# DEVELOPMENT PROPOSAL FOR PUBLIC COMMENT

The following amended development proposal has been submitted to the Council and although not designated under the Environmental Planning & Assessment Act, 1979, is notified for public comment as threatened species development:

| Portal Application Number | DA No. | Location | Proposal |
|---|---|---|---|
| PAN- 304413 | 25/2023 | LOT: 144 DP: 1110671, 142 Hilldale Road HILLDALE<br>Applicant: Perception Planning<br>Owners: Mrs A M & Mr R W Alexander<br>Consent Authority: Dungog Shire Council | Dwelling & Retaining wall (Amended Plans) |

Details of the above proposal are available for inspection on the NSW Planning Portal website from **Friday 26 April 2024.**

https://www.dungog.nsw.gov.au/Council/Council-Advertisements/Development-Applications

Submissions can be made via the NSW Planning Portal until **Friday 24 May 2024**. If you require assistance making a submission via the Planning Portal, please contact Council.

In accordance with *Section 10.4* of the *Environmental Planning & Assessment Act 1979*, a person who makes a public submission to Council in relation to this application is required to disclose all reportable political donations within two years prior to the submission being made and ending when the application is determined.

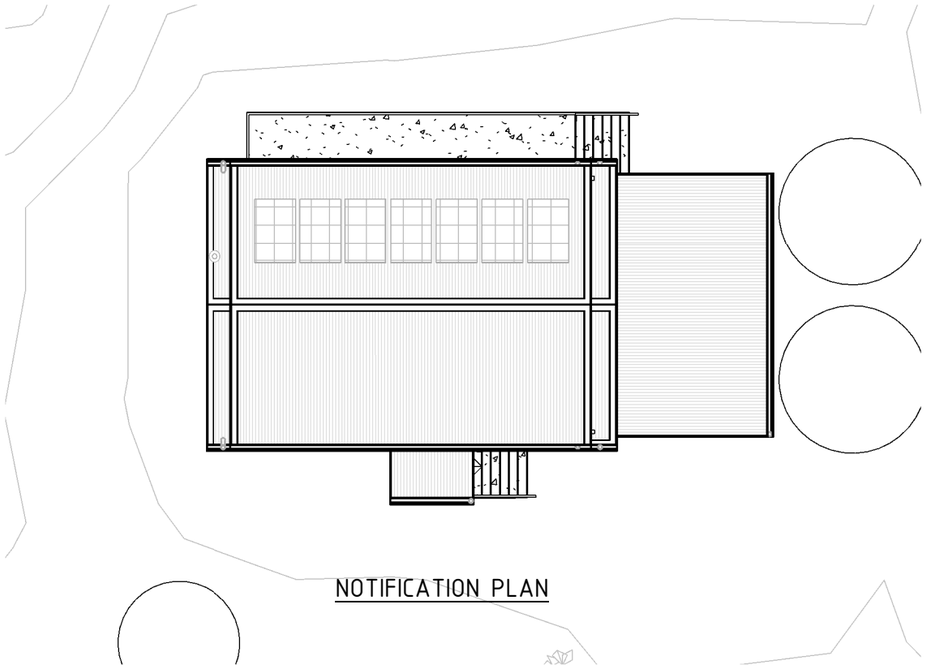
If the submission includes an objection to the proposal, the grounds of objection must be given. Council may also be obliged to release your submission as required by the *Government Information (Public Access) Act 2009* and the *Environmental Planning and Assessment Act 1979.*

Further, as stipulated in Council's Public Submissions Policy C1.19, Council will not place any weight on anonymous submissions when determining the respective development application.

**DUNGOG SHIRE COUNCIL**
**EXHIBITED COPY**

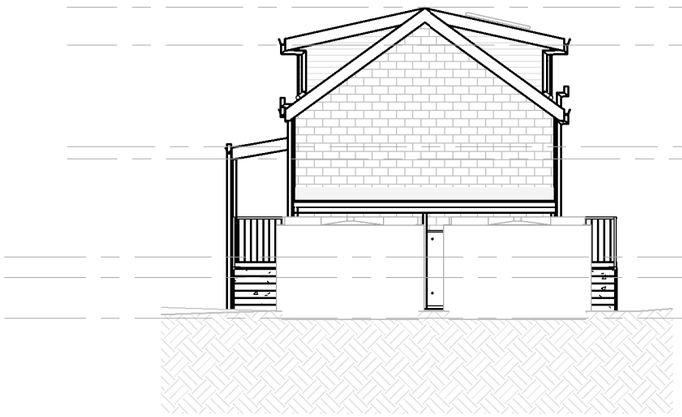
**Commencement Date** 26 April 2024

**Closing Date** 24 May 2024



NOTIFICATION PLAN


NORTH WESTERN ELEVATION



NORTH EASTERN ELEVATION

SOUTH EASTERN ELEVATION


SOUTH WESTERN ELEVATION

**NOT FOR CONSTRUCTION**

| REV | DESCRIPTION | ISSUED | DATE |
|---|---|---|---|
| 1 | ISSUED FOR APPROVAL | DB | 19.11.22 |
| 2 | REVISED FOR APPROVAL | DB | 26.08.23 |
| 3 | REVISED FOR APPROVAL | DB | 06.03.24 |

CLIENT
**A & R ALEXANDER**
**142 HILLDALE ROAD**
**HILLDALE, NSW, 2420**

**D.BILLS**

DRAWINGS NOT TO BE USED FOR CONSTRUCTION UNLESS NOTED OTHERWISE

UNLESS NOTED OTHER WISE DO NOT SCALE DRAWINGS. ALL DIMENSIONS TO BE VERIFIED BY BUILDER ON SITE BEFORE COMMENCING SHOP DRAWINGS OR SITE WORK. THE DRAFTSPERSON ACCEPTS NO RESPONSIBILITY FOR THE USABILITY, COMPLETENESS, ACCURACY OR SCALE OF DRAWINGS.

0 750 1500 2250 3000 3750 PLANS
0 750 1500 2250 3000 3750 ELEVATIONS

PROJECT
**PROPOSED DWELLING**
**LOT 144, DP1110671**
**142 HILLDALE ROAD,**
**HILLDALE, NSW 2420**

DRAWING TITLE
**NOTIFICATION PLAN**

JOB NUMBER **202205**
DRAWING NUMBER **N01**
REVISION **3**
DRAWING SHEET SIZE = A3

# PROPOSED RESIDENCE

## CIVIL DOCUMENTATION FOR DEVELOPMENT APPLICATION

### 142 HILLDALE ROAD, HILLDALE, NSW 2420


LOCALITY PLAN
NTS

## DRAWING LIST

| DWG No. | DRAWING TITLE |
|---|---|
| CIV-001 | COVER PAGE, DRAWING LIST & LOCALITY PLAN |
| CIV-005 | OVERALL SITE PLAN |
| CIV-011 | CIVIL WORKS PLAN |
| CIV-021 | CIVIL DETAILS |
| CIV-031 | CUT & FILL PLAN |
| CIV-041 | EROSION & SEDIMENT CONTROL PLAN |
| CIV-051 | B85 SWEPT PATH |

REVISIONS

| REV | DATE | DRN | CHK | APP | DRAWING STATUS |
|---|---|---|---|---|---|
| C | 12.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION |
| B | 08.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION |
| A | 06.03.2024 | J.J. | J.T. | | ISSUED FOR COORDINATION |

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ABN 64 625 755 482

CLIENT: ALEXANDER

TITLE: COVER PAGE, DRAWING LIST & LOCALITY PLAN

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD, HILLDALE, NSW 2420

| | | | |
|---|---|---|---|
| DRAWING STATUS: NOT FOR CONSTRUCTION | | | SHEET SIZE: A1 |
| SCALE: NOT TO SCALE | | | DRAWN: M.J. |
| PROJECT REF No.: 222097 | DRAWING No.: CIV-001 | | REVISION: C |

DRIVEWAY SITE DISTANCES

APPROACHING FROM THE EAST = 60m
APPROACHING FROM THE WEST = 72m

THE DRIVEWAY SITE DISTANCES REQUIRED BY AS2890 AS SEEN IN THE EXCERPT BELOW.

| Frontage road speed (Note 4) km/h | Distance (Y) along frontage road m | | |
|---|---|---|---|
| | Access driveways other than domestic (Note 5) | | Domestic property access (Note 6) |
| | Desirable 5 s gap | Minimum SSD | |
| 40 | 55 | 35 | 30 |
| 50 | 69 | 45 | 40 |
| 60 | 83 | 65 | 55 |
| 70 | 97 | 85 | 70 |
| 80 | 111 | 105 | 95 |
| 90 | 125 | 130 | Use values from 2nd and 3rd columns |
| 100 | 139 | 160 | |
| 110 | 153 | 190 | |

AS THIS IS A DOMESTIC PROPERTY AND AN POSTED 80 km/hr ROAD, THE SITE DISTANCE REQUIRED BY AS 2890 IS 95m.

THERE IS ONE ACCESS LOCATION WHERE THE ABOVE REQUIREMENT OF 95m IS ACHIEVABLE FOR THIS PROPERTY AND IS MARKED WITH THE RED CROSS. DUE TO THE VEGETATION IN THIS AREA, THE DRIVEWAY CANNOT BE PLACED HERE DUE TO THE ECOLOGICAL VALUE OF THE VEGETATION.

THEREFORE THE DRIVEWAY LOCATION SHOWN IS THE MOST APPROPRIATE GIVEN THE EXISTING SITE CONSTRAINTS. THE AVAILABLE SITE DISTANCES IN THIS LOCATION HAVE BEEN SHOWN. IT IS NOTED THAT THESE ARE LESS THAN THOSE REQUIRED BY AS2890.

BASED ON THE FOLLOWING COMMENTS AROUND THE EXISTING ROAD, IT HAS BEEN CONSIDERED A LOW RISK DRIVEWAY POSITION:
- NO THROUGH ROAD
- LOW TRAFFIC VOLUMES
- NARROW CARRIAGEWAY

IT IS PROPOSED THAT CONCEALED DRIVEWAY SIGNS ARE TO BE CONSTRUCTED AS PART OF THE DEVELOPMENT TO MITIGATE THE RISK OF REDUCED DRIVEWAY SITE DISTANCES AS SHOWN.



PROPOSED SIGNAGE
- REFER TO PLAN FOR PROPOSED LOCATIONS

## OVERALL SITE PLAN
SCALE 1:500

REVISIONS

| REV | DATE | DRN | CHK | APP | DRAWING STATUS |
|---|---|---|---|---|---|
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| A | 06.03.2024 | J.J. | J.T. | | ISSUED FOR COORDINATION |

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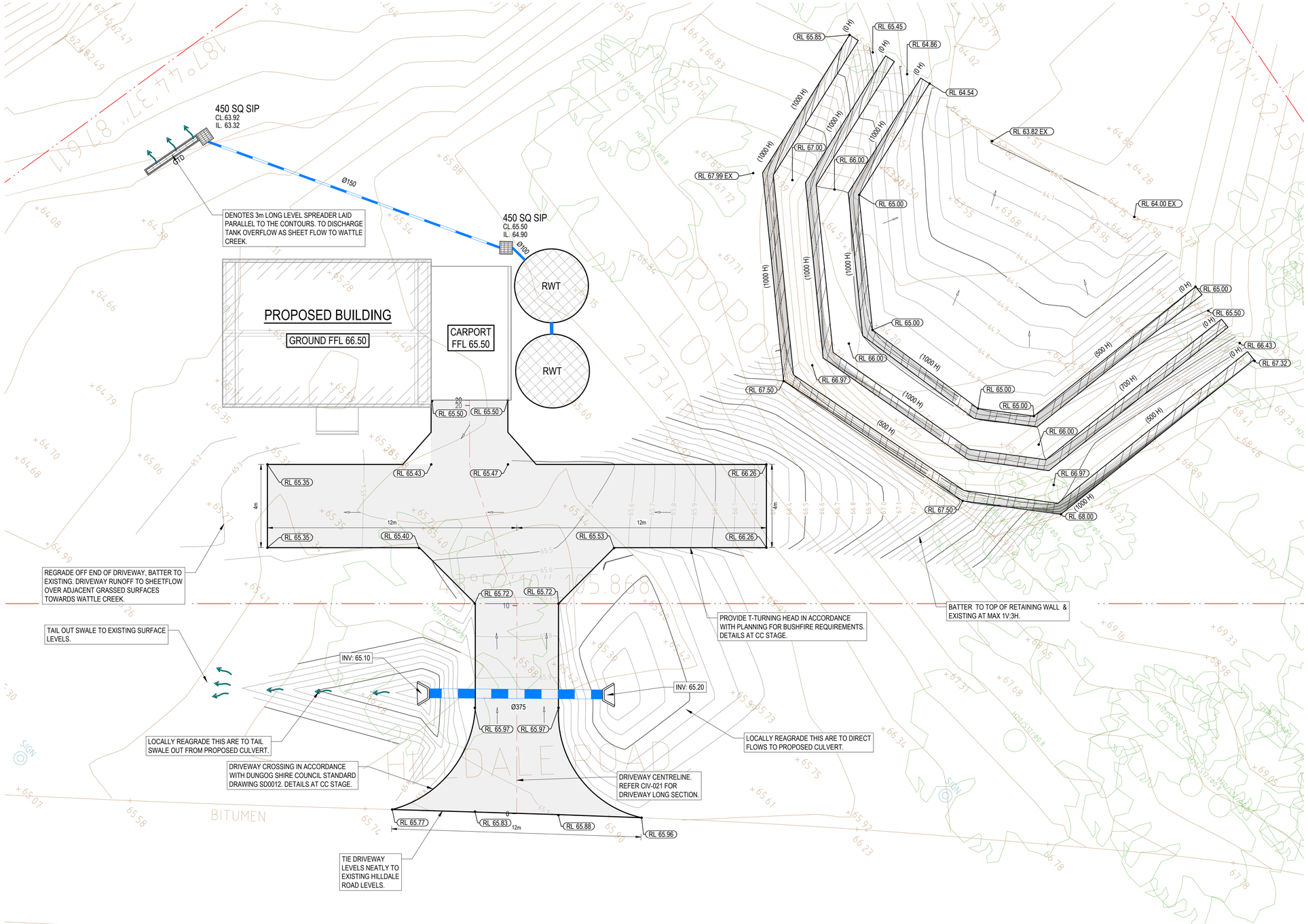
CLIENT: ALEXANDER

TITLE: OVERALL SITE PLAN

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD,
HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION
SHEET SIZE: A1
SCALE 1 : 500 (A1) 0 5 10 15 20 25m
DRAWN: M.J.
PROJECT REF No.: 222097
DRAWING No.: CIV-005
REVISION: C




## CIVIL WORKS PLAN

SCALE 1:100

NOTE: ALL ROOFWATER TO BE CONNECTED TO THE RESPECTIVE RAINWATER TANKS. PROVIDE FIRST FLUSH TO DOWNPIPES PRIOR TO CONNECTING TO TANK.

## LEGEND

- BOUNDARY LINE
- Ø150 — uPVC STORMWATER PIPE - DIAMETER NOTED
- SW PIT CL.XX.XX IL. XX.XX — STORMWATER PIT. DETAILS AT CC STAGE
- GTD — 200mm GRATED TRENCH DRAIN. DETAILS AT CC STAGE
- RWT — 30,000L ABOVE GROUND RAINWATER TANK. APPROX DIMENSIONS Ø3.55 x 2.835H. REFER CIV-021 FOR SCHEMATIC.
- (1000 H) — SANDSTONE RETAINING WALL - HEIGHT LABELLED - REFER CIV-021 FOR DETAILS.
- DENOTES EXTENT OF IMPERVIOUS PAVEMENT. DETAILS AT CC STAGE
- BUILDING OUTLINE
- FFL XX.XX — PROPOSED FINISHED FLOOR LEVEL
- RL x.xx — PROPOSED SPOT HEIGHT
- DIRECTION OF GRADE
- EMERGENCY OVERLAND FLOW PATH
- XX.XX — EXISTING CONTOURS
- EXISTING SPOT LEVEL
- CONCRETE HEADWALL

## STORM WATER CALCULATIONS

| | |
|---|---|
| SITE AREA | = 2,734.0 m² |
| PROPOSED ROOF AREA | = 96.0 m² |
| PROPOSED DRIVEWAY AREA | = 126.0 m² |

## STORM WATER & WATER STORAGE PHILOSOPHY

- THE DEVELOPMENT AT 142 HILLDALE ROAD, HILLDALE INVOLVES THE CONSTRUCTION OF A PROPOSED NEW DWELLING, RETAINING WALLS AND ACCESS DRIVEWAY.
- ALL ROOFWATER FROM THE PROPOSED DEVELOPMENT WILL BE DIRECTED THE 2x22,700L RAINWATER TANKS. THE RAINWATER TANKS ARE TO HAVE A BLEED PIPE AT THE 85% WATER LEVEL.
- OVERFLOW FROM THE RAINWATER TANK IS TO BE DIRECTED TO THE PROPOSED DISPERSAL PIT CONNECTED TO A GRATED DRAIN AND WILL FACILITATE A LEVEL SPREADER OVERFLOW TO NATURAL SURFACE LEVELS. FLOWS WILL CONTINUE TO EXIT INTO WATTLE CREEK MATCHING THE PRE-EXISTING SITE CONDITIONS.
- ALL SURFACE WATER FROM THE DRIVEWAY AREA WILL BE ALLOWED TO SHEET FLOW OFF THE SITE TOWARDS TO WATTLE CREEK.

REVISIONS

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CLIENT: ALEXANDER

TITLE: CIVIL WORKS PLAN

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD, HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION

SHEET SIZE: A1

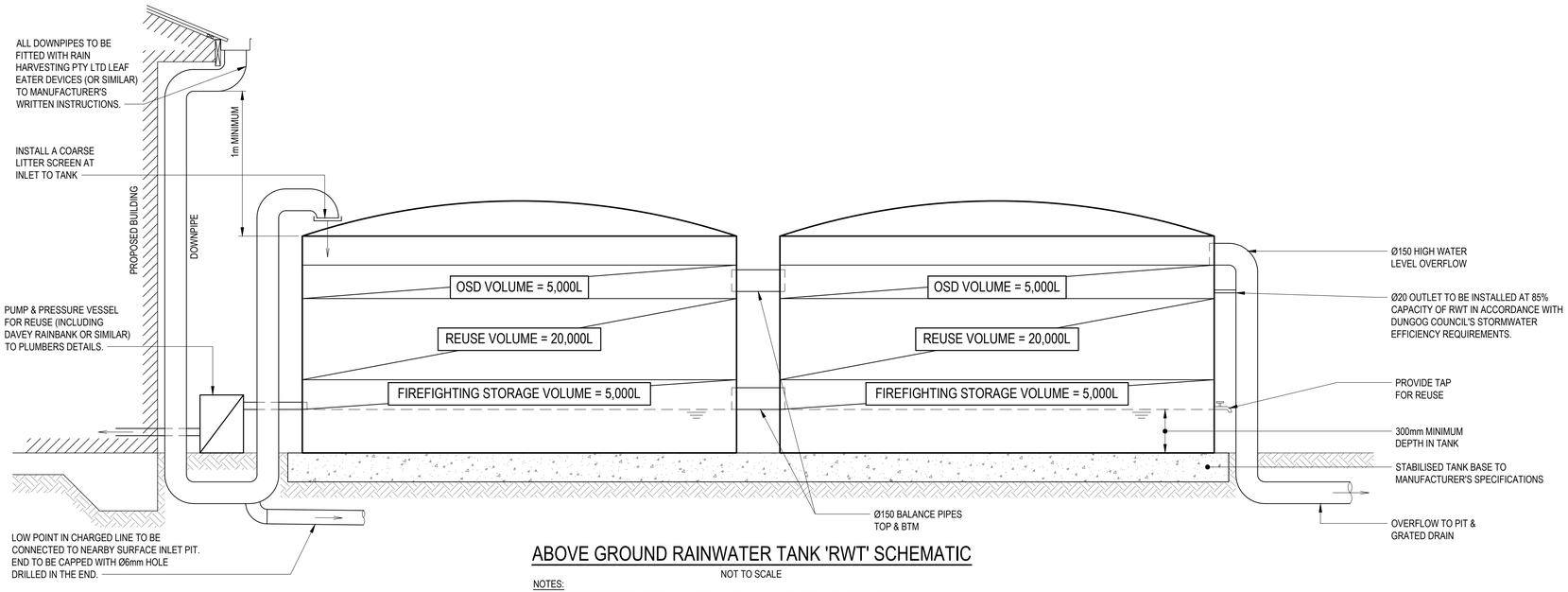
SCALE 1 : 100 (A1) 0 1 2 3 4 5m

DRAWN: M.J.

PROJECT REF No.: 222097

DRAWING No.: CIV-011

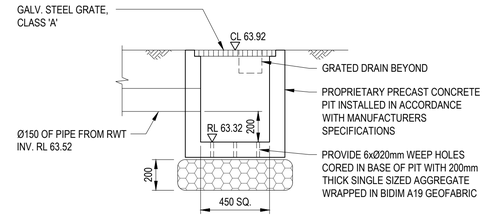
REVISION: C




## ABOVE GROUND RAINWATER TANK 'RWT' SCHEMATIC

NOT TO SCALE

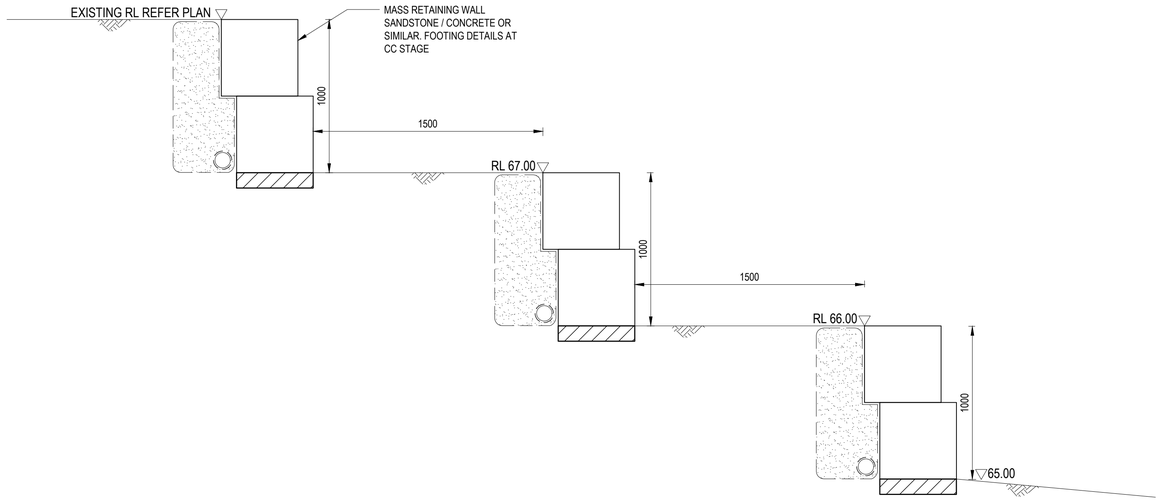
NOTES:
- THE ENTIRE PRESSURISED DOWNPIPE SYSTEM SHALL BE AIR TIGHT AND BE ABLE TO WITHSTAND ATMOSPHERIC PRESSURE. THE PIPING SYSTEM SHALL BE MINIMUM SN6 AND FITTINGS WITH INTERNAL ULTRA VIOLET STABILISING (OR APPROVED EQUIVALENT).




## SURFACE INLET PIT DETAIL

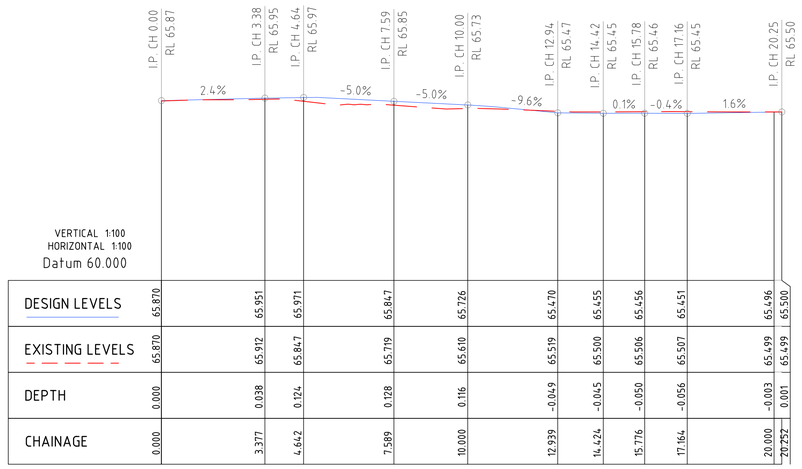
SCALE 1 :20

NOTES:
- PIT TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURERS SPECIFICATIONS
- GROUT INTERNAL PIT FACE AT ALL PIPE CONNECTIONS AND PENETRATIONS TO ENSURE PIPE CONNECTIONS ARE WATER TIGHT.
- GRATES AND COVERS SHALL COMPLY WITH AS3996 LOADING REQUIREMENTS.
- MAXIMUM PIPE PENETRATIONS TO BE IN ACCORDANCE WITH MANUFACTURES SPECIFICATIONS




## SANDSTONE RETAINING WALL DETAIL

SCALE 1:20




## DRIVEWAY LONG SECTION

| REV | DATE | DRN | CHK | APP | DRAWING STATUS |
|---|---|---|---|---|---|
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CLIENT: ALEXANDER

TITLE: CIVIL DETAILS

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD, HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION

SCALE (A1) 1:100 / 1:20 (0 1 2 3 4 5m / 0 0.2 0.4 0.6 0.8 1.0m)

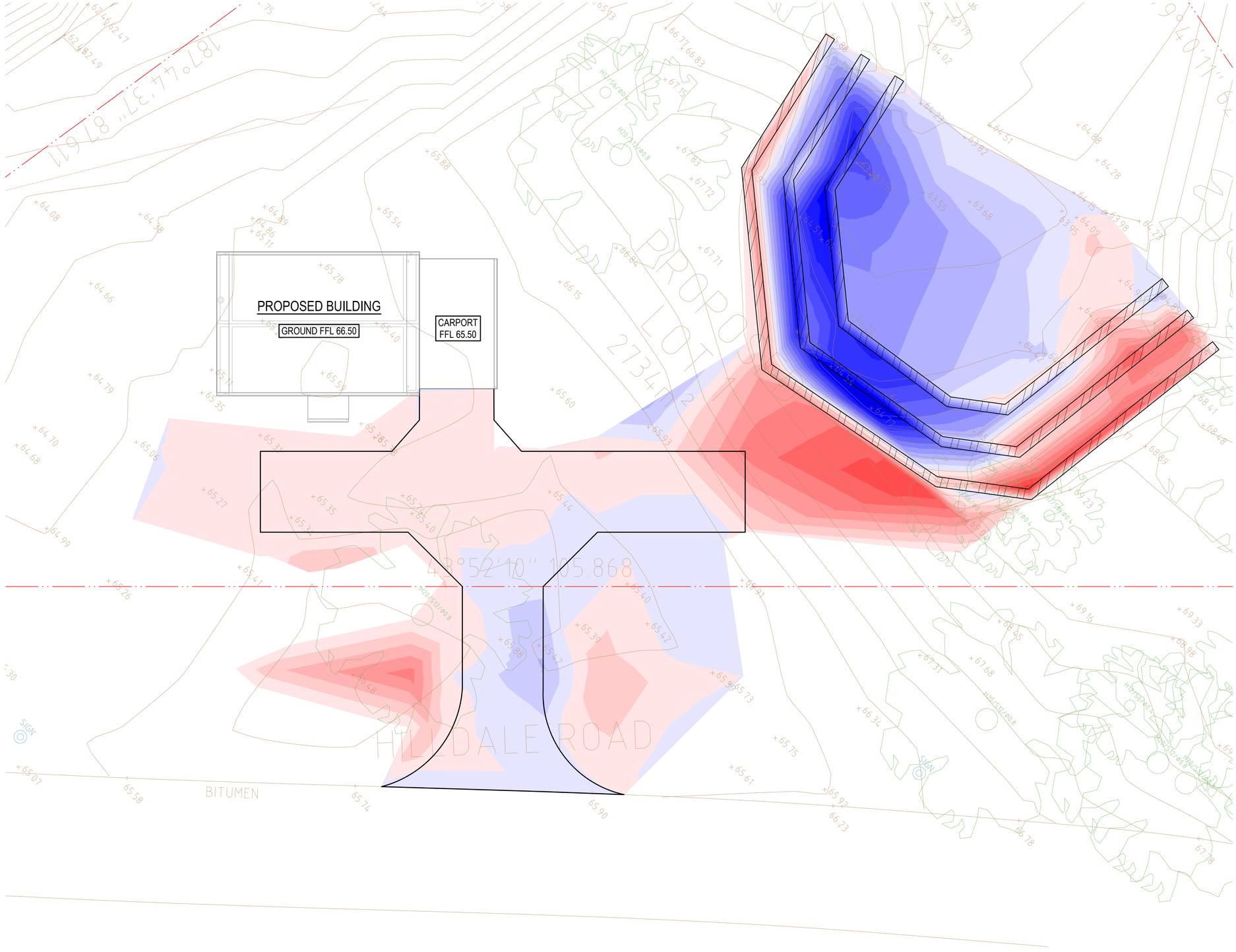
SHEET SIZE: A1

DRAWN: M.J.

PROJECT REF No.: 222097

DRAWING No.: CIV-021

REVISION: C




## LEGEND

- BOUNDARY LINE
- (1000 H) SANDSTONE RETAINING WALL - REFER CIV-021 FOR DETAILS.
- BUILDING OUTLINE
- FFL XX.XX — PROPOSED FINISHED FLOOR LEVEL
- EXISTING CONTOURS
- EXISTING SPOT LEVEL

### Surface Analysis: Elevation Ranges

| Number | Color | Minimum Elevation (m) | Maximum Elevation (m) |
|---|---|---|---|
| 1 | | -1.600 | -1.400 |
| 2 | | -1.400 | -1.200 |
| 3 | | -1.200 | -1.000 |
| 4 | | -1.000 | -0.800 |
| 5 | | -0.800 | -0.600 |
| 6 | | -0.600 | -0.400 |
| 7 | | -0.400 | -0.200 |
| 8 | | -0.200 | 0.000 |
| 9 | | 0.000 | +0.200 |
| 10 | | +0.200 | +0.400 |
| 11 | | +0.400 | +0.600 |
| 12 | | +0.600 | +0.800 |
| 13 | | +0.800 | +1.000 |
| 14 | | +1.000 | +1.200 |
| 15 | | +1.200 | +1.400 |
| 16 | | +1.400 | +1.600 |
| 17 | | +1.600 | +1.800 |
| 18 | | +1.800 | +2.000 |
| 19 | | +2.000 | +2.200 |
| 20 | | +2.200 | +2.400 |

| CUT | FILL |
|---|---|
| 69.47 m³ | 161.90m³ |
| NET VOLUME: 92.43 m³ FILL | |
| NOTE: NO STRIPPING<br>NO BULKING FACTORS APPLIED | |

## CUT & FILL PLAN

SCALE 1:100

REVISIONS

| REV | DATE | DRN | CHK | APP | DRAWING STATUS |
|---|---|---|---|---|---|
| C | 12.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION |
| B | 08.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION |
| A | 06.03.2024 | J.J. | J.T. | | ISSUED FOR COORDINATION |

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CLIENT: ALEXANDER

TITLE: CUT & FILL PLAN

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD,
HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION

SHEET SIZE: A1

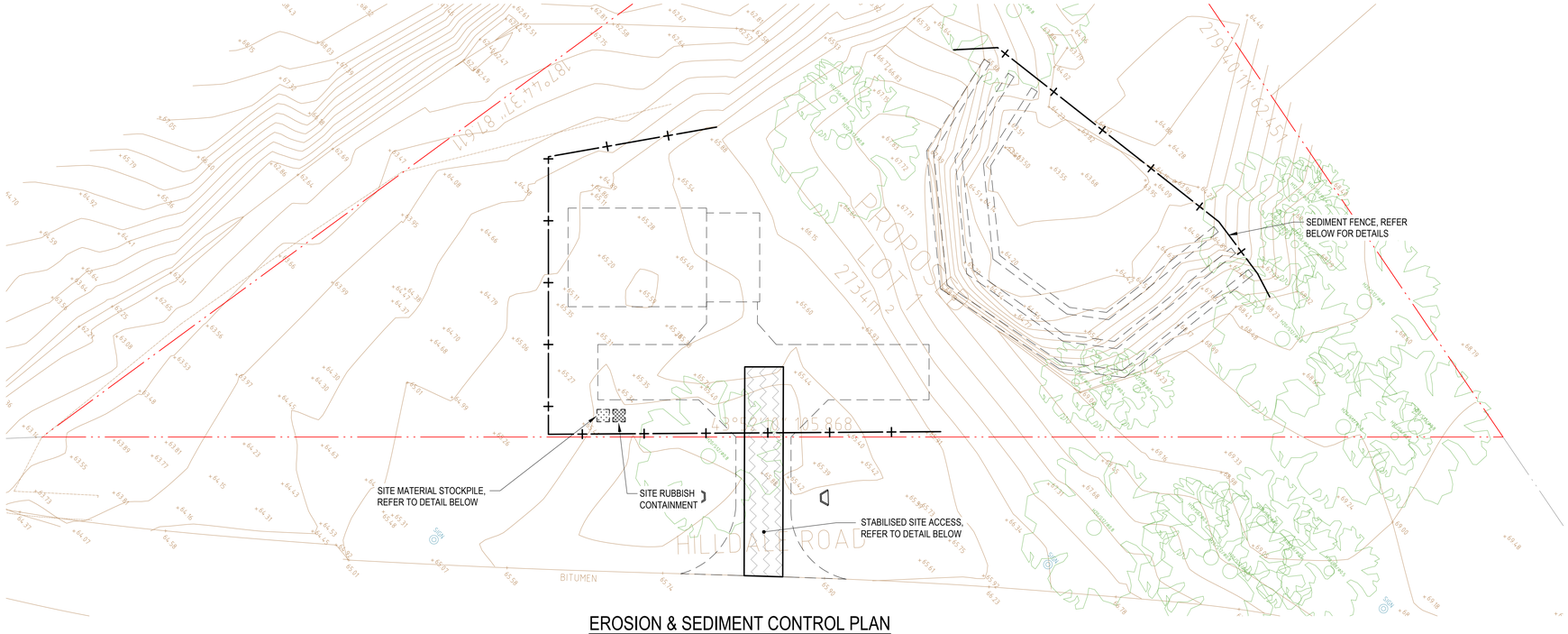
SCALE 1 : 100 (A1) — 0 1 2 3 4 5m

DRAWN: M.J.

PROJECT REF No.: 222097

DRAWING No.: CIV-031

REVISION: C

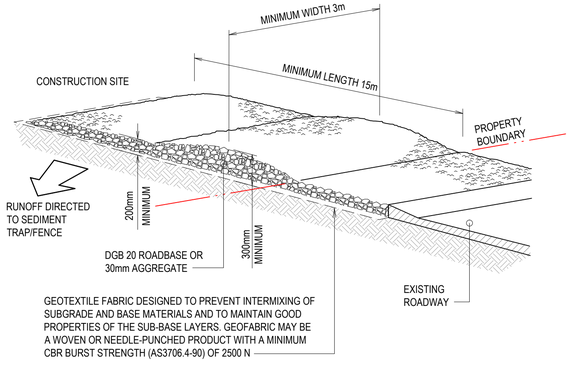



## EROSION & SEDIMENT CONTROL PLAN

SCALE 1:200

## LEGEND

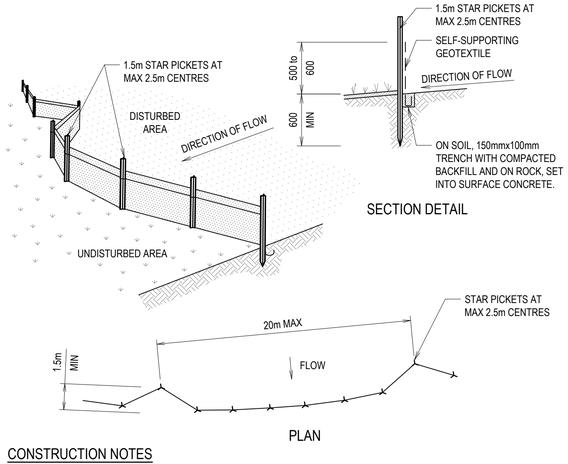
- BOUNDARY LINE
- ADJACENT BOUNDARY LINE
- EXISTING CONTOURS
- EXISTING SPOT LEVEL
- STOCKPILE
- SITE RUBBISH CONTAINMENT
- STABILISED SITE ACCESS




### CONSTRUCTION NOTES

1. STRIP THE TOPSOIL, LEVEL THE SITE AND COMPACT THE SUBGRADE.
2. COVER THE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
3. CONSTRUCT A 200mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30mm AGGREGATE.
4. ENSURE THE STRUCTURE IS AT LEAST 15 METRES LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METRES WIDE.
5. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT FENCE.

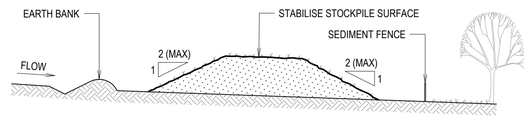
## STABILISED SITE ACCESS (SD 6-14)




### CONSTRUCTION NOTES

1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES PER SECOND IN THE DESIGN STORM EVENT, USUALLY THE 10-YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5 METRE LONG STAR PICKETS INTO GROUND AT 2.5 METRE INTERVALS (MAX) AT THE DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAR PICKETS ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.

## SEDIMENT FENCE (SD 6-8)




### CONSTRUCTION NOTES

1. PLACE STOCKPILES MORE THAN 2m (PREFERABLY 5m) FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 2m IN HEIGHT.
4. WHERE THEY ARE TO BE IN PLACE FOR MORE THAN 10 DAYS, STABILISE FOLLOWING THE APPROVED ESCP OR SWMP TO REDUCE THE C-FACTOR TO LESS THAN 0.10.
5. CONSTRUCT EARTH BANKS (STANDARD DRAWING 5-5) ON THE UPSLOPE SIDE TO DIVERT WATER AROUND STOCKPILES AND SEDIMENT FENCES (STANDARD DRAWING 6-8) 1 TO 2m DOWNSLOPE.

## STOCKPILES (SD 4-1)

REVISIONS

| REV | DATE | DRN | CHK | APP | DRAWING STATUS |
|---|---|---|---|---|---|
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CLIENT: ALEXANDER

TITLE: EROSION & SEDIMENT CONTROL PLAN

PROJECT: PROPOSED RESIDENCE
142 HILLDALE ROAD, HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION

SHEET SIZE: A1

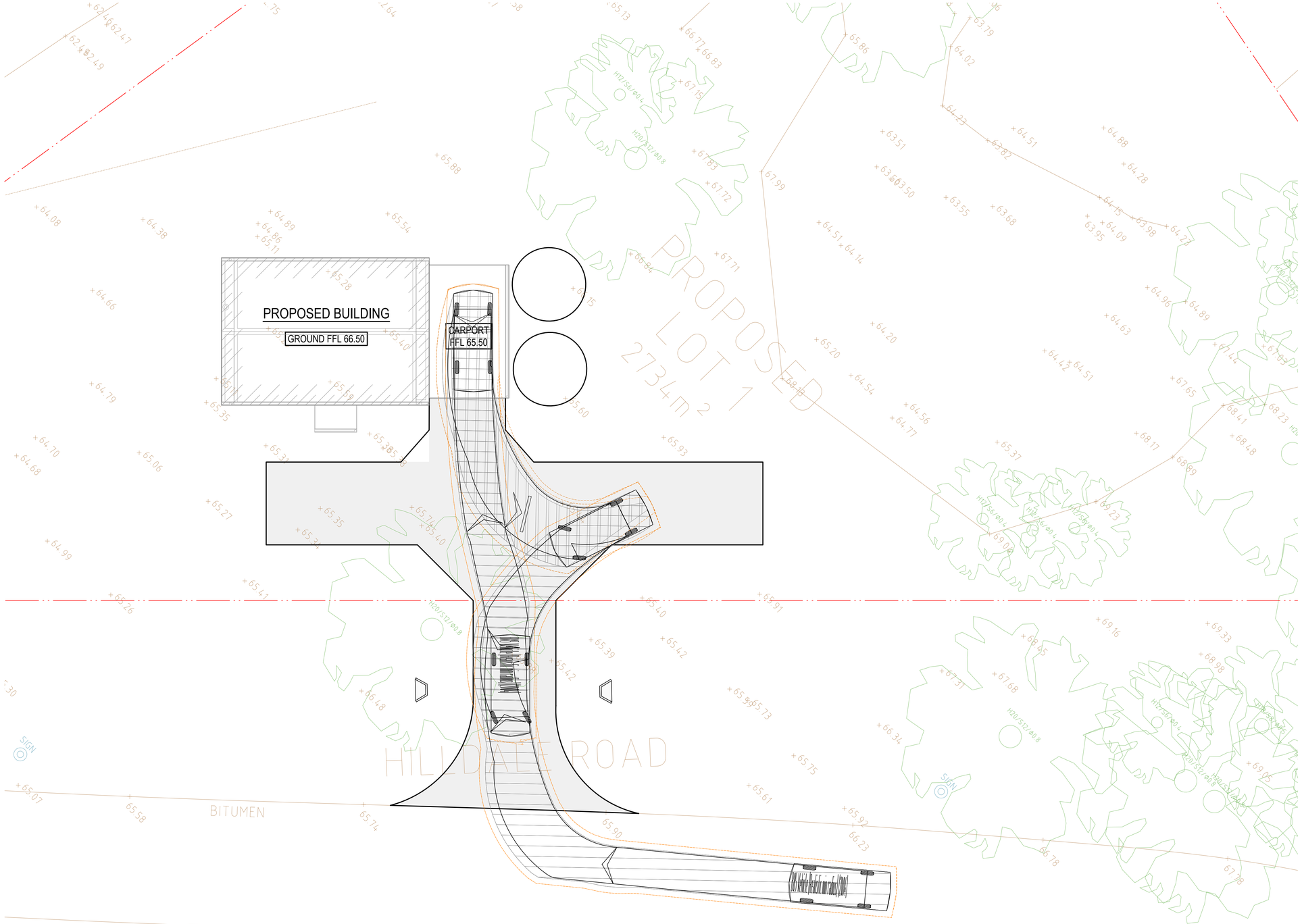
SCALE 1 : 200 (A1) 0 2 4 6 8 10m

DRAWN: M.J.

PROJECT REF No.: 222097

DRAWING No.: CIV-041

REVISION: C




## B85 SWEPT PATH

SCALE 1:100

| REVISIONS | | | | | | |
|---|---|---|---|---|---|---|
| REV | DATE | DRN | CHK | APP | DRAWING STATUS | |
| C | 12.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION | |
| B | 08.03.2024 | M.J. | J.T. | J.T. | ISSUED FOR DEVELOPMENT APPLICATION | |
| A | 06.03.2024 | J.J. | J.T. | | ISSUED FOR COORDINATION | |

This drawing is **not** approved for construction unless signed.

BEFORE YOU DIG www.byda.com.au



DRB CONSULTING ENGINEERS
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P: (02) 4040 0580
E: hello@drbengineering.com.au
ABN 64 625 755 482

CLIENT: ALEXANDER

TITLE: B85 SWEPT PATH

PROJECT: PROPOSED RESIDENCE

142 HILLDALE ROAD, HILLDALE, NSW 2420

DRAWING STATUS: NOT FOR CONSTRUCTION

SCALE 1 : 100 (A1) 0 1 2 3 4 5m

SHEET SIZE: A1

DRAWN: M.J.

PROJECT REF No.: 222097

DRAWING No.: CIV-051

REVISION: C

# BASIX® Certificate

Building Sustainability Index www.basix.nsw.gov.au

## Single Dwelling

Certificate number: 1327683S_02

This certificate confirms that the proposed development will meet the NSW government's requirements for sustainability, if it is built in accordance with the commitments set out below. Terms used in this certificate, or in the commitments, have the meaning given by the document entitled "BASIX Definitions" dated 10/09/2020 published by the Department. This document is available at www.basix.nsw.gov.au

This certificate is a revision of certificate number 1327683S lodged with the consent authority or certifier on 16 February 2023 with application PAN-304413.

It is the responsibility of the applicant to verify with the consent authority that the original, or any revised certificate, complies with the requirements of Schedule 1 Clause 2A, 4A or 6A of the Environment Planning and Assessment Regulation 2000

Secretary
Date of issue: Saturday, 24 February 2024
To be valid, this certificate must be lodged within 3 months of the date of issue.

| Project summary | |
|---|---|
| Project name | 142 Hilldale Road, Hilldale_02 |
| Street address | 142 HILLDALE ROAD HILLDALE 2420 |
| Local Government Area | Dungog Shire Council |
| Plan type and plan number | Deposited Plan 1110671 |
| Lot no. | 144 |
| Section no. | - |
| Project type | separate dwelling house |
| No. of bedrooms | 3 |

| Project score | | |
|---|---|---|
| Water | ✔ 40 | Target 40 |
| Thermal Comfort | ✔ Pass | Target Pass |
| Energy | ✔ 97 | Target 45 |

| Certificate Prepared by |
|---|
| Name / Company Name: Daniel Bills |
| ABN (if applicable): |

# Description of project

| Project address | |
|---|---|
| Project name | 142 Hilldale Road, Hilldale_02 |
| Street address | 142 HILLDALE ROAD HILLDALE 2420 |
| Local Government Area | Dungog Shire Council |
| Plan type and plan number | Deposited Plan 1110671 |
| Lot no. | 144 |
| Section no. | - |

| Project type | |
|---|---|
| Project type | separate dwelling house |
| No. of bedrooms | 3 |

| Site details | |
|---|---|
| Site area (m²) | 2890 |
| Roof area (m²) | 95 |
| Conditioned floor area (m²) | 120.3 |
| Unconditioned floor area (m²) | 12.5 |
| Total area of garden and lawn (m²) | 2688 |
| Roof area of the existing dwelling (m²) | 0 |

| Assessor details and thermal loads | |
|---|---|
| Assessor number | n/a |
| Certificate number | n/a |
| Climate zone | n/a |
| Area adjusted cooling load (MJ/m².year) | n/a |
| Area adjusted heating load (MJ/m².year) | n/a |
| Ceiling fan in at least one bedroom | n/a |
| Ceiling fan in at least one living room or other conditioned area | n/a |

| Project score | | | |
|---|---|---|---|
| Water | ✔ | 40 | Target 40 |
| Thermal Comfort | ✔ | Pass | Target Pass |
| Energy | ✔ | 97 | Target 45 |

## Schedule of BASIX commitments

The commitments set out below regulate how the proposed development is to be carried out. It is a condition of any development consent granted, or complying development certificate issued, for the proposed development, that BASIX commitments be complied with.

| Water Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| **Landscape** | | | |
| The applicant must plant indigenous or low water use species of vegetation throughout 2000 square metres of the site. | ✔ | ✔ | |
| **Fixtures** | | | |
| The applicant must install showerheads with a minimum rating of 4 star (> 4.5 but <= 6 L/min plus spray force and/or coverage tests) in all showers in the development. | | ✔ | ✔ |
| The applicant must install a toilet flushing system with a minimum rating of 5 star in each toilet in the development. | | ✔ | ✔ |
| The applicant must install taps with a minimum rating of 5 star in the kitchen in the development. | | ✔ | |
| The applicant must install basin taps with a minimum rating of 5 star in each bathroom in the development. | | ✔ | |
| **Alternative water** | | | |
| Rainwater tank | | | |
| The applicant must install a rainwater tank of at least 40000 litres on the site. This rainwater tank must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities. | ✔ | ✔ | ✔ |
| The applicant must configure the rainwater tank to collect rain runoff from at least 105 square metres of the roof area of the development (excluding the area of the roof which drains to any stormwater tank or private dam). | | ✔ | ✔ |
| The applicant must connect the rainwater tank to: | | | |
| • all toilets in the development | | ✔ | ✔ |
| • the cold water tap that supplies each clothes washer in the development | | ✔ | ✔ |

| Water Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| • all hot water systems in the development | | ✔ | ✔ |
| • all indoor cold water taps (not including taps that supply clothes washers) in the development | | ✔ | ✔ |
| Greywater treatment system | | | |
| The applicant must install a greywater treatment system on the site. This system must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities. | | ✔ | ✔ |
| The applicant must configure the greywater treatment system so that greywater for recycling is collected from: | | | |
| • the laundry | | ✔ | ✔ |
| The applicant must connect the greywater treatment system to: | | | |
| • a sub-surface or non-aerosol irrigation system, or if the greywater has been appropriately treated in accordance with applicable regulatory requirements, to at least one outdoor tap in the development (Note: NSWHealth does not recommend that greywater be used to irrigate edible plants which are consumed raw.) | | ✔ | ✔ |

| Thermal Comfort Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| **Do-it-yourself Method** | | | |
| General features | | | |
| The dwelling must not have more than 2 storeys. | ✔ | ✔ | ✔ |
| The conditioned floor area of the dwelling must not exceed 300 square metres. | ✔ | ✔ | ✔ |
| The dwelling must not contain open mezzanine area exceeding 25 square metres. | ✔ | ✔ | ✔ |
| The dwelling must not contain third level habitable attic room. | ✔ | ✔ | ✔ |
| Floor, walls and ceiling/roof | | | |
| The applicant must construct the floor(s), walls, and ceiling/roof of the dwelling in accordance with the specifications listed in the table below. | ✔ | ✔ | ✔ |

| Construction | Additional insulation required (R-Value) | Other specifications |
|---|---|---|
| floor - suspended floor above open subfloor, 54.3 square metres, framed | 0.8 (or 1.5 including construction) (down) | |
| floor - above habitable rooms or mezzanine, 45.9 square metres, framed | nil | |
| external wall - framed (weatherboard, fibre cement, metal clad) | 3.00 (or 3.40 including construction) | |
| external wall - concrete block/plasterboard | 2.88 (or 3.40 including construction) | |
| ceiling and roof - raked ceiling / pitched or skillion roof, framed | ceiling: 5 (up), roof: foil/sarking | framed; dark (solar absorptance > 0.70) |

| | |
|---|---|
| Note | • Insulation specified in this Certificate must be installed in accordance with Part 3.12.1.1 of the Building Code of Australia. |
| Note | • In some climate zones, insulation should be installed with due consideration of condensation and associated interaction with adjoining building materials. |

| Thermal Comfort Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| Windows, glazed doors and skylights | | | |
| The applicant must install the windows, glazed doors and shading devices described in the table below, in accordance with the specifications listed in the table. Relevant overshadowing specifications must be satisfied for each window and glazed door. | ✔ | ✔ | ✔ |
| The dwelling may have 1 skylight (<0.7 square metres) which is not listed in the table. | ✔ | ✔ | ✔ |
| The following requirements must also be satisfied in relation to each window and glazed door: | ✔ | ✔ | ✔ |
| • For the following glass and frame types, the certifier check can be performed by visual inspection.<br>- Aluminium single clear<br>- Aluminium double (air) clear<br>- Timber/uPVC/fibreglass single clear<br>- Timber/uPVC/fibreglass double (air) clear | | | ✔ |
| • For other glass or frame types, each window and glazed door must be accompanied with certification showing a U value no greater than that listed and a Solar Heat Gain Coefficient (SHGC) within the range of those listed. Total system U values and SHGC must be calculated in accordance with National Fenestration Rating Council (NFRC) conditions. Frame and glass types shown in the table below are for reference only. | | | ✔ |
| • Overshadowing buildings/vegetation must be of the height and distance from the centre and the base of the window and glazed door, as specified in the 'overshadowing' column. | ✔ | ✔ | ✔ |

| Window/glazed door no. | Maximum height (mm) | Maximum width (mm) | Type | Shading Device (Dimension within 10%) | Overshadowing |
|---|---|---|---|---|---|
| **South-East facing** | | | | | |
| W1.1 | 1200.00 | 1200.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| W1.2 | 1200.00 | 1200.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |

| Window/glazed door no. | Maximum height (mm) | Maximum width (mm) | Type | Shading Device (Dimension within 10%) | Overshadowing |
|---|---|---|---|---|---|
| W1.3 | 1200.00 | 1200.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| DE.1 | 2200.00 | 800.00 | U-value: 5.6, SHGC: 0.324 - 0.396 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| W2.1 | 1200.00 | 1500.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| W2.2 | 1200.00 | 1800.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| W2.3 | 1200.00 | 1500.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | >4 m high, 8-12 m away |
| **South-West facing** | | | | | |
| W1.4 | 1200.00 | 800.00 | U-value: 4.6, SHGC: 0.414 - 0.506 (composite, single, Lo-Tsol Low-e) | none | not overshadowed |
| W1.5 | 1200.00 | 800.00 | U-value: 4.6, SHGC: 0.414 - 0.506 (composite, single, Lo-Tsol Low-e) | none | not overshadowed |
| W1.6 | 1200.00 | 800.00 | U-value: 4.6, SHGC: 0.414 - 0.506 (composite, single, Lo-Tsol Low-e) | none | not overshadowed |
| **North-West facing** | | | | | |
| DW.1 | 2200.00 | 1600.00 | U-value: 5.6, SHGC: 0.324 - 0.396 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | not overshadowed |
| DW.2 | 2200.00 | 1600.00 | U-value: 5.6, SHGC: 0.324 - 0.396 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 2800 mm above head of window or glazed door | not overshadowed |

| Window/glazed door no. | Maximum height (mm) | Maximum width (mm) | Type | Shading Device (Dimension within 10%) | Overshadowing |
|---|---|---|---|---|---|
| W2.4 | 1200.00 | 1800.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 300 mm above head of window or glazed door | not overshadowed |
| W2.5 | 1200.00 | 1200.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 300 mm above head of window or glazed door | not overshadowed |
| W2.6 | 1200.00 | 1500.00 | U-value: 5.6, SHGC: 0.369 - 0.451 (aluminium, single, Lo-Tsol Low-e) | eave 600 mm, 300 mm above head of window or glazed door | not overshadowed |

| Energy Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| **Hot water** | | | |
| The applicant must install the following hot water system in the development, or a system with a higher energy rating: electric heat pump with a performance of 31 to 35 STCs or better. | ✔ | ✔ | ✔ |
| **Cooling system** | | | |
| The applicant must install the following cooling system, or a system with a higher energy rating, in at least 1 living area: ceiling fans + 1-phase airconditioning; Energy rating: 4 star (average zone) | | ✔ | ✔ |
| The applicant must install the following cooling system, or a system with a higher energy rating, in at least 1 bedroom: ceiling fans + 1-phase airconditioning; Energy rating: 4 star (average zone) | | ✔ | ✔ |
| **Heating system** | | | |
| The applicant must install the following heating system, or a system with a higher energy rating, in at least 1 living area: wood heater; Energy rating: n/a | | ✔ | ✔ |
| The bedrooms must not incorporate any heating system, or any ducting which is designed to accommodate a heating system. | | ✔ | ✔ |
| The wood heater must have a compliance plate confirming that it complies with the relevant Australian standards, and must be installed in accordance with the requirements of all applicable regulatory authorities. | | | ✔ |
| **Ventilation** | | | |
| The applicant must install the following exhaust systems in the development: | | | |
| At least 1 Bathroom: no mechanical ventilation (ie. natural); Operation control: n/a | | ✔ | ✔ |
| Kitchen: individual fan, ducted to façade or roof; Operation control: manual switch on/off | | ✔ | ✔ |
| Laundry: natural ventilation only, or no laundry; Operation control: n/a | | ✔ | ✔ |
| **Artificial lighting** | | | |
| The applicant must ensure that the "primary type of artificial lighting" is fluorescent or light emitting diode (LED) lighting in each of the following rooms, and where the word "dedicated" appears, the fittings for those lights must only be capable of accepting fluorescent or light emitting diode (LED) lamps: | | | |

| Energy Commitments | Show on DA plans | Show on CC/CDC plans & specs | Certifier check |
|---|---|---|---|
| • at least 4 of the bedrooms / study; dedicated | | ✔ | ✔ |
| • at least 2 of the living / dining rooms; dedicated | | ✔ | ✔ |
| • the kitchen; dedicated | | ✔ | ✔ |
| • all bathrooms/toilets; dedicated | | ✔ | ✔ |
| • the laundry; dedicated | | ✔ | ✔ |
| • all hallways; dedicated | | ✔ | ✔ |
| **Natural lighting** | | | |
| The applicant must install a window and/or skylight in 1 bathroom(s)/toilet(s) in the development for natural lighting. | ✔ | ✔ | ✔ |
| **Alternative energy** | | | |
| The applicant must install a photovoltaic system with the capacity to generate at least 6 peak kilowatts of electricity as part of the development. The applicant must connect this system to the development's electrical system. | ✔ | ✔ | ✔ |
| **Other** | | | |
| The applicant must construct each refrigerator space in the development so that it is "well ventilated", as defined in the BASIX definitions. | | ✔ | |

| Legend |
| --- |
| In these commitments, "applicant" means the person carrying out the development. |
| Commitments identified with a ✔ in the "Show on DA plans" column must be shown on the plans accompanying the development application for the proposed development (if a development application is to be lodged for the proposed development). |
| Commitments identified with a ✔ in the "Show on CC/CDC plans and specs" column must be shown in the plans and specifications accompanying the application for a construction certificate / complying development certificate for the proposed development. |
| Commitments identified with a ✔ in the "Certifier check" column must be certified by a certifying authority as having been fulfilled, before a final occupation certificate (either interim or final) for the development may be issued. |

Torrent Consulting Pty Ltd
PO Box 57
Wallsend NSW 2287

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Our Ref: DJW: L.T2270.003.docx

7 March 2024
A & R Alexander
c/o Perception Planning
PO Box 107
Clarence Town NSW 2321
Attention: Graham Bates

Dear Graham

**RE: FLOOD IMPACT AND RISK ASSESSMENT FOR PROPOSED DWELLING AT 142 HILLDALE ROAD, HILLDALE, NSW**

## Background

Torrent Consulting was engaged to undertake a Flood Impact and Risk Assessment to assist in the DA process for the proposed dwelling at 142 Hilldale Road, Hilldale, NSW (the Site). Dungog Shire Council has identified the Site as being potentially flood prone and has requested that a detailed assessment be undertaken to inform the approval process.

This Site is located beside Wattle Cully (as shown in Figure 1), which is a 4$^{th}$ order watercourse with an upstream catchment area of around 2.2 km$^2$.

The Wattle Gully valley upstream of the Site comprises steep terrain rising to over 350 m AHD, as presented in Figure 2. Typical elevations within the Site range from around 65 m AHD to 69 m AHD and lower within the watercourse channel.

This assessment includes the development of a TUFLOW model to simulate the flood hydrology and hydraulics of the contributing catchment at the Site. The modelling provides a platform to assess the existing flood risk profile at the Site, including a detailed understanding of the local flood depths, velocities, and hazards.

## Model Development

For this assessment, a TUFLOW hydrological model was developed covering the Wattle Gully catchment upstream of the Site, at which the contributing catchment area is around 2.2 km$^2$. The model utilised the NSW Spatial Services LiDAR data product, downloaded via the ELVIS Foundation Spatial Data portal to define the catchment topography.

The Digital Elevation Model (DEM) was pre-processed using GIS-based terrain analysis techniques to remove sinks within the grid and create a hydrologically corrected DEM. This prevents the initial loss of catchment rainfall to artificial trapped storages. A 10 m model grid cell resolution was adopted, with sub-grid sampling from a 5 m resolution DEM.

Land use coverage in the catchment was separated into cleared and vegetated areas using aerial imagery. The Log law hydraulic roughness representation was adopted, with a roughness depth of 0.2 m and ‘n’ values of 0.06 and 0.12 applied to the cleared and vegetated areas, respectively.

Rainfall losses were modelled using the Green-Ampt infiltration method, with a three-layer soil model comprising a 0.1 m deep topsoil, 0.2 m transition zone and a variable depth subsoil layer. The depth of the subsoil layer was derived from the September 2019 CSIRO gridded soil depth mapping dataset. Soil types for each layer were derived from the September 2022 NSW DPE gridded soil properties mapping dataset, with classification based on the clay, silt, and sand content. The available water holding capacity for each soil type was based on the MEDLI guidelines. The standard Green-Ampt parameters for suction and hydraulic conductivity were adopted.

The downstream boundary of the model was configured as a stage-discharge relationship, automatically generated within the model, adopting a hydraulic gradient of around 1%.

A more detailed TUFLOW model, as presented in Figure 3, was developed covering Wattle Gully from the railway to around 300 m downstream of the Site. The model was constructed using an 1 m grid cell resolution, with elevations defined using a 1 m horizontal grid cell resolution LiDAR DEM. The main watercourse channels were reinforced to ensure proper representation of the channel bed, with the bed profile being only intermittently captured within the LiDAR data.

Model inflow boundaries were extracted from the hydrological model. The downstream boundary of the model was configured as a stage-discharge relationship, automatically generated within the model, adopting a hydraulic gradient of around 1%. A Manning's 'n' value of 0.05 was used for the cleared floodplain and 0.1 for vegetated areas. An in-channel roughness of 0.045 was adopted for Wattle Gully.

The TUFLOW models were used to simulate the catchment rainfall-runoff process, utilising the ensemble storm method outlined in the ARR 2019 guidelines.

## Flood Modelling and Mapping

Catchment runoff was simulated (using the HPC solver) for the full range of design rainfall events for storm durations ranging from 30 minutes to 12 hours. The design rainfall depths were sourced from the BoM IFD (Intensity Frequency Duration) portal. No Areal Reduction Factor (ARF) was applied to the design point rainfall due to the small size of the catchment. The initial soil moisture was set at the 90$^{th}$ percentile conditions from the BoM AWRA-L model data.

The ensemble method involves the simulation of ten rainfall temporal patterns for each design event magnitude and duration, with the average condition of the ten being adopted for design purposes. The TUFLOW model simulations were analysed at the Site to identify the critical storm duration, i.e. that which produces the peak flood flow for each design event magnitude. The two-hour duration was identified as being critical for the 5% AEP event, with the one-hour duration being critical for the 1% AEP.

For the simulation of the PMF (Probable Maximum Flood) condition the Generalised Short Duration Method (GSDM) published by the BoM was adopted. The critical duration of the PMF is typically shorter than that of the standard design flood events. The 30-minute duration was found to provide the critical condition at the Site for the PMF event.

Table 1 presents the modelled peak design flows at the Site.

**Table 1 – Modelled Peak Design Flood Flows at the Site**

| Design Event | Flow ($m^3/s$) |
|---|---|
| 5% AEP | 14.9 |
| 1% AEP | 23.6 |
| 0.5% AEP | 27.2 |
| 0.2% AEP | 31.2 |
| PMF | 290 |

## Flood Risk Mapping

Design flood flow hydrographs from the hydrological modelling were simulated in the detailed TUFLOW hydraulic model to derive design flood conditions at the Site.

The modelled peak flood extents for the 5% AEP, 1% AEP and PMF events are presented in Figure 4, together with the proposed dwelling location. Figure 5, Figure 6, and Figure 7 are presented for additional flooding context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events, respectively.

Figure 8, Figure 9, and Figure 10 present the flood hazard classification at the Site for the 5% AEP, 1% AEP and PMF events, respectively. The flood hazards have been determined in accordance with Guideline 7-3 of the Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017). This produces a six-tier hazard classification, based on modelled flood depths, velocities and velocity-depth product. The hazard classes relate directly to the potential risk posed to people, vehicles, and buildings, as presented in Chart 1.

The flood hazard mapping is useful for providing context to the nature of the modelled flood risk and to identify potential constraints for development of the Site with regards to floodplain risk management.

## Flood Risk Management

The principal consideration of good practice floodplain risk management is to ensure compatibility of the proposed development with the flood hazard of the land, including the risk to life and risk to property. Requirements within a Council's LEP (Local Environment Plan) and DCP (Development Control Plan) typically consider the management of flood risk, with the application of an FPL (Flood Planning Level) being the principal control measure.

Dungog Shire Council nominates an FPL at the 1% AEP flood level plus a 0.5 m freeboard, which is consistent with standard practice. The 1% AEP flood level applicable to the proposed dwelling location is 64.8 m AHD, giving an FPL of 65.3 m AHD. The proposed dwelling location is generally situated just above this elevation and has a finished floor level of 66.9 m AHD (refer architectural drawing) 202205_A04.1), which is some 1.4 m above the FPL requirement and 0.5 m above the PMF level.

Council's document Dungog Development Control Plan No. 1 Part C.8- Managing Our Floodplains defines three Floodplain Risk Management Zones according to the corresponding flood risk as follows:

- Floodway/High Hazard area – Classified as Floodway or flood storage in a flood study or has depth > 4 m in 1% AEP event. Areas which are responsible for conveyance of flood water or

temporary storage of floodwater during an event. Change in these areas has the potential to affect flood levels and flood behaviour.

- Flood fringe - Part of flood planning area outside of the Floodway which is between the Flood Planning Level and the High Hazard area.
- Outer Floodplain - Remaining part of the Flood Planning area which is above the Flood Planning Level but below the PMF.

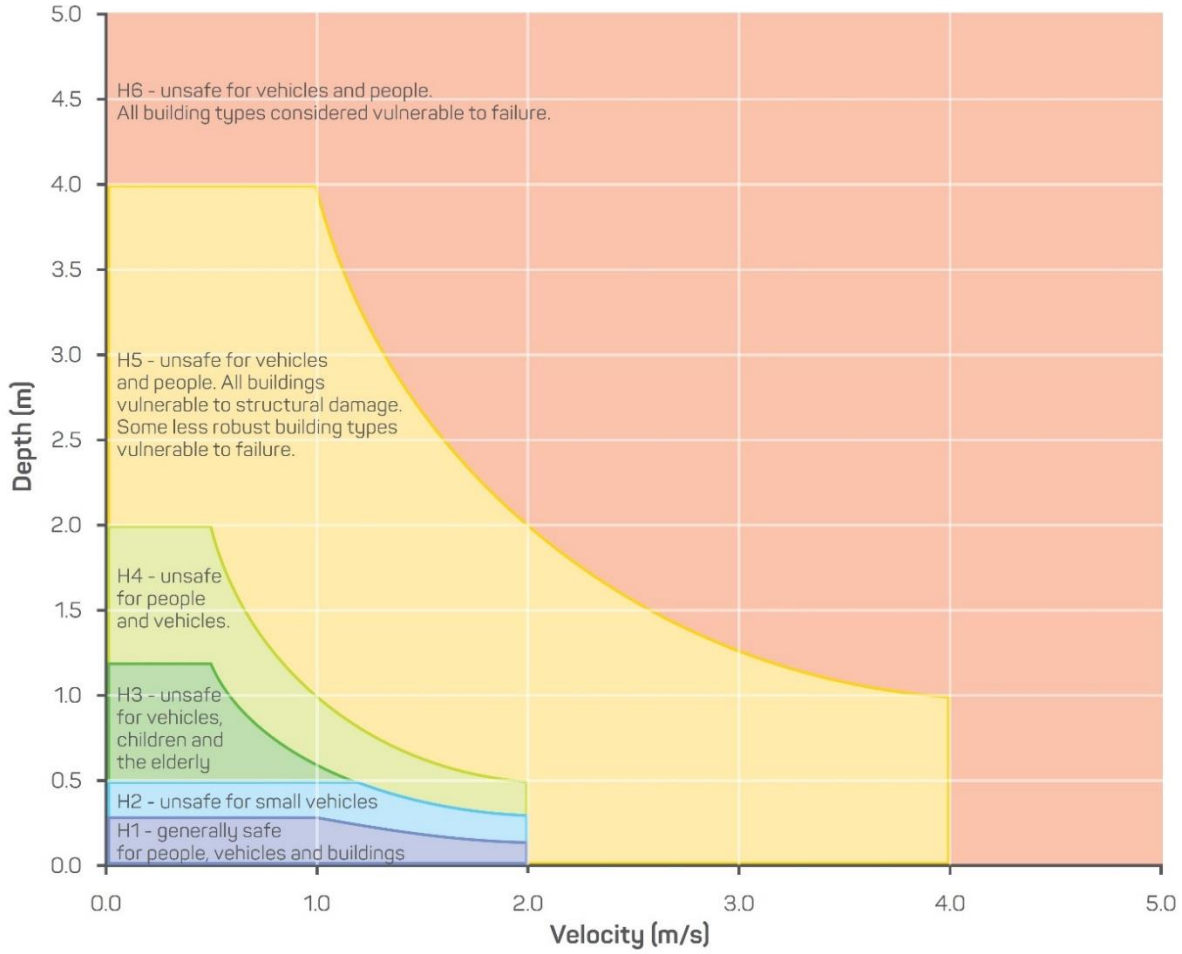



**Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)**

Figure 11 presents the extent of the three management zones and the proposed dwelling location at the Site. The floodway has been defined using a velocity x depth threshold of 0.3, with the flood fringe area representing the extent of the 0.05% AEP flood, as it is around 0.5 m higher than the 1% AEP at the Site.

Schedule 2 of the DCP document presents a matrix of Flood Planning Controls within each zone according to the land use category. For residential development within the Outer Floodplain the only requirement is for an S5.10.7 certificate to notify the applicability of the DCP. However, given the high hazard flood conditions at the PMF event, for which there would be limited warning available, the proposed dwelling has been designed to provide a suitable flood refuge.

The location of the proposed dwelling has been selected to minimise the potential flood velocity exposure of the structure, whilst maintaining required setback distances. The dwelling design incorporates a blade pier construction aligned parallel to the direction of floodplain flow , providing structural stability, and

allowing flow beneath the building. This ensures that in the event of an extremely rare flood, occupants can safely remain within the dwelling for the period of flood inundation, which could impact the Site for a period of around half an hour. The hydraulic parameters applicable to the design are a level of 66.4 m AHD and a typical peak flood velocity of around 2.0 m/s (locally peaking at 2.6 m/s).

## Flood Impact Assessment

As the dwelling location is only impacted at the PMF event and allows flow beneath the building, a modelling-based quantitative flood impact assessment is not required. Also, the stone block retaining works to the north-east of the dwelling are located within an area of lateral channel erosion. These works do not affect the conveyance capacity of the channel, which is governed by the narrow choke point through the high finger of land immediately downstream. These works will help stabilise the channel bank erosion without impacting on flows and water levels within the channel.

Chart 2 presents a series of channel cross sections in the vicinity of the proposed retaining works. The channel sections 20 m upstream and downstream of the works have much narrower floodplain widths than at the works themselves. In particular, the downstream section has virtually no floodplain, as the channel is constricted through a barrier of higher land. This pinch point acts as the dominant local hydraulic control, limiting conveyance and rendering the location of the proposed works as an area of effective backwater.

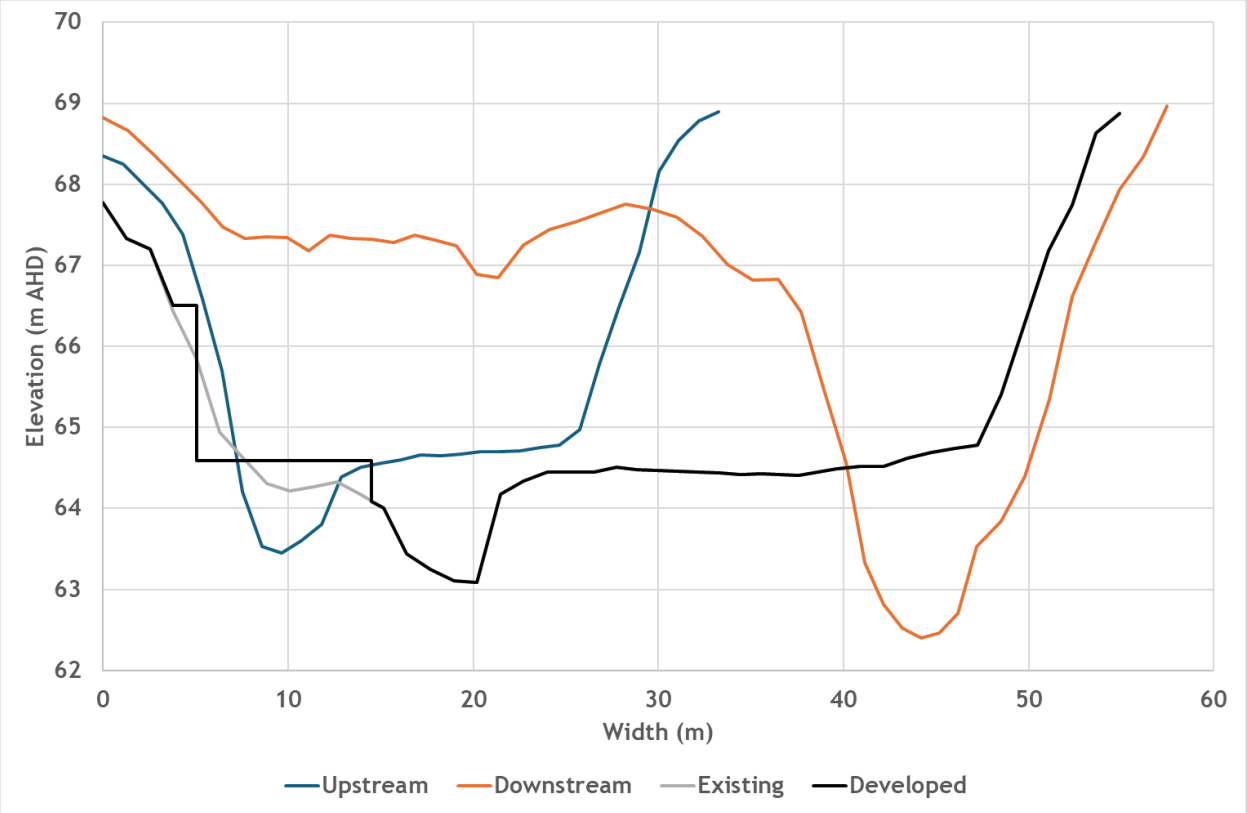



**Chart 2 – Channel Cross Sections**

## Conclusion

Torrent Consulting was engaged to undertake a Flood Impact and Risk Assessment to assist in the DA process for the proposed dwelling at 142 Hilldale Road, Hilldale, NSW.

This assessment has included development of a TUFLOW model for the Wattle Gully catchment upstream of the Site and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology.

A hydraulic model of the floodplain surrounding the Site was developed and simulated for the design flood events, with the resultant flood mapping used to define the three Floodplain Risk Management Zones identified by Council.

The proposed dwelling is located within the Outer Floodplain and has a finished floor level 1.4 m above the 1% AEP flood level and 0.9 m above the required FPL. Given the high hazard flood exposure at the PMF event, the dwelling has been designed to provide flood refuge.

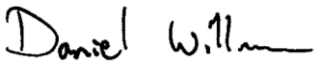
The proposed dwelling and stone block retaining works will not adversely impact the existing flood conditions.

The Online 10.7 Planning Certificate Service should be updated to identify the flood planning controls applicable to the Site.

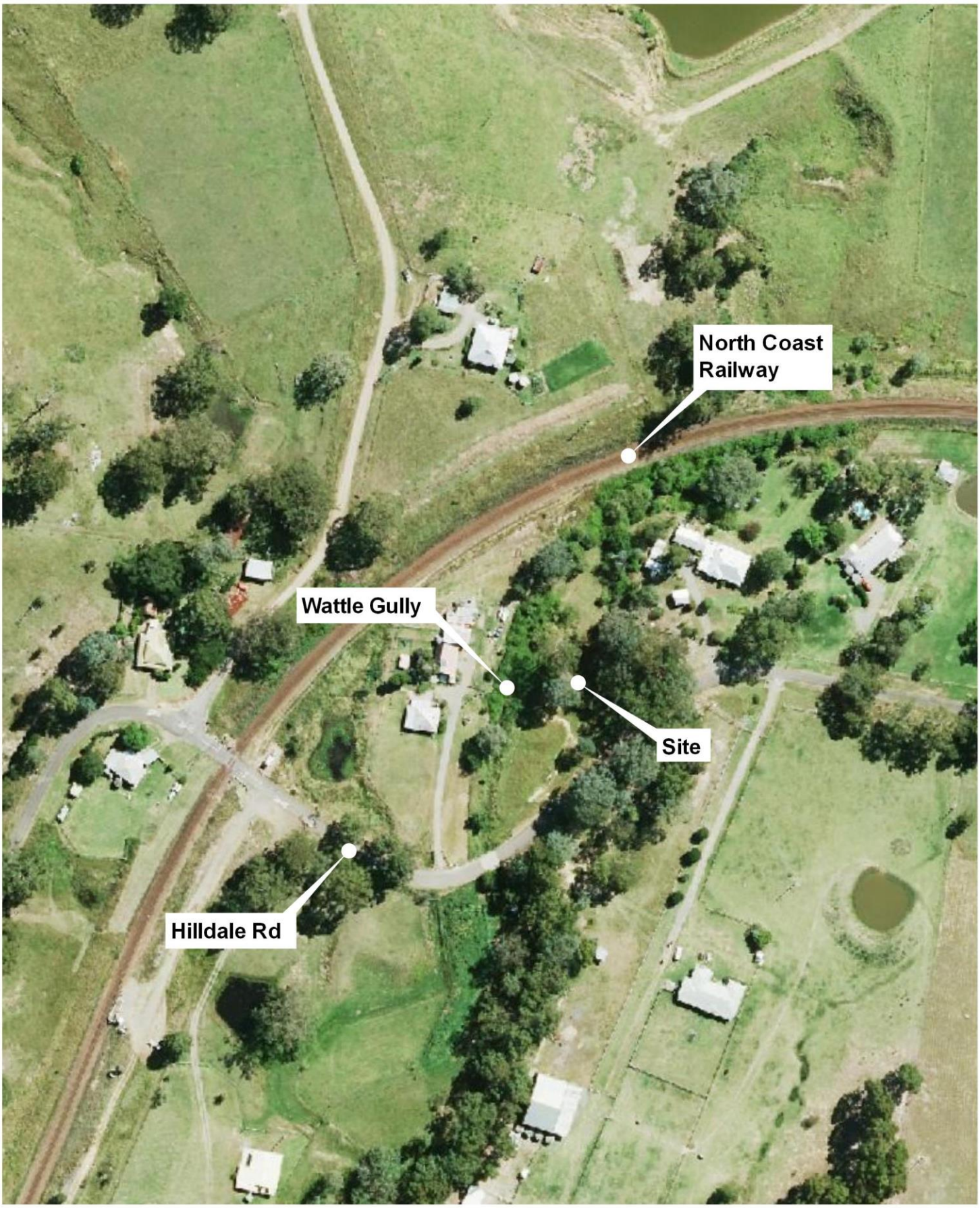
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

**Torrent Consulting**



**Dan Williams**
**Director**




Title:

## Study Locality

0 50 100 m

approx. scale

Figure: 1

Revision: A

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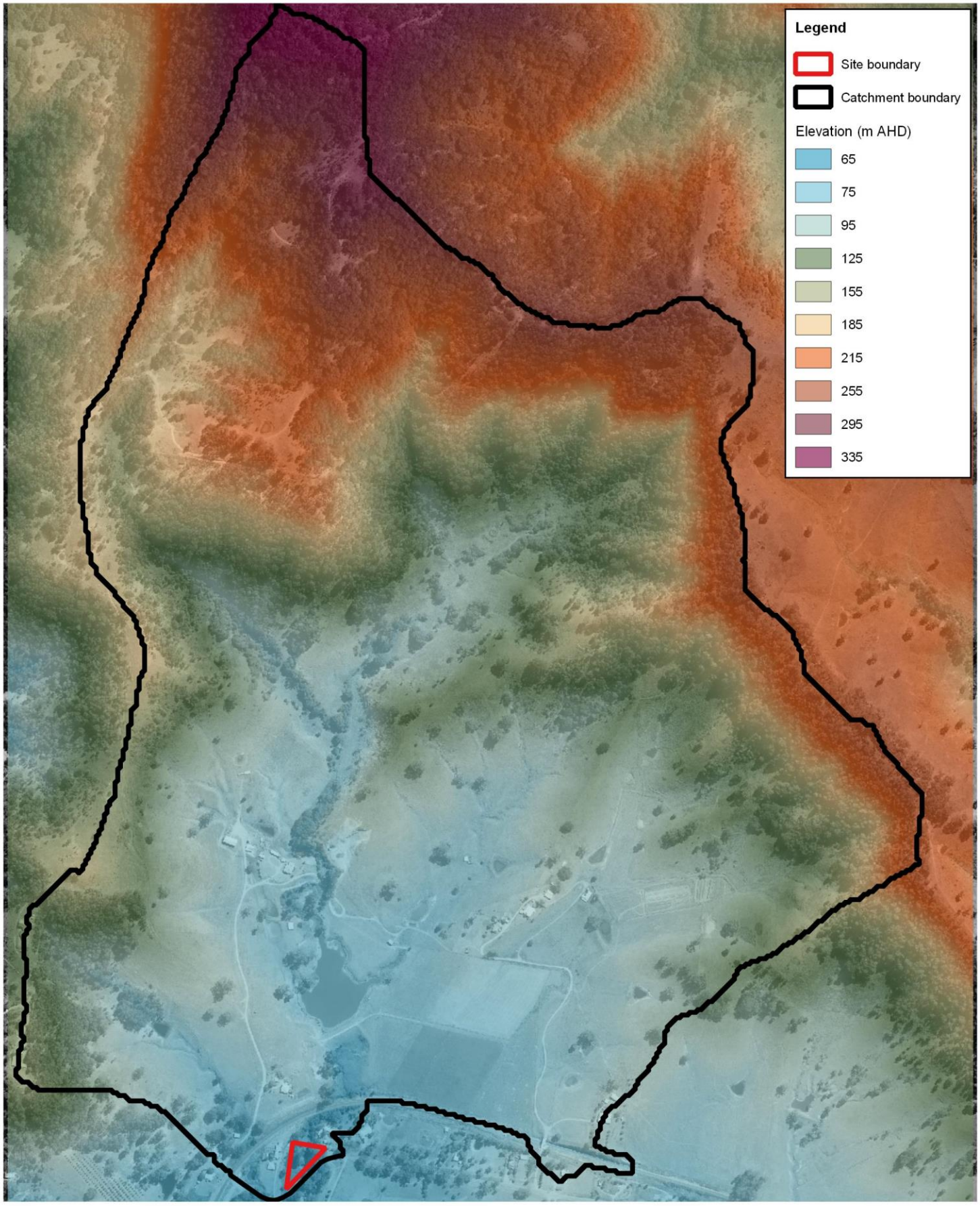


Title:

# Catchment Topography

0 200 400 m

approx. scale

Figure: 2

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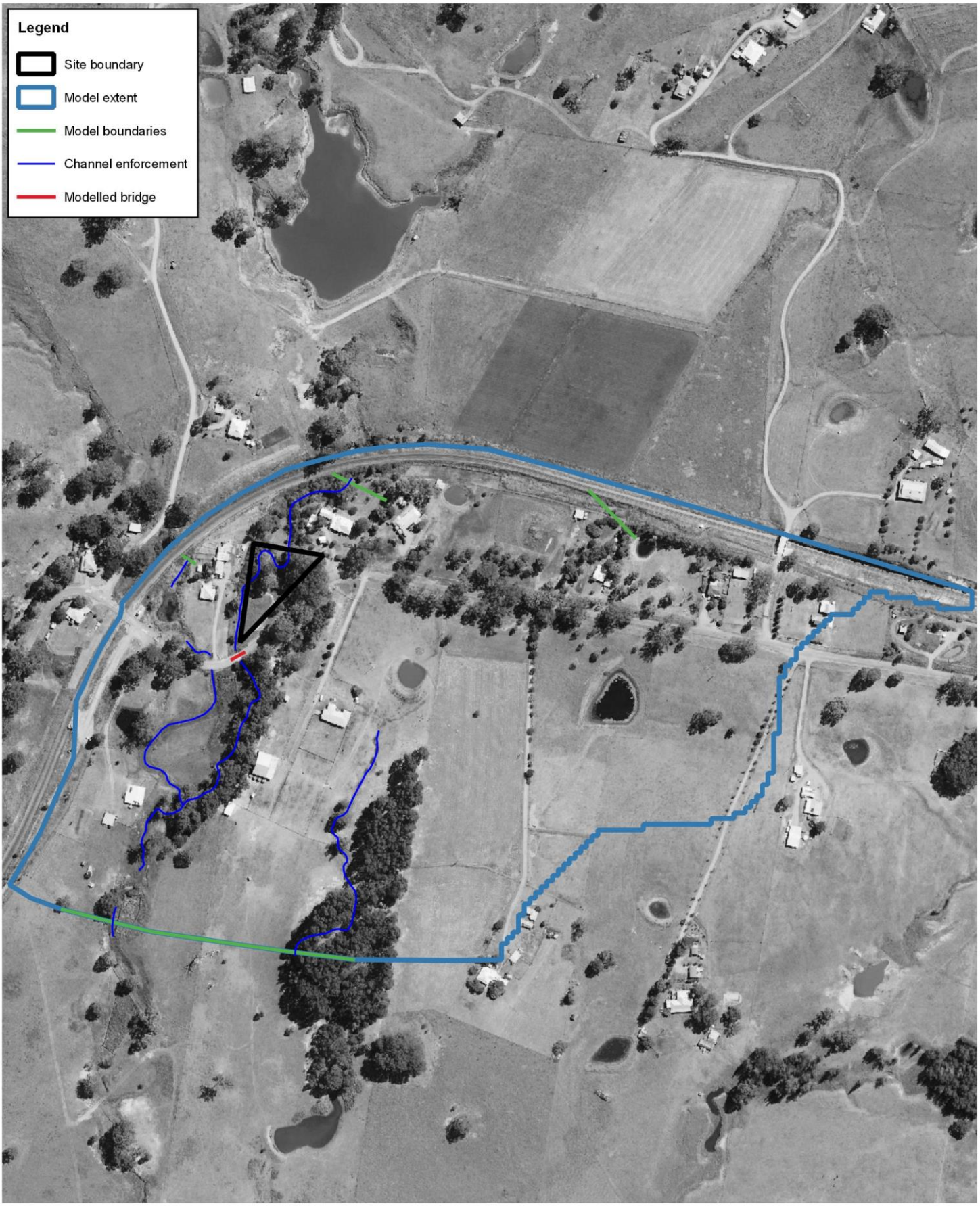


Title:

# TUFLOW Model Configuration

0 100 200 m

approx. scale

Figure: 3

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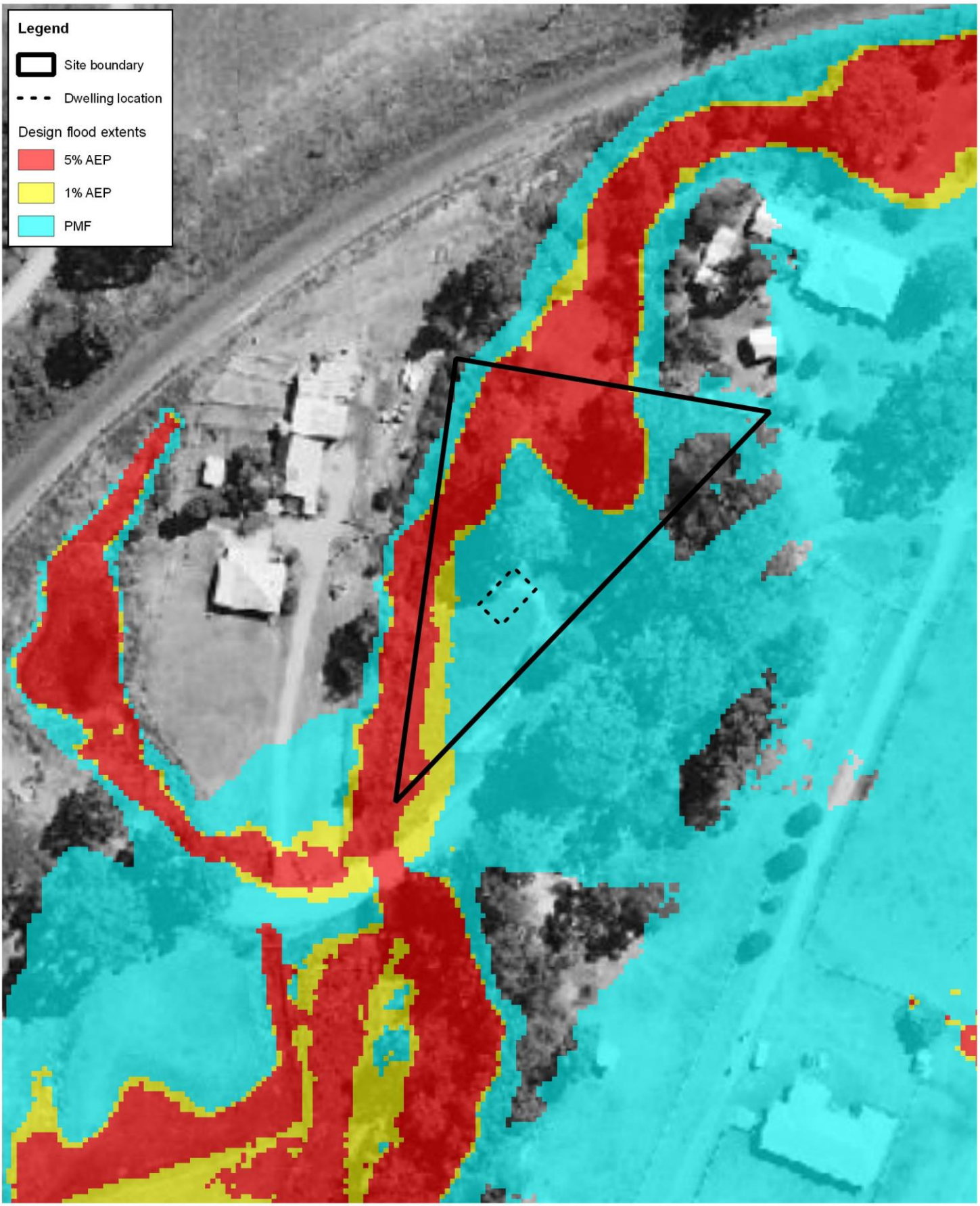


Title:

# Design Flood Extents

0 20 40 m

approx. scale

Figure: 4

Revision: A

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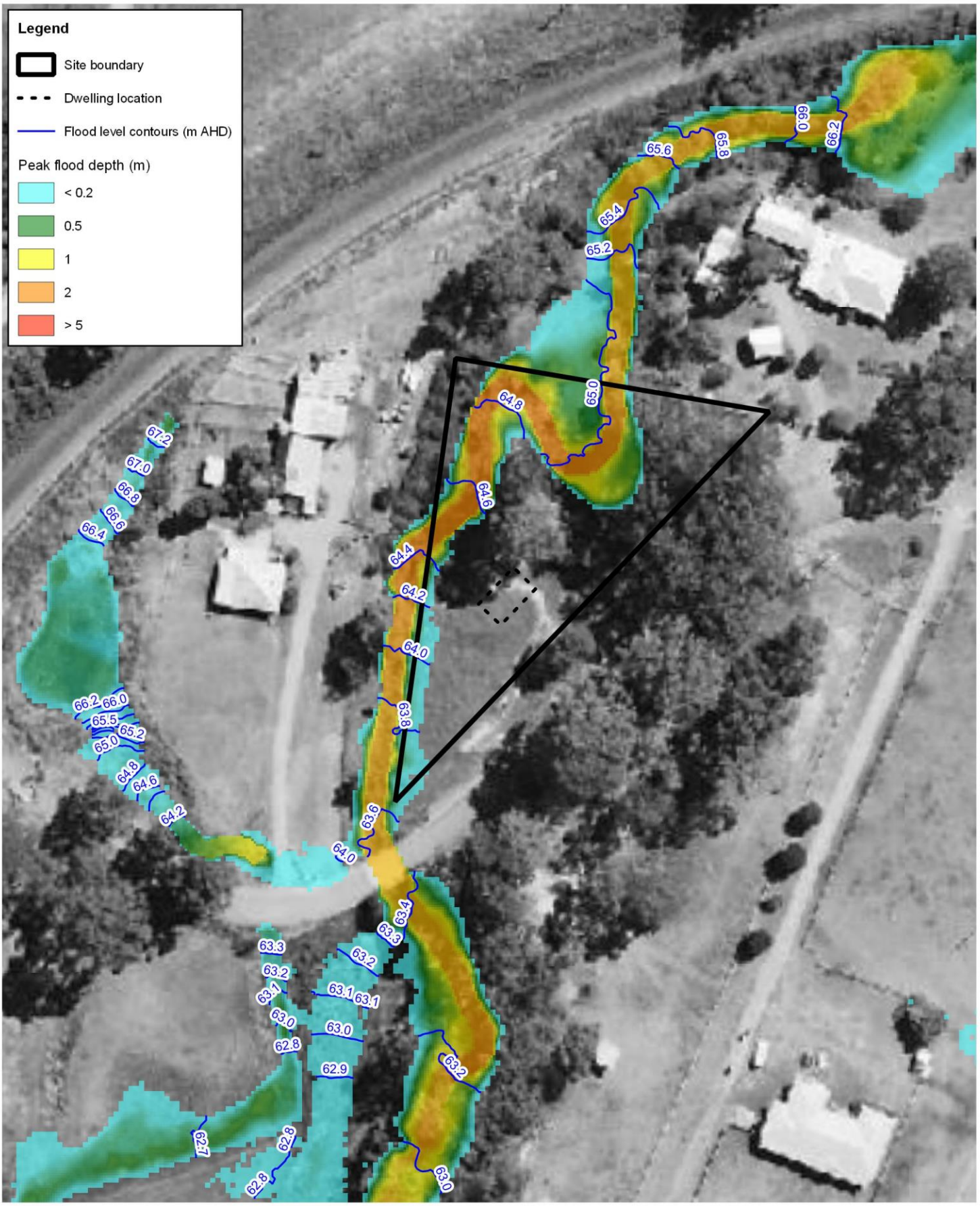


Title:

# Modelled 5% AEP Peak Flood Depths and Levels

0 20 40 m

approx. scale

Figure: 5

Revision: A

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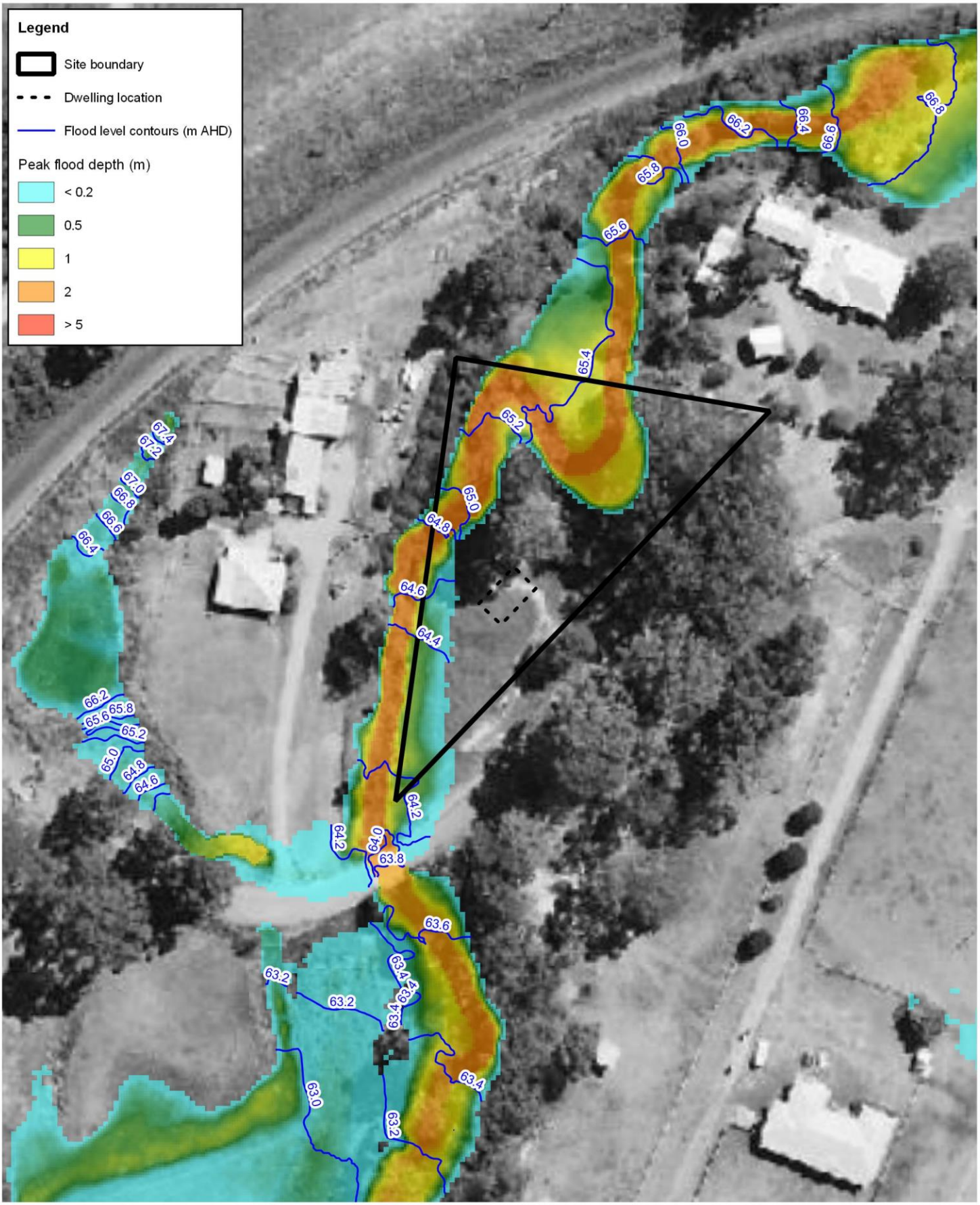


Title:

# Modelled 1% AEP Peak Flood Depths and Levels

0 20 40 m

approx. scale

Figure: 6

Revision: A

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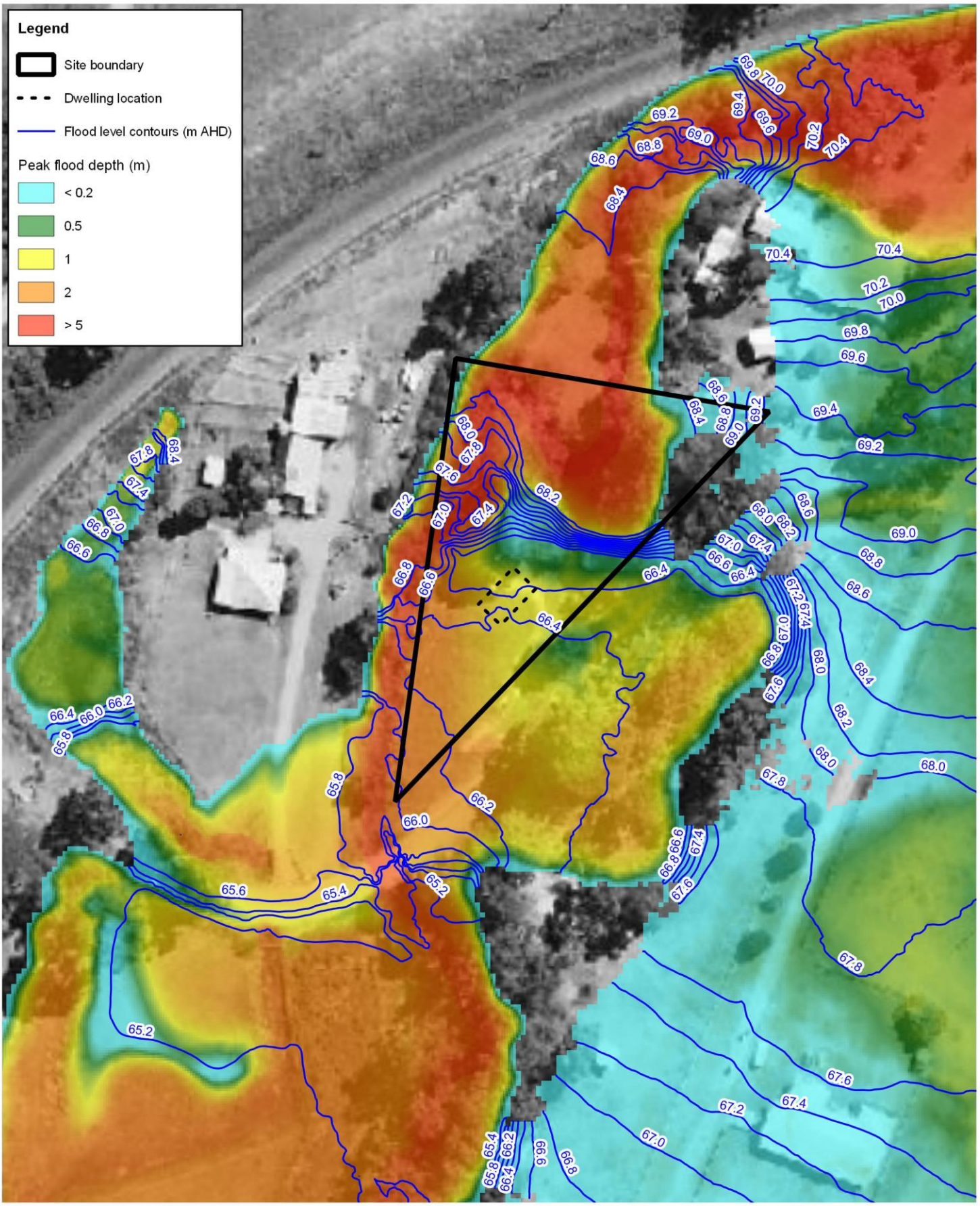


Title:

# Modelled PMF Peak Flood Depths and Levels

0 20 40 m

approx. scale

Figure: 7

Revision: A

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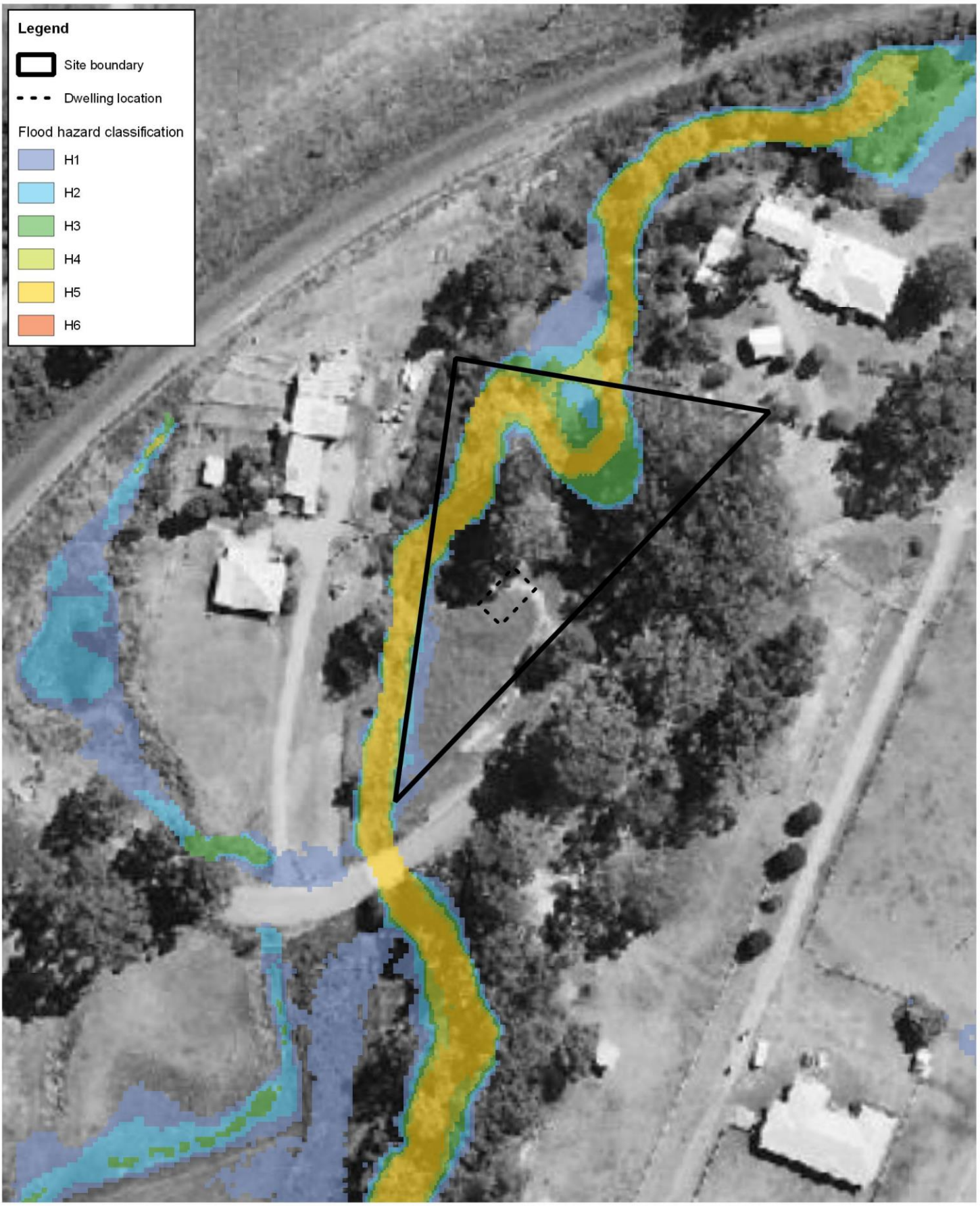


Title:

## 5% AEP Flood Hazard Classification

0 20 40 m

approx. scale

Figure: 8

Revision: A

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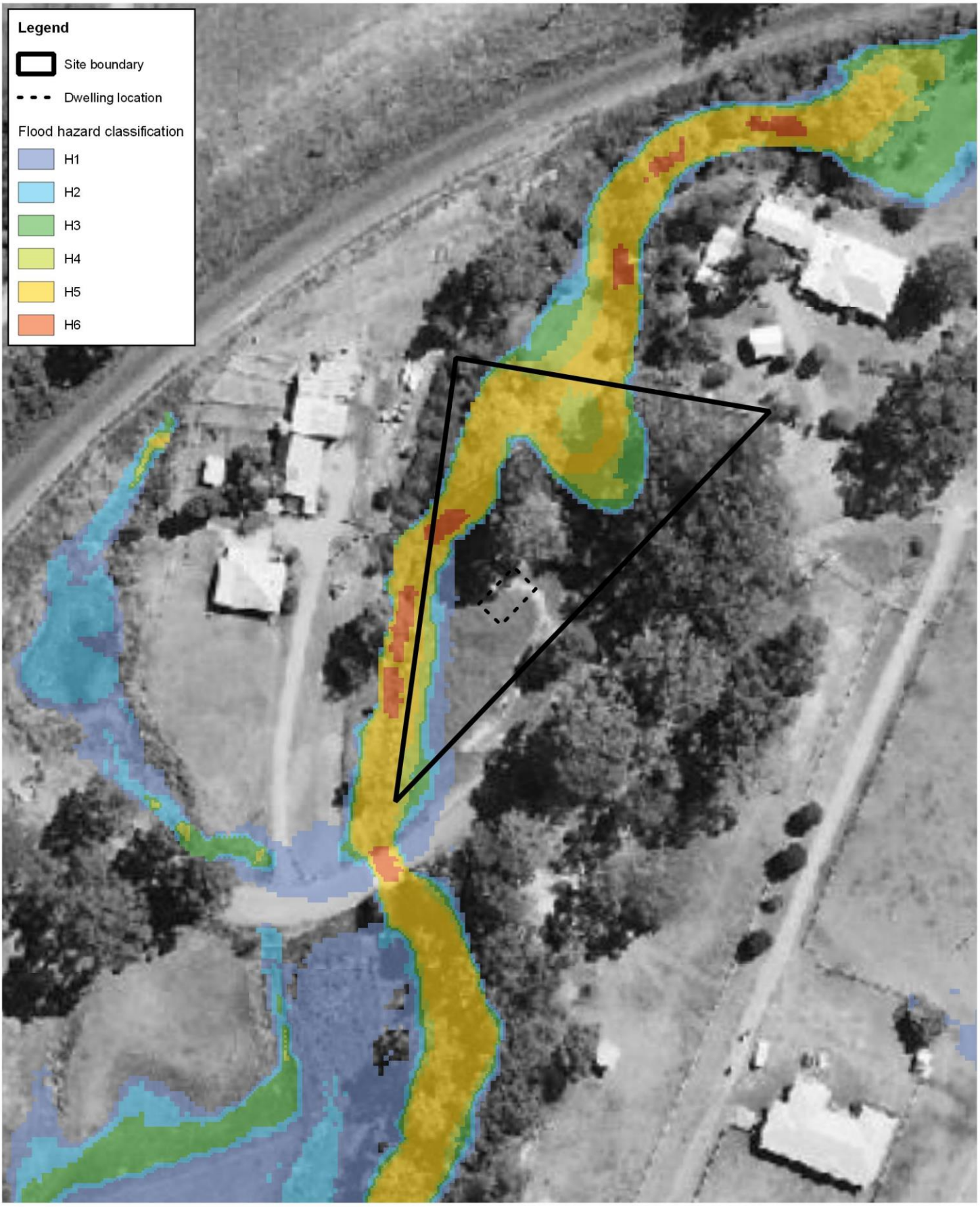


Title:

# 1% AEP Flood Hazard Classification

0 20 40 m

approx. scale

Figure: 9

Revision: A

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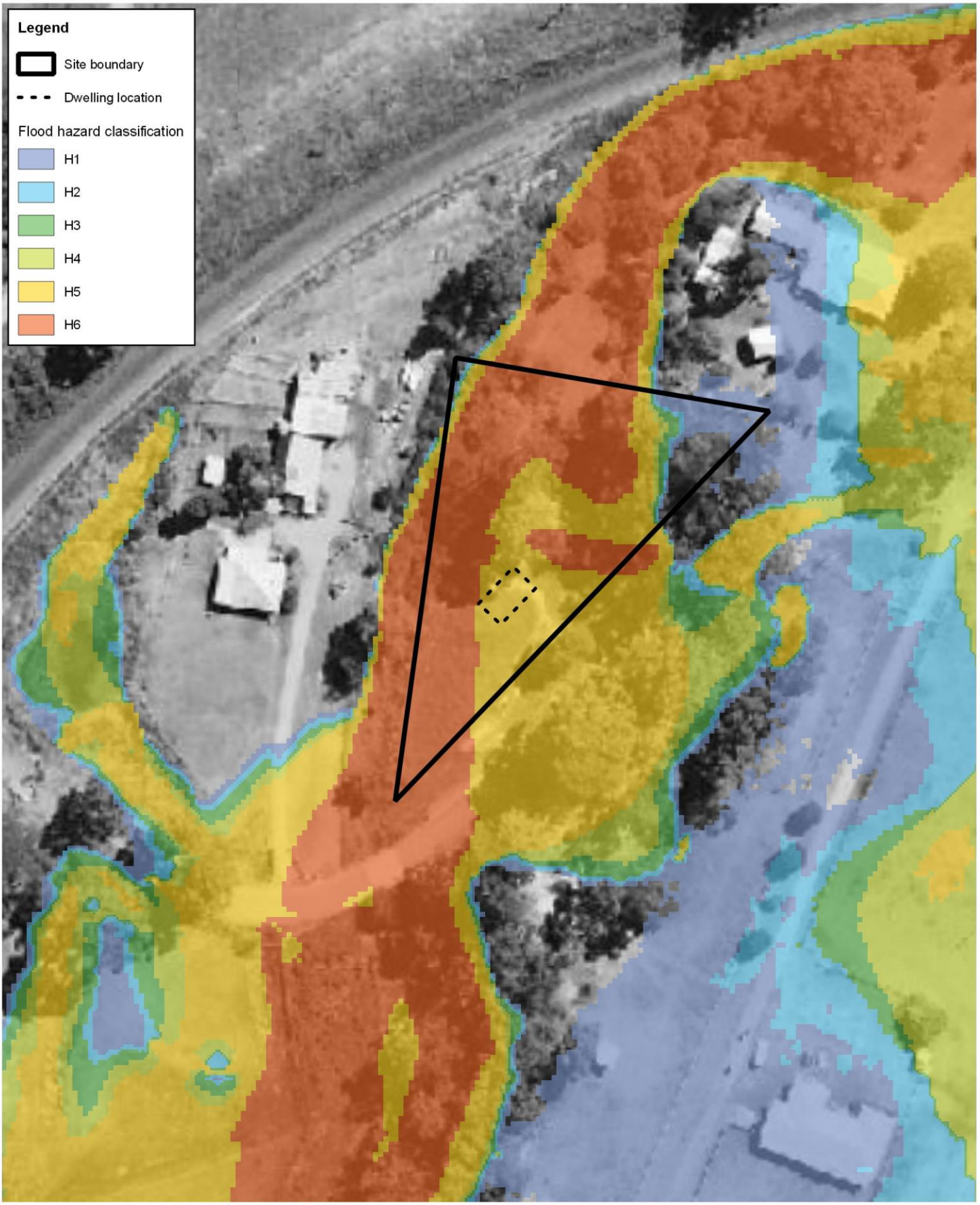


Title:

# PMF Flood Hazard Classification

0 20 40 m

approx. scale

Figure: 10

Revision: A

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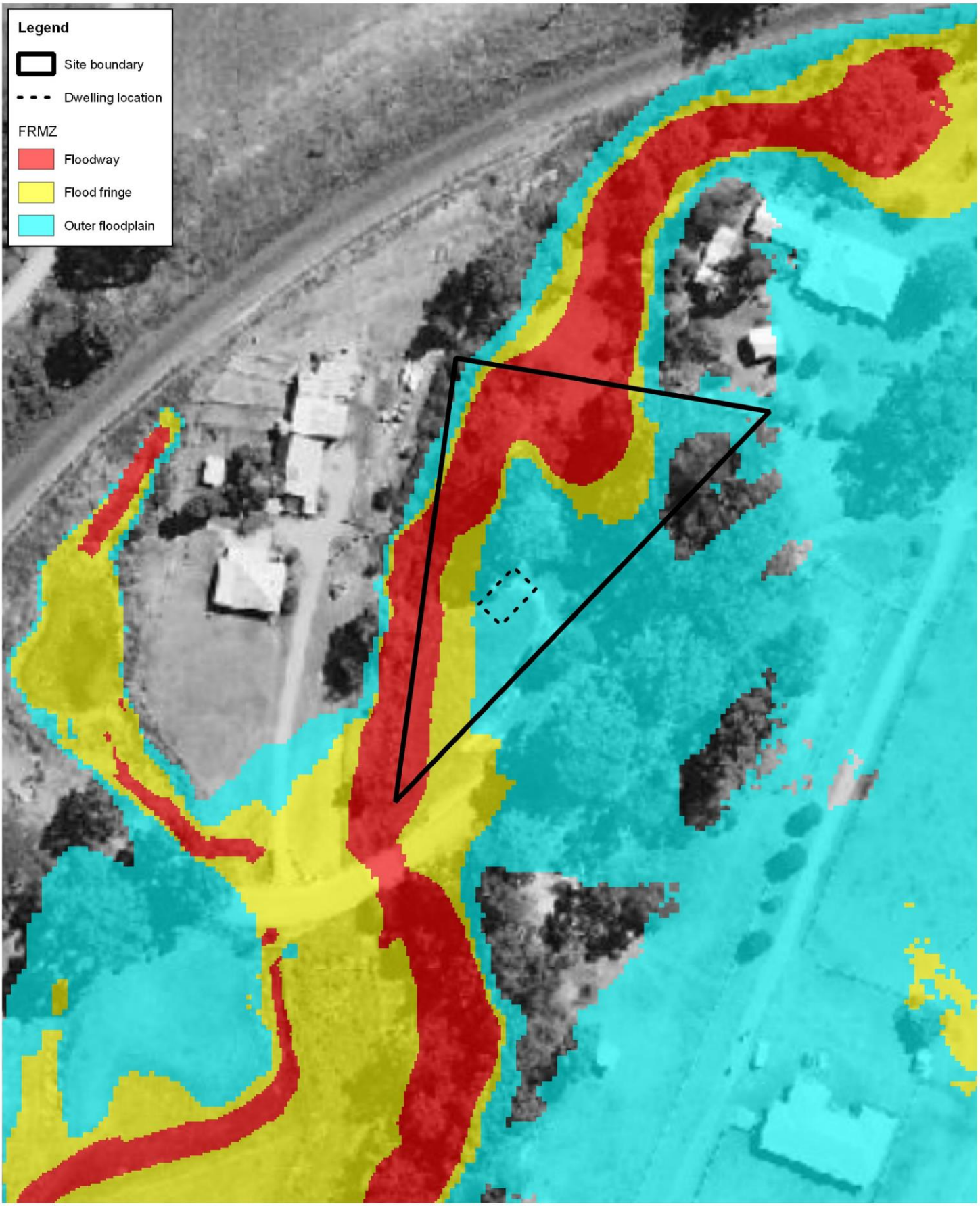


Title:

# Floodplain Risk Management Zones

0 20 40 m

approx. scale

Figure: 11

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# LIMITED GEOTECHNICAL ENGINEERS INVESTIGATION

at

# LOT 144 DP111067 No 142 HILLDALE ROAD, HILLDALE

for

# A & R ALEXANDER

**Project No. 222097.Rev A**

**12th March 2024**

hello@drbengineering.com.au | www.drbengineering.com.au

DRB Consulting Engineers PTY LTD | PO BOX 4105 Kotara East 2305 | 0402 915 549 | ABN 64 625 755 482

**TABLE OF CONTENTS**

## 1. INTRODUCTION

DRB Consulting Engineers (DRB) were engaged by A & R Alexander (owner), to undertake a Limited Geotechnical Engineers Investigation at 142 Hilldale Road, Hilldale.

The purpose of the investigation was to:

- Assess the existing subsurface site conditions within the site.
- Assess the slope stability risk category for the site in accordance with the methodology set out in Australian Geomechanics Society "Practice Note Guidelines for Landslide Risk Management 2007".
- Determine the site classification for the site in accordance with AS2870 "Residential Slabs and Footings".
- Provide footing recommendations for the proposed development.

## 2. EXISTING SITE DESCRIPTION

The site is Lot 144 DP1110671 No 142 Hilldale Road, Hilldale and is zoned RU1 – Primary Production. The site is bound by Hilldale Road to the southeast and by existing rural lots to the remaining sides.

At the time of the investigation, the site was a vacant undeveloped lot with no building structures present. Vegetation across the site consisted of a sparse grass groundcover and isolated scattered intermediate to mature trees. Site Slopes were approximately 2-3% across the proposed building envelope, sloping down in a general north to northeast direction. Additional site features include a "washout" area adjacent to the existing watercourse traversing the site, local surface slopes in this area were up to 30%.

**There was no evidence of Slope Instability or Soil Creep observed during the site investigation.**

The location of fieldwork and existing site conditions can be seen in Photographs 1 – 3 below and on the Site Plan within and in the Attachments section of this report.

Photograph 1 – Looking south across the proposed building envelope

Photograph 2 – Looking west across the proposed building envelope

Photograph 3 – Taken from the northern corner of the site looking across the existing creek "washout" area in the foreground and proposed building envelope in the background.

## 3. PROPOSED DEVELOPMENT

The proposed development consists of the construction of a new residential dwelling. Architectural drawings were provided to DRB prior to the site investigation to aid in the geotechnical assessment.

**The site is deemed suitable for such the development depicted in the supplied drawings.**

## 4. DESKTOP STUDY

Prior to committing resources to a field investigation, a desktop study was undertaken to understand any historical or recorded information that may be useful in the geotechnical investigation, or the proposed development itself. This investigation consisted of a review of:

- Sydney Basin 1 : 500,000 series Geology Mapping published by the Department of Mines NSW.
- Office of Environmental and Heritage Soil and Landscape eSpade Portal.

### 4.1 GEOLOGICAL FORMATION

Reference to the 1:500 000 Sydney Basin Geological Map Series Sheet SI 56-1 published by Department of Mines NSW indicates that the site lies within the Wallaringa geological formation.

The Wallaringa Formation from the Carboniferous Period consists largely of Conglomerate, tuff, and tuffaceous sandstone.

### 4.2 SOIL LANDSCAPE

Reference to the Office of Environmental and Heritage Soil and Landscape eSpade portal indicates that the site lies within the Hilldale Soil Landscapes.

The Hilldale Landscape is characterised by undulating to rolling hills on Carboniferous sediments in the Paterson Mountains region. Topographically, the Hilldale Landscape contains slope gradients between 5-15% on elevations ranging between 70 – 130m. Soils consist of moderately deep (70->130cm) well to imperfectly drained yellow Soloths with some shallow (<50cm), well-drained yellow Podzolic soils on crests. The Hilldale Landscape consists of predominately cleared tall containing spotted gum, grey box, red gum and some grey ironbark.

## 5. FIELDWORK

The fieldwork investigation was undertaken on Friday, 24th November 2023. The fieldwork comprised a visual assessment of the site and surrounding area, the excavation of 5 boreholes and the driving of 5 dynamic cone penetrometers (DCP).

Boreholes BH1 – BH5 were excavated with ø100mm auger via a ute-mounted drill rig to depths up to 5.0m below existing surface levels where they were terminated in weather sandstone and weathered gravelly sandstone.

A U50 undisturbed soil sample was recovered from borehole BH2 at a depth of 2.0 – 3.0m (i.e. the most plastic layer encountered). The sample was used in laboratory analysis for shrink/swell testing. The results can be seen in the Attachment section of this report.

The location of the boreholes and DCPs can be seen in the Site Plan in the Attachments section of this report.

## 6. SUBSURFACE PROFILE

The anticipated natural sub-surface profile, as identified in boreholes BH1 – BH5, can be seen in Table 1 below:

***Table 1: -*** *Subsurface Soil Profile - Boreholes*

| Unit | Soil Layer Encountered | Depth (m) | | | | |
|---|---|---|---|---|---|---|
| | | BH1 | BH2 | BH3 | BH4 | BH5 |
| Unit 1 | FILL/TOPSOIL – Silty Sand, Loam | 0.0 – 0.15 | 0 – 0.35 | 0.0 – 0.15 | 0.0 – 0.50 | 0.0 – 0.10 |
| Unit 2 | Sandy Silt | 0.15 – 0.4- | | 0.15 – 0.65 | | 0.10 – 0.40 |
| Unit 3 | Clayey Silty Sand | | 0.35 – 0.65 | | 0.50 – 1.0 | 0.4 – 0.5 |
| Unit 4 | Extremely Weathered Sandstone | 0.4 – 1.5 | 0.65 – 1.0 | 0.65 – 1.0 | 1.0 – 1.5 | 0.5 – 1.0 |
| Unit 5 | Weathered Sandstone – with and without Gravel | 1.5 – 5.0 (Terminated) | 1.0 – 5.0 (Terminated) | 1.0 – 5.0 (Terminated) | 1.5 – 5.0 (Terminated) | 1.0 – 2.0 (Terminated) |

The Engineering Logs of BH1 – BH5 can be seen in the Attachments section of this report.

Dynamic Cone Penetrometers P1 – P5 were driven across the site to help approximate the consistency of the Soil Layers encountered, as well as to approximate allowable soil bearing pressures. The penetrometer probes indicated that the following subsurface bearing capacities could be expected at the associated depth:

- 50kPa – at depths > 0.2m below encountered topsoil and fill material.
- 100kPa – at depths > 0.4m below the existing surface level
- 200kPa – within extremely weathered sandstone at a depth of 0.7m; and
- 300kPa in weathered sandstone at depths >1.2m below the existing surface level

It should be noted that the provided bearing capacities are approximate only and relevant only to the individual DCPs locations. Having not been determined using a visual assessment, this information is subject to confirmation at the time of construction. Actual soil compositions and allowable soil bearing capacities may vary. Please refer to Section 7.2 & 8.4 of this report for recommendations for proposed footing system.

**DRB should be consulted immediately for direction and recommendations if site conditions encountered during bulk excavation differ to those identified and described above.**

## 7. SLOPE STABILITY ASSESSMENT

### 7.1 RISK ASSESSMENT

Based on our limited geotechnical investigation, and with reference to the guidance provided in Australian Geomechanics Society's "Practice Note Guidelines for Landslide Risk Management 2007" (AGS Guidelines), we consider the potential landslide hazards associated with the site (in both the existing and proposed development state) to be the following:

**Existing Site Conditions**

*Hazard 1* - *Stability of the natural subsurface soils*

**Proposed Development Stage (including design in accordance with recommendations of this report)**

*Hazard 2* - *Stability of the natural subsurface soils*

A qualitative risk assessment was undertaken to assess the likelihood of each of the potential Hazards outlined above and determine the consequences to property and life, should the landslide occur. Table 2 below summarises the qualitative assessment.

The AGS Guideline suggests the following implications for each of the risk categories determined for this proposed development as a result of the qualitative assessment:

**Moderate** May be tolerated in certain circumstances but required investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce the risk to Low risk should be implemented as soon as possible.

**Low** Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.

**Very Low** Acceptable. Manage by normal slope maintenance procedures.

Where the suggested tolerable risk to life can be seen below.

| ***Situation*** | ***Suggested Tolerable Loss of Life Risk for the person most at risk*** |
|---|---|
| *Existing Slope / Existing Development* | *$10^{-4}$ / annum* |
| *New Constructed Slope / New Development / Existing Landslide* | *$10^{-5}$ / annum* |

| **Hazard** | **Likelihood** | **Consequence to the Existing Site Conditions** | **Risk to Property** | **Risk to Life** |
|---|---|---|---|---|
| ***1*** | Unlikely | Minor | **Low** | **NA*** |
| **Hazard** | **Likelihood** | **Consequence to the Proposed Development** | **Risk to Property** | **Risk to Life** |
| ***2*** | Unlikely | Minor | **Low** | **5 x $10^{-7}$ (OK)** |

*Table 2: - Qualitative Assessment – Risk to Property and Risk to Life*

** Note that no development in the existing site conditions results in zero risk to life.*

## 7.2 DEVELOPMENT RECOMMENDATIONS

Due to the subjective nature of risk assessments, the limitations on geotechnical investigations, and the numerous elements which can affect a site, the risk of instability for a site and/or proposed development cannot be completely removed.

In order to reduce the risks associated with slope instability to a level that can be tolerated by all stakeholders, the following development recommendations should be adopted. If any of these recommendations are not adopted, the risk assessment undertaken above is not considered accurate, and would need to be recalculated taking in to account the added risk.

- Any proposed structure (dwelling, retaining wall, driveway etc) must be designed in accordance with AS2870, and any further recommendations within this report. The proposed structure must be founded below any topsoil and/or fill material in natural material of suitable bearing capacity
- It is recommended that the existing "washout" area upslope of the proposed dwelling be supported by an appropriately designed retaining wall system to control any localized soil movement. It is noted that these works have no impact on the dwelling location nominated on the attached site plan and are simply to manage local surface slopes to minimize long term maintenance.
- Drainage behind retaining walls (both internal and external) must be carefully chosen to ensure subsurface flows are intercepted, collected and disposed of appropriately. The surface water runoff from all new impervious areas (roof and pavements) must be collected and conveyed to a point of discharge downstream of the proposed dwelling. Runoff must be designed to fall water to the outlets.
- Any proposed footing system must be designed in accordance with AS2870, and any further recommendations within this report.
- Without written approval from a geotechnical engineer, temporary batters must adhere to the guidelines provided in Part 3.1.1 'Earthworks' of the National Construction Code, for both cut and fill excavations. In no circumstances should the temporary batters exceed 2m without additional advice from a geotechnical engineer.
- Excavations should not be proposed unless substantial periods of dry weather have been forecast.
- Temporary batters should be tailed out to avoid ponding. If ponding of water occurs at the base of the batter, even during minor rainfall events, the toe can become saturated and accelerate any failure of the batter. Furthermore, cut off swales should be provided at the top of all temporary batters to direct runoff away from batter slope.
- Temporary shoring should be readily available onsite. In the event that unexpected wet weather occurs, or generally if the excavated batter appears to be showing signs of failure, shoring supports should be installed to ensure ongoing temporary stability of the excavation during construction.
- Site filling must be placed in accordance with AS3798 - Guidelines on earthworks for commercial and residential developments.
- The guidelines for Hillside Construction, as outlined in Appendix G of the AGS guidelines (and attached) should be adopted wherever practicable.

## 8. AS2870 – 2011 | SITE CLASSIFICATION

### 8.1 GENERAL

Section 2 of AS2870-2011 'Residential Slabs and Footings' provides guidance on classifying a site. It describes the Site Classification as being a combination of the expected ground surface movement and the depth to which this movement extends. However, the final classification of a site is either based on the soil reactivity or can be classified as a **Class P**, should other factors dictate.

### 8.2 SITE CLASSIFICATION BASED ON SOIL REACTIVITY

Classification of sites where ground movement is predominantly due to soil reactivity under normal moisture conditions shall be classified based on the expected level of ground movement. Table 4 below describes each of the Site Classification Classes.

***Table 4: -*** *Subsurface Soil Profile - Boreholes*

| Class | Soil Layer Encountered | $Y_s$ (mm) |
|---|---|---|
| A | Most sand and rock sites with little or no ground movement from moisture changes. | N/A |
| S | Slightly reactive clay sites, which may experience only slight ground movement from moisture changes. | 0 – 20 |
| M | Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes. | 20 – 40 |
| H1 | Highly reactive clay sites, which may experience high ground movement from moisture changes. | 40 – 60 |
| H2 | Highly reactive clay sites, which may experience very high ground movement from moisture changes. | 60 – 75 |
| E | Extremely reactive sites, which may experience extreme ground movement from moisture changes. | > 75 |

$Y_s$ – Refers to Characteristic Surface Movement as per Section 2.2.3 of AS2870

For Classes M, H1, H2 and E, further classification may be required, based on the depth of the expected moisture change. For sites with deep-seated moisture changes characteristic of dry climates and corresponding to a design depth of suction change ($H_s$) equal to or greater than 3 m, the classification shall be M-D, H1-D, H2-D or E-D as appropriate.

## 8.3 SITE CLASSIFICATION OF OTHER SITES (CLASS P)

Sites with inadequate bearing strength or where ground movement may be significantly affected by factors other than reactive soil movements due to normal moisture conditions shall be classified as **Class P**. Class P sites include soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions and sites that cannot be classified in accordance with Clause 2.1.2 of AS2870.

A site shall be classified as **Class P** if—

- the bearing strength is less than that specified in Clause 2.4.5 of AS2870;
- excessive foundation settlement may occur due to loading on the foundation;
- the site contains uncontrolled or controlled fill as identified in Clause 2.5.3 of AS2870;
- the site may be subject to mine subsidence, landslip, collapse activity or coastal erosion;
- the site may be subject to moisture changes due to site conditions more severe than the normal site conditions described in Clause 1.3.2; or
- the site may be subject to other factors resulting in foundation movement beyond the reactive soil movements resulting from moisture changes due to the normal site conditions described in Clause 1.3.2.

## 8.4 SITE CLASSIFICATION

The site, as presented at the time of investigation, is classified as **Class P** due to:

- The presence of >0.4m of uncontrolled fill material in some areas of the site
- The presence of mature trees across the site creating adverse subsurface moisture conditions.

Proposed footings should be designed for a **Class M (Moderately Reactive)** soil in accordance with the requirements of AS2870 founded in natural subsurface material of suitable bearing capacity (refer to section 6 for bearing capacity and associated depths).

Please refer to Section 7.2 for any additional requirements for footings based on the slope stability risks for the site.

The characteristic surface movement **Ys** was estimated as **23.3mm**. Laboratory test results and calculation spreadsheets can be seen in the Attachment section of this report.

It should be noted that, the Site Classification values calculated above are based on the existing site conditions at the test location only and may vary throughout the site subject variations in soil profile depths, depth to rock and depths of fill material.

Variable moisture conditions can also have a significant effect on the site classification. The moisture variations may be related to poor site drainage, leaking services or the effect of tree roots, both existing and proposed.

The attached CSIRO sheet BTF18 provides recommendations and guidance to the homeowner on how to manage moisture conditions and therefore minimise the extent of soil movement. These guidelines should be adopted where practicable.

## 9. REPORT LIMITATIONS

The information contained within this report, including interpretation of site conditions and project specific recommendations have been determined based on the limited and specific sampling and testing during the site investigation.

The existing subsurface site soil conditions can vary significantly across a site, and over periods of time. If conditions are encountered during construction that are not representative of the information contained within this report, please contact DRB Consulting Engineers immediately for site reassessment and/or modifications to the recommendations provided above.

Should you require any further advice or clarification of any of the above, please do not hesitate to contact us.

Yours faithfully

DRB CONSULTING ENGINEERS PTY LIMITED

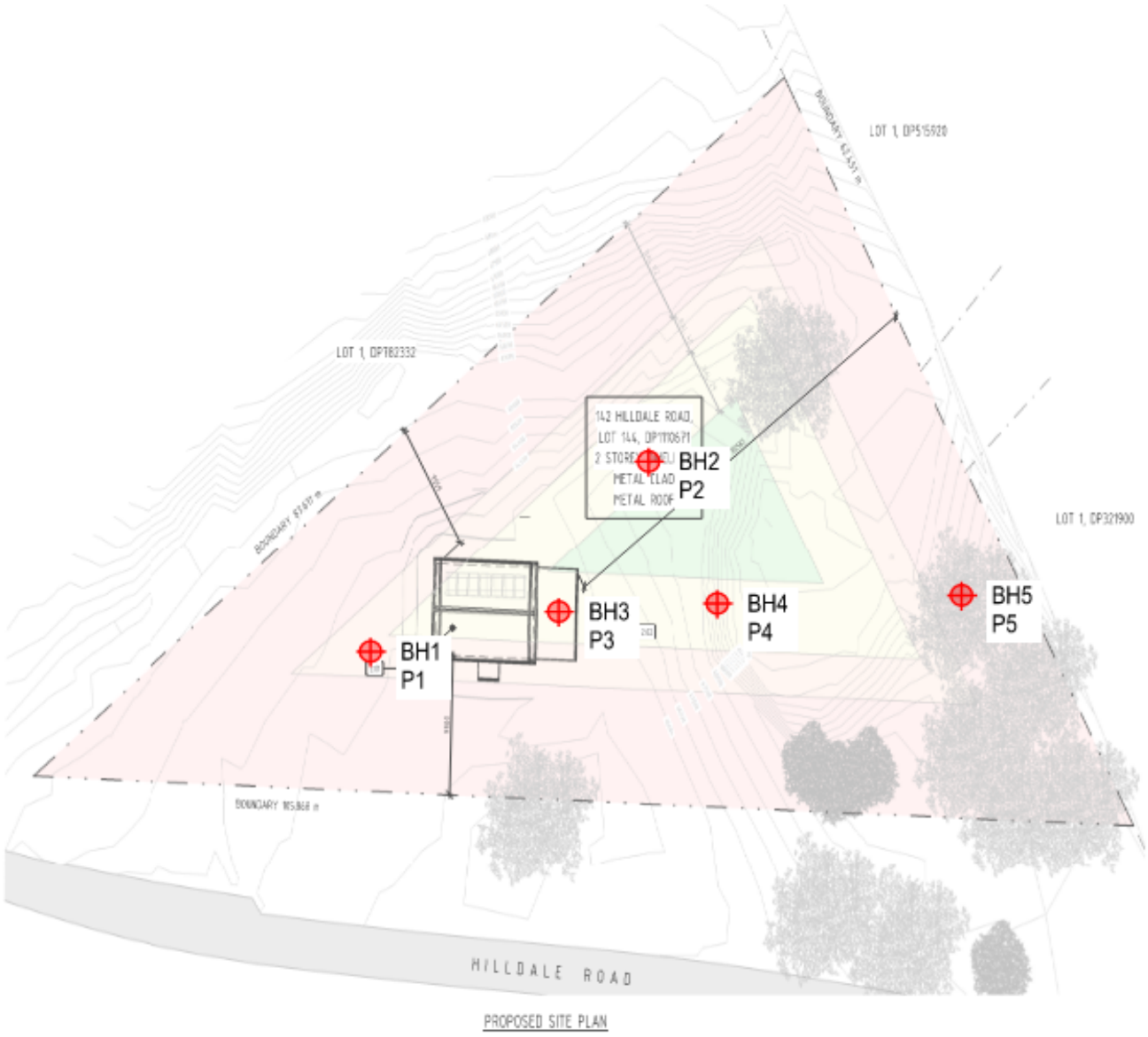
**Chris Smith**
BEng (Civil) CPEng MIE Aust

**Attachments**

(i) Site Plan
(ii) Engineering Log Sheets
(iii) Dynamic Cone Penetrometer Probe Logs
(iv) Laboratory Test Results
(v) Slope - *Practice Note Guidelines for Landslide Risk Management 2007*
(vi) Site Class - CSIRO BFT18 - Foundation Maintenance and Footing Performance
(vii) General Notes

## ATTACHMENTS

# Site Plan




PROPOSED SITE PLAN

BH - 100mm CONTINUOUS FLIGHT AUGER
P - DYNAMIC CONE PENETROMETER

| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | | |

# Engineering Log

DRB CONSULTING ENGINEERS

| BH1 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| 0 to 150 | TOPSOIL, SILTY SAND, Loam | BR | D | D |
| 150 to 400 | SANDY SILT, some Gravel | G-BR | D | D |
| 400 to 1500 | EXTREMELY WEATHERED SANDSTONE, Augers to SILTY SANDY CLAY | O | VST | D |
| 1500 to 5000 | WEATHERED SANDSTONE, Silty, some gravel | O | | D |
| 5000 | Terminated in WEATHERED SANDSTONE, Silty, some gravel | | | |
| | | | | |
| | | | | |
| | | | | |

Groundwater: Nil mm Sample: -

| BH2 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| 0 to 50 | FILL, topsoil, silty sand | BR | D | D |
| 50 to 350 | FILL, silty sand | BR | D | D |
| 350 to 650 | CLAYEY SILTY SAND, with tree roots | Lt-G | D | D |
| 650 to 1000 | EXTREMELY WEATHERED SANDSTONE, Silty | O | | D |
| 1000 to 1500 | WEATHERED SANDSTONE, some Gravel | O | | D |
| 5000 | EXTREMELY WEATHERED SANDSTONE, some CLAY Bands | O-G | VST-VD | D-SM |
| | Terminated in WEATHERED SANDSTONE | O | | D |
| | | | | |

Groundwater: Nil mm Sample: Remould u50 - 2.0/3.0m

| BH3 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| 0 to 150 | FILL, topsoil, silty sand | BR | D | D |
| 150 to 600 | CLAYEY SANDY SILT | Lt-G-BR | D-VD | D |
| 600 to 650 | SILTY SANDY CLAY | G-BR | VST | D-SM |
| 650 to 1000 | EXTREMELY WEATHERED SANDSTONE, Silty | O | | D |
| 1000 to 1500 | WEATHERED SANDSTONE, Silty | O | | D |
| 5000 | EXTREMELY WEATHERED SANDSTONE, with CLAY Bands | O-G | VST | D-SM |
| | Terminated in WEATHERED SANDSTONE | O | | D |
| | | | | |

Groundwater: Nil mm Sample: -

Additional comments:

## Legend

| | |
|---|---|
| **Colour:** | Red (R), Yellow (Y), Pink (P), Orange (O), White (W), Grey (G), Brown (Br), Black (Bl), Cream (C), Mottled (Mt), Dark (Dk), Light (Lt) |
| **Relative Density / Consistency** | Very Soft (VS), Soft (S), Firm (F), Stiff (St), Very Stiff (VSt), Hard (H), Very Loose (VL), Loose (L), Medium Dense (MD), Dense (D), Very Dense (VD) |
| **Moisture:** | Dry (D), Slightly Moist (SM), Moist (M), Wet (W), Saturated (S) |

| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | Test Location: | See Site Plan |

# Engineering Log

| BH4 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| 0 to 100 | FILL, topsoil, silty sand | BR | D | D |
| 100 to 500 | FILL, silty sand | BR | D | D |
| 500 to 1000 | CLAYEY SILTY SAND, with tree roots | Lt-G | D | D |
| 1000 to 1500 | EXTREMELY WEATHERED SANDSTONE, Silty | O | | D |
| 1500 to 2000 | WEATHERED SANDSTONE, some Gravel | O | | D |
| 5000 | EXTREMELY WEATHERED SANDSTONE, some CLAY Bands | O-G | VST-VD | D-SM |
| | Terminated in WEATHERED SANDSTONE | O | | D |
| | | | | |

Groundwater: Nil mm Sample: -

| BH5 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| 0 to 100 | FILL, topsoil, silty sand | BR | D | D |
| 100 to 400 | CLAYEY SANDY SILT | Lt-G | D | D |
| 400 to 500 | SILTY SANDY CLAY | G-BR | ST | D |
| 500 to 1000 | EXTREMELY WEATHERED SANDSTONE, Silty | O | | D |
| 1000 to 2000 | WEATHERED SANDSTONE, Silty | O | | D |
| 2000 | Practical Refusal in WEATHERED SANDSTONE, Silty | | | |
| | | | | |
| | | | | |

Groundwater: Nil mm Sample: -

| BH6 | 100mm CONTINUOUS FLIGHT AUGERED BOREHOLE | | | |
|---|---|---|---|---|
| **Depth (mm)** | **Material** | **Colour** | **Density** | **Moisture** |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Sample: -

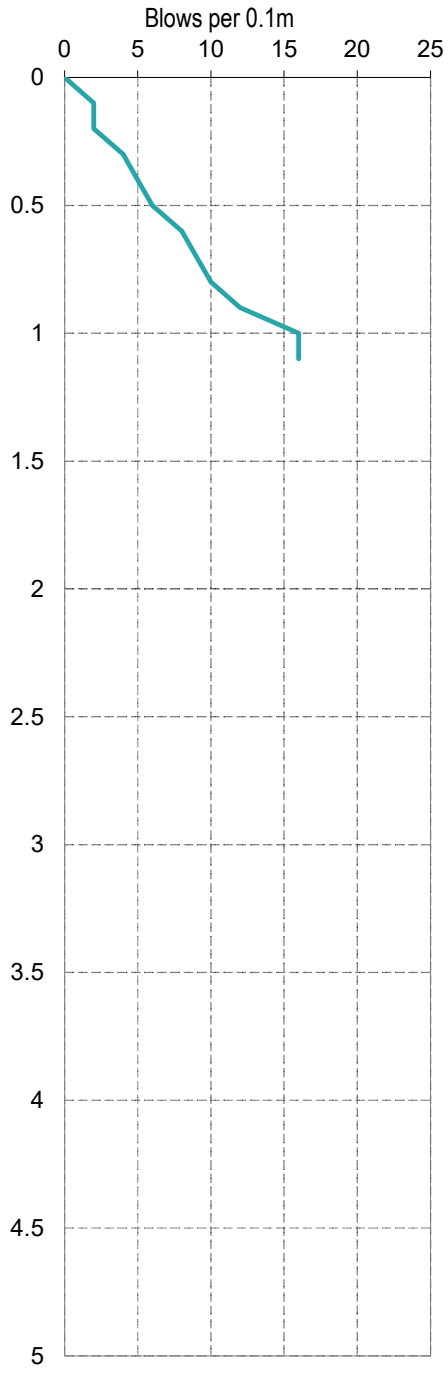
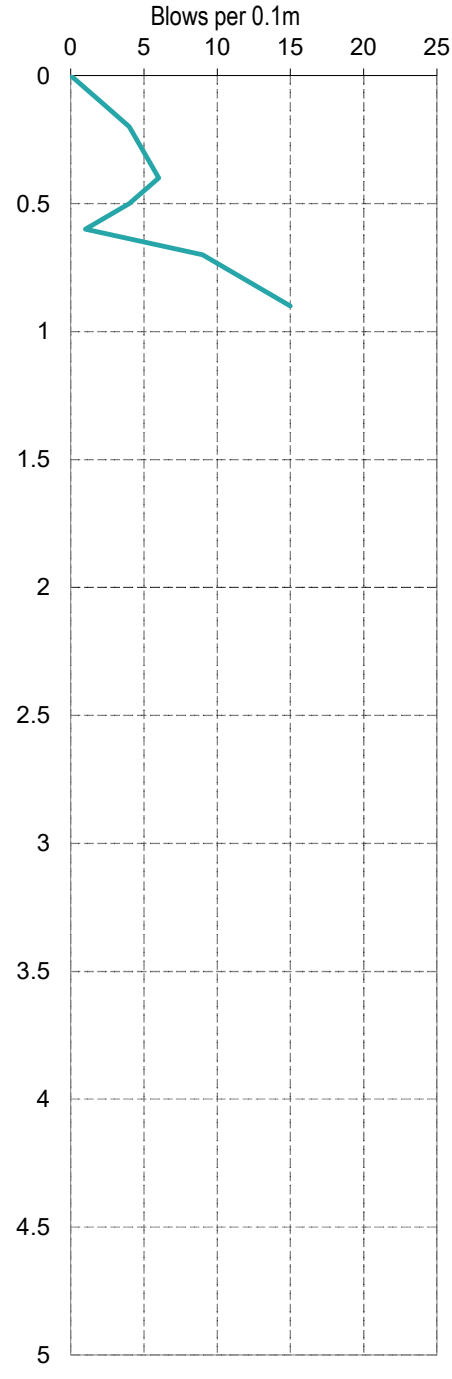
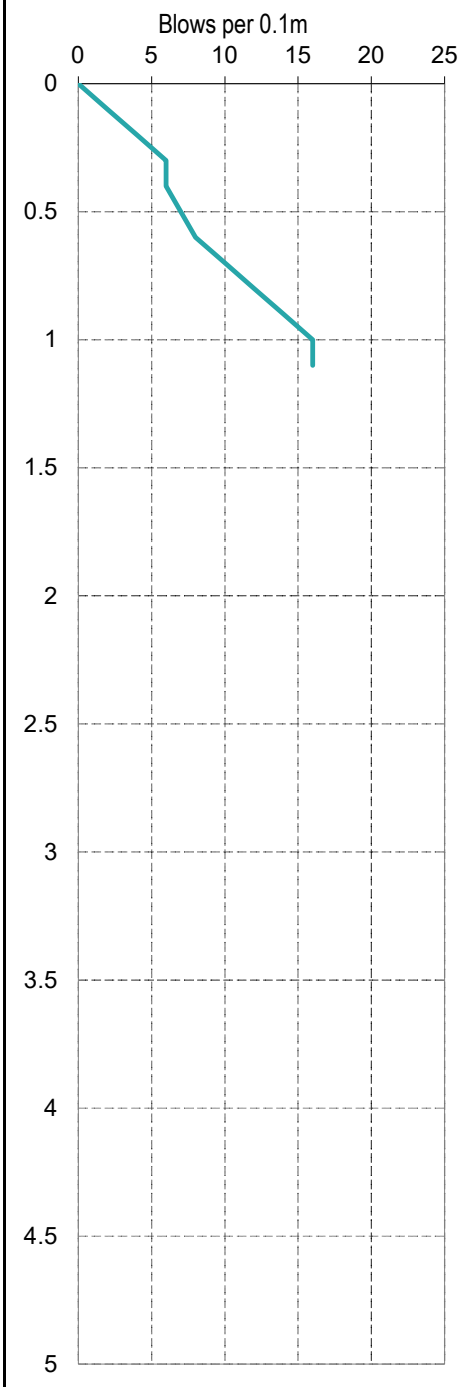
Additional comments:

## Legend

| | |
|---|---|
| **Colour:** | Red (R), Yellow (Y), Pink (P), Orange (O), White (W), Grey (G), Brown (Br), Black (Bl), Cream (C), Mottled (Mt), Dark (Dk), Light (Lt) |
| **Relative Density / Consistency** | Very Soft (VS), Soft (S), Firm (F), Stiff (St), Very Stiff (VSt), Hard (H), Very Loose (VL), Loose (L), Medium Dense (MD), Dense (D), Very Dense (VD) |
| **Moisture:** | Dry (D), Slightly Moist (SM), Moist (M), Wet (W), Saturated (S) |

| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | Test Location: | See Site Plan |

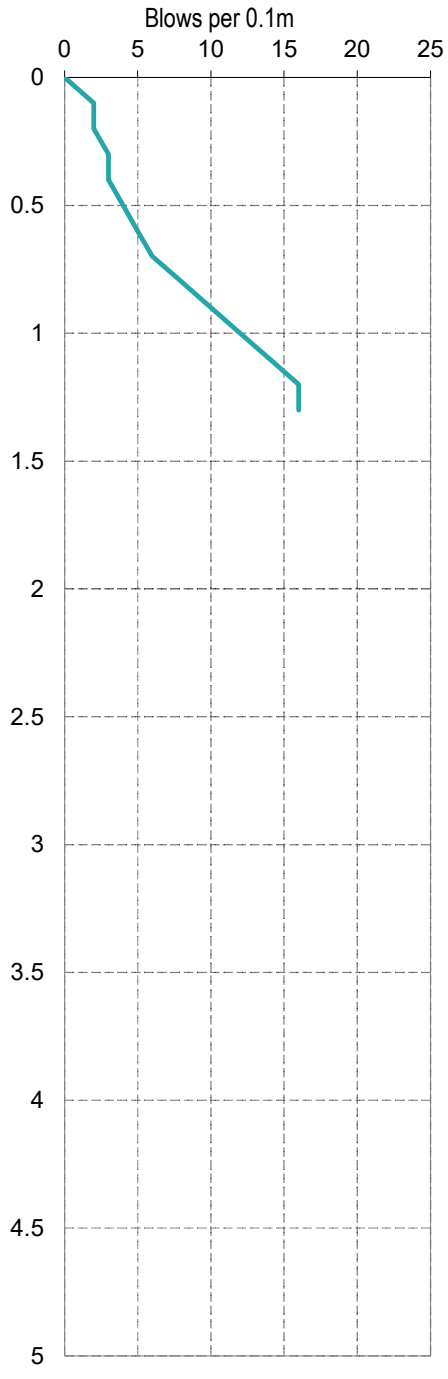
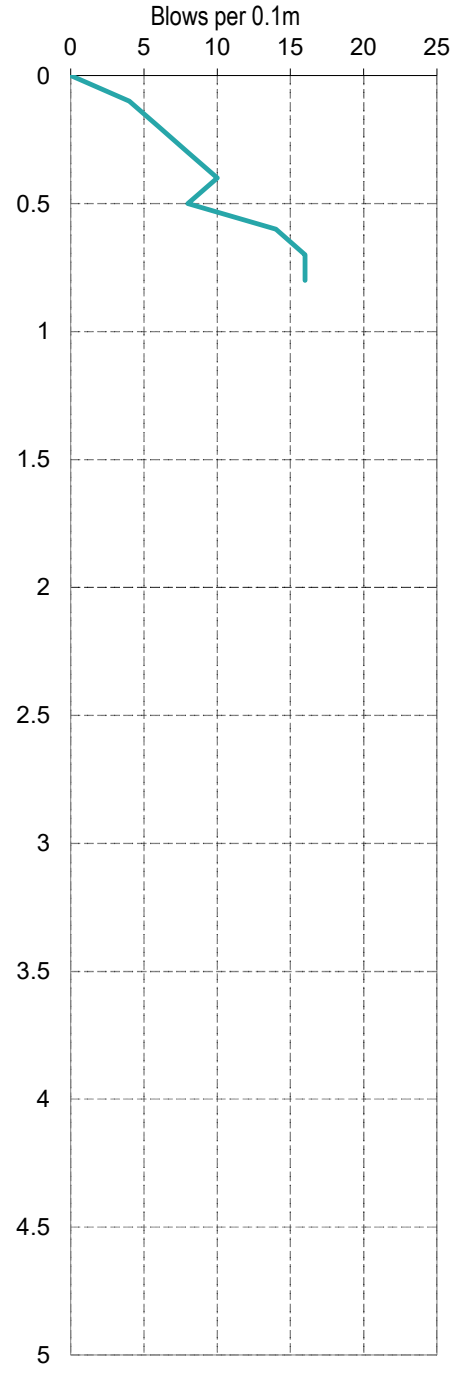
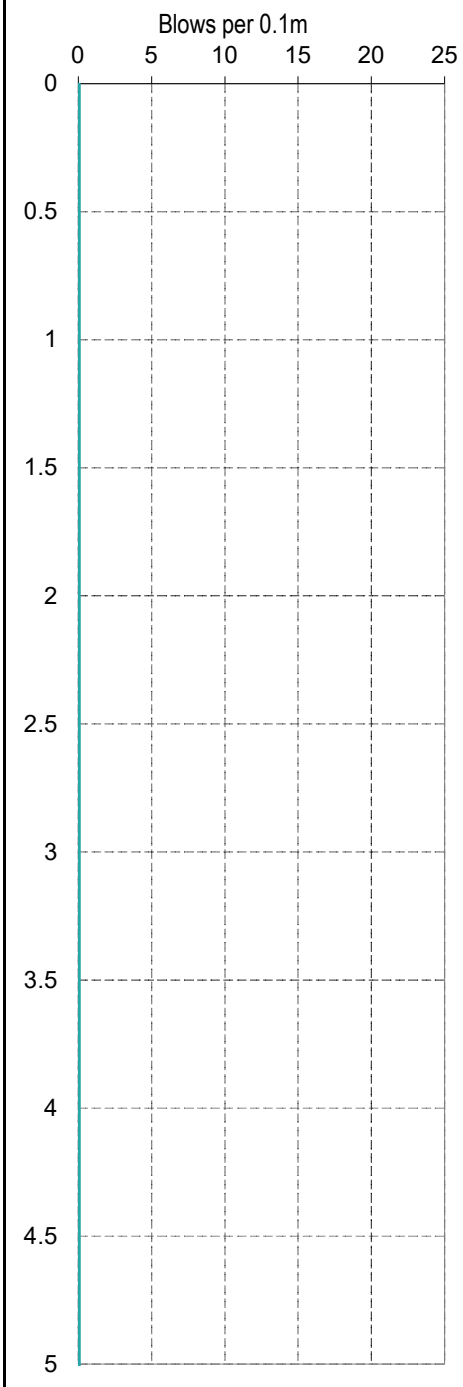
# Dynamic Cone Penetrometer Log

| Penetrometer: P1 | Penetrometer: P2 | Penetrometer: P3 |
|---|---|---|
|  |  |  |
| Terminated @ 1.1 | Terminated @ 0.9 | Terminated @ 1.1 |



| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | Test Location: | See Site Plan |

# Dynamic Cone Penetrometer Log

| Penetrometer: P4 | Penetrometer: P5 | Penetrometer: P6 |
|---|---|---|
|  |  |  |
| Terminated @ 1.3 | Terminated @ 0.8 | |



| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | Test Location: | See Site Plan |

# Shrink Swell Calculations

| | |
|---|---|
| Borehole / Testpit | **BH2** |
| Depth | *Remould u50 - 2.0/3.0m* |
| Date Tested | 26/11/2023 |
| Pocket Penetrometer (Before) | - |
| Pocket Penetrometer (After) | - |
| **Shrinkage** - Moisture Content | 17.64% |
| **Shrinkage** | **2.55%** |
| **Swell** - Moisture Content (Before) | 18.06% |
| **Swell** - Moisture Content (After) | 16.68% |
| **Swell** | **0.00%** |
| **Shrink Swell Index (Iss)** | **1.41** |

| | |
|---|---|
| **Change in Soil Suction (Δu)** | **1.2** |
| **Suction Depth (Hs)** | **2.3** |

| | |
|---|---|
| **Characteristic Surface Movement (Ys)** | **23.3** |

| | |
|---|---|
| **Change in Soil Suction (Δu)** | **0.6** |
| **Extra Suction Change (Δu base)** | **0.43** |
| **Suction Depth (Ht)** | **3.6** |
| **Depth of Soil Cracking** | **3.6** |

| | |
|---|---|
| **Maximum Potential Surface Movement (Ytmax)** | **16.5** |

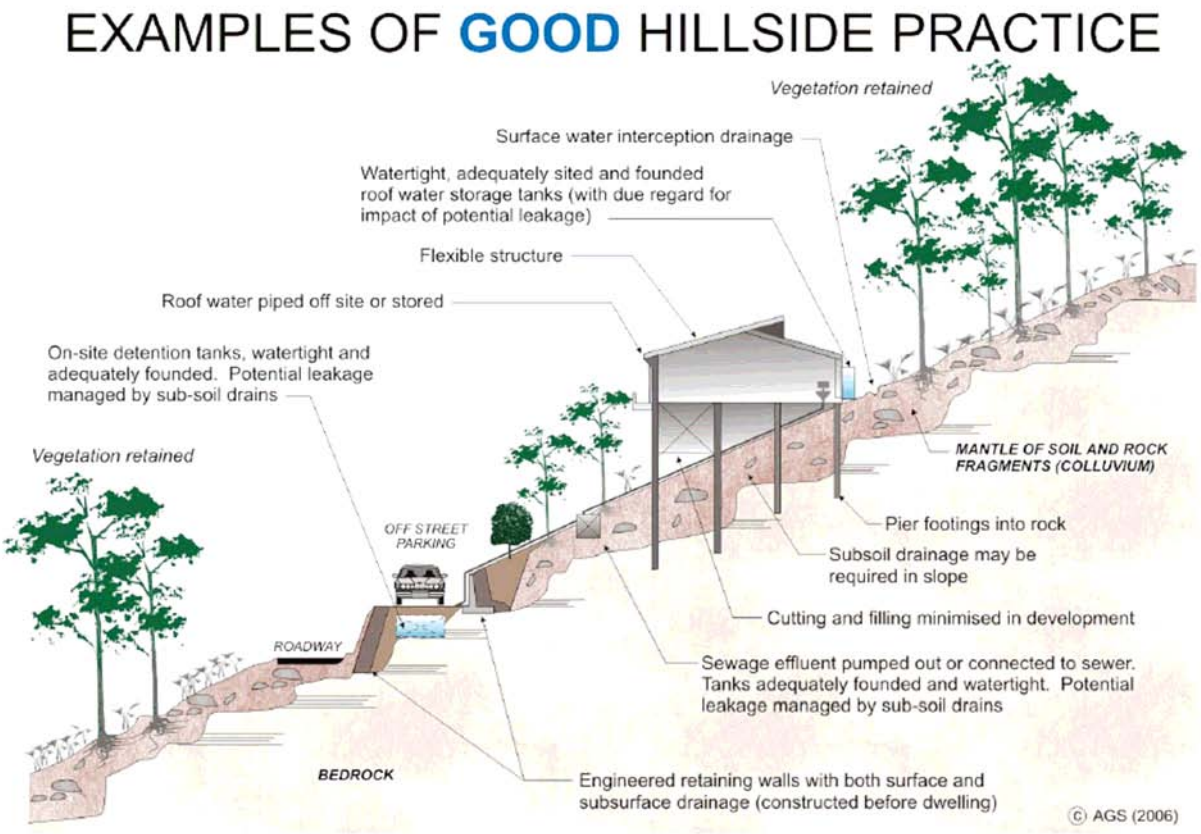
Additional comments:

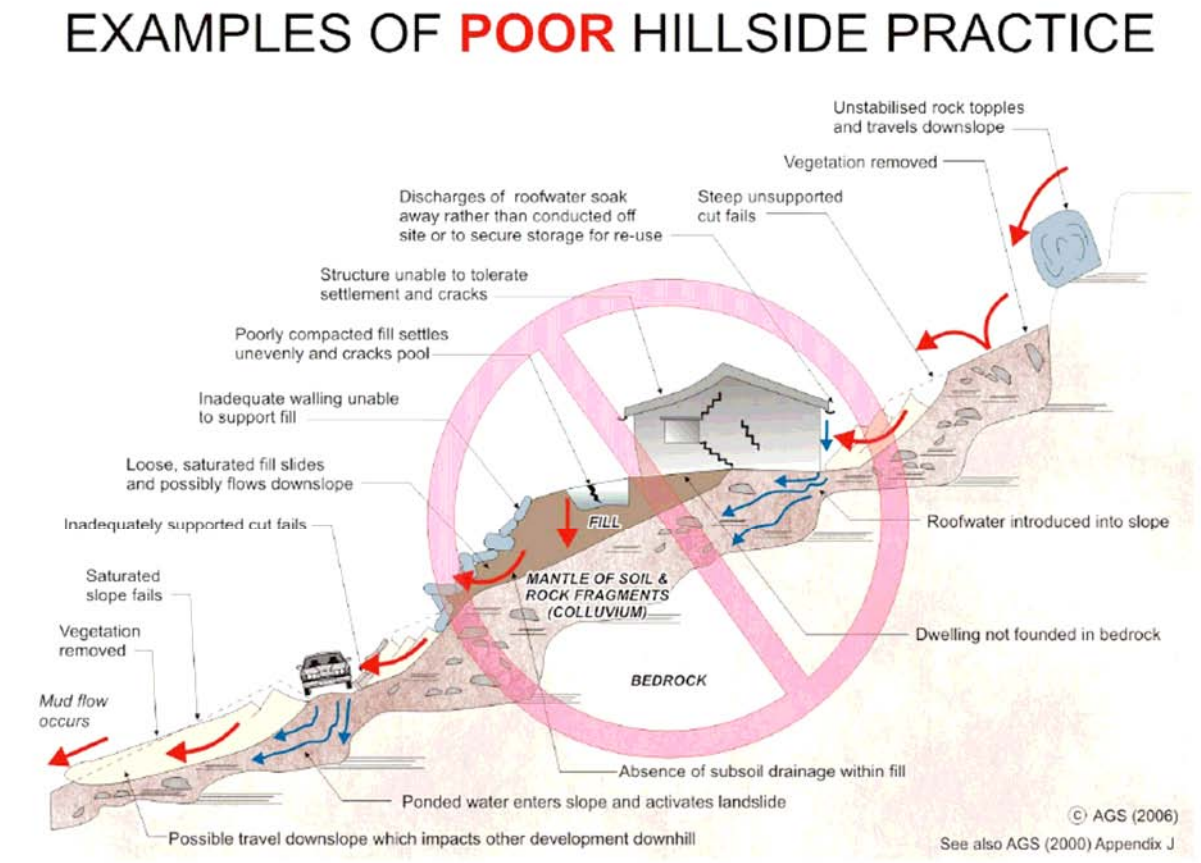
Field Moisture Content=9.9%

| | | | |
|---|---|---|---|
| Project Number: | 222097 | Site Address: | Lot 144 DP 1110671 No.142 Hilldale Road, Hilldale |
| Report Date: | 14/12/2023 | Fieldwork By: | Richard Badior |
| Fieldwork Date: | 24/11/2023 | Test Location: | See Site Plan |

# APPENDIX G - 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.<br>Consider use of split levels.<br>Use decks for recreational areas where appropriate. | Floor plans which require extensive cutting and filling.<br>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.<br>Council specifications for grades may need to be modified.<br>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.<br>Support with engineered retaining walls or batter to appropriate slope.<br>Provide drainage measures and erosion control. | Large scale cuts and benching.<br>Unsupported cuts.<br>Ignore drainage requirements |
| FILLS | Minimise height.<br>Strip vegetation and topsoil and key into natural slopes prior to filling.<br>Use clean fill materials and compact to engineering standards.<br>Batter to appropriate slope or support with engineered retaining wall.<br>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.<br>Block natural drainage lines.<br>Fill over existing vegetation and topsoil.<br>Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill. |
| ROCK OUTCROPS & BOULDERS | Remove or stabilise boulders which may have unacceptable risk.<br>Support rock faces where necessary. | Disturb or undercut detached blocks or boulders. |
| RETAINING WALLS | Engineer design to resist applied soil and water forces.<br>Found on rock where practicable.<br>Provide subsurface drainage within wall backfill and surface drainage on slope above.<br>Construct wall as soon as possible after cut/fill operation. | Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork.<br>Lack of subsurface drains and weepholes. |
| FOOTINGS | Found within rock where practicable.<br>Use rows of piers or strip footings oriented up and down slope.<br>Design for lateral creep pressures if necessary.<br>Backfill footing excavations to exclude ingress of surface water. | Found on topsoil, loose fill, detached boulders or undercut cliffs. |
| SWIMMING POOLS | Engineer designed.<br>Support on piers to rock where practicable.<br>Provide with under-drainage and gravity drain outlet where practicable.<br>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.<br>Discharge to street drainage or natural water courses.<br>Provide general falls to prevent blockage by siltation and incorporate silt traps.<br>Line to minimise infiltration and make flexible where possible.<br>Special structures to dissipate energy at changes of slope and/or direction. | Discharge at top of fills and cuts.<br>Allow water to pond on bench areas. |
| SUBSURFACE | Provide filter around subsurface drain.<br>Provide drain behind retaining walls.<br>Use flexible pipelines with access for maintenance.<br>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.<br>Storage tanks should be water-tight and adequately founded. | Discharge sullage directly onto and into slopes.<br>Use absorption trenches without consideration of landslide risk. |
| EROSION CONTROL & LANDSCAPING | Control erosion as this may lead to instability.<br>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.<br>Where structural distress is evident see advice.<br>If seepage observed, determine causes or seek advice on consequences. | |


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
© AGS (2006)


EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
Inadequately supported cut fails
FILL
Roofwater introduced into slope
Saturated slope fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Vegetation removed
Dwelling not founded in bedrock
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
© AGS (2006)
Possible travel downslope which impacts other development downhill
See also AGS (2000) Appendix J

# PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

## APPENDIX C: LANDSLIDE RISK ASSESSMENT

## QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

### *QUALITATIVE MEASURES OF LIKELIHOOD*

| Approximate Annual Probability | | Implied Indicative Landslide Recurrence Interval | | Description | Descriptor | Level |
|---|---|---|---|---|---|---|
| Indicative Value | Notional Boundary | | | | | |
| $10^{-1}$ | $5x10^{-2}$ | 10 years | 20 years | The event is expected to occur over the design life. | ALMOST CERTAIN | A |
| $10^{-2}$ | $5x10^{-3}$ | 100 years | 200 years | The event will probably occur under adverse conditions over the design life. | LIKELY | B |
| $10^{-3}$ | $5x10^{-4}$ | 1000 years | 2000 years | The event could occur under adverse conditions over the design life. | POSSIBLE | C |
| $10^{-4}$ | $5x10^{-5}$ | 10,000 years | 20,000 years | The event might occur under very adverse circumstances over the design life. | UNLIKELY | D |
| $10^{-5}$ | $5x10^{-6}$ | 100,000 years | 200,000 years | The event is conceivable but only under exceptional circumstances over the design life. | RARE | E |
| $10^{-6}$ | | 1,000,000 years | | The event is inconceivable or fanciful over the design life. | BARELY CREDIBLE | F |

**Note:** (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

### *QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY*

| Approximate Cost of Damage | | Description | Descriptor | Level |
|---|---|---|---|---|
| Indicative Value | Notional Boundary | | | |
| 200% | 100% | Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage. | CATASTROPHIC | 1 |
| 60% | 40% | Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage. | MAJOR | 2 |
| 20% | 10% | Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage. | MEDIUM | 3 |
| 5% | 1% | Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works. | MINOR | 4 |
| 0.5% | | Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.) | INSIGNIFICANT | 5 |

**Notes:** (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

## APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

### *QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY*

| LIKELIHOOD | | CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage) | | | | |
|---|---|---|---|---|---|---|
| | **Indicative Value of Approximate Annual Probability** | **1: CATASTROPHIC 200%** | **2: MAJOR 60%** | **3: MEDIUM 20%** | **4: MINOR 5%** | **5: INSIGNIFICANT 0.5%** |
| **A – ALMOST CERTAIN** | $10^{-1}$ | VH | VH | VH | H | M or **L** (5) |
| **B - LIKELY** | $10^{-2}$ | VH | VH | H | M | **L** |
| **C - POSSIBLE** | $10^{-3}$ | VH | H | M | M | **VL** |
| **D - UNLIKELY** | $10^{-4}$ | H | M | **L** | **L** | **VL** |
| **E - RARE** | $10^{-5}$ | M | **L** | **L** | **VL** | **VL** |
| **F - BARELY CREDIBLE** | $10^{-6}$ | **L** | **VL** | **VL** | **VL** | **VL** |

**Notes**: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

### *RISK LEVEL IMPLICATIONS*

| **Risk Level** | | **Example Implications** (7) |
|---|---|---|
| VH | VERY HIGH RISK | Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property. |
| H | HIGH RISK | Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property. |
| M | MODERATE RISK | May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable. |
| **L** | LOW RISK | Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required. |
| **VL** | VERY LOW RISK | Acceptable. Manage by normal slope maintenance procedures. |

**Note:** (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

# FOUNDATION MAINTENANCE AND FOOTING PERFORMANCE

## Understanding and preventing soil-related building movement

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

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

## SOIL TYPES

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

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. Table 1 below is a reproduction of Table 2.1 from Australian Standard AS 2870-2011, Residential slabs and footings.

## CAUSES OF MOVEMENT

### SETTLEMENT DUE TO CONSTRUCTION

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

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

These problems may be the province of the builder and should be taken into consideration as part of the preparation of the site for construction.

### EROSION

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

### SATURATION

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

### SEASONAL SWELLING AND SHRINKAGE OF SOIL

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below, from AS 2870). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

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

### SHEAR FAILURE

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

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

### TREE ROOT GROWTH

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

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.

**TABLE 1. GENERAL DEFINITIONS OF SITE CLASSES.**

| Class | Foundation |
|---|---|
| A | Most sand and rock sites with little or no ground movement from moisture changes |
| S | Slightly reactive clay sites, which may experience only slight ground movement from moisture changes |
| M | Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes |
| H1 | Highly reactive clay sites, which may experience high ground movement from moisture changes |
| H2 | Highly reactive clay sites, which may experience very high ground movement from moisture changes |
| E | Extremely reactive sites, which may experience extreme ground movement from moisture changes |

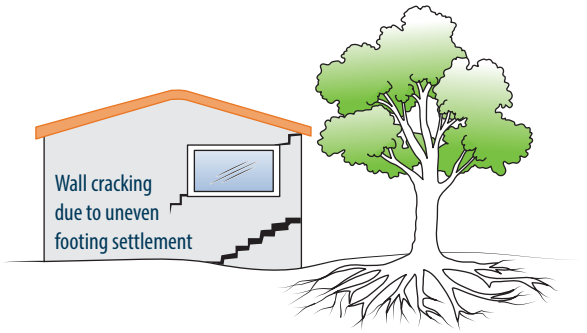



**FIGURE 1** Trees can cause shrinkage and damage.

- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

## UNEVENNESS OF MOVEMENT

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

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

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

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

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

## EFFECTS OF UNEVEN SOIL MOVEMENT ON STRUCTURES

### EROSION AND SATURATION

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

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

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

### SEASONAL SWELLING/SHRINKAGE IN CLAY

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

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

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

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

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

### MOVEMENT CAUSED BY TREE ROOTS

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

### COMPLICATIONS CAUSED BY THE STRUCTURE ITSELF

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

### EFFECTS ON FULL MASONRY STRUCTURES

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

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

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

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

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

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also

exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

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

### EFFECTS ON FRAMED STRUCTURES

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

### EFFECTS ON BRICK VENEER STRUCTURES

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

## WATER SERVICE AND DRAINAGE

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

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

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

## SERIOUSNESS OF CRACKING

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. Table 2 below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

## PREVENTION AND CURE

### PLUMBING

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

### GROUND DRAINAGE

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

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

### PROTECTION OF THE BUILDING PERIMETER

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

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

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

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

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

### CONDENSATION

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

**TABLE 2. CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS.**

| Description of typical damage and required repair | Approximate crack width limit | Damage category |
|---|---|---|
| Hairline cracks | <0.1 mm | 0 – Negligible |
| Fine cracks which do not need repair | <1 mm | 1 – Very Slight |
| Cracks noticeable but easily filled. Doors and windows stick slightly. | <5 mm | 2 – Slight |
| 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 – Moderate |
| 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 – Severe |

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

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

## THE GARDEN

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

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

## EXISTING TREES

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

## INFORMATION ON TREES, PLANTS AND SHRUBS

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information.

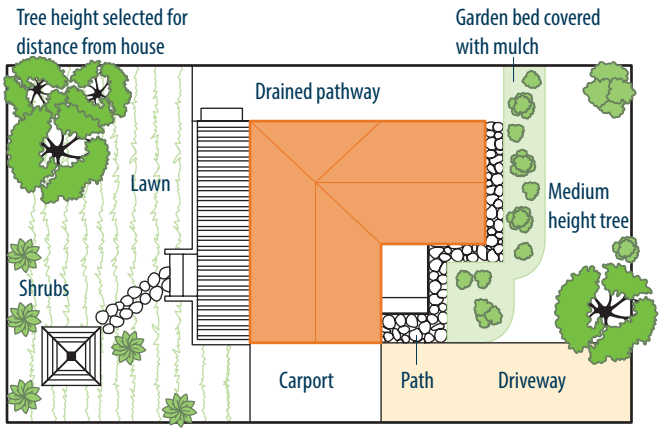


**FIGURE 2** Gardens for a reactive site.

## EXCAVATION

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

## REMEDIATION

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

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

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# GENERAL NOTES

## Introduction

These general notes have been prepared for inclusion in all of DRB Consulting Engineers Pty Ltd (DRB) geotechnical reports. Site subsurface conditions can be highly variable, and although the investigation and report prepared by DRB was undertaken with due care, the findings are limited to the extent and frequency of the test locations, and unexpected variations can occur. The following information provides guidance on the limitations of this report.

Should any site conditions encountered vary from those identified in this investigation and report, DRB should be consulted immediately.

## Fieldwork

*Subsurface Conditions*

Subsurface conditions are dynamic and can vary significantly over periods of time. These changes can be either naturally occurring or man made (as a result of excavations and filling). This report has been prepared based on the subsurface conditions encountered at the time of the subsurface investigations. DRB should be consulted immediately if the existing site conditions have (or appear to have) changed since the time of the fieldwork investigation.

*Groundwater*

Accurate groundwater measuring is not provided in DRBs standard reports. Once a borehole or testpit is excavated, groundwater or seepage may (or may not) be encountered, and recorded in the log sheet. However, the accuracy of this data is affected by several items including, but not limited to, low permeable soils, localised perched water tables, weather and/or tidal effects. Where the presence of groundwater critically affects the design, DRB recommends additional testing to confirm groundwater depths.

*Interpretation of Subsurface Investigation*

Subsurface investigations are undertaken by DRB in order to provide an indication of the existing subsurface conditions across the site. However, these investigations are only accurate for the exact location at each borehole, testpit or Dynamic Cone Penetrometer (DCP). DRB uses sampling, laboratory testing, literature and local geology reviews and experience, to interpret these investigations and provide an opinion on the conditions of the overall site.

Every care is taken to prepare an interpretive report for the site that is accurate and useful for any future civil or structural design. However, DRB cannot be responsible for any unexpected variations in ground conditions.

## Interpretative Report

This report has been developed for the specific site identified within. The information contained within the report is considered an interpretation of fieldwork (including subsurface soil investigation), laboratory testing, desktop review of local geology and experience. As such, the report must not be relied upon as factual, but rather, recommendations for the subject site in reference to the specific project scope of works DRB was engaged to perform.

This report should not be relied upon if there are any changes to the project, or the existing site, unless DRB are consulted to assess how these changes affect the findings of this report. DRB cannot accept responsibility from problems that may occur due to changes if they have not been consulted.

## Environmental Issues / Testing

This report does not cover any observations or assessment of contaminated or hazardous materials onsite. A specialised environmental consulting engineer should be engaged if there are concerns relating to the presence of these hazards.

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