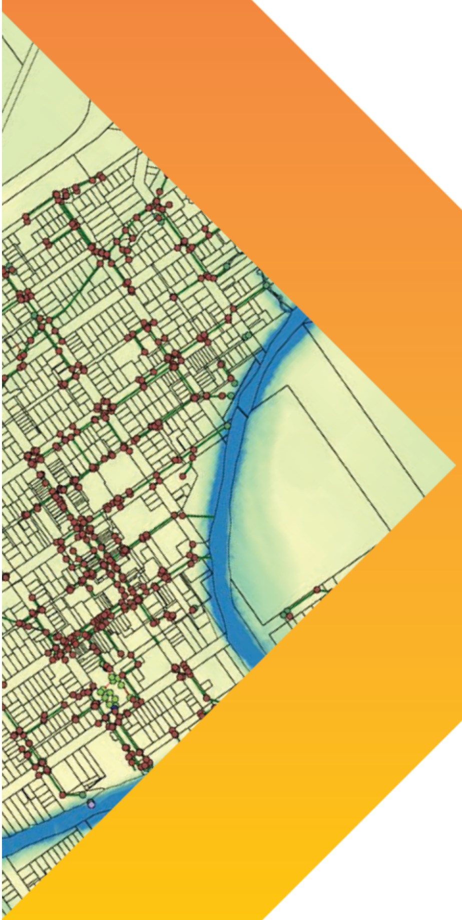
REPORT



68 GRANUAILLE CRESCENT, BANGALOW, NSW

HYDRAULIC ASSESSMENT

Instant Steel Pty Ltd

Contact us to design
the sustainable
towns and cities
of tomorrow.

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Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release	
					Signature	Date
-	Draft	TP	DM		D. Mackenzie	18/10/19
1.0	For Issue	TP	DM		D. Mackenzie	25/11/19
1.1	For Issue	TP	DM	Change to Lot Description	D. Mackenzie	19/03/20
1.2	For Issue	TP	DM	Change to lot boundaries	D. Mackenzie	02/04/20
1.3	For Issue	TP	DM	Removal of Lot182 DP1000507	D. Mackenzie	21/06/22
2.0	DRAFT	NT	DM	Developed Case. Add Causeway, Council comments	D. Mackenzie	16/11/23

Transmission Register

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1. Introduction

Instant Steel Pty Ltd has requested a hydraulic assessment as part of a proposed Subdivision Development Application for 68 Granuaille Crescent, Bangalow, NSW, Lot 261 DP 1262316, Lot 11DP 807867 (the subject site). The proposed development includes the subdivision of lands into rural lots and associated roads/ancillary development, a bio-basin and a proposed causeway (4/1.2x1.8 RCBC).

The hydraulic assessment will cover the existing case and developed case concept and potential impacts arising from the proposed development. The assessment will determine the flooded extent, velocity, peak depth and hazard assessment of the subject creek, and any proposed impacts arising from the proposed development.

The key objectives of the project are:

- Reduce flood risk where possible
- Develop a Hydrology model of the catchment to Australian Rainfall and Runoff (ARR2019) methodology
- Calibrate model to Regional Flood Frequency Estimation Tool (RFFE) and anecdotal data
- Construct a base case 1D/2D Tuflow Hydraulic model of the subject site to ARR2019
- A hydraulics assessment will be undertaken to determine the flooded extent of the subject creek. Additional information will include velocity, peak depth and hazard assessment
- The 1 %AEP (Annual Exceedance Probability), 1 %AEP_CC (Climate Change), 5%AEP and 20 %AEP design events have been assessed

The principal objective of this hydraulic assessment is to identify existing maximum water levels, maximum depths, maximum hazards and maximum velocities for the subject site. Detailed 1D/2D modelling has been undertaken to confirm the above objectives.

See Figure 1 below showing the location of the study site. The land area of the subject site is approximately 4.1ha, with an ephemeral creek running north to south through the eastern portion of the subject site.

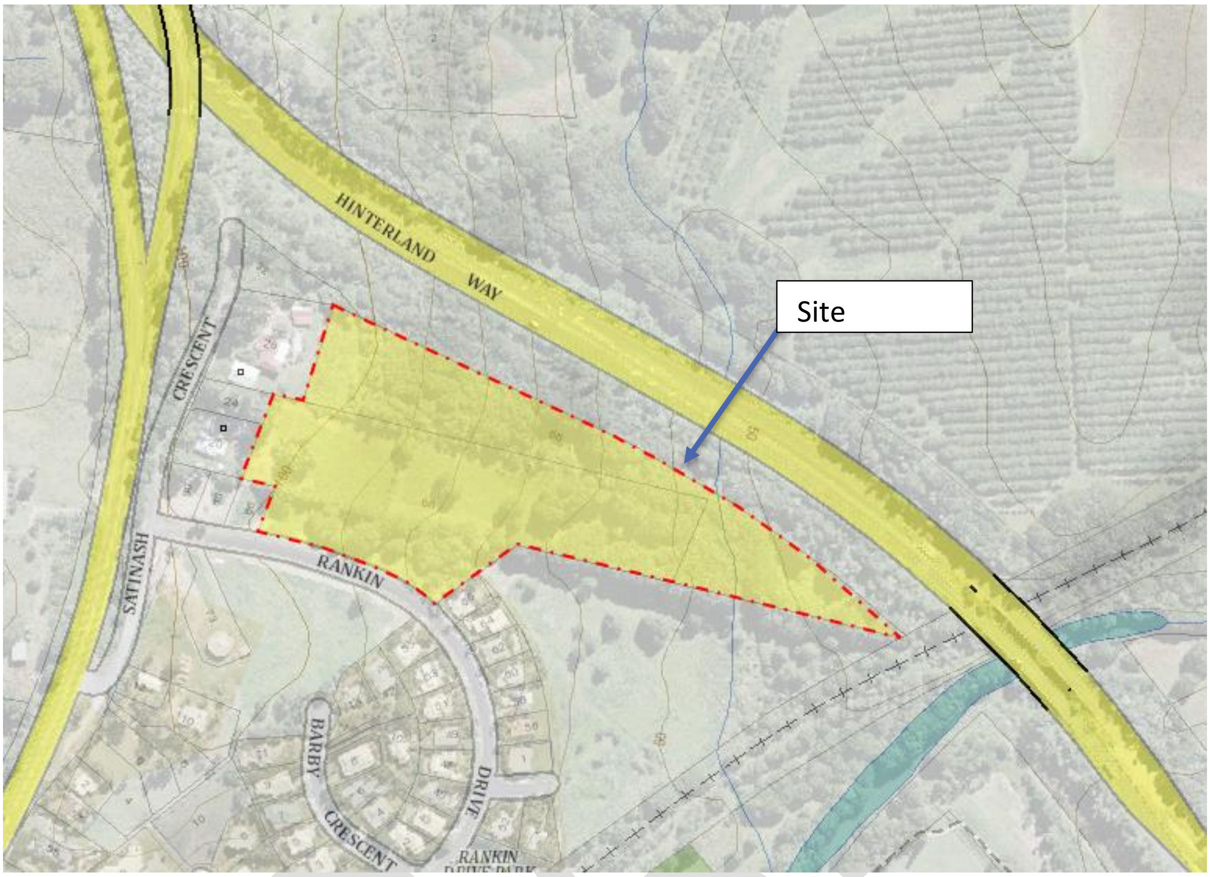

Figure 1 Subject Site

2. Hydrology

2.1. Methodology

The XP-SWMM runoff-routing model has been used to estimate design flood discharges within the study area. The model represents the sub-catchments as a network of nodes linked to either the 1D pipe drainage network or the 2D Digital Terrain Model (DTM) geometric base. The node is defined by its pervious and impervious areas, fraction impervious and average catchment slope. The net rainfall is routed through the network after appropriate losses (initial and continuing) and roughness factors are applied, resulting in a surface runoff hydrograph for each sub-catchment.

The XP-SWMM model was used to estimate the 1% AEP design runoff as per Instant Steel Pty Ltd requirements. The hydrologic assessment has been completed to the Australian Rainfall and Runoff 2019 (ARR2019) methodologies.

A numerical check has been undertaken using the Regional Flood Frequency Estimation model (https://rffe.arr-software.org/) and compared to the XP-SWMM results.

2.2. Hydrologic Model

2.2.1. Configuration

Figure 2 illustrates the extent of the XP-SWMM model. The contributing catchment was modelled as 7 sub-catchments with a total area of 58.6ha. These sub-catchments were delineated to accurately represent the inflow location and its impact on the subject site.

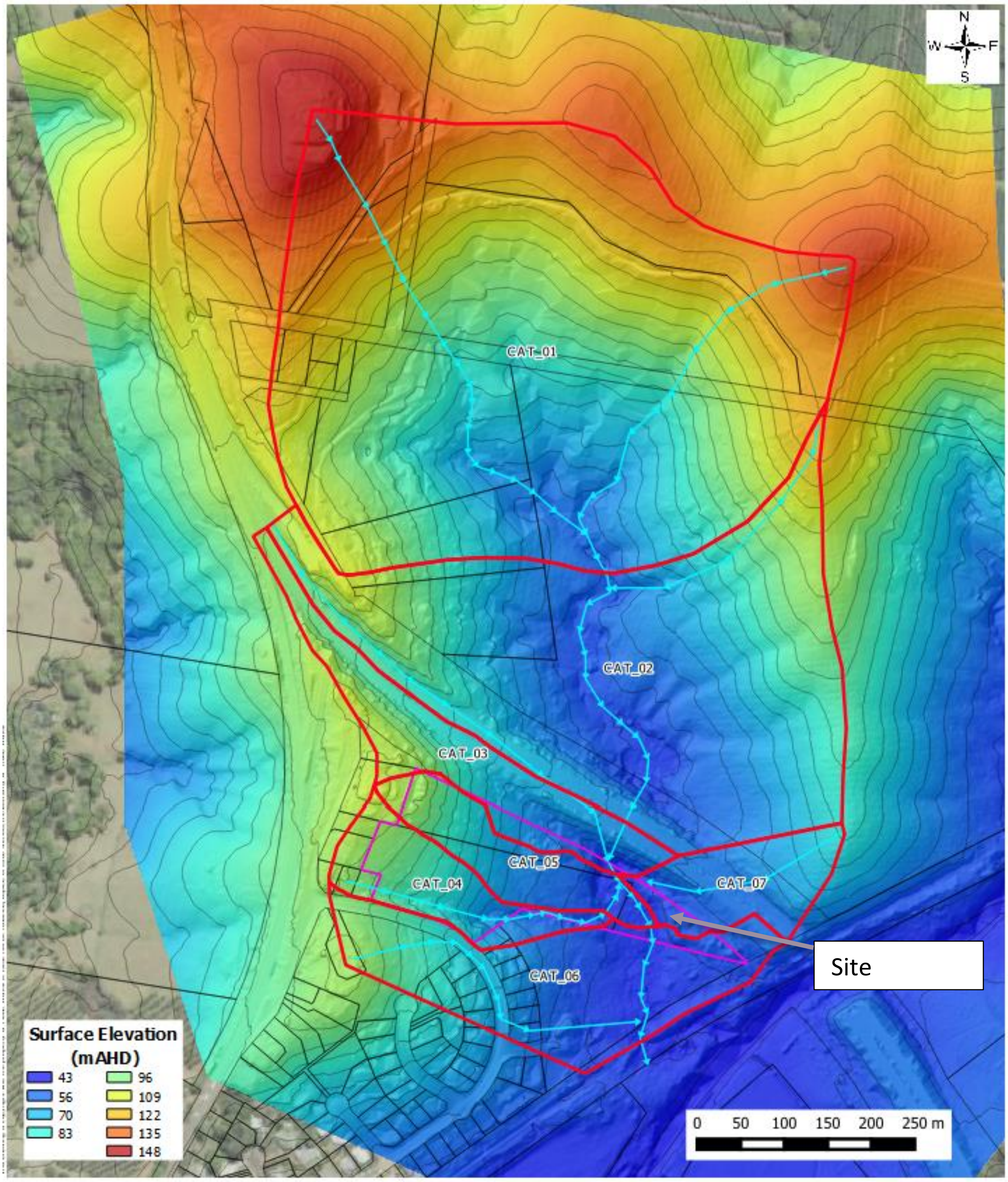

Figure 2 XP-SWMM Model Extents

2.2.2. Hydrologic Routing

Hydrologic modelling has been undertaken using the Laurenson runoff routing method. The Laurenson method requires the catchment to be divided into pervious (undeveloped) and an impervious (developed) portion. A fraction impervious of 0% has been applied to the undeveloped portion and 100% to the developed portion.

2.2.3. Manning's Roughness

Manning's roughness (n) values are applied to represent the undeveloped and developed portions of the catchment. XP-SWMM allows a range to be applied to represent the varied degrees of roughness that could be expected within the catchment.

The Manning value used in this model was used as a calibration tool to compare peak flow from XP_SWMM and the ARR Regional Flood Frequency Estimation (RFFE) model.

2.2.4. Rainfall Losses

Initial Loss (IL) and Continuing Losses (CL) were sourced from the Australian Rainfall and Runoff (ARR) Data Hub (*http://data.arr-software.org/*) and were applied to the modelling. The catchment has been modelled as approximately 100% pervious with only a small percentage of roofed area relative to the catchment size. The following loss rates have been adopted:

- Undeveloped Catchment IL = 12.1mm CL = 0.0mm/hr.

2.2.5. Existing Conditions Parameters

Table 1 summarises the XP-SWMM parameters adopted for the existing catchment conditions. The catchments equal area slope was calculated directly from the Digital Terrain Model for the Catchment.

The percentage impervious was determined using the Queensland Urban Drainage Manual (QUDM) guidelines for the fraction impervious for a Rural Undeveloped as 0% Impervious (QUDM, 2013).

The total contributing catchment is 58.6ha. The hydrologic factors adopted have been summarised in Table 1.

Table 1 XP-SWMM Hydrologic Model Parameters

Sub-Catchment	Area (ha)	Impervious (ha)	Pervious Area (ha)	Equal Area Slope (%)
CAT_01	27.964	0.933	27.030	27.964
CAT_02	15.886	1.150	14.736	15.886
CAT_03	3.267	0.718	2.549	3.267
CAT_04	2.104	0.274	1.830	2.104
CAT_05	1.956	0.018	1.937	1.956

CAT_06	5.357	0.550	4.807	5.357
CAT_07	2.026	0.382	1.644	2.026

2.3. ARR 2019 Hydrologic Results

The XP-SWMM ARR Storm Generator allows importation of the ARR Data Hub information, including rainfall global database, infiltration global database, and global storm definitions, into XP-SWMM. Information such as the ARR Data Hub Text File, ARR Temporal Patterns Increments File, and Bureau of Meteorology (BOM) IFD table files, are used to produce the Annual Exceedance Probability (AEP) and all of the durations for the given location, which are then analysed in the application.

Ten (10) temporal patterns were assessed per duration for each design event with the results statistically assessed using a box and whisker plot to determine the critical storm duration and temporal pattern for the catchment. The box and whisker plot displays information about the range, median, and quartiles of the results. This plot can easily demonstrate whether a distribution is skewed and whether there are potential outliers in the data set, especially for a large number of observations.

Figure 3 below demonstrates that the highest median storm duration for the 1%AEP, or the 1% Annual Exceedance Probability (AEP) design event, is the 2 hour storm using the standard temporal pattern 1, and producing a peak discharge of **18.3 m^3/s**.

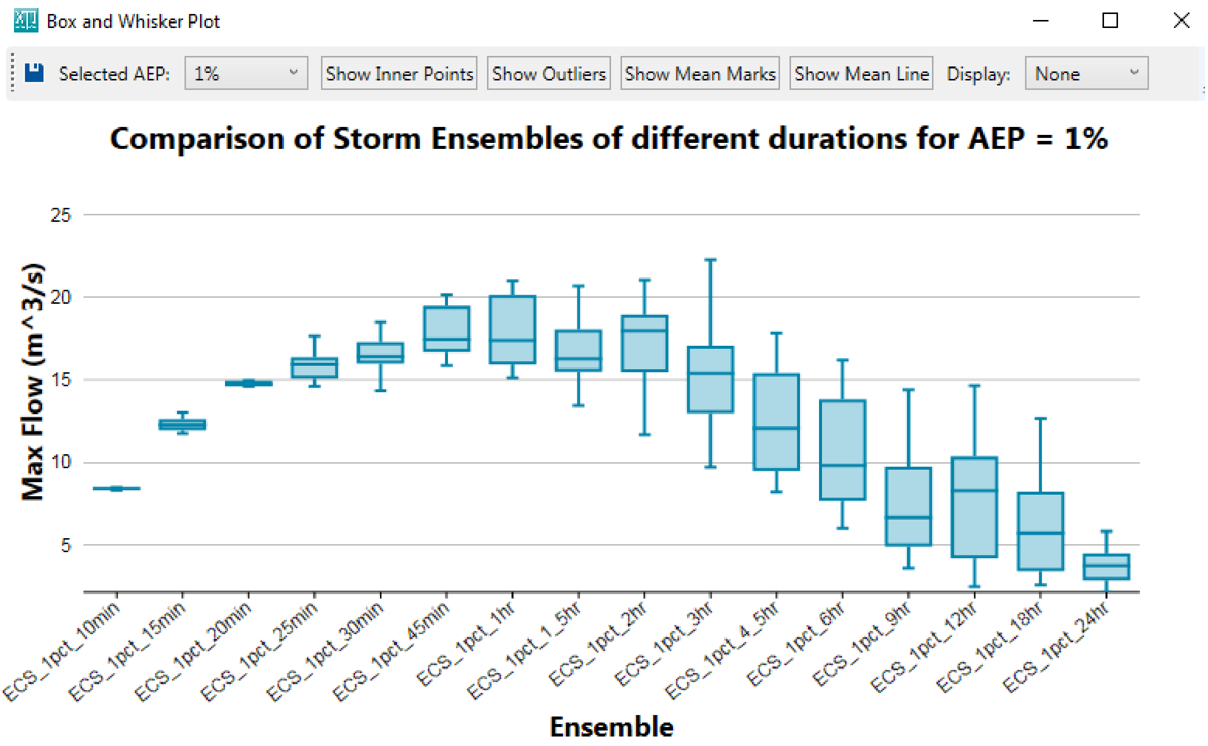

Figure 3 1%AEP Box and whisker plot of Ensemble results

2.4. Flood Frequency Analysis Comparison

The ARR Regional Flood Frequency Estimation (RFFE) model has replaced the rational method as a means to compare XP-SWMM's calculation of design discharges for the 1%AEP developed conditions at legal points of discharge for the catchment.

The tool requires the geographical coordinates of the catchment centroid and outlet. Based on regional rainfall data at gauged locations near the site, the tool produces a statistical estimate of the peak discharge.

The tool has the following limitations:

- The RFFE tool cannot be used for urban catchments, areas where large scale land clearing has occurred or where dams or other significant hydraulic controls have significantly affected the natural hydrology (ARR)
- RFFE is not accurate for catchments smaller than 0.5 km^2 or larger than 1000 km^2
- Catchments that are located more than 300km from a gauging station used by the tool

Table 2 and Figure 4 summarise the comparison of the RFFA tool and XP-SWMM peak discharges for the sub-catchment at the outlet.

Table 2 XP-SWMM and RFFE Peak Discharge

Event	Regional Estimation Tool			XP_SWMM (ARR2019)
	Discharge (m3/s)	Lower Confidence Limit (5%) (m3/s)	Upper Confidence Limit (95%) (m3/s)	
1%AEP	14.2	4.28	47.1	18.262

** Based on Medium Ensemble Storm*

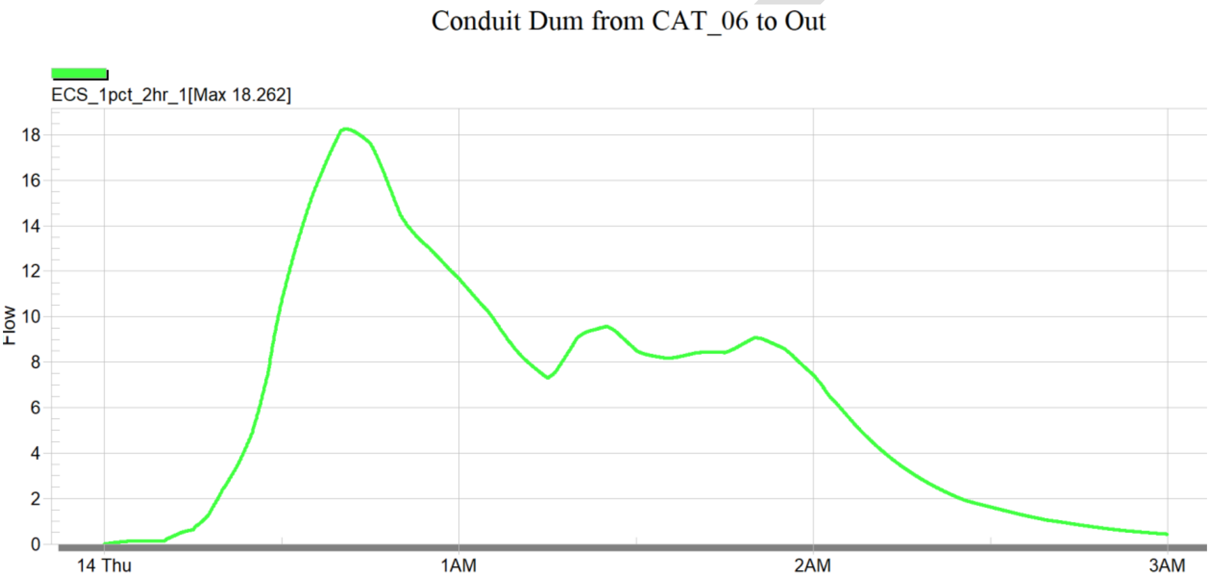

Figure 4 Critical Storm Duration And Temporal Pattern For The Outlet Catchment

3. Overland Flow Hydraulic Assessment

3.1. Objectives

The objective of this overland flow assessment is to demonstrate that the proposed pad does not significantly increase risk within the floodway.

1D/2D TUFLOW has been used for this analysis. The TUFLOW software models the design terrain (i.e. Digital Terrain Model) of the study area as a series of grid points (2D cells). This allows flows in excess of the channel capacity or pipe network, to break out and continue along the floodway in the 2D domain, as the topography dictates. The hydraulic structures (i.e. the minor culvert network) have been represented as 1D elements (ESTRY) which are dynamically linked to the 2D elements. The TUFLOW model computes the capacity of the 1D element and once exceeded, the surcharged flow is transferred to the 2D model. Flood levels, discharge and velocity can be extracted from the model as functions of time at required locations.

TUFLOW is an industry standard two-dimensional river analysis model used to estimate flood characteristics such as flood level, velocity and flood depth and any impacts arising from the proposed development on the surrounding properties.

3.2. 2D Model Set Up

3.2.1. Model Extent

The model extents for the TUFLOW model are presented in Figure 4. The extents were set at an appropriate distance from the subject site. The downstream boundary will be normal depth at the railway bridge.

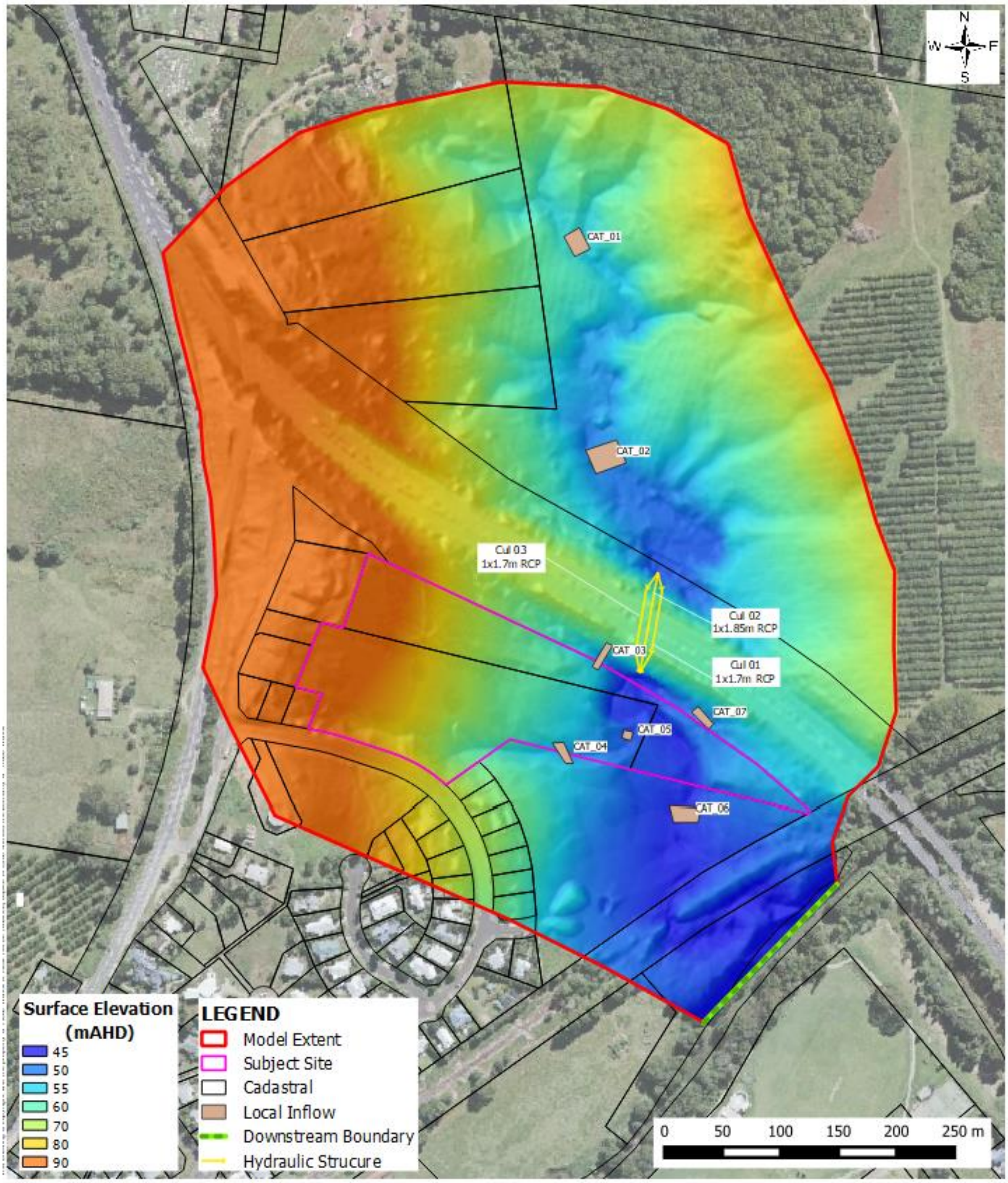

Figure 4 TUFLOW Model Extents

3.2.2. Resolution and Time Step

A grid size of 2m and time step 1s were used in the TUFLOW model for all scenarios. The grid size is based on model efficiency and size constraints for the extent of the model.

3.2.3. Topography

Lidar 1m (2010) data was used as the base topography for the TUFLOW model. The topography used in the pre-development and post-development scenario is shown in Figure 5 and Figure 6.

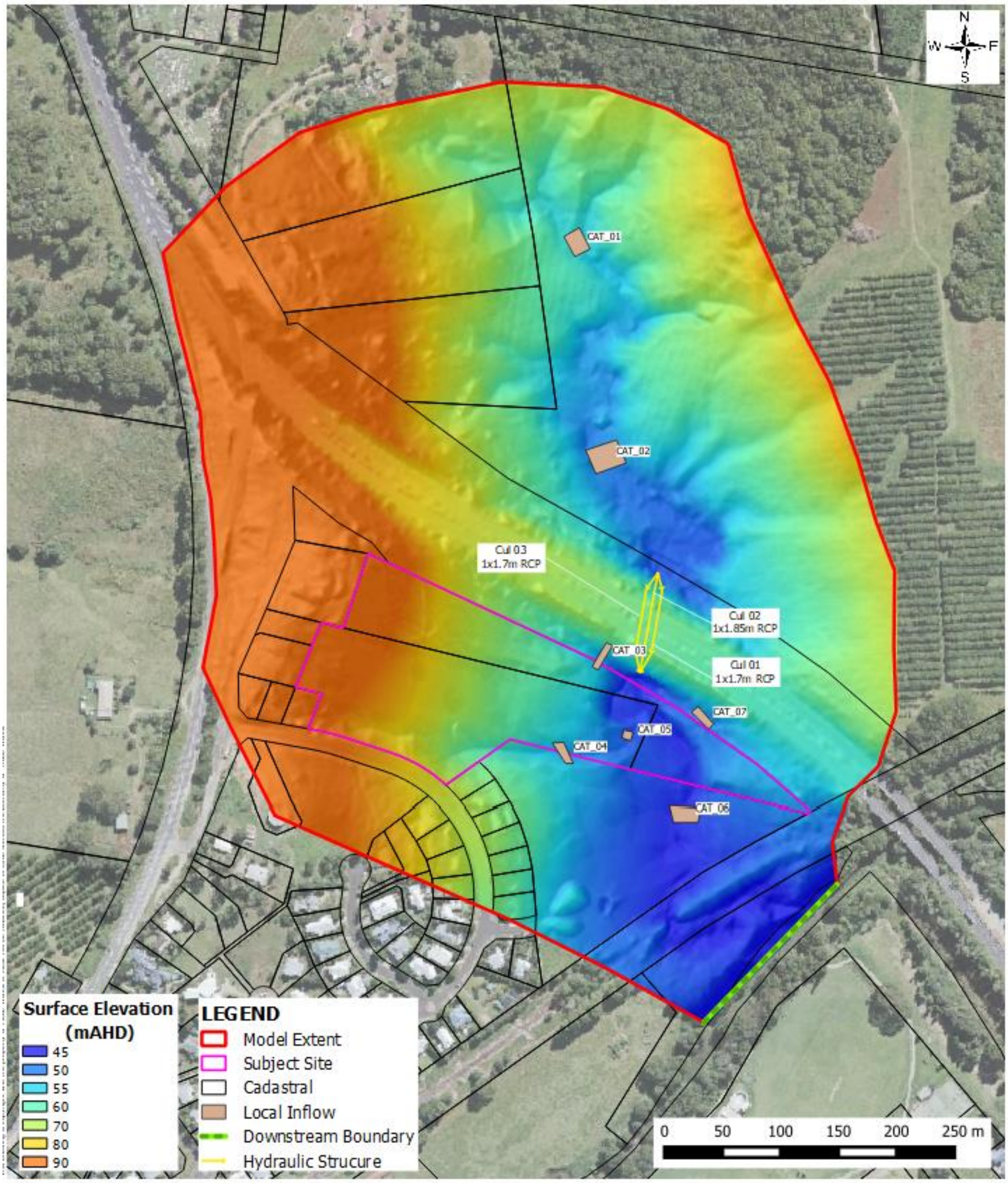

Figure 5 Existing Case Surface Elevation Data

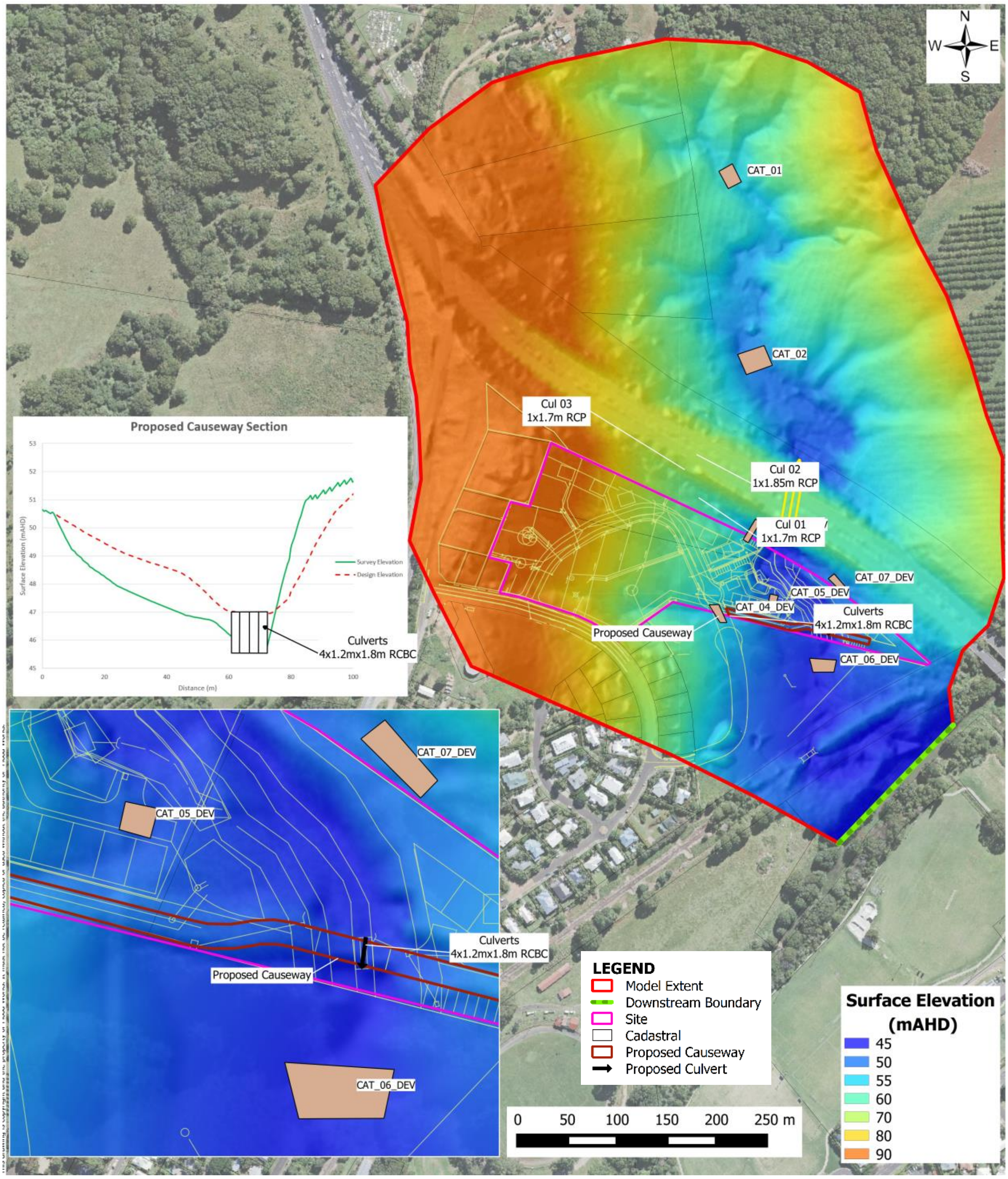

Figure 6 Developed Case Surface Elevation Data

3.2.4. Roughness

Figure 7 and Figure 8 show the roughness adopted in the hydraulic impact assessment model.

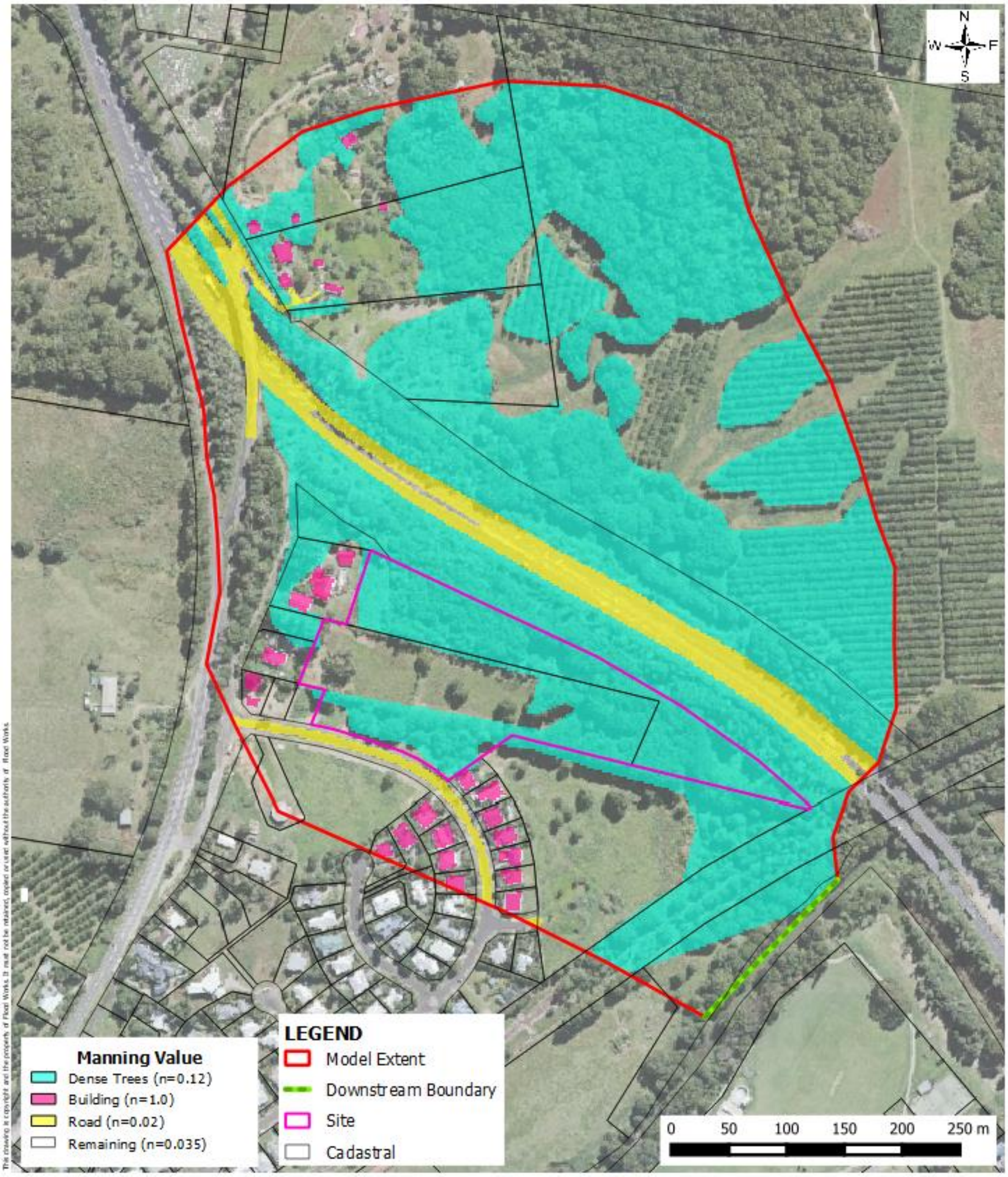

Figure 7 Existing Case Roughness Map

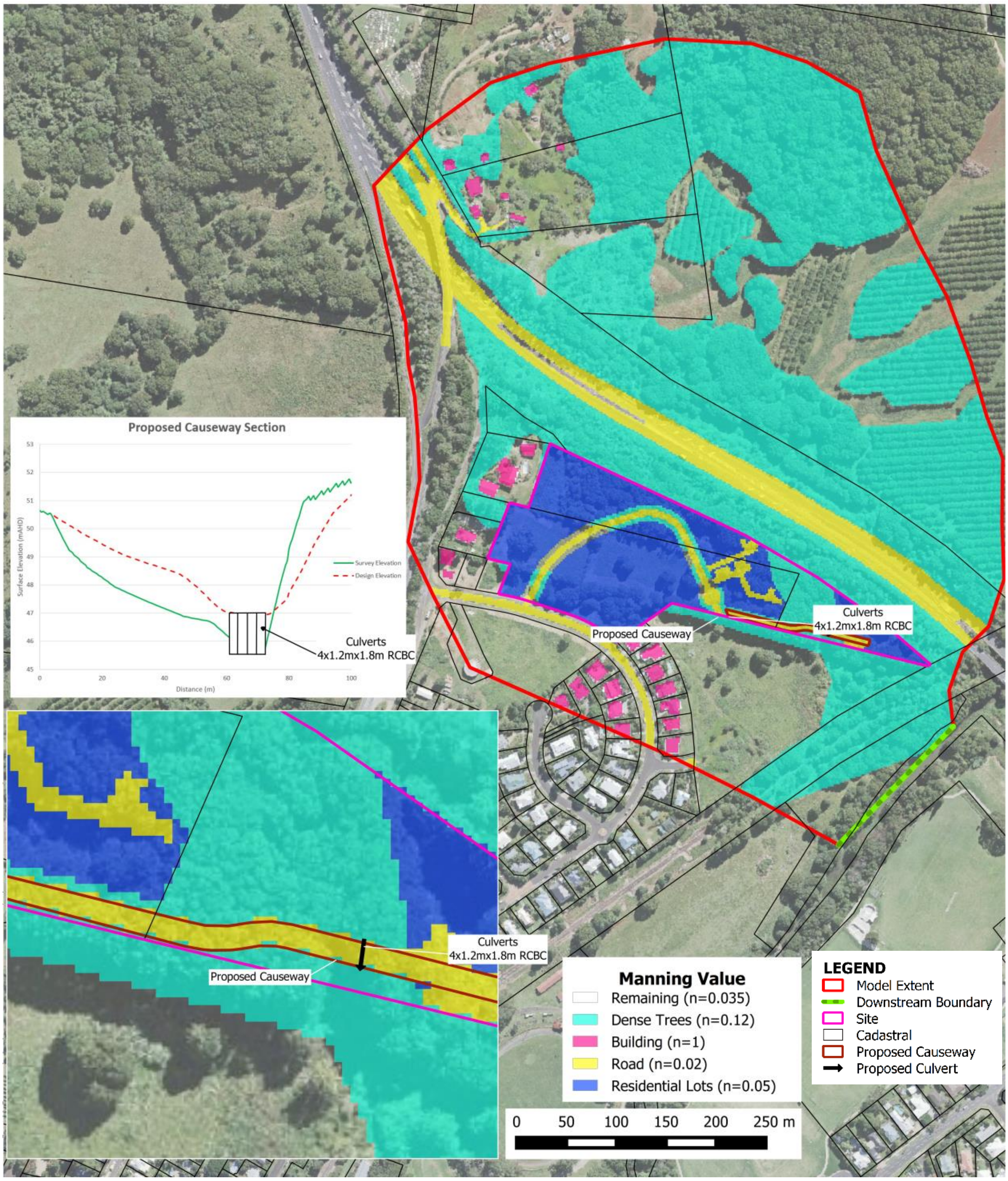

Figure 8 Developed Case Roughness Map

3.2.5. Inflows

The inflows within the TUFLOW model were extracted directly from the XP-SWMM Hydrology model (ARR 2019). See Figure 5 for inflow locations.

3.2.6. Rail Bridge and Hinterland Way Culverts

The rail bridge at the downstream boundary was presented by modifying topography to achieve a 14.7m bridge opening.

The Hinterland Way culverts (Figure 5), were modelled as a 1D element with a Manning n = 0.013.

3.3. Existing Case

The existing case 1 %AEP, 1%AEP_CC, 5%AEP and 20%AEP design event peak water level, depth, velocity and hazard are shown in Figure 10 to Figure 25 below respectively.

The peak water level (at the location of the proposed causeway) for the 1%AEP is 46.91 mAHD, and the 5 %AEP is 46.78 mAHD.

Peak water depth (at the location of the proposed causeway) for the 1%AEP is 1.22m, and the 5 %AEP is 1.09m.

Peak water velocity (at the location of the proposed causeway) for the 1%AEP is 1.0 m/s, and the 5 %AEP is 0.94 m/s.

The peak flood hazard (at the location of the proposed causeway) for the 1%AEP is H5 (high hazard) within the thalweg of the creek.

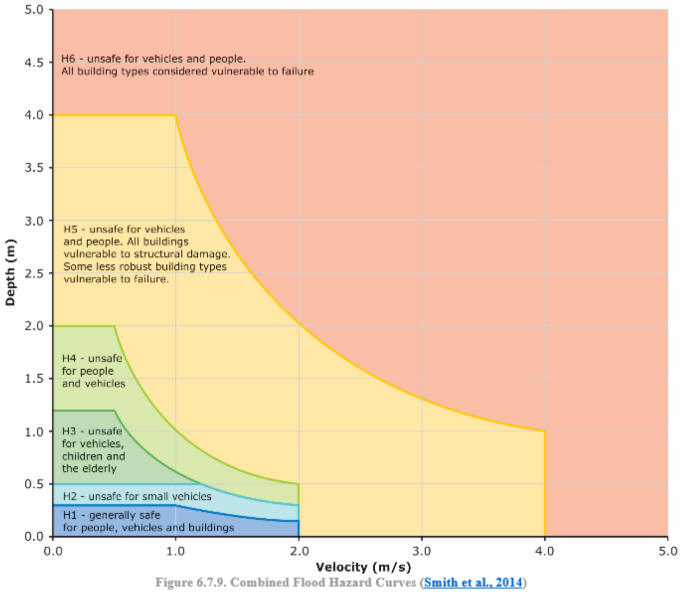

Figure 9 ARR2019 Combined Hazard Curves

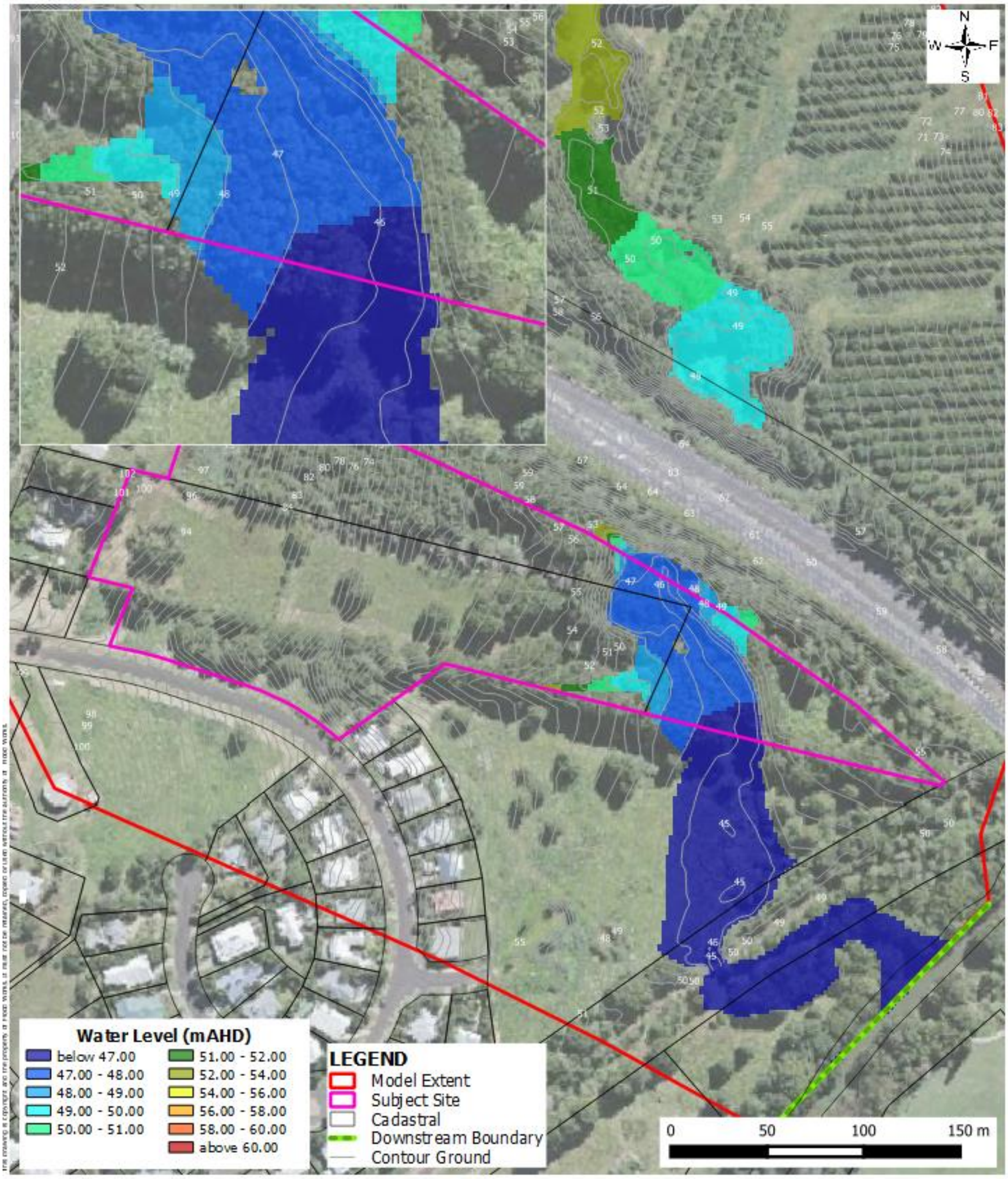

Figure 10 Existing Maximum Water Level – 1%AEP

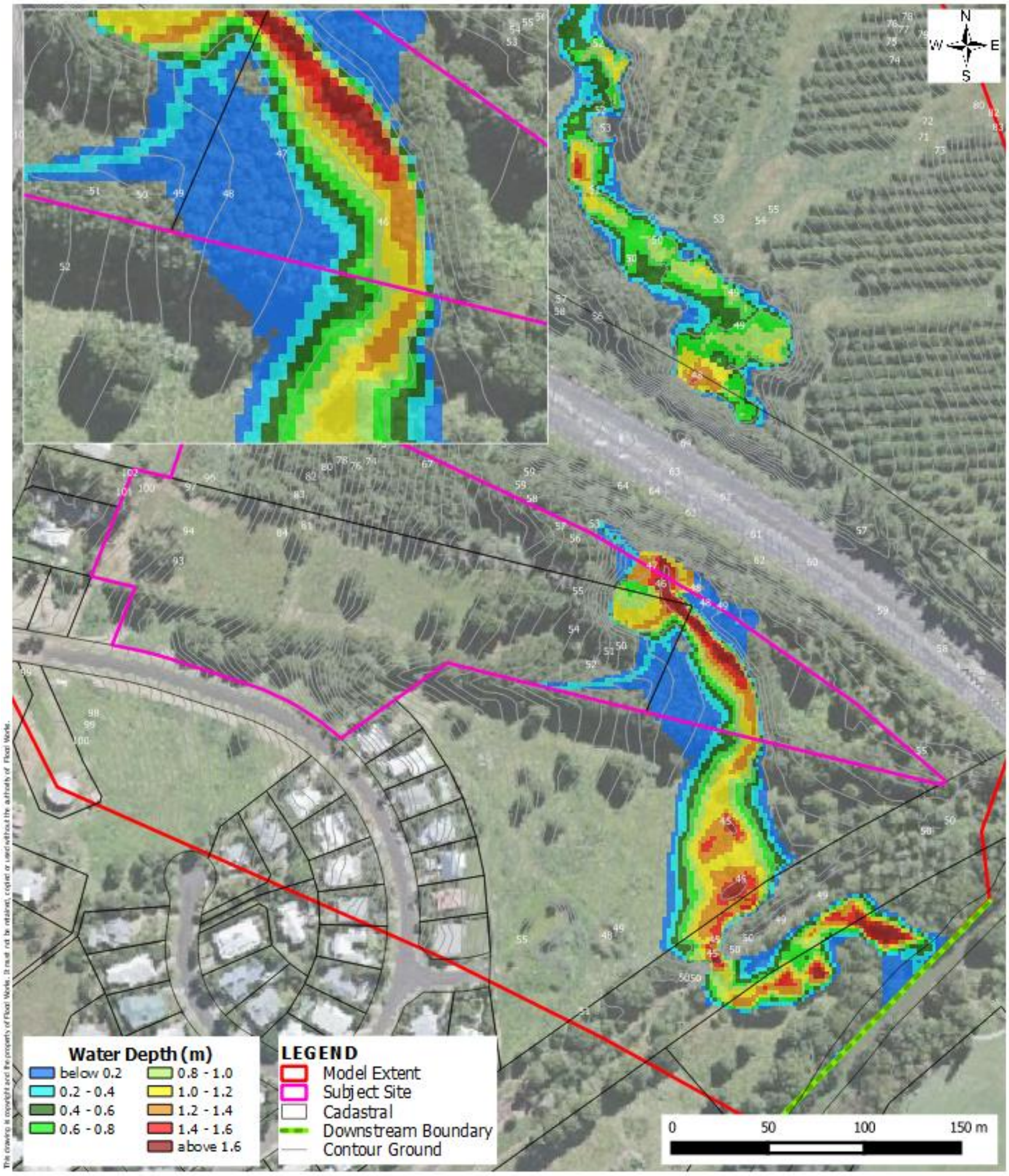

Figure 11 Existing Maximum Depth – 1%AEP

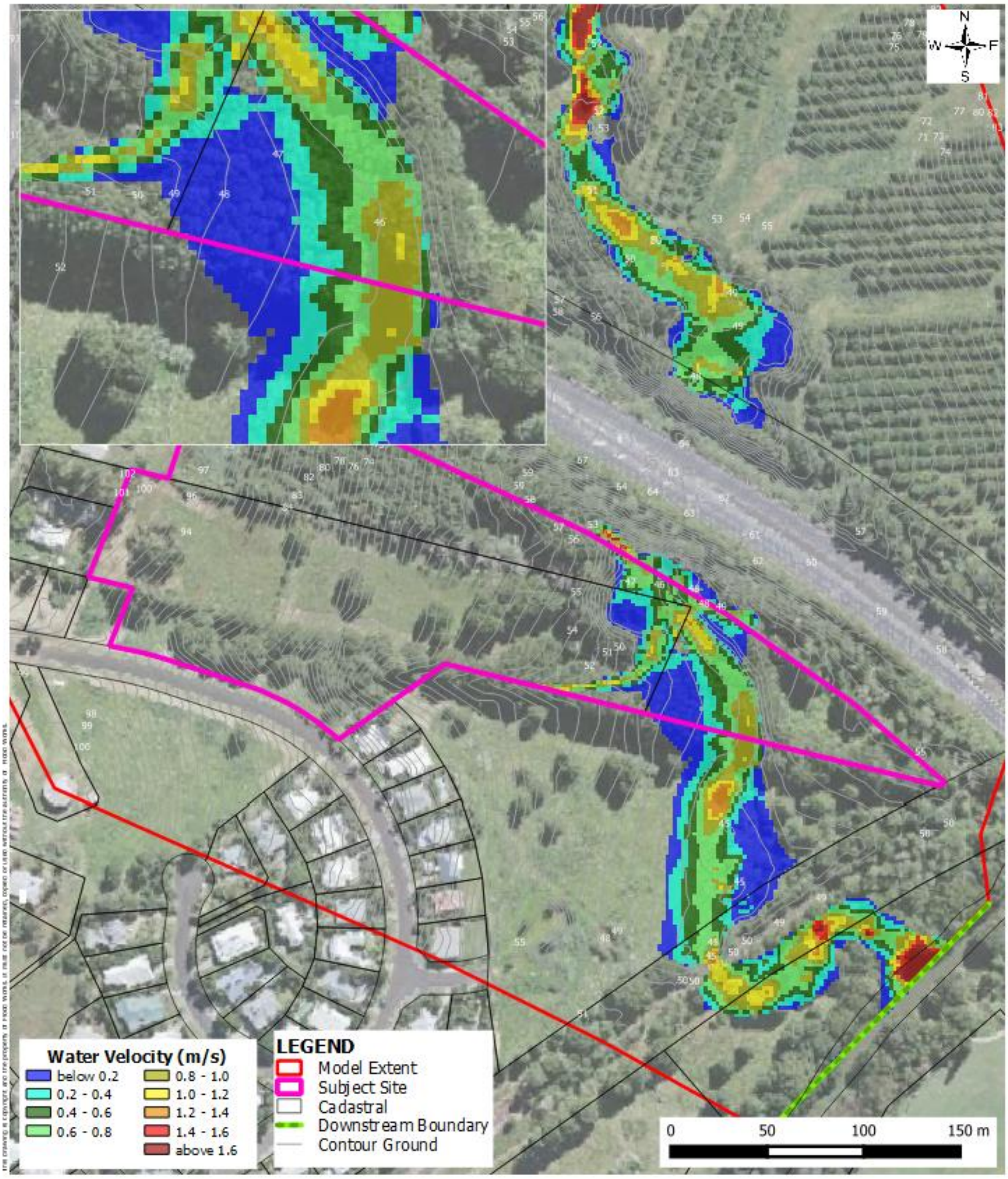

Figure 12 Existing Maximum Velocity – 1%AEP

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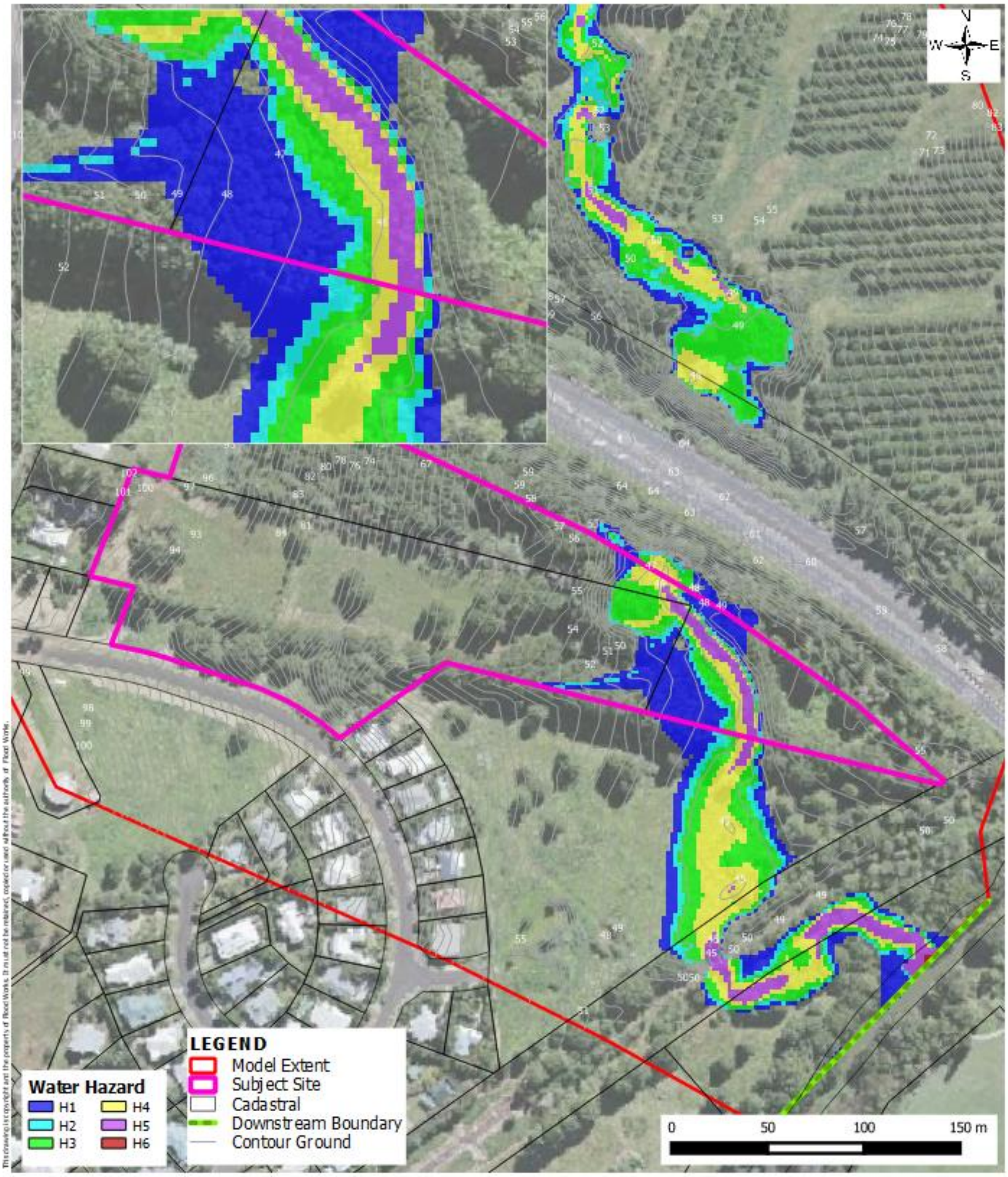


Figure 13 Existing Maximum Flood Hazard – 1%AEP

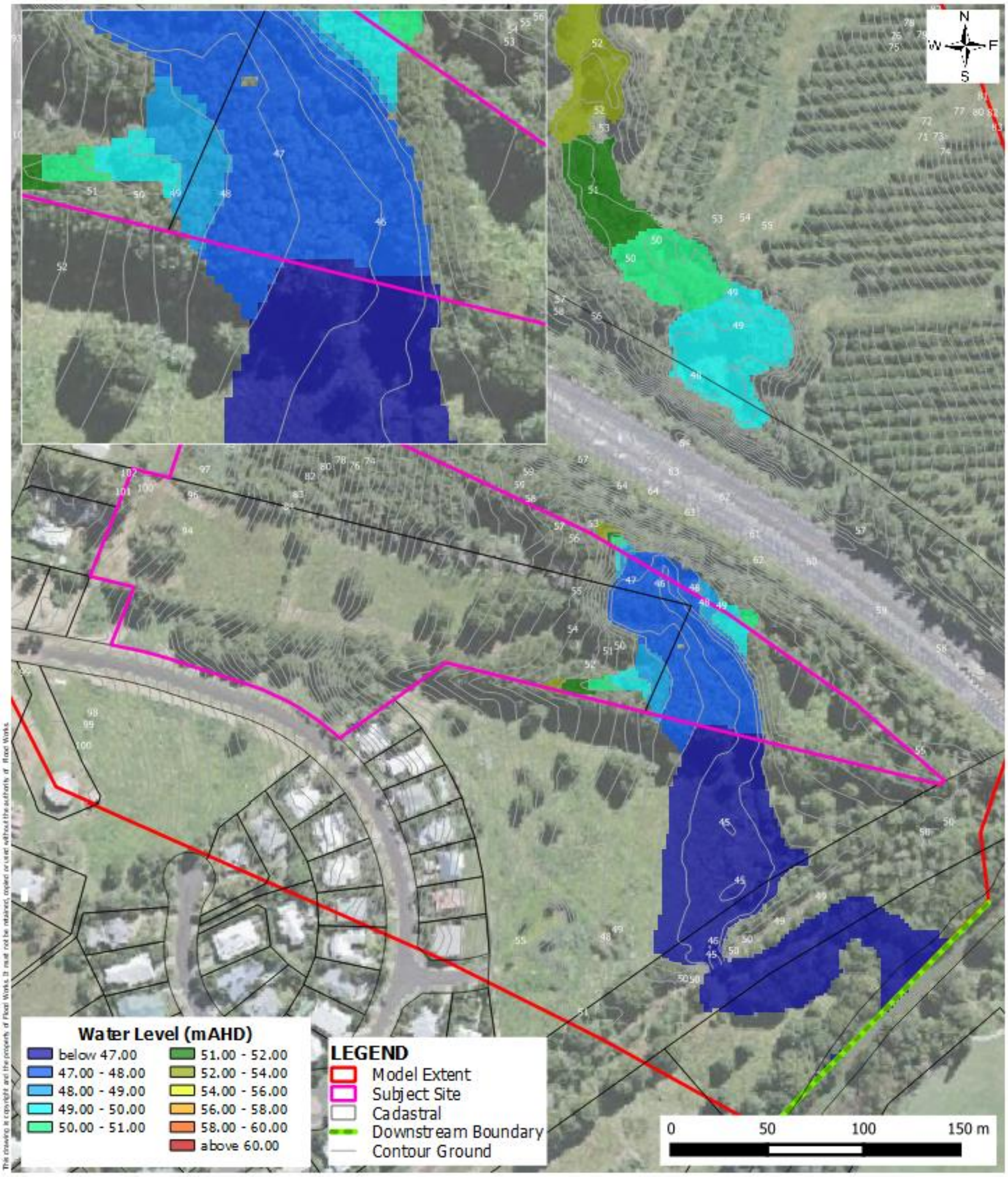


Figure 14 Existing Maximum Water Level – 1%AEP CC

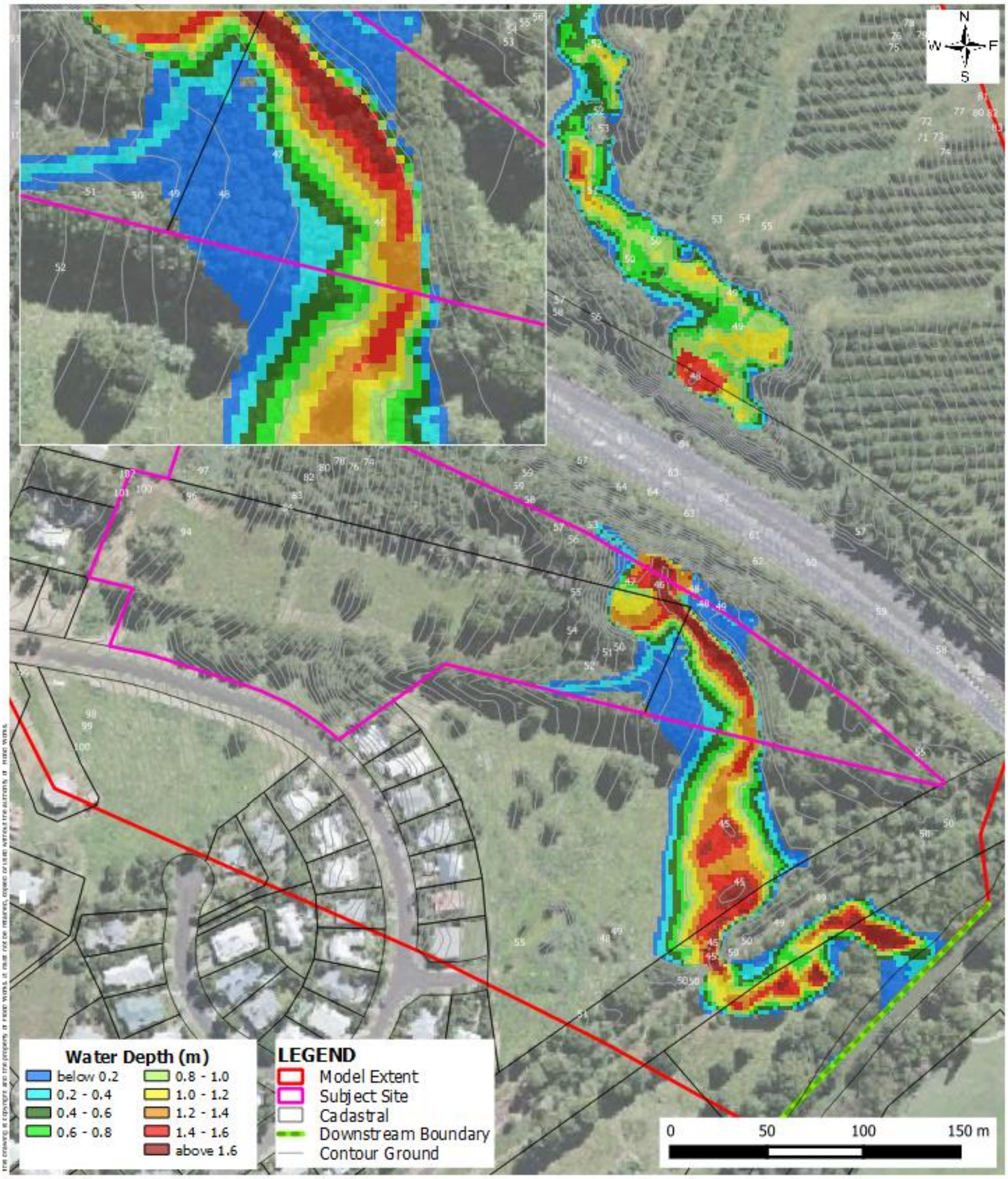


Figure 15 Existing Maximum Water Depth – 1%AEP CC

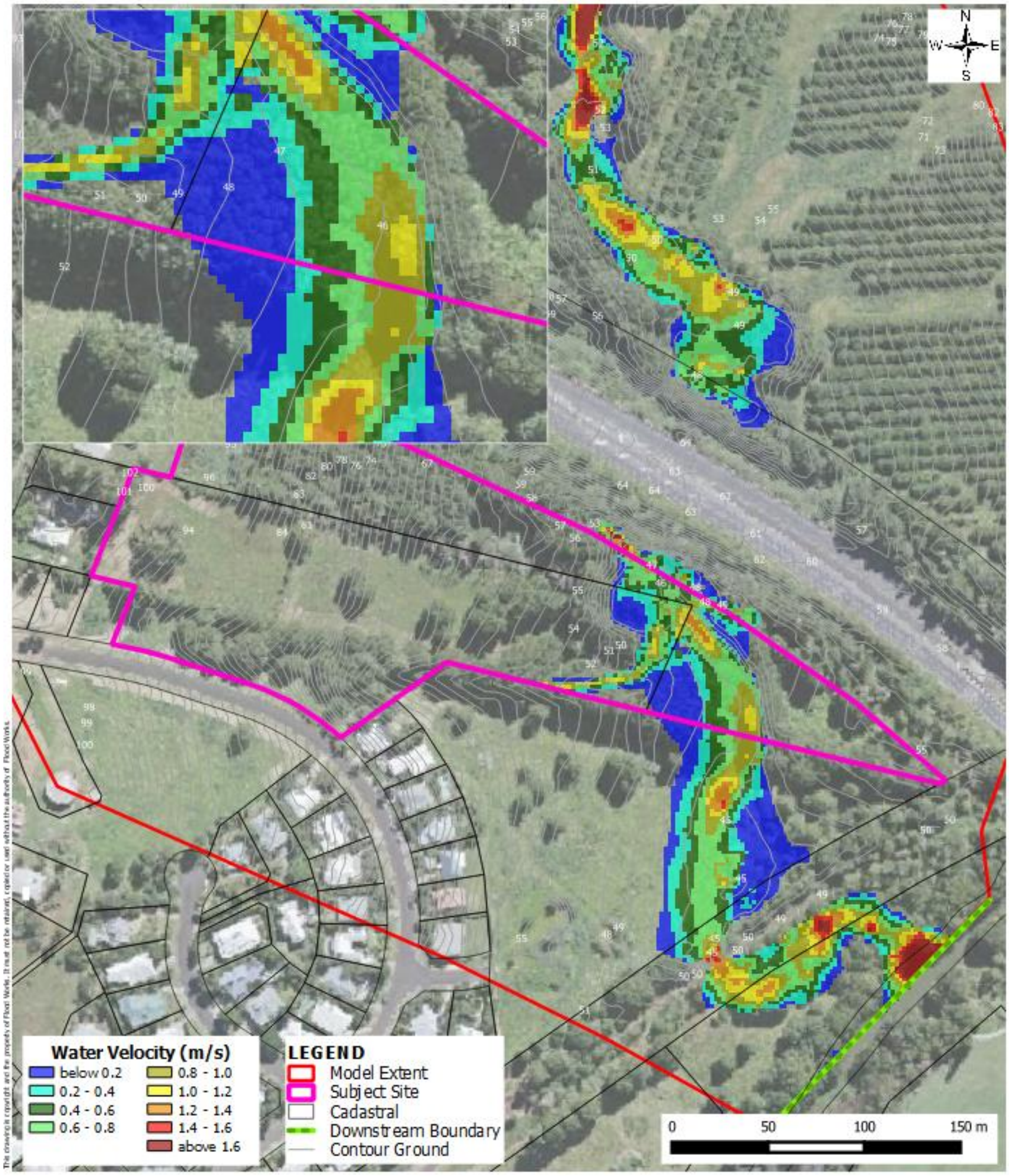


Figure 16 Existing Maximum Water Velocity – 1%AEP CC

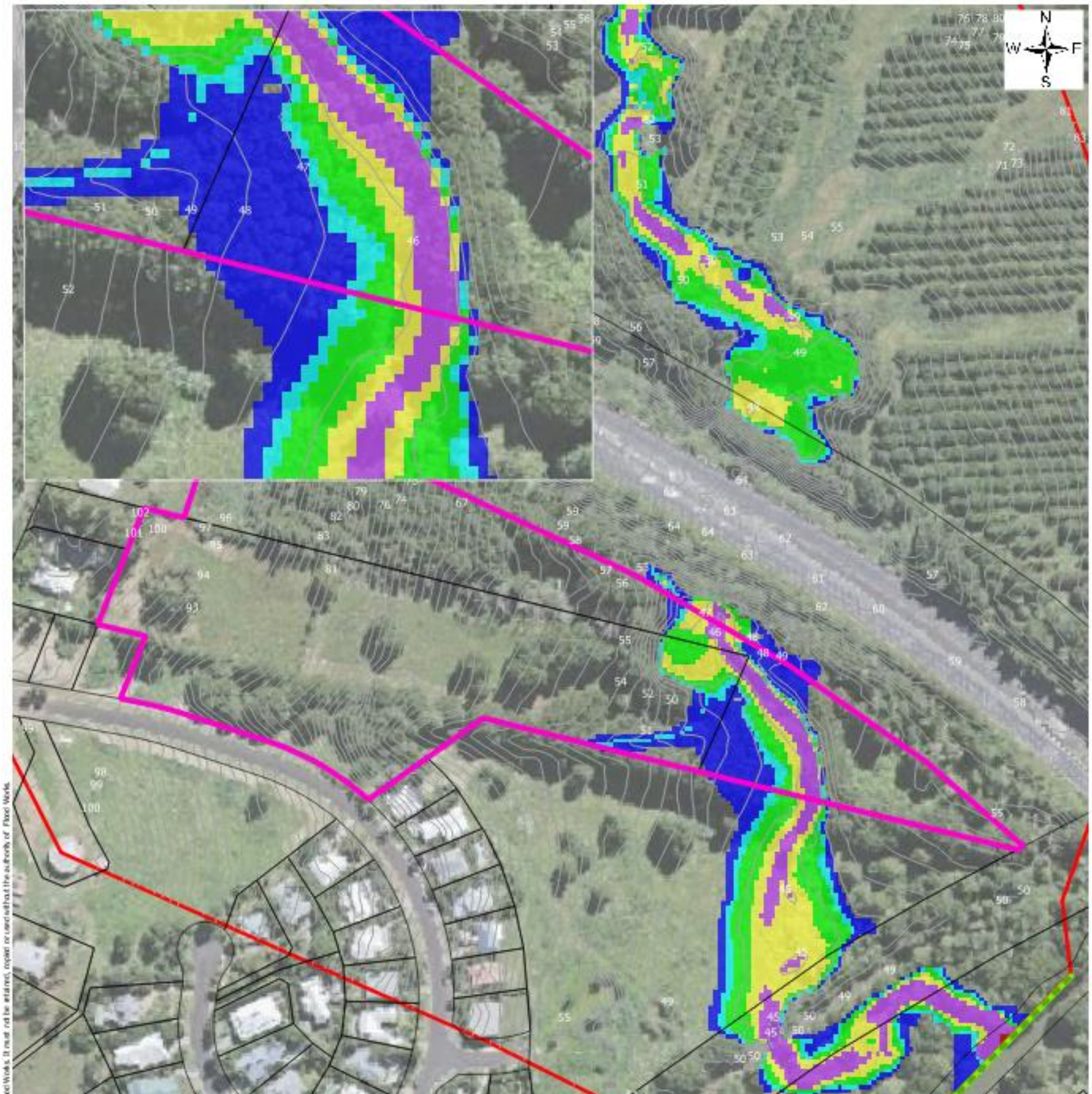


Figure 17 Existing Maximum Water Hazard – 1%AEP CC

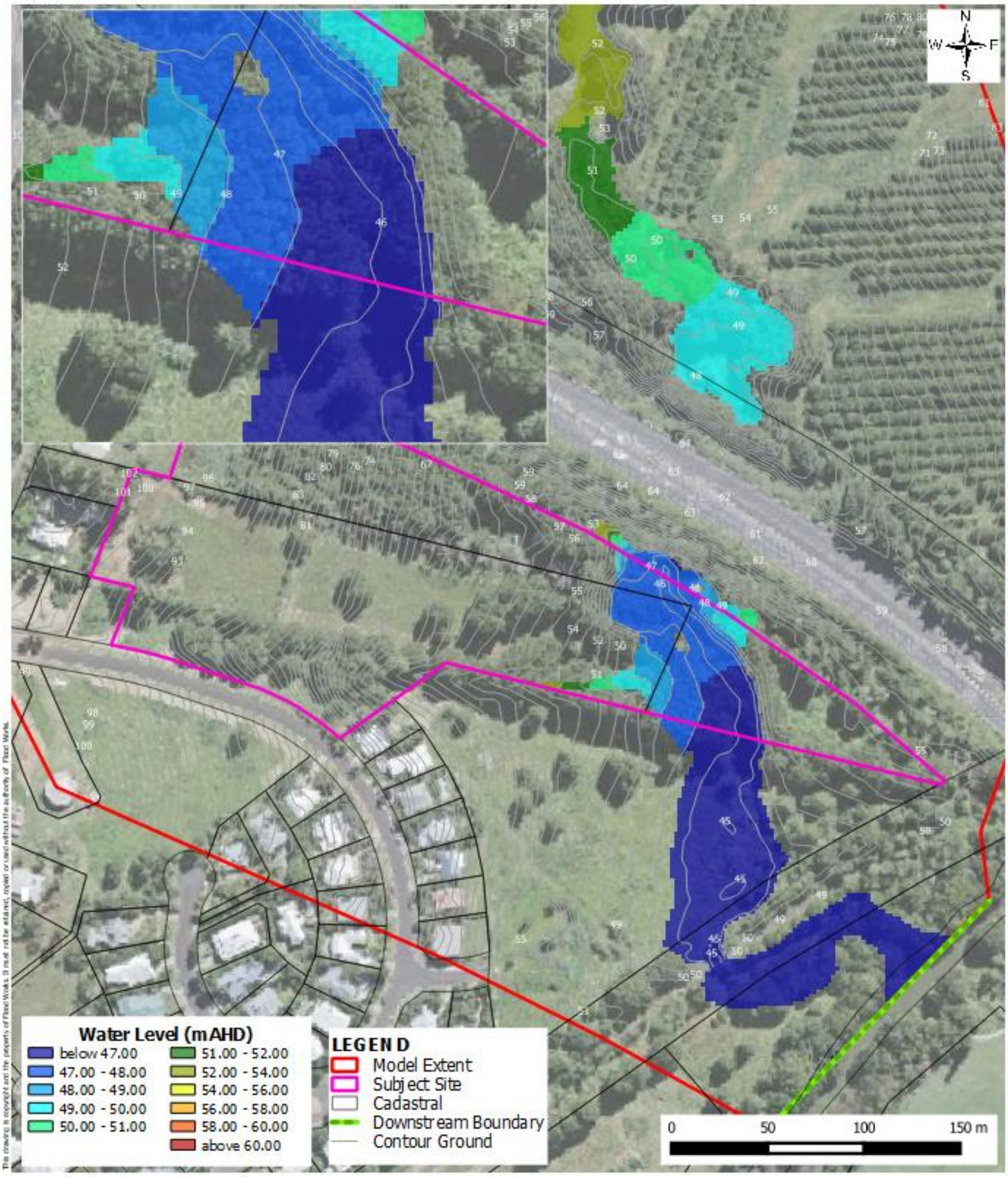


Figure 18 Existing Maximum Water Level – 5%AEP

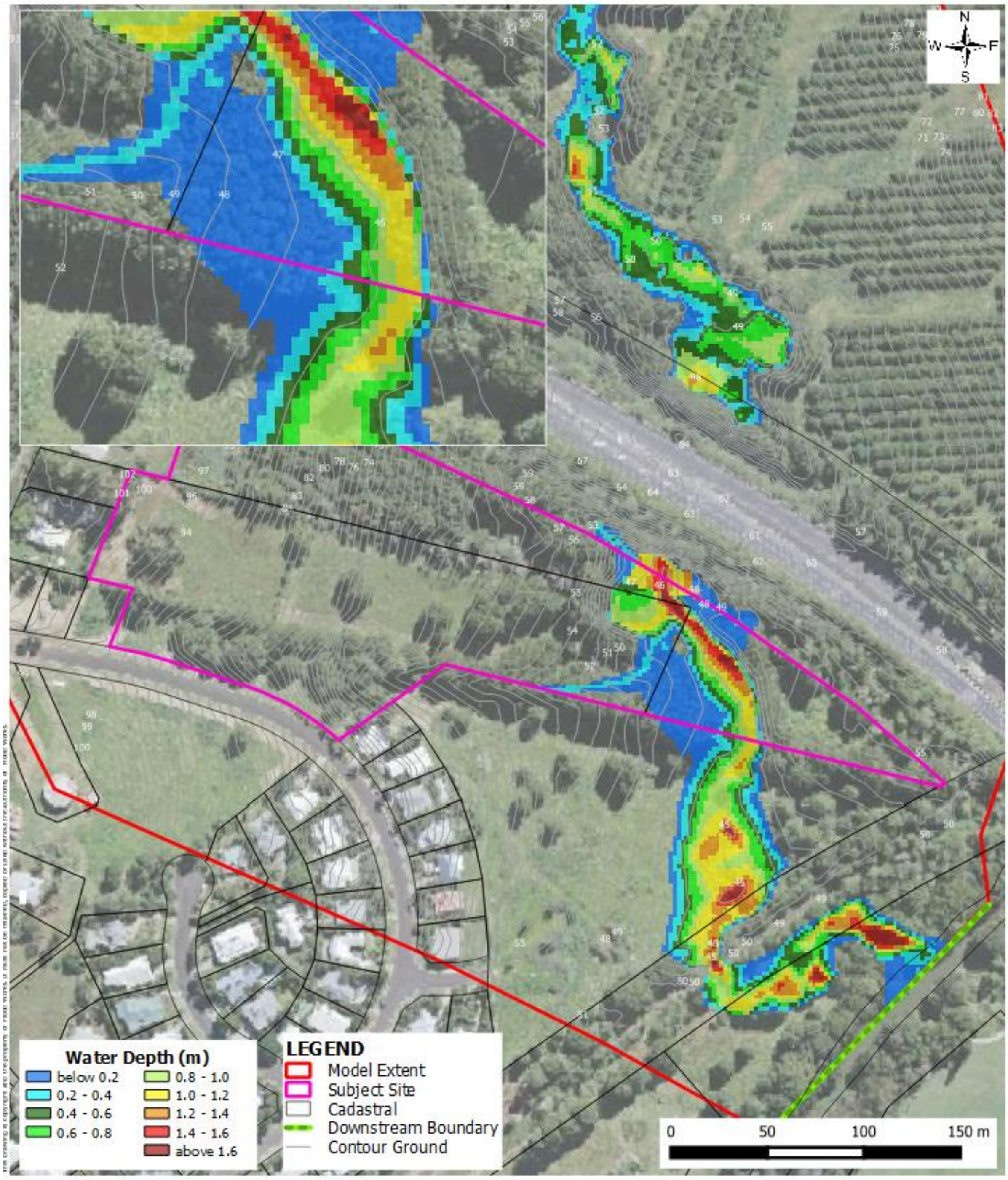


Figure 19 Existing Maximum Water Depth – 5%AEP

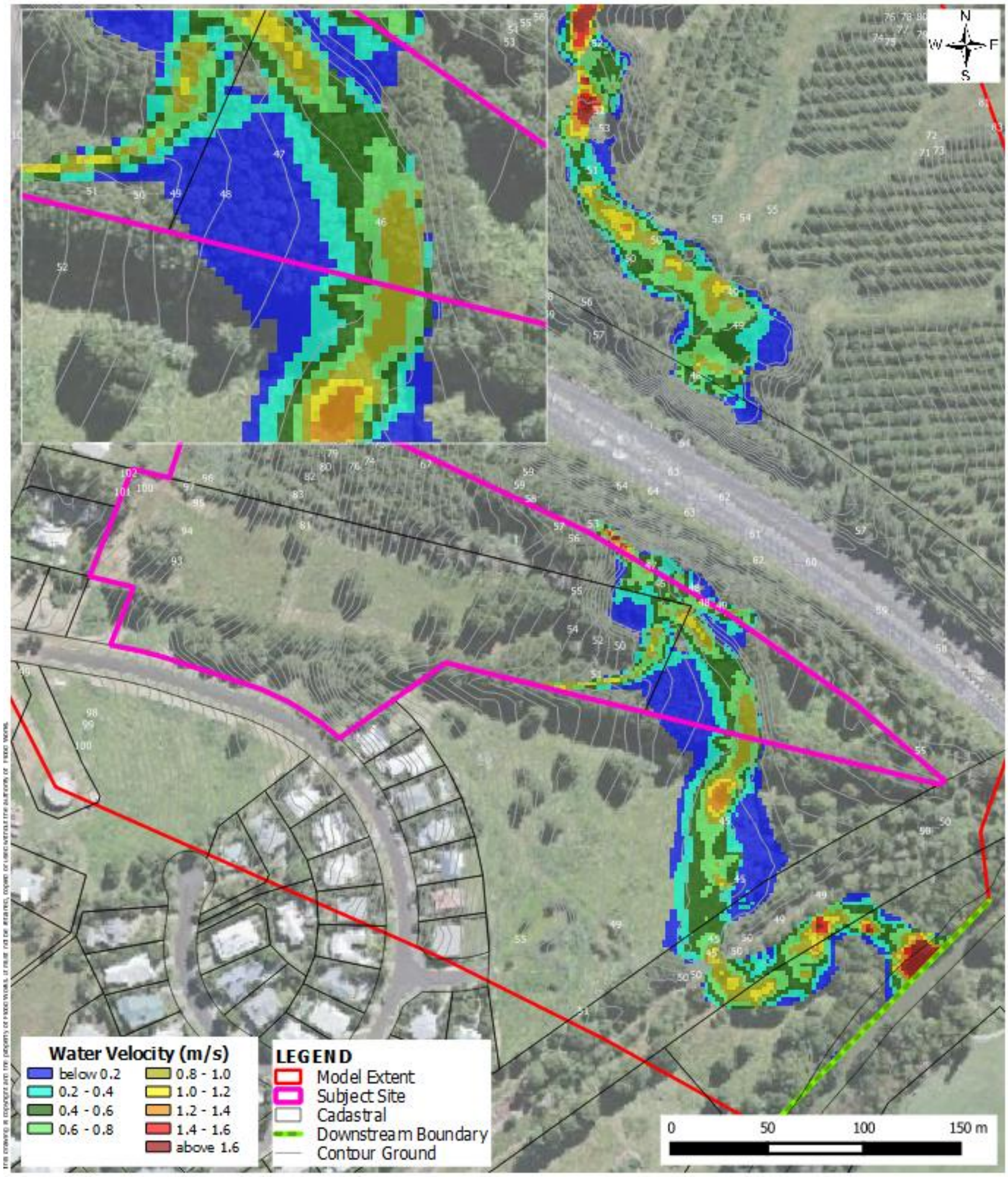


Figure 20 Existing Maximum Water Velocity – 5%AEP

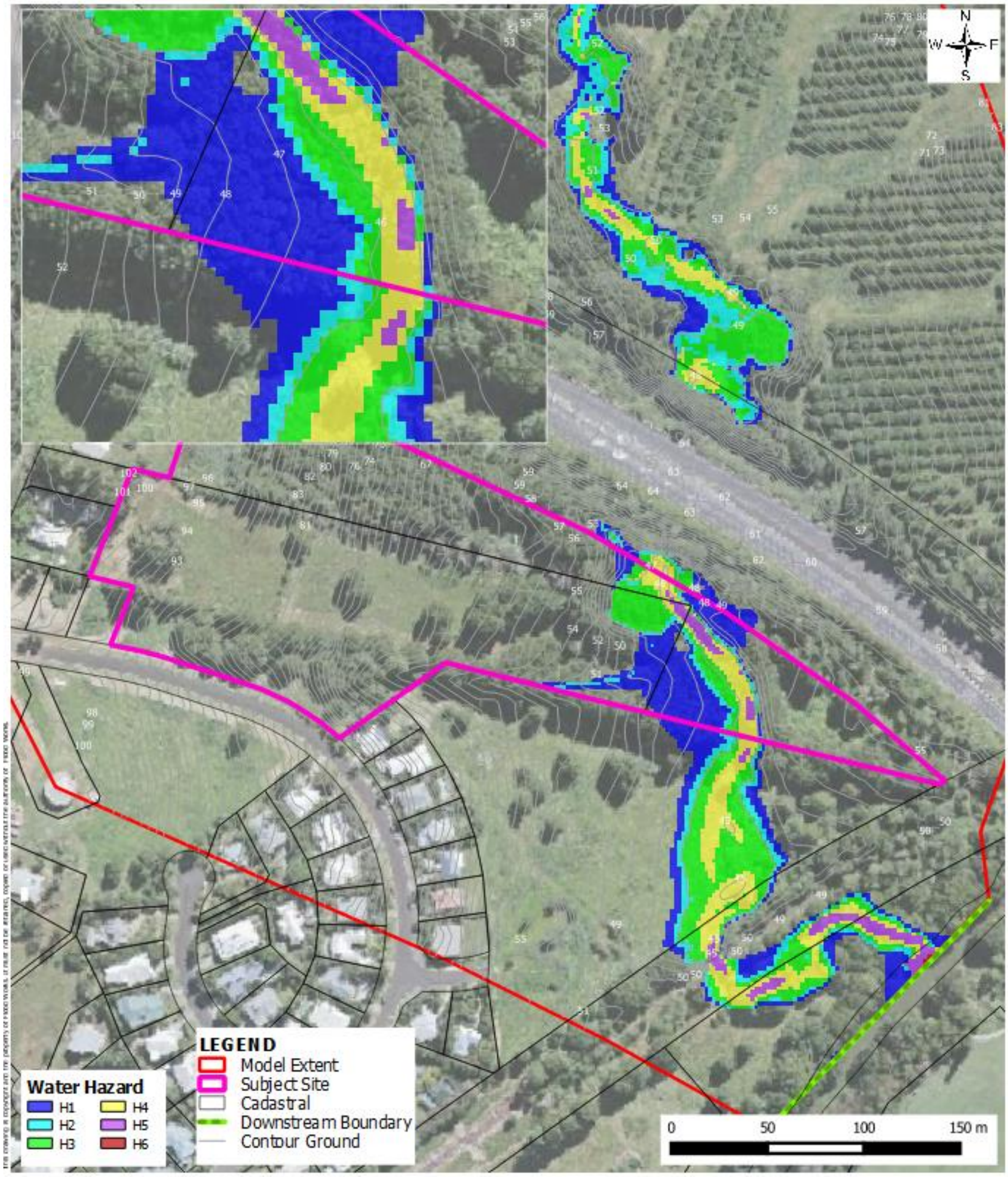


Figure 21 Existing Maximum Water Hazard – 5%AEP

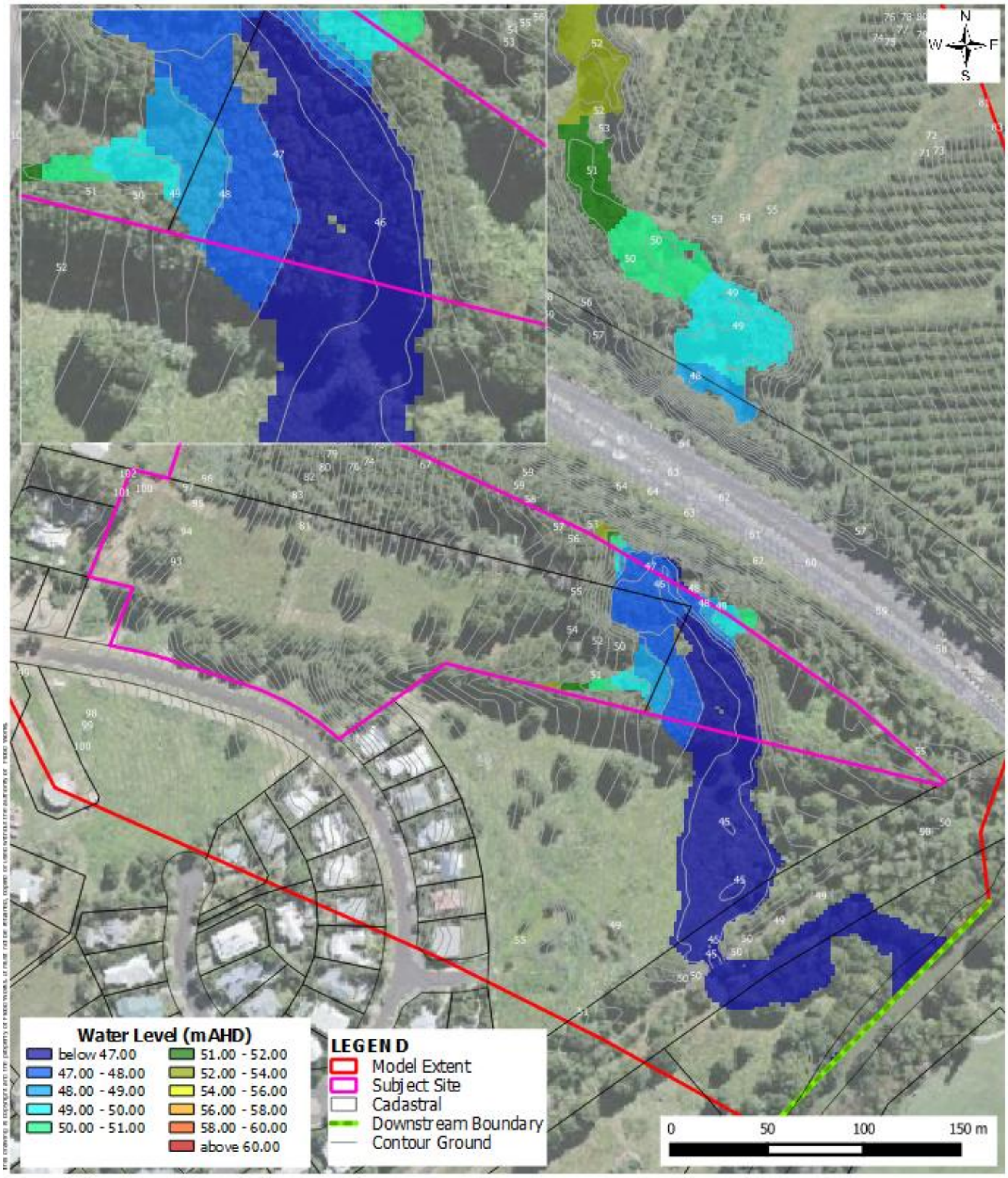


Figure 22 Existing Maximum Water Level – 20%AEP

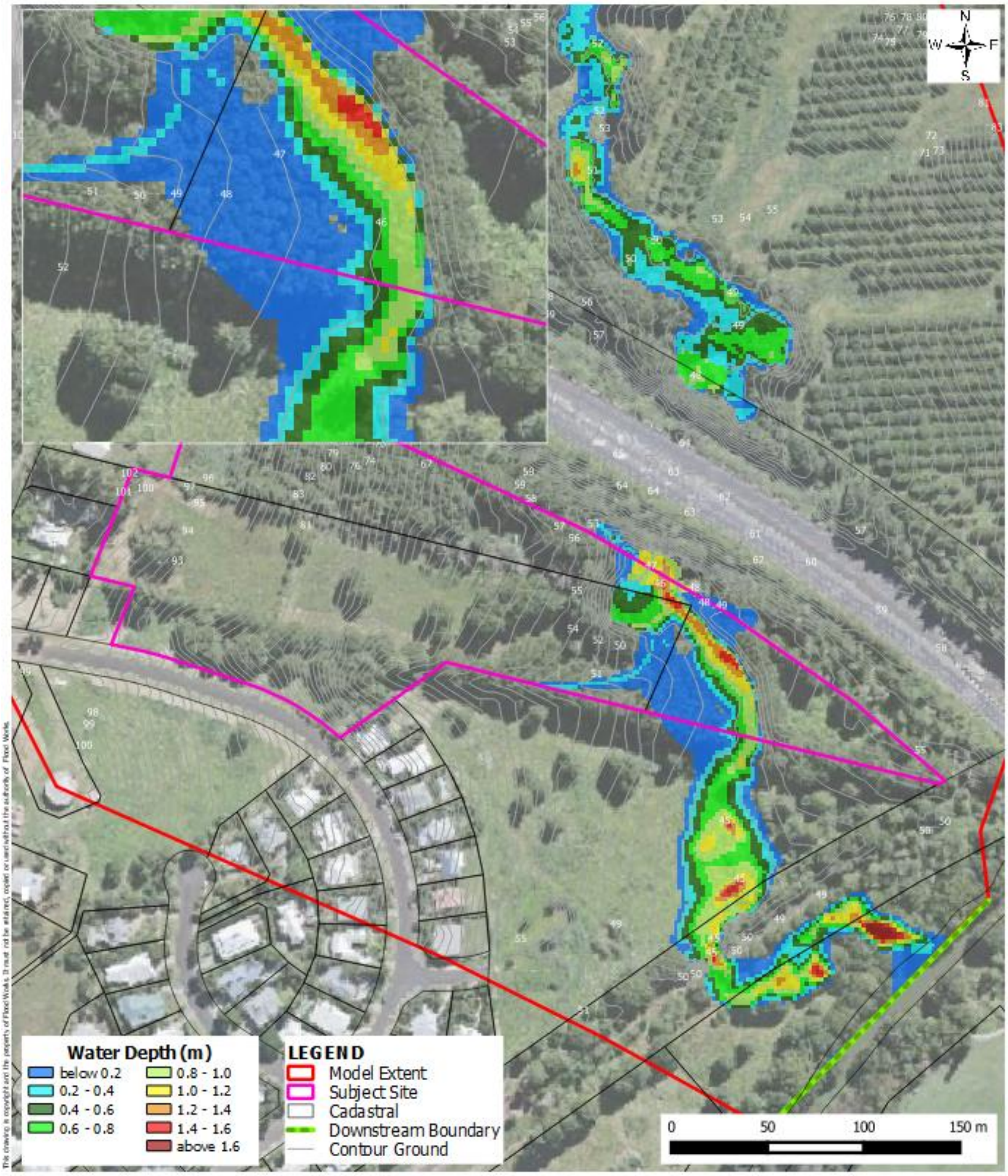


Figure 23 Existing Maximum Water Depth – 20%AEP

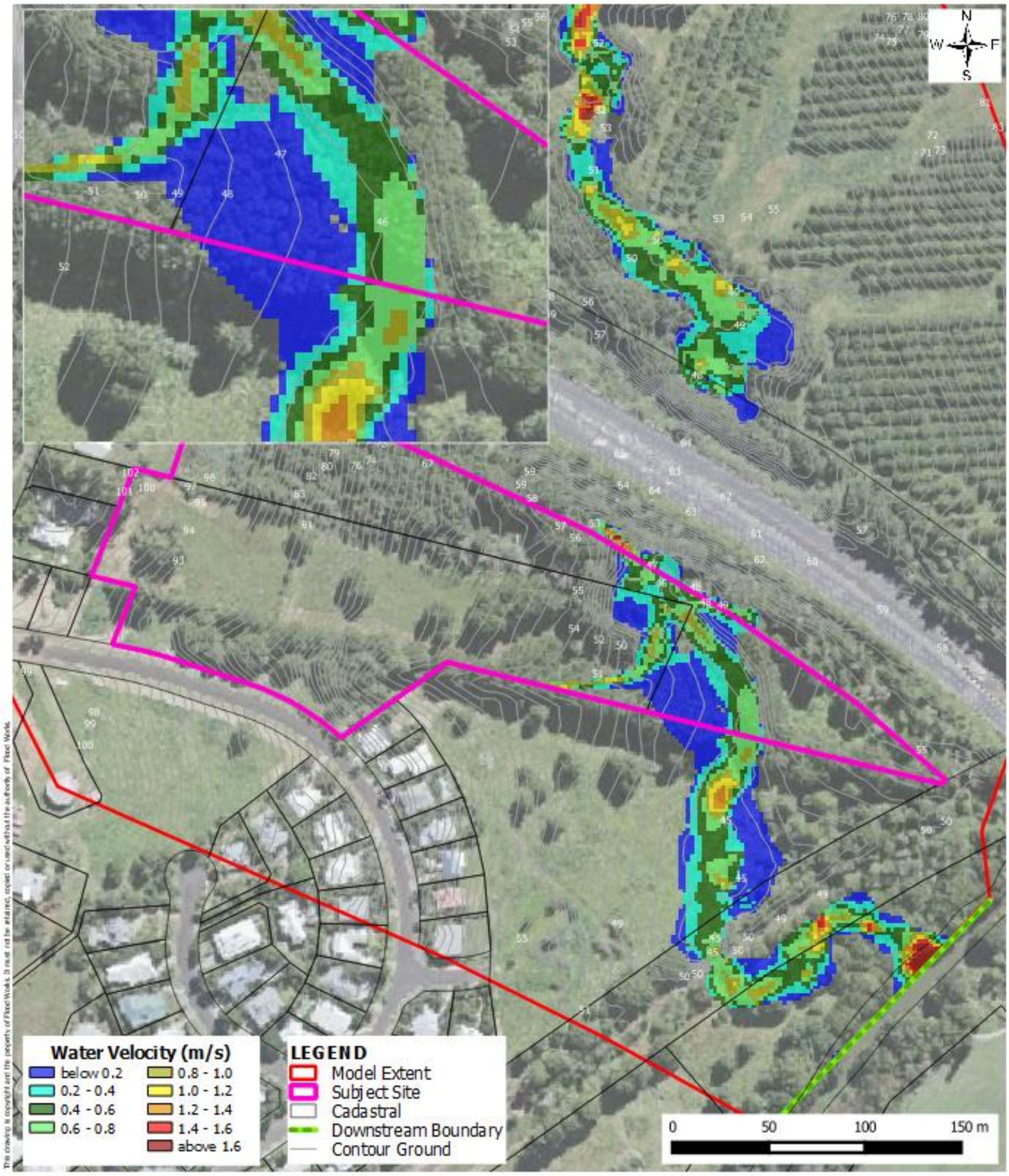


Figure 24 Existing Maximum Water Velocity – 20%AEP

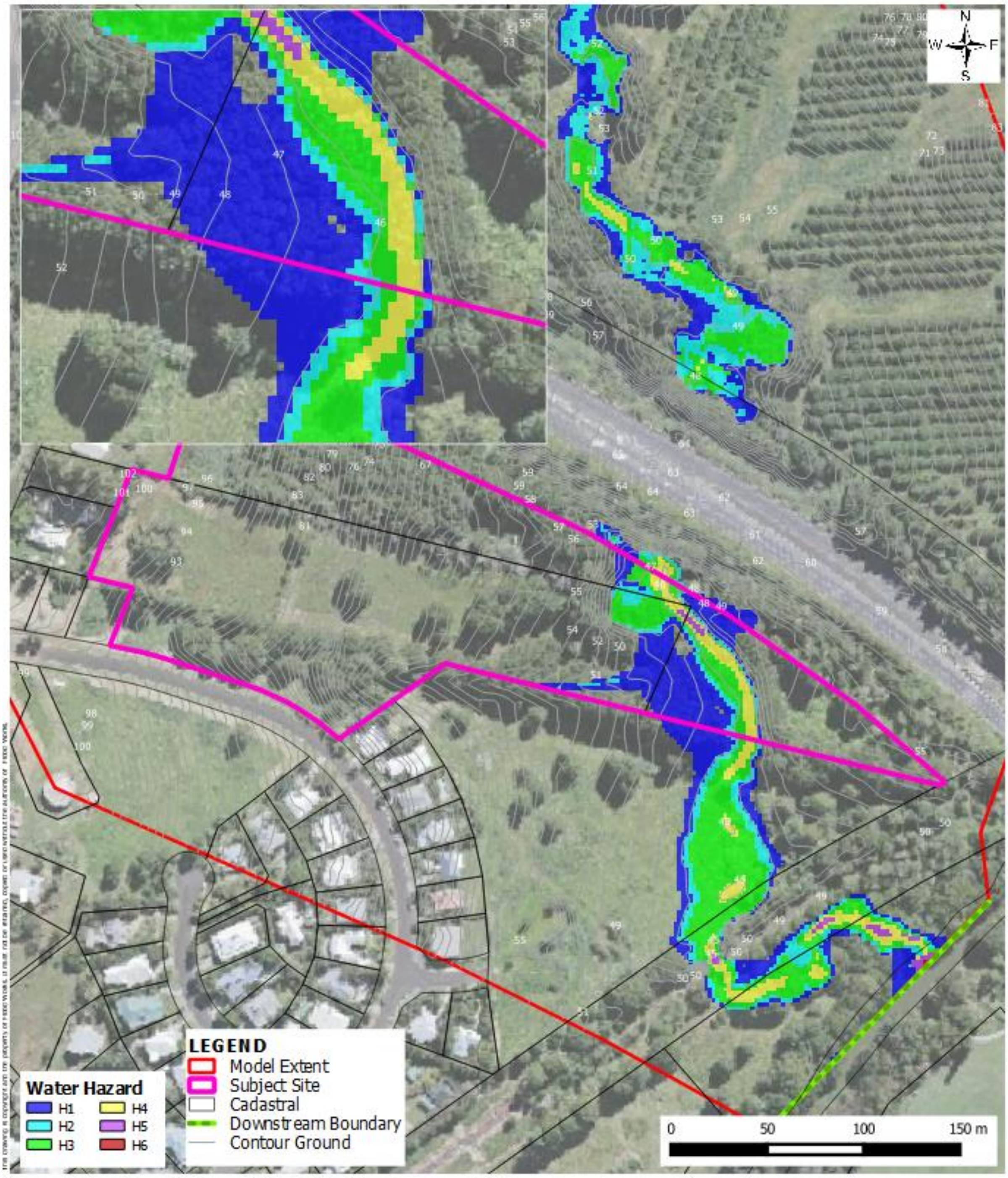


Figure 25 Existing Maximum Water Hazard – 20%AEP

3.4. Developed Case

The developed case 1 %AEP, 1 %AEP_CC, 5 %AEP and 20 %AEP design event peak water level, depth, velocity and hazard are shown in Figure 26 to Figure 41 below respectively.

The peak water level (at the location of the proposed causeway) for the 1 %AEP is 46.97 mAHD, and the 1 %AEP_CC is 47.08 mAHD. The 5 %AEP and 20 %AEP do not overtop the proposed causeway.

The peak water depth (at the location of the proposed causeway) for the 1 %AEP is 20mm, and the 1 %AEP_CC is 130mm. The 5 %AEP and 20 %AEP do not overtop the proposed causeway.

Peak water velocity (at the location of the proposed causeway) for the 1 %AEP is 0.35 m/s, and the 1 %AEP_CC is 1.2 m/s. The 5%AEP and 20%AEP do not overtop the proposed causeway.

Peak flood hazard (at the location of the proposed causeway) for both the 1%AEP and the 1%AEP_CC is H1 (low hazard) overtopping the causeway. The 5%AEP and 20%AEP do not overtop the proposed causeway.

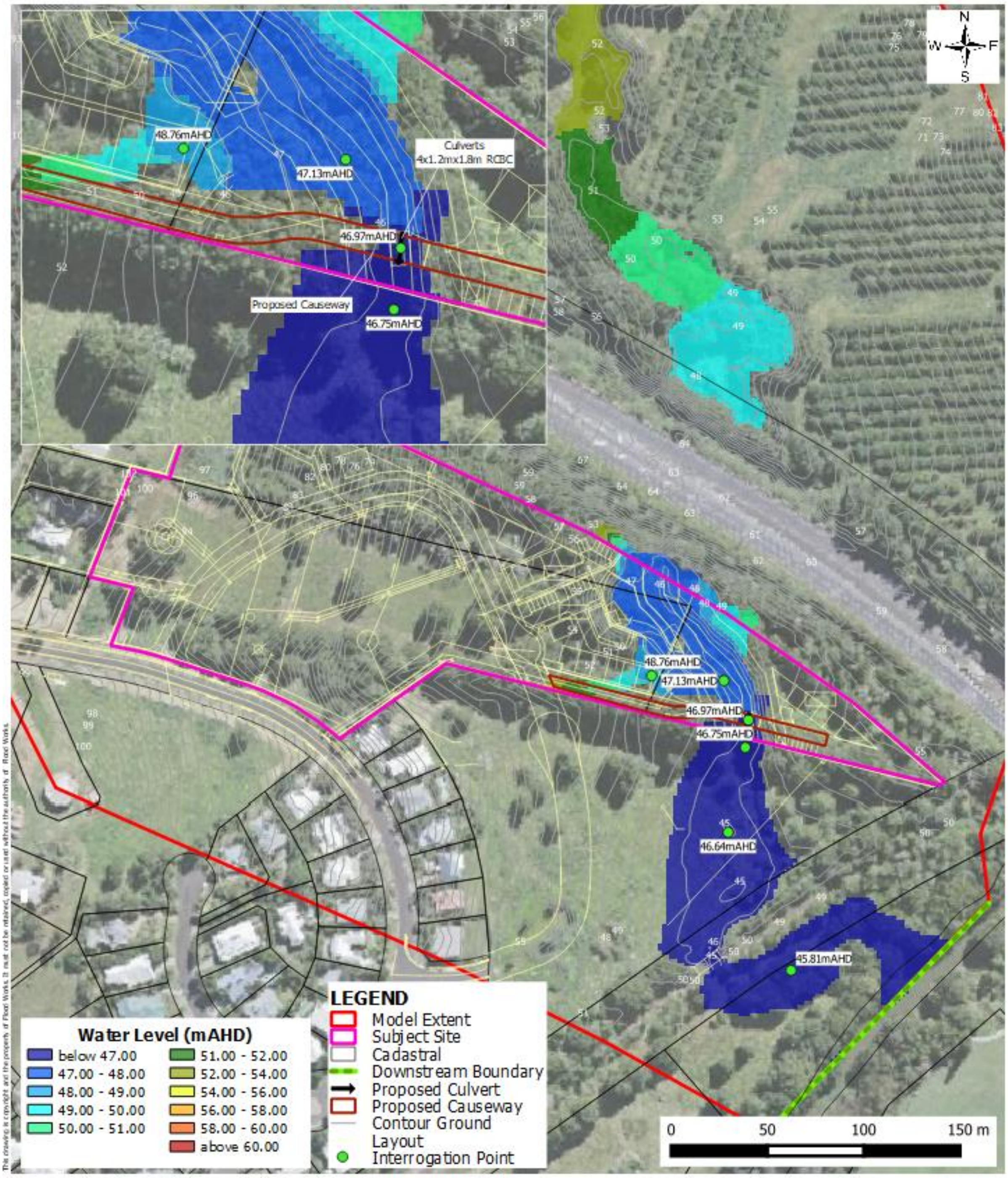


Figure 26 Developed Case Maximum Water Level – 1%AEP

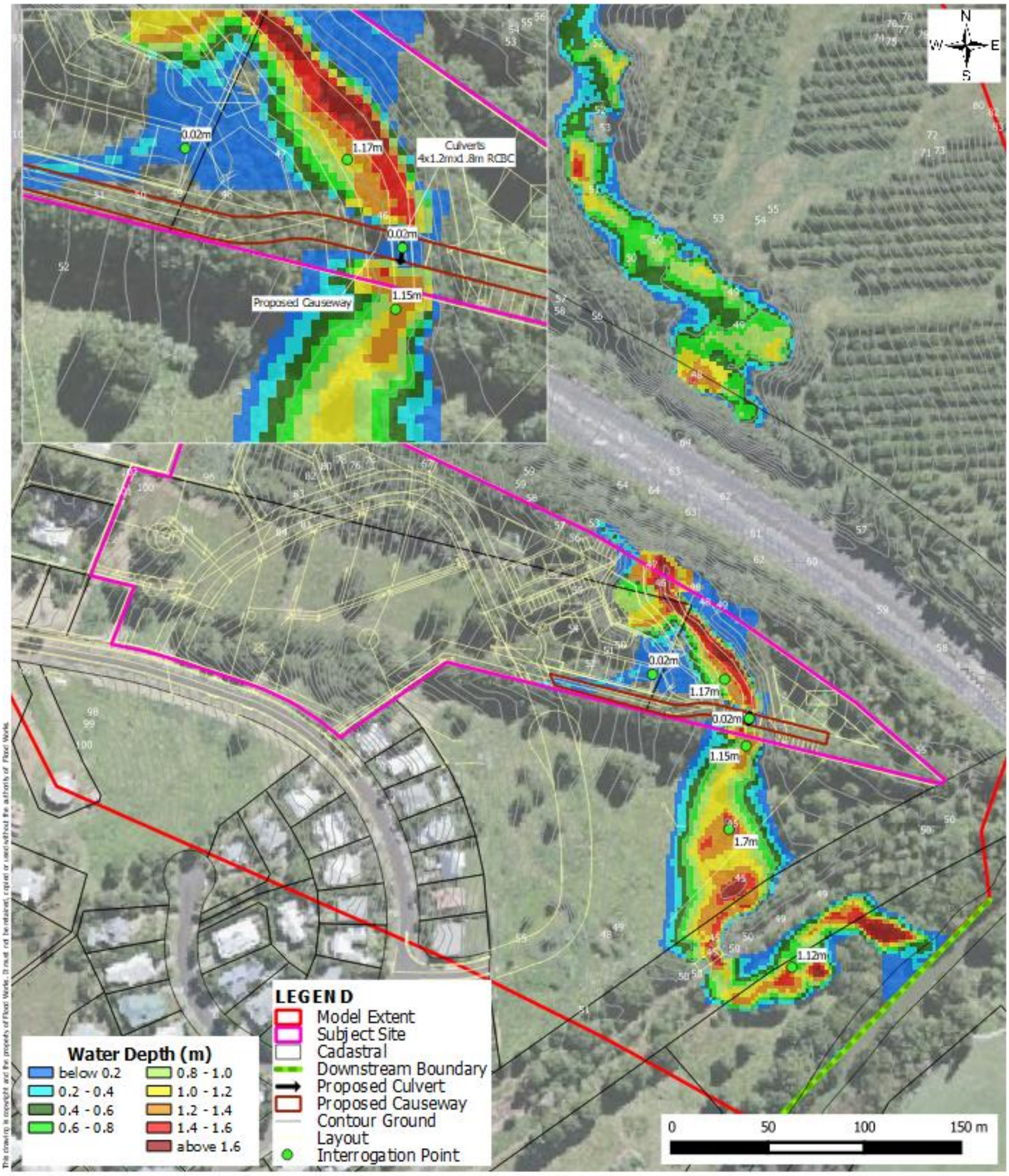


Figure 27 Developed Case Maximum Water Depth– 1%AEP

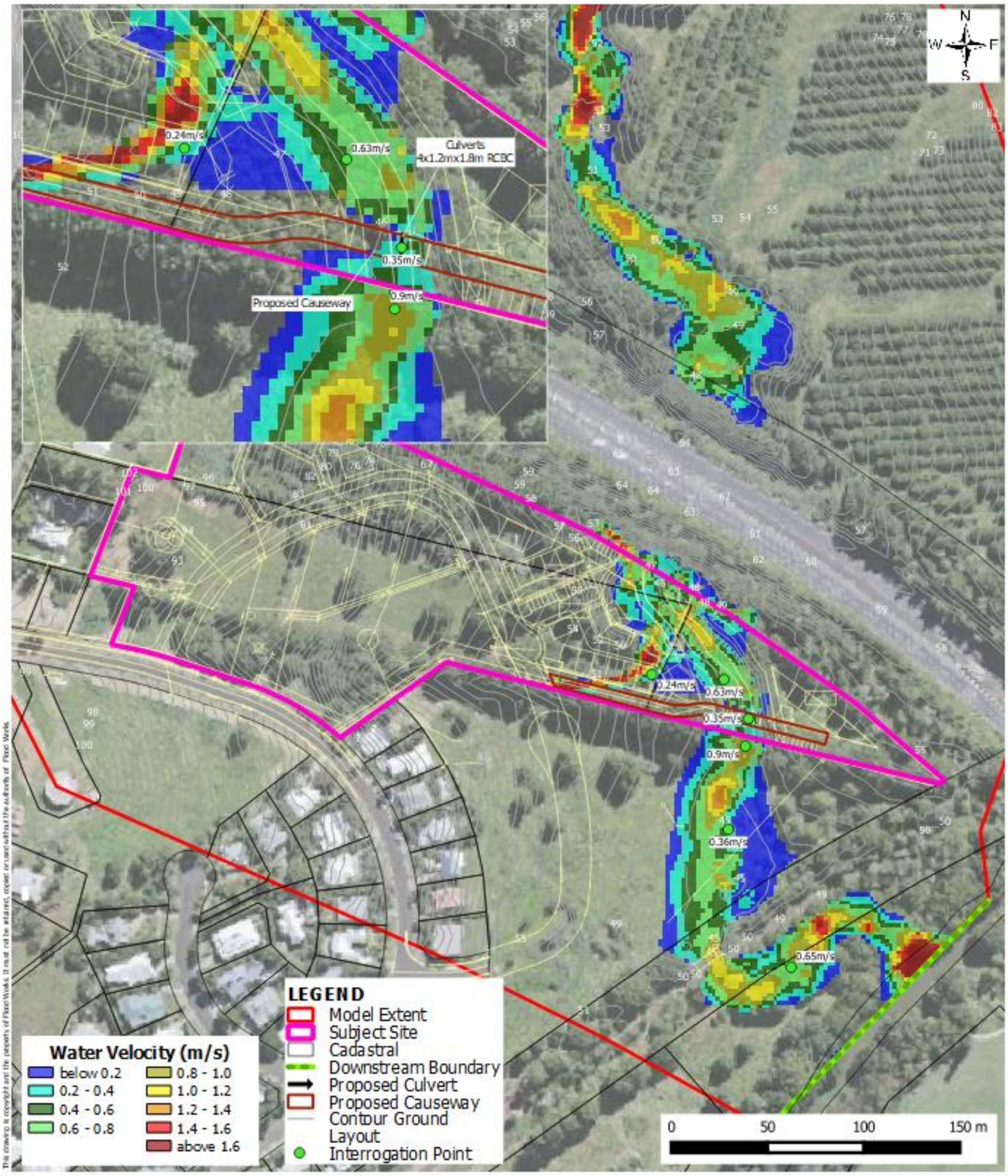


Figure 28 Developed Case Maximum Water Velocity – 1%AEP

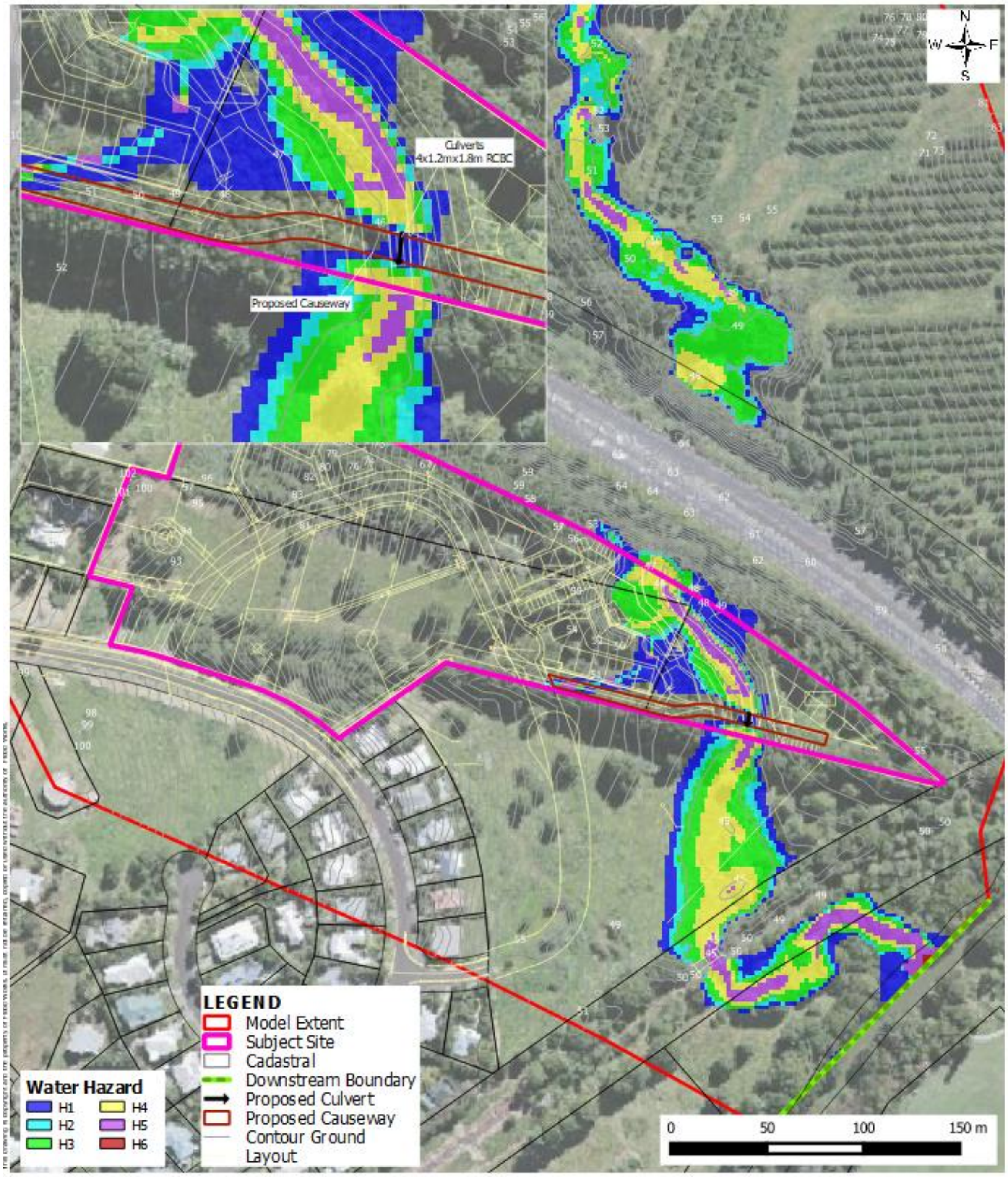


Figure 29 Developed Case Maximum Water Hazard – 1%AEP

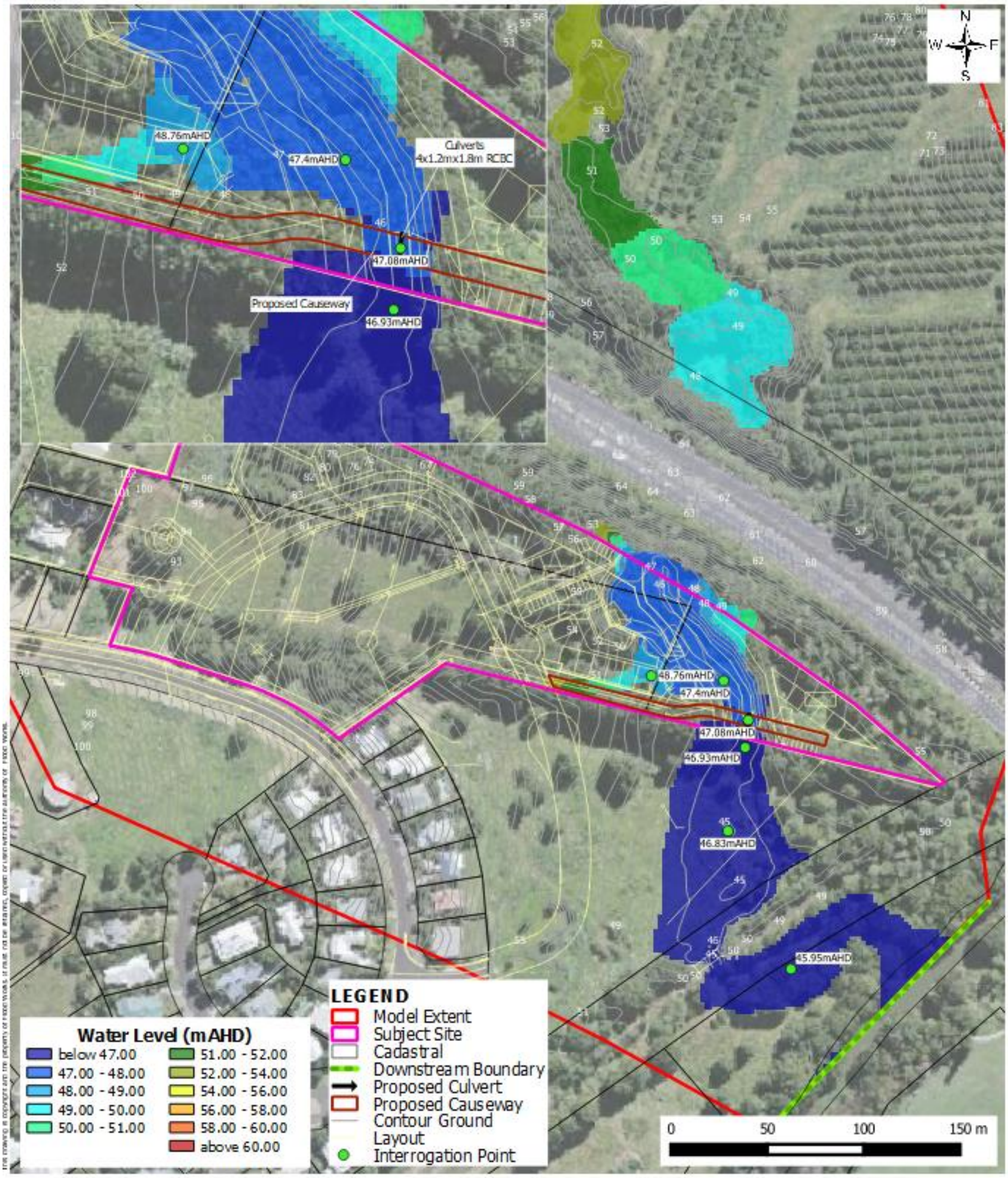


Figure 30 Developed Case Maximum Water Level – 1%AEP CC

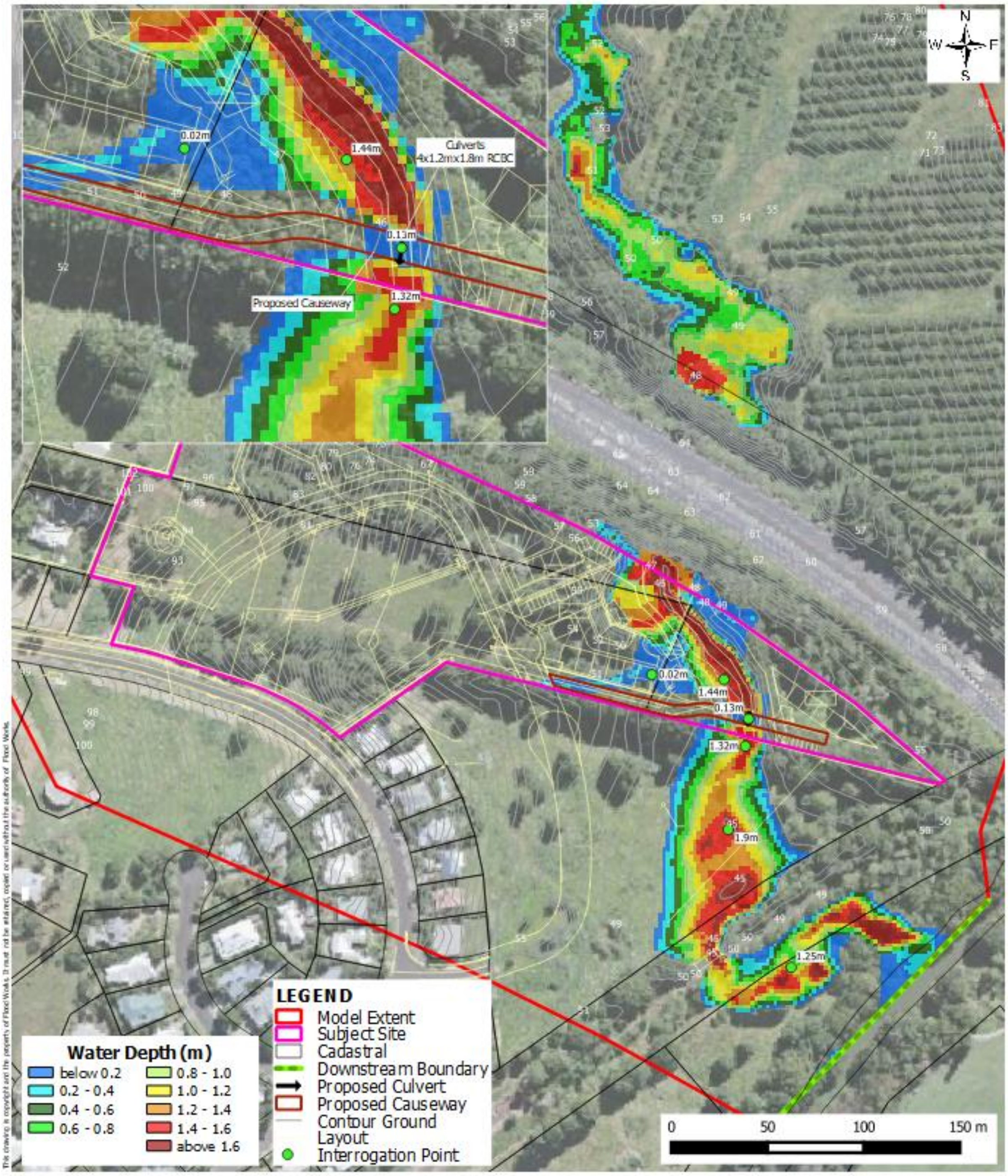


Figure 31 Developed Case Maximum Water Depth– 1%AEP CC

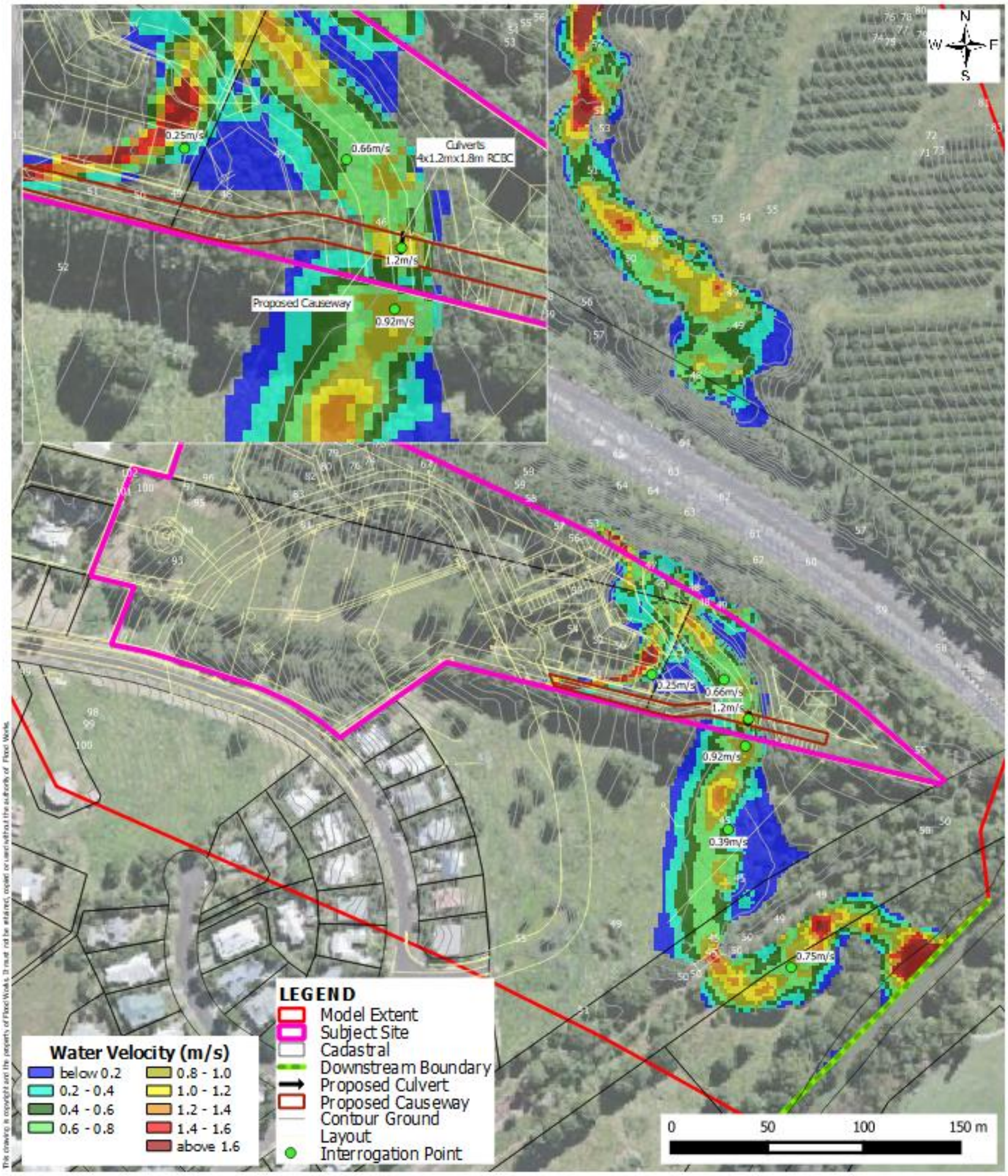


Figure 32 Developed Case Maximum Water Velocity – 1%AEP CC

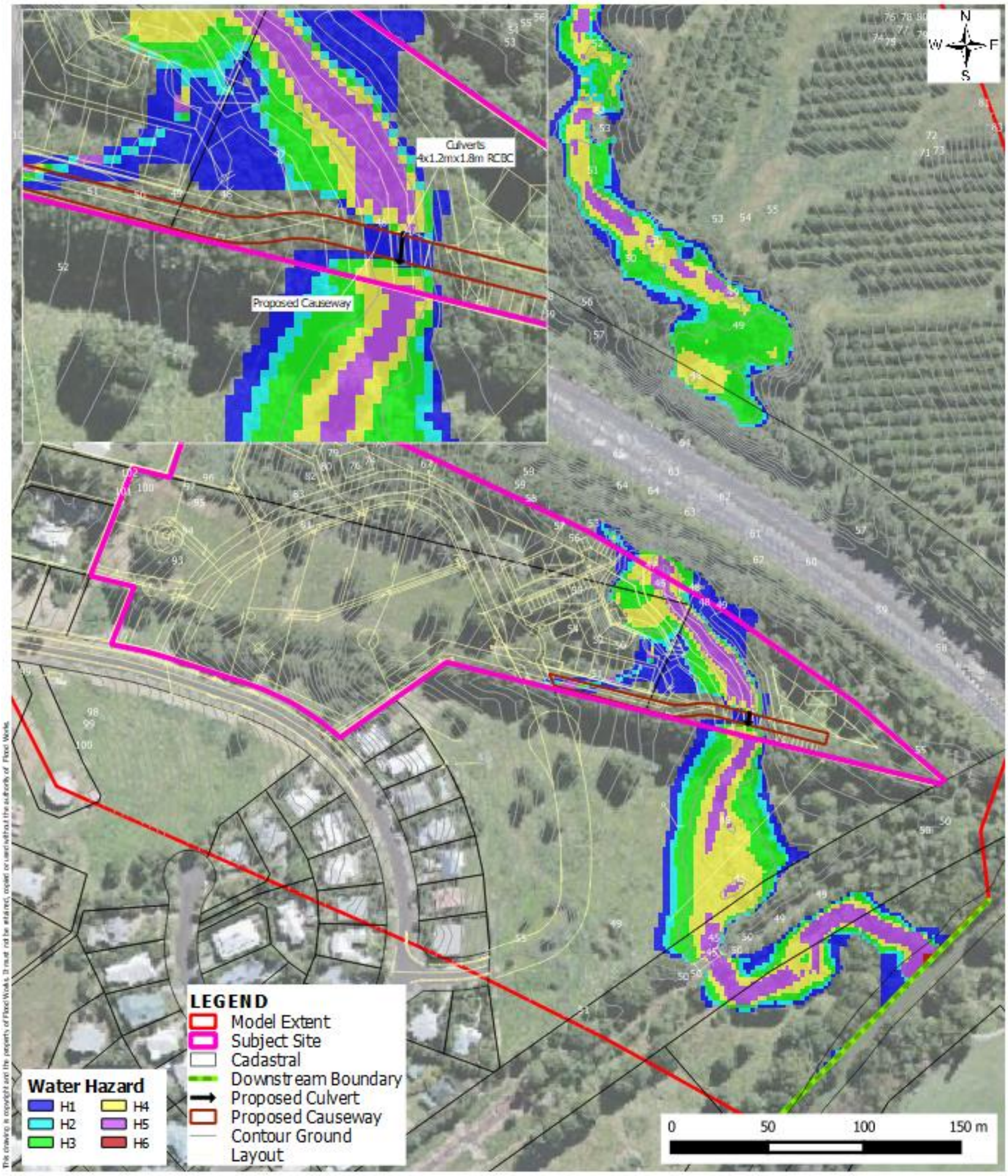


Figure 33 Developed Case Maximum Water Hazard – 1%AEP CC

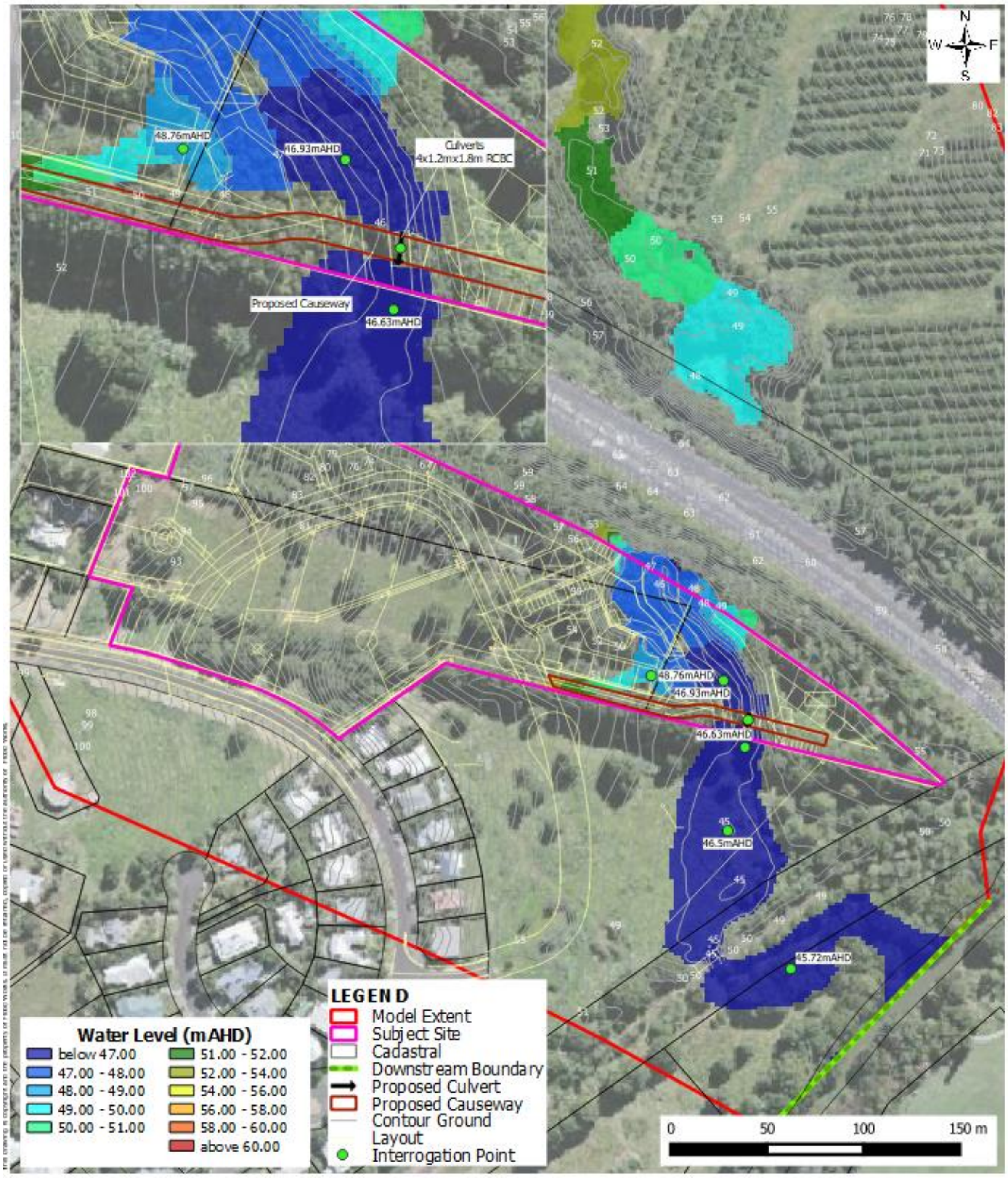


Figure 34 Developed Case Maximum Water Level – 5%AEP

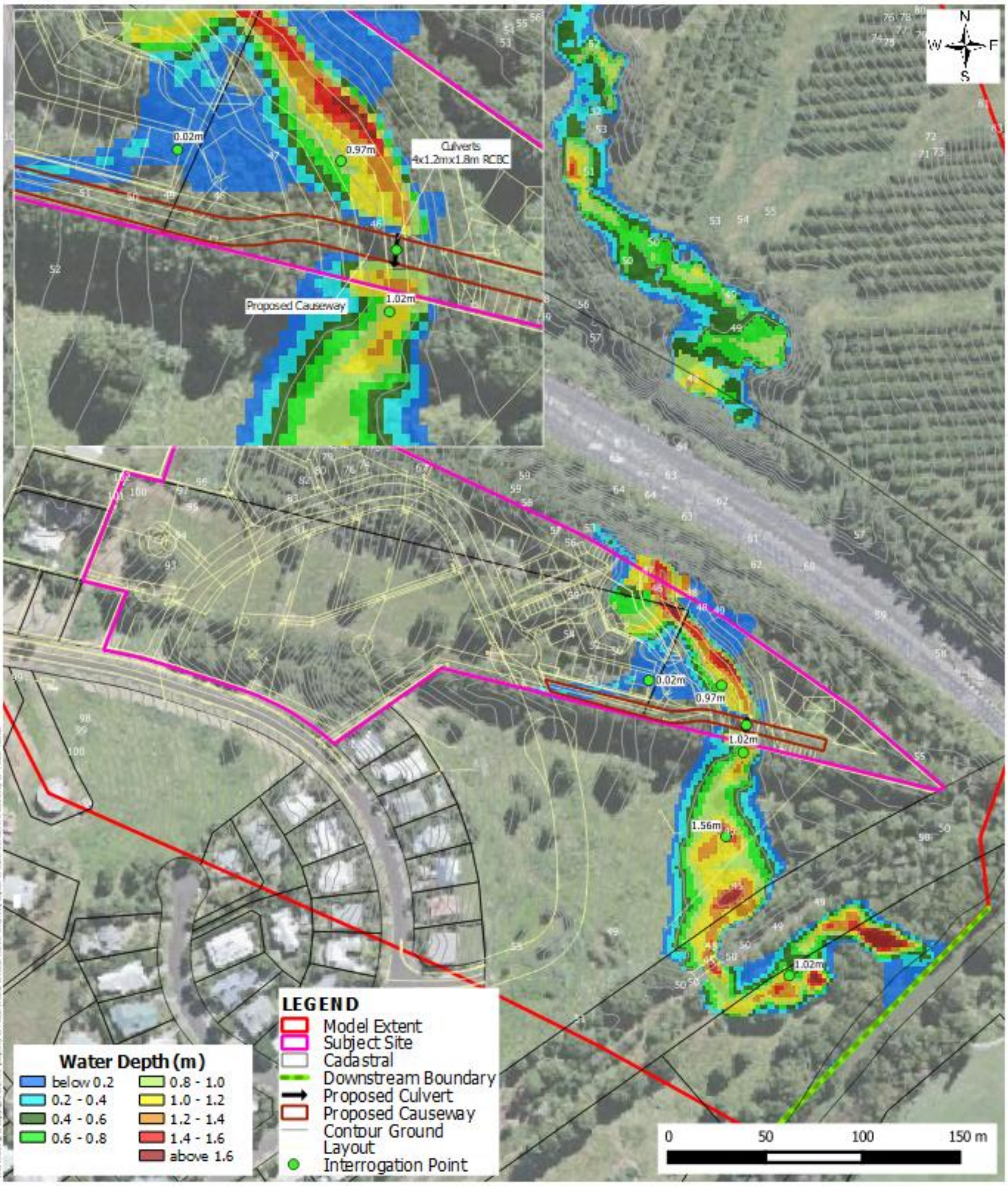


Figure 35 Developed Case Maximum Water Depth– 5%AEP

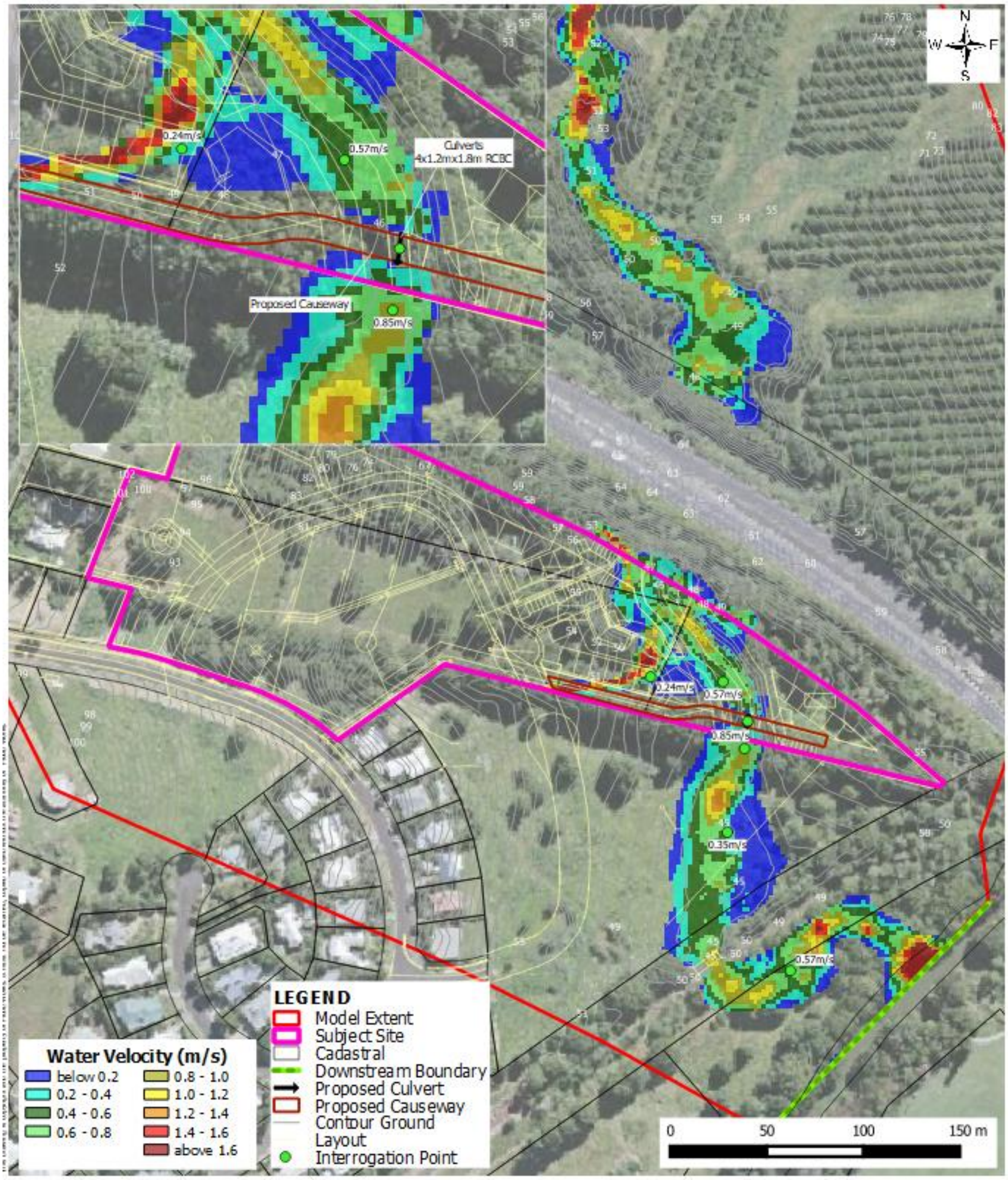


Figure 36 Developed Case Maximum Water Velocity – 5%AEP

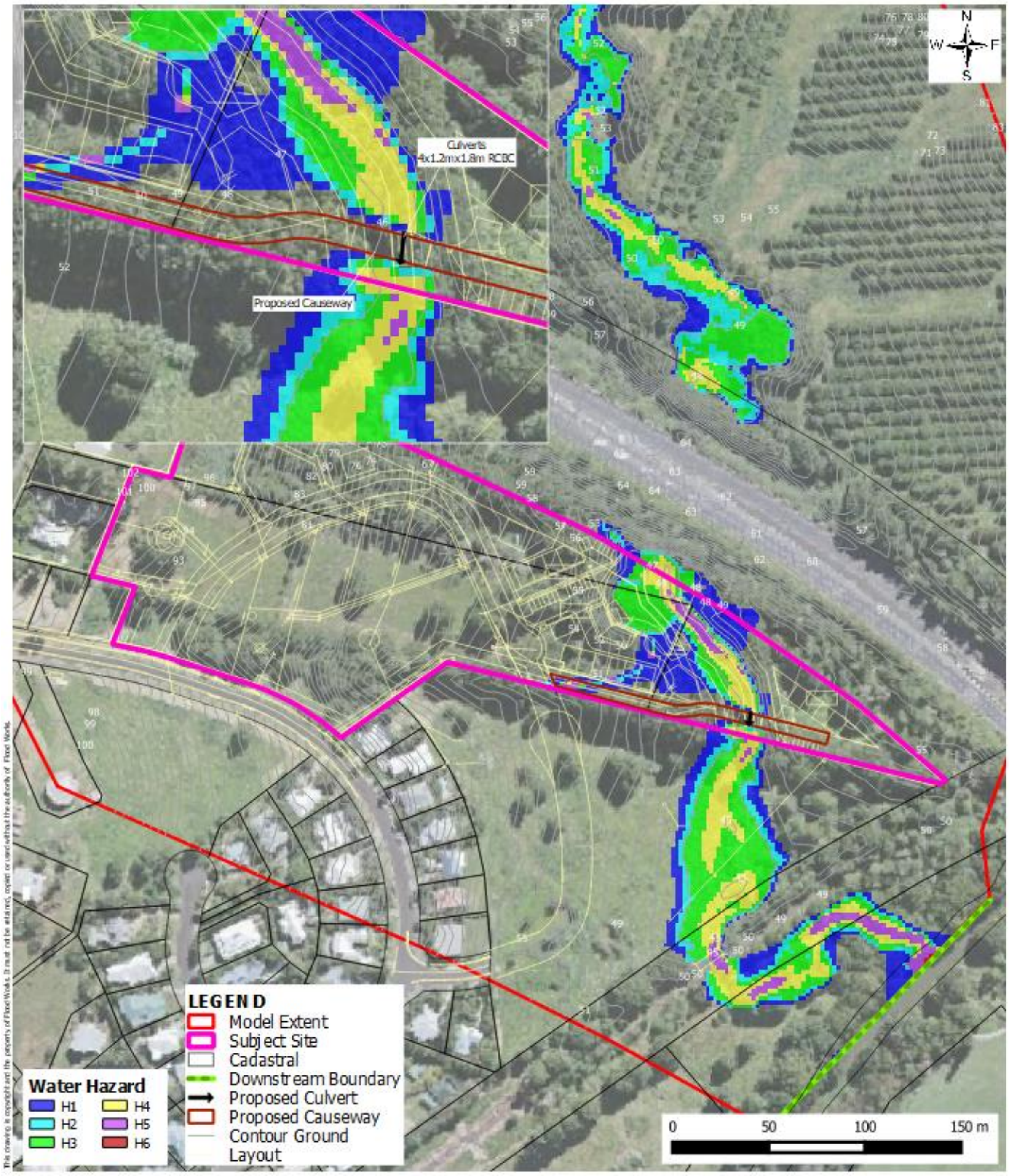


Figure 37 Developed Case Maximum Water Hazard – 5%AEP

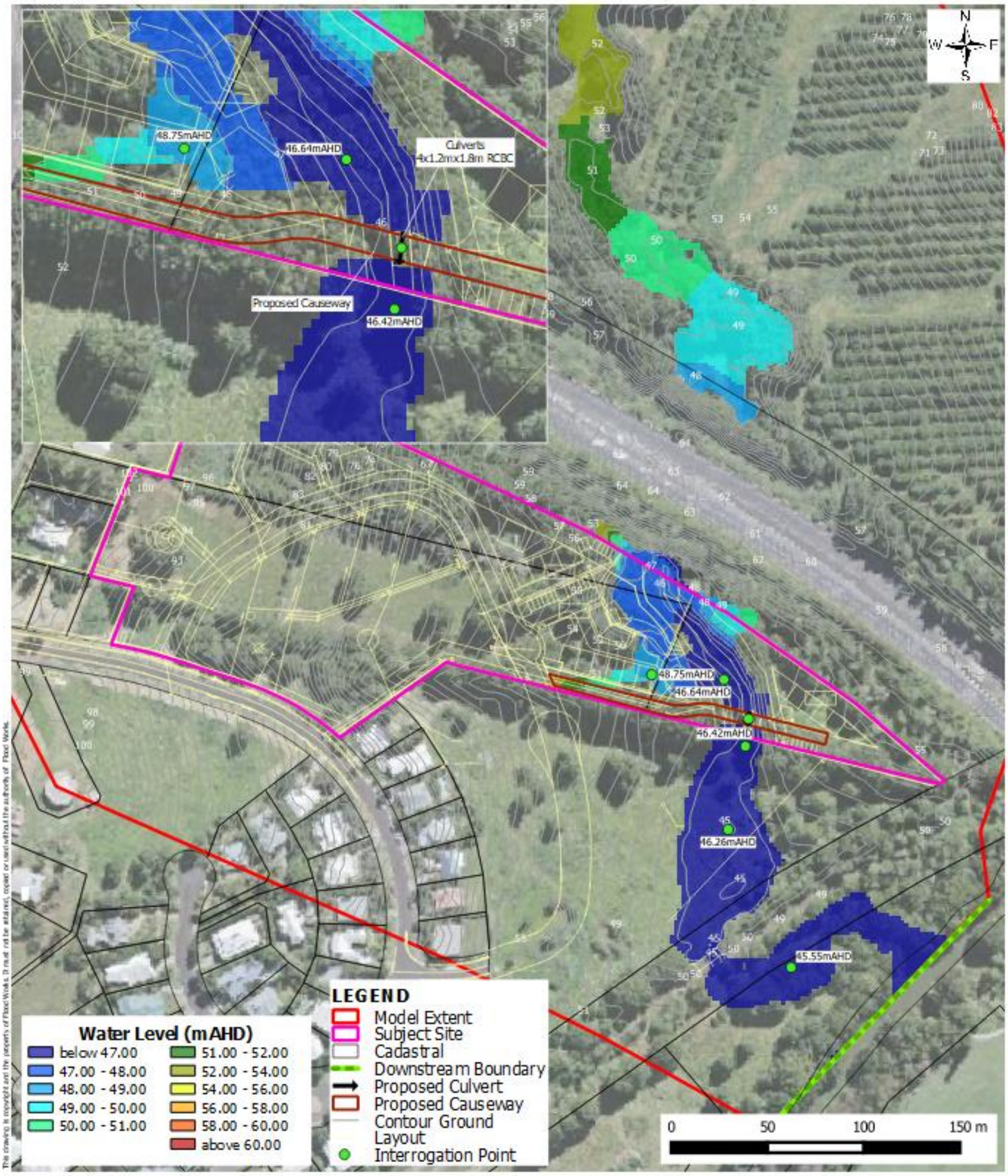


Figure 38 Developed Case Maximum Water Level – 20%AEP

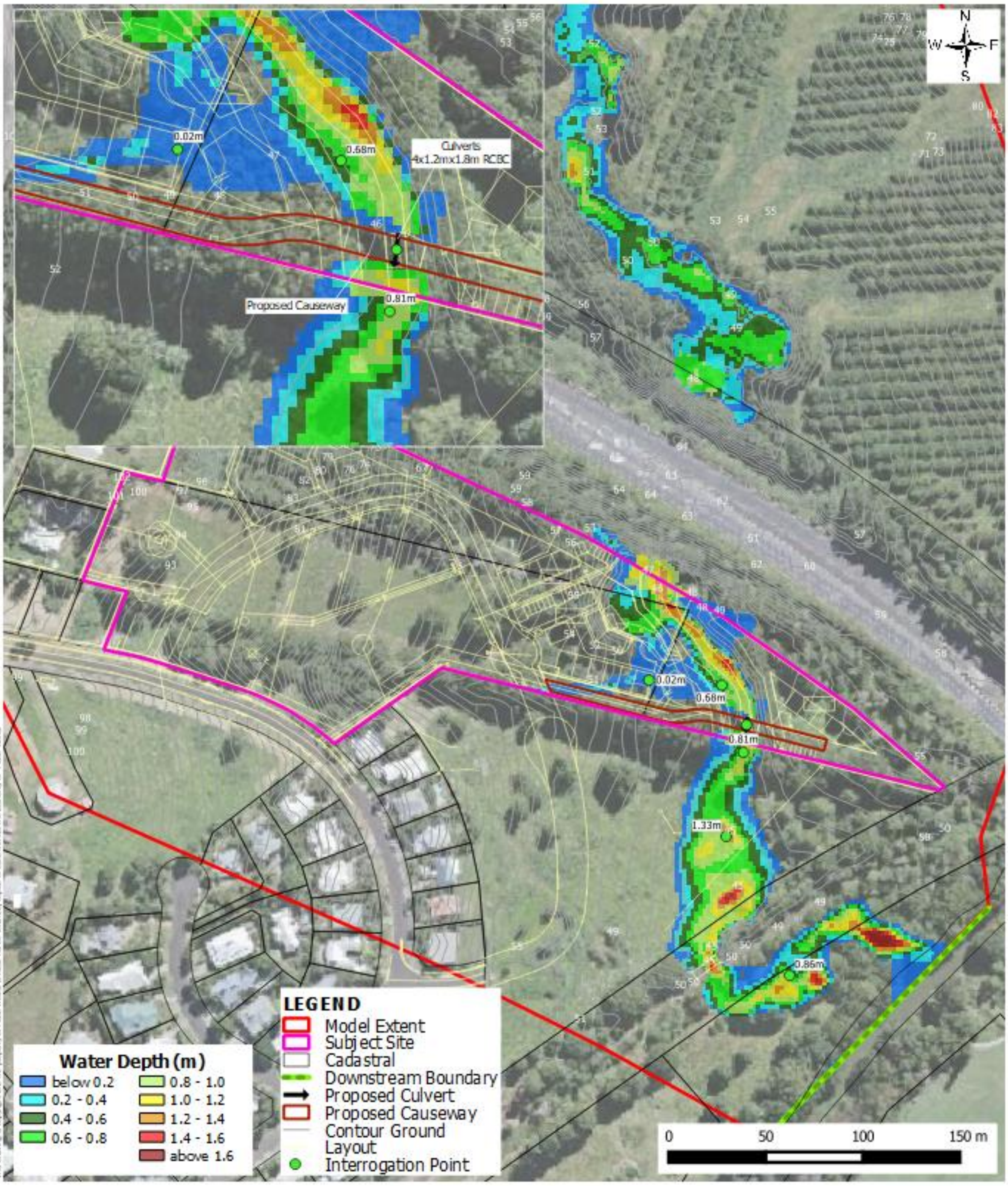


Figure 39 Developed Case Maximum Water Depth– 20%AEP

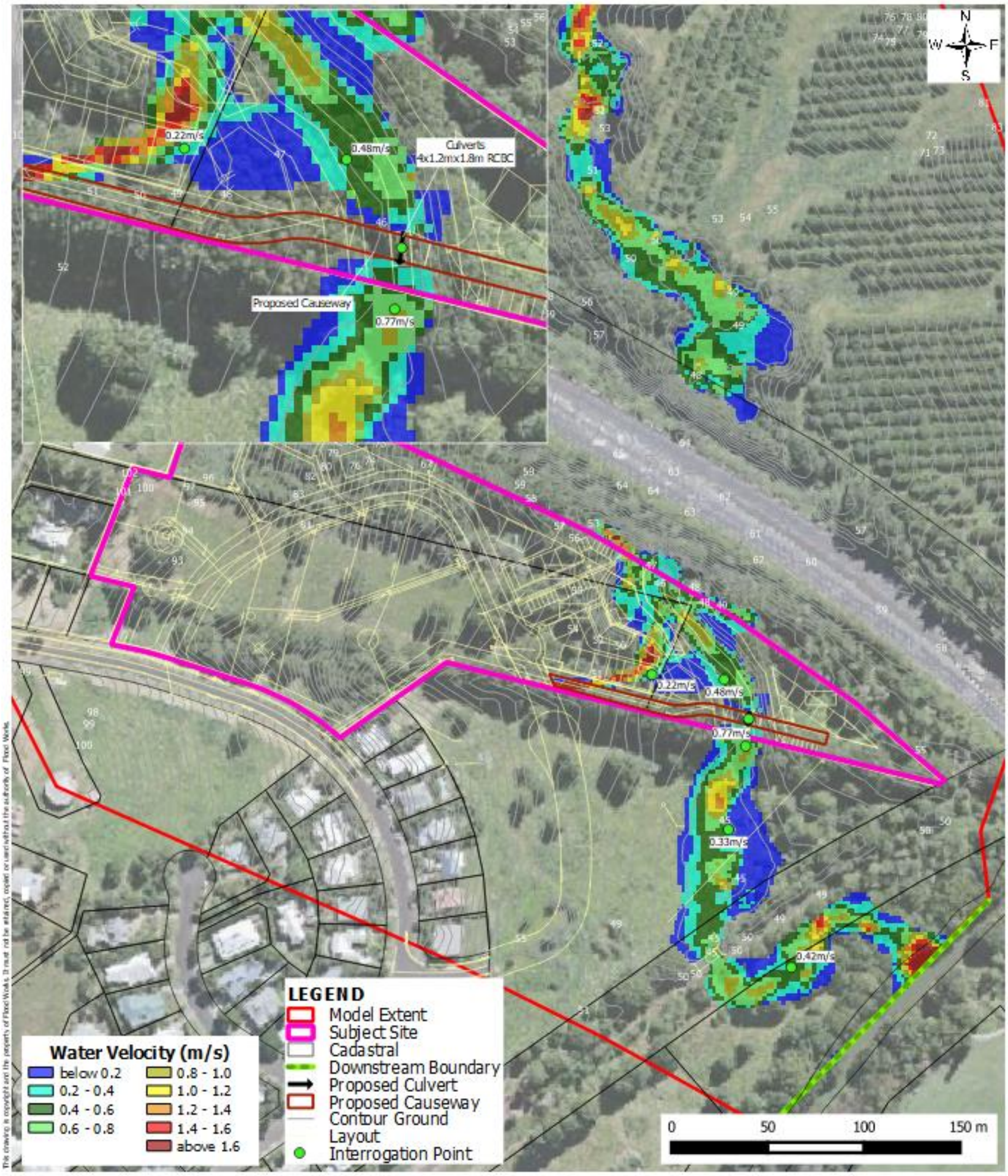


Figure 40 Developed Case Maximum Water Velocity – 20%AEP

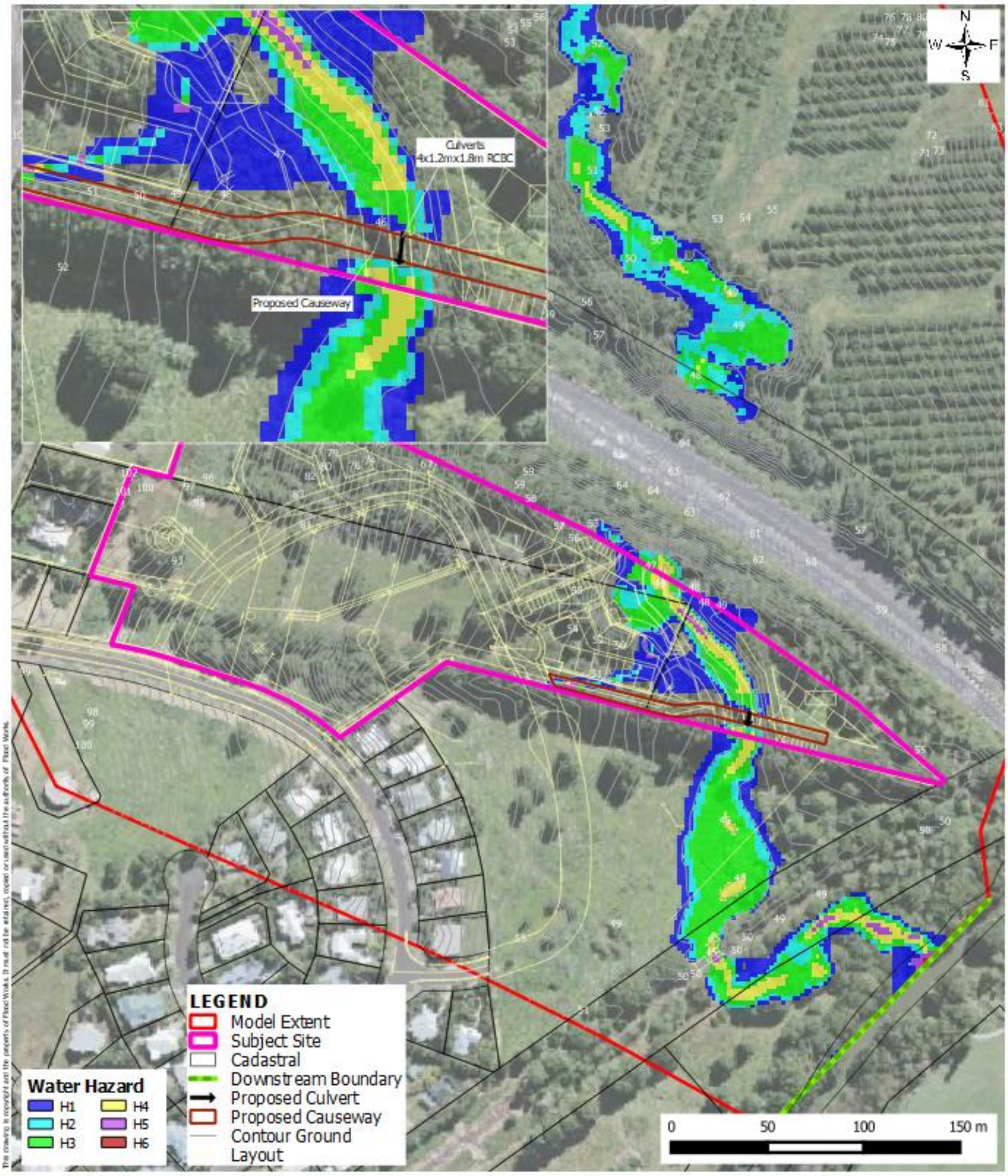


Figure 41 Developed Case Maximum Water Hazard – 20%AEP

3.5. Impact Assessment

An impact assessment was undertaken for the 1%AEP and 1%AEP_CC design events to determine any potential impacts that the proposed development (including the proposed causeway and proposed bio-basin) may have on the existing hydrodynamic function of the floodplain.

The results of the assessment demonstrate that the proposed causeway is flood-free during the 5%AEP and 20%AEP design events.

The 1%AEP design event increases maximum flood levels between 16-64mm immediately upstream of the proposed causeway and is contained within the property boundary. Maximum depth over the proposed causeway will be 20mm, with a velocity of 0.35m/s and a hazard rating of H1 (low hazard). There are no significant increases in maximum velocity (<0.1m/s) resulting from the proposed development.

The 1%AEP_CC design event increases maximum flood levels between 18-137mm immediately upstream of the proposed causeway and is contained within the property boundary. Maximum depth over the proposed causeway will be 130mm, with a velocity of 1.2m/s and a hazard rating of H1 (low hazard). There are no significant increases in maximum velocity (<0.1m/s) resulting from the proposed development.

The results show that the proposed development will have no significant impact on peak water levels or velocities upstream or downstream of the subject site for the 1% AEP, and 1%AEP_CC design events. The proposed causeway is flood-free during the 5%AEP and 20%AEP design events.

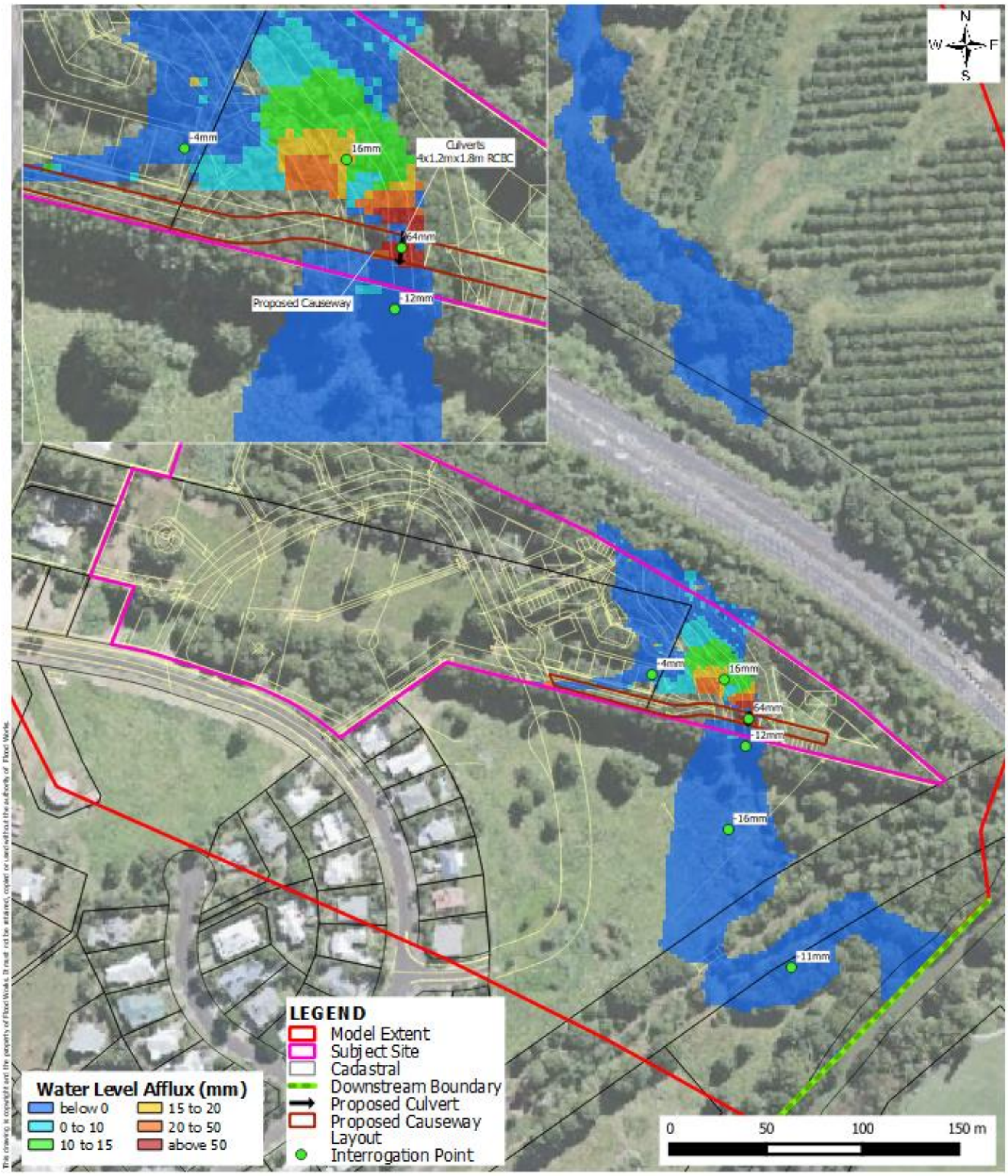


Figure 42 Developed Case Maximum Water Level Afflux – 1%AEP

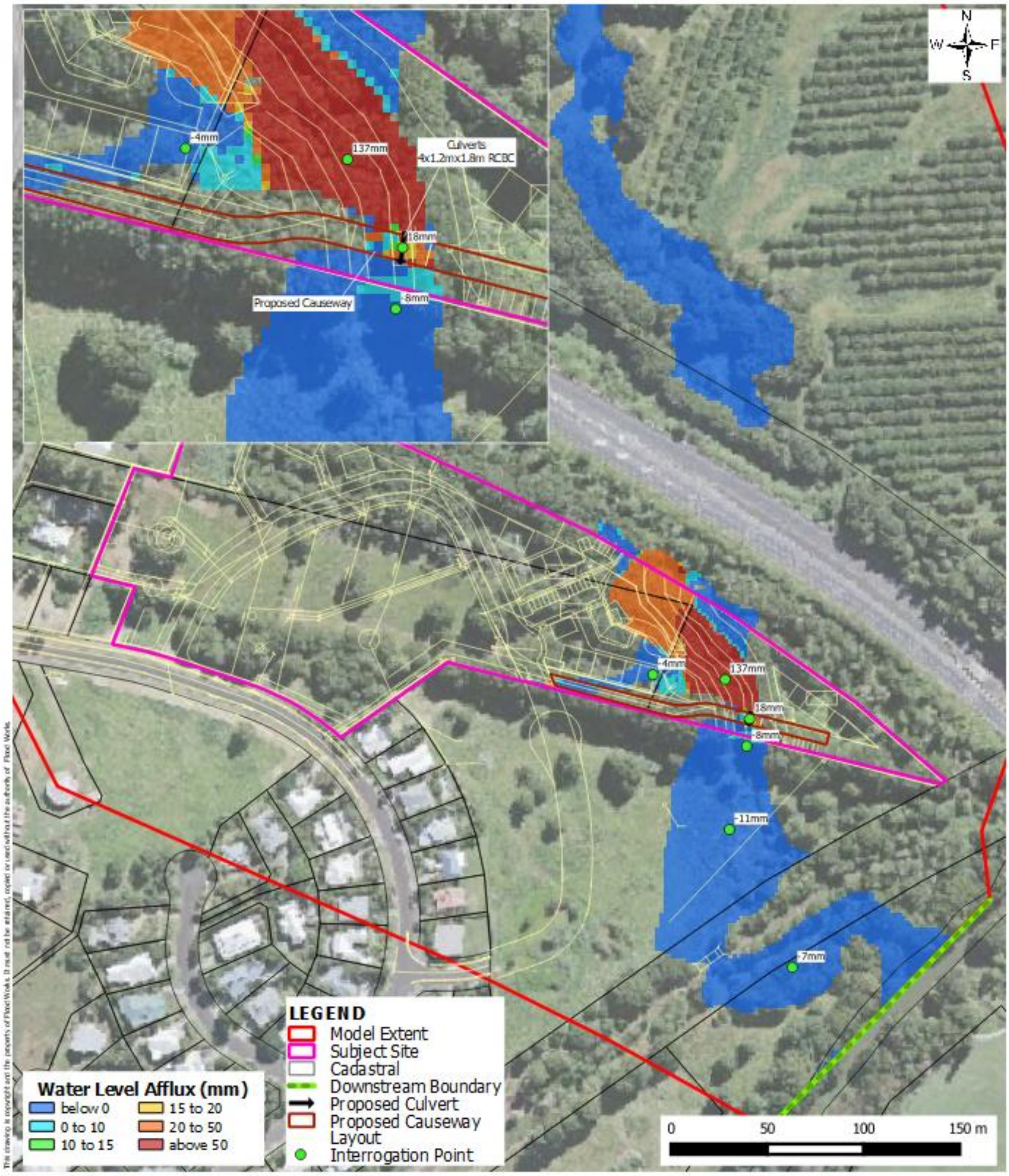


Figure 43 Developed Case Maximum Water Level Afflux – 1%AEP CC

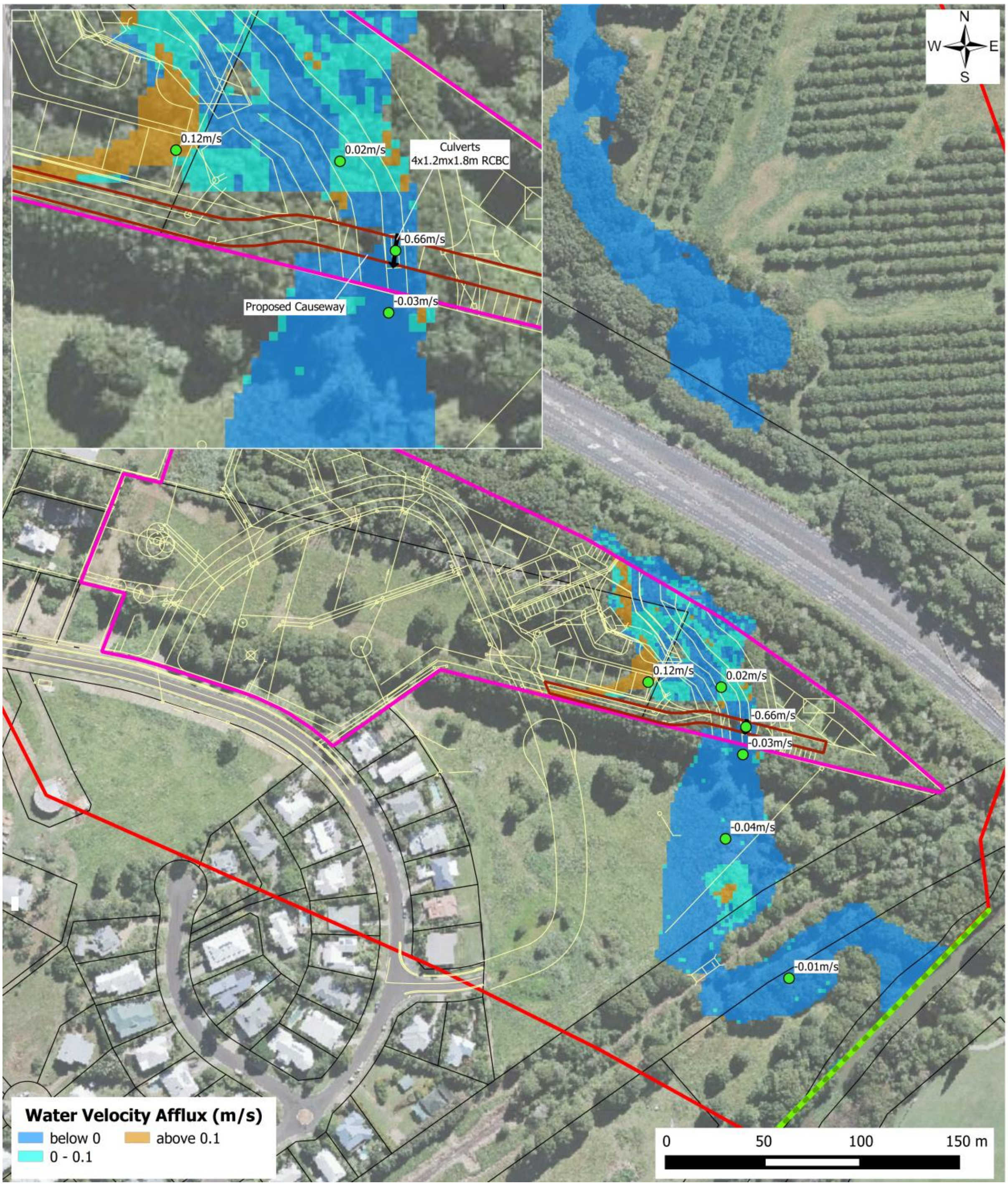


Figure 44 Developed Case Maximum Water Velocity Afflux – 1%AEP

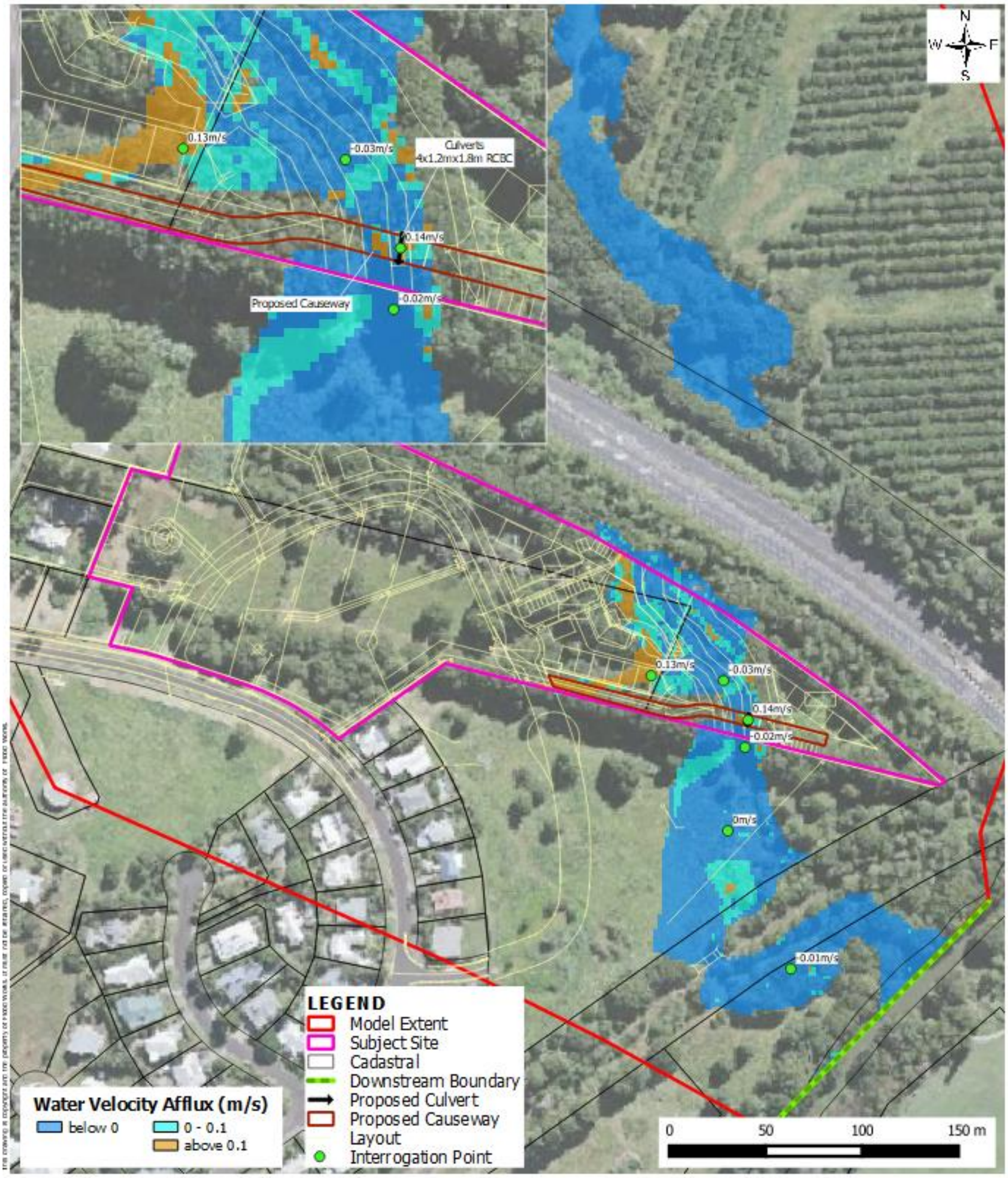


Figure 45 Developed Case Maximum Water Velocity Afflux – 1%AEP CC

4. Summary

Floodworks have completed a Hydraulic Assessment for the subject site 68 Granuaille Crescent, Bangalow, NSW. The proposed development includes the subdivision of lands into rural lots and associated roads/ancillary development, a bio-basin and a proposed causeway (4/1.2x1.8 RCBC).

A XP-SWMM hydrology model was developed to estimate the 1%AEP (Annual Exceedance Probability), 1%AEP_CC (Climate Change), 5%AEP and 20%AEP design runoff, used within the Tuflow hydrodynamic model. The hydrologic assessment has been completed to the Australian Rainfall and Runoff 2019 (ARR2019) methodologies, with results comparing well to the Regional Flood Frequency Estimation tool.

A dynamic 1D/2D linked TUFLOW flood model was developed for the existing and developed cases including the existing Hinterland Way culverts, the proposed bio-basin and proposed causeway (4/1.2x1.8 RCBC). The TUFLOW model provided maximum height, velocity, peak depth and hazard assessment for both the existing and developed case scenarios. An afflux assessment was then undertaken to determine any potential impacts arising from the proposed development.

The 1%AEP design event increases maximum flood levels between 16-64mm immediately upstream of the proposed causeway and is contained within the property boundary. Maximum depth over the proposed causeway will be 20mm, with a velocity of 0.35m/s and a hazard rating of H1 (low hazard). There are no significant increases in maximum velocity (<0.1m/s) resulting from the proposed development.

The 1%AEP_CC design event increases maximum flood levels between 18-137mm immediately upstream of the proposed causeway and is contained within the property boundary. Maximum depth over the proposed causeway will be 130mm, with a velocity of 1.2m/s and a hazard rating of H1 (low hazard). There are no significant increases in maximum velocity (<0.1m/s) resulting from the proposed development.

The results show that the proposed development will have no significant impact on peak water levels or velocities upstream or downstream of the subject site for the 1% AEP, and 1%AEP_CC design events. The proposed causeway is flood-free during the 5%AEP and 20%AEP design events.

The 1%AEP flood planning level will be 48 mAHD (47.5 mAHD + 0.5 mAHD freeboard = 48.0 mAHD).

5. References

- BOM (2018) Rainfall IFD Data System
- IPWEA 2013, Queensland Urban Development Manual (QUDM)
- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia
- Elevation - Foundation Spatial Data from http://elevation.fsdf.org.au/

Appendix A Australian Rainfall & Runoff Data Hub – Results

River Region

Division	South East Coast (NSW)
River Number	3
River Name	Richmond River

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
East Coast North	0.327	0.241	0.448	0.36	0.00096	0.48	-0.21	0.012	-0.0013

Short Duration ARF

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

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 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	2345.0
Storm Initial Losses (mm)	44.0
Storm Continuing Losses (mm/h)	2.1

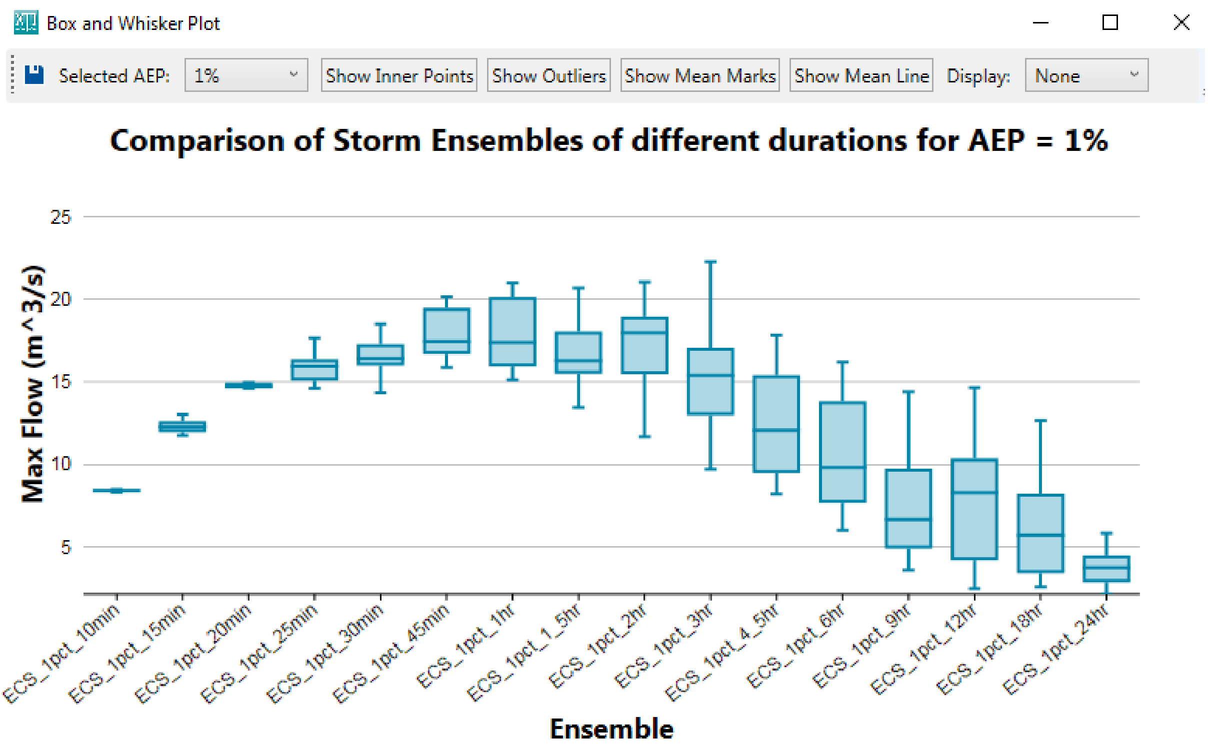
Interim Climate Change Factors

	RCP 4.5	RCP6	RCP 8.5
2030	**0.869 (4.3%)**	0.783 (3.9%)	**0.983 (4.9%)**
2040	**1.057 (5.3%)**	1.014 (5.1%)	**1.349 (6.8%)**
2050	**1.272 (6.4%)**	1.236 (6.2%)	**1.773 (9.0%)**
2060	**1.488 (7.5%)**	1.458 (7.4%)	**2.237 (11.5%)**
2070	**1.676 (8.5%)**	1.691 (8.6%)	**2.722 (14.2%)**
2080	**1.810 (9.2%)**	1.944 (9.9%)	**3.209 (16.9%)**
2090	**1.862 (9.5%)**	2.227 (11.5%)	**3.679 (19.7%)**

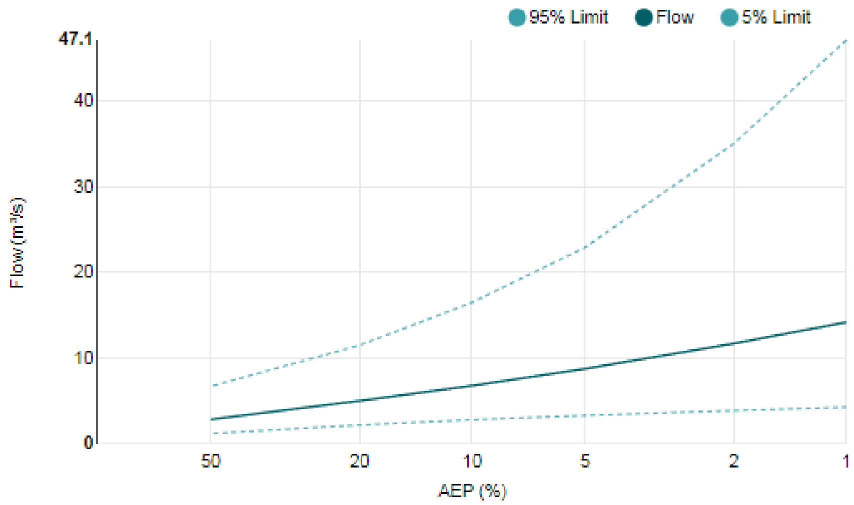
Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	24.2	13.2	12.3	12.0	10.8	7.7
90 (1.5)	25.1	14.7	13.3	12.0	10.2	8.3
120 (2.0)	22.4	13.4	13.0	11.1	10.3	6.1
180 (3.0)	21.9	13.7	12.6	10.2	9.6	5.2
360 (6.0)	19.9	12.8	12.2	10.9	11.1	3.5
720 (12.0)	21.9	15.3	15.0	12.2	13.8	4.5
1080 (18.0)	25.8	19.1	19.6	14.9	16.7	5.4
1440 (24.0)	29.9	21.7	21.4	16.5	14.3	5.9
2160 (36.0)	35.3	26.4	24.8	19.6	17.9	6.2
2880 (48.0)	37.4	27.7	26.6	23.7	23.2	7.0
4320 (72.0)	42.3	32.6	32.1	29.6	27.3	11.7

Appendix B Box and Whisker Plots



Appendix C Regional Flood Frequency Estimation (ARR2019)



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	2.85	1.21	6.71
20	5.03	2.21	11.5
10	6.80	2.82	16.5
5	8.76	3.32	22.9
2	11.7	3.89	35.0
1	14.2	4.28	47.1

Statistics

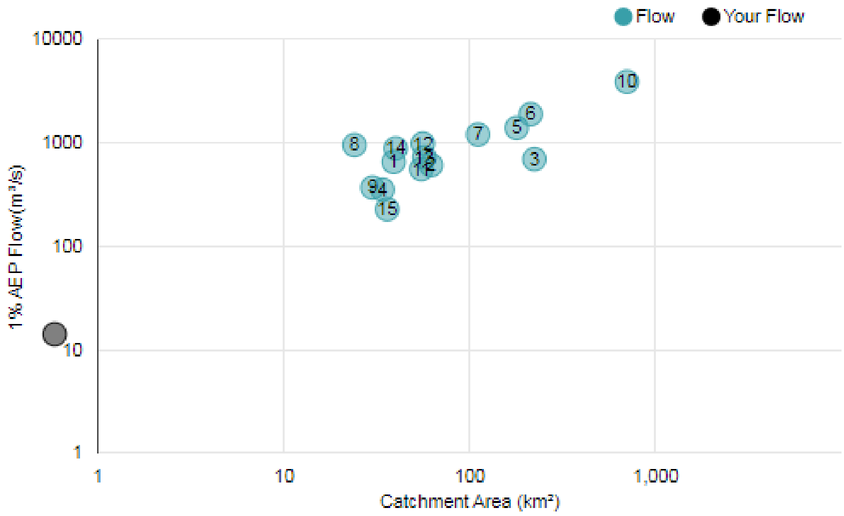
Variable	Value	Standard Dev
Mean	1.034	0.529
Standard Dev	0.642	0.303
Skew	0.074	0.029

Note: These statistics come from the nearest gauged catchment. Details.

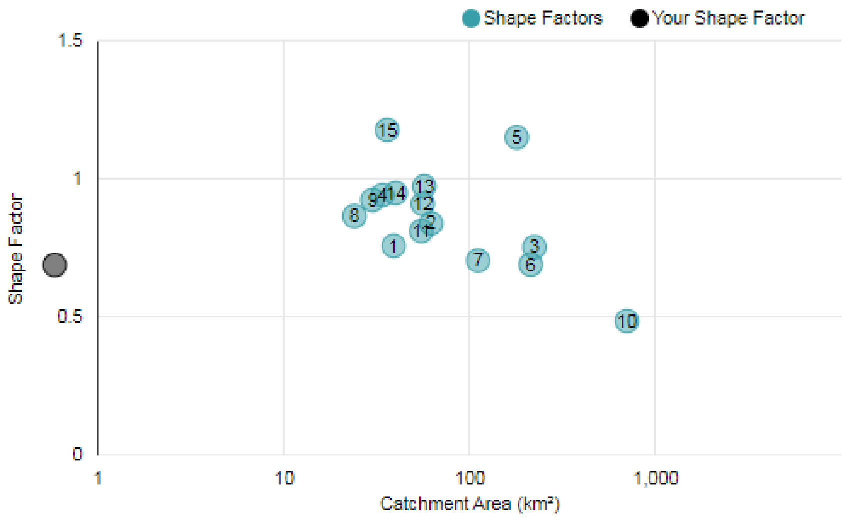
Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

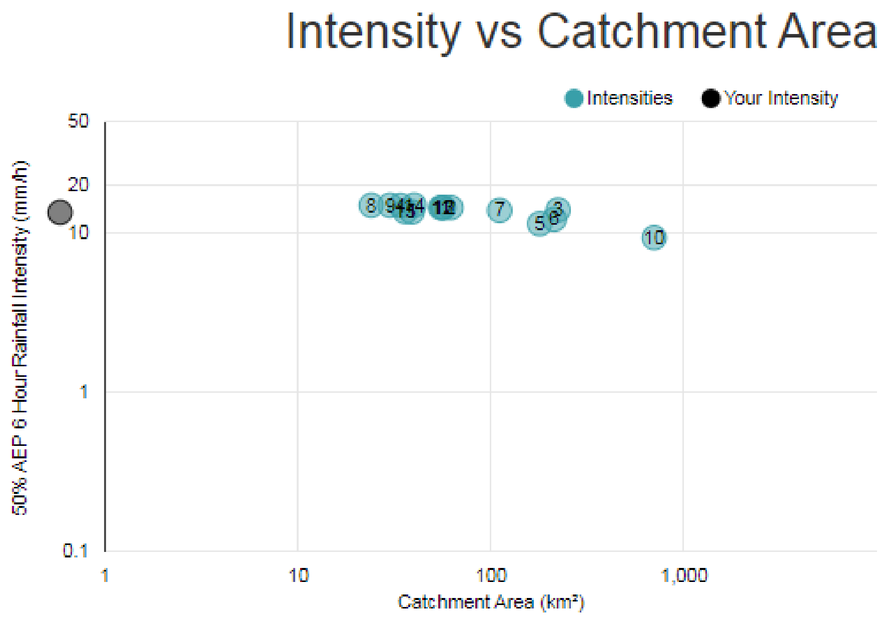
Note: These statistics are common to each region. Details.

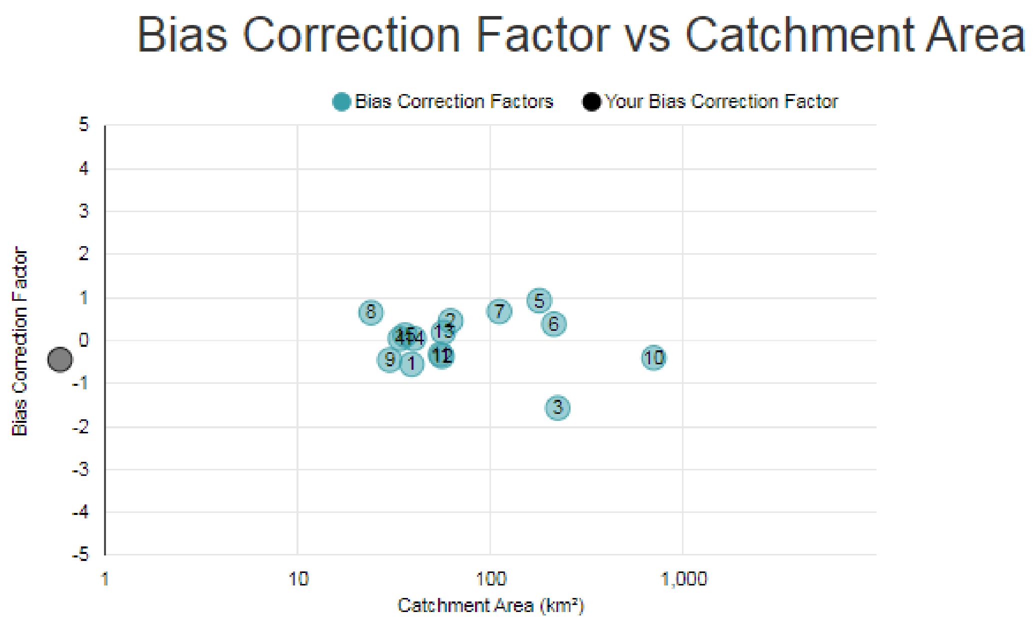
1% AEP Flow vs Catchment Area



Shape Factor vs Catchment Area




Intensity vs Catchment Area
Intensities
Your Intensity
50% AEP 6 Hour Rainfall Intensity (mm/h)
50
20
10
1
0.1
1
10
100
1,000
Catchment Area (km²)


Bias Correction Factor vs Catchment Area
Bias Correction Factors
Your Bias Correction Factor
Bias Correction Factor
5
4
3
2
1
0
-1
-2
-3
-4
-5
1
10
100
1,000
Catchment Area (km²)

Appendix D Tuflow Results