LOT 2 PHILLIP DRIVE FLOOD IMPACT ASSESSMENT

MARCH 2022

PREPARED FOR

Rise Projects

Project Details

Project Details	
Title	Lot 2 Phillip Drive Flood Impact Assessment
Prepared for	Rise Projects
Document Name	20002-R01-RISE-2PhillipDrSWR-1.docx

Document Control

Revision	Author	Reviewer	Approved for Issue	
			Name	Report Date
A	CS	CW	C.Schipplock	30/11/2021
B	CS	CW	C.Schipplock	3/12/2021
1	CS	CW	C.Schipplock	2/3/2022

Revision Status

Revision	Description
A	For client review
B	Draft for Council
1	Final

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LIST OF ABBREVIATIONS

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
DCP	Development Control Plan
DEM	Digital Elevation Model
FIA	Flood Impact Assessment
FSL	Full Supply Level
GEV	Generalised Extreme Value
GSDM	Generalised Short-Duration Method
HPC	Heavily Parallelised Compute
IFD	Intensity Frequency Duration
LEP	Local Environmental Plan
LGA	Local Government Area
LiDAR	Light Detecting and Ranging
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RFFE	Regional Flood Frequency Analysis
WMS	Water Modelling Solutions

1 INTRODUCTION

1.1 BACKGROUND

The proposed site is located at Lot 2, Phillip Drive in South West Rocks in the Kempsey Shire Council LGA in New South Wales. The property is approximately 5 Ha in size and is proposed to be subdivided to support construction of Town House, Dual Occupation and Medium Density Residential Development. The site is located within the Saltwater Creek catchment, with part of the site within the 1% AEP (Annual Exceedance Probability) extent as defined by the Saltwater Creek Flood Study (BMT WBM, 2006). A flood assessment is therefore required to demonstrate that the development complies with the requirements of the Kempsey Local Environmental Plan (LEP) 2013 and Development Control Plan (DCP) 2013.

In order to facilitate the sub-division, the developer is proposing to construct a fill pad to ensure new development is at or above the required flood planning level. Due to the changes in land form, a flood impact assessment (FIA) is required to be submitted as part of the development application. The FIA should clearly show:

- The existing conditions 1% AEP flood levels at the site;
- The proposed development, designed to withstand the effects of 1% AEP inundation of floodwaters;
- The proposed development does not increase the flood hazard or flood damage to other properties or adversely affect them in any way during floods; and
- Details confirming the orderly and safe evacuation of people from the site should a flood occur.

An aerial image of the proposed site location is illustrated in Figure 2-1.

1.2 SCOPE

The purpose of this FIA is to demonstrate that the proposed subdivision is compliant with flood related planning objectives and development controls required by Kempsey Shire Council. In particular, the FIA will develop modelling tools in accordance with current industry best practice to establish design flood behaviour under existing conditions, and determine the impacts of the proposed development.

The scope of works includes:

- Data Collection and Review
- Development of site specific rainfall-on-grid TUFLOW model
- Establish “Existing Conditions” flood behaviour for the 1% Annual Exceedance Probability (AEP)
- Assess the proposed development to determine offsite flood impacts, and provide advice/modelling to ameliorate impacts;
- Review Council’s planning policies and assess the proposed development’s compliance with relevant flood related development controls;
- Produce a report documenting the approach, methodology, outcomes and conclusions.

2 SITE CHARACTERISTICS

2.1 STUDY AREA

The site that is proposed to be developed is located west of the South West Rocks township and is bounded to the south by Phillip Drive and to the north by Saltwater Creek. Across the creek to the north is Fishos Trail and Fishos Walking Track which takes pedestrians through the coastal wetland to Trial Bay Front Beach.

Saltwater Creek is a small estuary connected to the ocean adjacent to South West Rocks. The creek is approximately 3.2 km long and flows from Saltwater Lagoon (upstream of the study area) and discharges to Trial Bay.

The estuary is an intermittently closed and open lake or lagoon, meaning that the waterway is not permanently connected to the ocean. In fact, beach sand keeps the entrance closed about 70% of the time, resulting in no tidal variability, and water levels that respond to catchment run-off and evaporation.

The proposed site location is illustrated in Figure 2-1.

2.2 LOCATION

The Site is located at Lot 2, Phillip Drive in South West Rocks in the Kempsey Shire Council LGA in New South Wales and is generally shown in Figure 2-1 below. The Site covers an area of approximately 4.87 ha.

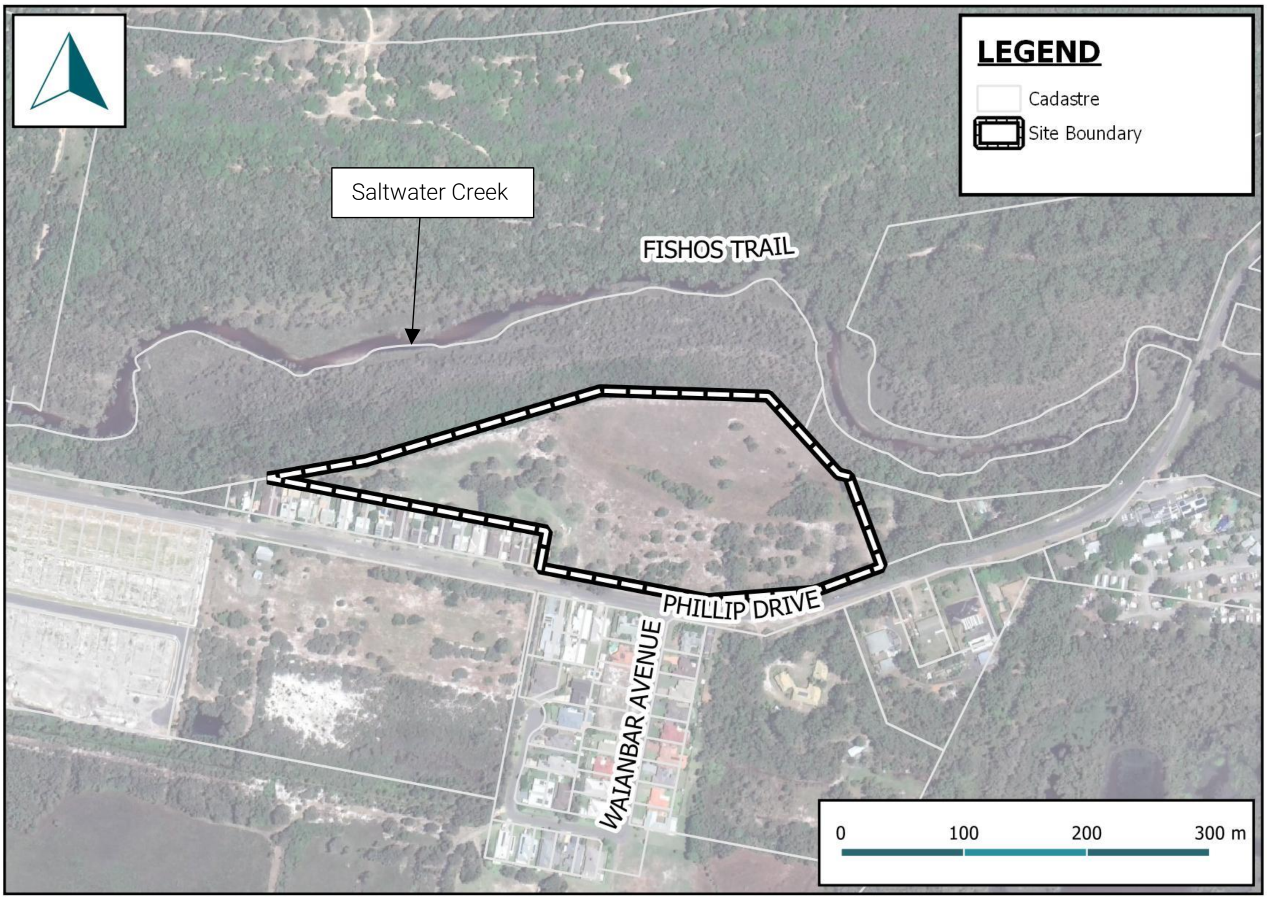


Figure 2-1 Site Locality Plan

2.3 EXISTING TOPOGRAPHY

The Site generally falls from the south-west to north-east determined from a site visit and LiDAR information.

The model DEM (Digital Elevation Model) was developed using a combination of the 1 m LiDAR DEM obtained from Elvis - Elevation and Depth - Foundation Spatial Data (See Appendix A) and detailed site survey.

The LiDAR was obtained as a series of ASCII tiles and all that was required for the DEM development was to determine the relevant tiles for the catchment and join them into one FLT (floating point binary file). The floating-point file is typically a much smaller file size and provides modelling run time efficiencies.

The site survey was provided as a .dem, which is a file format that is accessible by TUFLOW.

The resultant combined DEM is illustrated in Figure 2-2.

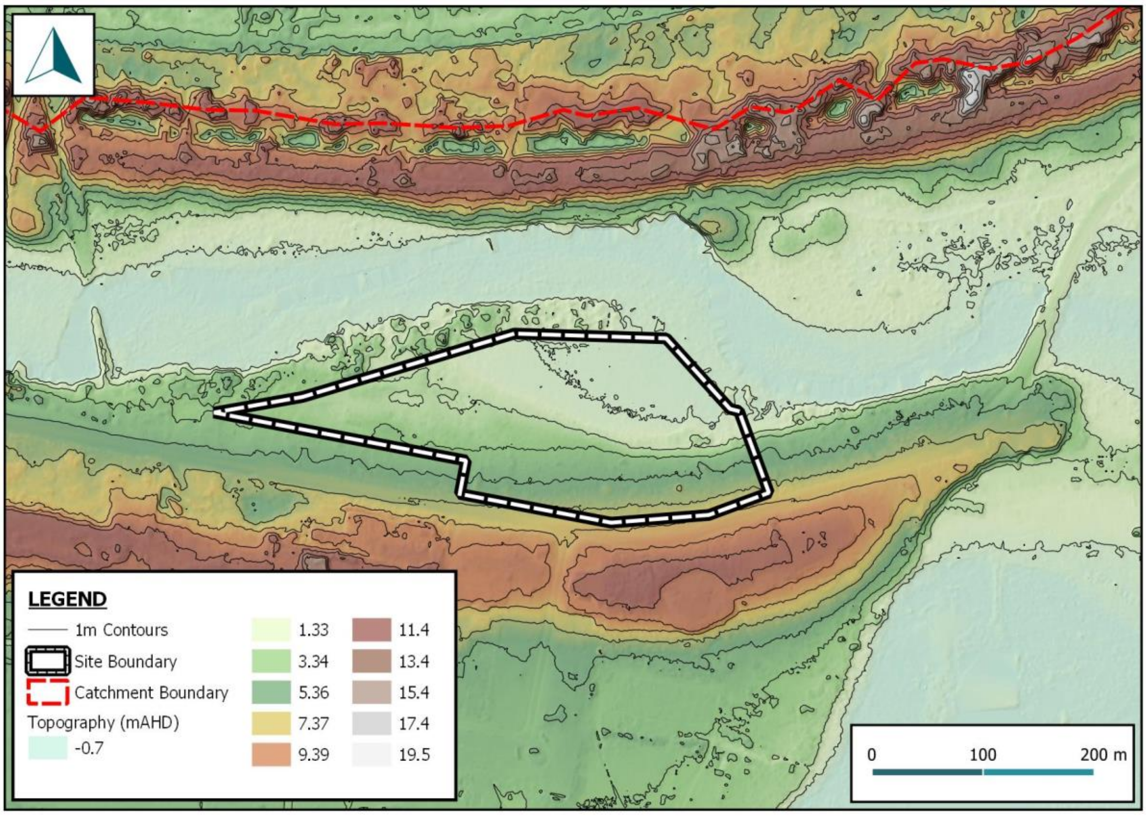


Figure 2-2 Study Area DEM

2.4 EXISTING STORMWATER INFRASTRUCTURE

Existing stormwater infrastructure located within the site services upstream catchments to the northeast of the site. Stormwater infrastructure in relation to the site can generally be seen in Figure 2-3.

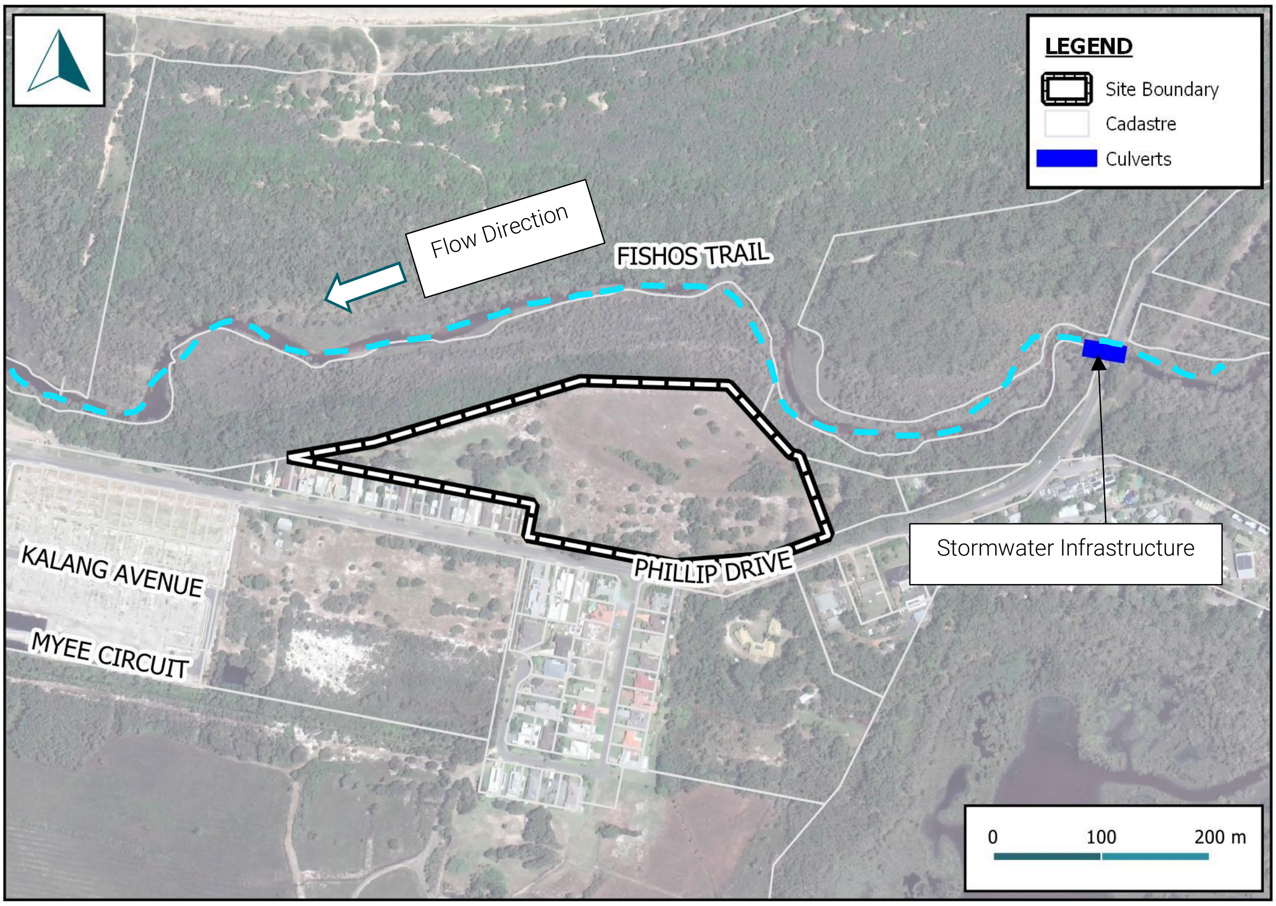


Figure 2-3 Existing stormwater infrastructure

3 PROPOSED DEVELOPMENT

3.1 GENERAL

The proposed development consists of town houses, dual occupation and a medium density residential development. The proposed development plan is provided in Figure 3-1

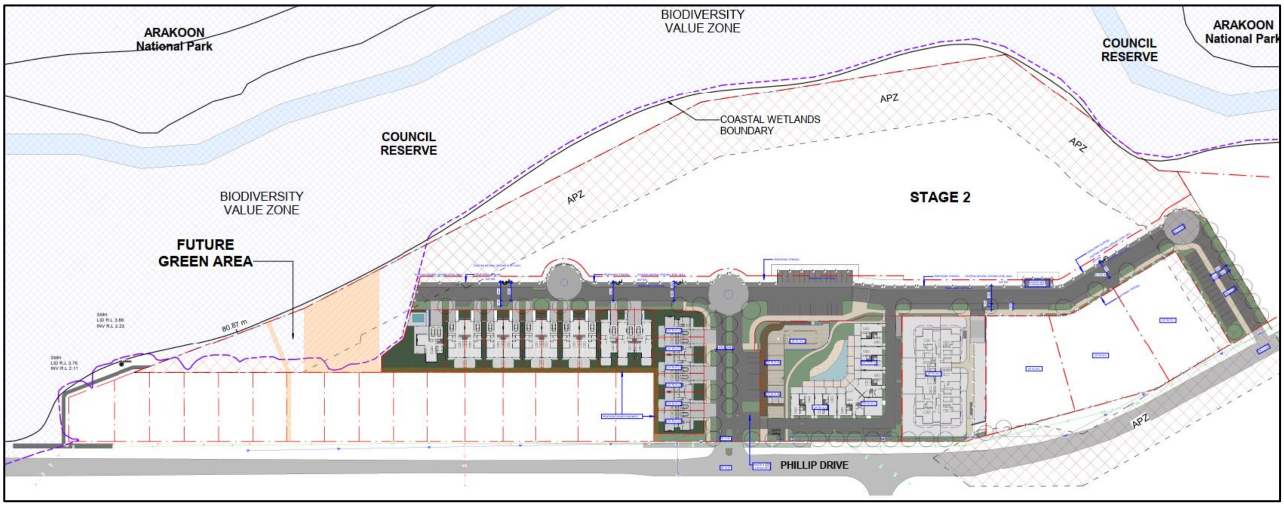


Figure 3-1 Proposed Development Site Plan – DA04.01, Rise Projects, 21.02.22

3.2 DEVELOPMENT STAGING

The proposed development is divided into three stages, and the Staging Plan is provided in Figure 3-2. For the purposes of this study both stages have been modelled (Stage 1 and the final development staging) and the impacts on flooding have been assessed.

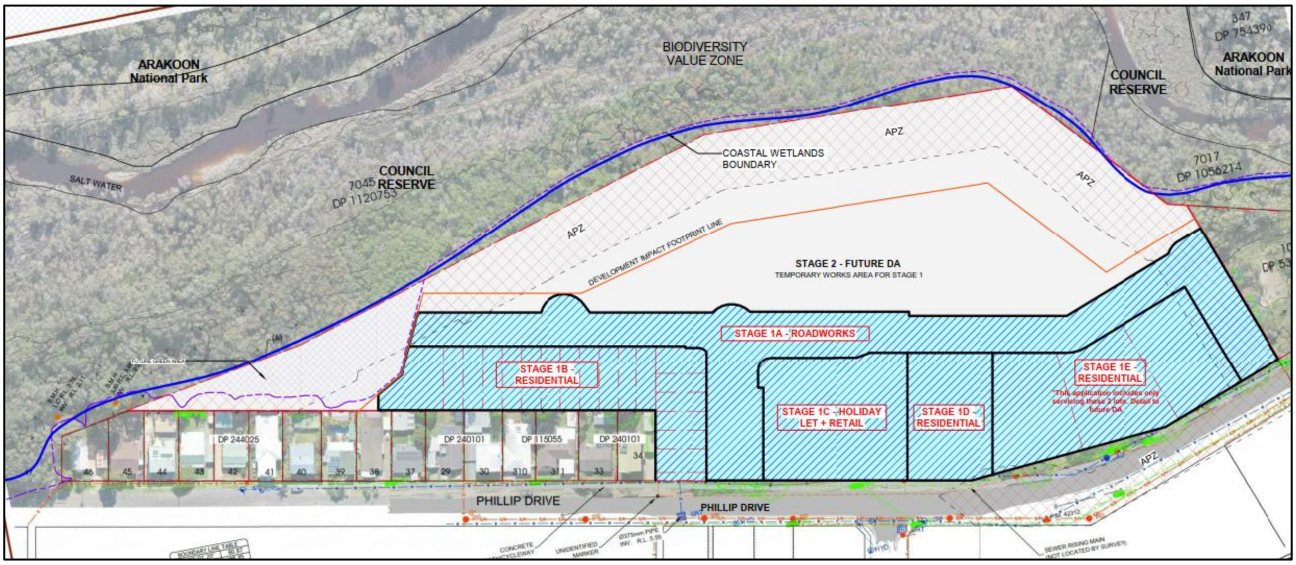


Figure 3-2 Staging Plan (DA03.03 Rev A, Rise Projects 21.02.22)

4 MODELLING APPROACH AND METHODOLOGY

This section provides a broad overview of the modelling approach, the methodology undertaken and the model development.

4.1 PROJECT INITIATION

A project initiation meeting was undertaken with de Groot Benson in July of 2021. Within this meeting the scope, methodology and timeframes for the project were confirmed as well as data requirements. The following details of specific concern to the flood modelling were discussed:

- The need to confirm appropriate assumptions for tailwater and boundary conditions;
- Initial water levels within Saltwater Lagoon (upstream of the site);
- Consideration of proposed boardwalk from site to Fishos Trail, and
- Need for initial flood planning levels to inform the civil design.

4.2 DATA COLLATION AND REVIEW

A high-level data review was undertaken as a gap analysis. The data was assumed to be fit-for-purpose for this study and as such was not analysed for data quality.

The following data was received and reviewed:

- Lower Macleay Flood Study (Jacobs, 2019);
- Saltwater Creek Flood Study (BMT WBM, 2006);
- Saltwater Creek & Lagoon, South West Rocks, Estuary Management Study & Plan (BMT WBM, 2006)
- Survey Data – Provided by the Client
- Nambucca LiDAR 2009;
- NSW Six Maps Data including:
  - Property Data
  - Land Use (Planning Scheme Zones)
  - Waterways and Hydro Areas; and
  - Roads and Rail.
- Email correspondence (20/07/21) with Council outlining the model needs to maintain consistency with the Lower Macleay Flood Study (Jacobs, 2019)
- Discussions with the Rise Projects and,
- Site Development Plans by Rise Projects (27/10/21).

4.3 MODEL DEVELOPMENT AND DESIGN EVENT MODELLING

The Saltwater Creek Flood Study was completed by BMT WBM in 2006, and defined design flood behaviour in the Saltwater Creek catchment. However, due to the age of the study and unavailability of the adopted flood model, KSC requested that a new model be established for the purposes of this assessment. Water Modelling Solutions therefore have developed a 2D TUFLOW model using Australian Rainfall and Runoff (ARR) 2019 methodologies and the latest available catchment information, including detailed site survey and LiDAR data (2009). In addition, WMS has taken cognisance of the Lower Macleay Valley Flood Study (Jacobs, 2019), and where appropriate, adopted similar approaches/parameters for consistency, noting however that the two systems differ significantly in scale.

4.3.1 Hydrology

As the catchment upstream of the proposed development is relatively small, the method utilised to undertake the hydrology for the Phillip Drive, South West Rocks development, was a rain-on-grid approach. For a small catchment, rain-on-grid is an efficient methodology as it is integrated within the hydraulic model and therefore there is no requirement to build separate hydrologic and hydraulic models.

The rain-on-grid approach was undertaken for the whole catchment, which is approximately 9 km². The hyetographs for the rain-on-grid modelling were obtained for the 1% AEP events for a selection of five key durations and ten temporal patterns from the ARR2019 Data Hub (Commonwealth of Australia, 2019) utilising the in-built TUFLOW ARR tool. The tool interfaces directly with the ARR2019 Data Hub and obtains the relevant hyetographs based on the catchment shape file input and the requested events, durations and temporal patterns.

The property is located within the Macleay River Region and use the East Coast South temporal pattern zone, spatial patterns are not required due to the small size of the catchment.

For the purposes of efficiency for this study, a selection of 5 key durations has been modelled. The 5 key durations modelled were the 270-minute, 360-minute 540-minute, 720-minute and 1080-minute. Further details are provided in Sections 5.

4.3.2 Model Development

The hydraulic modelling was undertaken utilising the industry standard software TUFLOW HPC. The model construction was undertaken in a stepwise format to ensure that all aspects of the model build were robust and that checks were undertaken to ensure model health.

A high-level summary of the stages of the model build are provided in Sections 5 and Section 6.

4.3.3 Staging Approach

Three design scenarios in total have been considered within this study and include:

- Existing Case;
- First Stages Developed Case and,
- Final Developed Case.

The First Stages Developed Case and Final Developed Case were modelled assuming the development is above the 1% AEP design event water surface elevation.

5 HYDROLOGIC MODELLING

5.1 RAINFALL

The average centroid of the contributing catchment's latitude and longitude were used as inputs to the Australian Bureau of Meteorology website to extract the Intensity Frequency Duration (IFD) Table which was used within the TUFLOW model.

The Design Rainfall Data System (2016) was used to extract IFD tables for the infrequent rainfall events.

The adopted IFD table is provided in Table 5-1.

Table 5-1 IFD Infrequent Depths Table (Australia Bureau of Meteorology)

Duration	Annual Exceedance Probability (AEP)						
	63.20%	50%	20%	10%	5%	2%	1%
1 min	2.65	2.99	4.08	4.84	5.6	6.63	7.43
2 min	4.44	5.03	7.03	8.52	10.1	12.4	14.3
3 min	6.2	7.01	9.74	11.8	13.8	16.9	19.3
4 min	7.82	8.83	12.2	14.6	17.1	20.6	23.4
5 min	9.29	10.5	14.4	17.1	20	23.9	27
10 min	15	16.8	22.8	26.9	31	36.5	40.7
15 min	18.8	21.2	28.7	33.9	39	45.7	51
20 min	21.7	24.5	33.2	39.3	45.3	53.3	59.5
25 min	24.1	27.1	36.9	43.7	50.5	59.7	66.8
30 min	26	29.3	40	47.5	55.1	65.3	73.3
45 min	30.4	34.3	47.2	56.5	65.9	78.9	89.3
1 hour	33.6	38	52.7	63.3	74.2	89.5	102
1.5 hour	38.5	43.7	60.9	73.6	86.9	106	121
2 hour	42.4	48.1	67.4	81.7	96.8	118	136
3 hour	48.6	55.3	77.7	94.5	112	138	159
4.5 hour	56.2	63.9	90	110	130	160	184
6 hour	62.5	71.2	100	122	145	177	203
9 hour	540	73.3	83.5	118	142	168	204
12 hour	720	82.4	94	132	160	188	227
18 hour	1080	97.4	111	156	188	221	264
24 hour	1440	110	125	176	212	248	295

5.2 TEMPORAL PATTERNS

ARR 2019 temporal patterns have been adopted for the analysis.

The temporal patterns adopted within the hydraulic models were taken from Chapter 5 of Book 2 of ARR 2019. The site is situated in the East Coast South region of Figure 5-1.

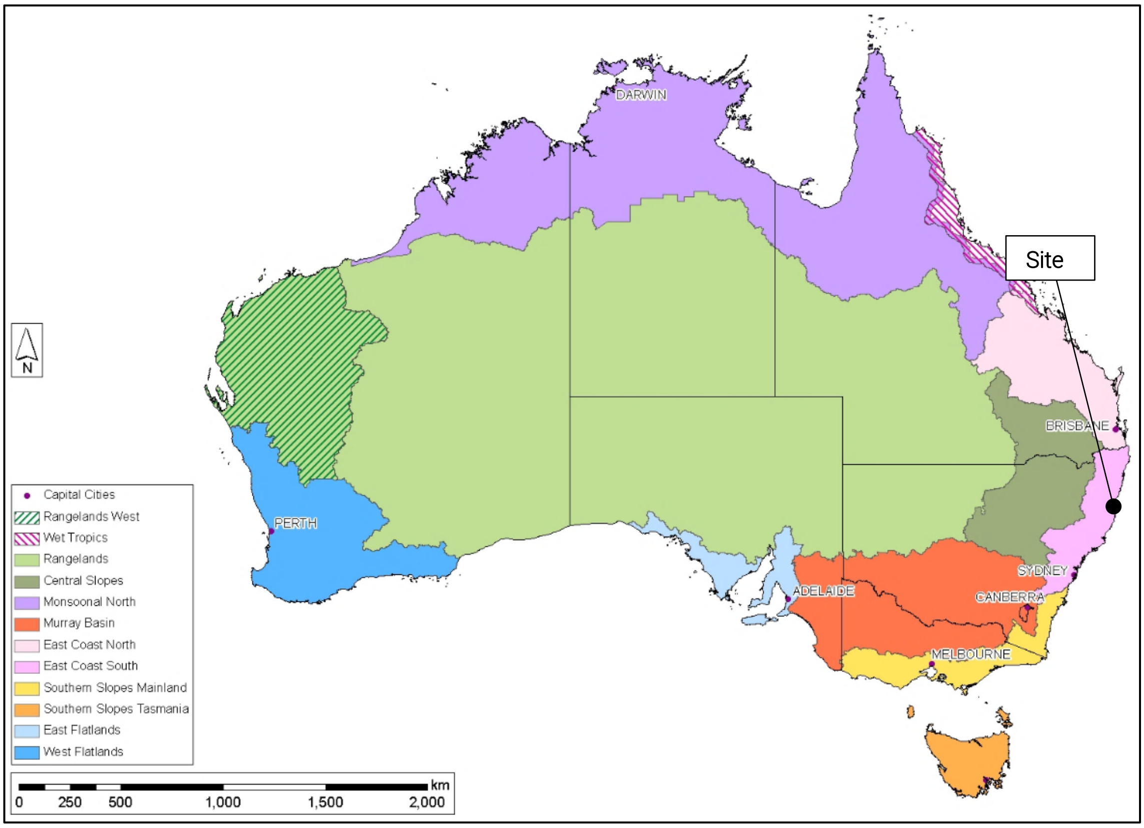


Figure 5-1 Temporal pattern regions (AR&R 2019)

5.3 PROBABLE MAXIMUM PRECIPITATION

The following table represents the rainfall depths adopted for the PMP estimates for the site. PMP's were calculated using the GSDM method. The critical PMP duration for the site was determined to be the 6hour storm event. Detailed calculations are provided in Appendix D.

Table 5-2 PMP Rainfall Depths

Duration (mins)	PMP Depth (mm)
0.25	160
0.5	230
0.75	300
1	350
1.5	450
2	520
2.5	580
3	630
4	720
5	790
6	840

5.4 RAINFALL LOSSES

Design rainfall losses for the assessment were adopted based on the losses from the Lower Macleay Flood Study (Jacobs, 2019), as per the extract shown in Figure 5-2. These losses are considered appropriate for application in the Saltwater Creek catchment given its proximity to the Macleay River catchment, as well as sharing similar catchment characteristics. An initial loss value of 0 mm and a continuing loss value of 2.0 mm/hr was adopted with the modelling (refer Figure 5-2).

The rainfall initial loss and continuing loss values were applied to the pervious areas within the hydrologic models. Impervious areas had an initial loss value of 0mm and a continuing loss value of 0.0mm/hr. These values are lower and more conservative than ARR 2019 design rainfall losses.

Flood Event	Rainfall Losses	Comment
Design flood events	IL 0mm, CL 2mm/hr	Based on model calibration to 1949, 1963, 1977 and 1980 historic flood events in Macleay River Flood Study (Webb McKeown and Associates, 1989). Lower and more conservative than ARR 2019 design rainfall losses.
March 2001	IL 70mm, CL 0.7mm/hr	Same as those in calibration of the WBNM hydrologic model in Kempsey Flood Study Hydraulic Modelling Report to 2001 event (Webb McKeown and Associates, 2009)
February 2013	IL 15mm, CL 0.7mm/hr	Initial loss selected from review of rainfall data prior to main burst on 22-23 February. Note that 50mm (inland areas) to 200mm (coastal area) of rain fell in the week prior to the 22 February.

Figure 5-2 Losses Extract from the Lower Macleay Flood Study

6 HYDRAULIC MODELLING

During the initial stages of the Flood impact Assessment WMS contacted Kempsey Shire Council to request model data. The Council's planning team indicated that there was very limited information related to flooding for the Saltwater Creek catchment and no model available.

A 2D hydraulic model was developed using TUFLOW version 2020-10-AA. The latest versions of TUFLOW incorporate the HPC (Heavily Parallelised Compute) model run engine. TUFLOW HPC is an explicit solver for the full 2D Shallow Water Equations (SWE), including a sub-grid scale eddy viscosity model. HPC can be used in GPU (Graphics Processing Unit) mode to improve simulation speed. TUFLOW HPC GPU was used for this assessment.

6.1 MODEL DEVELOPMENT

6.1.1 Model Extent

The model extent was defined to capture the Saltwater Creek and Saltwater Lagoon catchments within the vicinity of the study area. The total model extent is approximately 9km² and uses a 5m grid to define the model cell size.

The model terrain was sourced from Geosciences Australia and is comprised of 1m resolution Nambucca LiDAR flown in 2009. The LiDAR was inspected and found to be of good quality and generally consistent with recent aerial imagery. The hydraulic model extent and terrain is shown in Figure 6-3.

6.1.2 Boundary Conditions

The downstream boundary of the TUFLOW model is located approximately 2 km downstream of the Site to the west. A static tailwater level boundary condition of 2.0mAHD has been adopted based on the Lower Macleay Flood Study which represents a conservative approach as per the Lower Macleay Flood Study Tailwater Conditions (Figure 6-1). The model boundary location is shown in Figure 6-3.

Design Flood Envelope AEP	Dominant Flood Mechanism	Flood Event AEP			
		Macleay River	Local Catchment	Maria River	Ocean
0.2EY (i.e. 1 in 5)	Macleay River	0.2EY	0.2EY	0.2EY	HHWS(SS) 1.25m AHD
	Maria River	N/A. Incorporated into Macleay River flood run.			
	Ocean	N/A. HHWS(SS) is highest recommended TWL.			
5%	Macleay River	5%	5%	5%	HHWS(SS) 1.25m AHD
	Maria River	N/A. Incorporated into Macleay River flood run.			
	Ocean	N/A. HHWS(SS) is highest recommended TWL.			
1%	Macleay River	1%	1%	5%	5% Type B. TWL 2.0m AHD

Figure 6-1 Lower Macleay Flood Study Extract – Boundary Conditions

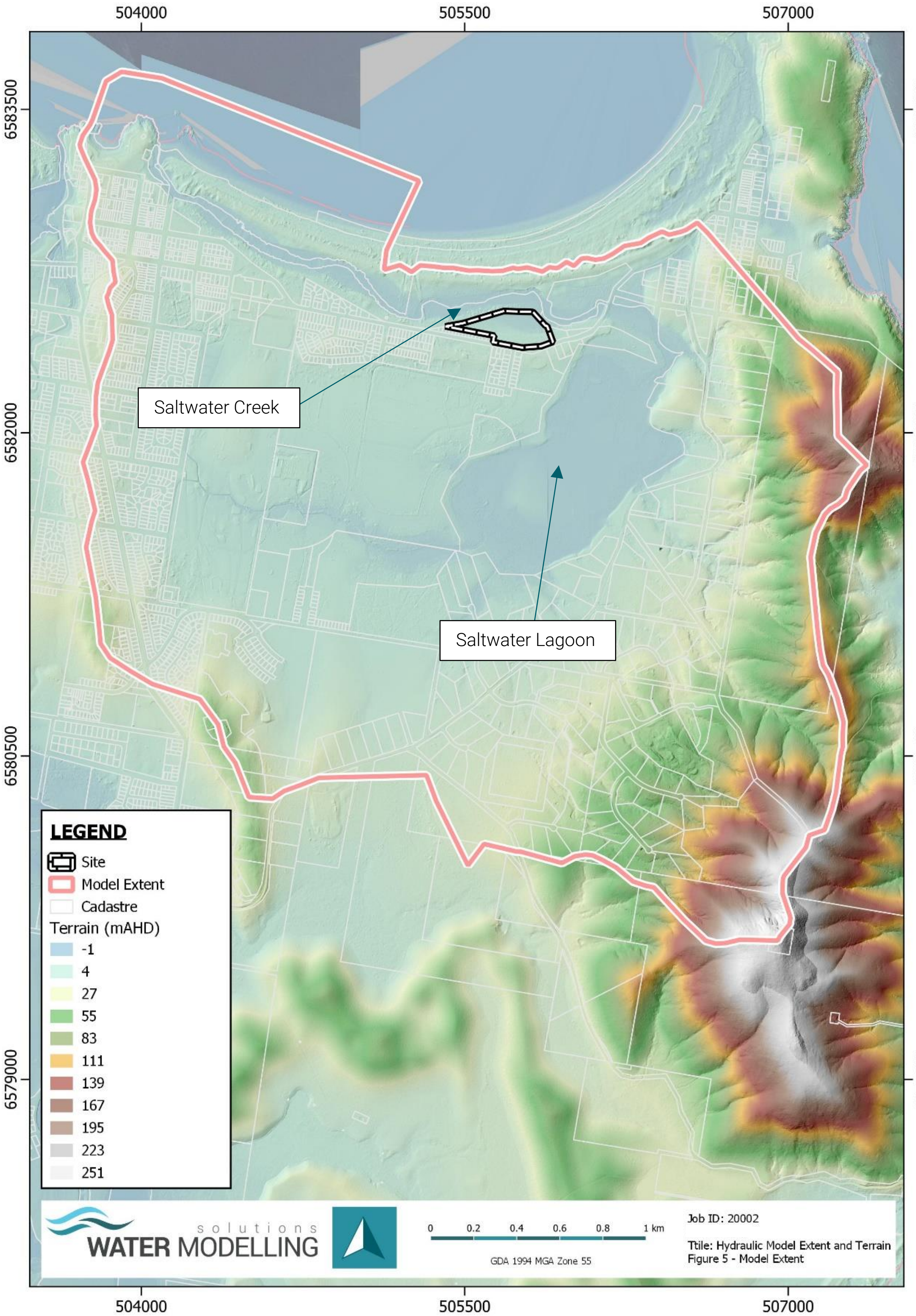


Figure 6-2 Hydraulic Model Extent and Terrain

Figure 6-3 Hydraulic Model Layout

6.1.3 Hydraulic Roughness

The Mannings 'n' values adopted for the FIA comply are outlined in Table 6-1. The spatial hydraulic roughness distribution is shown in Figure 6-4. These roughness values have been delineated based on inspection of aerial imagery and google street view. The values are in line with roughness value ranges outlined in Book 6 of the ARR 2019 Guidelines.

Table 6-1 Roughness (Mannings 'n') Values

Number	Description	'n' value
1	Waterways	0.025
2	Floodplain	0.03
3	Swamp	0.06
4	Light Vegetation	0.06
5	Medium Density Vegetation	0.08
6	Heavy Density Vegetation	0.12
7	Pavement or Roads	0.02
8	Low Density Residential	0.06
9	Urban Commercial or Industrial	0.04
10	Grass/Open Space	0.03
11	Buildings	1
12	Gravel	0.03
13	Sand	0.02

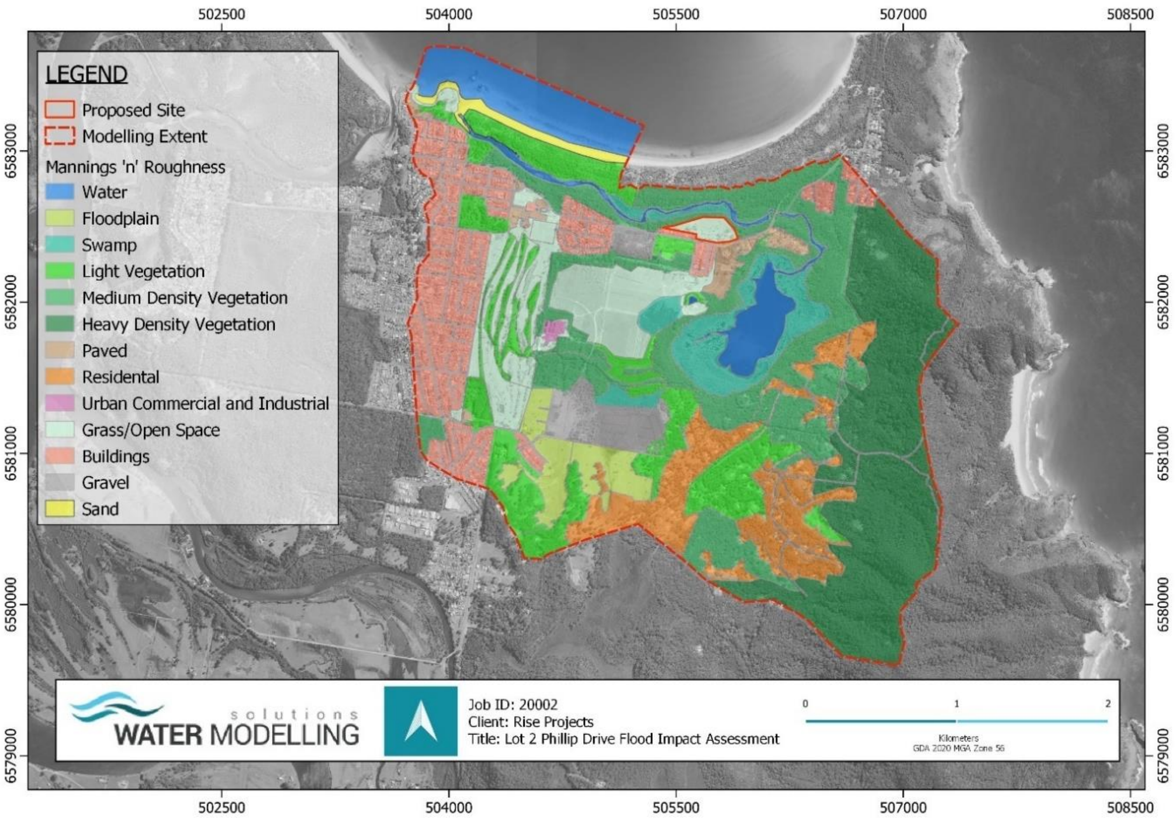


Figure 6-4 Existing Conditions Mannings 'n' Roughness Layer

7 RESULTS

7.1 1% AEP EXISTING CONDITIONS

The modelling of the catchment under existing conditions demonstrates that the majority of the flow path travels from east to west through a well-defined drainage reserve north of the site. The northern portion of the site is flood affected during the 1% AEP flood event under existing conditions.

The critical duration for the 1% AEP event is 720 minutes (12 hours). As the majority of the site is covered by the 720-minute critical duration, this is the adopted duration for further site analysis in the 1% AEP event. The key temporal pattern for the 720-minute duration is temporal pattern four.

Figure 7-1 illustrates the existing conditions 1% AEP flood depth results.

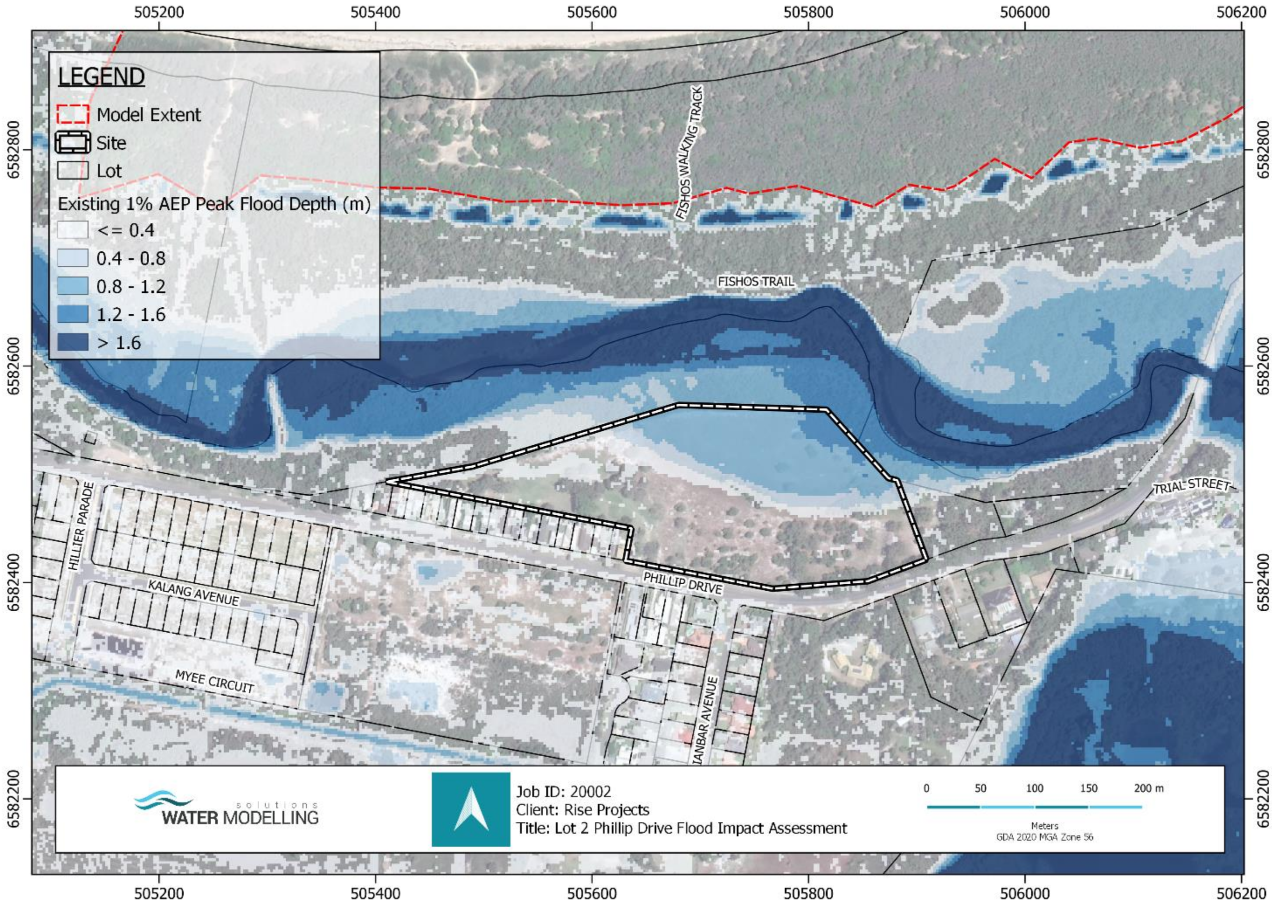


Figure 7-1 1% AEP Existing Flood Depth

7.2 INITIAL STAGING

7.2.1 1% AEP Initial Staging Conditions

As can be seen in Figure 7-2 below, the 1% AEP first staging conditions flood behaviour in the outer reaches of the catchment, is much the same as in existing conditions. The 1% AEP flood level does not reach the initial staging development area so the changes to flood velocity and level are very minor. Detailed flood mapping is also provided in Appendix B.

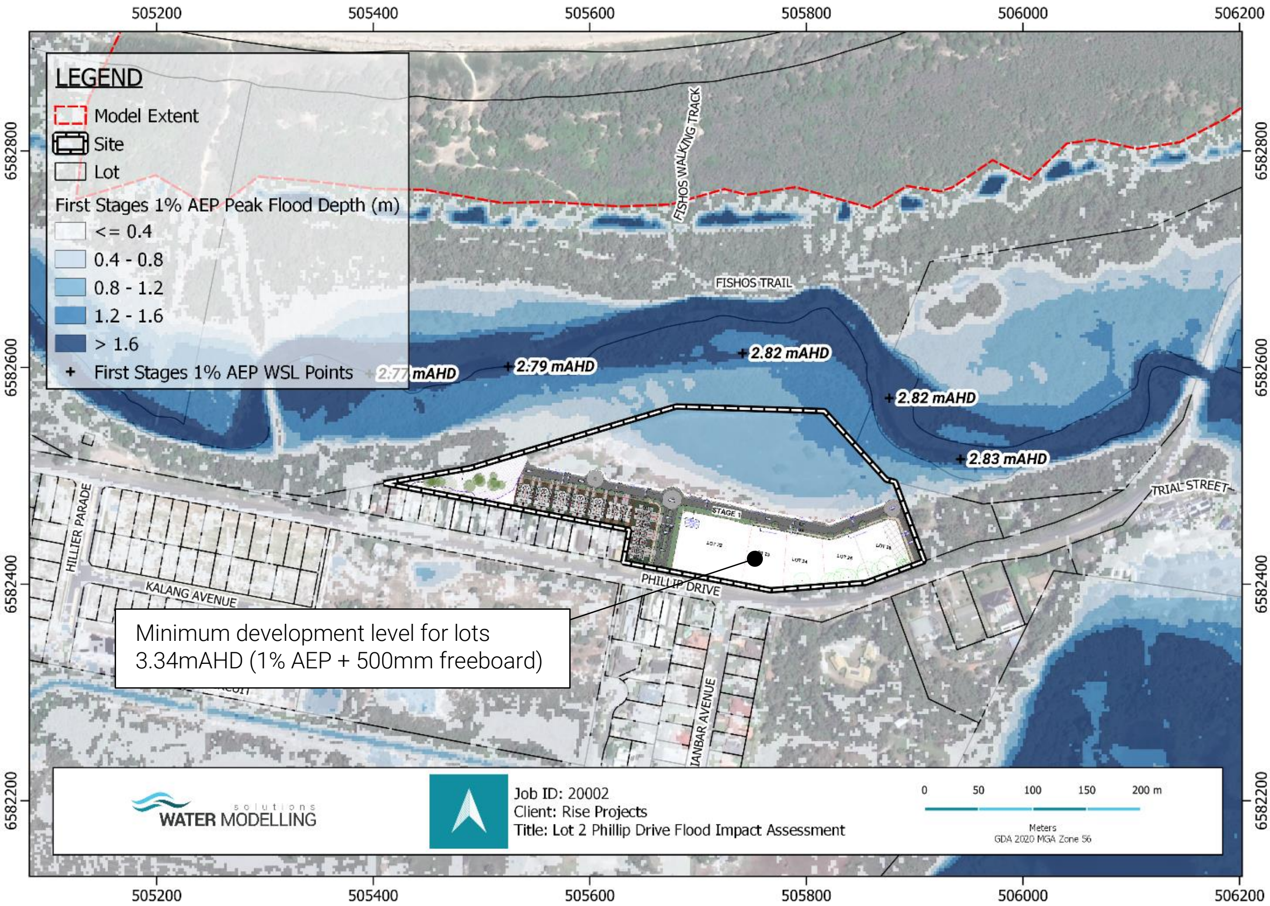


Figure 7-2 1% AEP Developed Flood Depth (Initial Stages)

7.2.2 1% AEP Water Surface Level Differences (Initial Stages Development Conditions)

An impact map is the difference between the water surface elevation of the developed conditions and the water surface elevation of the existing conditions. The impact map clearly highlights the areas where flood waters are increased or decreased due to development or changes in topography. In the impact maps below, yellow, orange and red colours indicate and increase in flood levels, whereas blue and green colours indicate a decrease in flood levels.

In the 1% AEP flood event, the inclusion of the initial staging design tin creates minor water level afflux at the boundary of the initial staging development, but this is generally maintained within the site development boundary. There is a small, localised area of afflux (up to 30 mm) on the North-West side of the development, but this occurs on crown land.

The change in flood levels due to the development are highlighted in Figure 7-3. Detailed flood mapping is also provided in Appendix B.

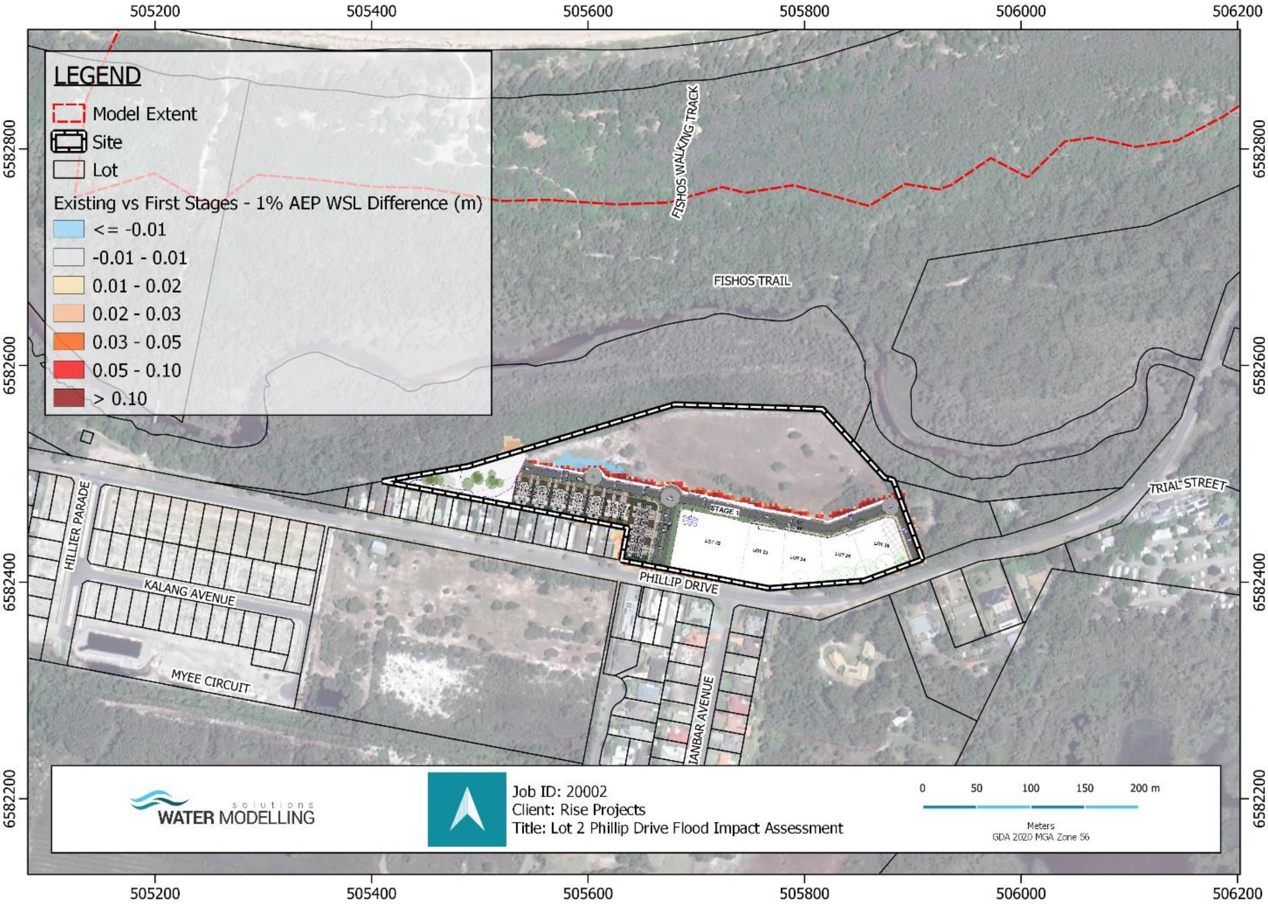


Figure 7-3 1% AEP Water Surface Level Difference (Existing vs Initial Stages)

7.3 FINAL DEVELOPMENT

7.3.1 1% AEP Final Development Conditions

As can be seen in Figure 7-4 below, the 1% AEP developed conditions flood behaviour in the outer reaches of the catchment is similar to the existing conditions. However, once the flooding reaches the proposed development site, the flood water is deflected by the outer ring road (2.84 m AHD) as this is situated above the water level of the creek. This means that the volume of water that would have previously passed through the site is instead constricted to the creek channel. This causes minor impacts to velocities and water levels as discussed below. Detailed flood mapping is also provided in Appendix B.

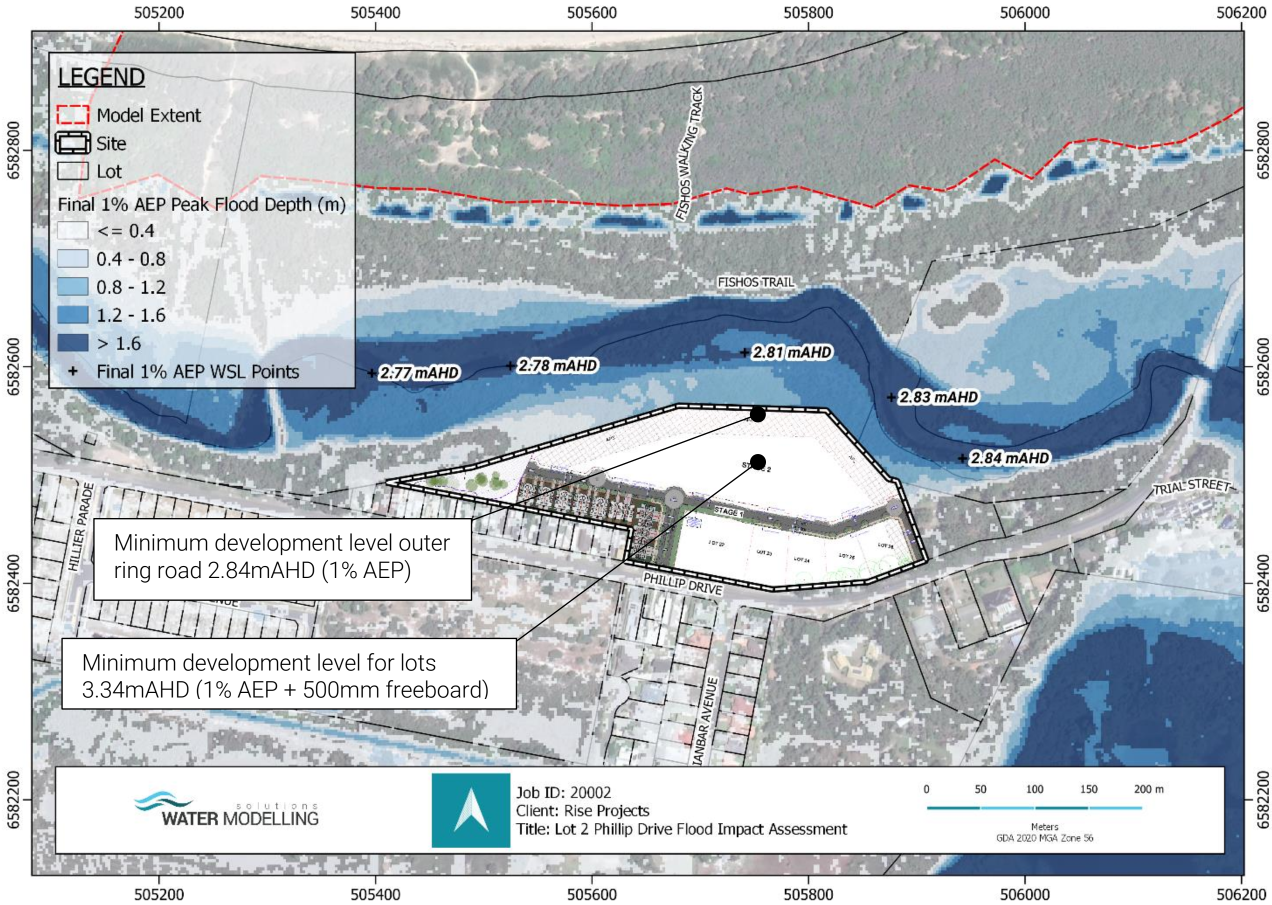


Figure 7-4 1% AEP Flood Depth (Final Development)

As can be seen in Figure 7-5, the 1% AEP developed conditions flood velocites are generally similar to the existing conditions. However, there are two locations in the Saltwater Creek channel where the final development causes a velocity increase of 0.2 – 0.5 m/s (occuring approximately 30 m and 70 m North of the site boundary). This increase, however, is not very significant given that peak flood velocities in this area remain less than 0.6 m/s.

There is also an area where velocity increase is between 0.5 – 1m/s on the downstream side of the site boundary (on crown land). However, this occurs at very shallow flood depths. Detailed velocity flood maps are provided in Appendix B.

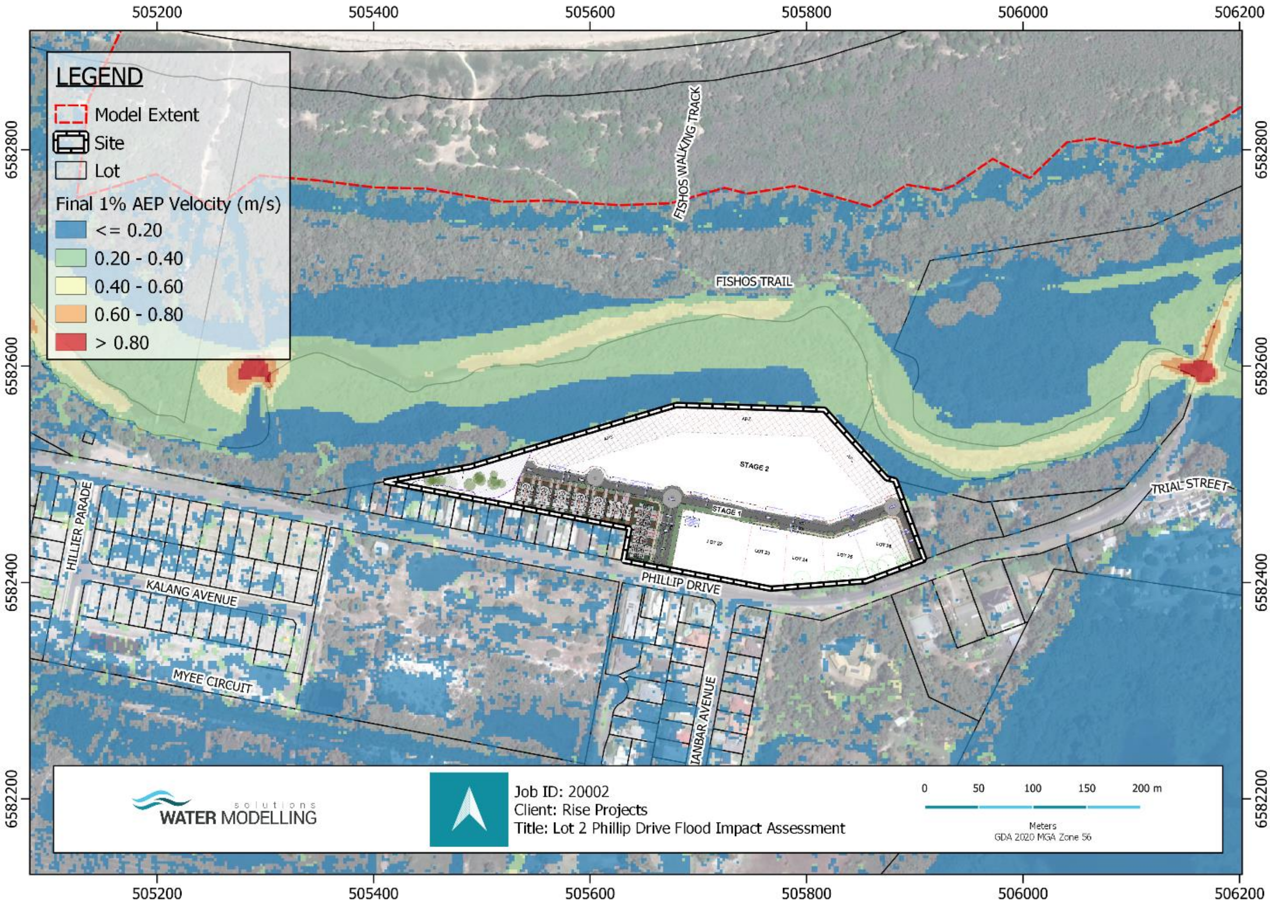


Figure 7-5 1% AEP Velocity (Final Development)

7.3.2 1% AEP Water Surface Level Differences (Final Development Conditions)

An impact map is the difference between the water surface elevation of the developed conditions and the water surface elevation of the existing conditions. The impact map highlights the areas where flood waters are increased or decreased due to development or changes in topography. In the impact maps below, orange and red colours indicate and increase in flood levels, whereas blue and green colours indicate a decrease in flood levels.

There is an increase in flood levels of 10 – 20 mm upstream of the site boundary, that occurs across an area of approximately 6 Ha (to the North-East of the site boundary). Although this is a relatively large area, the flood level increase is somewhat negligible as it occurs on crown land and does not impact any properties or structures.

The change in flood levels due to the final development are highlighted in Figure 7-6. Detailed flood mapping is also provided in Appendix B.

The development will cause minor changes in flood levels during the 1% AEP flood event (10-20mm), however, these changes are limited to undevelopable state and council reserve land, and areas which already receive a high degree of flooding. The development will not cause an actionable nuisance with quantifiable loss to upstream, downstream or neighbouring properties. Based on the outcomes of the detailed hydraulic modelling, we do not foresee any reasonable concerns that would preclude this development from being approved by council from a flood management perspective.

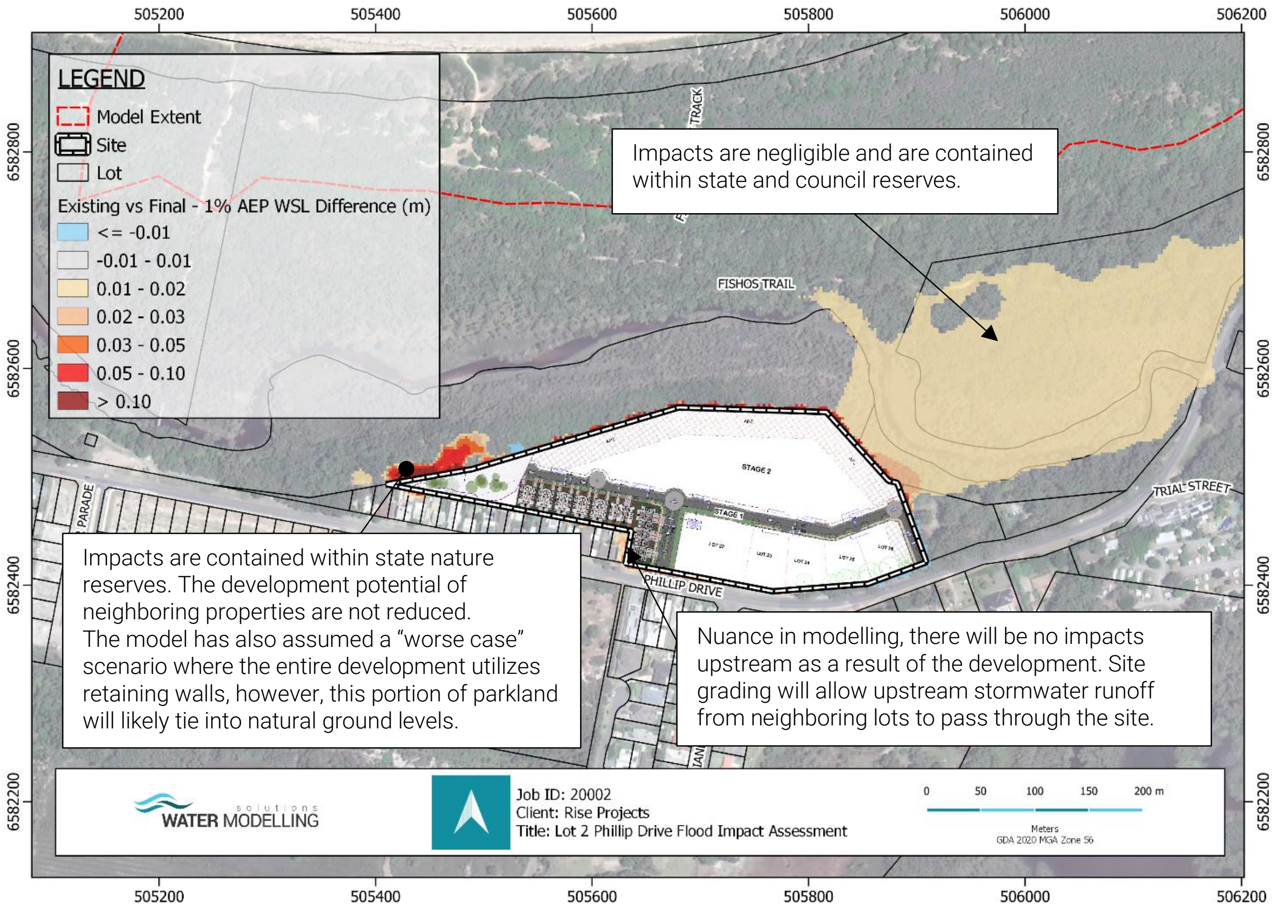


Figure 7-6 1% AEP Water Surface Level Difference (Existing vs Final Development)

7.3.3 Probable Maximum Flood

The PMF developed conditions flood behaviour can be seen in Figure 7-4 below. The maximum water surface level observed within the adjacent creek is approximately 4.65AHD. Further discussions on the PMF and evacuation routes for the site are provided in Section 8.

Detailed flood mapping for the PMF events are also provided in Appendix C.

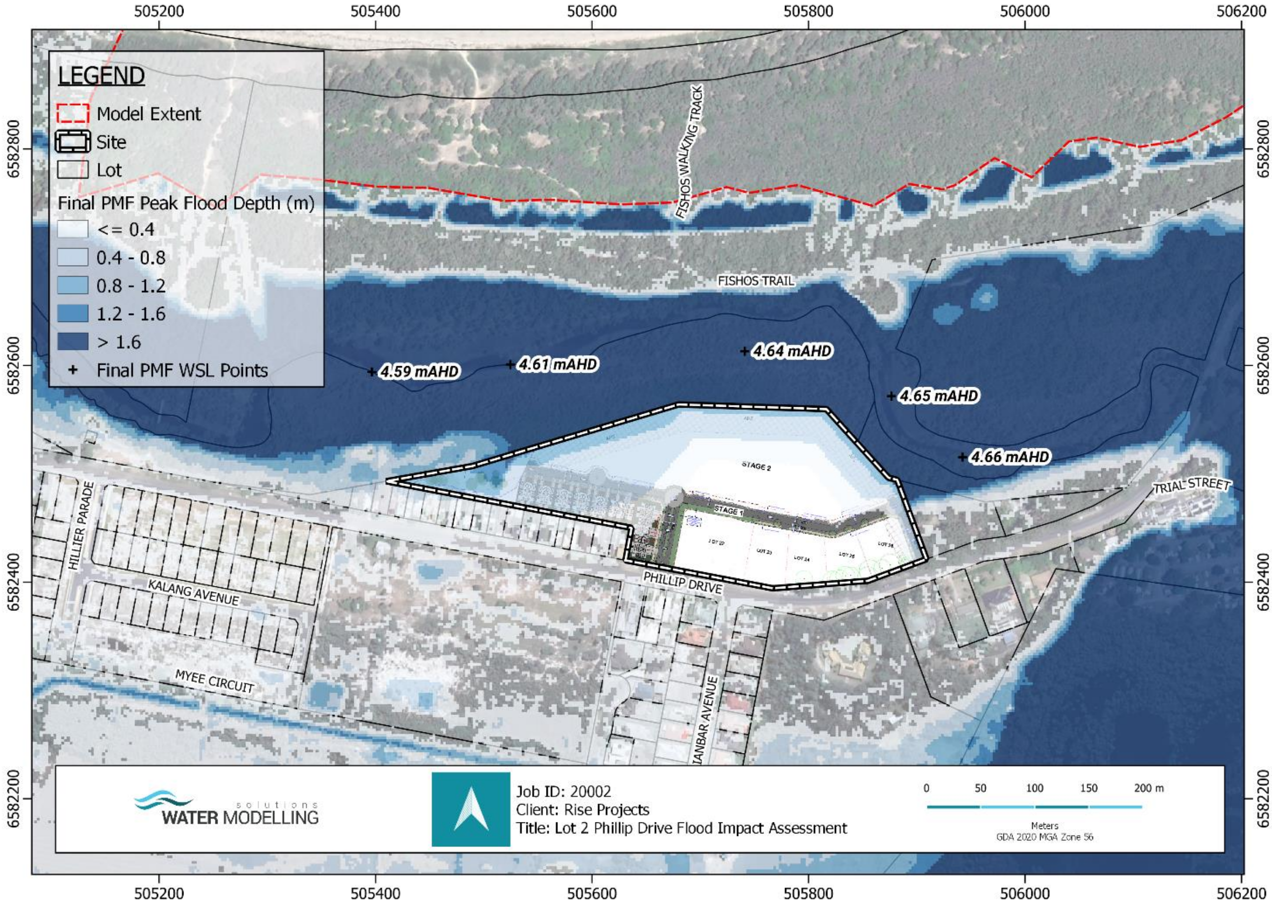


Figure 7-7 PMF Water Surface Level Final Development

8 EVACUATION AND EMERGENCY RESPONSE

8.1 OBJECTIVES

The proposed development is required to demonstrate compliance with the Kempsey LEP 2013, Clause 5.21 – Flood Planning.

A core objective of the LEP and the Floodplain Development Manual (NSW Government, 2005) is to enable safe occupation and efficient evacuation of people in the event of a flood. Development consent must not be granted to development on land within the flood planning area unless Council is satisfied that the development will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood.

The Kempsey DCP 2013 further includes the following controls pertaining to developments in the Flood Planning Area:

6.2 Evacuation Planning
New developments must demonstrate that the development will not place additional strain on emergency services.

6.3 Emergency Response Provisions
(b) (iii) New subdivisions: All new subdivision to have high level road evacuation route(s) to land above PMF level, accessible to all allotments via (as a minimum) pedestrian access at or above design flood level not exceeding 100m in length.

8.2 FLOOD EMERGENCY RESPONSE CLASSIFICATION

Flood emergency response classifications are defined by the Australian Disaster Resilience Handbook Collection Guideline 7-2, which divide the floodplain into six categories as shown below. Each category has specific evacuation requirements and constraints to be considered at the planning stage. The site at Lot 2 Phillip Drive is classified as "No Flood Impacts", as the entire site is not flood affected in the PMF, and services east of the site are accessible via Phillip Drive.

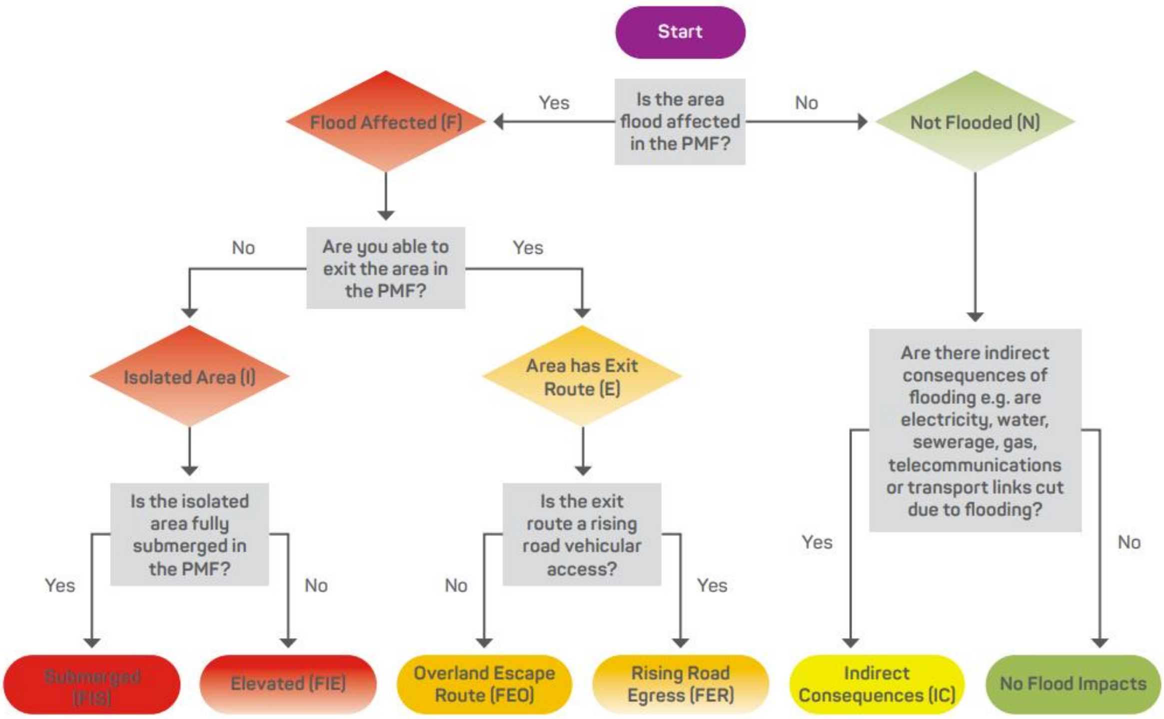


Figure 8-1 Flow chart for determining flood emergency response classifications

8.3 EVACUATION CAPABILITY AND ROUTE

As shown in Figure 7-7, there is an area of 2.1 Ha above the PMF level, in which occupants could safely shelter during a PMF. In addition, safe egress to South West Rocks is available via Phillip Drive. Evacuation capacity is not expected to be a constraint for the safe occupation and egress from the site.

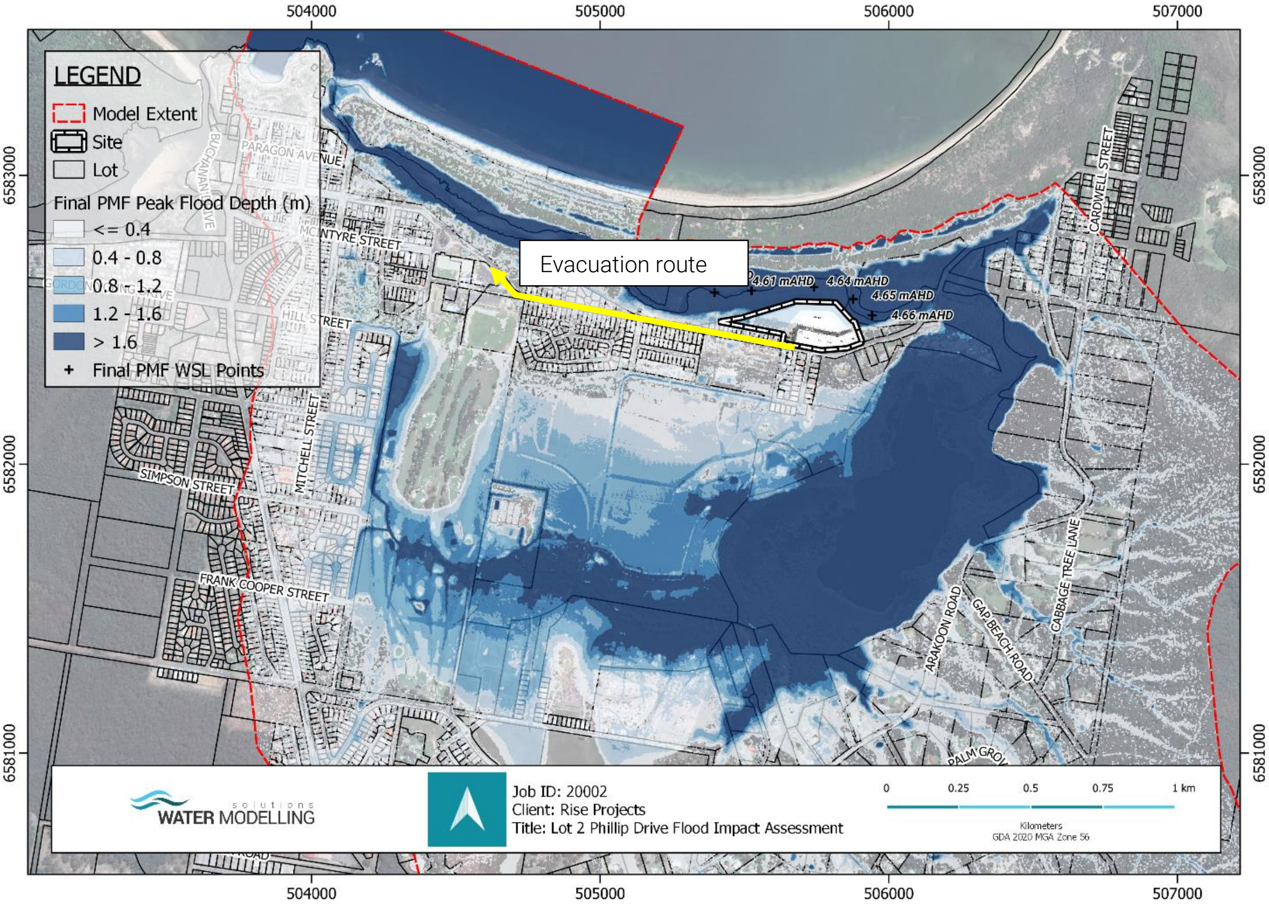


Figure 8-2 Evacuation route

9 COMPLIANCE WITH FLOOD RELATED DEVELOPMENT CONTROLS

The proposed subdivision is located within the Saltwater Creek floodplain, and is required to demonstrate compliance with the following:

- Kempsey Local Environmental Plan (LEP) 2013, Clause 5.21 (Formerly Clause 7.3)
- Kempsey Development Control Plan – Chapter B7 – Flood Hazard Area Management
- Council Policy No. 1.1 – Development Control Policy;
- Council Procedure No. 1.1.11 – Flood Risk Management; and
- Existing adopted Flood Risk Management Plans.

For an urban subdivision in the flood planning area (not in a floodway), the applicable planning objectives and development controls are set out in Table 9-1.

Table 9-1 Flood Related Planning Objectives and Development Controls

Policy Reference	Control	Compliance ✓/✗	Comment
Kempsey Development Control Plan – Chapter B7 – Floodplain Management	6.2 Evacuation Planning New developments must demonstrate that the development will not place additional strain on emergency services.	✓	
	6.3 Emergency Response Provisions iii. Residential Subdivisions New subdivisions: All new subdivision to have high level road evacuation route(s) to land above PMF level, accessible to all allotments via (as a minimum) pedestrian access at or above design flood level not exceeding 100m in length.	✓	
Policy 1.1 – Development Control Policy, Procedure 1.1.11 Flood Risk Management	2.3 The Flood Planning Level Flood Planning Levels are the combination of the 1 in 100 flood levels and 0.5m freeboard and within the Policy are shown as minimum floor levels.	✓	
	6.3.5 Urban Subdivision a) When land is within a flood prone area, subdivisions will not be approved unless contour surveys of land by a Registered Surveyor or qualified Engineer show that at least 500 square metres of each proposed lot will be above the 1 in 100 and/or highest flood level	✓	1% AEP (1 in 100 year event) is considered in this report.
	b) The 500m^2 identified in the subdivision is to be utilised for the erection of buildings on the site.	✓	
	c) In respect to the villages subdivisions may be permitted provided that it can be shown that the product of the depth and velocity of flow of waters during a 1 in 100 flood is equal to, or less than, one (1). (See Annexure 5), and suitable and adequate arrangements can be made for evacuation.	✓	Flood hazard (D x V product) is less than 1 within, and near, the proposed site.
	If filling is to be considered, the maximum depth of filling is not to exceed 1 metre.	N/A	*Filling is required to provide flood immunity to the site. Detailed hydraulic modelling was undertaken and demonstrates the no actionable nuisance with quantifiable loss will be cause as a result of the filling*

Policy Reference	Control	Compliance ✓/×	Comment
	8.Flood Proofing 8. 1 Earth Mounds When the method of flood proofing a building is to elevate the structure on an earth mound it shall have a minimum crest level equal to the 1 in 100 flood applicable and extending a minimum of 4m beyond the dwelling or structure. The habitable floor level to be at a minimum level of 500mm above the 1 in 100 flood level. The mound is to be constructed of compacted earth material able to withstand flooding, with side batters a maximum of 1 in 5.	✓	*The finished surface level of the development lots will be 500mm above the 1% AEP water surface depth*
	8.2 Elevated Buildings Where earth mounds are not appropriate, for example, where they adversely affect the behaviour of flood flows by concentrating and diverting floodwaters to adjacent development, the building shall be supported on piers, columns or piles to enable floodwater to pass beneath. Enclosed stairways and laundries may be acceptable at ground level provided they do not exceed 10 square metres in area. The structure shall be designed by a practising Structural Engineer to ensure that all structural members will withstand the forces created by floodwater and debris.	✓	*The finished surface level of the development lots will be 500mm above the 1% AEP water surface depth*
	8.3 Electrical Installations Electrical switchboards and fixed electrical installations should be located at a minimum level of 500mm above the 1 in 100 flood level; electrical circuits to areas below flood level should be separated from circuits serving areas above flood level. In the case of dairies located in flood prone lands, refrigeration and milk storage facilities should be located at a minimum level of 500mm above the 1 in 100 flood level.	✓	*The finished surface level of the development lots will be 500mm above the 1% AEP water surface depth.*

10 SUMMARY AND CONCLUSIONS

Development is proposed for a site that is located at Lot 2, Phillip Drive in South West Rocks in the Kempsey Shire Council LGA in New South Wales. The property is approximately 5 Ha in size and is proposed to be subdivided to support construction of Town House, Dual Occupation and a Medium Density Residential Development. The site is located within the Saltwater Creek catchment, with part of the site within the 1% AEP (Annual Exceedance Probability) extent as defined by the Saltwater Creek Flood Study (BMT WBM, 2006).

In order to facilitate the sub-division, the developer is proposing to construct a fill pad to ensure new development is at or above the required flood planning level. Due to the changes in land form, this flood impact assessment (FIA) is required to be submitted as part of the development application. Water Modelling Solutions have undertaken a full flood impact assessment using the design tin and design structures provided by Rise Projects. The fully dynamic industry standard software, TUFLOW, has been utilised to undertake the assessment.

This FIA report has shown the following:

- The proposed development is designed to withstand the effects of 1% AEP inundation of floodwaters, and
- The proposed development does not increase the flood hazard or flood damage to other properties or adversely affect them in any way during floods.

In existing conditions, the proposed site is flooded, in a 1% AEP event, to depths of up to 1.2m, particularly in the northwest corner, but also up to depths of 1m more broadly across the site.

In initial stage conditions, the flooding conditions are very similar to existing conditions with only minor flood level afflux experienced on crown land.

In final development conditions, the outer ring road is raised to a minimum level of 2.84mAHD. This causes a minor increase in flood velocities and water levels within Saltwater Creek. However, it has been demonstrated that any afflux outside the boundary of the property is generally under 20mm and is contained within a state and council reserves where the potential for development is unfeasible. The development will not cause an actionable nuisance with quantifiable loss to upstream, downstream or neighbouring properties.

11 REFERENCES

BMT Group Ltd (2007 – 2018), *TUFLOW, [Online] June 23rd, 2020, at < https://www.tuflow.com/>*

Commonwealth of Australia (Geoscience Australia), (2019), *ARR Data Hub, [Online] Wednesday 9th June, 2021, < https://data.arr-software.org/>.*

Department of Finance, Services and Innovation (Spatial Services) (2021), *Six Maps Clip & Ship, [Online] Wednesday 9th June, 2021, < https://maps.six.nsw.gov.au/clipnship.html>*

Jacobs (2019), Lower Macleay Flood Study, prepared for Kempsey Shire Council

BMT WBM (2006), Saltwater Creek Flood Study, prepared for Kempsey Shire Council

BMT WBM (2006), Saltwater Creek & Lagoon, South West Rocks, Estuary Management Study & Plan, prepared for Kempsey Shire Council

APPENDIX A

TUFLOW MODEL INPUTS

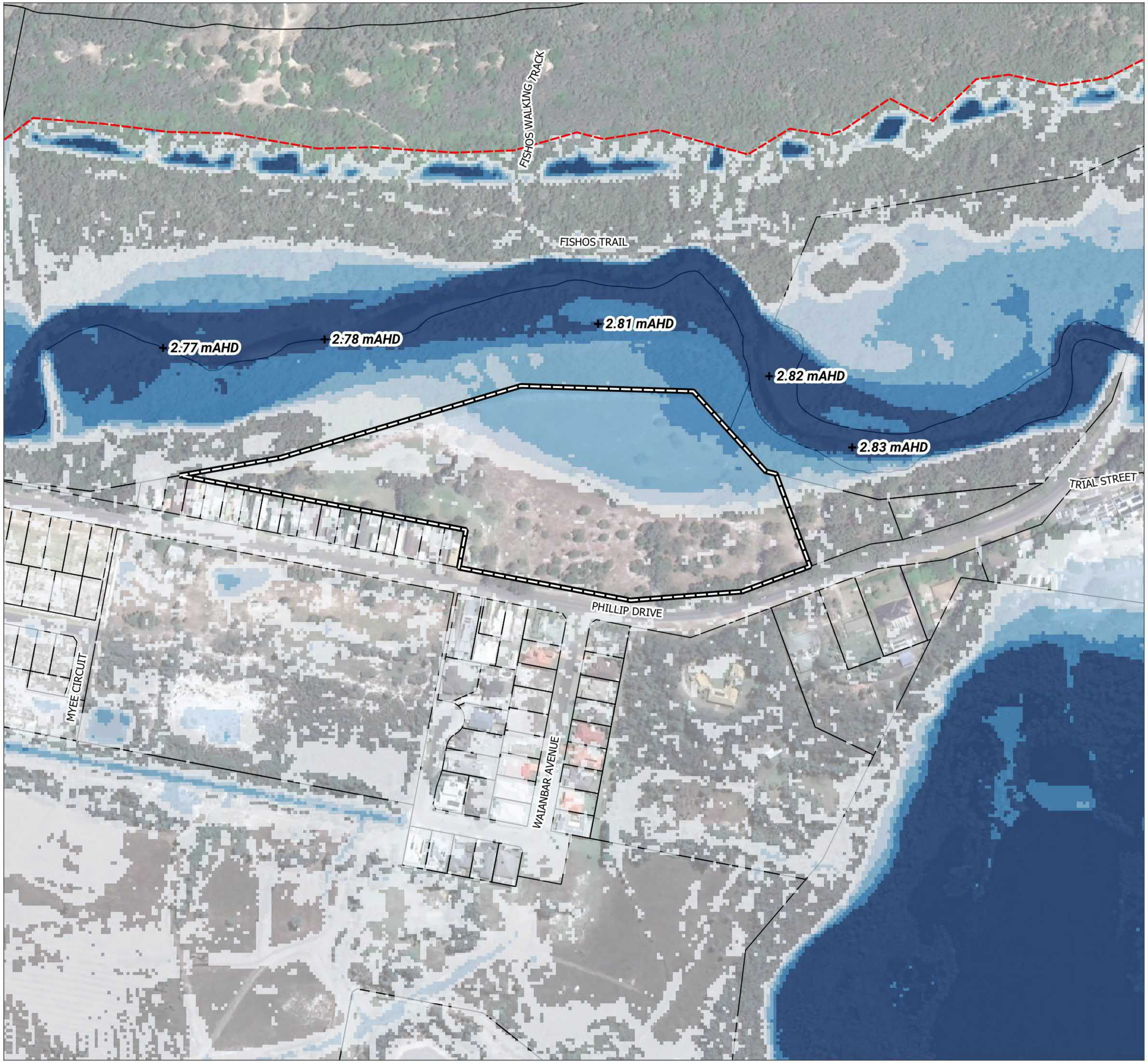
A.1 TUFLOW MODEL PARAMETERS

Table A-1 TUFLOW Model Parameters

Model Parameter	Value	Comments
TUFLOW Version	2020-10-AA-TUFLOW_iSP-w64	Utilising Sub Grid Sampling to Capture details in the channels
Guidelines	ARR2019 Kempsey Shire Council Development Guidelines	
LiDAR	1m Resolution	The coverage of this dataset is over the Nambucca region. The 1m metre Digital Elevation Model (DEM) is produced using TIN (Triangular Irregular Network) method of averaging ground heights to formulate a regular grid. This data set contains ground surface model in ASCII grid format derived from C3 LiDAR (Light Detection and Ranging) from an ALS50ii (Airborne Laser Scanner). The model is not hydrologically enforced. Standard Airbourne Laser Sensor (ALS) products are processed to ICSM standards level C3. This data has an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal with a minimum point density of UNK laser return per square metre measured at nadir. For more information on the data's accuracy, please refer to the lineage provided in the data history.
Hydrology	Losses IL = 0.0mm CL = 2.0mm/hr	
Cell Size	5m	
2D Starting Time Step	Adaptive time stepping used	Adaptive time stepping used
1D Starting Time Step	Adaptive time stepping used	Adaptive time stepping used
Projection	GDA2020 Z56	
Inflows	Rain-On-Grid	Hyetographs Obtained from the ARR2019 Data Hub
Downstream Boundary Conditions	Downstream Static Tailwater Level of 2.0mAHD (based on Lower Macleay Flood Study)	
Mannings Roughness Values	Outlined in Section 6.1.3	
Events	1% AEP Durations: 270m, 360m, 540m, 720m (Critical to site), 1080m. PMF Durations: 15m, 30m 45m 60m 90m, 120m, 150m, 180m, 240m, 300m, 360m (Critical to site),	

APPENDIX B

FLOOD MAPS 1% AEP



WATER MODELLING solutions

Appendix B-1

Existing 1% AEP Peak Depth

LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Existing 1% AEP Peak Flood Depth (m)

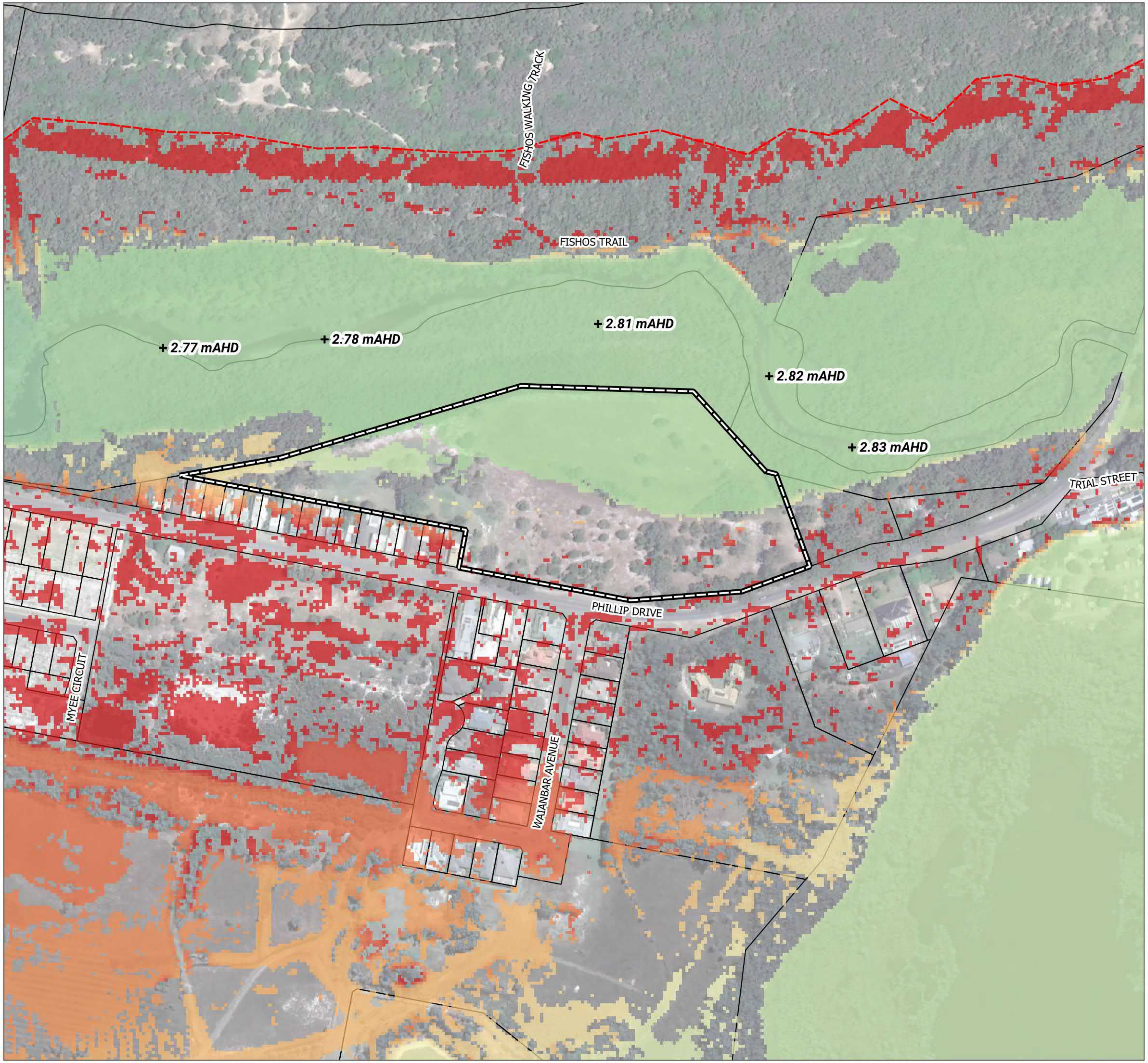
- <= 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- > 1.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix B-2
Existing 1% AEP Water Surface Level

LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Existing 1% AEP Water Suface Level (mAHD)

- 2.00
- 2.75
- 3.50
- 4.25
- 5.00

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix B-3
Existing 1% AEP Peak Velocity

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

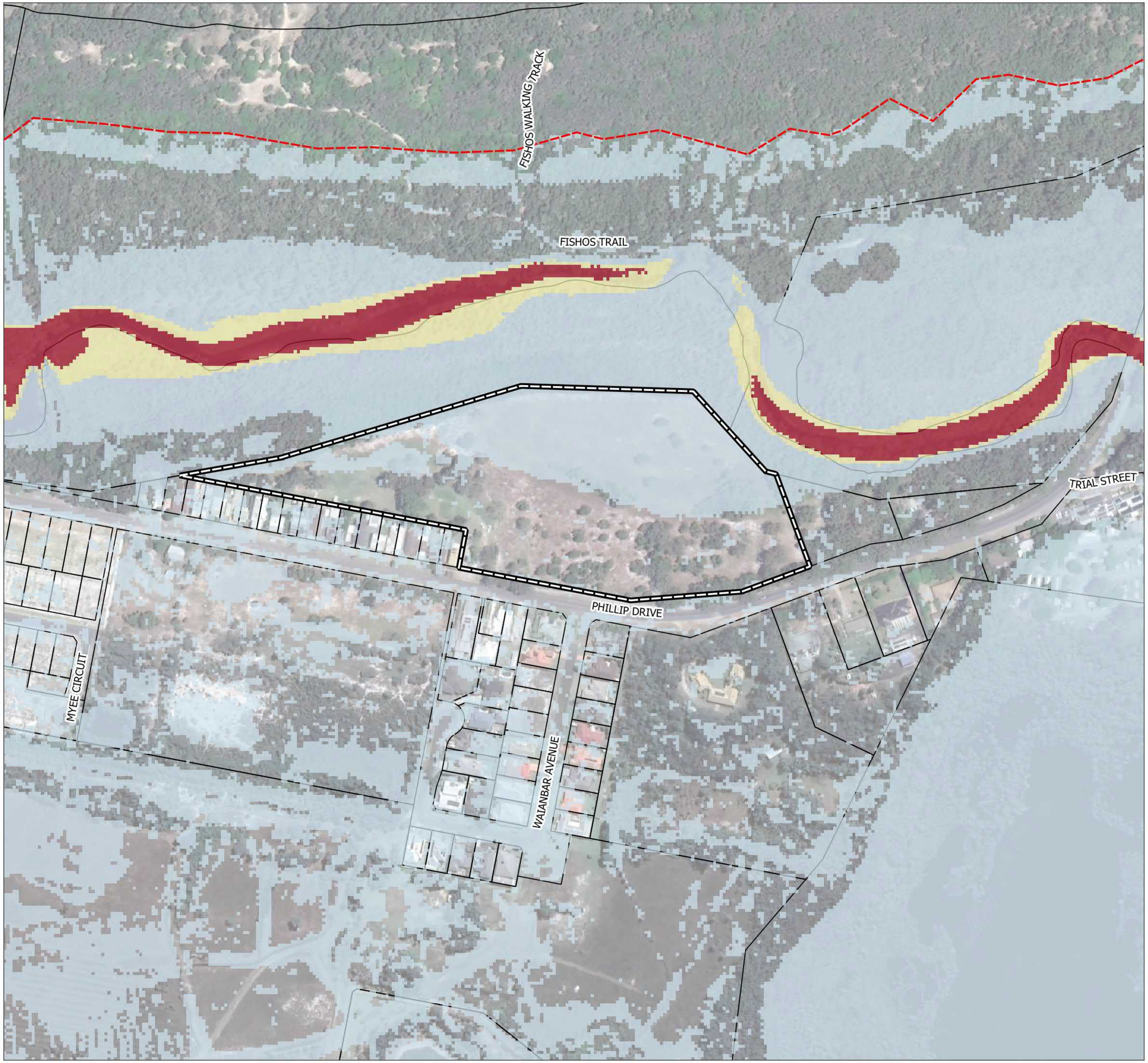
Existing 1% AEP Velocity (m/s)
- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- > 0.80

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



solutions
WATER MODELLING

Appendix B-4
Existing 1% AEP Peak Hazard

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Existing 1% AEP Velocity Depth Product (m^2/s)
- <= 0.4
- 0.4 - 0.6
- > 0.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

WATER MODELLING solutions

Appendix B-5

Stage 1 1% AEP Peak Depth

LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Stage 1 1% AEP Peak Flood Depth (m)

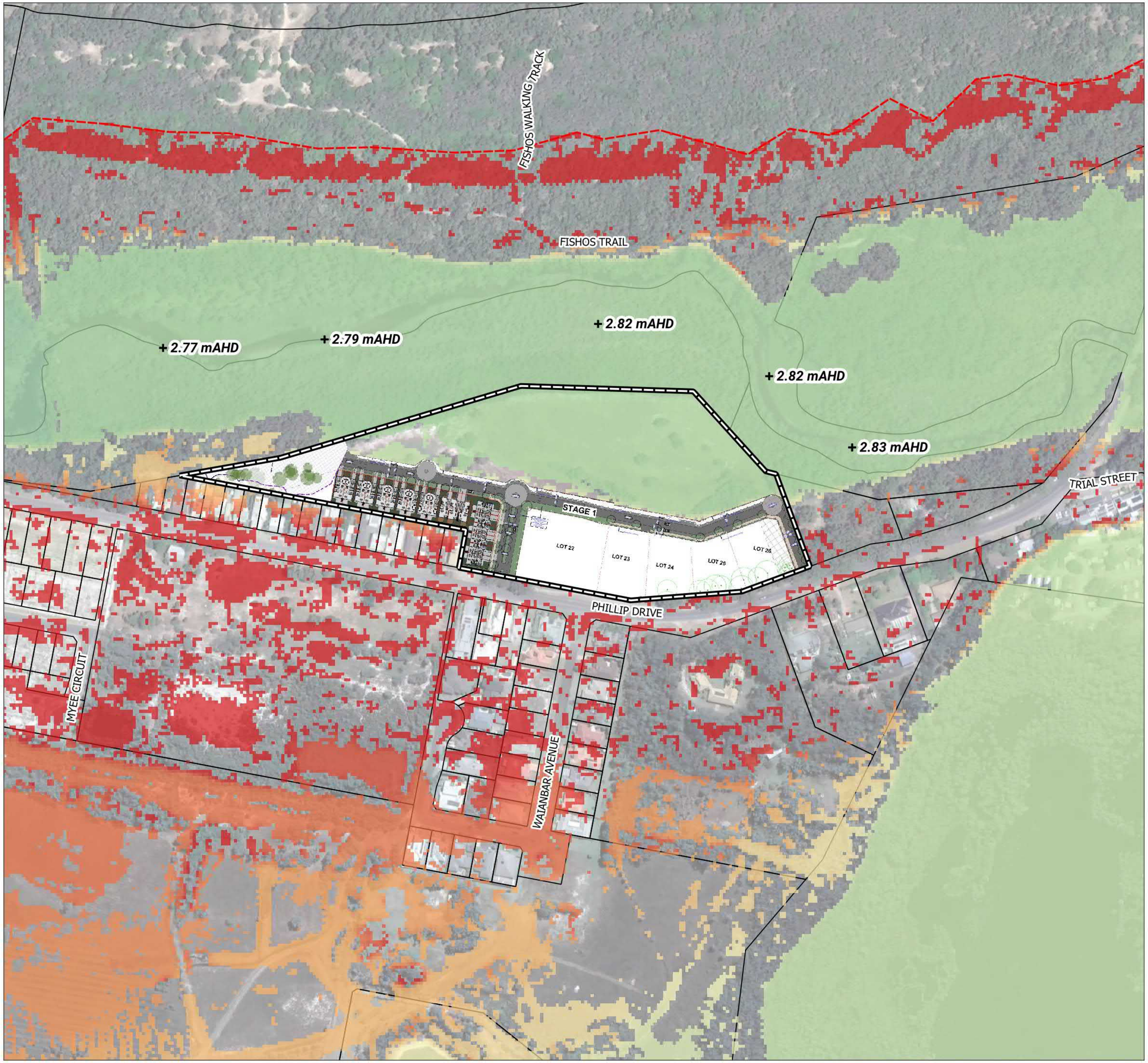
- <= 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- > 1.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



solutions
WATER MODELLING

Appendix B-6
Stage 1 1% AEP Water Surface Level

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Stage 1 1% AEP Water Suface Level (mAHD)
- 2.00
- 2.75
- 3.50
- 4.25
- 5.00

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix B-7
Stage 1 1% AEP Peak Velocity

LEGEND

TUFLOW
Model Extent
Cadastre
Site

Stage 1 1% AEP Velocity (m/s)
<= 0.20
0.20 - 0.40
0.40 - 0.60
0.60 - 0.80
> 0.80

2 Phillip Drive Flood Aseesment

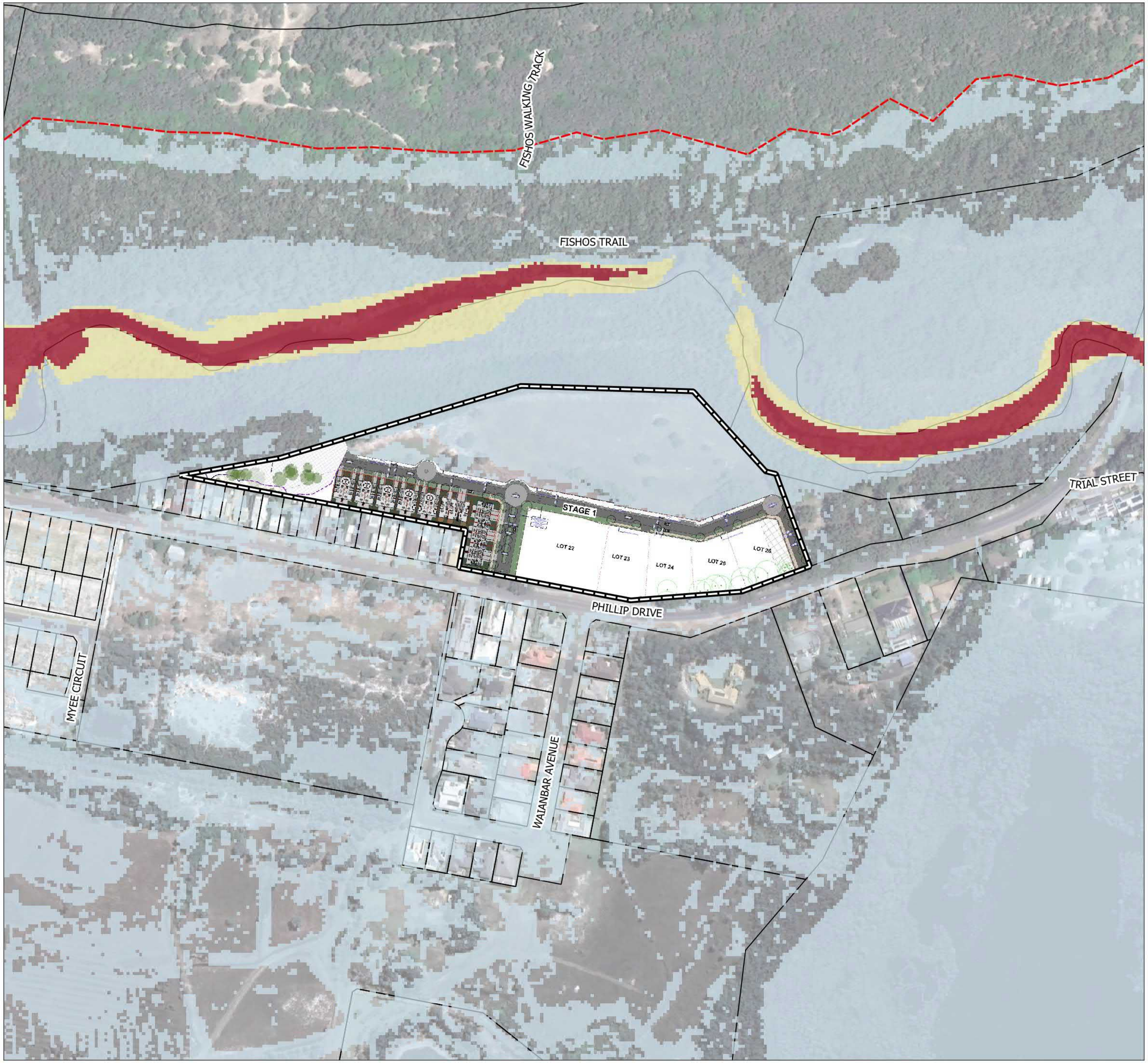
1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

WATER MODELLING solutions

Appendix B-8
Stage 1 1% AEP Peak Hazard



LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Stage 1 1% AEP Velocity Depth Product (m²/s)

- <= 0.4
- 0.4 - 0.6
- > 0.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

WATER MODELLING solutions

Appendix B-9
Final Development 1% AEP Peak Depth

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

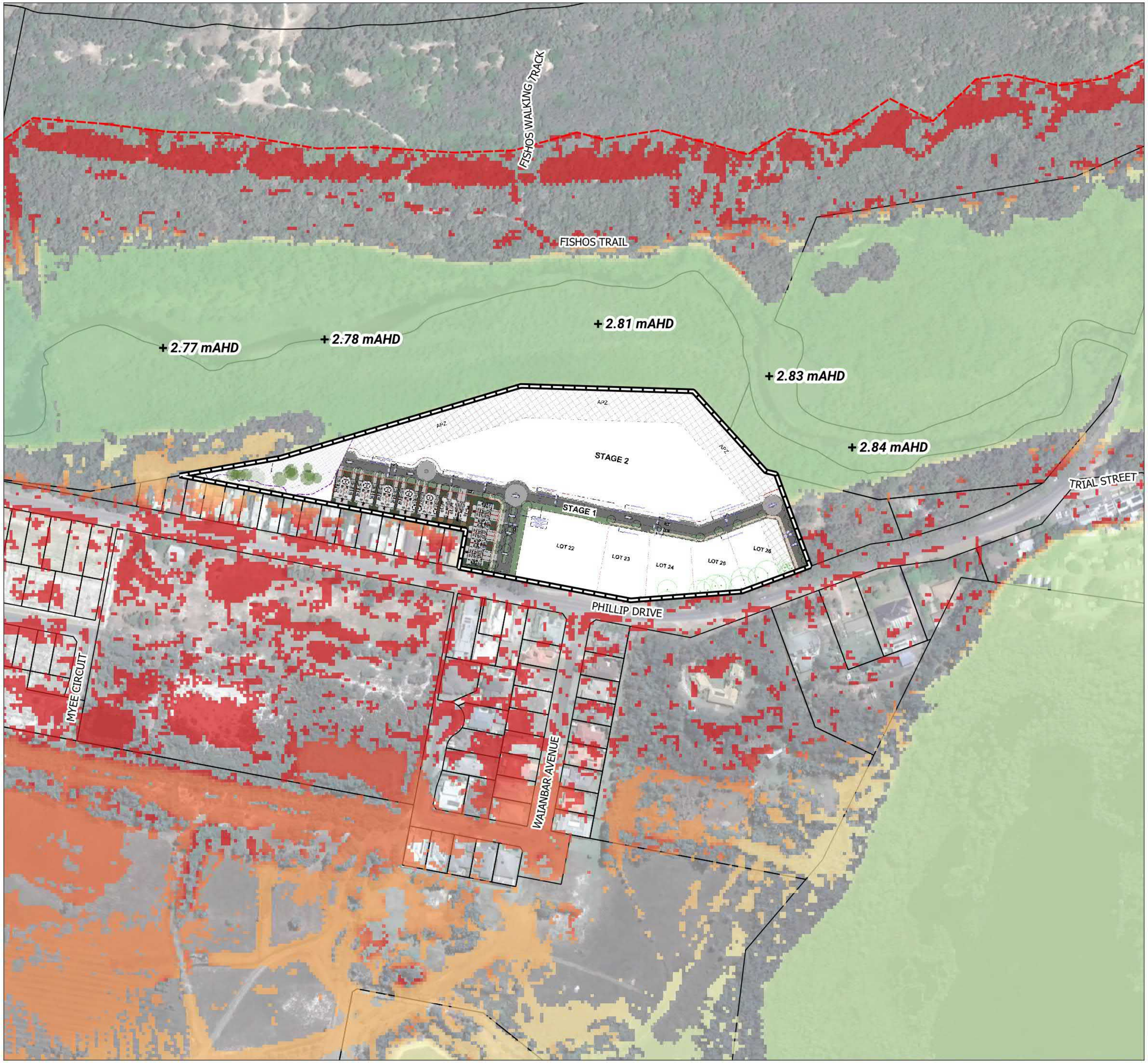
Final Development 1% AEP Peak Flood Depth (m)
- <= 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- > 1.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix B-10
Final Development 1% AEP Water Surface Level

LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Final Development 1% AEP Water Suface Level (mAHD)

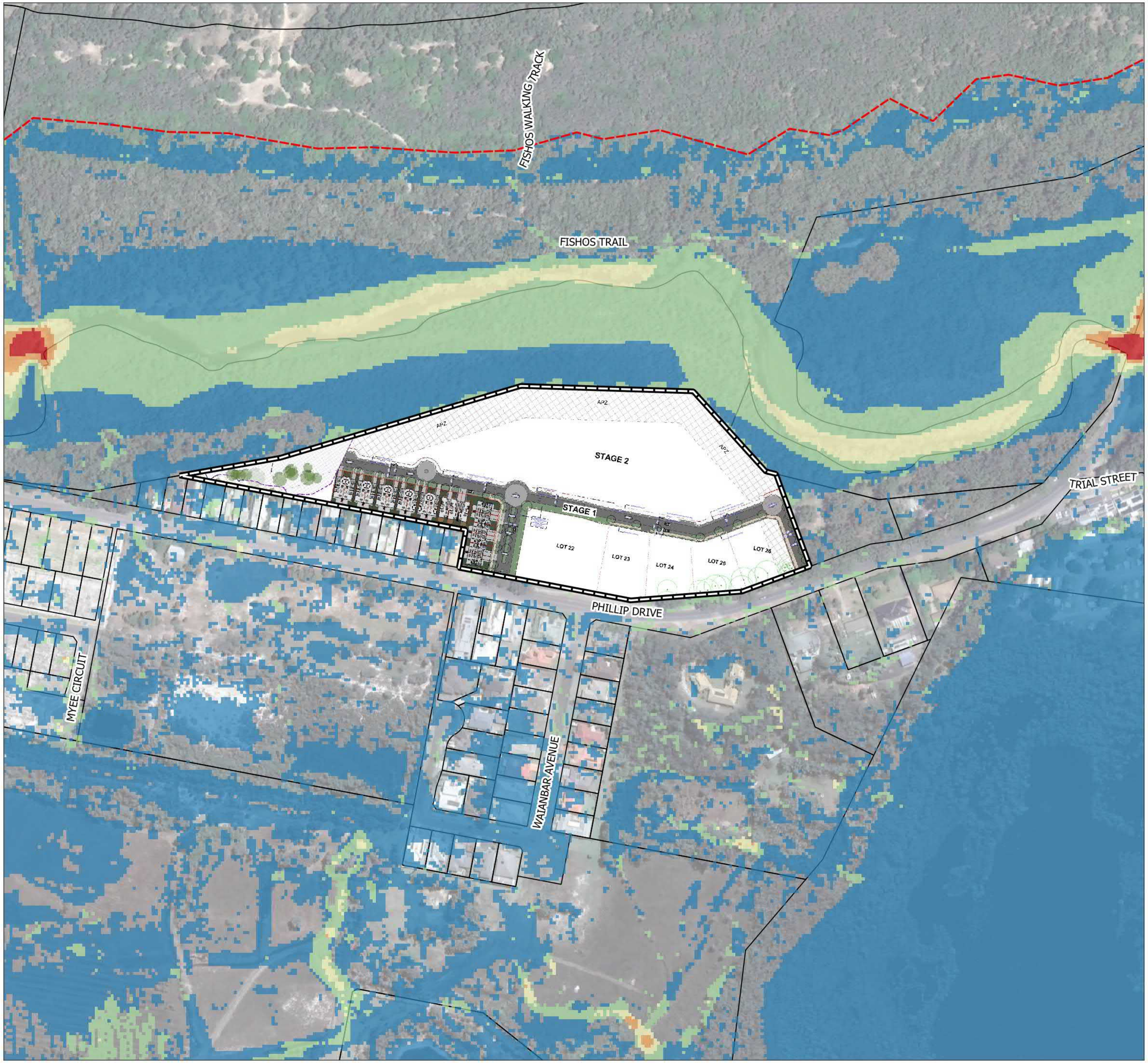
- 2.00
- 2.75
- 3.50
- 4.25
- 5.00

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix B-11
Final Development 1% AEP
Peak Velocity

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Final Development 1% AEP Velocity (m/s)
- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- > 0.80

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix B-12
Final Development 1% AEP Peak Hazard

LEGEND

TUFLOW

- Model Extent
- Cadastre
- Site

Final Development 1% AEP Velocity Depth Product (m^2/s)

- <= 0.4
- 0.4 - 0.6
- > 0.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix B-13
Existing vs Stage 1 1% AEP
Water Surface Level

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Existing vs Stage 1 - 1% AEP WSL Difference (m)
- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- > 0.10

2 Phillip Drive Flood Aseesment

1:4000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix B-14
Existing vs Stage 1 1% AEP Velocity Difference

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Existing vs Stage 1 - 1% AEP Velocity Difference (m/s)
- Less than -1
- -1 to -0.2
- -0.2 to 0.2
- 0.2 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 3
- Greater than 3

2 Phillip Drive Flood Aseesment

1:4000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

WATER MODELLING solutions

Appendix B-15
Existing vs Final Development 1% AEP Water

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

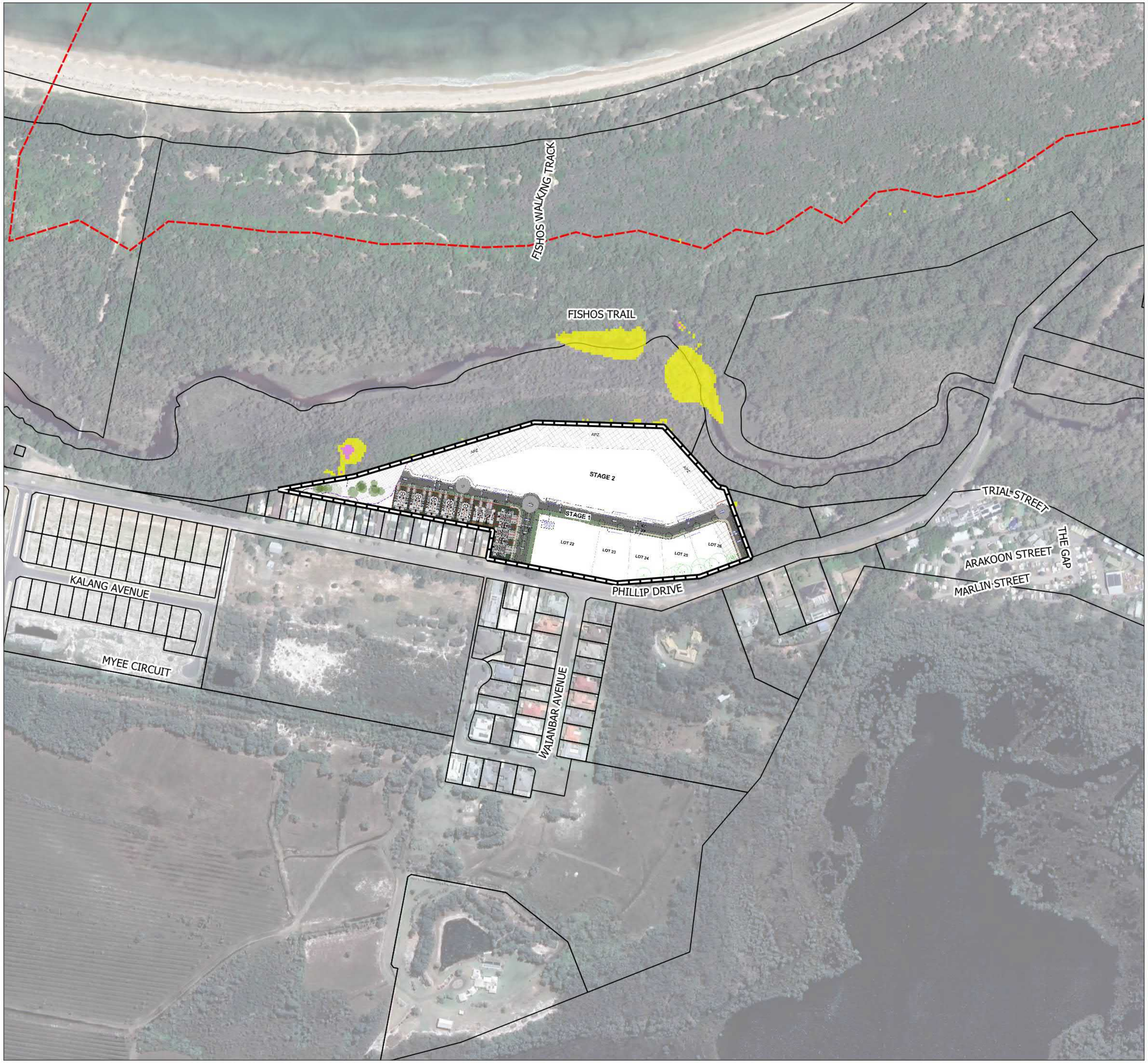
Existing vs Final - 1% AEP WSL Difference (m)
- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- > 0.10

2 Phillip Drive Flood Aseesment

1:4000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix B-16
Existing vs Final
Development 1% AEP

LEGEND

TUFLOW
- Model Extent
- Cadastre
- Site

Existing vs Final - 1% AEP Velocity Difference (m/s)
- Less than -1
- -1 to -0.2
- -0.2 to 0.2
- 0.2 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 3
- Greater than 3

2 Phillip Drive Flood Aseesment

1:4000 @ A3
GDA 2020 / MGA Zone 56

Job No: 20002
Date: 01/03/2022

0 50 100 150 200 m

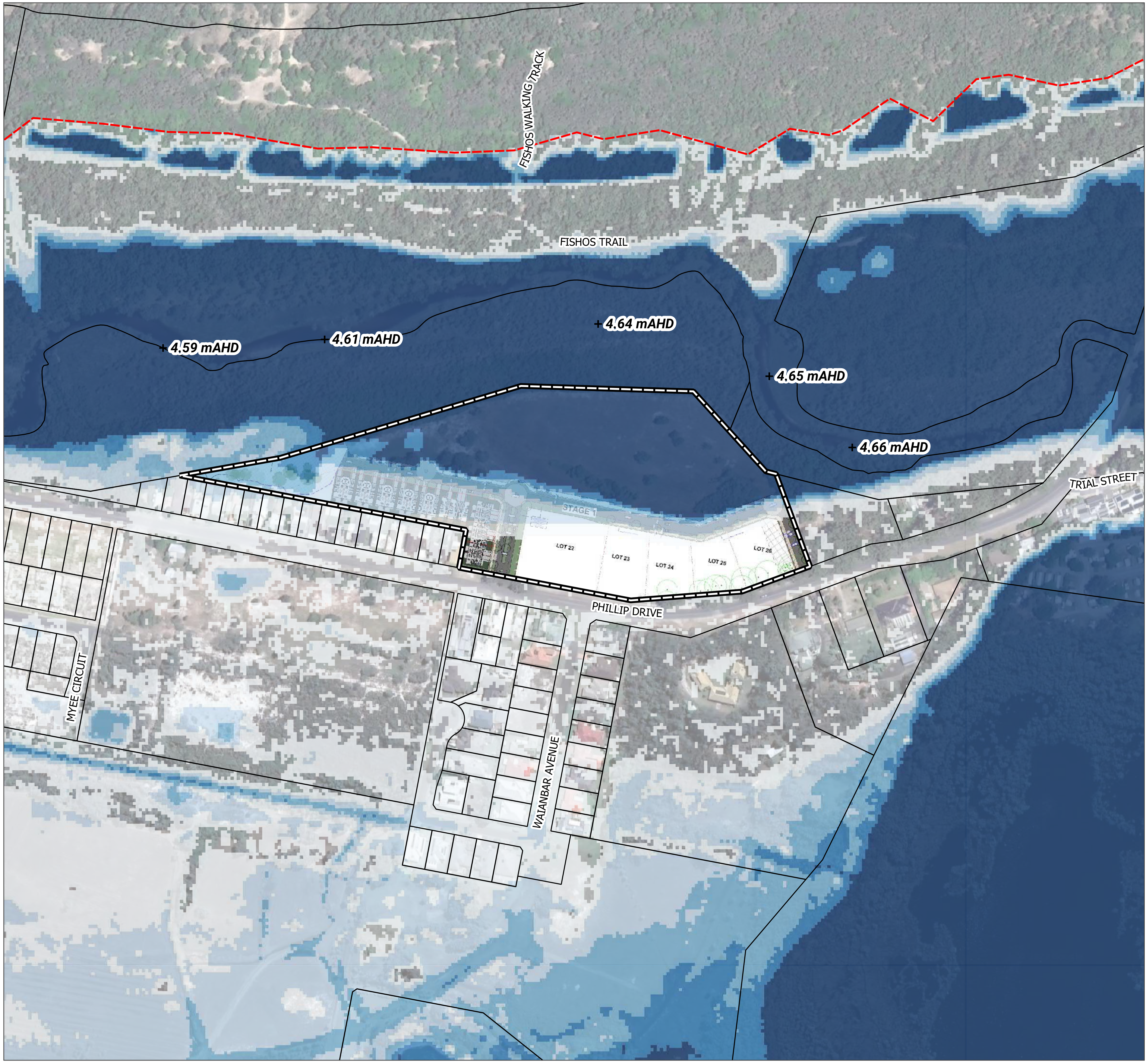
APPENDIX C

FLOOD MAPS PMF

WATER MODELLING solutions

Appendix C-1

Stage 1 PMF Peak Depth



LEGEND

Model Extent
Site
Cadastre

Stage 1 PMF Peak Flood Depth (m)

- <= 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- > 1.6

2 Phillip Drive Flood Aseesment

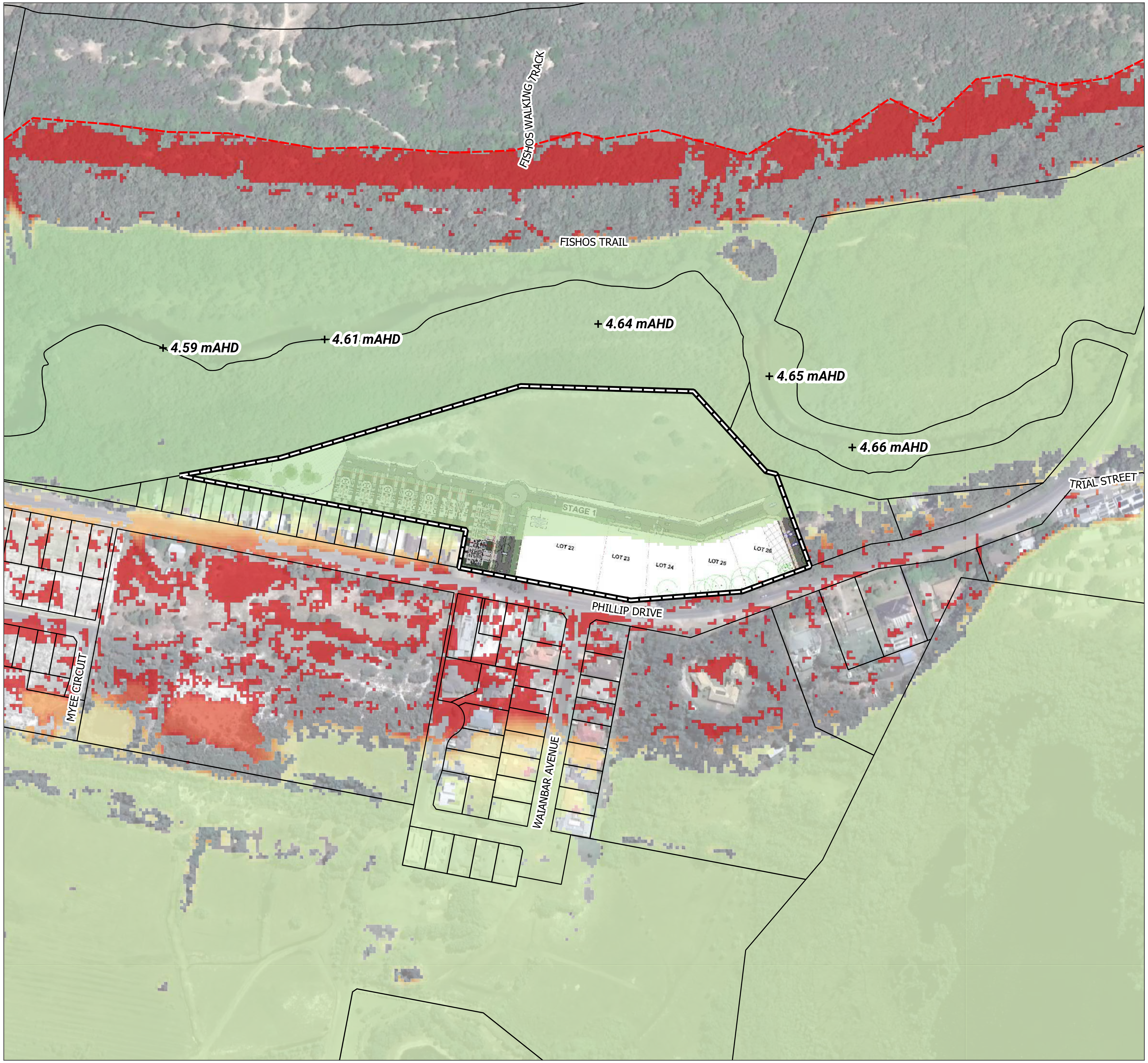
1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m

solutions
WATER MODELLING

Appendix C-2
Stage 1 PMF Water Surface Level



LEGEND

- Model Extent
- Site
- Cadastre

Stage 1 PMF Water Suface Level (mAHD)

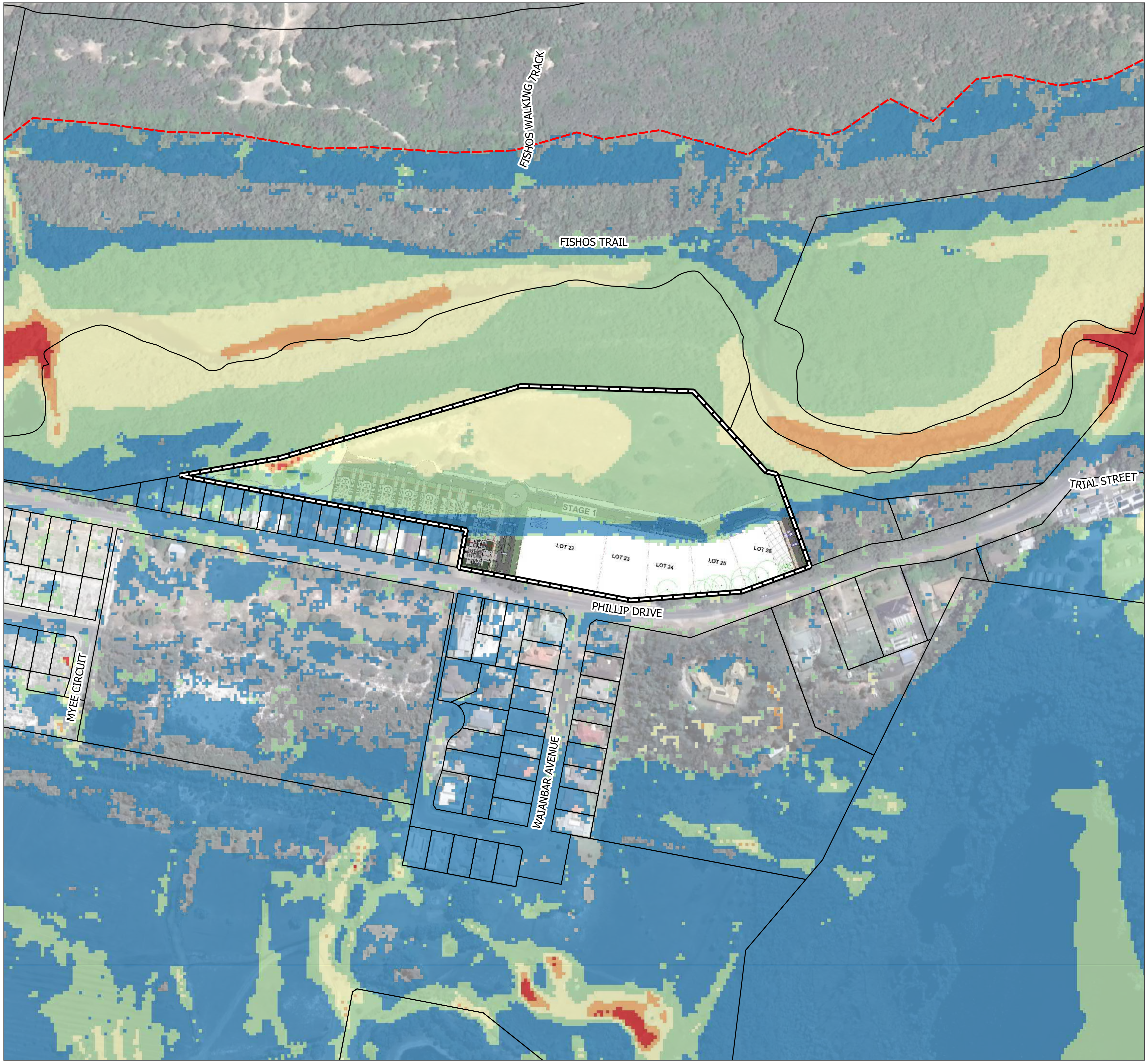
- 4.00
- 4.50
- 5.00
- 5.50
- 6.00

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix C-3

Stage 1 PMF Peak Velocity

LEGEND

- Model Extent
- Site
- Cadastre

Stage 1 PMF Velocity (m/s)

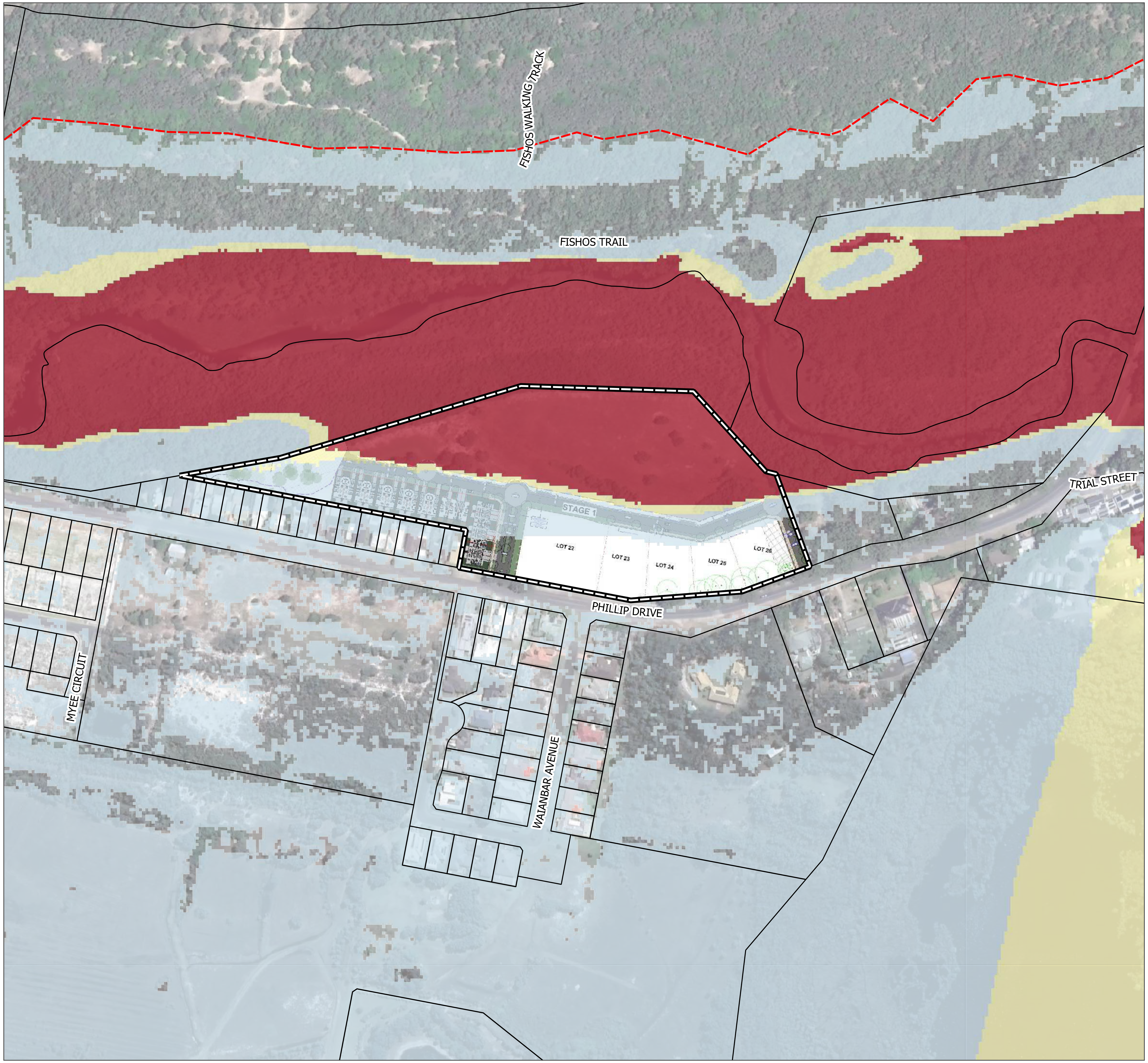
- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- > 0.80

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m



solutions
WATER MODELLING

Appendix C-4

Stage 1 PMF Peak Hazard

LEGEND

- Model Extent
- Site
- Cadastre

Stage 1 PMF Velocity Depth Product (m²/s)

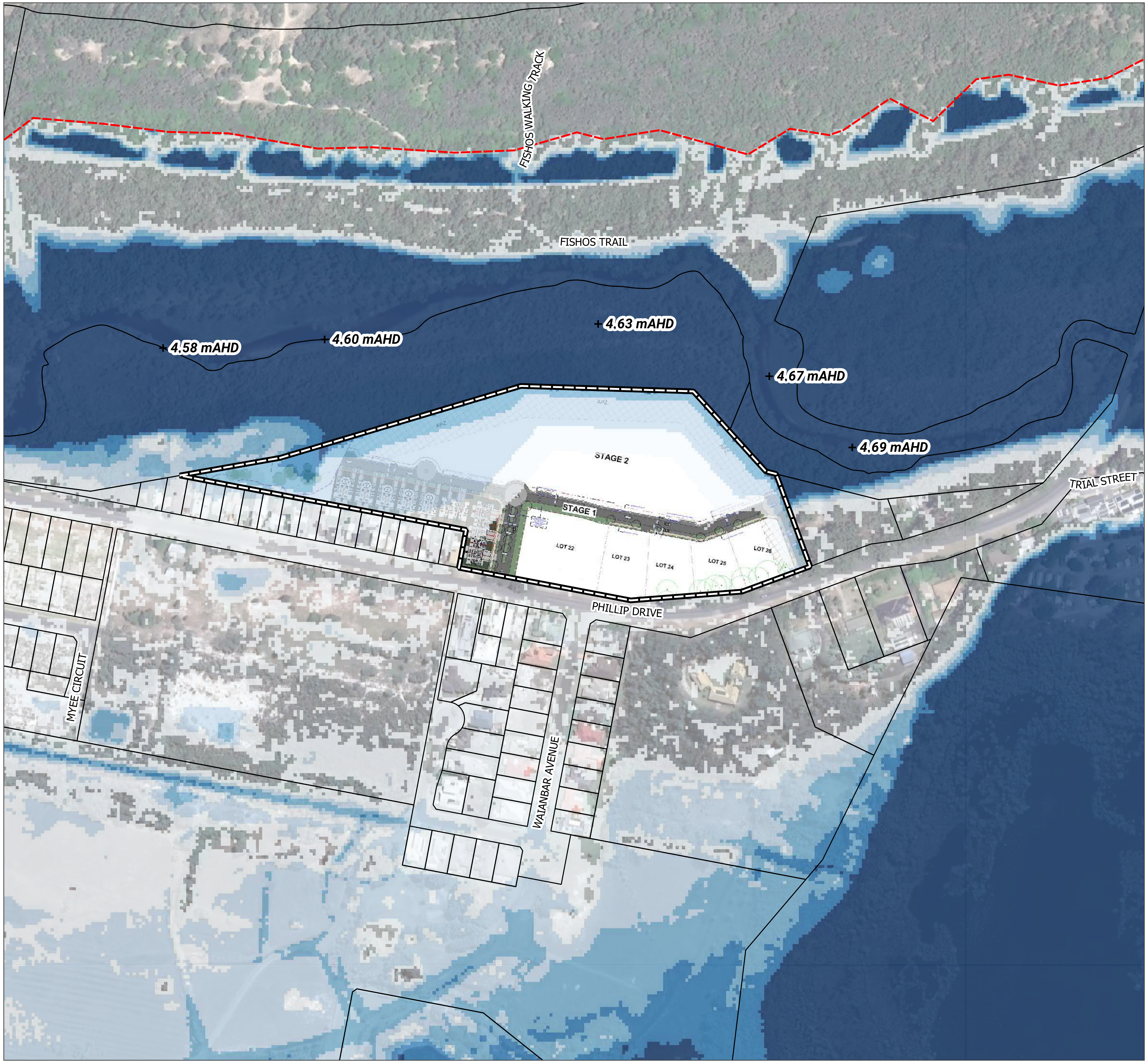
- <= 0.4
- 0.4 - 0.6
- > 0.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m



WATER MODELLING solutions

Appendix C-5

Final Development PMF Peak Depth

LEGEND

- Model Extent
- Site
- Cadastre

Final Development PMF Peak Flood Depth (m)

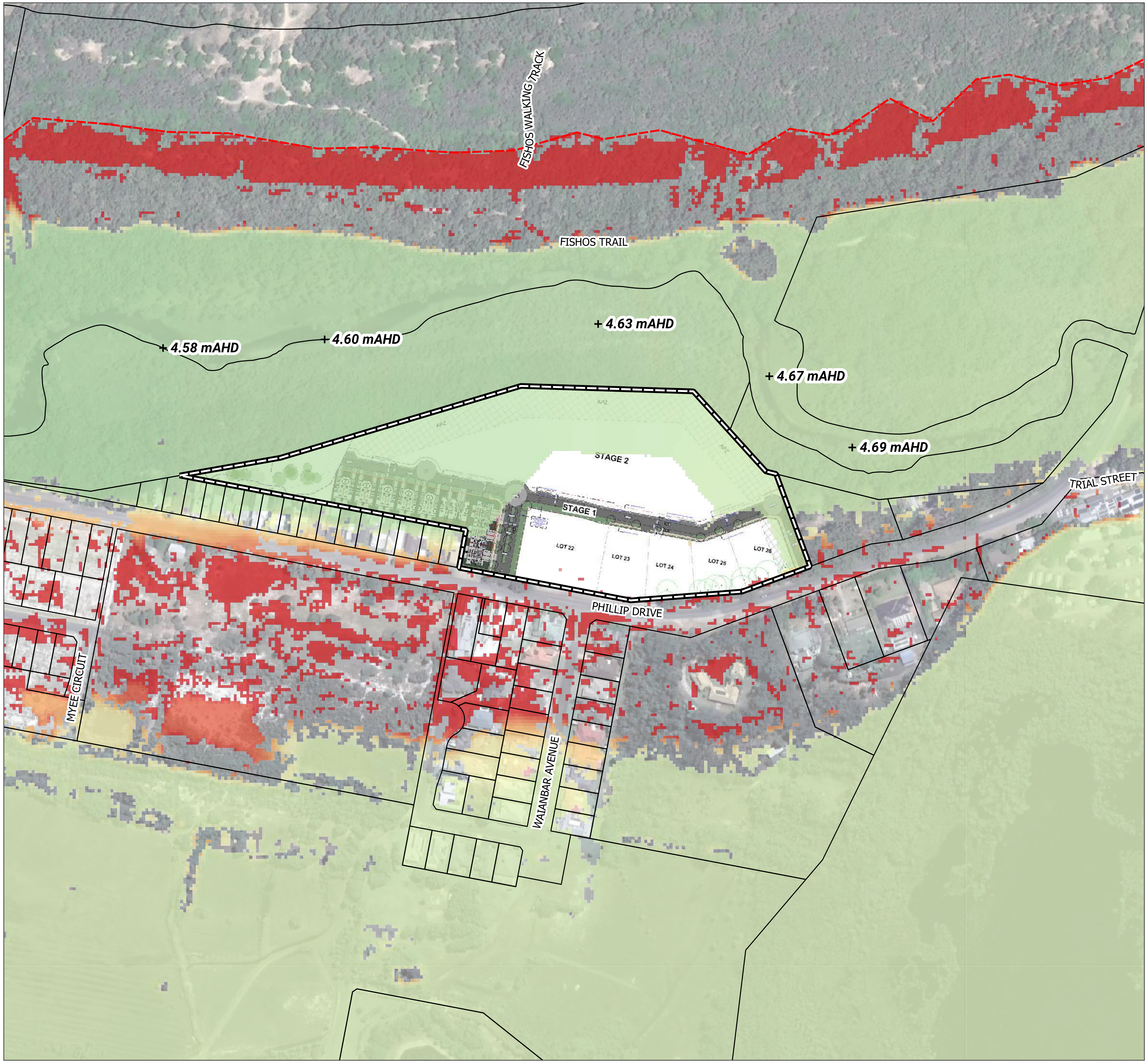
- <= 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- > 1.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m



solutions
WATER MODELLING

Appendix C-6
Final Development PMF Water Surface Level

LEGEND

Model Extent
Site
Cadastre

Final Development PMF Water Suface Level (mAHD)

- 4.00
- 4.50
- 5.00
- 5.50
- 6.00

2 Phillip Drive Flood Aseesment

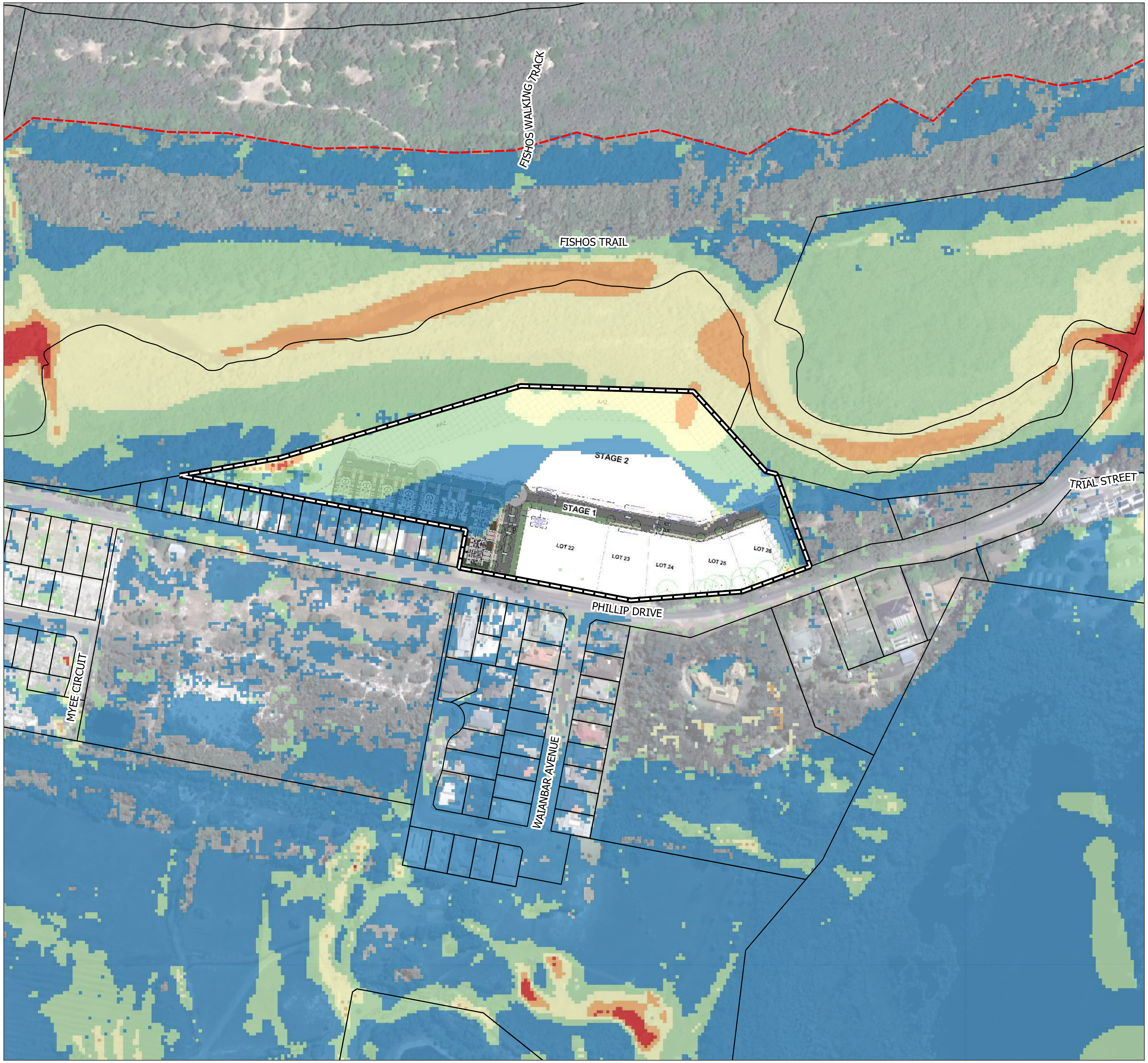
1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m

WATER MODELLING solutions

Appendix C-7
Final Development PMF Peak Velocity



LEGEND

- Model Extent
- Site
- Cadastre

Final Development PMF Velocity (m/s)

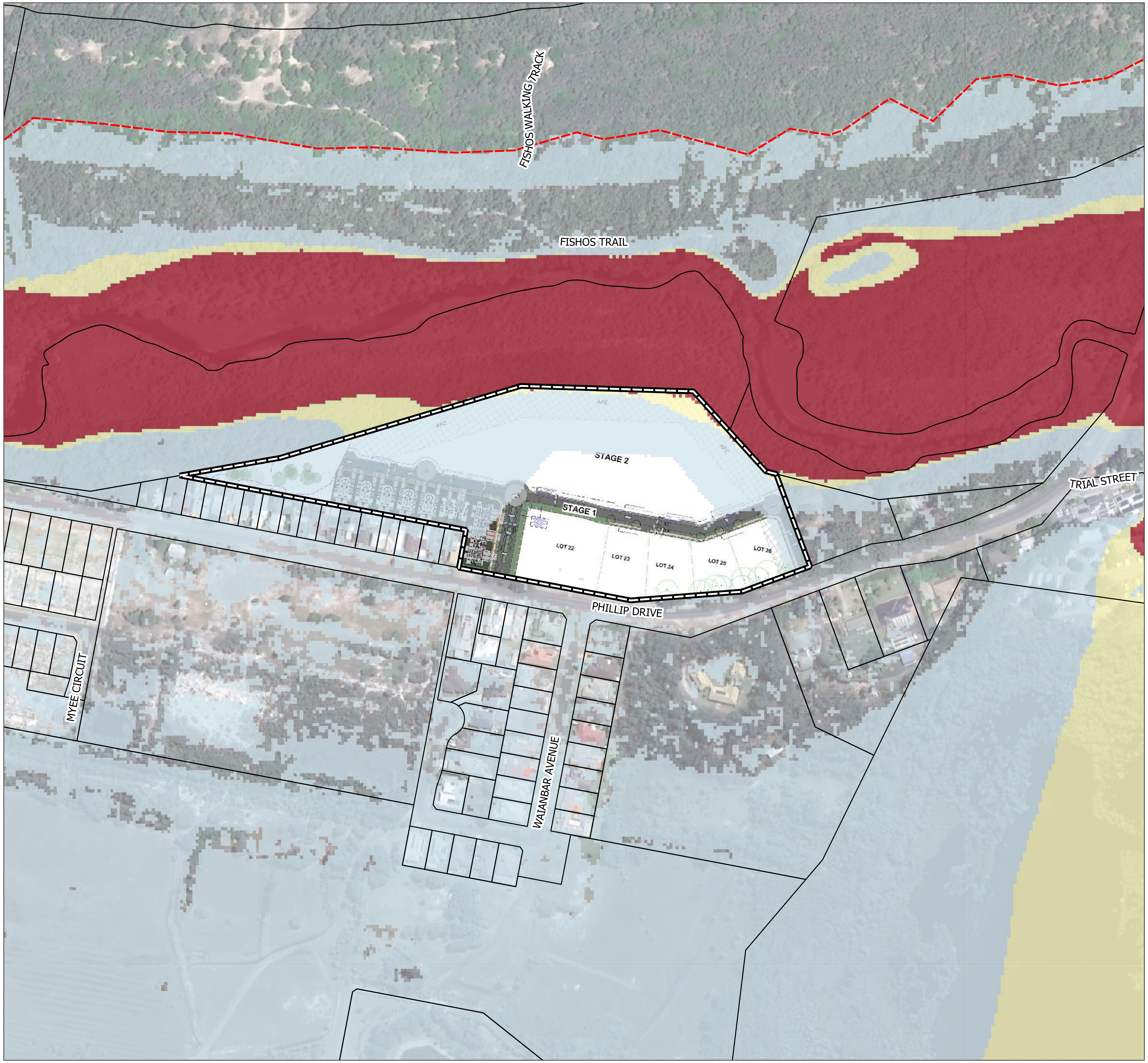
- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- > 0.80

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

0 50 100 150 200 m

Job No: 20002
Date: 02/03/2022



WATER MODELLING solutions

Appendix C-8
Final Development PMF Peak Hazard

LEGEND

- Model Extent
- Site
- Cadastre

Final Development PMF Velocity Depth Product (m²/s)

- <= 0.4
- 0.4 - 0.6
- > 0.6

2 Phillip Drive Flood Aseesment

1:3000 @ A3
GDA 1994 / MGA Zone 56

Job No: 20002
Date: 02/03/2022

0 50 100 150 200 m

APPENDIX D

GSDM CALCULATIONS

GSDM WORKSHEET

LOCATION INFORMATION				
Catchment :	20002		State:	NSW
Duration Limit:	(3-6 hours)	6	Area (km^2):	9
Approx. Centroid:	Latitude (° S):	27.5998	Longitude (° E):	152.283
Portion of Area Considered:				
	Smooth, **S** (0.0 - 1.0)=	0	Rough, **R** (0.0-1.0) =	1

ELEVATION ADJUSTMENT FACTOR (EAF)			
Mean Elevation:	300	(m)	required if greater than 1,500 m
Adjustment for Elevation:	0		-0.05 per 300m above 1500 m
EAF =	**1**	(0.85 - 1)	

GSDM MOISTURE ADJUSTMENT FACTOR (MAF)			
$EPW_{catchment}$=			GSDM MAF = $EPW_{catchment}$/104.5
OR read directly off GSDM Moisture Adjustment Factor chart at centroid (refer Fig 3.)			
GSDM MAF =	**0.75**	(0.46-1.19)	

PMP VALUES (mm)

Duration (hours)	Initial Depth - Smooth (D_S)	Initial Depth - Rough (D_R)	PMP Estimate = (D_S x S+ D_R x R) x MAF x EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	213	213	160	160
0.5	312	312	234	230
0.75	396	396	297	300
1	463	463	347	350
1.5	529	594	446	450
2	592	695	521	520
2.5	630	767	575	580
3	662	839	629	630
4	730	959	719	720
5	786	1055	791	790
6	833	1121	841	840

Prepared by Date: 22/11/21
Checked by Date 22/11/21

CIVIL | WATER | ENVIRONMENT

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ABN | 85 700 247 836
Ref | 20002-L01
Date | 22 June 2022

Proposed Subdivision, Lot 2 Phillip Drive, South West Rocks (DA2200404)

Dear Liam,

Thankyou for providing the opportunity to respond to comments made by NSW Department of Planning and Environment (Biodiversity and Conservation Division (BCD)) relating to the staged community title subdivision at Lot 2 DP 1091323 Phillip Drive, South West Rocks. Items 26, 27 and 28 in Attachment 1 from BCD relate to the Flood Impact Assessment report prepared by WMS (submitted as Appendix N to the planning portal) and have been addressed below.

Item 26. Climate Change and Minimum Floor Levels

BCD Recommendation

The flood impact assessment should consider climate change impacts to flood behaviour and flood levels at the site in setting minimum floor levels for the proposal.

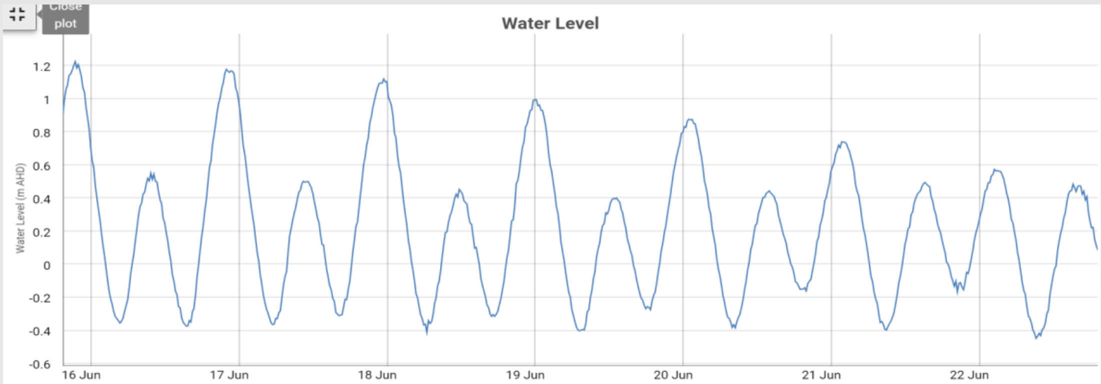
WMS Response

Minimum floor level requirements have been defined based on Kempsey Shire Council Policy 1.1 – Development Control Policy, Procedure 1.1.11 Flood Risk Management, Section 8, which requires habitable floor levels to be a minimum level of 500 mm above the 1 in 100 AEP flood level.

This 500mm allowance is known as 'freeboard'. In accordance with the NSW Floodplain Development Manual (2005), Section K5, 'freeboard' is an additional allowance intended to provide reasonable certainty that the reduced risk of exposure provided by a selection of a particular flood as the basis of a Flood Planning Level (FPL) is actually provided. The impact of Climate Change (i.e., changes in rainfall patterns and ocean water levels) on flood levels is included in the freeboard allowance, and as such, is 'built into' the minimum floor level requirements for the subdivision as set out in Council's planning policies.

Further, the flood modelling undertaken for the assessment assumed a static ocean level of 2 mAHD as the tailwater boundary condition (described in Section 6.1.2 of Appendix N). This level was selected to ensure a consistent approach with the Lower Macleay Flood Study (Jacobs, 2019), and represents a conservative assumption, which, in this context, is a proxy for the consideration of climate change impacts on sea levels.

A plot of recent tidal data from the Manly Hydraulics Laboratory (MHL) South West Rocks Gauge (No. 206456) is provided below to provide further context to the typical range of tidal oscillations compared to the conservative, static level of 2 mAHD applied in the hydraulic modelling:



Item 27. Shelter-in-Place Requirements

BCD Recommendation

The proposed minimum floor level at 3.34 m[AHD] will be inundated in extreme events, so shelter-in-place for these properties is not advisable unless the floor level is above the PMF level.

WMS Response

The PMF level in the vicinity of the site is estimated at 4.65 mAHD, as such, WMS agree with BCD's comment that shelter-in-place is not advisable for properties in the lower lying portions of the site.

Much of the remainder of the site (an area of 2.1 Ha) is above the PMF level and can be utilised by residents to safely shelter during extreme events. A flood emergency response plan (FERP) would be advisable to formalise safe shelter-in-place arrangements and is recommended to be developed in consultation with the NSW SES. This FERP could be prepared at a later stage, prior to release of the occupation certificate.

Horizontal evacuation of the site is also available via Phillip Drive, which is also flood free in the PMF event.

Item 28. Consultation with SES

BCD Recommendation

The council should seek SES's comments regarding the proposed evacuation to South West Rocks via Phillip Drive in extreme flood events

WMS Response

WMS support the recommendation to consult with the NSW SES regarding evacuation route alignment and capacity as well as safe shelter-in-place arrangements.

The South West Rocks Anglican Hall (15 McIntyre Street, South West Rocks) is designated as an Evacuation Centre in the NSW SES Kempsey Shire Flood Emergency Subplan. Flood free access to the Anglican Hall is available via Phillip Drive (1.8 km from the subject site).

Please do not hesitate to contact me if you require further clarification.

Yours sincerely,

Catherine Walker

Catherine Walker
NSW Regional Manager