Finley Hospital Redevelopment

Flooding Assessment

Health Infrastructure (NSW Government Health Infrastructure)

May 06, 2024

→ **The Power of Commitment**

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[Compliance statement]

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1. Introduction

1.1 Purpose of this Report

The purpose of this report is to present a Flood Impact Assessment for the Finley Hospital Redevelopment at Lot 246, DP 1016411, which is required to be included as part of the REF assessment. The assessment presents the agreed scope:

– A review the flooding requirements and controls of the Berrigan Shire Council LEP (2013) and DCP (2014).
– Compilation of a hydrological (WBNM) and flood (TUFLOW) models and simulate 1 in 100 AEP and the PMF overland flooding flows down Dawe Avenue. Flooding data will be assessed in the context of any LEP and DCP controls.
– Compilation of this flooding assessment report.

1.2 Project Description

The NSW Government has committed $25 million to the Finley Health Services redevelopment, which will provide a high-quality contemporary health facility and ensure health care services are carefully planned to meet community needs now and into the future. The project is currently in the planning stage, with master planning currently underway.

The works will involve the augmentation and modest expansion of the existing building consisting of Emergency/ IPU/ Medical Imaging/ FOH/ Admin and Plant spaces.

The project works include an extension of the existing building, infill of part of the existing building and refurbishment of the existing building. It is noted that the existing finished floor levels at the location of the works are approximately 108.9 mAHD. It has been assumed that the works would maintain these finished floor levels.

1.3 Scope, limitations and clarifications

This report has been prepared by GHD for Health Infrastructure (NSW Government Health Infrastructure) and may only be used and relied on by Health Infrastructure (NSW Government Health Infrastructure) for the purpose agreed between GHD and Health Infrastructure (NSW Government Health Infrastructure) as set out in section 1.1 of this report. GHD otherwise disclaims responsibility to any person other than Health Infrastructure (NSW Government Health Infrastructure) arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect. Specific assumptions related to the flood modelling are as follows:

– For the flood model, the results exclude any subsurface drainage infrastructure, and therefore present results which are considered marginally conservative with respect to overland flooding.
– For the flood model, the model compilation has assumed free draining conditions at the downstream extent of the model domain, without any backwater flooding. It is noted that along the downstream boundary of the flood model, Hamilton Street and associated transverse drainage infrastructure could control flood levels. The overflow

level is approximately 108.7 mAHD, which would be lowered by transverse drainage infrastructure, which would govern downstream backwater flood levels.

– It is noted that the existing finished floor levels of the existing hospital at the location of the works are approximately 108.9 mAHD. It has been assumed that the proposed works would maintain these finished floor levels.

1.4 Site location

The Finley Hospital is located on Dawe Avenue, within the township of Finley (refer to Figure 1.1). The location of the hospital within the wider Finley Township is shown in Figure 1.2.

Figure 1.1 Finley Hospital

Source: NearMap aerial imagery

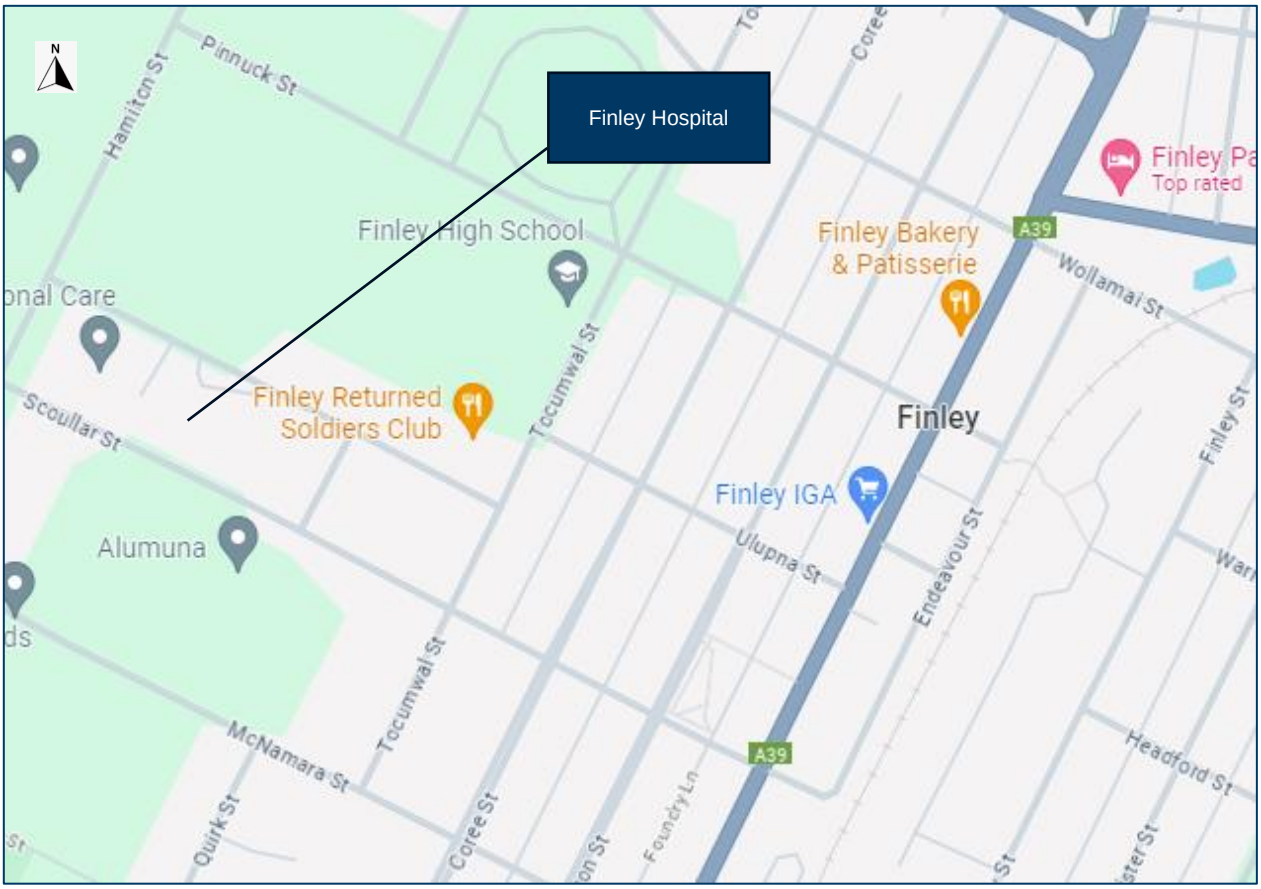

Figure 1.2 Finley hospital – local context

Source: Google Maps modified by GHD

2. Relevant Flood Planning Matters

2.1 Acts

2.1.1 Water Management Act 2000

The Water Management Act 2000, (WM Act) is administered by regulators including WaterNSW and Department of Industry: Water to manage water resources. The aim of the WM Act is to ensure that water resources are conserved and properly managed for sustainable use benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions.

Principles of the WM Act relating to drainage and floodplain management include the need to manage flood risk and avoid or minimise land degradation including soil erosion, compaction, geomorphic instability, and waterlogging.

2.1.2 Protection of the Environment Operations Act 1997

The Protection of the Environment Operations (POEO) Act 1997, is administered by the NSW Environment Protection Authority (EPA) and is implemented throughout NSW to protect, restore, and enhance the quality of the environment.

The aim of the POEO Act is to reduce risks to human health, provide increased opportunities for public involvement and participation in environment protection, rationalise, simplify and strengthen the regulatory framework for environment protection and improve the efficiency of administration of environment protection legislation.

To ensure that potential impacts on stormwater are managed in accordance with the objectives of the POEO Act, mitigation measures would need to be implemented during the construction and operational phases.

2.2 Policies, guidelines, and standards

2.2.1 NSW Flood Risk Management Manual

The NSW Flood Risk Management Manual and NSW Flood Prone Land Policy (NSW Government, 2023) relates to the management of flood-prone land within NSW. It provides guidelines in relation to the management of flood liable lands, including any development that has the potential to influence flooding, particularly in relation to increasing the flood risk to people and infrastructure. Activities of the project which have the potential to increase flood risk would be subject to consideration under the Manual.

The primary object of the NSW Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods. At the same time the policy recognises that benefits flowing from the use, occupation, and development of flood prone land. The policy promotes the use of a merit approach which balances social, economic, environmental and flood risk parameters to determine whether development or use of the floodplains is appropriate and sustainable.

2.2.2 Australian Rainfall and Runoff (2019)

Australian Rainfall and Runoff (ARR, 2019) is the primary technical publication for stormwater and flood estimates and design considerations and provides updates to the previous version of Australian Rainfall and Runoff (Engineers Australia, 1987). The technical analysis and development of the hydrologic and hydraulic models, including the management of stormwater and flooding at the site would need to consider this guideline.

2.3 Berrigan Shire Council

2.3.1 Berrigan Shire Council Local Environmental Plan (Berrigan LEP 2013)

The Berrigan Shire Council Local Environmental Plan 2013 (Berrigan LEP 2013) applies to land within the Berrigan Shire Council local government area and identifies planning provisions relevant to flooding. Amongst others, key matters noted in the Berrigan LEP 2013 flooding sections are that development consent must not be granted to development on land to which the flood planning clause applies unless the consent authority is satisfied that the development

(a) is compatible with the flood hazard of the land, and

(b) will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

The Berrigan LEP 2013 provides six flood planning maps, which show flood planning areas. The Finley Hospital Redevelopment is not located in any flood planning areas on these maps. The Berrigan LEP 2013 Clause 6.2 (flood

planning) applies to land identified as “Flood planning area” on the flood planning maps and other land at or below flood planning level. For Clause 6.2, flood planning level means the level of a 1:100 ARI (average recurrent interval) (1 in 100 AEP) flood event plus 0.5 metre freeboard.

2.3.2 Berrigan Shire Council Development Control Plan (Berrigan DCP 2014)

The Berrigan DCP 2014 Flood Prone Land provides controls to:

(a) provide detailed controls and criteria for the assessment of development applications on land effected by flooding in Berrigan Shire;

(b) consolidate existing flood planning principles and policies from relevant government agencies into a coherent framework for application at the development control level by Berrigan Shire Council.

(c) reduce the impact of flooding and flood liability on individual property owners and occupiers.

(d) reduce private and public losses resulting from flooding.

(e) restrict the intensification of development below the Flood Planning Level (FPL).

(f) limit development below the FPL to those activities and works considered to have an essential relationship with the river and its floodplain.

(g) provide specific measures for the control of caravan parks and associated development types within flood affected areas.

(h) provide for the consideration of the cumulative effects of any development on flood affected land, which in or of itself may be considered to be insignificant.

(i) provide for and protect the natural passage, storage and quality of flood waters.

(j) recognise and help sustain the natural ecosystems of floodplains and riparian zones including the protection of associated vegetation and wetlands.

(k) inform the community as to the extent and hazard of flood affected land in Berrigan Shire.

(l) deal consistently with applications for development on flood affected land, generally in accordance with the Floodplain Management Manual: The Management of Flood Liable Land issued by the New South Wales Government 2005; and

(m) encourage the development and use of land which is compatible with the indicated flood hazard.

For the purposes of Chapter 11 (Flood Prone Land) in the Berrigan DCP 2014, “flood prone land” is defined as land identified as ‘flood planning area’ on the flood planning map associated with Berrigan LEP 2013. The Finley Hospital Redevelopment site is not identified as part of the “flood planning area” in the Berrigan LEP 2013.

In addition, the Berrigan DCP 2014 notes that it is not possible to accurately map the limits of flooding in a Probable Maximum Flood (PMF) event. The documents notes that the Council will use its discretion in determining whether land outside of the flood planning area to which a proposal relates is within the PMF and therefore subject to the controls of Chapter 11 of the DCP.

2.4 SES

The Berrigan Shire Flood Emergency Sub Plan (SES 2017) is a sub plan of the Local Emergency Management Plan (EMPLAN). This plan covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures from flooding within the Berrigan Shire LGA. It covers operations for all levels of flooding within the council area.

The EMPLAN describes the arrangements at local level to prevent, prepare for, respond to and recover from emergencies and also provides policy direction for the preparation of Sub Plans and Supporting Plans. The EMPLAN identifies the following Evacuation Centres:

– Barooga Sports Club
– Tocumwal Aerodrome
– Finley Town Hall
– Berrigan Townhall
– Tocumwal State School.
– Sacred Heart Catholic School.

3. Hydrology and Flood Assessment

3.1 Hydrology

For the purposes of this assessment, design rainfall information for the site has been extracted from the ARR Online Data Hub. Rainfall losses were adopted from the ARR Data Hub with consideration of the jurisdiction specific recommendations for NSW. As such, probability neutral burst initial losses were adopted. Adopted initial and continuing loss values for the hydrologic model are summarised below in Table 3.1.

Table 3.1: Adopted Rainfall Losses

ARR Data Hub Storm Initial Loss (mm)	24.0
Adopted Probability Neutral Burst Initial Loss (mm)	Varies for each storm event and duration
ARR Data Hub Continuing Loss (mm/hr)	0
Adopted Continuing Loss (mm/hr)	0

3.1.1 Model

A WBNM (Version WBNM_ENG_001b, 2017) was used to calculate discharge hydrographs at the site location for the range of design storm events. A model lag parameter (C) value of 1.60 was adopted for the purposes of undertaking this assessment, as recommended by the WBNM manual. 10 storm temporal patterns were simulated for a range of durations for 1% AEP, 0.5% AEP (climate change assessment) and PMF events.

The catchment areas draining to Lot 246, DP 1016411 were delineated based on ICSM Elvis LiDAR (Elvis Data Portal). The catchment plan is shown in Figure 3.1.

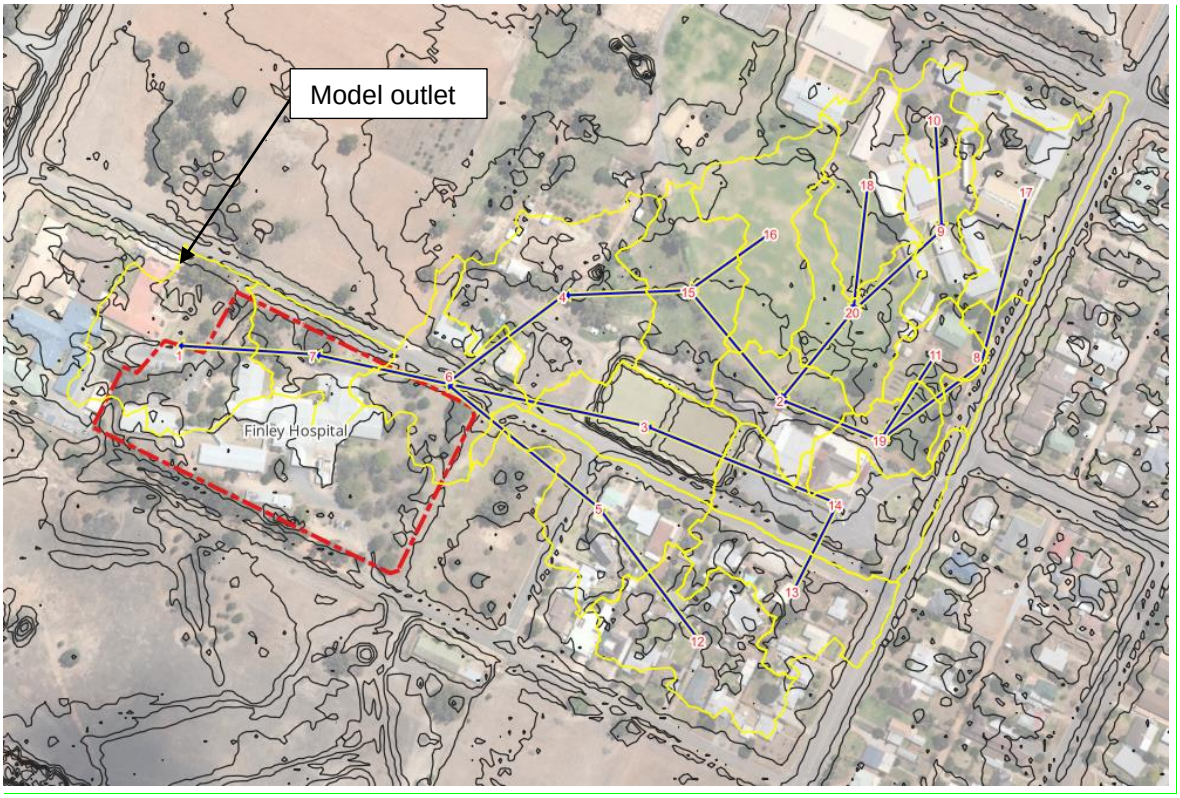

Figure 3.1: Hydrologic Model Catchment Plan

3.1.2 Climate Change

The 0.5% (1 in 200 year) AEP event was used as a proxy for future climate change conditions. The Flood Impact and Risk Assessment Guideline LU01 (DPE, 2023) and Understanding and Managing Flood Risk Guideline FB01 (DPE, 2023) note the suitability of the 0.5% AEP event, in addition to 0.2% AEP event, as reasonable proxy for climate change assessments on the basis that rainfall depths in these events are based on fixed growth factors and increases to rainfall depths for the 1% AEP event. Therefore, the 0.5% AEP event can be used for understanding the scale of impacts on the flood behaviour in the 1% AEP event under future climatic conditions.

3.1.3 Flood Peaks

WBNM model was compiled for existing conditions. For each duration the median outflow peak discharge was identified from the 10 storm patterns. This was adopted as the design peak discharge for that duration, whereafter the design peak discharges were enveloped across all durations to identify the critical duration and corresponding design peak discharge. This is an approach acceptable under ARR2019, however does not precluded a design peak discharges greater than the critical discharge adopted. Bureau of Metrology (BOM) temporal patterns were used for 1% and 0.5% AEP and Jordanian durations (Jordan et al. 2005) were used for PMF events. Median outflow peak discharges calculated by the WBNM model at the model outlet (catchment 1) are summarised in Table 3.2.

Table 3.2: Outflow Peak Discharges at the Model Outlet

Design Storm Event	Median Peak Discharge (m^3/s)	Critical Duration (and Temporal Pattern)

1% AEP	2.5	20 min TP02 (BOM Temporal Pattern)
0.5% AEP (Climate Change Assessment)	2.8	20 min TP02 (BOM Temporal Pattern)
PMF	21.2	1 hr TO98 (Jordanian Temporal Pattern)

3.2 Flood Model

3.2.1 Model Compilation

The TUFLOW (version 2023-03-AC) 2D flood model was used to determine flood data for the model domains (Figure 3.2) to simulate the existing case flood data. The model extent covers Lot 246, DP 1016411, Dawe Avenue, Hamilton Street, Scoullar Street and McNamara Street. The model boundary is located sufficiently downstream of the lot to remove the effects of model boundaries from the area of interest. Inflows from the hydrological model have been applied at the upstream model boundaries. Due to the land being extremely flat, several downstream HQ boundaries were placed at suitable cross-sections with low bed slope (0.1%). The model domain for the PMF simulation was extended to allow for the greater flood extent. The TUFLOW flood model was used to simulate the design event hydrology using a two-dimensional (2D) representation of the site. No bridges, culverts or any inground stormwater systems were configured in the TUFLOW model. Further, at the downstream model boundary it was assumed that flood waters would be free draining without backwater effects.

Geometry for the flood model extent has been represented using both publicly available LiDAR (Elvis Data Portal) consisting of 1m resolution LiDAR data sets. A 2m cell size has been adopted for the flood model.

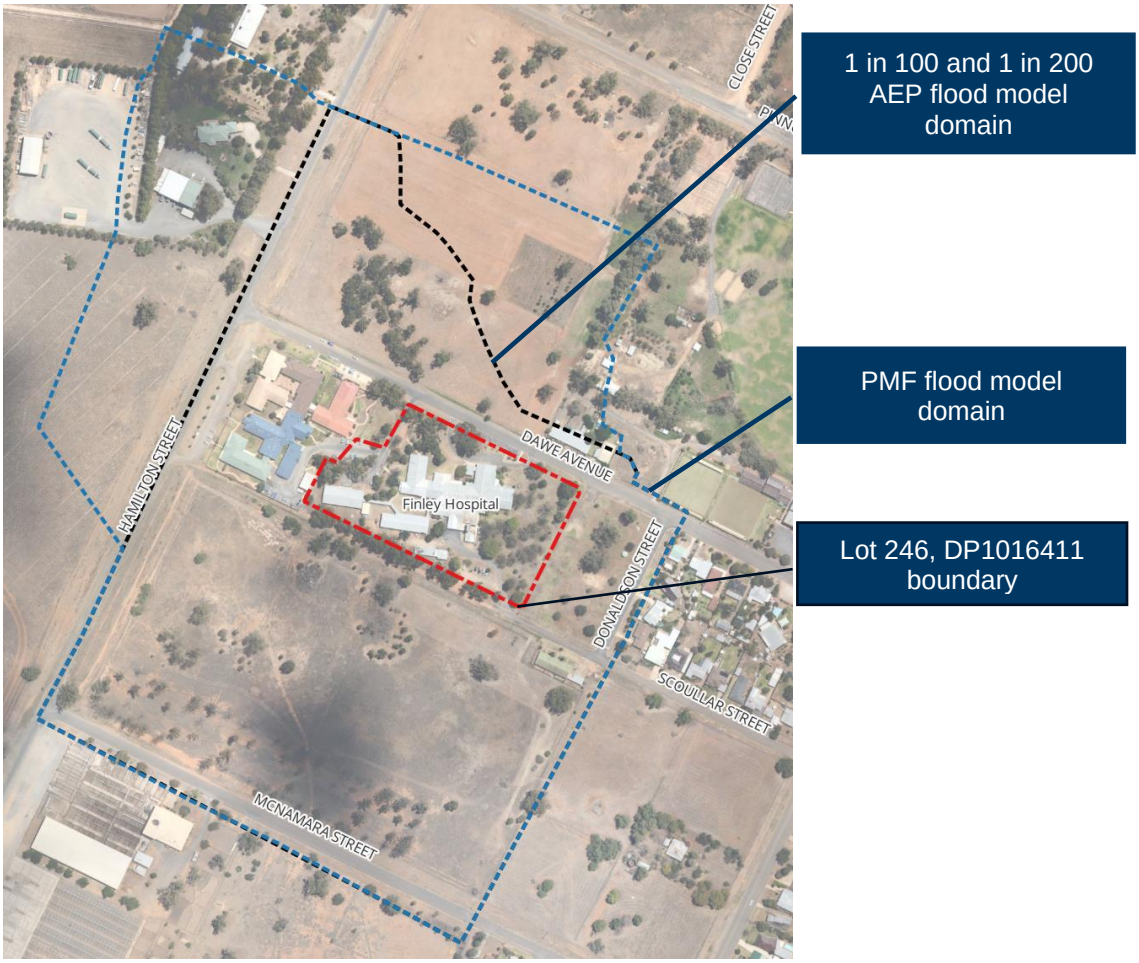

Figure 3.2: Flood model domains

Mannings “n” roughness were digitized for the extent of the flood model using available aerial imagery. Manning’s “n” values were assigned for each terrain type based on Chow (1959). Table 3.3 below summarises the adopted Manning’s roughness values which were applied across the flood model domain.

Table 3.3: Adopted Mannings "n" Roughness

Description	Adopted Mannings “n” value
Grass, lawns, medium vegetation	0.06
Buildings	0.04
Roads	0.02

3.2.2 Results

3.2.2.1 Flood Depths and Levels

The results in Appendix A (Figures A1 – A3) show:

1 in 100 and 1 in 200 AEP

– No flooding occurs at the location of proposed works.

– Peak flood level results for various locations of interest are tabulated in Table 3.4. Hamilton Street is not inundated in the 1 in 100 and 1 in 200 AEP event. Peak flood levels on Dawe Avenue ranges from 108.56 mAHD to 108.60 mAHD at various locations recorded in Table 3.4.

PMF

– Flooding occurs at the location of the extension; however, no flooding is registered at the location of the infill development. Peak flood depth at the site of extension is shallow, at 0.06 m. Peak flood level for the same location is 108.8 mAHD. Hamilton Street opposite to Lot 246, DP1016411 shows peak flood level of 108.77 mAHD. Peak flood levels on Dawe Avenue ranges from 108.80 mAHD to 108.81 mAHD for PMF event at various locations recorded in Table 3.4.

Table 3.4 Peak Flood Level results at various road locations

Location	1 in 100 AEP	1 in 200 AEP	PMF
Hamilton Street opposite to Lot 246 DP1016411	Not inundated	Not inundated	108.77 mAHD
Dawe Avenue opposite to location of extension works	108.56 mAHD	108.57 mAHD	108.80 mAHD
Dawe Avenue opposite to location of infill works	108.58 mAHD	108.59 mAHD	108.81 mAHD
Dawe Avenue opposite to location of refurbishment works	108.59 mAHD	108.60 mAHD	108.81 mAHD

3.2.2.2 Flood velocity

The results in Appendix A (Figures A4 – A6) show:

1 in 100 and 1 in 200 AEP

– No flooding occurs at the location of proposed works.

– Peak flood velocity results for various locations of interest are tabulated in Table 3.5. Hamilton Street is not inundated in the 1 in 100 and 1 in 200 AEP event. Peak flood velocity on Dawe Avenue ranges from 0.48 m/s to 0.63 m/s mAHD at various locations recorded in Table 3.5.

PMF

– Flooding occurs at the location of the extension; however, no flooding is registered at the location of the infill. Peak flood velocity at the site of extension is negligible, at 0.08 m/s. Hamilton Street opposite to Lot 246, DP1016411 shows peak flood velocity of 0.48 m/s. Peak flood velocity on Dawe Avenue ranges from 0.97 m/s to 1.08 m/s for PMF event at various locations recorded in Table 3.5.

Table 3.5 Peak Flood Velocity results at various road locations

Location	1 in 100 AEP	1 in 200 AEP	PMF
Hamilton Street	Not inundated	Not inundated	0.48 m/s
Dawe Avenue opposite to location of extension works	0.48 m/s	0.50 m/s	0.97 m/s

Location	1 in 100 AEP	1 in 200 AEP	PMF
Dawe Avenue opposite to location of infill works	0.66 m/s	0.69 m/s	1.08 m/s
Dawe Avenue opposite to location of refurbishment works	0.60 m/s	0.63 m/s	1.07 m/s

3.2.2.3 Flood Hazard

The Flood Risk Management Guideline FB03 (Flood Hazard), which supports the Flood Risk Management Manual (NSW Government, 2023), provides a general flood hazard vulnerability curve, which can be used as a general classification of flood hazard on a floodplain as shown in Figure 3.3 below.

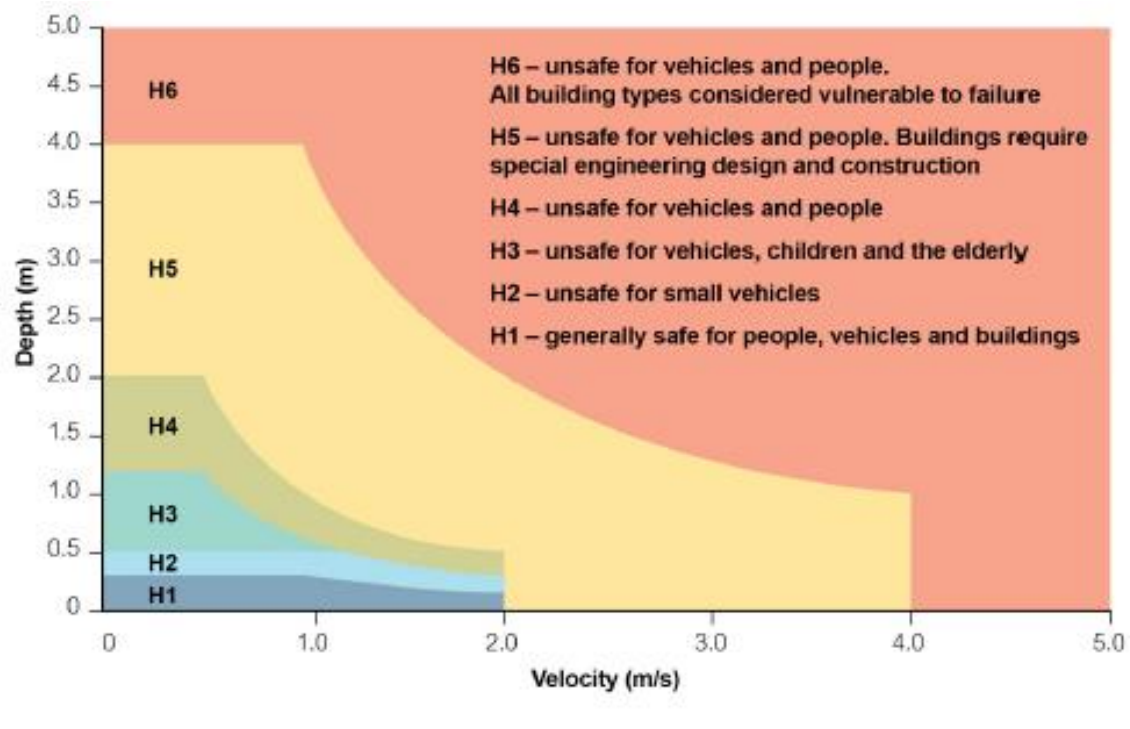

Figure 3.3: General flood hazard vulnerability curve (NSW Government, 2023)

The results in Appendix A (Figures A7 – A9) show:

1 in 100 and 1 in 200 AEP

– No flooding occurs at the location of proposed works.
– Flood hazard results for various locations of interest are tabulated in Table 3.6. Hamilton Street is not inundated in the 1 in 100 and 1 in 200 AEP event. Flood hazard on Dawe Avenue is classified as “H2” at various locations recorded in Table 3.6.

PMF

– Flooding occurs at the location of the extension; however, no flooding is registered at the location of the infill. Flood Hazard is classified as “H1” at the site of extension suggesting it is generally safe for people, vehicle and buildings. Hamilton Street opposite to Lot 246, DP1016411 shows flood hazard classified as “H1”. Flood hazard on Dawe Avenue is classified as “H3” for PMF event at various locations recorded in Table 3.6.

Table 3.6 Flood Hazard results at various road locations

Location	1 in 100 AEP	1 in 200 AEP	PMF
Hamilton Street	Not inundated	Not inundated	H1
Dawe Avenue opposite to location of extension works	H2	H2	H3
Dawe Avenue opposite to location of infill works	H2	H2	H3
Dawe Avenue opposite to location of refurbishment works	H2	H2	H3

3.3 Assessment

3.3.1 Flood Impact on the Proposal

The Berrigan LEP 2013 provides six flood planning maps, which show flood planning areas. The Finley Hospital Redevelopment is not located in any flood planning areas on these maps. However, the flood planning Clause (6.2) of the Berrigan LEP 2013 applies to other land at or below the flood planning level. As seen in Figure A1, the locations of hospital extension and infill within Lot 246, DP 1016411 is not inundated in the 1 in 100 AEP event. The floor level of the existing hospital structure at the location of proposed works is about 108.9 mAHD. This level sits above the peak flood level at various points on Hamilton Street and Dawe Avenue for 1 in 100 AEP as noted in Section 3.2.2.1.

The 1 in 200 AEP event was simulated as proxy for future climate change conditions. As seen in Figures A2, A5 and A8, the results show negligible changes from 1 in 100 AEP event results, with slight increase in flood extent and similar flood depth, velocity and hazard classifications. The hospital extension and infill locations are out of the flood extent in the 1 in 200 AEP event.

The Probable Maximum Flood (PMF) results show flooding in the location of proposed extension, with flood level of 108.8 mAHD, which is about 0.1 m below the existing floor level. The location of the infill is out of the PMF flood extent. The hazard classification for most of the hospital, including the extension location, is “H1”. It is therefore considered that generally low hazard condition would prevail in a PMF across the hospital site.

On the basis of the flood results, and because the proposal includes minor extensions of the existing facility, it is considered that there would be no flood impact of the proposal in the 1 in 100 AEP event and under future climate conditions. In the PMF there may be minor flood depths adjacent to the proposed extension location, however it must be recognised that the PMF event is an extremely rare event, with a low probability of occurring. Further in the PMF event, the existing hospital floor levels are approximately 0.1m above the adjacent flood level in Dawe Avenue.

3.3.2 Flood Impact due to the proposal

The existing case flooding assessment shows that the location of the proposed extensions would not be inundated in the 1 in 100 AEP event and in the future climate 1 in 100 AEP event. The proposed works in the extension locations are therefore assessed not to have any impact in these events. In the PMF event flood depths are shallow, and flood waters are slow moving, and therefore any impacts would be negligible. However, again, it must be recognised that the PMF event is an extremely rare event, with a low probability of occurring.

4. Summary and Findings

The purpose of this report is to present a Flood Impact Assessment for the Finley Hospital Redevelopment at Lot 246, DP 1016411, which is required to be included as part of the REF assessment. The assessment reviewed the Berrigan Shire Council LEP (2013) and DCP (2014) and results from flood modelling undertaken as part of this assessment.

The Finley Hospital Redevelopment is not identified as “flood planning area” in any flood planning maps provided by the Berrigan LEP 2013. The Berrigan DCP 2014 applies to land use and development on flood prone land within the Shire. Outside of this flood planning area the extent of flooding in a Probable Maximum Flood is not known and consequently Council would use its discretion in applying the flood controls within the DCP.

A hydrological assessment and flood model was used to determine flood data in the vicinity of the site. This modelling showed that the location of the extension and infill for Finley Hospital Redevelopment is beyond the flood extent for 1 in 100 and 1 in 200 (climate change) AEP event and it is therefore considered that there is no flood risk to the Finley Hospital Redevelopment in these events. In the PMF event flood depths of 0.06 m and velocity of 0.08 m/s was simulated at the site of the extension. The hazard at the extension site is classified as “H1” in the PMF event which is generally safe for vehicles, people, and buildings.

In the PMF event flood depths are shallow, and flood waters are low moving, and therefore any impacts would be negligible. However, it must be recognised that the PMF event is an extremely rare event, with a low probability of occurring. Further in the PMF event, the existing hospital floor levels are approximately 0.1m above the adjacent flood level in Dawe Avenue.

5. References

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– Berrigan LEP 2013, Berrigan Shire Council Environmental Plan 2013, (**https://www.berriganshire.nsw.gov.au/Home).**
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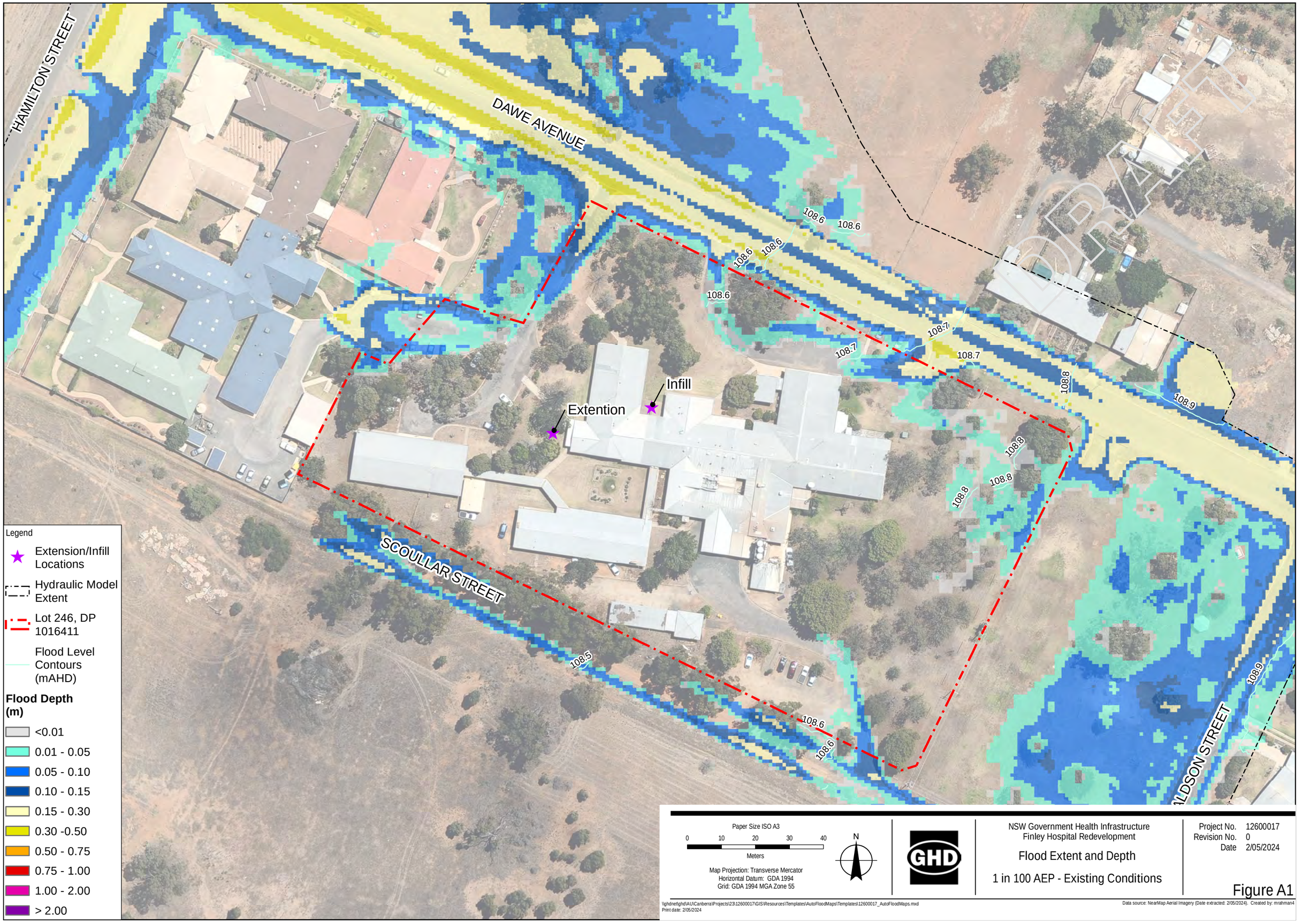
– Phillip Jordan, Rory Nathan, Lauren Mittiga & Brian Taylor (2005) Growth curves and temporal patterns of short duration design storms for extreme events, Australasian Journal of Water Resources, 9:1, 69-80
– SES 2017, Berrigan Shire Flood Emergency Sub Plan (March 2017).
– Understanding and Managing Flood Risk Guideline FB01, NSW Department of Planning and Environment (DPE), 2023.

Appendix A

Flood Mapping


HAMILTON STREET
DAWE AVENUE
SCOULLAR STREET
ALDSON STREET
Infill
Extention
108.6
108.7
108.8
108.9
108.5
Legend
Extension/Infill Locations
Hydraulic Model Extent
Lot 246, DP 1016411
Flood Level Contours (mAHD)
Flood Depth (m)
<0.01
0.01 - 0.05
0.05 - 0.10
0.10 - 0.15
0.15 - 0.30
0.30 -0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 2.00
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Meters
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NSW Government Health Infrastructure
Finley Hospital Redevelopment
Flood Extent and Depth
1 in 100 AEP - Existing Conditions
Project No. 12600017
Revision No. 0
Date 2/05/2024
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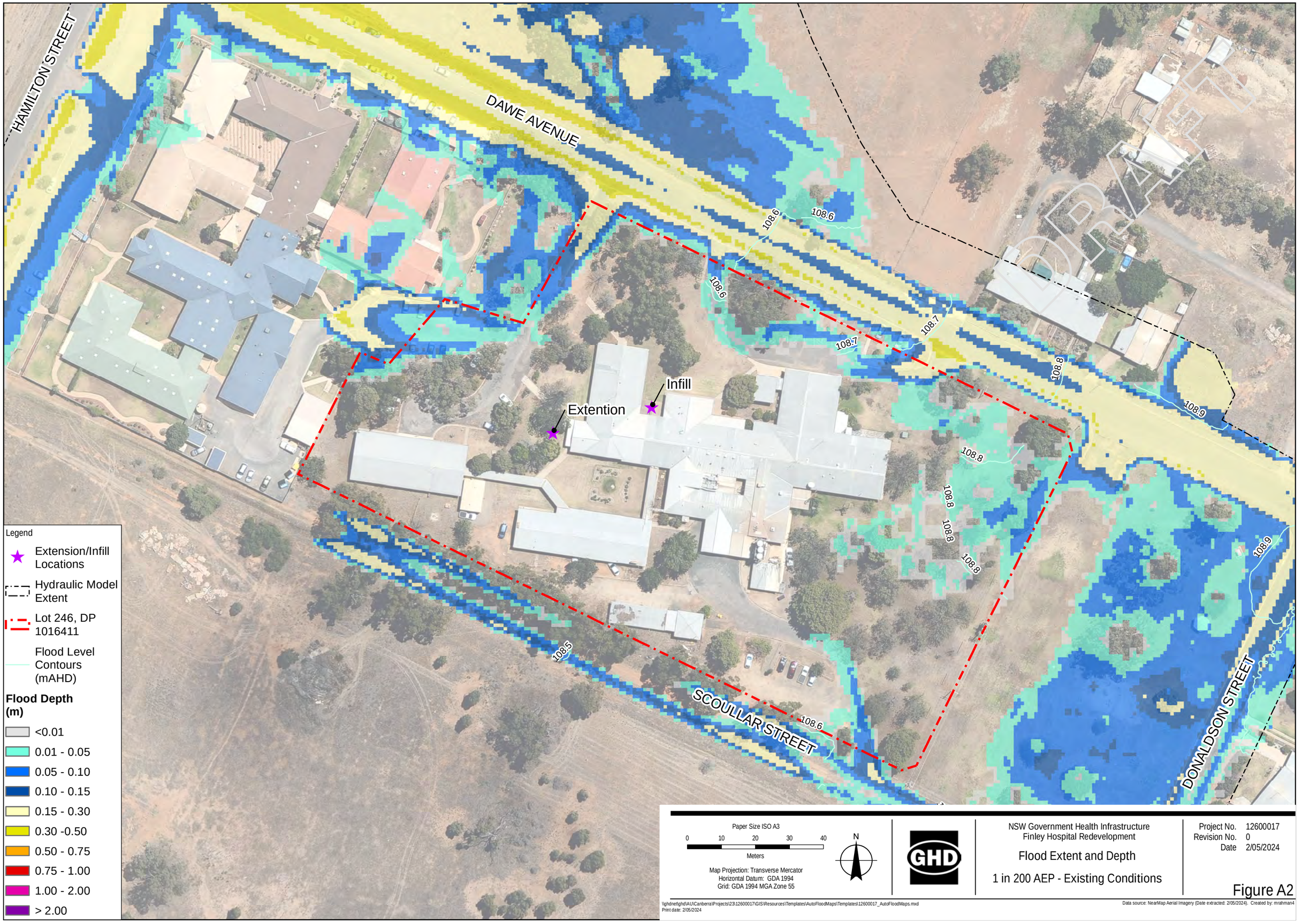
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Extension/Infill Locations
Hydraulic Model Extent
Lot 246, DP 1016411
Flood Level Contours (mAHD)
Flood Depth (m)
<0.01
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NSW Government Health Infrastructure
Finley Hospital Redevelopment
Flood Extent and Depth
1 in 200 AEP - Existing Conditions
Project No. 12600017
Revision No. 0
Date 2/05/2024
Figure A2
\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 2/05/2024
Data source: NearMap Aerial Imagery (Date extracted: 2/05/2024). Created by: mrahman4

DAWE AVENUE

SCOULLAR STREET

DONALDSON STREET

Infill

Extention

108.5
108.6
108.8
108.9
109
109.1

Legend

- Extension/Infill Locations
- Hydraulic Model Extent
- Lot 246, DP 1016411
- Flood Level Contours (mAHD)

Flood Depth (m)

- <0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 -0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- > 2.00

Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Flood Extent and Depth

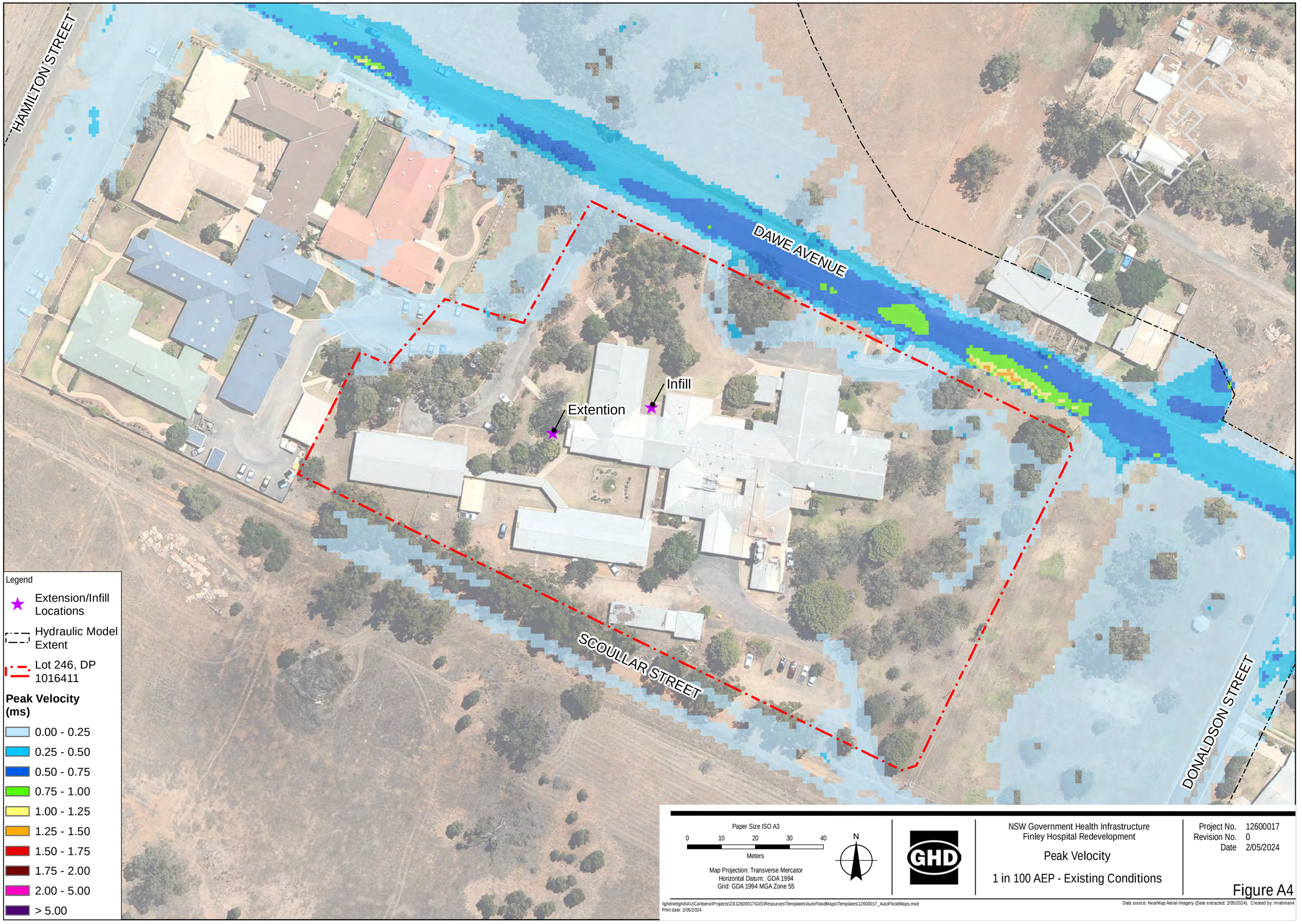
PMF - Existing Conditions

Project No. 12600017
Revision No. 0
Date 2/05/2024

Figure A3

\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 2/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 2/05/2024). Created by: mrahman4



Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Peak Velocity

1 in 100 AEP - Existing Conditions

Project No. 12600017
Revision No. 0
Date 2/05/2024

Figure A4

\\ghdnetfghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 2/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 2/05/2024). Created by: mrahman4

HAMILTON STREET

DAWE AVENUE

Infill

Extention

SCOULLAR STREET

DONALDSON STREET

Legend

- Extension/Infill Locations
- Hydraulic Model Extent
- Lot 246, DP 1016411

Peak Velocity (ms)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 1.75
- 1.75 - 2.00
- 2.00 - 5.00
- > 5.00

Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Peak Velocity

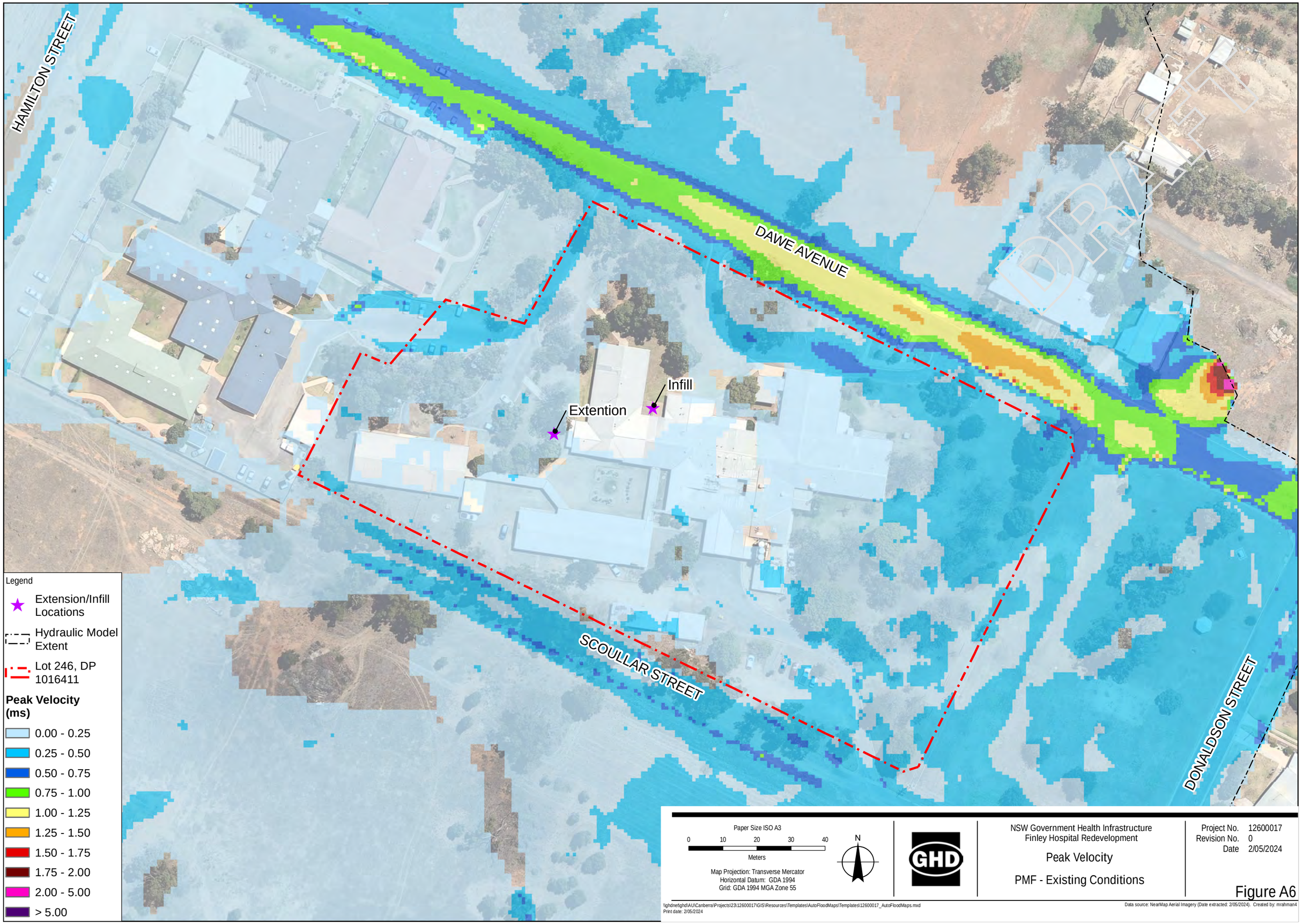
1 in 200 AEP - Existing Conditions

Project No. 12600017
Revision No. 0
Date 2/05/2024

Figure A5

\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 2/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 2/05/2024). Created by: mrahman4



Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Peak Velocity

PMF - Existing Conditions

Project No. 12600017
Revision No. 0
Date 2/05/2024

Figure A6

\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 2/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 2/05/2024). Created by: mrahman4

HAMILTON STREET

DAWE AVENUE

SCOULLAR STREET

DONALDSON STREET

Infill

Extention

Legend

- Extension/Infill Locations
- Hydraulic Model Extent
- Lot 246, DP 1016411

Flood Hazard

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.

Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Flood Hazard

1 in 100 AEP - Existing Conditions

Project No. 12600017
Revision No. 0
Date 3/05/2024

Figure A7

\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 3/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 3/05/2024). Created by: mrahman4

HAMILTON STREET

DAWE AVENUE

SCOULLAR STREET

DONALDSON STREET

Infill

Extention

Legend

- Extension/Infill Locations
- Hydraulic Model Extent
- Lot 246, DP 1016411

Flood Hazard

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.

Paper Size ISO A3

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

NSW Government Health Infrastructure
Finley Hospital Redevelopment

Flood Hazard

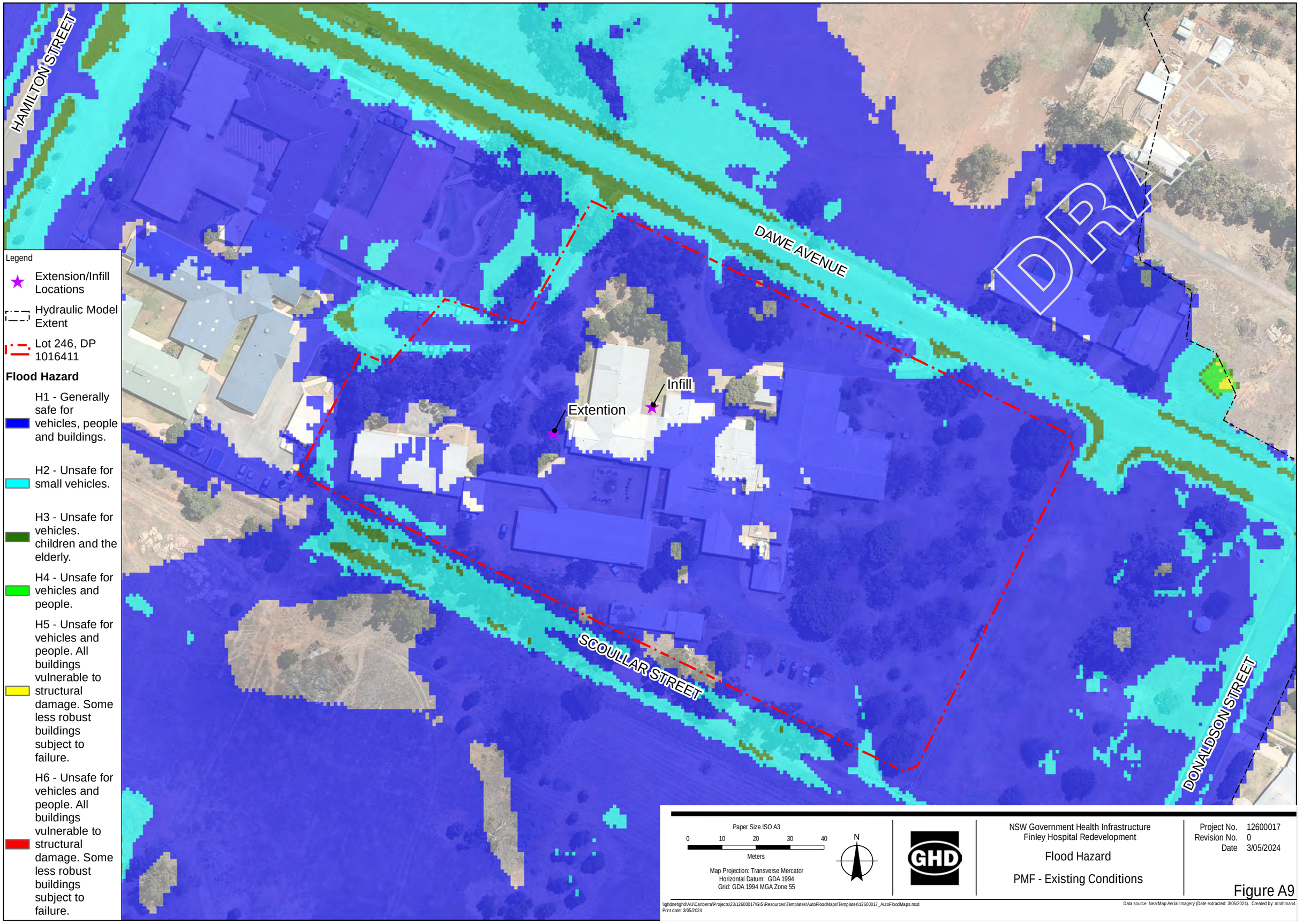
1 in 200 AEP - Existing Conditions

Project No. 12600017
Revision No. 0
Date 3/05/2024

Figure A8

\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 3/05/2024

Data source: NearMap Aerial Imagery (Date extracted: 3/05/2024). Created by: mrahman4


HAMILTON STREET
DAWE AVENUE
SCOULLAR STREET
DONALDSON STREET
Infill
Extention
DRAFT
Legend
Extension/Infill Locations
Hydraulic Model Extent
Lot 246, DP 1016411
Flood Hazard
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for vehicles. children and the elderly.
H4 - Unsafe for vehicles and people.
H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
Paper Size ISO A3
0 10 20 30 40
Meters
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
GHD
NSW Government Health Infrastructure
Finley Hospital Redevelopment
Flood Hazard
PMF - Existing Conditions
Project No. 12600017
Revision No. 0
Date 3/05/2024
Figure A9
\\ghdnetghd\AU\Canberra\Projects\23\12600017\GIS\Resources\Templates\AutoFloodMaps\Templates\12600017_AutoFloodMaps.mxd
Print date: 3/05/2024
Data source: NearMap Aerial Imagery (Date extracted: 3/05/2024). Created by: mrahman4

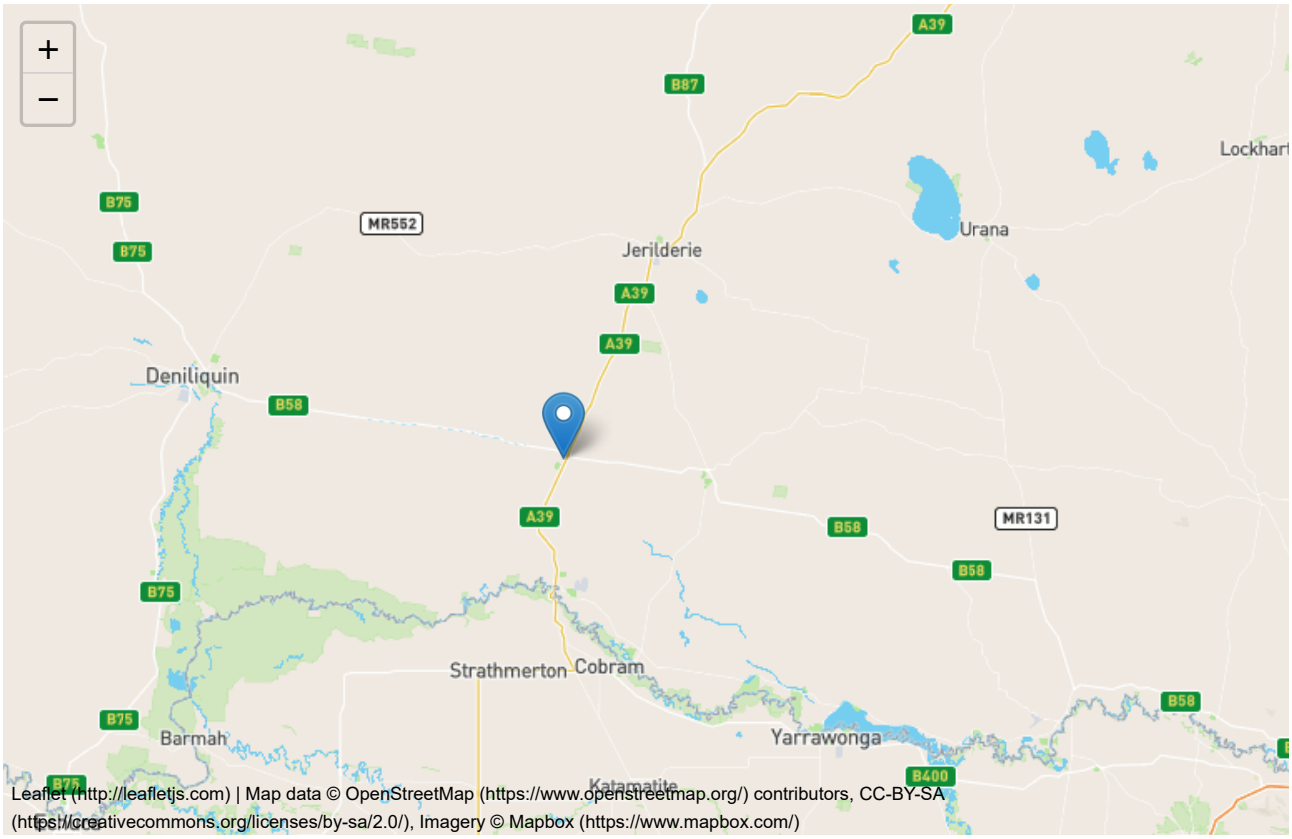
Appendix B

ARR Data Hub Extracts

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	145.571
Latitude	-35.641
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show



Data

River Region

Division	Murray-Darling Basin
River Number	10
River Name	Murray Riverina

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Semi-arid	0.254	0.247	0.403	0.351	0.0013	0.302	0.058	0.0	0.0

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26\text{ x }10^{-3}\text{ x }Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141\text{ x }Area^{0.213}\text{ x }10^{-0.021\frac{(Duration-180)^{2}}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	10233.0
Storm Initial Losses (mm)	24.0
Storm Continuing Losses (mm/h)	0.0

Layer Info

Time Accessed	10 April 2024 12:46PM

Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/MB.zip)

code	MB
Label	Murray Basin

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_MB.zip)

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-35.641463019&longitude=145.57074973&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	10 April 2024 12:46PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	2.3 (0.124)	2.0 (0.076)	1.8 (0.056)	1.6 (0.043)	1.3 (0.029)	1.1 (0.021)
90 (1.5)	2.0 (0.098)	2.7 (0.091)	3.2 (0.087)	3.6 (0.083)	1.9 (0.037)	0.7 (0.011)
120 (2.0)	3.0 (0.130)	3.7 (0.114)	4.2 (0.106)	4.7 (0.100)	2.1 (0.037)	0.2 (0.003)
180 (3.0)	3.0 (0.116)	3.1 (0.084)	3.2 (0.071)	3.2 (0.061)	2.7 (0.042)	2.3 (0.032)
360 (6.0)	1.4 (0.045)	1.5 (0.033)	1.5 (0.029)	1.6 (0.025)	3.6 (0.048)	5.2 (0.060)
720 (12.0)	0.0 (0.000)	1.0 (0.019)	1.7 (0.026)	2.3 (0.031)	4.9 (0.054)	6.9 (0.067)
1080 (18.0)	0.0 (0.000)	0.5 (0.009)	0.9 (0.012)	1.2 (0.014)	1.9 (0.018)	2.4 (0.021)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.3 (0.003)	0.6 (0.005)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	16.4 (0.885)	16.7 (0.627)	16.9 (0.520)	17.1 (0.444)	15.6 (0.333)	14.4 (0.270)
90 (1.5)	13.9 (0.661)	16.3 (0.540)	17.9 (0.487)	19.4 (0.447)	17.6 (0.332)	16.2 (0.268)
120 (2.0)	11.3 (0.495)	14.6 (0.445)	16.7 (0.419)	18.8 (0.398)	16.8 (0.293)	15.3 (0.233)
180 (3.0)	12.7 (0.494)	14.8 (0.402)	16.1 (0.361)	17.4 (0.331)	19.4 (0.303)	20.8 (0.285)
360 (6.0)	7.5 (0.240)	12.5 (0.281)	15.8 (0.294)	19.0 (0.300)	20.3 (0.265)	21.3 (0.245)
720 (12.0)	2.5 (0.065)	7.2 (0.134)	10.4 (0.160)	13.4 (0.176)	17.5 (0.192)	20.6 (0.200)
1080 (18.0)	0.7 (0.015)	5.6 (0.094)	8.9 (0.123)	12.0 (0.142)	12.2 (0.120)	12.3 (0.107)
1440 (24.0)	0.0 (0.001)	3.8 (0.059)	6.2 (0.080)	8.6 (0.094)	9.6 (0.087)	10.3 (0.083)
2160 (36.0)	0.0 (0.000)	0.4 (0.006)	0.7 (0.008)	1.0 (0.010)	2.9 (0.024)	4.3 (0.032)
2880 (48.0)	0.0 (0.000)	0.2 (0.002)	0.3 (0.003)	0.4 (0.004)	1.2 (0.009)	1.7 (0.012)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	35.0 (1.888)	31.9 (1.198)	29.9 (0.919)	27.9 (0.725)	29.9 (0.640)	31.5 (0.589)
90 (1.5)	25.9 (1.236)	30.7 (1.020)	33.9 (0.923)	36.9 (0.849)	35.1 (0.664)	33.8 (0.559)
120 (2.0)	25.4 (1.113)	30.0 (0.917)	33.1 (0.830)	36.0 (0.763)	34.3 (0.598)	33.1 (0.504)
180 (3.0)	23.2 (0.902)	28.6 (0.779)	32.3 (0.722)	35.8 (0.678)	40.7 (0.636)	44.4 (0.607)
360 (6.0)	17.3 (0.550)	25.7 (0.575)	31.2 (0.578)	36.6 (0.576)	43.9 (0.574)	49.4 (0.569)
720 (12.0)	10.6 (0.278)	19.1 (0.355)	24.8 (0.381)	30.2 (0.397)	34.8 (0.381)	38.2 (0.371)
1080 (18.0)	8.6 (0.204)	16.3 (0.272)	21.4 (0.296)	26.3 (0.310)	26.4 (0.261)	26.6 (0.232)
1440 (24.0)	3.8 (0.085)	12.6 (0.197)	18.4 (0.237)	24.0 (0.263)	23.3 (0.213)	22.7 (0.184)
2160 (36.0)	2.2 (0.045)	9.3 (0.133)	14.0 (0.164)	18.6 (0.183)	18.9 (0.156)	19.2 (0.140)
2880 (48.0)	0.9 (0.017)	2.9 (0.040)	4.3 (0.048)	5.6 (0.052)	13.3 (0.102)	19.0 (0.129)
4320 (72.0)	0.0 (0.000)	1.0 (0.013)	1.7 (0.017)	2.3 (0.020)	8.6 (0.060)	13.2 (0.082)

Layer Info

Time Accessed	10 April 2024 12:46PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.816 (4.1%)**	0.726 (3.6%)	**0.934 (4.7%)**
2040	**1.046 (5.2%)**	1.015 (5.1%)	**1.305 (6.6%)**
2050	**1.260 (6.3%)**	1.277 (6.4%)	**1.737 (8.8%)**
2060	**1.450 (7.3%)**	1.520 (7.7%)	**2.214 (11.4%)**
2070	**1.609 (8.2%)**	1.753 (8.9%)	**2.722 (14.2%)**
2080	**1.728 (8.8%)**	1.985 (10.2%)	**3.246 (17.2%)**
2090	**1.798 (9.2%)**	2.226 (11.5%)	**3.772 (20.2%)**

Layer Info

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Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	**50.0**	**20.0**	**10.0**	**5.0**	**2.0**	**1.0**
60 (1.0)	16.1	10.0	9.2	10.0	10.0	8.3
90 (1.5)	16.5	10.8	9.7	10.4	9.6	7.7
120 (2.0)	16.6	11.3	10.2	10.8	9.9	8.0
180 (3.0)	16.6	11.9	11.1	11.4	10.1	7.4
360 (6.0)	18.8	14.1	12.8	11.8	10.6	7.2
720 (12.0)	21.4	16.9	15.3	14.8	12.2	8.2
1080 (18.0)	22.3	18.0	16.9	16.4	14.9	10.2
1440 (24.0)	23.6	19.6	18.6	18.4	16.8	11.7
2160 (36.0)	24.4	20.6	20.2	21.9	19.4	13.8
2880 (48.0)	24.8	21.8	23.0	24.6	21.7	15.9
4320 (72.0)	25.2	22.6	24.0	26.0	23.8	17.7

Layer Info

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Note As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

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