run-on with no protection from surface water above the property.

4.3 Subsurface conditions

4.3.1 Lithology

The conditions encountered in the boreholes indicated subsurface conditions generally consistent with those described on the geological map. The following geotechnical units have been identified in the boreholes:

SURFICIAL (1)	Clayey SILT, low plasticity, moist to wet, firm to stiff
GELLIBRAND MARL (2)	Silty CLAY, high plasticity, moist, very stiff. Slickensided surfaces observed at 3 m BGL.
	Sandy CLAY, medium plasticity, moist, very stiff

The depths at which the above geotechnical units were encountered are summarised in Table 1. This forms the geological model.

TABLE 1
SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED

BOREHOLE	DEPTH TO TOP OF UNIT (m)		TOTAL DEPTH (m)
	1	2	
BH1	0.0	0.3	5.0
BH2	0.0	0.2	5.0

4.3.2 Groundwater

Permanent groundwater was not observed in the boreholes.

Considering the proposed position of the development and slope of the site, it is unlikely that permanent groundwater would be encountered on this site at depths relevant to the development. Saturated soils, seepage and perched water tables are expected during months where rainfall exceeds evaporation (e.g. during winter).

5.0 SITE CLASSIFICATION

In accordance with the recommendations and provisions of Section 2 of AS2870-2011, a site classification of **"M" - Moderately Reactive** is appropriate for the site under normal site conditions as described in Section 8 of this report.

If the requirements of AS2870-2011 and the attached CSIRO notes are not met for any reason, then a classification of **"P" – Problem Site** must be adopted and an engineer designed footing system will be required. It should be noted that additional site investigation works beyond the scope of this site classification may be required to complete a footing design for a "P' site.

The minimum founding depth for strip and pad footings for a Class "M" site can be obtained from Figure 3.5 in Section 3 of AS2870-2011. All footings must be founded at the minimum founding depth as described in Section 5.0 of this report, whilst maintaining overall minimum footing dimensions.

There are a number of trees on the site, or on adjacent land that are estimated to have no adverse effect on the foundations for the proposed residence at this time. However, if any of these existing trees are allowed to remain in place they may grow to a size that violates the "tree rules" in the attached CSIRO notes. At this stage it will be necessary to remove these trees or install deep root barriers, or damage may result to the residence. If the owner does not wish to remove these trees or install root barriers, it will be prudent to use special footing systems other than just the minimum acceptable designs in AS2870; such footings need to be designed by engineering principles. It is important that the owner be consulted about their requirements and expectations about trees.

Note: Up to 300 mm of SURFICIAL topsoil was detected on site. It is recommended that all footings be excavated through any topsoil and founded on or into the underlying CLAY, whilst maintaining minimum overall footing dimensions.

This is conditional on the requirements of AS2870-2011 and the attached CSIRO notes being met.

6.0 LANDSLIDE RISKS

As part of the geotechnical assessment, Yttrup has reviewed the credible potential modes of failure at the site and determined that the risks to the development are 'Acceptable', as defined by AGS (2007) and summarised in Table 2, provided the recommendations in this report are adopted.

TABLE 2
ACCEPTABLE RISK

RISK TYPE FOR LOW RISE RESIDENTIAL DEVELOPMENT	ACCEPTABLE RISK LEVEL (AS PER AGS 2007 C AND D)
Risk to Property and infrastructure (Qualitative Assessment)	LOW
Risk to Life for existing slopes and development (Quantitative Assessment)	1×10^{-5}
Risk to Life for new slopes and new development (Quantitative Assessment)	1×10^{-6}

With regards to slopes of the proposed development;

1. Slopes above and below the proposed development, within well vegetated areas, and that are to be unmodified are considered to be 'existing' slopes.
2. Slopes within the footprint of the proposed dwelling are considered to be 'new' slopes.

Based on the results of the fieldwork, two credible modes of failure has been identified as follows:

- Creep: slow movement of slopes in the order of 20° to the west of the proposed dwelling, Figure 1.
- Large translational slide of slopes in the order of 20° to the west of the proposed dwelling, Figure 1.

As the likely location of these failures is over 125 m to the north west of the dwelling and slope angles at the dwelling (1° to 3°) are significantly flatter than residual strengths of the Gellibrand Marl (worst case 10° to 12° slickenside effective strength) this is considered barely credible to impact on the development. Furthermore there was no evidence of the development being located on the toe of a historical slip.

The Land Capability Assessment has been completed by others. Yttrup notes that effluent applied in accordance with EPA891.4, AS1547-2012 and the COS DWMP is unlikely to increase the probability of failure due to the gentle slopes and the significant areas that are required to achieve water balance in this part of the Otway Ranges.

Therefore the modes of failure at this site have been considered are the risks to life and property are considered to be acceptable. Ground movements due to seasonal shrink swell cycles are likely to control footing design.

7.0 RECOMMENDATIONS

The following control measures shall be adopted to maintain acceptable risk levels for property damage. The dwelling shall be design and constructed in accordance with AS2870-2011.

7.1 Building Structure

Typically, lightweight, flexible construction is recommended in order to comply with AGS Good Hillside Practice (2007).

It is likely that natural ground surface movements from shrink/swell cycles, the influence of adjacent trees and bearing capacity would control the footing design as the risks due to landslide movements are considered low.

7.2 Footing System

Due to the low risk of the modes of failure impacting the proposed dwelling shallow footings may be adopted and designed for seasonal shrink-swell movements, Section 5.0.

For the proposed building footings may be designed using the parameters provided in Table 3.

Note that the surficial topsoil SILT is not a suitable material for building foundations.

Footings shall be clean of spoil and preferably inspected by a suitably qualified building inspector. Should sub-surface conditions vary significantly from this report, then Yttrup shall be contacted for further advice.

TABLE 3 ENGINEERING PARAMETERS OF INFERRED GEOTECHNICAL UNITS

INFERRED UNIT	DEPTH (m) AND EMBEDMENT	BULK UNIT WEIGHT (kN/m^3)	UNDRAINED SHEAR STRENGTH, Su (kPa)	ALLOWABLE BEARING CAPACITY (kPA)
UNIT 2	Shallow Min 0.2-0.3m BGL	18	60 (factored for fissuring)	120

7.3 Site Drainage

The development would benefit from carefully designed surface cut off drains. Surface water shall be discharged to the legal point of discharge.

Site drainage shall be constructed and maintained in accordance with AS 2870-2011 and good hillside construction practice (refer to notes in Appendix D). No ponding of surface water shall occur across the site or at levelled areas. Levelled areas shall have fall of at least 1 in 50 towards a drainage point.

7.4 Revegetation

Due to the gentle slopes maintenance of vegetation should be in accordance with the attached CSIRO notes, Appendix E.

7.5 Ongoing site maintenance

Ongoing site maintenance and development shall be in accordance with the attached notes for Good Practices for Hillside Development (refer to Appendix D).

8.0 CONCLUSION

The geotechnical assessment has found that the development can be made suitable with risk mitigation measures, and that the proposed development can meet the “acceptable” risk criteria outlined by AGS Guidelines (2007). This will include:

- Design and Construction in accordance with AS2870-2011
- Drainage, re-vegetation and maintenance in accordance with attached Good Practices for Hillside Development and recommendations enclosed in this report.

We consider that the proposed development can meet the ‘acceptable risk management’ criteria, provided that the recommendations given in Section 7 are adopted.

Dane Pope
Chartered Professional Engineer
Senior Geotechnical Engineer

Nathan McLaren
Chartered Professional Engineer
Director

P.J. YTTRUP & ASSOCIATES PTY. LTD.

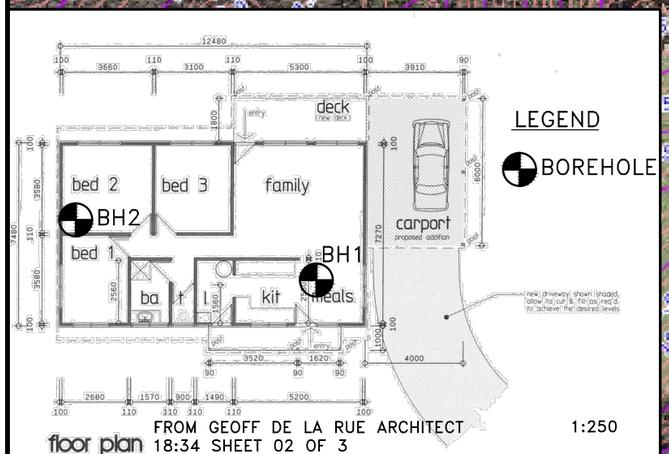
7 February 2019

9.0 REFERENCES

1. AGS 2007. Landslide Risk Management. Australian Geomechanics, V 42 (1)
2. COONEY, A.M. (1980). GSV- Otway Landslide Susceptibility Study- Report - UR 1980-76
3. Dalhaus,, P.G., Miner, A.S. (2002). Implementing the AGS landslide Risk Management guidelines in a Municipal Planning Scheme – A Case Study in the Colac Otway Shire, Victoria, Australian Geomechanics, V37(2), , pp199-211
4. Edwards J., Leonard J.G., Pettifer G.R. and McDonald P.A., 1996. Colac 1:250 000 map geological report. Geological Survey of Victoria Report 98.
5. Miner, AS (2007). Erosion and Landslide Resources in the CCMA Region. http://www.ccma.vic.gov.au/soilhealth/resource/index.htm).

FIGURES

Mature tree>30m from fence
15m buffer to break in slope
DAM
1°
PROPOSED RESIDENCE
20°
8°
9°
GULLY
GULLY
DAM
SMALL RIDGE
2-3°
8°
8°
1:5000



FROM GEOFF DE LA RUE ARCHITECT 1:250
floor plan 18:34 SHEET 02 OF 3

DATE	ISSUED TO	NO	DATE	ISSUED TO	NO

DATE	REVISION	BY

P.J.YTTRUP & ASSOCIATES PTY. LTD.
CONSULTING ENGINEERS
Email: admin@yttrup.com
A.C.N. 005 909 919 A.B.N. 71 687 799 203
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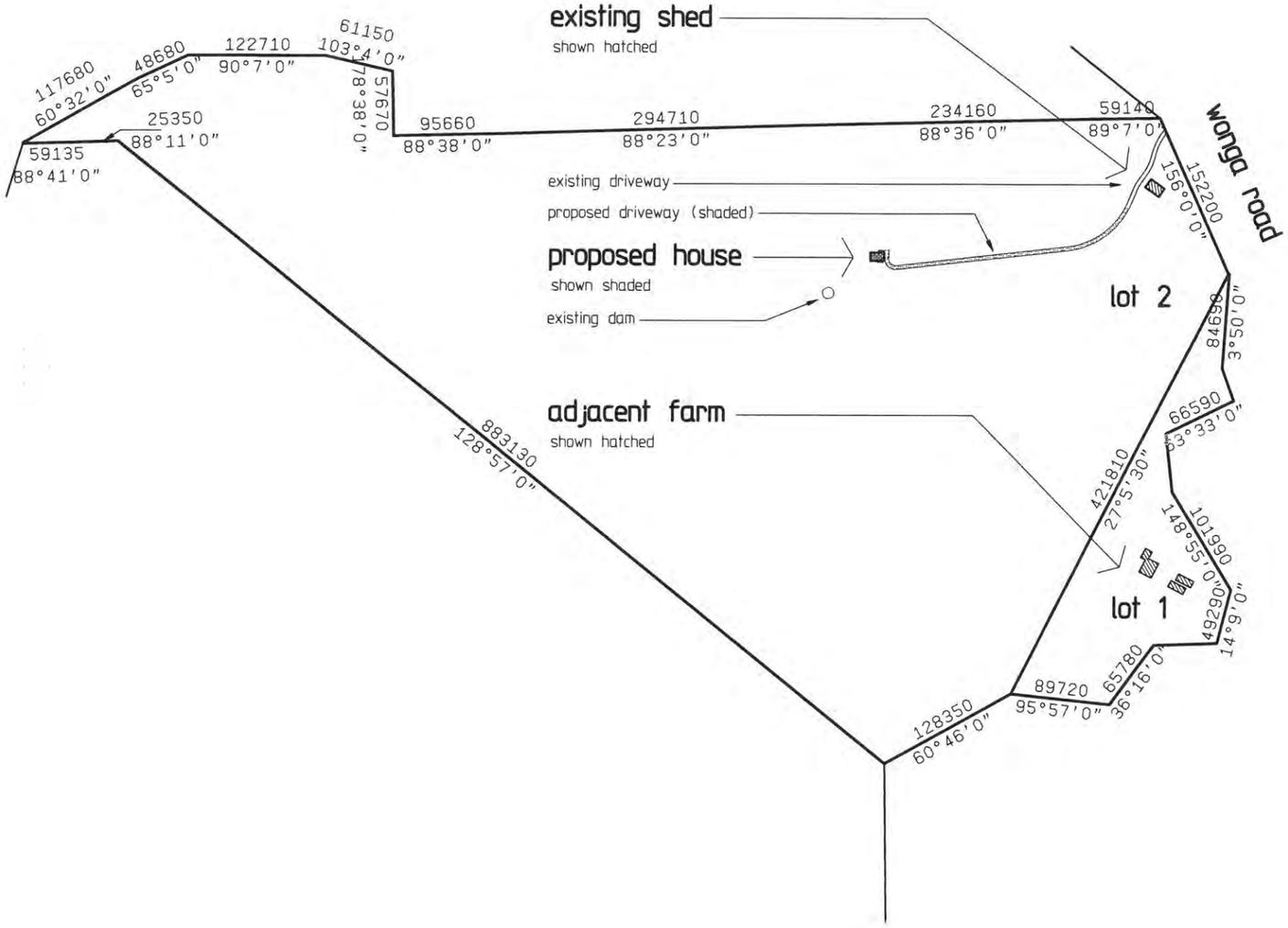
BELMONT 3216
PH: (03) 5243 3388 FAX: (03) 5244 3023

CLIENT
GEOFF DE LA RUE

PROJECT
2010 COLAC–LAVERS HILL ROAD
GELLIBRAND

ENGINEER	DRAWN AH	JOB No. 23156	ISSUE CONCEPT ONLY NOT FOR CONSTRUCTION
CHECKED	SHEET 1 of 1		DRAWING SITE PLAN
SCALE 1:5000 1:250	DATE JAN 19	REV No.	A3

APPENDIX A
Architectural Drawings



new driveway and turning area shown shaded, allow to cut & fill as req'd. to achieve the desired levels

outline of area set aside for effluent disposal field

refer to the geotech report for reference to the best effluent disposal field location

locate the effluent disposal field above the wetter, lower section of the site, after liaising with the COS health surveyor

bush fire rating:
BAL has been .....TBC

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architect
26 murray street colac
po box 92 colac 3250
telephone 03 52314787
mobile 0419 351 185
email gdelarue@iinet.net.au

site plan
scale: 1:5,000

REVISIONS:

NOTES:
DO NOT SCALE OFF THE DRAWINGS
REFER TO FIGURED DIMENSIONS ONLY
BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

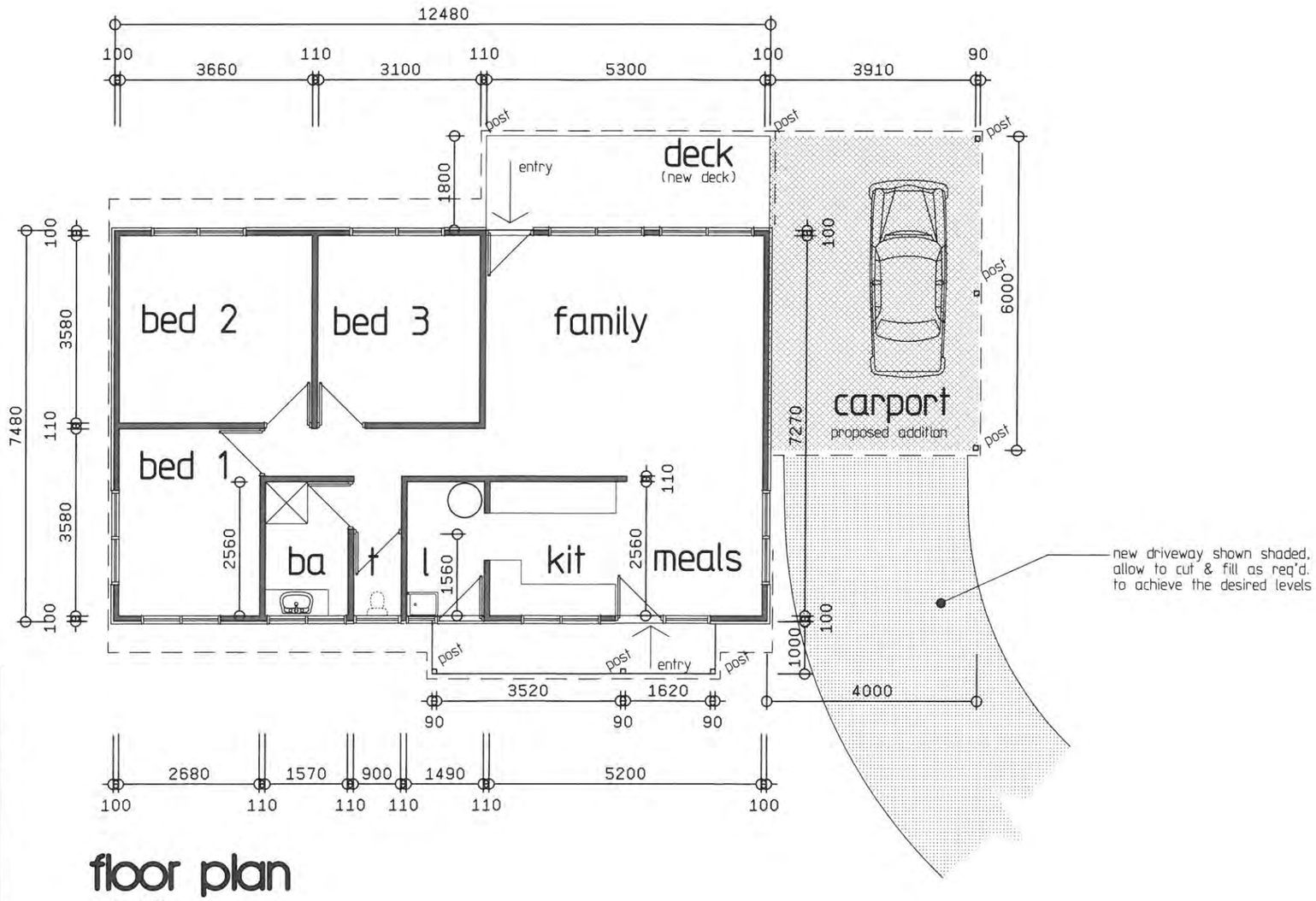
NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - site plan

DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD
DATE: 20-09-18

SCALE: AS SHOWN
ISSUED:
TO:
FOR:

18:34
PROJECT NUMBER:
01 3 - A3
SHEET: OF: REV: FORMAT



floor plan

scale: 1:100

Geoff De La Rue
b arch, raia, bdav

architect

26 murray street colac
po box 92 colac 3250
telephone 03 52314787
mobile 0419 351 185
email gdelarue@iinet.net.au

REVISIONS:

NOTES:
DO NOT SCALE OFF THE DRAWINGS
REFER TO FIGURED DIMENSIONS ONLY
BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

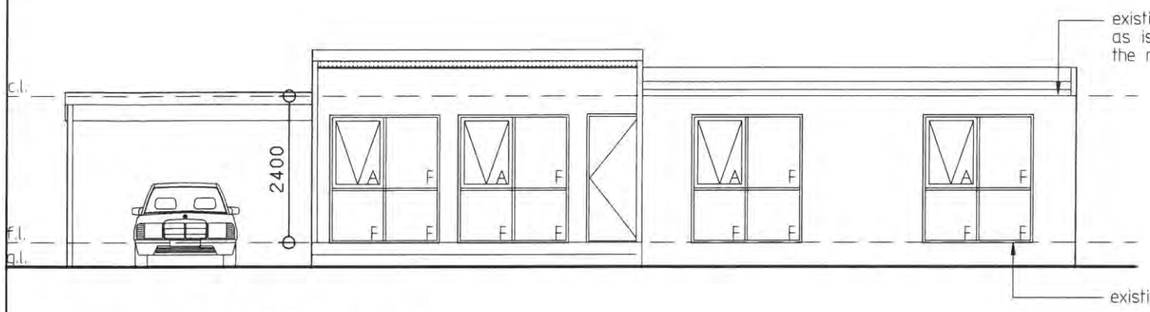
NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - proposed plan

DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD.....
DATE: 20-09-18

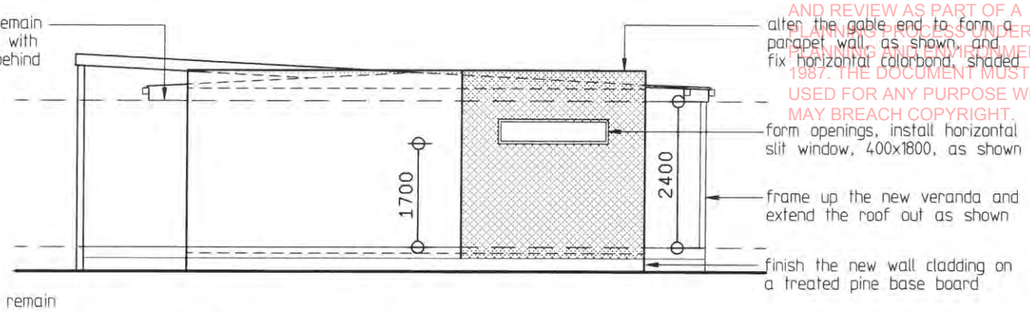
SCALE: AS SHOWN
ISSUED: .....
TO: .....
FOR: .....

18:34
PROJECT NUMBER:
02 3 -
SHEET: OF: REV:
A3
FORMAT



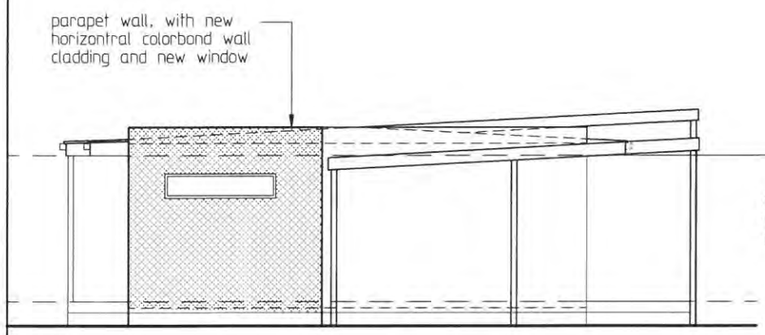
north elevation

scale: 1:100



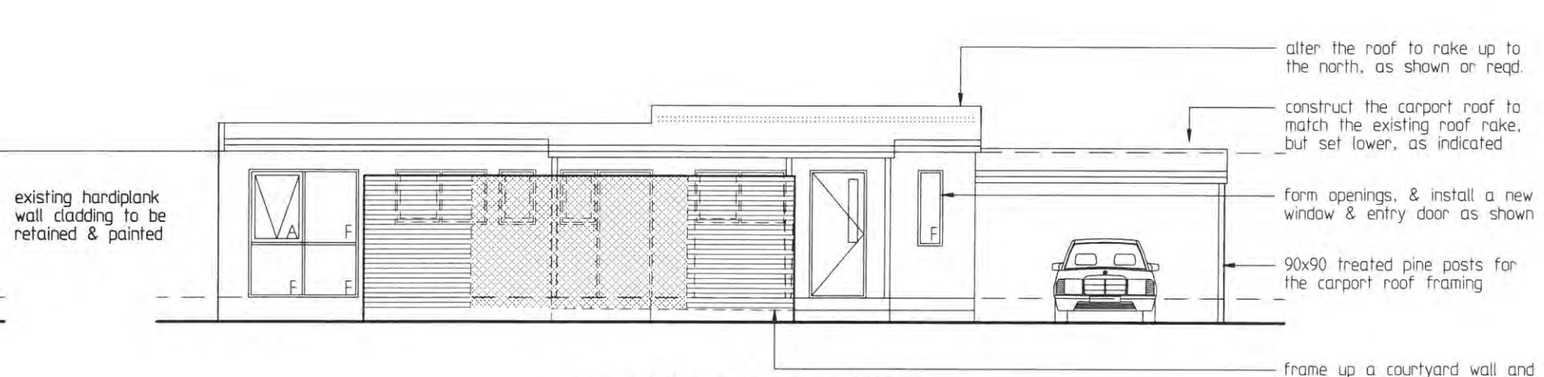
west elevation

scale: 1:100



east elevation

scale: 1:100



south elevation

scale: 1:100

general construction notes:

existing colorbond deck roof to be removed and re-used

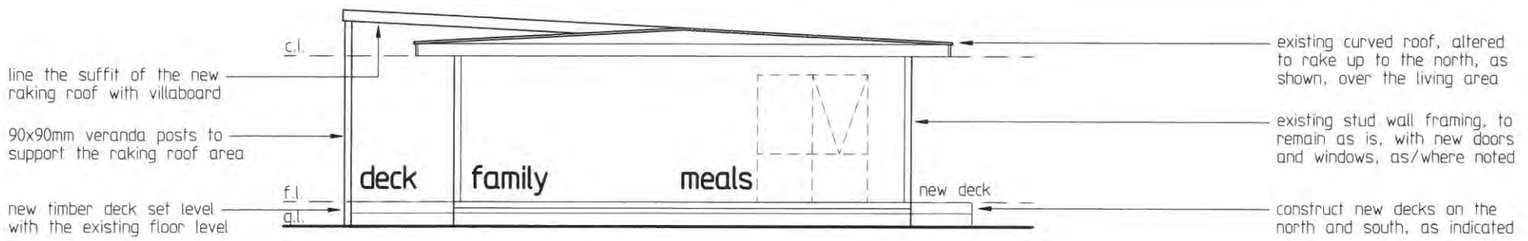
existing hardiplank cladding to be retained, generally

replace existing cladding with colorbond, where indicated

install new door and windows, & retain exg. where indicated

add carports and decking where indicated, as noted

concrete stumps to support the exg., relocated buildings



section 1

scale: 1:100, (typical)

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REVISIONS:

NOTES:
DO NOT SCALE OFF THE DRAWINGS
REFER TO FIGURED DIMENSIONS ONLY
BUILDER TO VERIFY DIMENSIONS ON SITE
CONFIRM ALL LEVELS, & SITE FEATURES
NOTIFY DISCREPANCIES TO THIS OFFICE

NORTH:

PROJECT: house relocation
CLIENT: g. sutherland
SITE: 2010 colac-lavers hill road, gellibrand
TITLE: DESIGN DRAWINGS - proposed elevations

DESIGN: G.DeLaRue
DRAWN: LR
CHECK: GAD
DATE: 20-09-18

SCALE: AS SHOWN
ISSUED:
TO:
FOR:

18-34 PROJECT NUMBER:
03 3 - SHEET: OF: REV:
A3 FORMAT

APPENDIX B

Geotechnical borehole logs & Explanatory Terms

P.J. YTTRUP
& ASSOCIATES PTY. LTD.
Consulting Engineers

Hole ID: **BH1**

CLIENT	: Geoff De La Rue	POSITION	: Refer to Site Plan
CONTRACTOR	:	EASTING	:
PROJECT	: Geotechnical Assessment	NORTHING	:
LOCATION	: 2010 Colac-Lavers Hill Road, Gellibrand	COORD. SYS.	: MGA94 Zone 55
PROJECT No.	: 23156	GROUND RL	:

Drill Rig: GT10
Date: 29/11/2018
Logged By: SB
Reviewed By:DP

Depth (m)	Water	Graphic Log	Description	Sample or Field Test	Moisture Condition	Estimated Strength	Shear Vane (kPa)	LABORATORY TESTING: Moisture Content (%)	Free Swell (%)	Shrink Swell Index (%)	Total Suction (pF)	Electrical Conductivity EC 1:5 dS/m	Electrical Conductivity ECe dS/m	Remarks/Testing DCP Blows/100 mm (0 5 10 15 20 25)
			Clayey SILT, low plasticity, brown		M to W	F to St								
			becoming; trace fine sub-rounded ironstone gravel	U 0.30 m FV s_v>140 kPa			>140							
0.5			Silty CLAY, high plasticity, brown and red brown											
			becoming; brown and red brown and grey	DS 0.60 m FV s_v>140 kPa			>140	33	40					
			becoming; red brown and grey and brown	U 0.90 m FV s_v>140 kPa			>140							
1.0				DS 1.20 m FV s_v>140 kPa			>140	38	40					
1.5			becoming; red brownand grey, trace fine sub-rounded ironstone gravel	U50 1.50 m UCS = 260 kPa FV s_v>140 kPa			>140							
				DS 1.80 m FV s_v>140 kPa			>140	34	30					
2.0														
				DS 2.40 m FV s_v>140 kPa	M	VSt	>140	37	40					
2.5														
3.0				U50 3.00 m UCS = 215 kPa FV s_v>140 kPa			>140	37	50					
3.5														
4.0				DS 4.00 m FV s_v>140 kPa			>140	24	30					
			Sandy CLAY, medium plasticity, pale grey, fine sand											
4.5				U50 4.50 m UCS = 188 kPa										
5.0			Hole Terminated at 5.00 m Target depth	DS 5.00 m				20	20					

See Explanatory Notes for details of abbreviations & basis of descriptions.

P.J. YTTRUP
& ASSOCIATES PTY. LTD.
Consulting Engineers

Hole ID: **BH2**

CLIENT	: Geoff De La Rue	POSITION	: Refer to Site Plan
CONTRACTOR	:	EASTING	:
PROJECT	: Geotechnical Assessment	NORTHING	:
LOCATION	: 2010 Colac-Lavers Hill Road, Gellibrand	COORD. SYS.	: MGA94 Zone 55
PROJECT No.	: 23156	GROUND RL	:

Drill Rig: GT10
Date: 29/11/2018
Logged By: SB
Reviewed By:DP

Depth (m)	Water	Graphic Log	Description	Sample or Field Test	Moisture Condition	Estimated Strength	Shear Vane (kPa)	LABORATORY TESTING: Moisture Content (%)	Free Swell (%)	Shrink Swell Index (%)	Total Suction (pF)	Electrical Conductivity EC 1:5 dS/m	Electrical Conductivity ECe dS/m	Remarks/Testing DCP Blows/100 mm (0 5 10 15 20 25)
			Clayey SILT, low plasticity, brown		M to W	F to St								
			Silty CLAY, high plasticity, brown and red brown and grey											
0.5				U 0.50 m FV s_v>140 kPa			>140							
			becoming; red brown and grey and brown, trace sub-rounded ironstone gravel											
1.0				U 1.00 m FV s_v>140 kPa			>140							
1.5				U 1.50 m FV s_v>140 kPa			>140							
			becoming; pale grey and red brown and brown											
2.0				U 2.00 m FV s_v>140 kPa			>140							
2.5					M	VSt								
3.0				U 3.00 m FV s_v>140 kPa			>140							
3.5														
4.0			Sandy CLAY, medium plasticity, pale grey, trace red brown, fine sand											
4.5														
5.0			Hole Terminated at 5.00 m Target depth											

See Explanatory Notes for details of abbreviations & basis of descriptions.

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CONSULTING ENGINEERS
A.C.N. 005 909 919
A.B.N. 71 687 799 203

METHOD OF SOIL DESCRIPTION

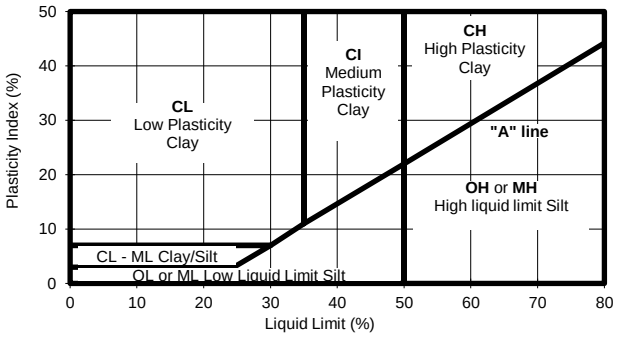
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and rock is classifed and described using the method outlined in AS1726-1993 (Amdt1-1994 and Amdt2-1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		>200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.0075 mm
CLAY		<0.002 mm

Plasticity Properties



MOISTURE CONDITION

Reference: AS1726-1993 Section A2.5(a)

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and Silts may be brittle or friable
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY[1]

Reference: AS1726-1993 Section A2.5(b)

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

Symbol	Term	Density Index (%)	SPT "N" Value[2]
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

Notes:
1. In the absence of test results, consistency and density may be assesed from correlations with the observed behaviour of the material.
2. SPT correlations are not stated in AS1726 (1996), refer Terzaghi et al (1996). N values may be subjected to corrections for overburden pressure and equipment type.

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TERMS USED ON LOGS

DRILLING/EXCAVATION METHOD

AD/	Auger Drilling	RD	Rotary blade or Drag bit	NQ	Diamond Core - 47 mm
*V	V-Bit	RT	Rotary Tri-cone bit	NMLC	Diamond Core - 52 mm
*T	TC-Bit	RA	Rotary Air	HQ	Diamond Core - 63 mm
HA	Hand Auger			HMLC	Diamond Core - 63 mm
ADH	Hollow Auger			BH	Tractor mounted Backhoe
HA	Hand Auger			EX	Tracked hydraulic excavator

PENETRATION RESISTANCE

Symbol	Term	Description
L	Low	Rapid penetration with little effort.
M	Medium	Acceptable penetration rate requiring a moderate effort.
H	High	Slow penetration with significant applied effort.
R	Refusal	No further progress without risk of damage to equipment.

The excavatability is dependent on both the operator and plant used. This assessment is dependent on numerous factors including the equipment type (power, weight, size), experience of the operator and condition of the equipment.

WATER


Water level at date shown


Partial loss of water circulation


Water inflow


Full loss of water circulation

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
6,7,12 N = 19	6,7,12 denotes blows per 150 mm. The N value denotes blows per 300 mm penetration following 150 mm seating
30/150 mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed Sample
BDS	Bulk Disturbed Sample
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PP	Pocket penetrometer test expressed as instrument reading in kPa
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
DCP	Dynamic cone penetration test

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Client: Geoff De La Rue
Site: 2010 Colac-Lavers Hill Road
Gellibrand
Job: 23156

Logged by: SB
Fieldwork Date: 29.11.2018

Unconfined Compression Testing of Clay Samples

RING:5kN No.8485

BORE NO:	1				
DEPTH:	1500	mm			
SOIL DESCRIPTION:					
SAMPLE DIAMETER:	50	mm	Area=	1963.50	mm^2
SAMPLE LENGTH:	100.36	mm	Volume=	197056.40	mm^3
SAMPLE WEIGHT:	395.22	g	Density=	2.01	$tonnes/m^3$

Divisions at failure = **29**

failure plane 45^o +/- 5^o y (Y / N)

Unconfined Compressive Strength = **260** **KPa**
Undrained Shear Strength = 130 KPa

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Site: 2010 Colac-Lavers Hill Road
Gellibrand
Job: 23156

Logged by: SB
Fieldwork Date: 29.11.2018

Unconfined Compression Testing of Clay Samples

RING:5kN No.8485

BORE NO:	1				
DEPTH:	3000	mm			
SOIL DESCRIPTION:					
SAMPLE DIAMETER:		mm	Area=	0.00	mm^2
SAMPLE LENGTH:	100.76	mm	Volume=	0.00	mm^3
SAMPLE WEIGHT:	377.29	g	Density=	#DIV/0!	$tonnes/m^3$

Divisions at failure = **24**

failure plane 45^o +/- 5^o y (Y / N)

Unconfined Compressive Strength = **215** **KPa**
Undrained Shear Strength = 108 KPa

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Client: **Geoff De La Rue**
Site: **2010 Colac-Lavers Hill Road**
Gellibrand
Job: **23156**

Logged by: **SB**
Fieldwork Date: **29.11.2018**

Unconfined Compression Testing of Clay Samples

RING:5kN No.8485

BORE NO:	1				
DEPTH:	4500	mm			
SOIL DESCRIPTION:					
SAMPLE DIAMETER:	50	mm	Area=	1963.50	mm^2
SAMPLE LENGTH:	100.55	mm	Volume=	197429.46	mm^3
SAMPLE WEIGHT:	402.39	g	Density=	2.04	$tonnes/m^3$

Divisions at failure = **21**

failure plane 45^o +/- 5^o y (Y / N)

Unconfined Compressive Strength = **188** **KPa**
Undrained Shear Strength = 94 KPa

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APPENDIX C

Photos

Photo 1 Slopes from proposed residence looking north west

Photo 2 Looking south east towards a dam with the drill rig at the proposed dwelling location.

APPENDIX D

Good Practice for Hillside Construction

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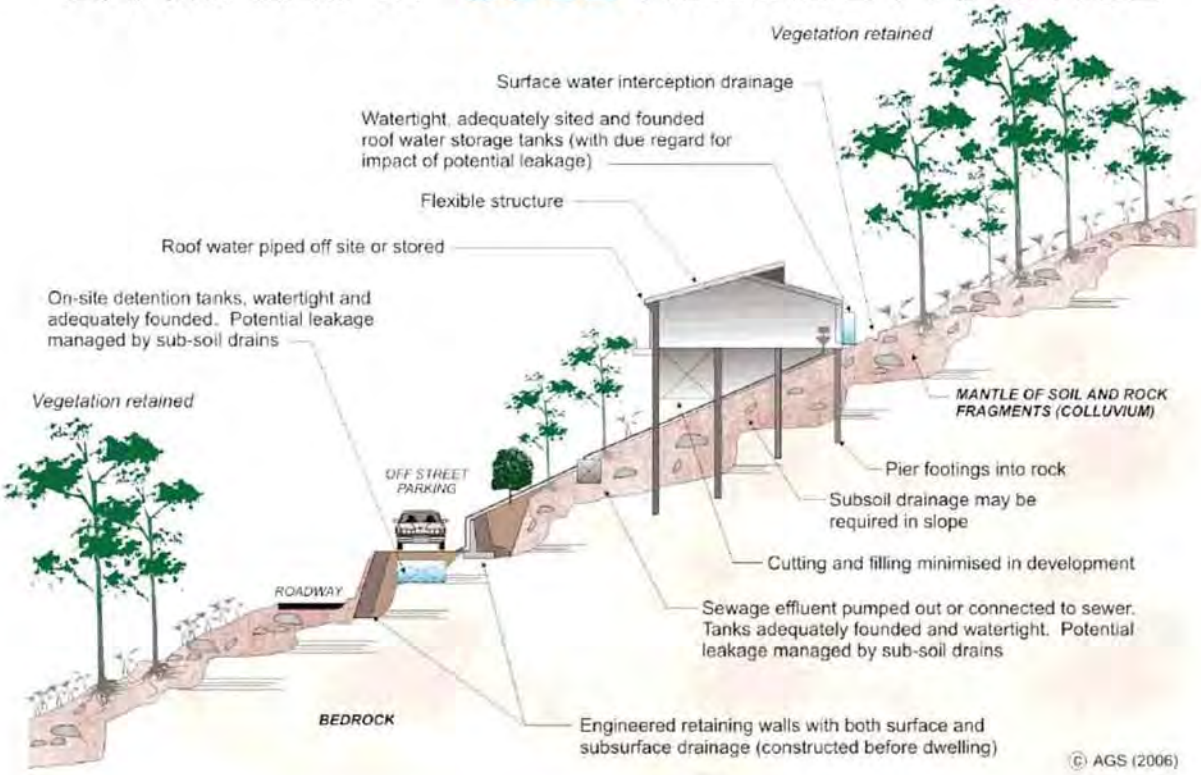
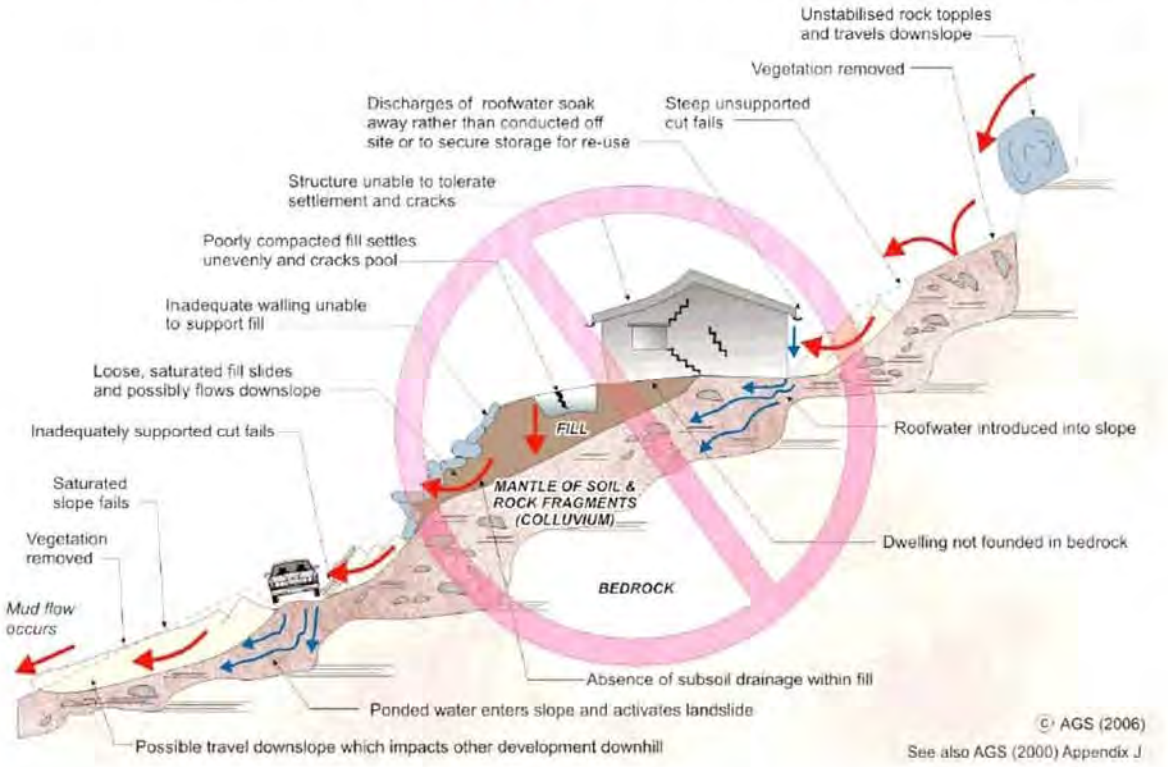
EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE



SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

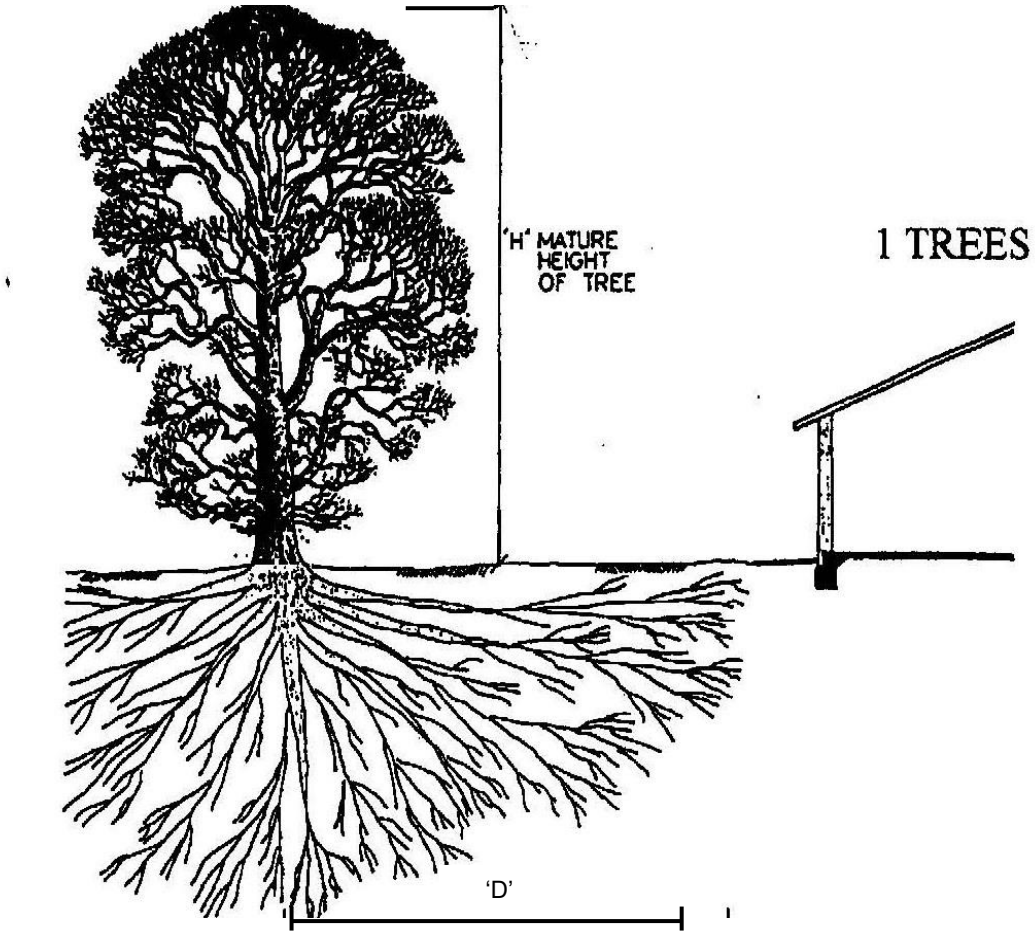
	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

APPENDIX E

General Notes 1 to 3
CSIRO Sheet 10-91 – "Guide to home owners on foundation maintenance and footing performance

GENERAL NOTES – SHEET 1

It is important to prevent the development of localised wet or dry areas at the perimeter of the proposed building.
In domestic or light weight construction, built on clayey soil, these wet or dry areas can result in differential ground movement and cause distress to the super-structure.
For this reason it is important for the builder and home owner to understand and realise the necessity of the following precautions.



Possible Zone of Soil Significantly Affected by Root System.

One Tree	D up to 1H	Class M Sites	D up to ¾ H
Class H Sites	D up to 1H	Class E Sites	D up to 1 ½ H

For a Row of Trees Increase H by 50%

IN CLAYEY SOILS

- Trees should be planted at a reasonable distance away from the proposed dwelling. A distance equivalent to the expected mature height of the tree is considered reasonable.
- Trees should be selected with the above information in mind.
- Information can be obtained from nurserymen on the selection of, and possible growth characteristics of, most trees and shrubs.

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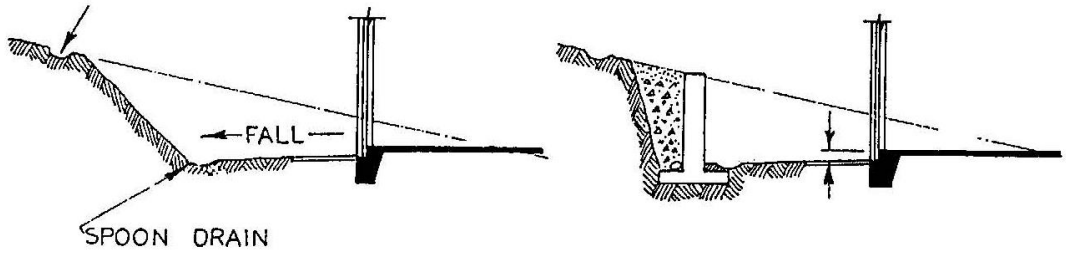
GENERAL NOTES – SHEET 2

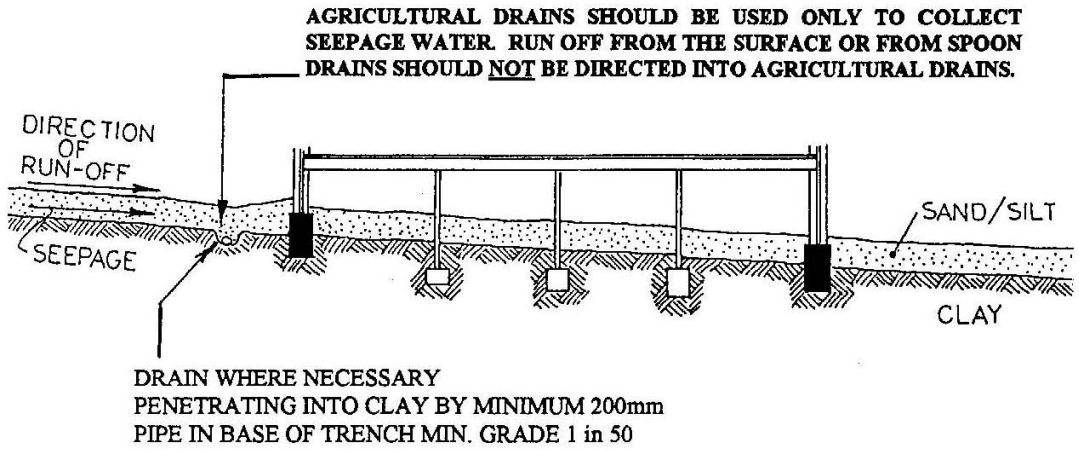
2 DRAINAGE

It is essential that the site be well drained to prevent any excessive build-up of moisture under footings or slabs. (In clayey soil, localised wetting up or drying out of the soil can result in heave or settlement within the soil foundation. Brickwork and / or structural damage can result from such movement).

SPOON DRAIN TO COLLECT RUN OFF WATER AND PREVENT SCOURING TO FACE OF CUTTING



- On slope or low lying sites concrete slabs must be raised off the ground and adequate drainage provided so as to prevent any possibility of storm water inundations.



Problems can occur at sloping sites where topsoil, silts, and sands overlay stiff clay. The downhill flow of seepage water can be stopped at a footing which is excavated into the clay. This dammed up water can produce undesirable wet areas. It may prove necessary to provide an agricultural drain to remove this water (see sketch above).

SCHEMATIC DRAWING NOT TO SCALE

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GENERAL NOTES – SHEET 3

3 PATHS AND PAVING

- The soil around the perimeter of all dwellings should be graded to fall away from the external walls.
- In Highly Reactive clay areas, perimeter paving is recommended. This provides some degree of protection to the foundation soils from seasonal moisture change.
- All paths should be graded to shed water away from the dwelling.

4 FLEXIBILITY OF CONSTRUCTION

For dwellings built on clayey soils the house super-structure should be designed to have some degree of flexibility in order to cope with possible footing movement that may occur.

Flexibility of the super-structure is achieved by articulating the brickwork to the Cement and Concrete Association Technical Note 61, “Articulated Walling”. Following are some example locations of joints.

- Use floor to ceiling windows and doors where possible.
- Use timber panels above windows in place of brickwork.
- Provide movement joints at –
  - Half-height windows.
  - Large expanses of brickwork.
  - Between old and new construction.
  - Between one and two storey sections.
  - Between wing walls and the main structure.

*** The above “movement joint locations” are examples only. The number and location of joints must also be considered from an aesthetic viewpoint. Where joints are considered unsuitable it may prove necessary to provide additional reinforcement to the brickwork.

5 SERVICE TRENCHES AND EASEMENTS

To avoid the detrimental and unwanted formation of wet or dry areas close to the building, particularly in clay soil, and to avoid interference to footings and slab beams, it is important that all service trenches be located well clear of the building perimeter and be kept to minimum acceptable depth.

The building footings must be capable of catering for the effects of any easements on this property or the neighbouring properties.

CSIRO

Improving the Built Environment
information sheet

Sheet No. 10–91 Revised August 1996

Guide to home owners on foundation maintenance and footing performance (updated for AS 2870–1996)

Introduction

This guide was prepared by Dr P.F. Walsh, formerly of CSIRO and now with the University of Newcastle, with advice from the Standards Australia Committee on Residential Slabs and Footings, to provide guidance to home owners on their responsibilities for the care of clay foundations, and to discuss the performance that can be expected from a footing system. (The ground that supports a house is called a foundation, and the concrete structure that transfers the load to this foundation is the footing system.)

The best information about the design and construction of footing systems is contained in the Australian Standard AS 2870 'Residential Slabs and Footings'. The Standard gives a system of site classification, prescribed footing and slab designs, and construction methods that provide an excellent footing system for Australian houses. However, a warning is given that the chance of a footing failure is higher if extreme site conditions are permitted to occur, viz.:

- growth of trees too close to a footing;
- excessive or irregular watering of gardens adjacent to the house;
- lack of maintenance of site drainage; and
- failure to repair plumbing leaks.

The Standard further states that compliance with this guide is a way to avoid extreme site conditions.

Clay foundations are the cause of major problems for houses. Clays are very fine-grained soils that are plastic and sticky when wet, and hard and strong when dry. All clays swell or shrink to some degree as they become wet or dry out. 'Reactive' clays swell or shrink to such an extent that foundation movements can damage houses.

All house sites are classified. Reactive-clay sites are classified as S, M, H or E, in order of increasing reactivity. Proper maintenance of such clay sites requires that the moisture content of the clay should be kept reasonably constant.

Some minor cracking of masonry walls on reactive clay sites is almost inevitable despite proper design, construction and maintenance. Very slight cracks (up to 1 mm wide) could be expected in most houses. Larger cracks (up to 5 mm) may occur in some houses with properly designed and constructed footings if reactive clay sites have been subject to large changes of moisture. Cracks larger than 5 mm are regarded as significant damage.

Non-reactive sites – sands, silts and certain clays of class A or S – need only be protected from becoming extremely wet. This requires adequate attention to site drainage and prompt repair of plumbing leaks.

Further information on these topics is given in the following sections. The guide has been updated to be consistent with the revised edition of AS 2870 (1996).

Site classification

AS 2870 requires all sites to be classified. The emphasis has been placed on reactive clays that swell and shrink with changes of moisture content, because these are the most common cause of problems. The classification system is fairly complicated but, as a general guide, the following may be helpful in understanding the system for clay sites.

S Clays that have not given trouble in the past.

M Moderately reactive clays that may cause minor damage to brick houses on old-style light strip footings. Moderately reactive clays are common.

H Highly reactive clays that often damage houses, paths and fences.

E Extremely reactive clays that frequently damage houses even with strong footings. Generally rare in major cities except Adelaide. Other occurrences include outback NSW, Darling Downs, Geelong and Horsham.

Since the precautions necessary depend on the reactivity of the site, the owner should check the classification that is shown on the house plans.

The maintenance of the building and the site is the responsibility of the owner, and so the owner should be familiar with the requirements of this guide.

Care of clay foundations

All clays move with changes of moisture content, so the aim is to minimise such changes in the clay by:

- draining the site;
- keeping gardens and trees away from the house;
- adequate but moderate garden watering; and
- repairing plumbing leaks.

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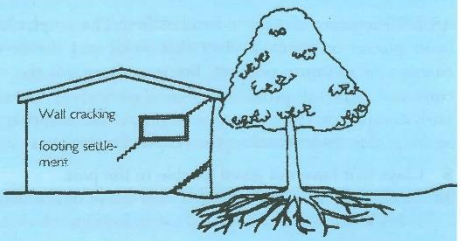
On a reactive-clay site there are some restrictions on the way the owner can safely develop the garden around the house. These restrictions apply mainly to brick houses. In most cases, only minimal precautions are justified for framed houses clad with timber or sheeting.

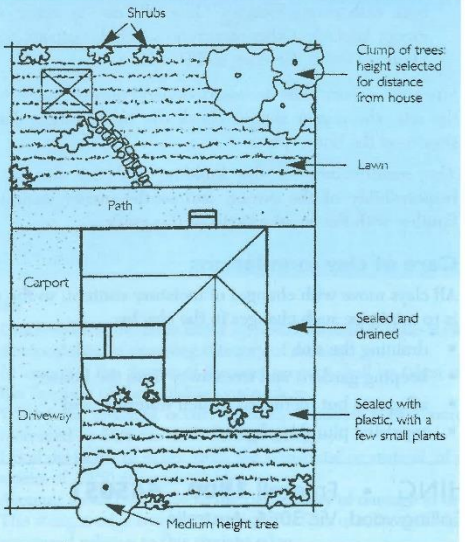
The site must be well drained. Under no circumstances should water be allowed to lie against the house or even near the house. The ground immediately next to the house should be graded away with a slope of about 50 mm over the first metre. Suitable surface drains should be provided to take the surface water away from the house. Where topsoil is brought in, it should not interfere with the site drainage, nor should it raise the ground level enough to block the weepholes in the brick walls or any subfloor vents. Even the subfloor of houses with timber floors should be drained so that water does not collect under the house.

Large garden beds are best not located near the house. This will avoid the possibility of introducing too much moisture to the foundation clay by overwatering. The zone near the house should be planned for paths or covered with gravel and plastic sheeting. Small shrubs may be planted at reasonable spacings.

Trees cause shrinkage and damage



Gardens for reactive site



Gardens and lawns should be watered adequately but not excessively. Uniform, consistent watering can be important to prevent damage to the foundation during dry spells such as droughts or dry summers.

Trees and large shrubs require substantial amounts of water, and if the soil near the tree dries out, the roots will extend in search of soil moisture. Tree watering is important in late summer and in drought. The use of slow-drip watering systems may be appropriate. It has also been found useful to drill holes near trees and fill them with gravel to allow water better access to the tree roots. Otherwise, clays will shrink as they dry, and a house may settle as shown below.

Removal of large trees creates the opposite problem. As soil moisture is gradually restored, clays swell and may lift shallow footings.

Many factors determine the extent of clay drying by trees. The more important include soil type, and the size, number and species of trees. Trees obtain moisture from roots that spread sideways, and the drying zone is influenced by the extent of these roots. For single trees, the drying zone is usually half to twice the tree height, but the zone may be larger for groups or rows of trees. Although it is known that the species can influence the extent and severity of the drying zone, little definite information is available. Some Australian trees are particularly efficient in extracting water from very dry soils and can be more dangerous than non-Australian species that use large amounts of water in normal conditions. The effect of tree drying on the amount of movement is also related to the reactivity of the clay. To minimise the risk of damage, trees (especially groups of trees) should not be planted near the house on a reactive clay site, and the following limits are recommended:

$d = 1.5\,h$ for Class E sites

$d = 1\,h$ for Class H sites

$d = 0.75\,h$ for Class M sites

where d is the distance of the tree from the house, and h is the eventual mature height of the tree. These values should be increased by 50% if the trees are in a dense group. These rules mean that on the average suburban block, trees that grow higher than 8–9 m are often impractical unless the owner accepts the risk of some damage to the house. If large trees are desired, it may be practical to adopt a specially designed footing system, e.g. a piled footing system.

A leak in the plumbing can cause the footings of a house on a reactive clay to move. The water seeps into the clay causing it to swell and push the footing system upwards. Any obvious leaks in stormwater, drainage or sewerage pipes should be investigated. Leaking water pipes can be detected by turning off all the taps and checking if the water meter records any flow.

The above restrictions may seem onerous for new home owners, but lack of site maintenance on a reactive clay can cause damage to the house. The whole issue should be kept in some perspective. The damage to houses caused by reactive clays is mostly unsightly cracks in the brickwork. In the typical Australian brick-veneer house, the brickwork does not support the structure. It is the timber frame that

carries the walls and roof loads, so brick cracks do not affect the structural safety of the house.

If owners choose to disregard some of the above restrictions and, say, plant large trees all around the house, they should not blame the builder, the engineer or the Council if the house suffers some cracking.

Performance of footing systems

All building materials move. Concrete and timber shrink, bricks grow, and so on. Many building practices have been evolved to reduce the damage that such movements cause, and the minor difficulties that arise are usually repaired without significant problems.

Where footings are designed by an engineer, the basis of the design is the limitation of any vertical movement that might occur between the centre of the wall and a line joining the ends of the wall. This is termed the differential movement and limits are given in AS 2870 for various forms of house construction. For example, a masonry veneer house with articulation joints is designed for a movement limit of 30 mm. The amount of this movement at a house can be checked using a level or even a string line along a brick course in the wall. If the vertical differential movement is less than the prescribed limit then the footing system has performed up to standard.

Masonry wall cracking can have many causes other than footing movement, including bricks growing as they absorb moisture, the structural or shrinkage movements of the frame within the veneer skin or even accidental damage during construction. If the cracking is less than a few millimetres it is virtually impossible to determine the cause. Certainly if there is no evidence of excessive differential movement then footings should not be regarded as the cause of the cracking.

However, it must be accepted that on reactive clay sites, particularly Class H and E, some movement is likely and for some sensitive houses cracking may occur even for footings performing within expectations. In order to set realistic expectations, AS 2870 contains Appendix C which is included in this report.

The performance requirement of AS 2870 suggests that Category 0 to 1 damage may be expected for houses on a reactive-clay site, but that the damage is of little consequence. Category 2 damage (isolated cracks up to 5 mm wide) is clearly not satisfactory, but it still does not constitute significant failure and could be expected to occur under adverse environmental conditions.

For these categories of damage, it is the intention of AS 2870 that consequent repairs are part of the normal house maintenance, although during the warranty period this may be the responsibility of the builder.

Nonetheless, to ensure that the damage does not proceed to a more serious state, the owner should take some action.

- Check that the recommendations on site treatment, drainage, garden arrangement, trees etc., have been observed.
- Keep a record of the crack width against the time of the year. If the damage is as high as Category 2 and seems to be increasing, the owner should consult the builder who may be able to offer more specific advice. If this does not prove satisfactory, the owner should engage a consulting engineer who specialises in house footings.
- Engage a plumber to check for leaks if this is suspected to be the cause.
- Replace soil moisture in dry spells by watering. Such watering can be more effective if holes or trenches are dug into the clay. The holes or trenches should be filled with compacted crushed rock or gravel and moderately watered. Some trees may need to be removed or kept pruned.

Complete stability is difficult to achieve, so repairs to damaged walls should include methods that will disguise further movements. Extra joints should be included in external masonry walls and further cracking in internal walls can be concealed by flexible paints, wall paper or panelling. Repairing of cracks with brittle fillers should be avoided unless the cracks have stabilised.

For the more serious categories of damage, the steps to be taken are similar, but there should be little delay in seeking advice. Remedial action for significant failure may still only include attention to stabilising moisture conditions as described above, but could also involve constructing a concrete path or a wall in the ground to stop drying of the foundation clay. Walls may even be designed to span over sagging footings or to cantilever beyond sagging footings. Underpinning is usually not satisfactory in reactive clays.

Experience indicates that lack of maintenance is responsible for many failures. Even with proper design and site maintenance the occasional failure may still occur because footing behaviour is so complex.

Shrinkage of concrete floors

Concrete needs water. Firstly to allow the fresh concrete to flow, and secondly to develop strength during its first few weeks. As a slab starts to dry, it shrinks and tries to contract. Some of this movement is restrained or resisted by friction on the bottom of the slab and by the beams in the ground. This restraint causes tension or stretching forces in the slab and these forces are often large enough to crack the slab.

Shrinkage cracking is almost inevitable and does not represent failure. Most owners never notice the cracks because they often do not occur until after the carpets are laid. Cracks under brittle or sensitive floor coverings are of concern, but the risk of damage can be reduced by using flexible mortars and glues for fixing slate and tiles etc. Also it helps to delay installing the floor covering until after the shrinkage has occurred. The length of delay should be at least three months after the slab has started to dry (i.e. from the time the slab is last wet from rain or during construction).

Adhesive-fixed floor coverings

A concrete slab takes a long time to dry. For example, under temperate conditions a slab will take about three months to dry. Moisture in the concrete can interfere with the bond or break down the adhesive used to attach floor coverings. However, a range of adhesives is available for various floor coverings and these should perform quite well on slabs that have been allowed to dry sufficiently. If there is any doubt, the moisture condition of the slab should be assessed before coverings are placed.

Conclusion

This guide has been prepared to advise owners on how to care for the foundation of their houses and what to expect from a well-designed footing system. The main concern with foundation maintenance is to prevent the foundation soil becoming too wet or too dry, and a variety of recommendations are given to achieve this.

Further information

Cameron, D. A. & Earl, I. 1982, *Trees and Houses: A Question of Function*, Cement & Concrete Association, Melbourne.

Cameron, D. A. & Walsh, P. F. 1984, *Damage to Buildings on Clay Soils*, Technical Bulletin 5.1, Australian Council of National Trusts.

CSIRO 1995, *House Cracking in Drought Periods*, Information Sheet No. 10–88, CSIRO Australia, Division of Building, Construction and Engineering, Melbourne.

Martin, K. G., Lewis, R. K., Palmer, R. E. & Walsh, P. F. 1983, *Floor Coverings on Concrete Slab-on-ground*, CSIRO Australia, Division of Building Research Report, Melbourne.

Disclaimer

Appendix C of As 2870

Table C1 Classification of damage with reference to walls

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

Table C2 Classification of damage with reference to concrete floors

Description of typical damage	Approximate crack width limit in floor	Change in offset from a 3 m straight edge centred over defect (see Note 5)	Damage category
Hairline cracks, insignificant movement of slab from level	<0.3 mm	<8 mm	0
Fine but noticeable cracks. Slab reasonably level	<1.0 mm	<10 mm	1
Distinct cracks. Slab noticeably curved or changed in level	<2.0 mm	<15 mm	2
Wide cracks. Obvious curvature or change in level	2–4 mm	15–25 mm	3
Gaps in slab. Disturbing curvature or change in level	4–10 mm	>25 mm	4

Notes:

1 Crack width is the main factor by which damage to walls is categorised. The width may be supplemented by other factors, including serviceability, in assessing category of damage.

2 In assessing the degree of damage, account shall be taken of the location in the building or structure where it occurs, and also of the function of the building or structure.

3 Where the cracking occurs in easily repaired plasterboard or similar clad-framed partitions, the crack width limits may be increased by 50% for each damage category.

4 Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible. Overall deviations in excess of 1/150 are undesirable.

5 Account should be taken of the past history of damage in order to assess whether it is stable or likely to increase.

6 The straight edge is centred over the defect, usually, and supported at its ends by equal height spacers. The change in offset is then measured relative to this straight edge.

Nov 97

APPENDIX F

Form A – Geotechnical Declaration

FORM A — Geotechnical Declaration and Verification Development Application

Office Use Only

Colac Otway SHIRE

To be submitted with planning application. It must accompany the Geotechnical Assessment and/or Landslip Risk Assessment. This form is essential to verify that the Geotechnical Assessment and/or Landslip Risk Assessment has been prepared in accordance with Cl 44.01 of the Colac Otway Planning Scheme and that the author of the Assessment/s is a geotechnical engineer or engineering geologist as defined by this clause.

Section 1 — Related Application

Planning Application Number (if known)	
Site Address	2010 Colac Lavers Hill Rd, Gellibrand
Applicant	Geoff De La Rue

Section 2 — Geotechnical Assessment and /or Landslip Risk Assessment

Details	*Report Title:* GEOTECHNICAL ASSESSMENT	
	Author's Company/ Organisation Name: P.J. YTTRUP & ASSOC.	*Report Reference No:* 190207 Geotechnical Assessment 23128
	Author: DANE POPE	*Dated:* 7 / 2 / 2019

Section 3 — Checklist

Geotechnical Requirements (Tick as appropriate either Yes or No)		**The following checklist covers the minimum requirements to be addressed in a Geotechnical Assessment and/or Landslip Risk Assessment. The report must also cover any additional matters required by Clause 44.01. This checklist must accompany each report. Each item is to be cross-referenced to the section or page of the Geotechnical Assessment and/or Landslip Risk Assessment which addresses that item.**
☑ Yes	☐ No	A review of readily available history of slope instability in the site or related land as per < 23156 Section 4.2 >
☑ Yes	☐ No	An assessment of the risk posed by all reasonably identifiable geotechnical hazards as per < 23156 Section 6.0 >
☑ Yes	☐ No	Plans and sections of the site and related land as per < 23156 Figures >
☑ Yes	☐ No	Presentation of a geological model as per < Section 4.0 >
☑ Yes	☐ No	Photographs and/or drawings of the site as per < 23156 App. C >
☑ Yes	☐ No	A conclusion as to whether the site is suitable for the development proposed to be carried out either conditionally or unconditionally as per < 23156 Section 8 >
☐ Yes	☐ No	If any items above are ticked No, an explanation is to be included in the report to justify why < >
		Is the approval subject to recommendations and conditions relevant to:
☑ Yes	☐ No	Selection and construction of footing systems.
☐ Yes	☑ No	Earthworks.
☑ Yes	☐ No	Surface and sub surface drainage.
☑ Yes	☐ No	Recommendations for the selection of structural systems consistent with the geotechnical assessment of the risk.
☑ Yes	☐ No	Any conditions that may be required for the ongoing mitigation and maintenance of the site and the proposal from a geotechnical viewpoint.
☑ Yes	☐ No	Highlighting and detailing the inspection regime to provide the <PCA> and builder with adequate notification for all necessary inspections.
50 Years		State the Design Life of the Structure adopted in the Geotechnical Assessment and/or the Landslip Risk Assessment.
☑ Yes	☐ No	Are the risk mitigation measures as recommended in the Geotechnical Assessment and/or the Landslip Risk Assessment suitable for the design life of the structure?

NOTE: **<Add Reference> - Add in the relevant section or page number of the listed Geotechnical Assessment and/or Landslip Risk Assessment which addresses each item**

FORM A — Geotechnical Declaration and Verification Development Application

Section 4 — List of Drawings referenced in Geotechnical Assessment and/or Landslip Risk Assessment

Design Documents	Description	Plan or Document No.	Revision or Version No.	Date	Author
	Geoff De La Rue -2010 Colac Lavers Hill Road, Gelibrand	18-34		20/09/18	GAD
	1:25,000 Landslide Susceptibility Map			18/03/07	CCMA
	1:25,000 Landslide Inventory Map			19/03/07	AM

Section 5 — Declaration

Declaration (Tick all that apply)		
☑ Yes	☐ No	I am a geotechnical engineer or engineering geologist as defined by the Colac Otway Planning Scheme and on behalf of the company below:
☑ Yes	☐ No	I am aware that the Geotechnical Assessment and/or Landslip Risk Assessment I have either prepared or am technically verifying (referenced above) is to be submitted in support of a planning application for the proposed development site (referenced above) and its findings will be relied upon by the Colac Otway Shire Council in determining the planning application
☑ Yes	☐ N/A	I prepared the Geotechnical Assessment and/or Landslip Risk Assessment referenced above in accordance with the Colac Otway Planning Scheme and the AGS Guidelines 2007 as defined in the planning scheme.
☑ Yes	☐ N/A	I technically verify that the Geotechnical Assessment and/or Landslip Risk Assessment referenced above has been prepared in accordance with the Colac Otway Planning Scheme and the AGS Guidelines 2007 as appropriate.
☑ Yes	☐ No	I technically verify that the Geotechnical Assessment prepared for the planning application for the site confirms the land can meet the acceptable risk criteria specified in the schedule to Clause 44.01 of the Colac Otway Planning Scheme taking into account the total development and site disturbance proposed.
☐ Yes	☐ No ☑ N/A	I technically verify that the Landslip Risk Assessment prepared for the planning application for the site confirms the land can meet the tolerable risk criteria specified in the schedule to Clause 44.01 of the Colac Otway Planning Scheme taking into account the total development and site disturbance proposed.

Section 6 — Geotechnical Engineer or Engineering Geologist Details

Company/ Organisation Name	P.J. YTTRUP & ASSOCIATES	
Name (Company Representative)	Surname: POPE	Dr / Mr / Mrs / Ms / Miss
	Given Name(s)	DANE
	Chartered Professional Status CPENG	Registration Number 3435860
Signature		Dated: 07 02 2019

Reference: AGS Guidelines 2007c *"Practice Note Guidelines for Landslide Risk Management"*, Australian Geomechanics Society, Australian Geomechanics. V42. N1 March 2007.

Note: N/A = Not Applicable

Bushfire Management Report

For Lot.2 LP 120918

2010 Colac-Lavers Hill rd Gellibrand

Report commissioned by

Geoff La Rue Architects

October 2018

NR LINKS
Your Planning & Permit Consultants

Bushfire Report for a dwelling

Lot 2 LP 120918 (2010 Colac-Lavers Hill rd, Gellbrand)

Project: 840

Report prepared by: Julie Lee of Natural Resource Link Pty

Natural Resource Link Pty Ltd

ABN 83 609 952 025

17 Armstrong Street South Ballarat Central

Ph: 0406 459 522

Email: julie@nrlinks.com.au

REV	DATE	DETAILS
A	17/10/2018	FINAL
B		
C		
D		

Copyright

Disclaimer

Natural Resource Link Pty Ltd does not accept any liability for an error, omission or loss or other consequence that may arise from relying on this report. Bushfires are a complex set of inter-related activities and environmental parameters and that the onus is on the owner to ensure all due care is taken to manage the risk. The owners survival relies on constant vigilance, maintenance and a completed bushfire survival plan.

Contents

Bushfire Management Statement

PATHWAY 2 APPLICATION

√ Construction of a dwelling (including an extension or alteration to a dwelling)

☐ Dependent Persons Unit

☐ Industry

☐ Office

☐ Retail Premises

Property Address: Lot 2 LP 120918 (2010 Colac-Lavers Hill rd, Gellibrand)

Applicant/Owner Name: Natural Resource Link Pty Ltd

Date: 17 October 2018

Prepared by:

Name: Julie Lee. Dip. Post Grad. Bushfire Planning and Management (*Melbourne University*)

Address: 17 Armstrong Street south, Ballarat Central Vic, 3350

Telephone: 0406 459 522

Email: julie@nrlinks.com.au

Introduction

This Bushfire Management Statement has been prepared in response to the requirements of Clause 44.06-1 – Bushfire Management Overlay, and in accordance with the application requirements of Clause 52.47 – Planning for Bushfire.

The statement contains two components:

1. A **bushfire hazard landscape assessment** including a plan that describes the bushfire hazard of the general locality more than 150 metres from the site. Photographs or other techniques may be used to assist in describing the bushfire hazard.
2. A **bushfire management statement** describing how the proposed development responds to the requirements of Clause 44.06 and 52.47

Classifiable vegetation (Forest) to most aspects from the proposed dwelling

Application Details

Municipality:	Colac Otway Shire Council
Title description:	Lot 2 LP 120918 (2010 Colac-Lavers Hill rd Gellibrand)
Overlays:	Bushfire Management Overlay (BMO). Erosion Management Overlay (EMO), Environmental Significant Overlay (ESO),
Zoning:	Farming Zone (FZ)

Site Description

Site shape:	Odd
Site Dimensions:	900m x 360m
Site Area	119.35ha.
Existing use and siting of buildings and works on and near the land:	Vacant site
Existing vehicle arrangements:	Existing driveway
Location of nearest fire hydrant:	None in the area
Any other features of the site relevant to bushfire considerations:	The site is mainly grazing farm land.

CLAUSE	COMMENT
13.02-1S Bushfire planning- Bushfire planning, strategies and principles	
Apply the precautionary principle to planning and decision-making when assessing the risk to life, property and community infrastructure from bushfire.	Precautionary principles includes consideration of landscape risk
Prioritise the protection of human life over other policy considerations in planning and decision-making in areas at risk from bushfire.	Dwelling is to be moved on site and most likely will have footings and will require mitigation from ember attack
Applies best science to identify vegetation, topography and climatic conditions that create a bushfire hazard	N/A
Address Landscape risk and consider siting	Addresses egress and ember density
Ensure biodiversity and environmental objectives are compatible	N/A
Ensure easy implementation of mitigation requirements	Mitigation requirement can be made to a potential dwelling.
Ensure access and egress are compatible for emergency vehicle access	Good clear access and egress is provided
Clause 44.06 Bushfire Management Overlay	
Prioritises protection of human life	Siting prioritises human safety
To ensure that the development of land prioritises the protection of human life and strengthens community resilience to bushfire.	Siting sites the dwelling at 100m from the road to place the house site lower and semi-sheltered from ember attack and also closer to the road for egress.
Clause 44.06-1 Bushfire management objectives and application of schedules	
Clause 44.06-2 Buildings and works A permit is required to develop	A permit is required
Permit not required for If a schedule to this overlay specifically states that a permit is not required. A building or works consistent with an agreement under Section 173 of the Act prepared in accordance with a condition of permit issued under the requirements of Clause 44.06-5.	N/A

Permit not required for an extension if <50% of gross floor area (dwelling)	N/A
Permit not required for an alteration or extension to an existing building (excluding a dwelling and a dependent person's unit) that is less than 10 percent of the gross floor area of the existing building	N/A
Permit not required for a building or works with a floor area of less than 100 square metres not used for accommodation and ancillary to a dwelling	N/A
Permit not required for a building or works associated with Timber production provided the buildings or works are not within 150 metres of Accommodation or land zoned for residential or rural residential purposes.	N/A

44.06-3 Application requirements Unless a schedule to this overlay specifies different requirements, an application must be accompanied by: • A bushfire hazard site assessment including a plan that describes the bushfire hazard within 150 metres of the proposed development. The description of the hazard must be prepared in accordance with Sections 2.2.3 to 2.2.5 of AS3959:2009 Construction of buildings in bushfire prone areas (Standards Australia) excluding paragraph (a) of section 2.2.3.2. Photographs or other techniques may be used to assist in describing the bushfire hazard.	A bushfire hazard site assessment has been undertaken
Clause 44.06-4 Requirements of Clause 53.02 An application must meet the requirements of Clause 53.02 unless the application meets all of the requirements specified in a schedule to this overlay. A schedule to this overlay may specify substitute approved measures, additional alternative measures and additional or substitute decision guidelines for the purposes of Clause 53.02.	Application meets the requirements of Clause 53.02
Clause 53.02-1 This clause applies to an application under Clause 44.06 - Bushfire Management Overlay, unless the application meets all of the requirements specified in a schedule to Clause 44.06. Clause 53.02-3 applies to an application to construct a single	Complies with all requirements of Clause 53.02-1

dwelling or construct or carry out works associated with a single dwelling if all of the following requirements are met: • The land is zoned Neighbourhood Residential Zone, General Residential Zone, Residential Growth Zone, Urban Growth Zone, Low Density Residential Zone, Township Zone or Rural Living Zone. • There is only one dwelling on the lot. • The application meets all of the approved measures contained in Clause 53.02-3. Clause 53.02-4 applies to all other applications. **2-1 Application**	
Clause 53.02-2 Operation The provisions of this clause contain: Objectives. An objective describes the outcome that must be achieved in a completed development. • Approved measures (AM). An approved measure meets the objective. • Alternative measures (AltM). An alternative measure may be considered where the responsible authority is satisfied that the objective can be met. The responsible authority may consider other unspecified alternative measures. • Decision guidelines. The decision guidelines set out the matters that the responsible authority must consider before deciding on an application, including whether any proposed alternative measure is appropriate.	Meets all requirements of Clause 53.02-2
Clause 53.02-4 Bushfire protection objectives	
Clause 53.02-4.1 Landscape, siting and design objectives Development is appropriate having regard to the nature of the bushfire risk arising from the surrounding landscape. Development is sited to minimise the risk from bushfire. Development is sited to provide safe access for vehicles, including emergency vehicles. Building design minimises vulnerability to bushfire attack	Development is best placed closer to the road and in a lower part of the block to reduce ember risk.

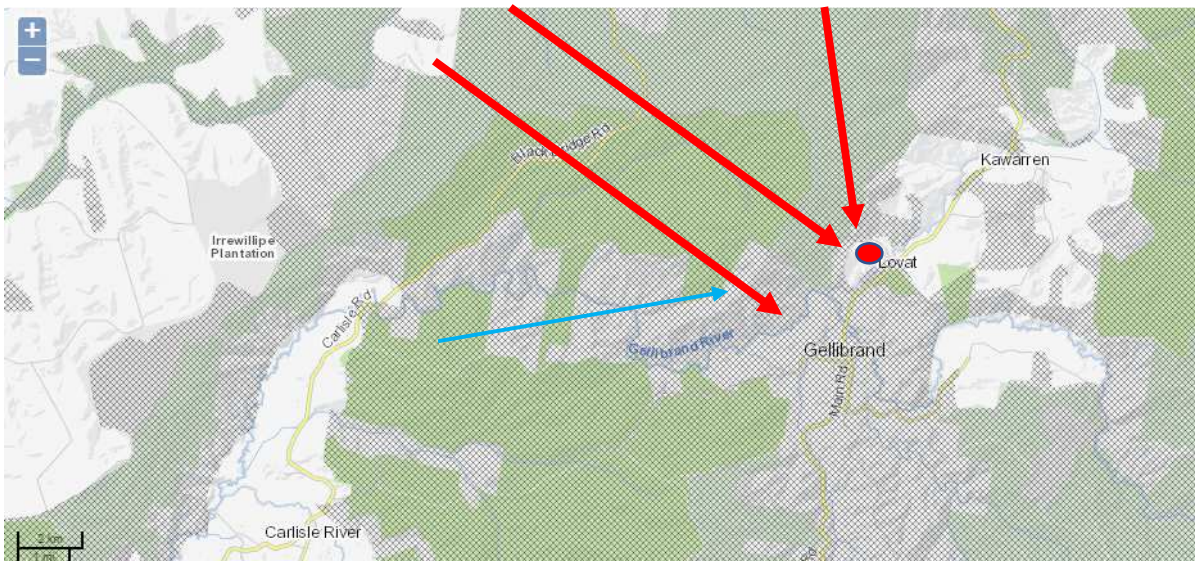
Approved measures Measure Requirement **AM 2.1**The bushfire risk to the development from the landscape beyond the site can be mitigated to an acceptable level	The landscape risk of embers is of high concern and although the BAL level is low a higher level of ember density will be specified.
AM 2.2 A building is sited to ensure the site best achieves the following: The maximum separation distance between the building and the bushfire hazard. The building is in close proximity to a public road. Access can be provided to the building for emergency service vehicles.	Building moved to 100m off the road.
AM 2.3 A building is designed to be responsive to the landscape risk and reduce the impact of bushfire on the building.	The building is likely to be an older type and moved to site-ember resistance will berequired.
Clause 53.02-4.2 Defendable space and construction objective Defendable space and building construction mitigate the effect of flame contact, radiant heat and embers on buildings.	Defendable space for a BAL of 19 has been applied.
AM 3.1 Approved measures A building used for a dwelling (including an extension or alteration to a dwelling), a dependent person's unit, industry, office or retail premises is provided with defendable space in accordance with: Table 2 Columns A, B or C and Table 6 to Clause 53.02-5 wholly within the title boundaries of the land; or If there are significant siting constraints, Table 2 Column D and Table 6 to Clause 53.02-5. The building is constructed to the bushfire attack level that corresponds to the defendable space provided in accordance with Table 2 to Clause 53.02-5.	Defendable space is from Column B
AM 3.2 A building used for accommodation (other than a dwelling or dependent person's unit), a child care centre, an education centre, a hospital, leisure and recreation or a place of assembly is: Provided with defendable space in accordance with Table 3 and Table 6 to Clause 53.02-5 wholly within the title boundaries of the land. Constructed to a bushfire attack level of BAL12.5.	N/A
AltM 3.3 Alternative measures Adjoining land may be included as defendable space where there is a reasonable assurance that the land will remain or continue to be	N/A

managed in that condition as part of the defendable space	
AltM 3.4 Defendable space and the bushfire attack level is determined using Method 2 of AS3959:2009 Construction of buildings in bushfire prone areas (Standards Australia) subject to any guidance published by the relevant fire authority.	N/A
AltM 3.5 A building used for a dwelling (including an extension or alteration to a dwelling) may provide defendable space to the property boundary where it can be demonstrated that: The lot has access to urban, township or other areas where: – Protection can be provided from the impact of extreme bushfire behaviour. – Fuel is managed in a minimum fuel condition. – There is sufficient distance or shielding to protect people from direct flame contact or harmful levels of radiant heat. Less defendable space and a higher construction standard is appropriate having regard to the bushfire hazard landscape assessment. The dwelling is constructed to a bushfire attack level of BAL FZ. This alternative measure only applies where the requirements of AM 3.1 cannot be met	N/A
AltM 3.6 A building used for accommodation (other than a dwelling or dependent person's unit), child care centre, education centre, hospital, leisure and recreation or place of assembly may provide defendable space in accordance with Table 2 Columns A, B or C and Table 6 to Clause 53.02-5 where it can be demonstrated that: An integrated approach to risk management has been adopted that considers: – The characteristics of the likely future occupants including their age, mobility and capacity to evacuate during a bushfire emergency. – The intended frequency and nature of occupation. – The effectiveness of proposed emergency management arrangements, including a mechanism to secure implementation. Less defendable space and a higher construction standard is appropriate having regard to the bushfire hazard landscape assessment.	N/A
Clause 53.02-4.3 Water supply and access objectives	

AM 4.1 A building used for a dwelling (including an extension or alteration to a dwelling) • A static water supply for fire fighting and property protection purposes specified in Table 4 to Clause 53.02-5. • Vehicle access that is designed and constructed as specified in Table 5 to Clause 53.02-5 • The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for fire fighting water supplies.	Complies
Clause 53.02-5 Tables : Defendable space, construction, water supply, vehicle access, vegetation management and outbuilding construction requirements **Table 2** Defendable space and construction	Complies
Table 5 Vehicle access design and construction	Complies
Table 6 Vegetation management requirement	See Appendix.1
Table 7 Outbuilding construction requirement Building construction condition The proposed outbuilding is separated from the adjacent building by a wall that extends to the underside of a non-combustible roof covering and: • has a FRL of not less than 60/60/60 for loadbearing walls and -/60/60 for non-load bearing walls when tested from the attached structure side, or • is of masonry, earth wall or masonry-veneer construction with the masonry leaf of not less than 90 millimetres in thickness. Any openings in the wall shall be protected in accordance with the following: i. Doorways – by FLR -/60/30 self-closing fire doors ii. Windows – by FRL -/60/- fire windows permanently fixed in the closed position iii. Other openings – by construction with a FRL of not less than -/60/-	Not applicable

Landscape Risk

BROADER LANDSCAPE RISK



The broader landscape risk is type three the site is:

- Fire can arrive at site from many aspects.
- Access to shelter is long and through high risk vegetation
- Extent of landscape vegetation will result in extreme fire weather

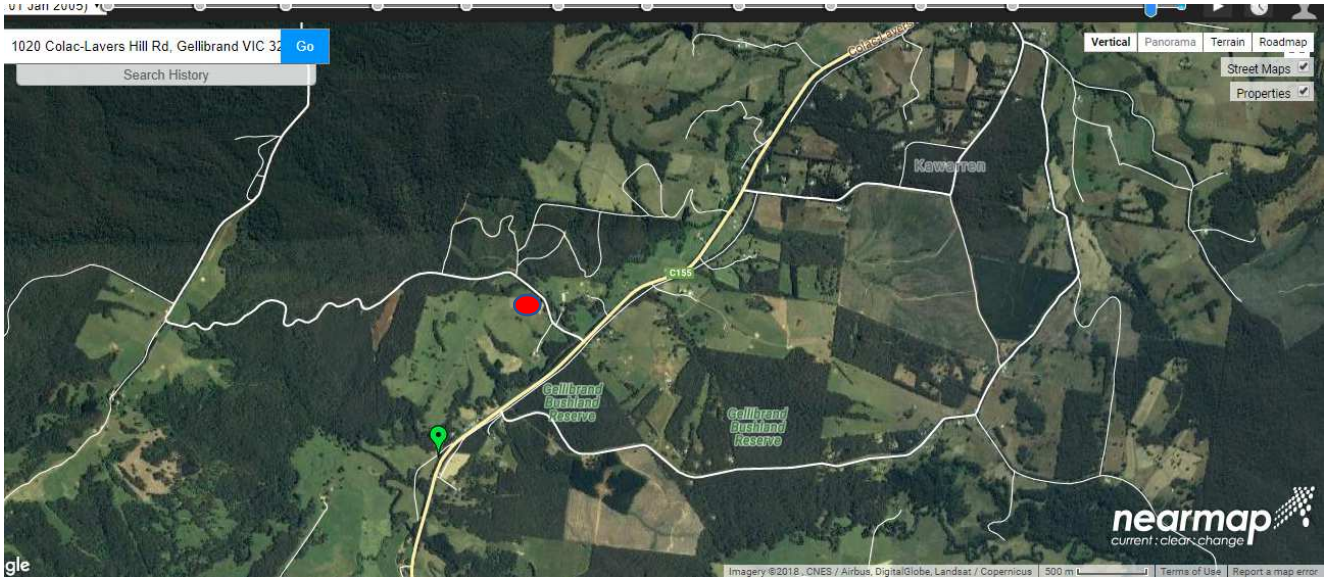
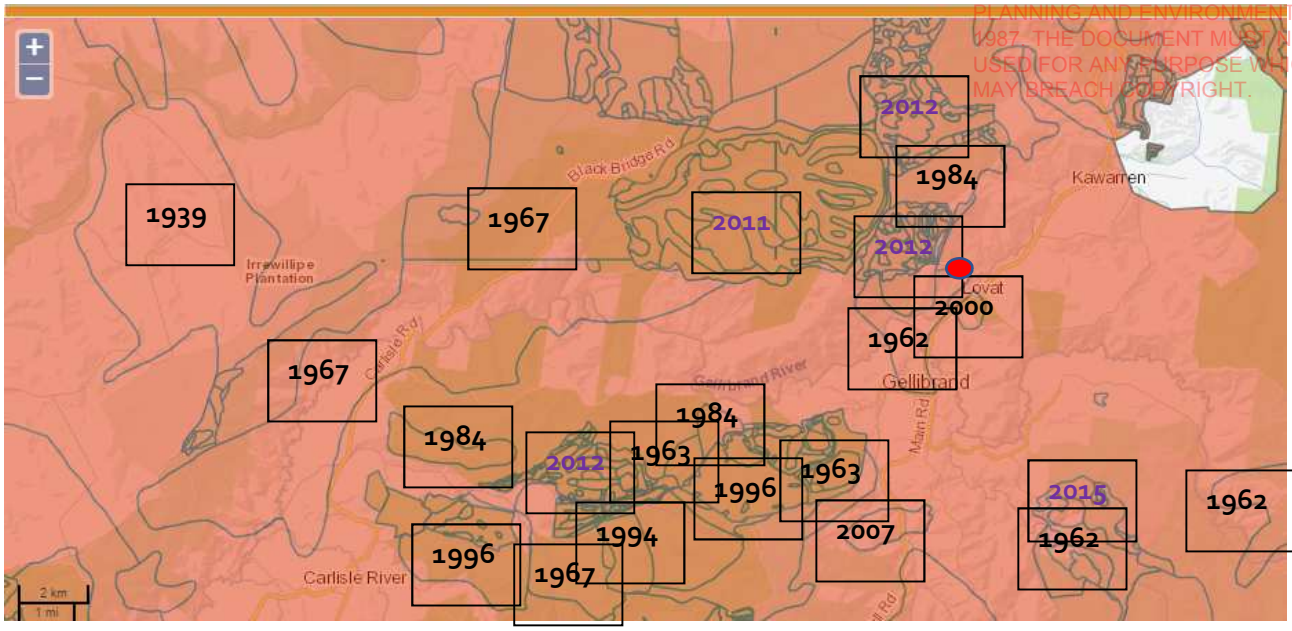


Image of the landscape with site show in red above

Fire History



LANDSCAPE FIRE HISTORY.

The site has a strong history of fire as shown above the entire area was burnt in the fire of 1939 shown in red (background). Site is shown with a red circle

The other fires are smaller and range from 1962-2000 with several areas of Fuel reduction burns in 2001-2015.

The site is well serviced by the Colac-Lavers Hill main rd which is a category one road providing clear access from the site which is close to the junction of Wonga and Colac-Lavers Hill rd's.

Construction Level

A building is constructed to the bushfire attack level:

That corresponds to the defendable space provided in accordance with Table 2 to Clause 53.02-5. The building will be constructed to **BAL19**

Any other comments

The bushfire risk to the development from the landscape beyond the site can be mitigated to an acceptable level.

The risk from the landscape has been mitigated with the following conditions which will provide a higher level of protection from embers:

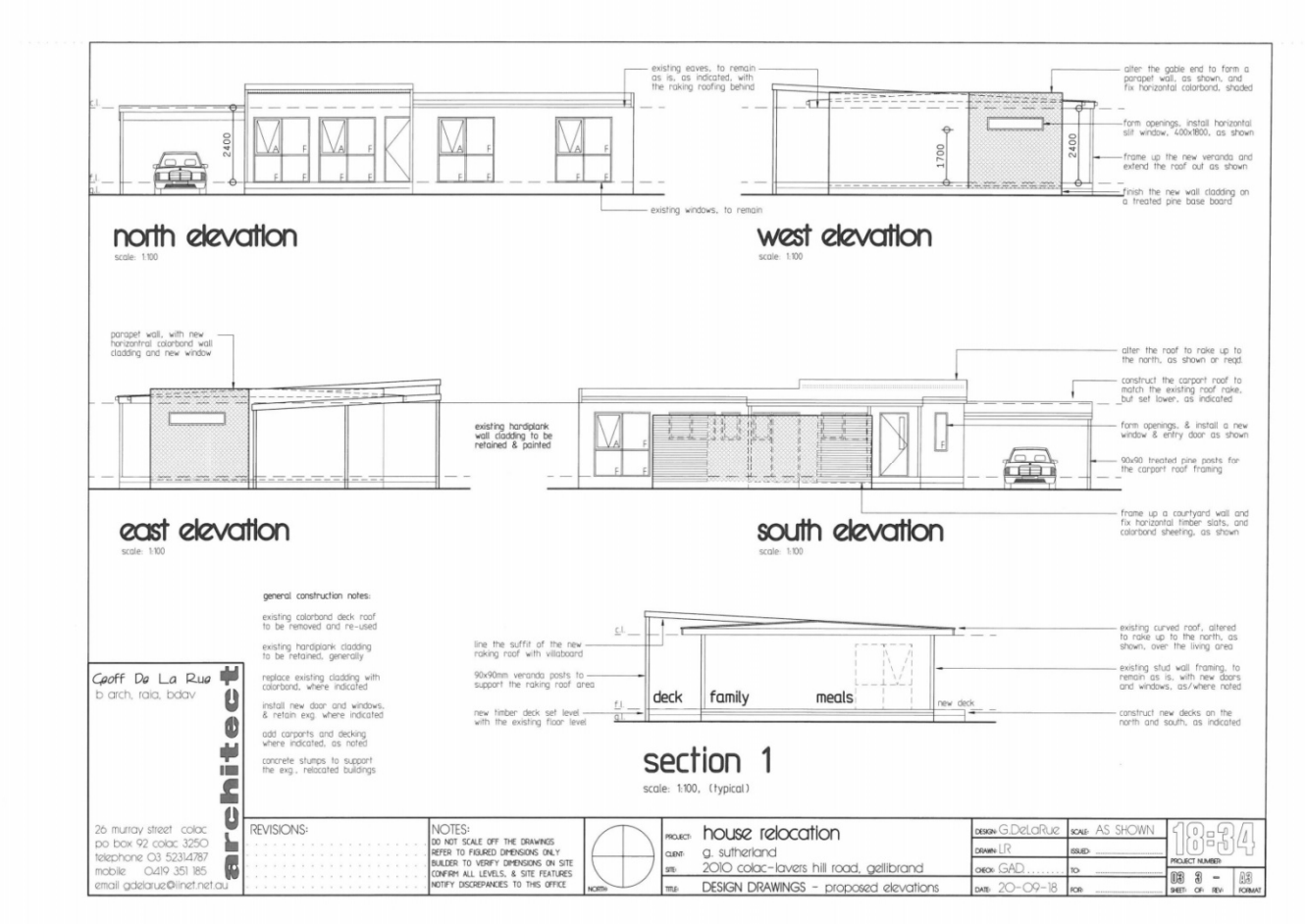
- All external doors to be protected with non-combustible screens that comply with Clause 7.5.1.A (AS3959-2009)
- If using a metal roof place, a non-combustible insulation to all joins and edge of the roof to prevent the entry of embers. The building is a square and limits re-entry corners with a simplified one level roof design.
- Subfloor supports if exposed to comply with Clause 8.2 (AS3959-2009)
- Elevated floors unenclosed to comply with Clause 8.3.2.2. (AS 3959-2009)
- Roof penetrations to comply with Clause 8.6.5 (As3959-2009)
- Decking to comply with Clause 8.7 (AS3959-2009).

.

Looking east from site

Looking south from site

Building Design



Bushfire Hazard Assessment-Lot.1.

Classify the vegetation within 150 metres of the proposed development in accordance with AS3959:2009 Construction of buildings in bushfire prone areas.

	Direction (Aspect)			
	N	**S**	**W**	**E**
Vegetation (within 150 metres of subdivision)	Excludable / Low Threat ☐ Modified ☐ Forest ☐ Woodland ☐ Scrub (tall) ☐ Shrubland (short) ☐ Mallee ☐ Rainforest ☐ Grassland √	Excludable / Low Threat ☐ Modified ☐ Forest ☐ Woodland ☐ Scrub (tall) ☐ Shrubland (short) ☐ Mallee ☐ Rainforest ☐ Grassland √	Excludable / Low Threat ☐ Modified ☐ Forest ☐ Woodland ☐ Scrub (tall) ☐ Shrubland (short) ☐ Mallee ☐ Rainforest ☐ Grassland √	Excludable / Low Threat ☐ Modified ☐ Forest ☐ Woodland ☐ Scrub (tall) ☐ Shrubland (short) ☐ Mallee ☐ Rainforest ☐ Grassland √
Effective Slope (under the classifiable vegetation within 150 metres)	Upslope / Flat √ **DOWNSLOPE** >0 to 5 ° ☐ >5 to 10° ☐ >10° to 15° ☐ >15 to 20° ☐	Upslope / Flat ☐ **DOWNSLOPE** >0 to 5 ° ☐ >5 to 10° √ >10° to 15° ☐ >15 to 20° ☐	Upslope / Flat √ **DOWNSLOPE** >0 to 5 ° ☐ >5 to 10° ☐ >10° to 15° ☐ >15 to 20° ☐	Upslope / Flat ☐ **DOWNSLOPE** >0 to 5 ° ☐ >5 to 10° √ >10° to 15° ☐ >15 to 20° ☐
Defendable space(m) and BAL	13m BAL 19	17m BAL 19	13m BAL 19	17m BAL 19

Water Supply Requirement

The dwelling will need to comply with the following.

The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for firefighting water supplies.

Lot Size (m^2)	Hydrant Available	Capacity (litres)	Fire Authority Fittings & Access Required	Select Response
Less than 500	Not Applicable	2,500	No	☐
500 – 1000	Yes	5,000	No	☐
500 – 1000	No	10,000	Yes	☐
1001 and above	Not Applicable	**10,000**	Yes	√
Note: a hydrant is available if it is located within 120 metres of the rear of the building				

Confirm Static Water Supply meets the following requirements	√ Is stored in an above ground water tank constructed of concrete or metal √ All fixed above ground water pipes and fittings for firefighting purposes must be made of corrosive resistant metal. **The following additional requirements apply when 10,000 litres of static water is required:** √ Incorporate a ball or gate valve (British Standard Pipe (BSP 65mm) and coupling (64mm CFA 3 thread per inch male fitting) √ The outlet/s of the water tank must be within 4 metres of the access way and unobstructed √ Be readily identifiable from the building or appropriate identification signage to the satisfaction of CFA must be provided. √ Any pipework and fittings must be a minimum of 65mm (excluding the CFA coupling)

Water tank location is shown on the bushfire management plan-Appendix.6

Access Requirement

A building used for a dwelling (including an extension or alteration to a dwelling), a dependant person's unit, industry, office or retail premises is provided with vehicle access is designed and constructed as specified in Table 5 to Clause 52.47-3.

Column A	Column B
Length of access is less than 30 metres	√ There are no design and construction requirements if fire authority access to water supply is not required under AM 4.1
Length of access is less than 30 metres	√ Where fire authority access to the water supply is required under AM 4.1 fire authority vehicles must be able to get within 4 metres of the water supply outlet
Length of access is greater than 30 metres	The following design and construction requirements apply: √ All weather construction √ A load limit of at least 15 tonnes √ Provide a minimum trafficable width of 3.5 metres √ Be clear of encroachments for at least 0.5 metres on each side and at least 4 metres vertically √ Curves must have a minimum inner radius of 10 metres √ The average grade must be no more than 1 in 7 (14.4%) (8.1°) with a maximum grade of no more than 1 in 5 (20%) (11.3°) for no more than 50 metres. √ Dips must have no more than a 1 in 8 (12.5 per cent) (7.1 degrees) entry and exit angle √ The average grade must be no more than 1 in 7 (14.4%)(8.1°) with a maximum grade of no more than 1 in 5 (20%)(11.3°) for no more than 50 metres

Length of access is greater than 100metres.	A turning area for fire fighting vehicles must be provided close to the building by one of the following: • A turning circle with a minimum radius of eight metres • A driveway encircling the dwelling • The provision of other vehicle turning heads-such as a T or Y head-which meets the specification of Austroad Design for an 8.8 metre service vehicle.

Appendix. One- Vegetation management standards

Vegetation management standards for the defendable space are provided below

Table 6 Clause 52.47-3

Vegetation management requirement

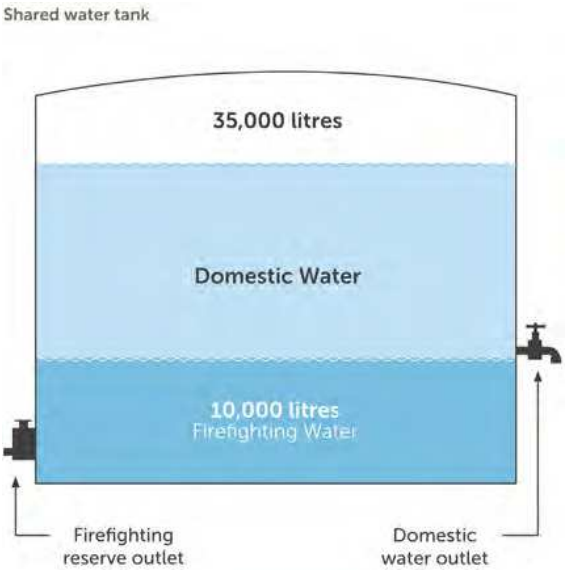
Defendable space is provided and is managed in accordance with the following requirements:

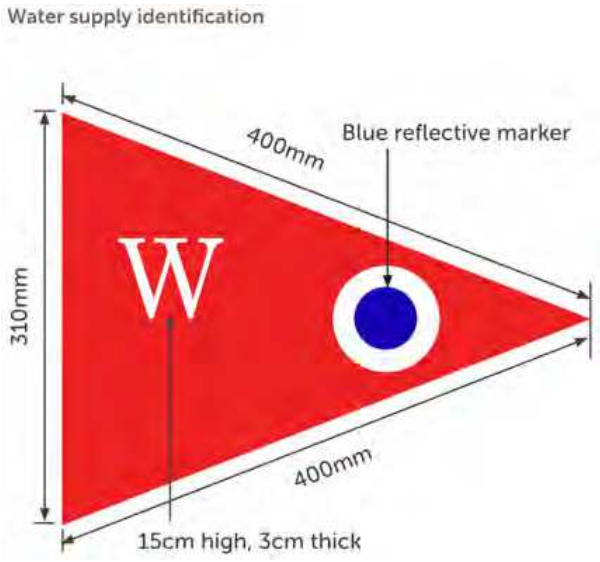
- Grass must be short cropped and maintained during the declared fire danger period.
- All leaves and vegetation debris must be removed at regular intervals during the declared fire danger period.
- Within 10 metres of a building, flammable objects must not be located close to the vulnerable parts of the building.
- Plants greater than 10 centimetres in height must not be placed within 3 metres of a window or glass feature of the building.
- Shrubs must not be located under the canopy of trees.
- Individual and clumps of shrubs must not exceed 5 square metres in area and must be separated by at least 5 metres.
- Trees must not overhang or touch any elements of the building. ♣ The canopy of trees must be separated by at least 5 metres.
- There must be a clearance of at least 2 metres between the lowest tree branches and ground level.

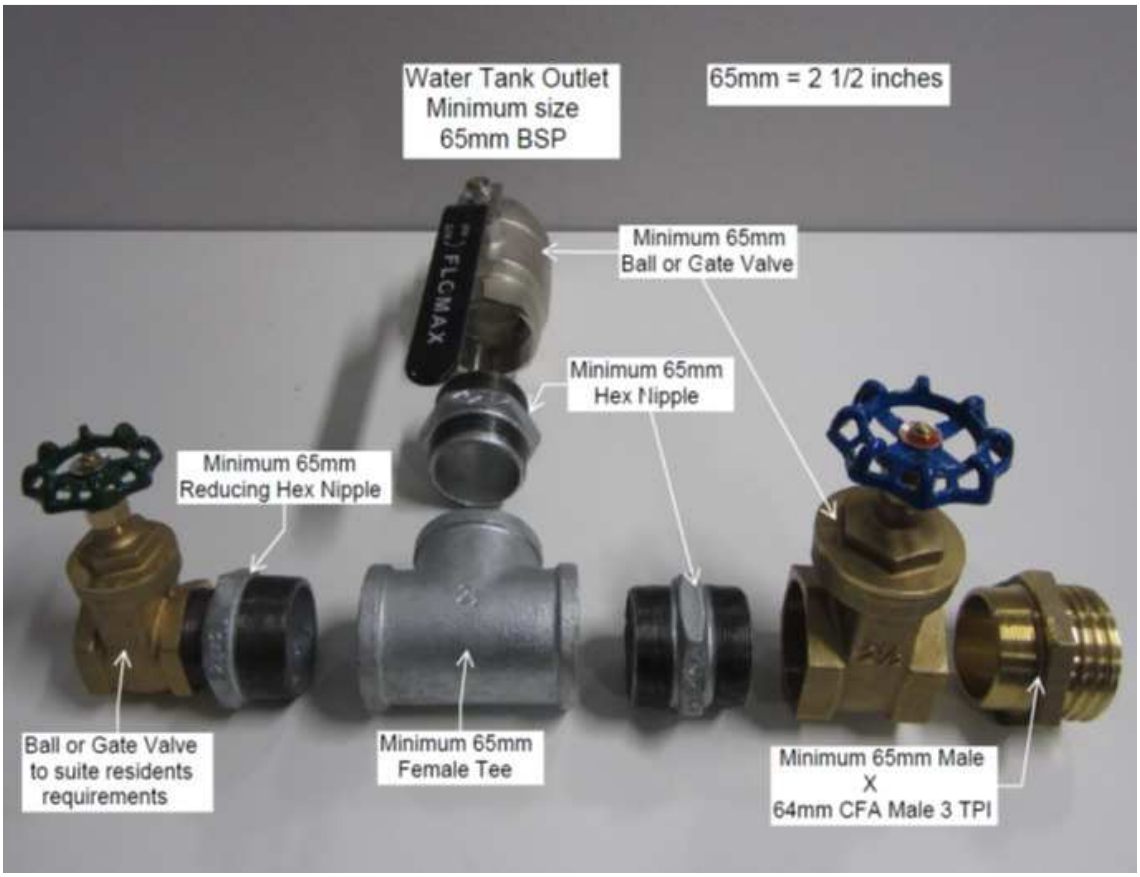
Appendix Two - Water supply requirements

Unless otherwise agreed in writing by the relevant fire authority, the water supply must:

- Be stored in an above ground water tank constructed of concrete or metal.
- Have all fixed above ground water pipes and fittings required for firefighting purposes made of corrosive resistant metal.
- Include a separate outlet for occupant use. Where a 10,000 litre water supply is required, fire authority fittings and access must be provided as follows:
- Be readily identifiable from the building or appropriate identification signage to the satisfaction of the relevant fire authority.
- Be located within 60 metres of the outer edge of the approved building.
- The outlet/s of the water tank must be within 4 metres of the accessway and unobstructed.
- Incorporate a separate ball or gate valve (British Standard Pipe (BSP 65 millimetre) and coupling (64 millimetre CFA 3 thread per inch male fitting).
- Any pipework and fittings must be a minimum of 65 millimetres (excluding the CFA coupling







Appendix Three - Access requirements

Access 30m to 100m

Access 30m to 100m

The following design and construction requirements apply:

√ All weather construction

√ A load limit of at least 15 tonnes

√ Provide a minimum trafficable width of 3.5 metres

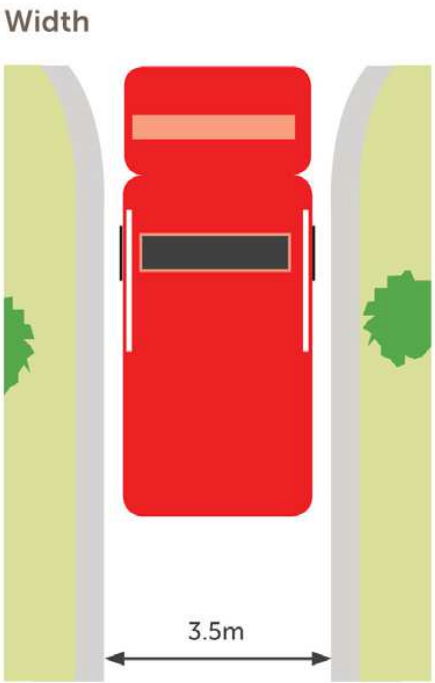
√ Be clear of encroachments for at least 0.5 metres on each side and at least 4 metres vertically

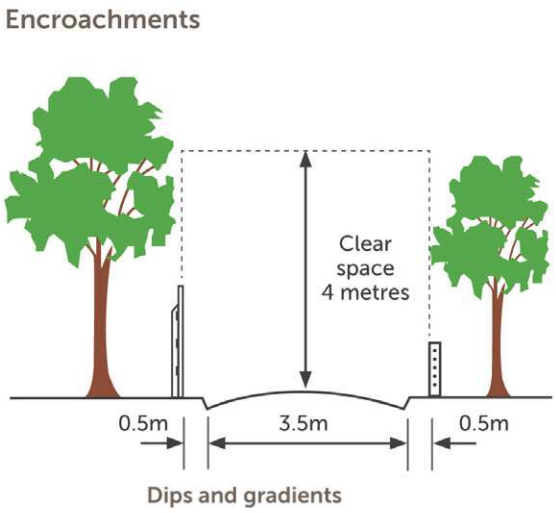
√ Curves must have a minimum inner radius of 10 metres

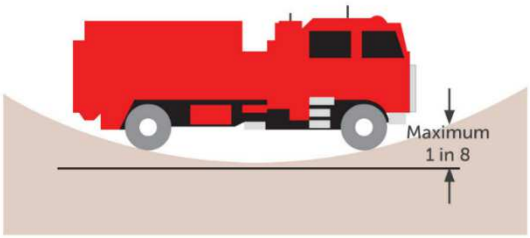
√ The average grade must be no more than 1 in 7 (14.4%) (8.1°) with a maximum grade of no more than 1 in 5 (20%) (11.3°) for no more than 50 metres.

√ Dips must have no more than a 1 in 8 (12.5 per cent) (7.1 degrees) entry and exit angle

√ The average grade must be no more than 1 in 7 (14.4%)(8.1°) with a maximum grade of no more than 1 in 5 (20%)(11.3°) for no more than 50 metres





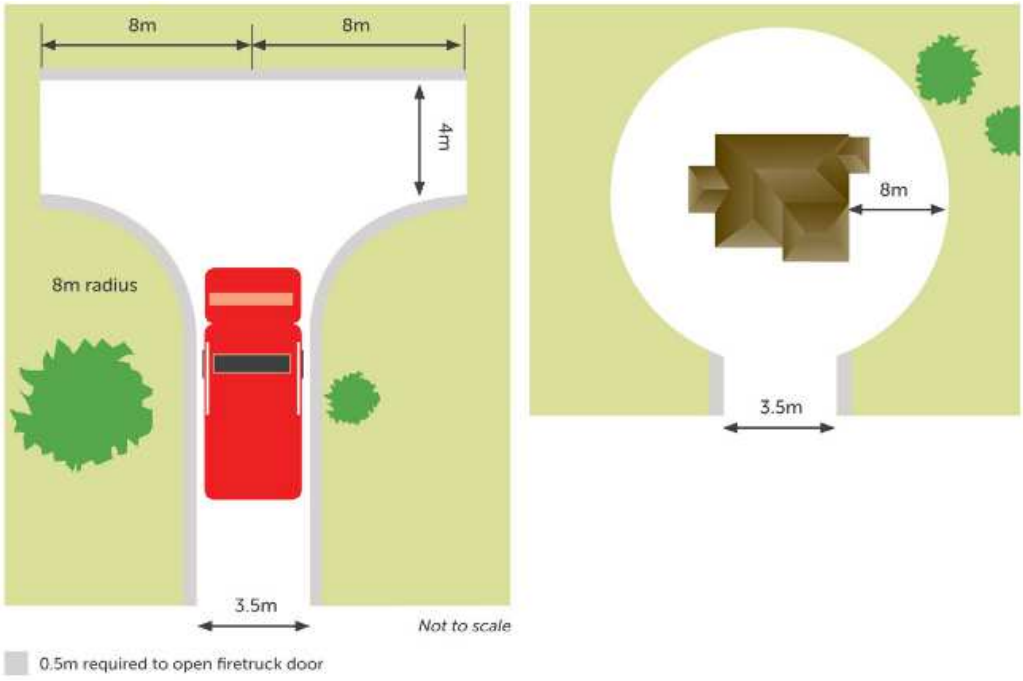


Access 100m to 200m

In addition to the above:

A turning area for fire fighting vehicles must be provided close to the building by one of the following:

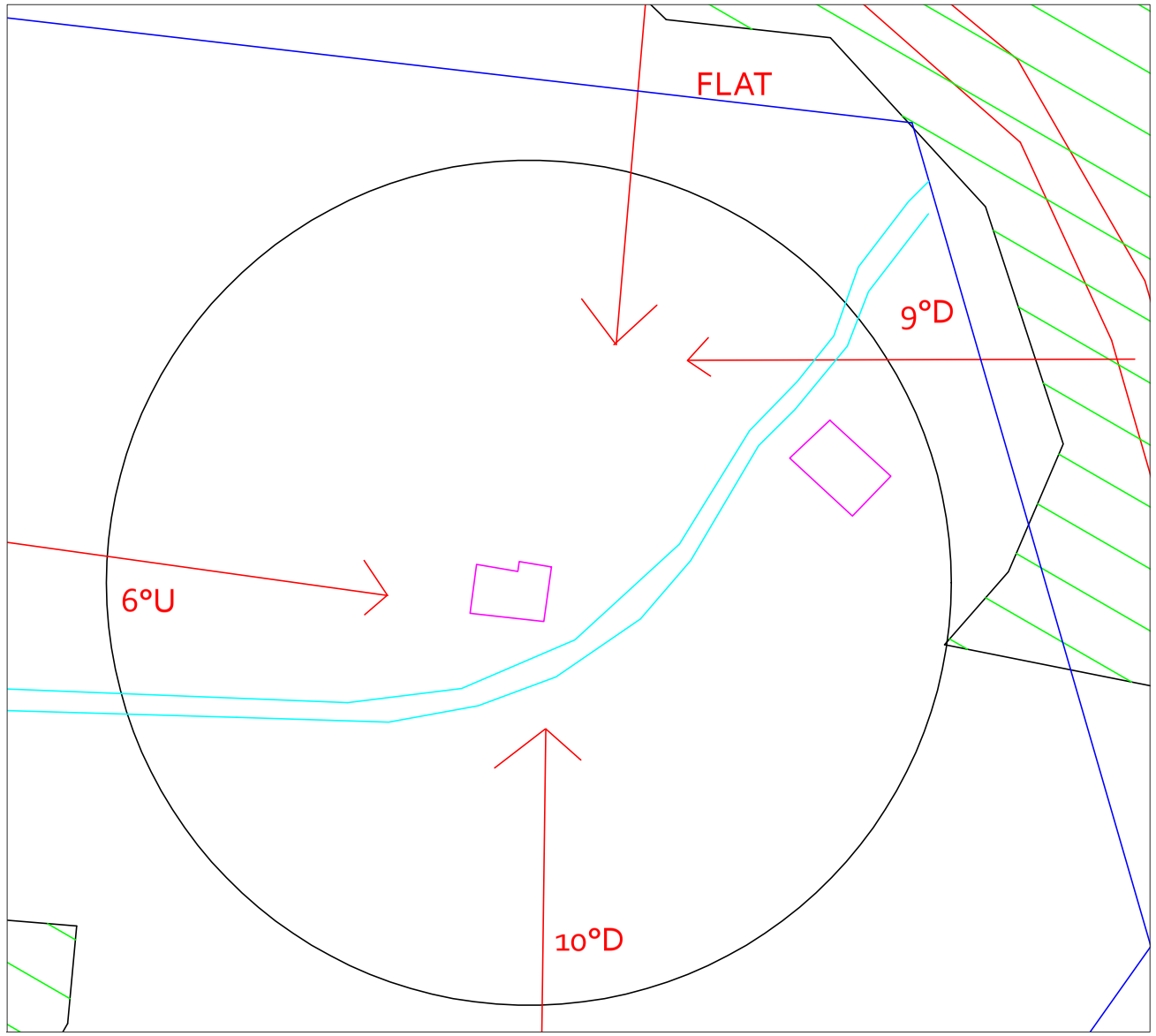
- a turning circle with a minimum radius of 8 metres
- a driveway encircling the dwelling
- other vehicle turning heads such as a T or Y head which meet the specification Austroad Design for an 8.8 metre service vehicle.



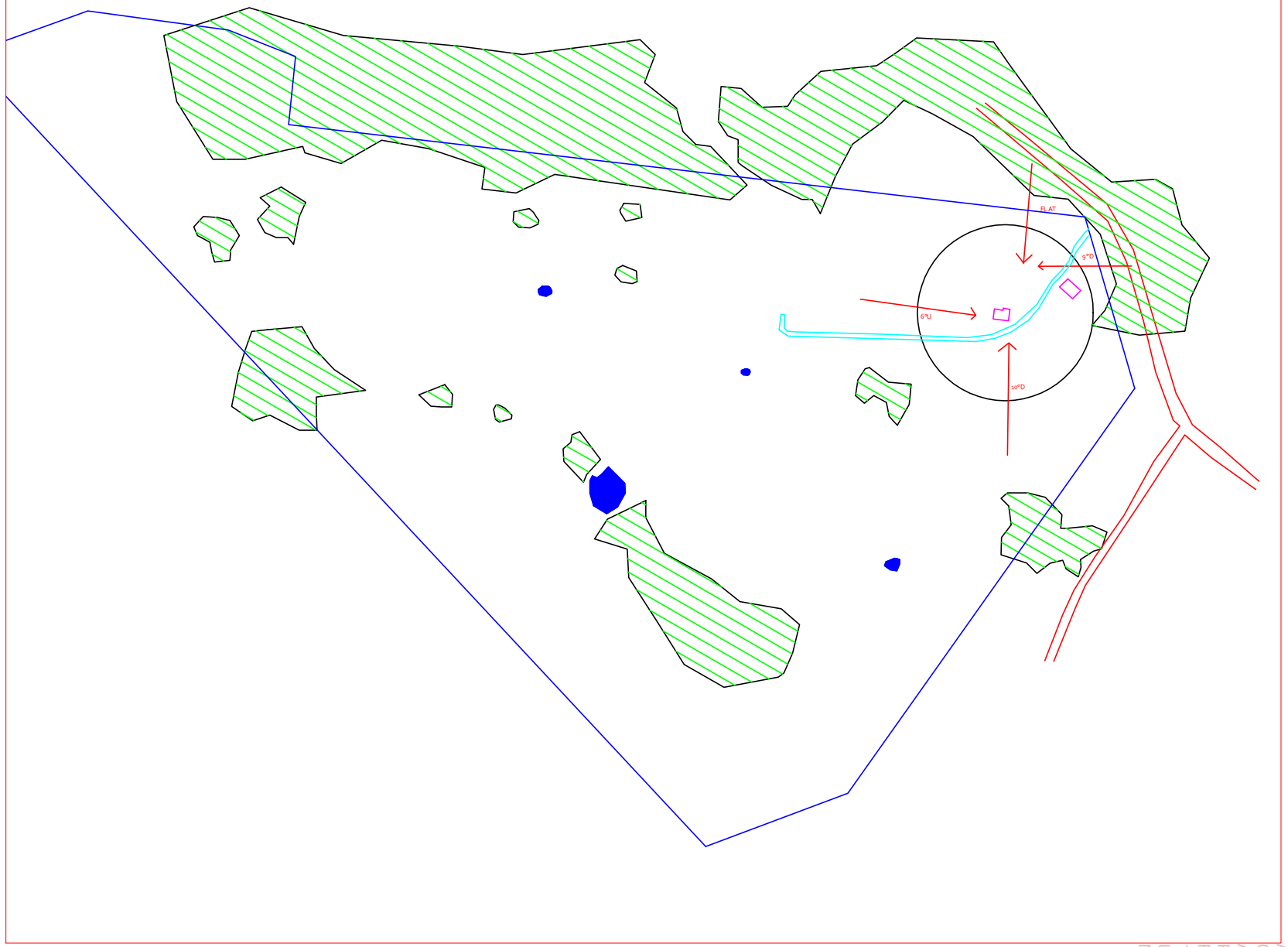
Appendix Four - Bushfire Attack Levels (BALs)

Bushfire Attack Level (BAL)	Risk Level	Construction elements are expected to be exposed to…	Comment
BAL-12.5	LOW: There is risk of ember attack.	A radiant heat flux not greater than 12.5 kW/m²	At 12.5kW/m² standard float glass could fail and some timbers can ignite with prolonged exposure and piloted ignition.
BAL-19	MODERATE: There is a risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to radiant heat.	A radiant heat flux not greater than 19 kW/m²	At 19kW/m² screened float glass could fail.
BAL-29	HIGH: There is an increased risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to an increased level of radiant heat.	A radiant heat flux not greater than 29 kW/m²	At 29kW/m² ignition of most timbers without piloted ignition after 3 minutes exposure. Toughened glass could fail.
BAL-40	VERY HIGH: There is a much increased risk of ember attack and burning debris ignited by windborne embers, a likelihood of exposure to a high level of radiant heat and some likelihood of direct exposure to flames from the fire front.	A radiant heat flux not greater than 40 kW/m²	At 42kW/m² ignition of cotton fabric after 5 seconds exposure (without piloted ignition).
BAL- FZ (i.e. Flame Zone)	EXTREME: There is an extremely high risk of ember attack and a likelihood of exposure to an extreme level of radiant heat and direct exposure to flames from the fire front.	A radiant heat flux greater than 40 kW/m²	At 45kW/m² ignition of timber in 20 seconds (without piloted ignition).

Appendix Five – Site Assessment Plan



SITE ASSESS



Note the contractor
shall verify all dimensions and all underground services at the site before commencing work. The contractor shall verify all levels from the consulting engineer prior to construction.

DO NOT SCALE FROM DRAWINGS

PROJECT
Lot.2. LP 120918
2010 Colac-Lavers Hill rd
Gellibrand

DWG TITLE
SITE ASSESSMENT

NORTH

PROJECT NO 840

SCALE NTS

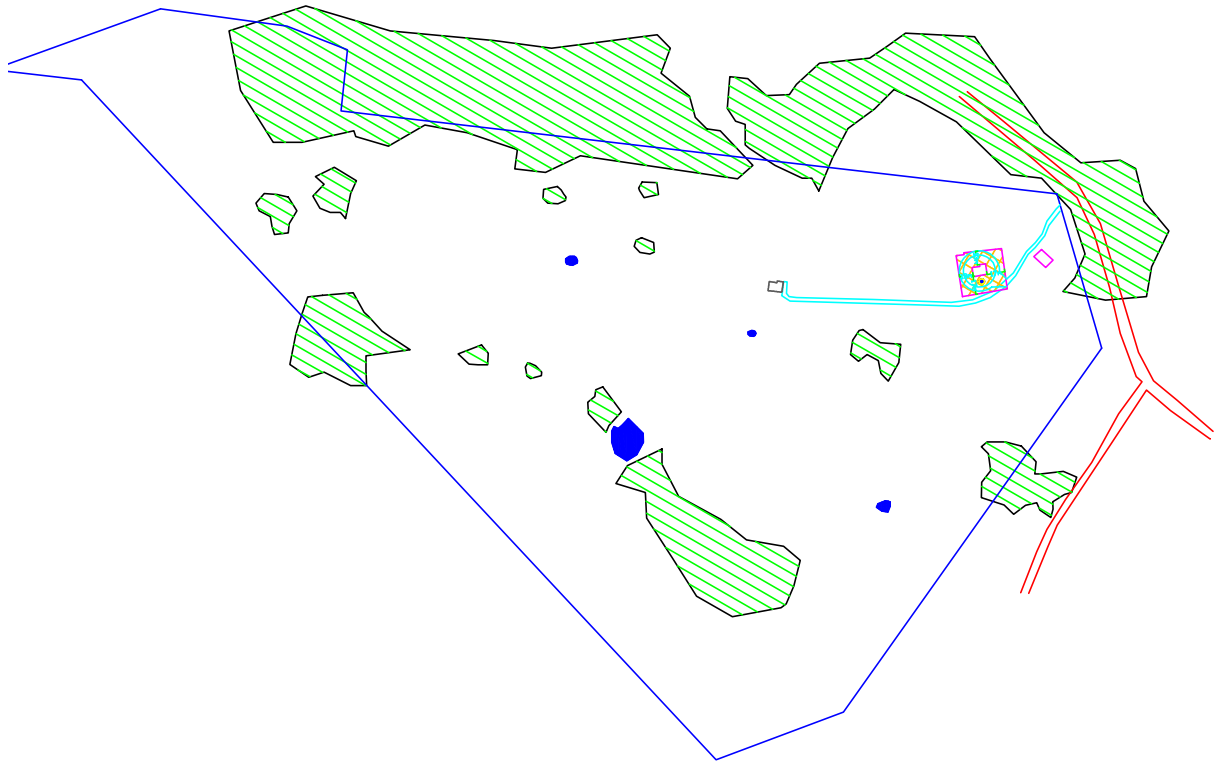
DATE OCT 2018

DRAWINGS FOR PLANNING PERMIT ONLY NOT TO BE USED FOR CONSTRUCTION

NR LINKS
Your Planning & Permit Consultants

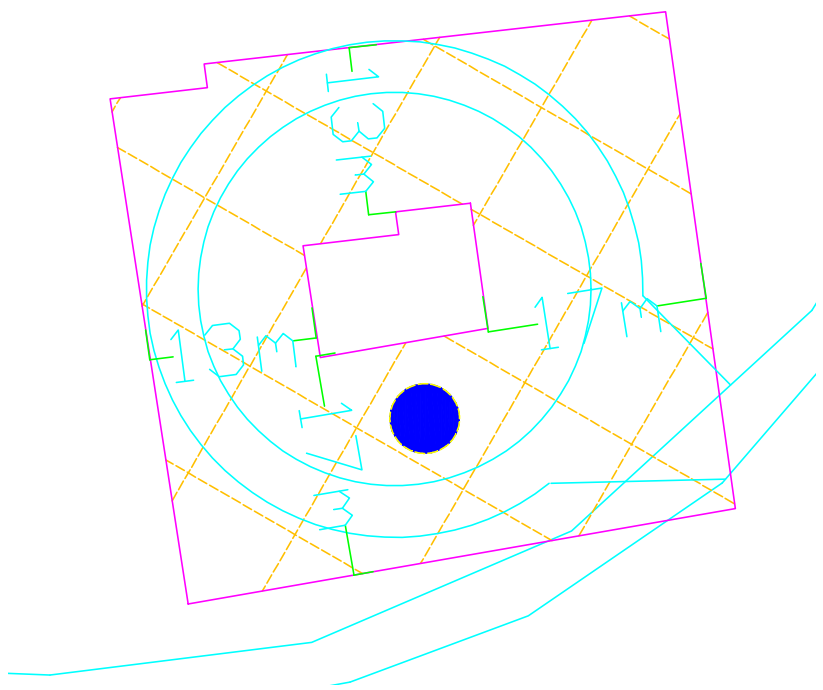
NATURAL RESOURCE LINK PTY LTD
17 Armstrong Rd,
Ballarat Central
julie@nrlinks.com.au

Appendix Six– Bushfire Management Plan



Water tank requirements.

This dwelling requires a 10,000 Litre water tank that is constructed from either steel or concrete. The tank must be within 4m of an access driveway and within 60m of the dwelling. CFA fittings are required on this tank and a water sign is required at the driveway to advise CFA where the water is stored in the event of a fire.



Access designed to accommodate CFA

Table 5 Vehicle access design and construction
Vehicle access (or part thereof) of a length specified in Column A implements the design
and construction requirements specified in Column B.
Column A Column B

Length of access is less than 30 metres

There are no design and construction requirements if fire authority access to the water supply is not required under AM4.1.

Length of access is less than 30 metres

Where fire authority access to the water supply is required under AM4.1 fire authority vehicles should be able to get within 4 metres of the water supply outlet.

Length of access is greater than 30 metres

The following design and construction requirements apply:
All-weather construction.
A load limit of at least 15 tonnes.
Provide a minimum trafficable width of 3.5 metres.
Be clear of encroachments for at least 0.5 metres on each side and at least 4 metres vertically.
Curves must have a minimum inner radius of 10 metres.
The average grade must be no more than 1 in 7 (14.4%) (8.1°) with a maximum grade of no more
than 1 in 5 (20%) (11.3°) for no more than 50 metres.
Dips must have no more than a 1 in 8 (12.5 per cent) (7.1 degrees) entry and exit angle.

Length of access is greater than 100 metres

A turning area for fire fighting vehicles must be provided close to the building by one of the following:
A turning circle with a minimum radius of eight metres.
A driveway encircling the dwelling.
The provision of other vehicle turning heads – such as a T or Y head – which meet the specification of Austroad Design for an 8.8 metre Service Vehicle.

Length of access is greater than 200 metres

Passing bays must be provided at least every 200 metres.
Passing bays must be a minimum of 20 metres long with a minimum trafficable width of 6 metres.

Water supply for firefighting purposes

Fire authority requirements

Unless otherwise agreed in writing by the relevant fire authority, the water supply must:
Be stored in an above ground water tank constructed of concrete or metal.
Have all fixed above ground water pipes and fittings required for firefighting
purposes made of corrosive resistant metal.
Include a separate outlet for occupant use.
Where a 10,000 litre water supply is required, fire authority fittings and access must be
provided as follows:
Be readily identifiable from the building or appropriate identification signs to
the satisfaction of the relevant fire authority.
Be located within 60 metres of the outer edge of the approved building.
The outlet/s of the water tank must be within 4 metres of the accessway and
unobstructed.
Incorporate a separate ball or gate valve (British Standard Pipe (BSP 65
millimetre) and coupling (64 millimetre CFA 3 thread per inch male fitting).
Any pipework and fittings must be a minimum of 65 millimetres (excluding the
CFA coupling).

Table 6 Vegetation management requirement
Vegetation management requirement

Defendable space is provided and is managed in accordance with the following
requirements:
- Grass must be short cropped and maintained during the declared fire danger period.
- All leaves and vegetation debris must be removed at regular intervals during the declared
fire danger period.
- Within 10 metres of a building, flammable objects must not be located close to the
vulnerable parts of the building.
- Plants greater than 10 centimetres in height must not be placed within 3 metres of a
window or glass feature of the building.
- Shrubs must not be located under the canopy of trees.
- Individual and clumps of shrubs must not exceed 5 square metres in area and must be
separated by at least 5 metres.
- Trees must not overhang or touch any elements of the building.
- The canopy of trees must be separated by at least 5 metres.
- There must be a clearance of at least 2 metres between the lowest tree branches and
ground level.

Unless specified in a schedule or otherwise agreed in writing to the satisfaction of the
relevant fire authority2)

Construction

Will have a minimum Bushfire Attack Level of

BAL –19

that the building will be designed and constructed to in accordance with AS3959.
Minimum building separation between the house and any other building of 10m.

- All external doors to be protected with non-combustible screens that comply with Clause 7.5.1.A (AS3959-2009)
- If using a metal roof place, a non-combustible insulation to all joins and edge of the roof to prevent the entry of embers. The building is a square and limits re-entry corners with a simplified one level roof design.
- Subfloor supports if exposed to comply with Clause 8.2 (AS3959-2009)
- Elevated floors unenclosed to comply with Clause 8.3.2.2. (AS 3959-2009)
- Roof penetrations to comply with Clause 8.6.5 (As3959-2009)
- Decking to comply with Clause 8.7 (AS3959-2009).

Note the contractor
shall verify all dimensions and all underground services at the site before commencing work. The contractor shall verify all levels from the consulting engineer prior to construction.

DO NOT SCALE FROM DRAWINGS

PROJECT
LOT.2 LP 120918
(2010 Colac-Lavers Hill rd
Gellibrand)

DWG TITLE
Bushf ir e Management Plan (BMP)

PROJECT NO 840
SCALE NTS
DATE OCT 2018

DRAWINGS FOR PLANNING PERMIT ONLY
NOT TO BE USED FOR CONSTRUCTION

NATURAL RESOURCE LINK PTY LTD
17 Armstrong Rd,
Ballarat Central
julie@nrlinks.com.au

From: Geoff De La Rue <gdelarue@iinet.net.au>
Sent: Thursday, 6 June 2019 5:10 PM
To: 'Luke Gavin'
Cc: 'INQ'
Subject: 35.06-6

Luke,

My response to the criteria in the above Clause, (35.07-6 31/07/2018 VC148), is follows:

Agricultural issues and the impacts from non-agricultural uses:

1 The capability of the land to accommodate the proposed use or development, including the disposal of effluent: There is more than adequate space to install an Effluent Disposal Field on the site, (80Ac)

2 How the use or development relates to sustainable land management. The proposed house if to allow a second generation farmer in the same family work the land.

3 Whether the site is suitable for the use or development and whether the proposal is compatible with adjoining and nearby land uses. The aim is to allow the exisitng farm use to continue by allowing a second farmer to live on site and farm the land.

4 How the use and development makes use of existing infrastructure and services. The additional house will be accessed by existing tracks and crossover at the road.

5 Agricultural issues and the impacts from non-agricultural uses Whether the use or development will support and enhance agricultural production. Having an extra worker will allow the farm to expand it's stocking.

6 Whether the use or development will adversely affect soil quality or permanently remove land from agricultural production. The house will ensure that farm will remain viable as a farm, the farming use remains the same so it will not adversly affect the soil.

7 The potential for the use or development to limit the operation and expansion of adjoining and nearby agricultural uses. The use consolidates a larger farm so it can be viable without the need to add extra properties.

8 The capacity of the site to sustain the agricultural use. The overall site area is approximately 100Ha, (33 + 66 of the adjacent farm), which is a very viable farm.

9 The agricultural qualities of the land, such as soil quality, access to water and access to rural infrastructure. The existing infrastructure works well as it is, the new house will not affect that.

11 Whether the dwelling will result in the loss or fragmentation of productive agricultural land. The house is located towards the centre of the site so the minimal loss of land, (maybe an acre for a "home paddock"), will have minimal affect on the agricultural use, but will suit it well from a management point of view.

12 Whether the dwelling will be adversely affected by agricultural activities on adjacent and nearby land due to dust, noise, odour, use of chemicals and farm machinery, traffic and hours of operation. It's a farm house in a farming area, there will be no issue…….

13 Whether the dwelling will adversely affect the operation and expansion of adjoining and nearby agricultural uses. It is in the same useage, (farming), so there should be no adverse affects.

14 The potential for the proposal to lead to a concentration or proliferation of dwellings in the area and the impact of this on the use of the land for agriculture. Future dwellings are only possible with Planning Approval, unless over the 40Ha arbitary limit.

Environmental issues:

15 The impact of the proposal on the natural physical features and resources of the area, in particular on soil and water quality. The addition of a house will have no perceivable affect on water or Soil quality.

16 The impact of the use or development on the flora and fauna on the site and its surrounds. The addition of a house will have no perceivable affect on flora and fauna on site.

17 The need to protect and enhance the biodiversity of the area, including the retention of vegetation and faunal habitat and the need to revegetate land including riparian buffers along waterways, gullies, ridgelines, property boundaries and saline discharge and recharge area. There is no vegetation except grass and no fauna except cows, and there are no waterways on this site.

18 The location of on-site effluent disposal areas to minimise the impact of nutrient loads on waterways and native vegetation.As noted, there are no waterways on this site, the EDF will begin the centre of the site so will have no perceivable affect on the site.

Design and siting issues:

The need to locate buildings in one area to avoid any adverse impacts on surrounding agricultural uses and to minimise the loss of productive agricultural land. As noted earlier, the house is located to best supervise the overall site, and there is minimal loss of arable land.

The impact of the siting, design, height, bulk, colours and materials to be used, on the natural environment, major roads, vistas and water features and the measures to be undertaken to minimise any adverse impacts. The house is well off the road and probably will not be visible from Wonga Road or the main Colac-Gellibrand road. The house is modest on site and can have muted colors, if needed.

The impact on the character and appearance of the area or features of architectural, historic or scientific significance or of natural scenic beauty or importance. See above……

The location and design of existing and proposed infrastructure including roads, gas, water, drainage, telecommunications and sewerage facilities. Services that are provided, road access, Electricity and phone are available.

Whether the use and development will require traffic management measures. None wil be required.

With regard to Clause 21.05-1, ALL of the Objectives appears to be met with this proposed usage, Dwelling associated with a (dairy) farming use.

With regard to the Strategies:

The proposal is on a lot that is not a lot less than the 40 Ha mark, and the dwelling is needed to efficiently run the farm to allow proper farm husbandry for the cows.

The use and development have no effect of the native vegitation, and the house is not prominent in the landscape.

The use and development will not lead to localise deconcentration of dwellings. Or change the land use or the local character of the area.

As noted earlier the development will not adversly impact on the agricultural production, the environmental characteristics or the vegitation/water quality etc.

Regards,
Geoff De La Rue
Architect

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