WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Flood Assessment and Stormwater Management Plan

176-228 Mountain Ridge Road

Orchard (No.10) Developments Pty Ltd

September 2019

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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1 INTRODUCTION

Water Technology Pty Ltd (Water Technology) has been commissioned by Orchard (No. 10 Developments Pty Ltd (Orchard) to prepare a Stormwater Management Plan and Flood Assessment for a proposed residential development located immediately South of Mountain Ridge Road, South MacLean (real property description Lot 30 on SP309195) (The Site).

The site is located within the Logan City Council (LCC) local government area. However, the site is also located within the Greater Flagstone Priority Development Area (PDA) and is administered by Economic Development Queensland (EDQ). The location of the site on the context of the PDA is indicated in Figure 1-1. EDQ replaced the former Urban Land Development Authority (ULDA) and facilitates planning in areas which are declared as provisional or priority development areas, for which the subject property is located. EDQ is also the responsible agency for development assessment and compliance relating to any proposed development within the declared PDA areas.

The strategic vision for future development with the Greater Flagstone PDA is outlined in the document entitled "Greater Flagstone Urban Development Area – Development Scheme" prepared by the Urban Land Development Authority, October 2011 (GFDS, 2011). Core elements of the scheme in respect to flooding and stormwater management which are relevant in the context of this report are stated as follows: -

> *"..maintains and improves the functionality and characteristics of the hydrological network (including surface and groundwater) and generally maintains the natural flow regime";*
>
> *"..incorporates total water cycle management and water sensitive urban design principles to appropriately manage floodwater and stormwater".*

Specific outcomes to be achieved for proposed development within the PDA are outlined in the various guidelines prepared by the Department of State Development, Infrastructure and Planning and administered by EDQ. With respect to flooding and stormwater management for this site, the guidelines of specific interest include: -

- "Environmental Values and Sustainable Resource Use – EDQ Guideline 14" dated May 2015 (Guideline 14); and
- "Protection from Flood and Storm Tide Inundation – EDQ Guideline 15" dated May 2015 (Guideline 15).

This SMP and flood assessment has been prepared with the intent of addressing the relevant requirements of the above-mentioned guidelines. The following sections of this report provide the associated detail and results of the technical assessments prepared with respect to stormwater and flood management for the proposed development.

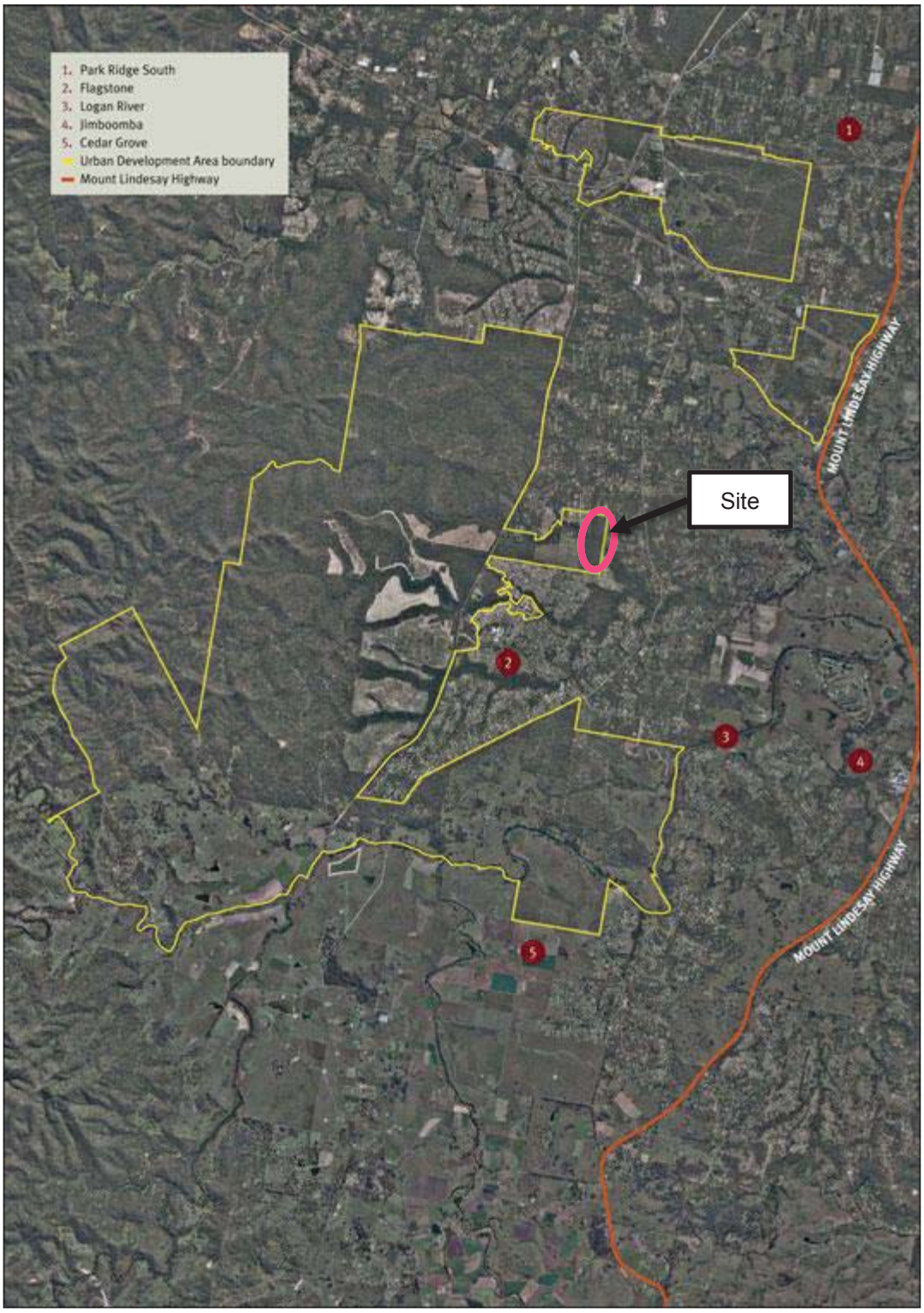

Figure 1-1 Subject Site and Greater Flagstone PDA Area (Source – DILGP, 2017)

2 EXISTING SITE DESCRIPTION

The site is located to the south of Mountain Ridge Road, South MacLean and extends to the south towards Silver Wattle Drive, Jimboomba as illustrated in Figure 2-1. There is currently vehicle access to the site provided via Mountain Ridge Road to the north. The site comprises of a single lot which is described as Lot 30 on SP309195 (formerly Lot 3 on RP133386).

The total area of the site is approximately 40.3 ha. The upper catchment to Flagstone Creek, which has a total approximate external catchment area of 1585 ha, primarily consists of undeveloped land. Of the 1585 ha external catchment, approximately 725 ha of the upper catchment lies within the Greater Flagstone PDA, with the remaining 860 ha assigned as rural residential, environmental management and conservation areas. The neighbouring lots immediate upstream have since received development approval (refer EDQ DA reference DEV2017/887) for 650 individual lots which includes the construction of a vehicle access bridge crossing Flagstone Creek. The new Bridge link will provide a vehicular access link from Mountain Ridge Road to Rose Almond Street to the south-west of the site. Water Technology have previously prepared flood and stormwater management reporting for the upstream approved development which is of direct relevance to this current study.

Flagstone Creek flows through the centre of the site and joins with the Logan River approximately 5 km downstream and to the east of the subject site.

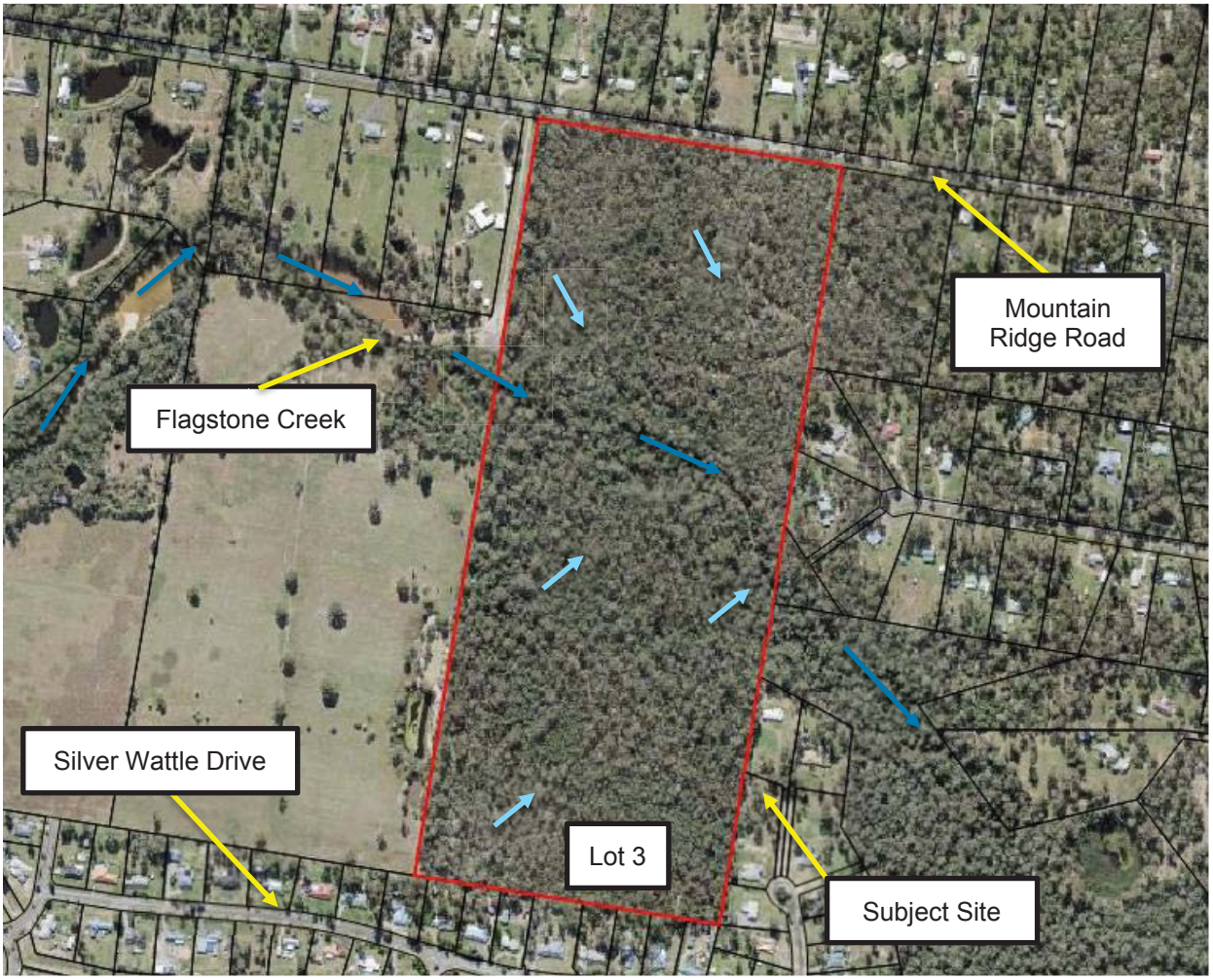

Figure 2-1 Location of Subject Site (Source – QLD Globe, 2019)

3 PROPOSED DEVELOPMENT

The development is proposing a residential sub-division to comprise of 517 individual lots, a child care facility and includes all associated internal roads, services and related infrastructure to service the development. A plan of development is illustrated in Figure 3-1, with the development being proposed over a total of ten (10) discrete stages. The development is proposing vehicular access from the adjacent development to the west (refer EDQ reference DEV2017/887) on both the northern and southern side of Flagstone Creek and for which will utilise the new bridge vehicular access provided for the adjacent development. No additional bridge crossing of Flagstone Creek is therefore contended as part of this development.

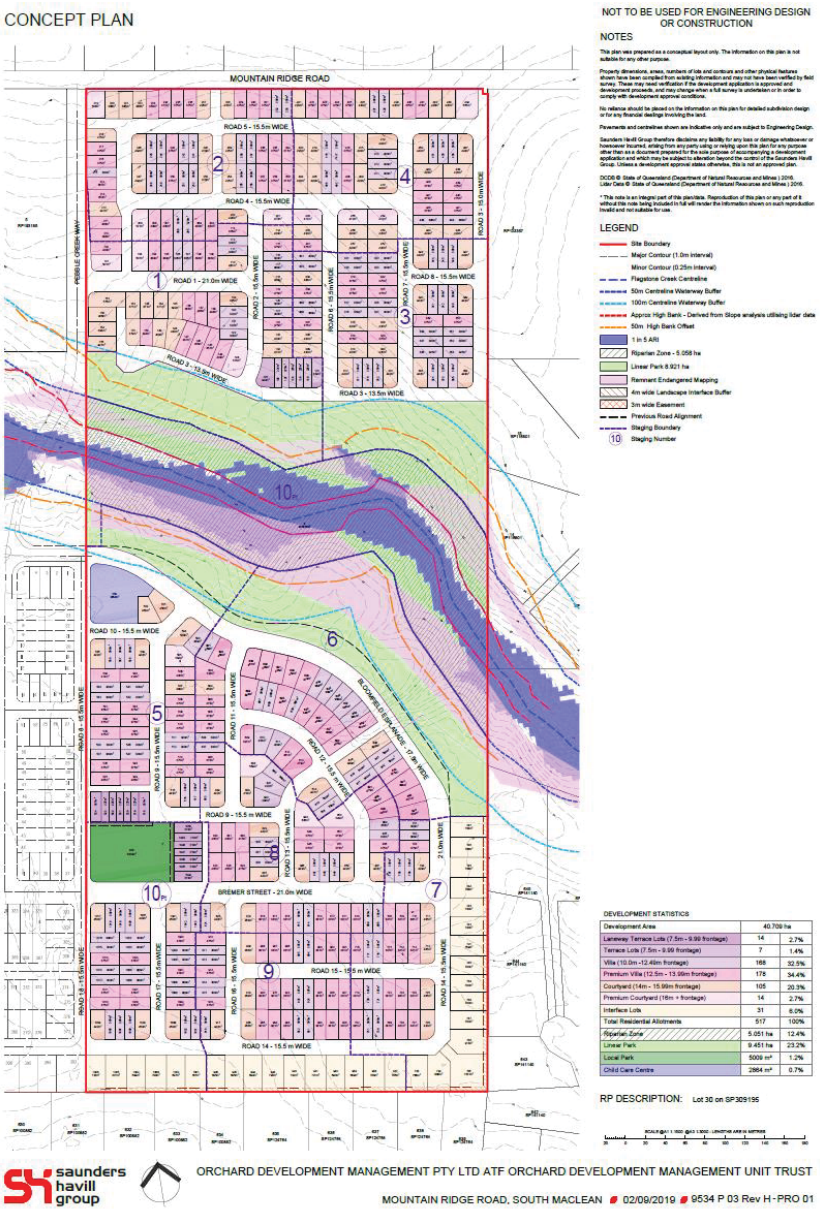

Figure 3-1 Proposed Development Layout (Source: Orchard, 2019)

4 FLOOD ASSESSMENT

4.1 Background

Water Technology have previously prepared flood and stormwater assessments relating to the upstream approved development under EDQ DA reference DEV2017/887. This work included a hydrological and hydraulic model for the greater Flagstone Creek catchment and specifically quantified flooding over the subject site. This previous work was documented in the report entitled "Flood Assessment and Stormwater Management Plan", dated 16 August 2018 by Water Technology (WT, 2018) which was subject to technical review by EDQ and formed the basis upon which approval was issued under EDQ DA reference DEV2017/887.

This previous work is therefore of direct relevance to the current site and this report. The current investigations have therefore utilised all previously developed modelling at the site and in the absence of any fundamental change. In the context of this current investigation, the technical reporting provided in WT, 2018 remains valid has been incorporated into this report for overall completeness and in order to provide standalone flood and stormwater reporting for the subject site, the following sections of this report summarises the technical assessments relating to flooding.

4.2 Overview

To assess flooding at the site associated with Flagstone Creek, both a hydrologic and hydraulic model of the greater Flagstone Creek catchment has been prepared as part of this assessment. The hydrology model prepared includes a WBNM (Version 2007_0000) non-linear runoff routing program developed by the University of Wollongong in NSW. The hydrologic model has been subject to calibration and used to inform inflows to a TUFLOW 1D/2D hydraulic model to quantify flood levels and flood impacts at the site. The hydrological model has also been used to assess changes to stormwater characteristics resulting from the proposed development. The following sections of this report provide further and specific details in respect to the technical modelling prepared to inform the flood assessment completed as part of this study.

4.3 WBNM Catchment Hydrology

4.3.1 Regional Catchments

A WBNM hydrological model has been prepared and used to assess both an existing and ultimate case development scenario to inform this investigation. The WBNM model sub-catchment delineation has been prepared using LiDAR topographical data to define the various watershed boundaries for the external Flagstone Creek catchment and is illustrated in Figure 4-1. The WBNM model structure is identical across both the existing and ultimate case scenarios, with the only change applied being in respect to the future catchment development land use and subsequent fraction imperviousness.

Land use zones within the catchment have been defined based on two (2) scenarios to include the following:-

- Existing case development – to represent the current catchment land use condition; and
- Ultimate case development – to reflect all proposed future catchment development which includes both the Greater Flagstone PDA as well as Logan City Council strategic plan.

The land use fraction imperviousness applied for each of the existing and ultimate conditions is based on that summarised in Table 4-1. Illustrations of the catchment imperviousness applied for both the existing and ultimate case WBNM models is presented in Figure 4-1 and Figure 4-2 respectively.

Table 4-1 Adopted Fraction Impervious Categories

Land Use	Land Use Category	Fraction Impervious
Environmental/Rural Zone	Open Space	0.0
	Open Space	0.0
Rural residential developments	Low Density Residential	0.2
	Low - Medium Density Residential	0.3
	Medium Density Residential	0.35
Priority Development Area	Assumed Dense Urban Development	0.85

In the ultimate case scenario, the areas within the PDA have conservatively been assigned a fraction imperviousness of 0.85 to match with the "Dense Urban Development" land use classification and in the absence of any specific development outcomes for the PDA being defined. A detailed summary of the fraction imperviousness breakdown based on the individual WBNM model sub-catchment arrangement for both scenarios is included in Appendix A.

In respect to the land use applied in the WBNM model, we note that the preliminary development layout may be subject to future revision and in response to final design changes. However, minor alterations of lot boundaries and the like will not fundamentally change the overall WBNM flow assessment given that a conservative approach has been applied in the allocation of catchment fraction imperviousness. Consequently, any subsequent revisions made are not expected to have any bearing on the flood related estimates assessed as part of this study and the study findings will remain equally valid.

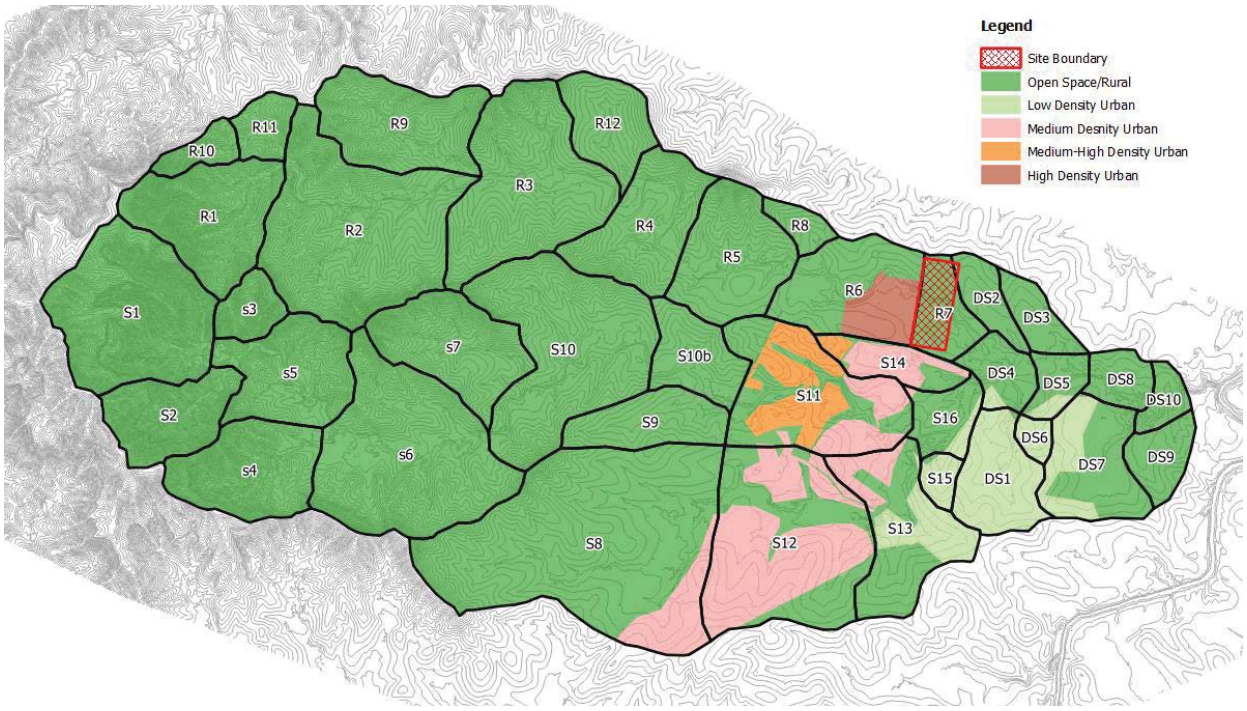

Figure 4-1 Flagstone Creek WBNM Sub-Catchments and Land Use – Existing Scenario

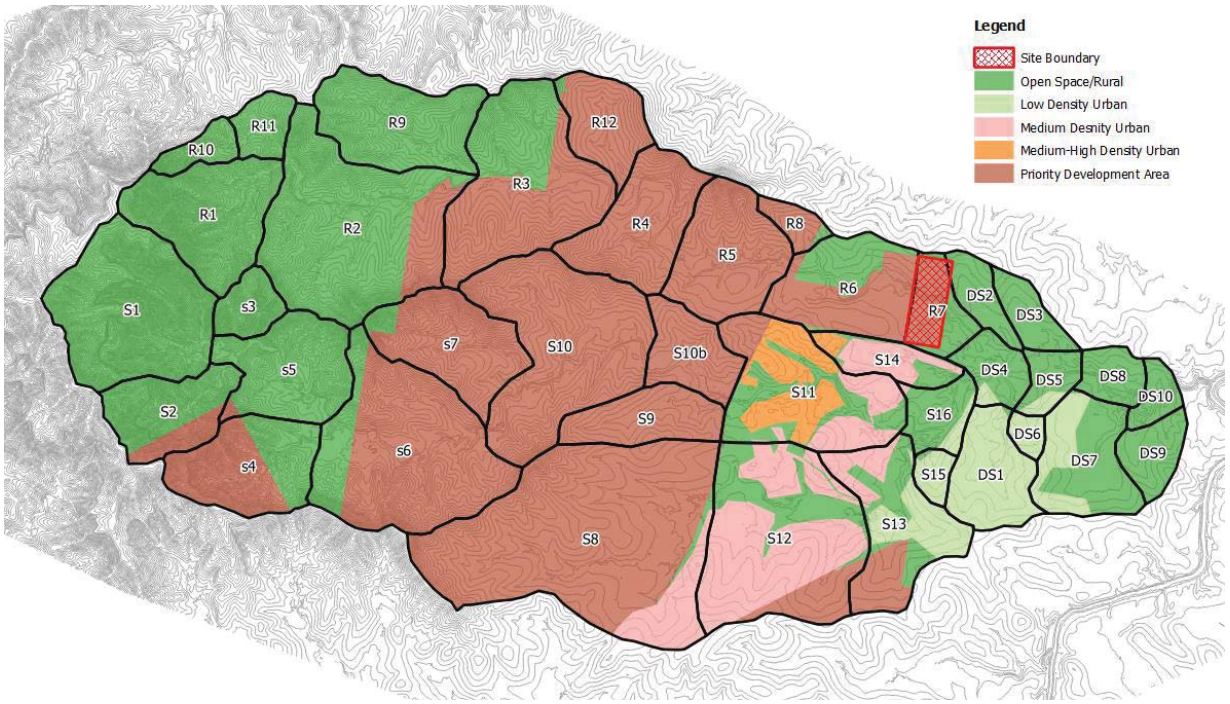

Figure 4-2 Flagstone Creek WBNM Sub-Catchments and Land Use– Ultimate Scenario

4.3.2 Rainfall Intensity and Losses

IFD parameters for the site are summarised in Table 4-2 and were obtained using the online Bureau of Meteorology (BoM) design rainfall intensity calculator based on standard methods as outlined in AR&R (1987). The IFD was taken at the catchment centroid.

Table 4-2 IFD Parameters, AR&R (1987)

Parameter	Value
2 year ARI, 1 hr duration (mm/hr)	44.84
2 year ARI, 12 hr duration (mm/hr)	7.37
2 year ARI, 72 hr duration (mm/hr)	2.08
50 year ARI, 1 hr duration (mm/hr)	83.44
50 year ARI, 12 hr duration (mm/hr)	14.01
50 year ARI, 72 hr duration (mm/hr)	4.53
Geographical Factor F2	4.39
Geographical Factor F50	17.13
Skewness	0.15

The rainfall losses for the design events were adjusted to suit the model calibration. Specifically, this included consideration of the Australian Rainfall and Runoff (ARR) Regional Flood Frequency Estimation (RFFE) Model as being an appropriate technique outlined in the current ARR16 procedures. This aspect is discussed separately in Section 4.3.4. The calibration approach was undertaken in the absence of any site-specific hydrological data being available for Flagstone Creek and to otherwise consider alternative calibration approaches. The initial losses adopted for the WBNM model are summarised in Table 4-3 and are consistent

(if not conservative) based on industry guidance. Note that for the 1% Annual Exceedance Probability (AEP) event, no initial losses have been applied in the model and is an appropriately conservative approach in this instance.

Table 4-3 Rainfall Loss Parameters

Design Event	Initial Loss (mm) Pervious	Continuing Loss (mm) Pervious	Initial Loss (mm) Impervious
39% AEP Event	20	1.5	1
18% AEP Event	20	1.5	1
10% AEP Event	15	1.5	1
5% AEP Event	12.5	1.5	1
2% AEP Event	10	1.5	1
1% AEP Event	0	1.5	1

4.3.3 WBNM Model Parameters and Calibration

The WBNM hydrologic models were subjected to a two (2) step calibration process as follows: -

- An existing catchment land use WBNM model was initially calibrated to the results from the ARR RFFE model to determine the WBNM model parameters. The ARR RFFE estimates are informed using historical stream gauge information taken from the greater area and is therefore reflective of a current level of catchment development land use condition. This process resulted in appropriate WBNM model parameters being determined; and
- The same WBNM parameters were then adopted and applied for the ultimate catchment land use conditions to reflect a fully developed catchment condition for Flagstone Creek. The ultimate catchment flows for Flagstone Creek have been applied in the subsequent hydraulic assessment and are conservative estimates suitable to inform the flood assessments for this study.

A catchment lag parameter of 1.6 was adopted in the WBNM model for the pervious portion of the catchment and 0.1 for the impervious catchment portion. These parameters are standard values in accordance with the WBNM model guidelines. Stream lag factors of 0.5 have been used for all sub-catchments due to the nature of the waterways and having regard to the ultimate case development scenario maintaining environmental, rural zone and open space areas. Again, these parameters fall within the recommended parameter ranges for WBNM model guidelines.

4.3.4 ARR Flood Frequency Estimation

Being a site-specific investigation of an ungauged local catchment, there is no site-based data to calibrate runoff for the site. Accordingly, the existing case WBNM hydrologic model has been calibrated to produce results which compare to the site specific ARR RFFE results. The initial hydrology calibration was conducted with the results of the ARR RFFE model at the outlet of the main flow path within the catchment at the confluence with the Logan River. The ARR RFFE model inputs at the catchment outlet (i.e. WBNM model node DS10) are presented in Table 4-4. Results from the RFFE model are summarised in Table 4-5 (i.e. again at the same sub-catchment DS10 outlet) and additionally include a comparison to the WBNM discharge estimates. Appendix B includes the RFFE results.

Table 4-4 ARR Regional Flood Frequency Estimation (RFFE) Model Input Parameters

Input Parameter	Catchment DS10
Region Code	1 (East Coast)
Latitude and Longitude at Catchment Outlet	-27.80155°, 153.00075°
Latitude and Longitude at Catchment Centroid	-27.79686°, 152.92758°
Catchment Area	55.91 km^2
1 in 2 AEP, 6 Hour Design Rainfall Intensity	9.51 mm/hr
1 in 50 AEP, 6 Hour Design Rainfall Intensity	22.9 mm/hr
Ungauged Catchment Shape Factor	0.97

Table 4-5 ARR Regional Flood Frequency Analysis Comparison

Design Event	RFFE Q (m^3/s)	RFFE 5% CL (m^3/s)	RFFE 95% CL (m^3/s)	WBNM Peak Flow (Q m^3/s)	Variation (%)
Q_{100}	**327**	99	1070	**330**	1
Q_{50}	**258**	87	753	**294**	14
Q_{20}	**181**	72	457	**248**	37
Q_{10}	**134**	59	302	**177**	32
Q_5	**93**	45	195	**151**	62

The WBNM results were found to compare favourably for the larger design events for which the calibration was based. The WBNM model was found to over-predict the RFFE discharges in the more frequent event. However, this is considered of lesser significance in the context of this assessment, with the subsequent flow estimates being conservative in nature. The WBNM model was subsequently adopted to inform design inflows to the hydraulic model and given the emphasis on the 1% AEP design event.

4.3.5 Critical Duration Assessment

The WBNM hydrological analysis indicated that there were minimal differences in peak discharge between the 90 and 180-minute storm durations at the site for all return intervals, with the 120-minute storm peaking slightly higher for all events in the ultimate case, and the 180-minute storm events peaking higher in the existing case. To confirm the critical duration event for peak water surface levels at the site, both the 120 and 180-minute duration events for the 1% AEP were compared through their respective results from the hydraulic model. For the more frequent AEP events, there were minimal differences in peak water levels between the respective durations. The 120-minute storm duration has been adopted for this assessment.

4.4 Hydraulic Assessment

4.4.1 Overview

Logan City Council (LCC) have previously prepared the Logan and Albert River regional flood study. The subject reach of Flagstone Creek is included as part of this larger regional model. While a copy of the relevant section of the model was able to be purchased from LCC to inform the hydraulic assessment, we did not look to obtain a copy of this model. Rather, for a site-specific investigation such as this, the LCC regional model is considered to be too coarse to inform the current assessment as it is based on a much larger 40m grid size. Accordingly, a decision was made to prepare a site-specific and localised model for this assessment in preference to reliance on Council's regional based model.

A TUFLOW hydraulic model of the site was prepared which employed the current HPC (Highly Parallelised Computations) solution scheme (build 2018-03-AC) software. TUFLOW is a 1D-2D linked hydraulic model that solves the depth-averaged shallow water equations. The TUFLOW model has been used to undertake all hydraulic assessments for this study. The following sections outline in further detail the model preparation and subsequent results of the assessment.

4.4.2 Model Topography

The topography used for the TUFLOW model was created based on a detailed 1m LiDAR data sets which was collected in 2009. Additionally, survey of the upstream property has been included in the model. Slight modifications to the outer extent of the survey have been applied through the use of TUFLOW Z Shapes to reflect a smooth interpolation between topographic layers.

No topographic adjustments as a direct result of the development have been included in the model as the development is situated entirely outside of the 1% AEP flood extent even considering both Council's regional flood mapping as well as the flood extent mapping informed by the site-specific assessment as outlined in this report. As there is no encroachment into the 1% AEP flood extent contended by the subject development, conveyance properties are fully maintained and no opportunity for adverse flood impacts to occur. Accordingly, this negates the need or requirement to include a flood impact assessment for the proposed development.

4.4.3 Model Layout and Boundary Locations

The TUFLOW model prepared covers an area of approximately 624 ha and was prepared based on a detailed 2m grid cell size. Site-specific survey of Flagstone Creek in the vicinity of the proposed bridge was also included in the model topography. The TUFLOW model layout is illustrated in Figure 4-3. The inflows from the larger upstream catchment of both Flagstone Creek and Sandy Creek have been applied as 2d_bc lines, with the smaller external catchments and local catchments applied using a series of discrete 2d_sa polygons commensurable with the WBNM hydrological model sub-catchments. All inflows were applied directly from the WBNM model and include full time varying hydrographs.

The TUFLOW model was extended downstream well beyond the site boundary and just prior to the confluence with the Logan River. A HT boundary was adopted at the downstream boundary to allow for varying initial tailwater levels from the Logan River. The downstream model boundary is well in excess of the site boundary to minimise the potential for boundary influences in the hydraulic results in the area of the site.

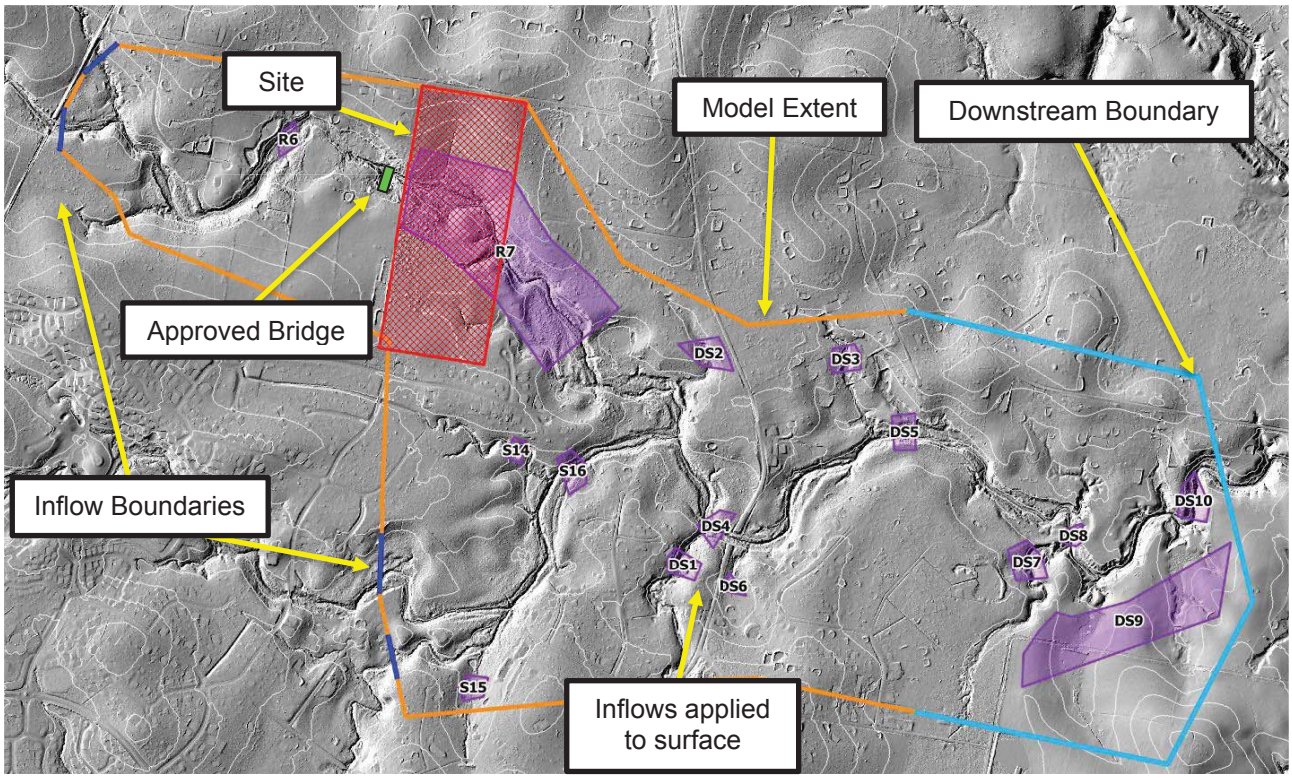

Figure 4-3 Overview of TUFLOW Model

4.4.4 Floodplain Roughness

Floodplain roughness was represented based on a Manning's "n" roughness coefficient assigned to various land uses and spatial areas throughout the model and informed using aerial imagery. Figure 4-4 illustrates the magnitude and spatial application of floodplain roughness across the model domain. The roughness was unchanged between the existing and developed scenarios as any subsequent development will be located in areas external from the main waterways and in areas outside of the 1% AEP extent. Conservative roughness has been applied for all in-stream floodplain roughness as illustrated in Figure 4-4.

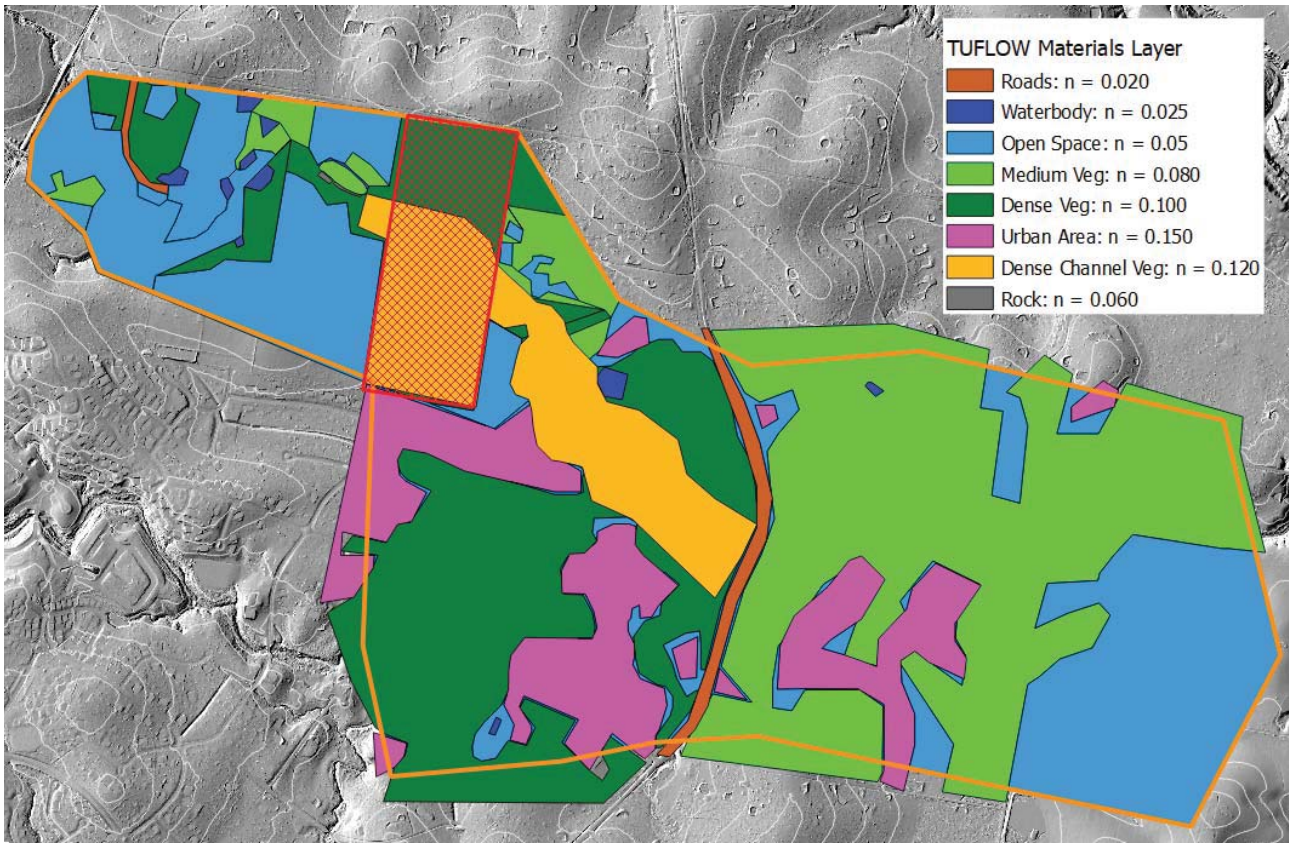

Figure 4-4 Hydraulic Model Spatial Roughness and Magnitude

4.4.5 Tailwater Boundary

Water levels in Flagstone Creek are subject to variation depending on the antecedent tailwater conditions assumed to occur within the Logan River. The application of model tailwater boundaries for this investigation has considered a range of scenarios as follows: -

- A low tailwater level condition for the purposes of calibration of the hydraulic model against Council's flood certificates; and
- A high tailwater condition applied for setting design planning levels for the development. In this instance, it is appropriate to consider a joint coincidence of flooding in Flagstone Creek combined with the Logan River. For this assessment, a combined 1% AEP flood event in both systems has been assessed.

The magnitude of the downstream water levels during the standard recurrence interval flood events of Flagstone Creek were interpolated from the estimations made as part of the 2014 Logan-Albert River Flood Study (LCC, 2014). The outlet of Flagstone Creek is located approximately 1.9 km downstream of the South Maclean Weir gauge and 6.0 km upstream of the Maclean Bridge gauge, both of which have reported water levels from the 2014 study. To establish an appropriate water level condition at the confluence with Flagstone Creek, water levels were interpolated between the Logan River sites noted above and are presented in Table 4-6.

Table 4-6 Estimated Tailwater Levels at the Flagstone Creek Outlet

Flood AEP	Estimated WSL at Flagstone Creek model boundary (m AHD)	WSL at South Maclean Weir (m AHD)	WSL at Maclean Bridge (m AHD)
1%	15.62	16.67	12.38
2%	19.45	20.37	16.61
5%	22.38	23.23	19.78
10%	24.33	25.12	21.88
18%	26.62	27.33	24.42
39%	27.26	27.93	25.21

4.4.6 Upstream Bridge Crossing and Waterway Stability Works

The approved bridge arrangement at the upstream site (refer to EDQ reference DEV2017/887) includes a three-span bridge, the outer spans of which are 16m in length and a longer 25m central span. There were also four (4) sets of 1050mm diameter piers located to support each bridge span throughout the waterway. The bridge was modelled as a 2d layered flow constriction shape (2d_lfcsh) within the TUFLOW model, the details of which are illustrated in Figure 4-5 and Figure 4-6. The channel was assigned a blockage and a form loss coefficient to represent the effect of the bridge and piers within the waterway. The waterway underneath the bridge deck obvert was assigned a blockage of 4.77% and a form loss coefficient of 0.01, with a perpendicular flow length of 17 meters. Although the bridge deck is well above the 1% AEP flood level, a 100% blockage was applied for the super-structure.

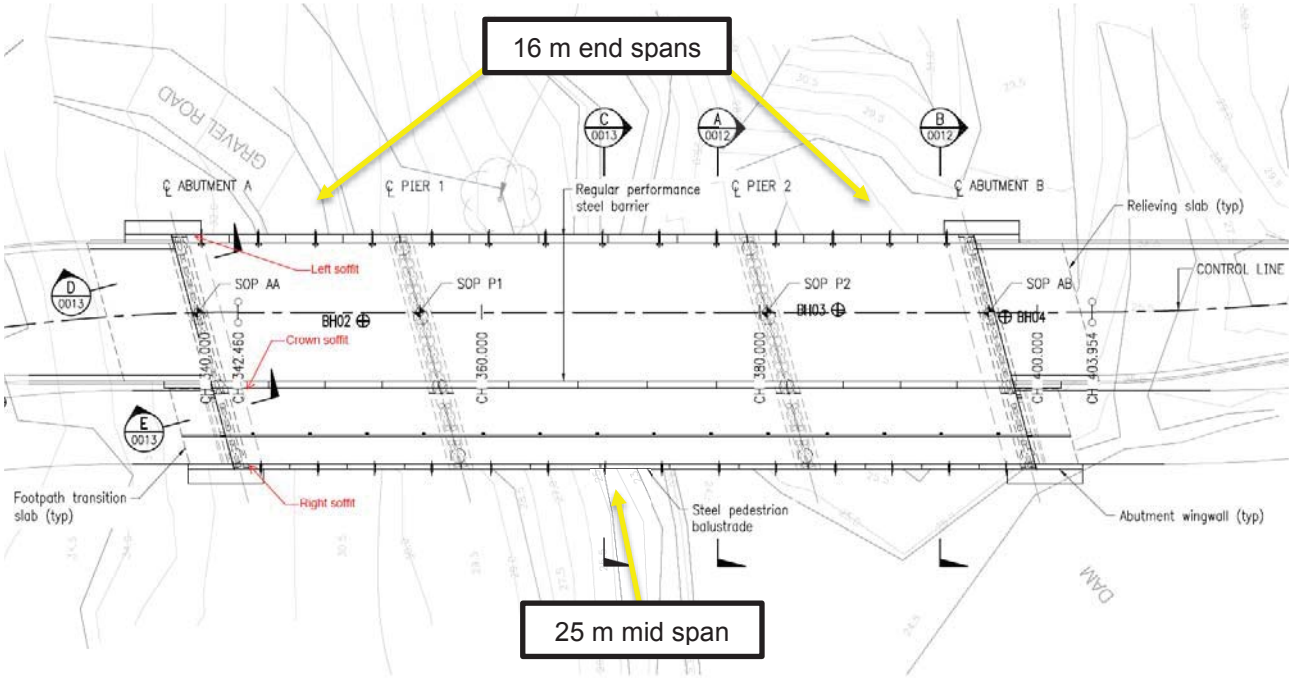

Figure 4-5 Plan View of Proposed Bridge Crossing

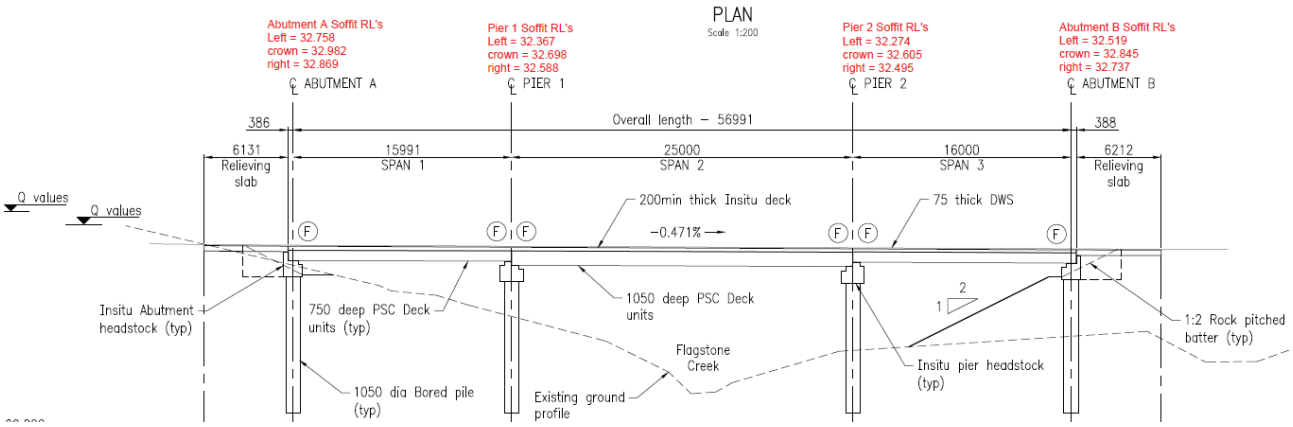

Figure 4-6 Cross Section of Proposed Bridge Crossing

In addition to the above bridge works, the waterway stabilisation works currently under design for the upstream site have been included in the hydraulic model as illustrated in Figure 4-7. We note that these works do not fundamentally change the regional flood extents or levels at the subject site but however have been included for completeness only.

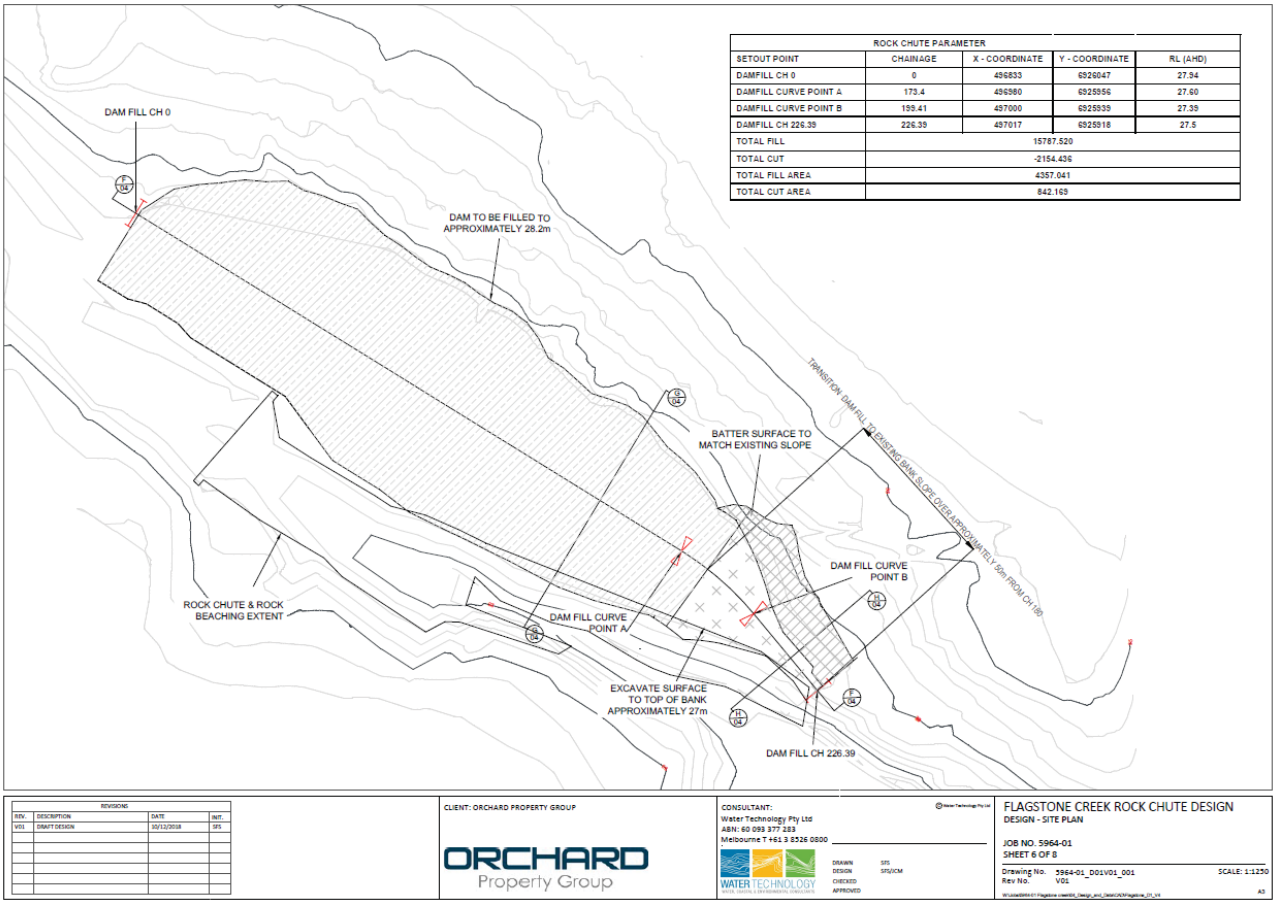

Figure 4-7 Waterway Stabilisation Works Detail

4.4.7 Hydraulic Model Validation

Given that this investigation has prepared a site-specific hydraulic model to inform flooding in Flagstone Creek, it is likely that the hydraulic outcomes will be different to the LCC regional flood model and by virtue of the different level of detail included in the respective models. Although fundamentally different in approach, it is appropriate that a comparison of the model results is at least undertaken to ensure some level of consistency is maintained between the respective studies and to provide confidence in the subsequent results.

In the absence of obtaining a copy of the LCC regional model to otherwise provide flood level information, we do however have flood levels for a range of subject properties within Flagstone Creek for the 1% AEP event which were sourced from LCC via flood certificates (refer Appendix C). We note that these certificates are outside of the 6-month validity period, however LCC informs that they no longer issue flood certificates for this area (as discussed with Janaka Gunawardena, Senior Civil Engineer – Flooding and Stormwater of Logan City Council on 16/01/2019). As LCC's flood modelling has not been updated since issuing of the flood certificates, we consider the previously supplied flood levels to likely apply and be appropriate in this regard, as well as for conducting validation of our flood model. In addition to the above, we note that the flood certificate associated with Lot 30 on SP309195 is documented in Appendix C as 3 RP133386. We understand that the real property description changed sometime between October 2018 and February 2019.

The 1% AEP level information sourced from the property certificates was compared against the levels estimated using the site-specific hydraulic model prepared for this investigation and based on the ultimate catchment land use condition. A summary of the flood level comparisons is presented in Table 4-7 and an illustration of the flood level comparison points as well as flood extents between the current study versus the LCC regional extent is presented in Figure 4-8.

Table 4-7 1% AEP Flood Level Comparisons – LCC Flood Certificate versus Site Specific Hydraulic Model

ID	Lot	1% AEP Flood Certificate WSL (m AHD)	1% AEP Hydraulic Model Peak Flood WSL (m AHD)
1	9 SP203507	34.48	32.75
2	6 RP193185	31.10	31.13
3	30 SP309195	29.32	29.22

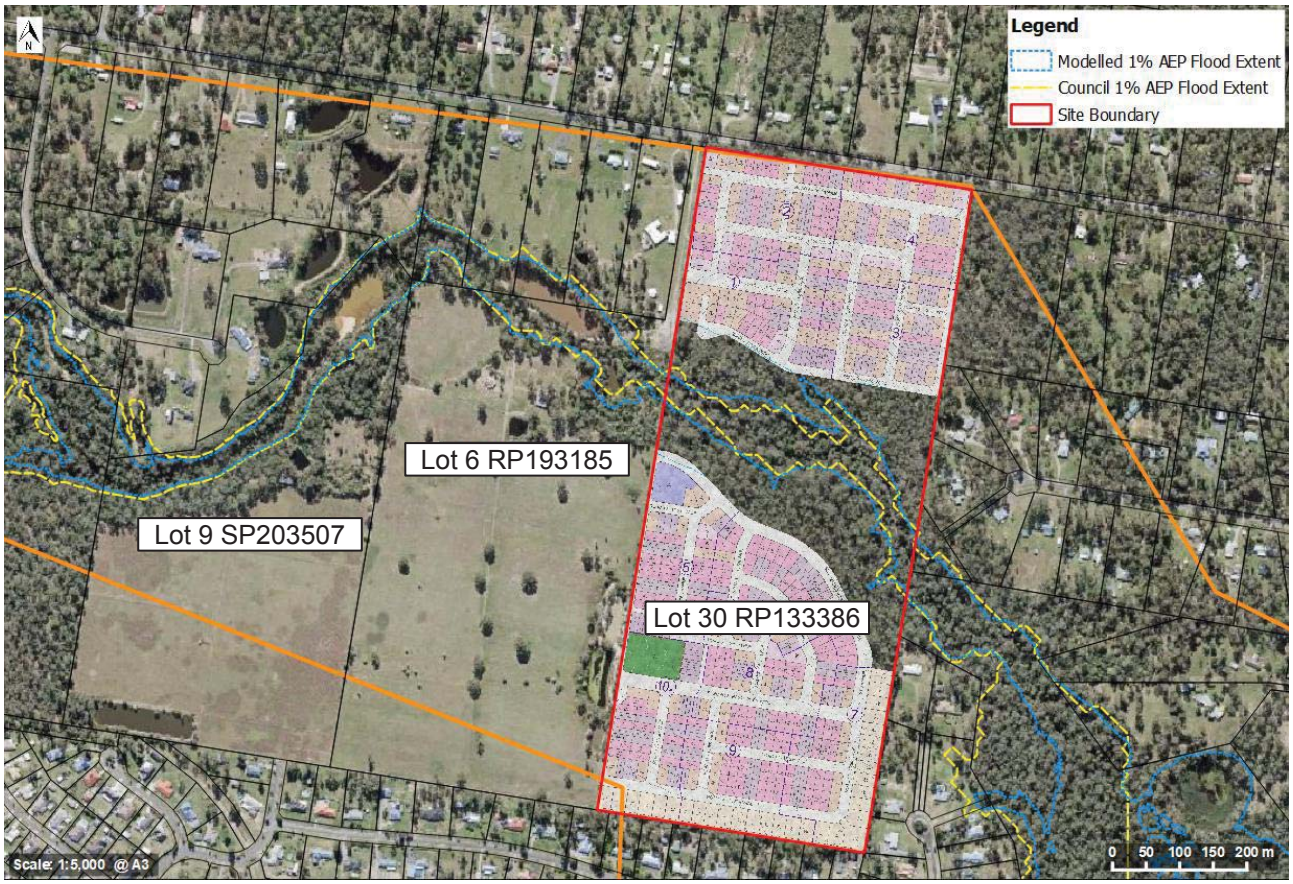

Figure 4-8 Flood Level Comparison Points

As can be seen in Table 4-7, the flood levels over the greater area of the subject site were found to compare well with the LCC flood level certificate information. There was however a large difference observed in the upstream model extent and in the vicinity of Lot 9 SP203507. The flood extent between the respective models is also comparably similar. While the reasons for the level difference associated with Lot 9 SP203507 are not known, possible reasons include: -

- Differences in the local topographical representations associated with Lot 9 based on the 40m grid compared to the finer 2m grid. We note from the flood extent comparison shown in Figure 4-8 that the LCC flood extent is also consistently higher in areas upstream from Lot 9 and may suggest some form of hydraulic control included in the 40m grid model that is not replicated in the finer 2m grid; and
- Discharge differences between the models. Although not clear as to what discharge the LCC model used, the preliminary hydraulic assessments completed by WT for the development in circa 2014 was based on the RFFE which at that time was a 1% AEP discharge of 214m^3/s at the site (refer Appendix B). The current 2019 RFFE estimate for the 1% AEP at the site is now 122m^3/s. Given the LCC study was completed in 2014, it is possible that higher flows were used. Additionally, as the LCC model is a regional model, the design flows in Flagstone Creek would have likely been informed using the regional catchment parameters as opposed to a local catchment context.

In further considering the above, the current hydrology and hydraulic analysis is considered to be appropriate and suitably rigorous for the purposes of this assessment as: -

- It is informed based on the current ARR16 flow estimates;
- It is based on a detailed and site-specific hydraulic model;

- There is a reasonable degree of consistency in both the flood level comparisons as well as flood extent comparisons; and
- In any case, the 1% AEP levels and extent has little bearing to the development which is located well outside of the 1% AEP extent and to a much higher level. That is, even if the 1% AEP is larger than that estimated, there will be little if any implications to the current plan of development.

4.5 Hydraulic Model Results

The TUFLOW hydraulic model has been assessed for the 1 in 10, 20, 50 and 100-year AEP events for the 120-minute storm duration and ultimate development catchment conditions. The hydraulic analysis has considered only the pre-development scenario with the approved upstream development with associated bridge arrangements and waterway stabilisation works. Results of the hydraulic assessment are included as a series of GIS maps to illustrate flood depths, velocities and water surface levels and are included as appendices to this report, the structure of which is as follows: -

- Ultimate catchment conditions scenario GIS maps – Appendix D; and
- Flood design planning levels GIS map – Appendix E

4.5.1 Design Planning Levels

An assessment for design planning levels for the development has been undertaken using the hydraulic model. The assessment has considered a 1% AEP flood event occurring in Flagstone Creek in combination (coincidence) with a 1% AEP Logan River flood event for overall conservatism. The 1% AEP flood planning levels for the development are presented as a GIS figure included in Appendix G.

In accordance with the LCC flood overlay code provisions, minimum habitable building floor levels need to be set at least 500mm above the 1% AEP design flood event levels. Even with consideration of the 500mm freeboard provision, the development can readily achieve the minimum flood planning levels and without the need for inclusion of fill. Minimum flood planning levels for the development should be subject to final confirmation as part of any subsequent operational works approval.

4.5.2 Flood Impact Assessment

The proposed development is situated entirely outside of the 1% AEP flood extent even considering both Council's regional flood mapping as well as the flood extent mapping informed by the site-specific assessment as outlined in this report. As there is no encroachment into the 1% AEP flood extent contended by the subject development, conveyance properties are fully maintained and no opportunity for adverse flood impacts to occur. Accordingly, this negates the need or requirement to include a flood impact assessment for the proposed development.

5 STORMWATER QUANTITY ASSESSMENT

5.1 Stormwater Quantity Management Strategy

The existing site has two (2) distinct catchment areas, being the northern and southern sides of Flagstone Creek. A proportion of each of the northern and southern catchment areas discharge to the adjacent private properties on the eastern boundary as indicated in Figure 5-1.

The strategy for stormwater quantity management for the development at the site generally consists of: -

- Discharge stormwater from the entire northern catchment to Flagstone Creek via water quality treatment device(s). No specific stormwater quantity mitigation infrastructure is proposed, and Lawful Point of Discharge is addressed by discharging stormwater directly to Flagstone Creek and in a similar manner to what was approved for the upstream development under EDQ DA reference DEV2017/887.
- Discharge stormwater from the entire southern catchment to Flagstone Creek. This will include the re-direction of stormwater from the southern portion of the southern catchment to Flagstone Creek via water quality treatment device(s). No specific stormwater quantity mitigation infrastructure is proposed, and Lawful Point of Discharge is addressed by discharging stormwater directly to Flagstone Creek as has been discussed above.

The adjacent development to the west of the site (EDQ reference DEV2017/887) demonstrated that stormwater detention was not required for areas with direct discharge to Flagstone Creek given the large external catchment which dominates flows in the receiving waterway. The stormwater management strategy proposed maintains a similar approach for the subject site. Assessment of flows in Flagstone Creek utilising the regional WBNM model as detailed in Section 4.3.3 to quantify the change in flow characteristics in the receiving waterway as a result of a 'no stormwater detention' strategy for the site catchment.

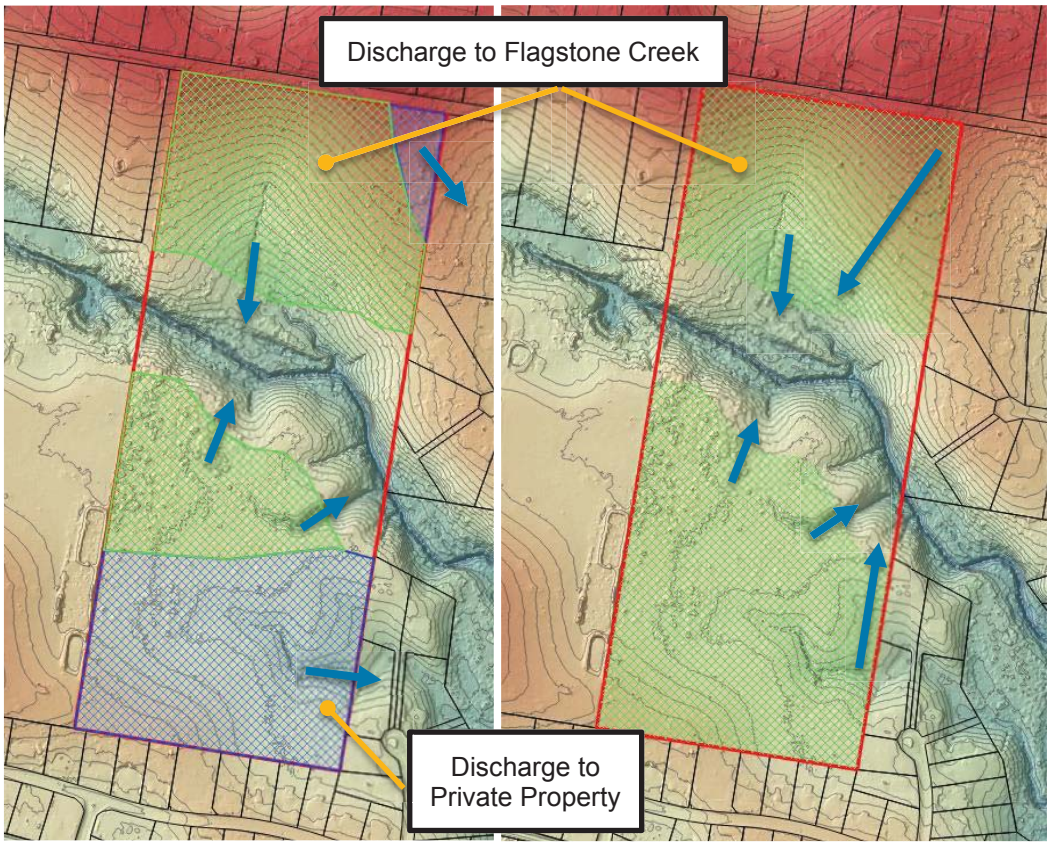

Figure 5-1 Existing Onsite Catchments (Left) and Proposed Developed Catchments (Right)

5.2 Receiving Waterway Assessment

5.2.1 Overview

As discussed in Section 5.1, no on-site detention is proposed for the site as the large catchments associated with the Flagstone Creek (~15km^2 to the downstream site boundary) dominates the timing and magnitude of flows and associated flood levels in Flagstone Creek. Downstream of the site, the additional flows associated with the larger Sandy Creek catchment and Logan River become the dominant source of flooding in the region.

As required by the DA condition 22(iii) for the approved development to the west of the site (refer EDQ DA reference DEV2017/887), to support the 'no detention' stormwater strategy for the site, an assessment of the receiving waterway has been undertaken to consider the following: -

- An assessment of a range of return periods and event durations in the hydrological model, in particular, events longer than the critical duration event for the site;
- Reporting of flows at the downstream site boundary and at the confluence of Flagstone Creek with the Logan River; and
- Inclusion of a sensitivity analysis for cumulative impacts should other development within the PDA east of the Brisbane Sydney Railway request a no-detention strategy.

The following sections outline the regional assessment made to address and satisfy the above points.

5.2.2 Model Setup

The existing scenario WBNM model as detailed in Section 4.3 was adopted for the regional no-detention analysis. A summary of the model setup for this assessment includes: -

- Site assessment
  - Increase the fraction impervious for the sub-catchment containing the site. This was conducted based on a development footprint of approximately 30.14 ha and an FI of 0.7 as indicated in Figure 5-2, which is consistent with the receiving waterway assessment undertaken for the adjacent site.
  - Run the hydrological model for the 63%, 5% and 1% AEP events for a range of durations from 60 minutes to 48 hours.
  - Extract peak discharges at two reporting points, being the sub-catchment boundary and end of the model (at the confluence of the Logan River).
  - Compare peak discharges for each AEP event and duration.
- Sensitivity Assessment
  - Identify the extent of the PDA east of the Brisbane Sydney Railway, and identify potential development footprints incorporating buffers to Flagstone Creek as indicated in Figure 5-2.
  - Adjust the WBNM model sub-catchments as required to represent the identified development areas with a FI of 0.7.
  - Extract peak discharges at two reporting points.
  - Compare peak discharges for each AEP event and duration.

The relative increase in imperviousness fraction associated with development of the site and associated minor redirections of sub-catchments within this context is therefore of little relevance.

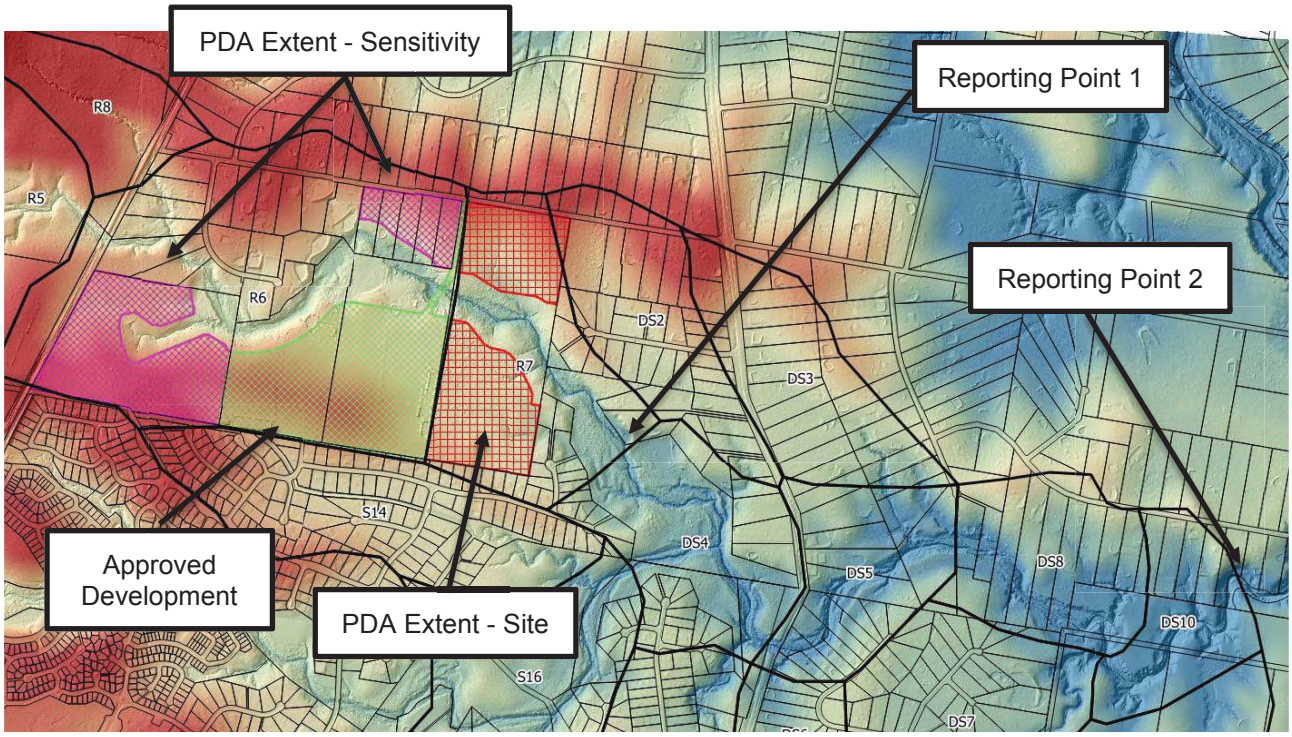

Figure 5-2 Regional Assessment of No Detention Strategy

5.2.3 Results – Site Only

The peak discharge at the downstream site boundary and at the confluence of Flagstone Creek with the Logan River is provided in Table 5-1 and Table 5-2 respectively. The results demonstrate the following: -

- For the 5% and 1% AEP events (all durations), the development of the site with no provision for on-site stormwater detention does not result in an increase in peak flows within Flagstone Creek at either downstream of the site boundary or the confluence with the Logan River. Therefore, no further consideration of worsening in peak discharge for events greater than the 5% AEP is made in this report.
- For the 63% AEP event, up to and including the critical duration event there was no increase in the peak discharge in the receiving waterway at the downstream site boundary. Therefore, the proposed development without provision of stormwater detention in the northern catchment achieves the SPP waterway stability criteria by virtue of the no increase in the peak discharge in the 1 in 1 year ARI event.
- There were slight (0.5% to 0.6%) increases in the 63% AEP peak discharge at the downstream site boundary for durations longer than the critical duration of 360 minutes. These represent a difference of approximately 0.1m^3/s and are of no significance and of the magnitude that is considered to be beyond the numerical accuracy of the hydrological model.
- When considering the peak flow in Flagstone Creek at the confluence of the Logan River for the 63% AEP event, there was no increase in peak discharge noted for durations up to the critical duration event of 360 minutes. For events longer than the duration event, there were slight increases in peak flow of 0.1%, which is again of no significance and also considered to be beyond the realistic numerical accuracy of the hydrological model.

Table 5-1 Flagstone Creek Peak Discharge Comparison at Downstream Site Boundary

Return Interval (AEP)	Event Duration (minutes)	Existing Catchment Discharge (m^3/s)	Existing Catchment, Developed Site Discharge (m^3/s)	Difference (%)	Difference (m^3/s)
63%	60	13.1	12.9	-0.9	-0.1
	120	18.4	18.2	-0.9	-0.2
	180	20.8	20.6	-0.9	-0.2
	270	21.2	21.2	-0.2	0.0
	360	21.6*	21.6*	-0.1	0.0
	1440	15.9	16.0	0.5	0.1
	2880	9.6	9.7	0.6	0.1
5%	60	56.9	56.2	-1.2	-0.7
	120	68.5	67.7	-1.2	-0.8
	180	74.1	73.3	-1.1	-0.8
	270	75.1*	74.7*	-0.6	-0.5
	360	74.5	74.2	-0.4	-0.3
	1440	66.8	66.6	-0.3	-0.2
	2880	54.0	53.8	-0.4	-0.2
1%	60	90.0	89.0	-1.1	-1.0
	120	106.2	105.1	-1.1	-1.1
	180	112.1*	110.9*	-1.1	-1.3
	270	111.4	110.7	-0.6	-0.7
	360	107.8	107.3	-0.4	-0.4
	1440	95.0	94.7	-0.4	-0.3
	2880	77.7	77.4	-0.4	-0.3

* Critical duration event

Table 5-2 Flagstone Creek Peak Discharge Comparison at Confluence with Logan River

Return Interval (AEP)	Event Duration (minutes)	Existing Catchment Discharge (m^3/s)	Existing Catchment, Developed Site Discharge (m^3/s)	Difference (%)	Difference (m^3/s)
63%	60	37.5	37.3	-0.4	-0.2
	120	53.1	52.9	-0.5	-0.2
	180	61.1	60.9	-0.4	-0.2
	270	63.9	63.9	-0.1	0.0
	360	65.2*	65.2*	0.0	0.0
	1440	48.3	48.4	0.1	0.1
	2880	30.1	30.1	0.2	0.1
5%	60	160.8	160.1	-0.4	-0.7
	120	196.8	195.9	-0.4	-0.9
	180	218.1	217.3	-0.4	-0.9
	270	225.5*	225.1*	-0.2	-0.3
	360	224.2	224.0	-0.1	-0.2
	1440	200.6	200.4	-0.1	-0.2
	2880	163.5	163.3	-0.1	-0.2
1%	60	257.4	255.9	-0.6	-1.4
	120	307.2	305.7	-0.5	-1.5
	180	330.3	329.2	-0.3	-1.1
	270	335.5*	335.0*	-0.2	-0.5
	360	325.6	325.3	-0.1	-0.3
	1440	285.7	285.4	-0.1	-0.3
	2880	236.1	235.9	-0.1	-0.2

* Critical duration event

5.2.4 Results – Sensitivity Scenario

The peak discharge for the sensitivity scenario, being development within the PDA area east of the railway with a 'no detention' strategy, at the downstream PDA boundary and at the confluence of Flagstone Creek with the Logan River is provided in Table 5-3 and Table 5-4 respectively. The results demonstrate the following: -

- For the 5% and 1% AEP events (all durations), the development of the PDA area east of the Brisbane Sydney Railway with no provision for on-site stormwater detention did not result in an increase in peak flows within Flagstone Creek at either the downstream site boundary or the confluence with the Logan River. Therefore, no further consideration of worsening in peak discharge for events greater than the 5% AEP is made in this report.
- For the 63% AEP event, up to and including the critical duration event there was no increase in the peak discharge in the receiving waterway at the downstream PDA boundary. Therefore, should other developments in the PDA area east of the railway the proposed development without provision of stormwater detention in the northern catchment achieves the SPP waterway stability criteria by virtue of the no increase in the peak discharge in the 1 in 1 year ARI event in the receiving waterway.
- There were slight (0.9% to 1.2%) increases in the 63% AEP peak discharge at the downstream PDA boundary for durations in excess of the critical duration of 360 minutes. These represent a difference of approximately 0.2m^3/s and occur when the peak flow in the receiving waterway is approximately 20% to 50% less than the critical duration flow.
- When considering the peak flow in Flagstone Creek at the confluence of the Logan River for the 63% AEP event, the peak discharge varied up to 0.6% from the existing conditions peak flow. The change in peak flow for the critical duration event was 0.1%, which is considered insignificant.

Table 5-3 Flagstone Creek Sensitivity Case Peak Discharge Comparison at Downstream PDA Boundary

Return Interval (AEP)	Event Duration (minutes)	Existing Catchment Discharge (m^3/s)	Existing Catchment, Developed PDA Discharge (m^3/s)	Difference (%)	Difference (m^3/s)
63%	60	13.1	12.8	-2.2	-0.3
	120	18.4	18.0	-2.2	-0.4
	180	20.8	20.3	-2.3	-0.5
	270	21.2	21.1	-0.6	-0.1
	360	21.6*	21.6*	-0.2	0.0
	1440	15.9	16.1	0.9	0.2
	2880	9.6	9.7	1.2	0.1
5%	60	56.9	55.5	-2.4	-1.4
	120	68.5	66.8	-2.4	-1.6
	180	74.1	72.4	-2.3	-1.7
	270	75.1*	74.3*	-1.1	-0.8
	360	74.5	74.0	-0.7	-0.5
	1440	66.8	66.4	-0.6	-0.4
	2880	54.0	53.6	-0.7	-0.4
1%	60	90.0	87.9	-2.4	-2.1
	120	106.2	103.6	-2.4	-2.5
	180	112.1*	109.6	-2.3	-2.6
	270	111.4	110.2*	-1.1	-1.2
	360	107.8	107.1	-0.6	-0.7
	1440	95.0	94.4	-0.7	-0.7
	2880	77.7	77.2	-0.7	-0.5

* Critical duration event

Table 5-4 Flagstone Creek Sensitivity Case Peak Discharge Comparison at Downstream PDA Boundary

Return Interval (AEP)	Event Duration (minutes)	Existing Catchment Discharge (m^3/s)	Existing Catchment, Developed PDA Discharge (m^3/s)	Difference (%)	Difference (m^3/s)
63%	60	37.5	38.1	1.5	0.6
	120	53.1	52.6	-0.9	-0.5
	180	61.1	60.8	-0.5	-0.3
	270	63.9	63.9	0.0	0.0
	360	65.2*	65.3*	0.1	0.0
	1440	48.3	48.5	0.3	0.1
	2880	30.1	30.2	0.6	0.2
5%	60	160.8	159.2	-1.0	-1.6
	120	196.8	195.0	-0.9	-1.7
	180	218.1	216.9	-0.6	-1.3
	270	225.5*	225.0*	-0.2	-0.5
	360	224.2	223.8	-0.2	-0.4
	1440	200.6	200.2	-0.2	-0.4
	2880	163.5	163.3	-0.1	-0.2
1%	60	257.4	254.8	-1.0	-2.6
	120	307.2	304.6	-0.8	-2.6
	180	330.3	328.7	-0.5	-1.6
	270	335.5*	334.8*	-0.2	-0.7
	360	325.6	325.0	-0.2	-0.6
	1440	285.7	285.2	-0.2	-0.5
	2880	236.1	235.8	-0.1	-0.2

* Critical duration event

5.2.5 Discussion

The above assessment therefore demonstrates that peak flows at the site and associated with a local flood event will be controlled and dominated by the external catchments as opposed to the proposed development, or additional development within the PDA east of the Brisbane Sydney Railway. On this basis, the inclusion of on-site detention as part of the development provides no practical purpose and may even result in a worsened condition depending on the timing of peaks. As such, on-site detention is therefore not required as part of the proposed development. Further, there will be no fundamental change in peak discharge or existing drainage and flooding characteristics of the downstream private properties as a result of the proposed development which is again controlled by the much larger external catchment as opposed to development of the site itself.

The analysis has indicated that the adoption of a 'no detention' strategy for the site, which has direct discharge to Flagstone Creek, will not fundamentally change the discharge characteristics of the 63% AEP event and therefore satisfies the waterway stability criteria of the SPP. In addition, the analysis has not considered the benefits of the bioretention basins which are to be incorporated into the areas adjacent to Flagstone Creek which will provide limited flood storage and flow attenuation in the minor events.

5.3 Other Applications in the Greater Flagstone PDA

It has been noted that several applications have been submitted to EDQ in regards to proposed development within the Greater Flagstone PDA. Technical reports provided in support of three (3) of the applications are potentially relevant to this application. The applications that are relevant and the associated details are summarised separately below.

Dev2017/887

This application covers the two adjacent properties to the west of the site (Lot 6 on RP193185 and Lot 9 on SP 203507). The approved development included a 'no detention' strategy for areas which had direct discharge to Flagstone Creek. The study indicated that a 'no detention' strategy did not create a worsening of flooding in Flagstone Creek, which is a consistent conclusion drawn by this current study.

Dev2012/402 – Flagstone City Masterplan Flooding Assessment

Application Reference Dev2012/402 covers a significant portion of the PDA, including the area upstream of the subject site in the Flagstone Creek Catchment as indicated in Figure 5-3. The upstream development included on-site detention measures to mitigate increases in peak discharge. The results presented by Cardno in the report 'Flagstone City – Masterplan Flooding Assessment' dated 5 September 2014 (reference 721743/032/R1V6) indicate that providing on-site detention in the upper catchment area has resulted in a reduction in peak water levels and discharge at the subject site, as indicated in Figure 5-4 and Table 5-5 below.

The study indicates that the development of the upper Flagstone Creek catchment, if incorporating stormwater detention as intended, reduces the peak discharge in Flagstone Creek adjacent to the site. This supports the no-mitigation strategy for the northern catchment, as it indicates that cumulative impacts of development in the upper catchment does not necessarily result in a worsening of flows at the site.

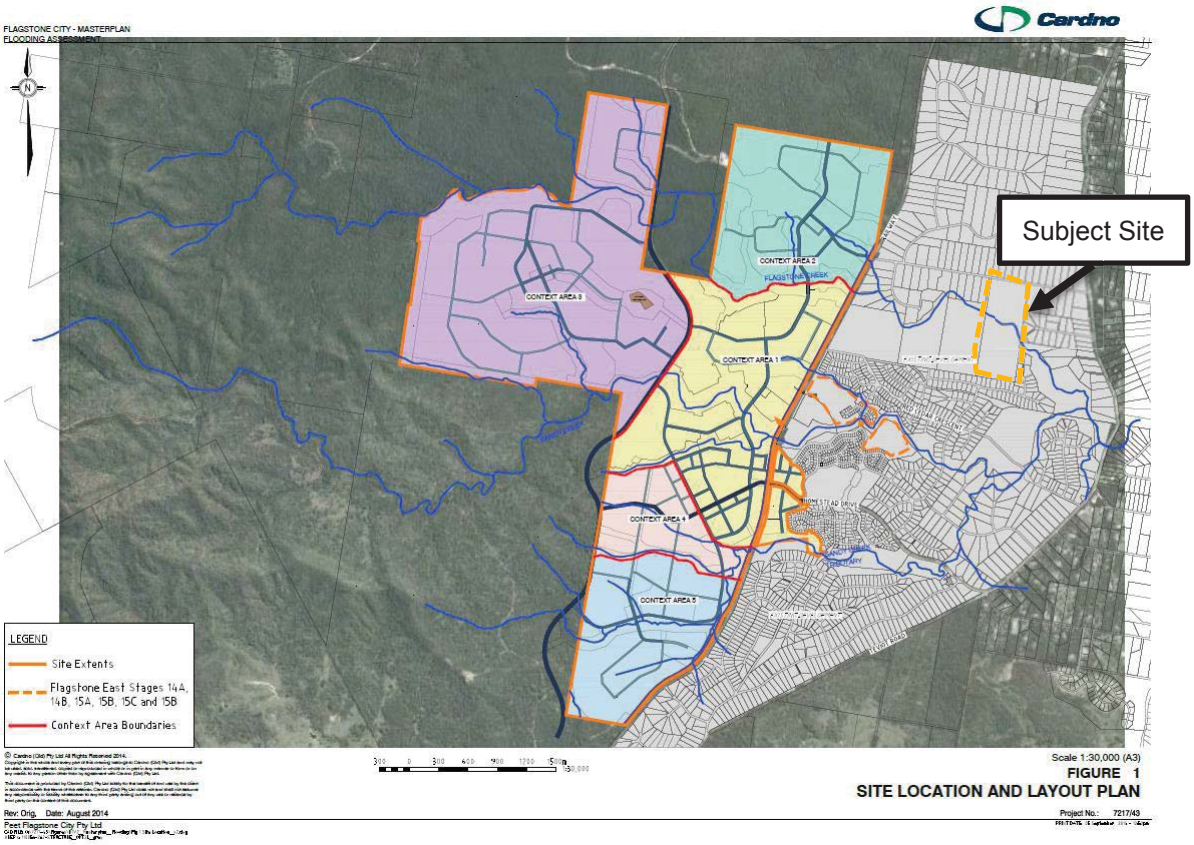

Figure 5-3 Application Extent and Subject Site (Cardno 2014)

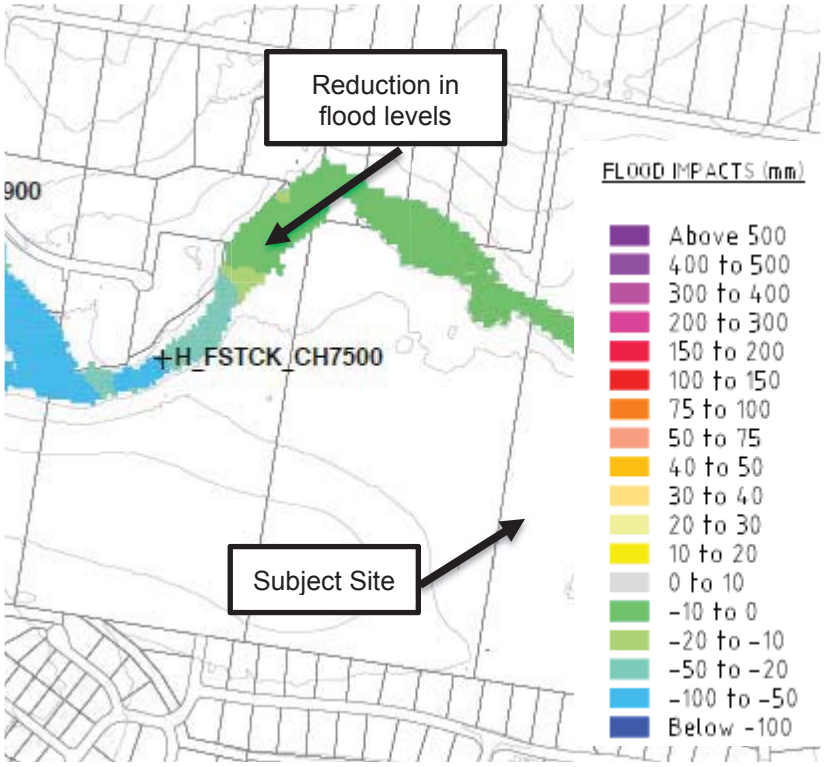

Figure 5-4 Reduction in Flood Levels as Modelled by Cardno (2014)

Table 5-5 Reduction in Peak Flow at the Site (Cardno 2014)

Location	Existing Case (m^3/s)	Developed Case (m^3/s)	Impact (m^3/s)
FSTCK_CH7500	92.3	88.5	-3.8

Dev2016/811 – Cumulative Impact Assessment for Final Response to Item B-1 of Summary of Flood Investigation and Stormwater Management Review Document

Application Reference Dev2016/811 includes the Jimboomba Celestino Master Plan Development located within the PDA, as indicated in Figure 5-5. The document 'Cumulative Impact Assessment for Final Response to Item B-1 of Summary of Flood Investigation and Stormwater Management Review Document' prepared by Calibre and dated 2 May 2017 includes a detailed analysis of the potential impacts to the flooding conditions in the Logan River should a no-detention development scenario be adopted for all PDA or urban development areas with direct discharge to the Logan River.

The analysis indicated that there was no fundamental change to the flooding conditions within the Logan River as a result of a no detention strategy and as summarised in Figure 5-6. This indicates that on-site stormwater mitigation measures do not have a bearing on regional flood levels and confirms that on-site detention at the subject site is not required in order to mitigate against regional flood impacts.

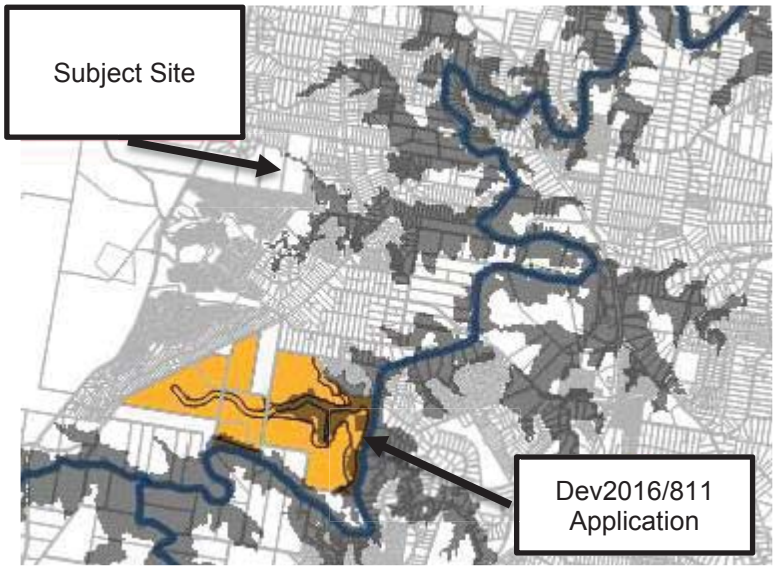

Figure 5-5 Location of Dev2016/211 Application (Source: Calibre 2017)

Location	Description	Approximate Bridge Levels (m AHD)	Change in Flood Warning Time (mins)[2]	Change in Peak Flood Level (mm)[2]
Cusack Lane Payne Bridge	2.2km downstream of master plan development	25.5m AHD	+7 to -10.5mins	+4 to -13mm
Mt Lindesay Highway Maclean Bridge	13km downstream of master plan development	21.5m AHD	+4 to -10mins	+3 to -20mm
Wendt Park (LR012)	26km downstream of master plan development	14.5m AHD[1]	+3 to -7mins	+3 to -9mm

[1]Relates to sag level along Wendt Road adjacent to the Logan River
[2]Results indicate the range of change in flood warning times or peak levels over the various storm durations (6hr to 72hr) modelled

Figure 5-6 Change in Flood Conditions - Extract from Calibre (2017)

5.4 Summary

The stormwater quantity assessment undertaken for the proposed development has demonstrated: -

- Stormwater from the entire site will be discharged to Flagstone Creek, which represents the Lawful Point of Discharge for the site.
- The analysis has demonstrated that the inclusion of on-site detention measures for the site is not necessary, as the 'no detention' strategy does not result in any fundamental change in peak discharge in the receiving waterway.
- The proposed 'no detention' strategy is consistent with other approved developments within the Flagstone Creek catchment and PDA.

6 STORMWATER QUALITY ASSESSMENT

6.1 Overview

This section of the report outlines the assessment of stormwater quality at the site which includes Water Sensitive Urban Design (WSUD) measures proposed to mitigate impacts to the water quality of runoff leaving the developed site and comply with recommended Water Quality Objectives (WQOs). These WSUD measures are proposed for the operational (post-construction) phase of the development and are therefore long-term water quality management measures.

This section of the report discusses the following: -

- Water Quality Concerns (Section 6.2);
- Water Quality Standards and Guidelines (Section 6.3);
- MUSIC Model Setup (Section 6.4); and
- Discussion of Results (Section 6.5)

6.2 Water Quality Concerns

Typical pollutants from this development are listed in Table 6-1 below.

Table 6-1 Typical Pollutants from Site (Operational Phase)

Pollutant Type	Pollutant sources
Gross Pollutants	Litter such as food, drink and materials packaging and wrappers, leaf matter and grass clippings.
Sediment	Sediment brought in by vehicles, erosion, atmospheric deposition, organic matter, spills and accidents.
Hydrocarbons	Fuel and oil spills from cars and trucks, asphalt pavements.
Nutrients	fertiliser, decaying organic matter, animal faeces, detergents, atmospheric deposition.

6.3 Water Quality Standards and Guidelines

The standards and guidelines referenced for the MUSIC analysis are listed as follows: -

- “State Planning Policy” (SPP), Department of State Development, Infrastructure and Planning, 2017;
- “South East Queensland Regional Plan 2009 - 2031 - Implementation Guideline No. 7”, November 2009 by Department of Infrastructure and Planning;
- “MUSIC Modelling Guidelines – Version 1.0 – 2010” produced under the Water by Design Program by the South East Queensland Healthy Waterways Partnership 2010;
- “Urban Stormwater Quality Planning Guidelines”, Department of Environment and Resource Management, 2009;
- “Urban Stormwater – Queensland best practice environmental management guidelines – Technical Note: Derivation of Design Objectives”, Environmental Protection Agency, January 2009; and
- “Urban Stormwater Quality Planning Guidelines 2010” Department of Heritage Protection, 2010.

The stormwater quality pollutant load reduction requirements, as specified in Table B in Appendix 3 of the State Planning Policy (DSDIP 2017) are listed in Table 6-2. These reduction targets are calculated as reductions in total pollutant load to be achieved as compared to the theoretical runoff of untreated stormwater from the proposed development. To assess the pollutant load reductions from the proposed development, the Model for Urban Stormwater Conceptualisation (MUSIC) models have been prepared and are documented in the following sections of this report.

Table 6-2 Post Construction Phase Stormwater Management Design Objectives (SPP)

Pollutant	Water Quality Objectives
Total Suspended Solids (TSS)	80% reduction in average annual load of pollutants
Total Phosphorus (TP)	60% reduction in average annual load of pollutants
Total Nitrogen (TN)	45% reduction in average annual load of pollutants
Gross Pollutants (GP)	90% reduction in average annual load of pollutants

6.4 MUSIC Model Setup

Water quality modelling of the proposed development has been undertaken using the Model for Urban Stormwater Conceptualisation (MUSIC). The MUSIC model enables the user to estimate the pollutant export from the proposed development site and quantify the effectiveness of the proposed stormwater quality treatment train. MUSIC provides quantitative modelling for Total Suspended Solids (TSS), Total Phosphorous (TP), Total Nitrogen (TN) and Gross Pollutants (GP).

The MUSIC model was set up in accordance with Water by Design MUSIC Modelling Guidelines (2010) which has been produced under the Water by Design Program by the South-East Queensland Healthy Waterways Partnership. In addition, Healthy Waterways recommends using MUSIC version 6 to ensure compliance with stormwater pollutant loads reduction objectives, with the following parameters adopted when modelling bioretention filter media: -

- Minimum 30 mg/kg Orthophosphate (OP); and
- Minimum 400 mg/kg Total Nitrogen (TN)

The modelling has adopted the split catchment approach for residential development in accordance with the breakdown of surface types indicated in Table 3.3 of the MUSIC Modelling Guidelines (2010) (refer Table 6-3 below).

The proposed childcare centre has been modelled as a lumped catchment, as at this stage there is insufficient details available regarding the likely site layout to accurately represent the site as a split catchment.

Table 6-3 Split Catchment Assumptions – Proposed Development (Water by Design)

Residential Development	Breakdown of Surface Type (%)			Impervious Fraction (%)		
	Road	Roof	Ground Level	Road	Roof	Ground Level
15 Dwelling/ha	25	32.5	42.5	60	100	20

6.4.1 Catchment Areas

A split catchment approach has been undertaken using the “typical” surface-type splits as documented by Water by Design (2010) and the site plan prepared by Saunders Havill Group. Note that individual sub-

catchments have not been delineated at this design stage; this analysis will indicate the required proportion of bioretention filter media required per area of development.

The catchment split is outlined in Table 6-4, and the childcare centre as a lumped catchment in Table 6-5. We note that the corridor parks and local park indicated on the proposed development layout has not been included in the catchment areas.

Table 6-4 Catchment Breakdown – Split Catchment Approach

Sub-Catchment	Total Area (ha)	Dwelling/ha	Road Area (ha)	Lot Roof Area (ha)	Ground Level (ha)
Urban Residential	29.75	18	7.44	9.67	12.64

Table 6-5 Catchment Breakdown – Lumped Catchment Approach

Sub-Catchment	Total Area (ha)	Percentage Impervious
Childcare (commercial)	0.286	90

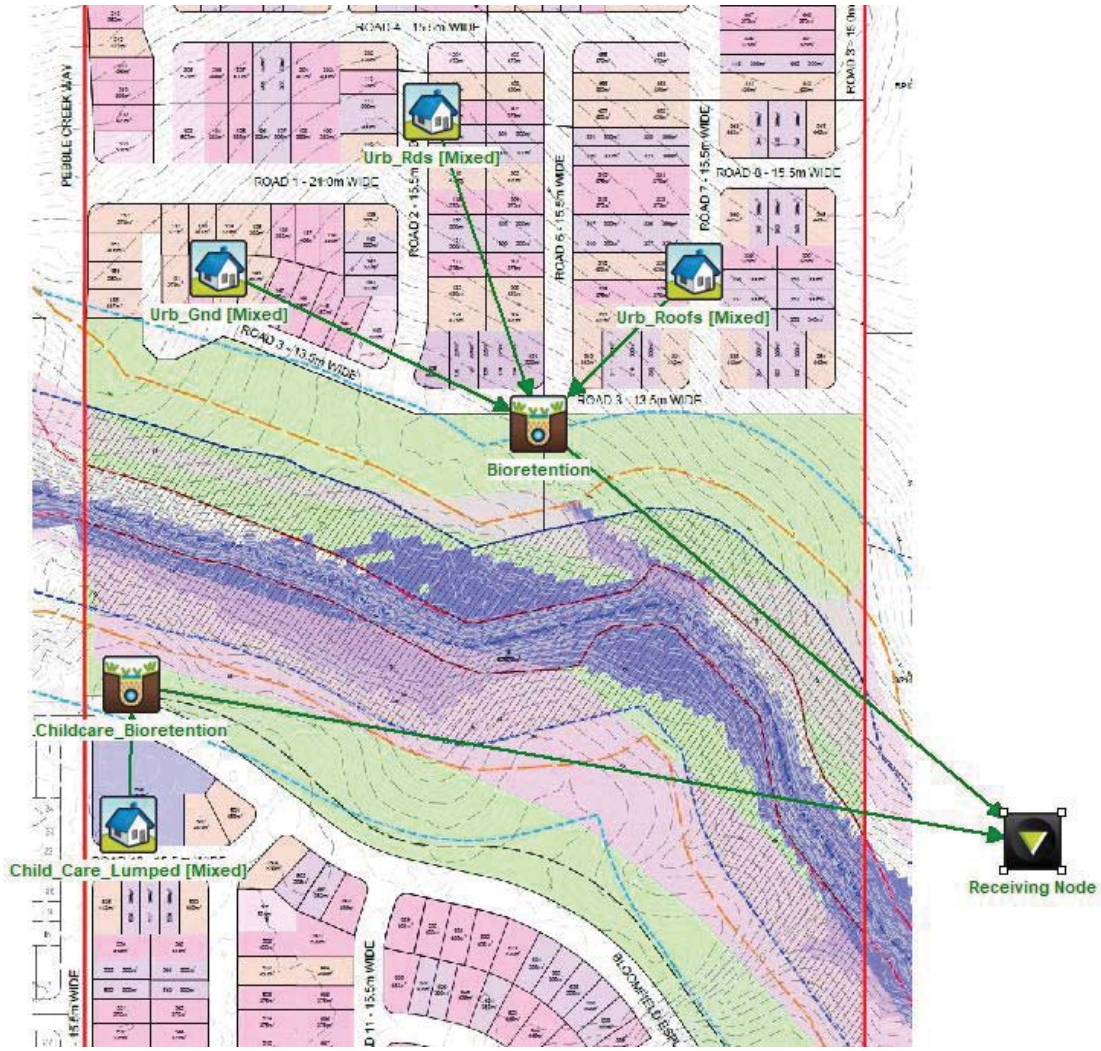

Figure 6-1 Water Quality Device Catchments

6.4.2 Pollutant Export Parameters

As recommended in Water by Design (2010), a “Split Catchment" pollutant export parameter set has been adopted for the residential development as per Table 6-6. Lumped catchment pollutant export parameters have been setup as per Table 6-7.

Table 6-6 Pollutant Export Parameters (Split Catchment Approach) - Water By Design (2010).

Flow Type	Surface Type	TSS log^{10} values		TP log^{10} values		TN log^{10} values	
	Urban Res	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Baseflow Parameters	Roof	N/A	N/A	N/A	N/A	N/A	N/A
	Roads	1.00	0.34	-0.97	0.31	0.20	0.20
	Ground level	1.00	0.34	-0.97	0.31	0.20	0.20
Streamflow Parameters	Roof	1.30	0.39	-0.89	0.31	0.26	0.23
	Roads	2.43	0.39	-0.30	0.31	0.26	0.23

Flow Type	Surface Type	TSS log^{10} values		TP log^{10} values		TN log^{10} values	
	Ground level	2.18	0.39	-0.47	0.31	0.26	0.23

Table 6-7 Pollutant Export Parameters (Lumped Catchment Approach) - Water By Design Guidelines (2010)

Flow Type	Surface Type	TSS log^{10} values		TP log^{10} values		TN log^{10} values	
		Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Commercial	Baseflow	0.78	0.39	-0.60	0.5	0.32	0.30
	Streamflow	2.16	0.38	-0.39	0.34	0.37	0.34

6.4.3 Rainfall and Evapotranspiration Data

The rainfall and evapotranspiration data were sourced from the Bureau of Meteorology (BoM) for Logan City Council (west) representative gauges, being Greenbank Thompson Rd (Station Number 40659) and covered the period from the 1st January 1980 to the 31st December 1989 with 6-minute rainfall data resolution. This is as per that recommended by the MUSIC Modelling Guidelines (2010). Table 6-8 summarises the monthly evapotranspiration data adopted for the MUSIC analysis.

Table 6-8 Evapotranspiration Data (PET) Observed at Greenbank Thompson Rd

Month	Evapotranspiration (mm)
January	181
February	139
March	137
April	102
May	72
June	62
July	63
August	81
September	108
October	138
November	159
December	184

6.4.4 Treatment Nodes

This assessment has considered bioretention systems as the preferred water quality treatment device to service the development. The bioretention basins have conceptually been modelled using MUSIC, the details of which are summarised as follows: -

- No low-flow bypass or high-flow bypass;
- Extended detention depth of 0.3m;
- Saturated hydraulic conductivity of 200 mm/hr;
- Filter depth of 0.5m;
- TN Content of Filter Media of 400 mg/kg;
- Orthophosphate Content of Filter Media of 30 mg/kg;
- Vegetated with effective nutrient removal plans;
- Basin as lined with underdrain present;
- Equal area (surface area and filter media area);
- Weir as 1/10th of surface area; and
- Filter media sizes as outlined in Table 6-9.

Note that coarse sediment forebays were not included in the analysis. As per the Water by Design Bioretention Technical Guidelines (2014), coarse sediment forebays should only be considered for all bioretention basins with a catchment area exceeding 2 ha.

Table 6-9 Bioretention Basin Sizes as Modelled

Sub-Catchment	Filter Media Area (m^2)	Ratio filter media to contributing Catchment (%)
Residential Development	1850	0.66
Childcare (Commercial)	26	0.92

6.5 Results

The MUSIC pollutant load reductions for the design scenario are detailed in Table 6-10 for all bioretention basins represented for the overall site development. The MUSIC results demonstrate that the pollutant load reduction objectives for the site have been achieved for the whole development footprint. The location of the devices is as per that presented in Figure 6-1.

Table 6-10 Pollutant Reduction Outcomes

Catchment	TSS Reduction (%)	TP Reduction (%)	TN Reduction (%)	GP Reduction (%)	Targets Achieved
Residential Development	80.2	70.5	47.7	100	Yes
Childcare (Commercial)	80.3	74.2	50.0	100	Yes

6.6 Summary

The MUSIC analysis documented in this report indicates that the basin sizes proposed for the development effectively mitigates the pollutant loads generated from the entire development site to the SPP pollutant load reduction targets. The water quality analysis completed to date has indicated that water quality targets for the site can readily and practically be achieved.

7 DEVELOPMENT ASSESSMENT COMPLIANCE

7.1 Overview

The site is located within the Logan City Council (LCC) local government area. However, the property is also located within the Greater Flagstone Priority Development Area (PDA) and is administered by Economic Development Queensland (EDQ). EDQ is also the responsible agency for development assessment and compliance relating to any proposed development within the declared PDA areas. As such, the compliance or otherwise for the proposed development will be subject to assessment against the relevant EDQ Guidelines.

An assessment of the compliance of the development in respect to the EDQ Guidelines is outlined separately below.

7.2 Flooding

The requirements for compliance with flooding for the development is outlined in Table 1 of Guideline 15 and is summarised as follows: -

1. The Defined Flood Event (DFE) for Flagstone Creek is as that adopted by the relevant Council for the area. Logan City Council define the DFE as being the 1% AEP event in the Flood Hazard Code (FHC), Logan Planning Scheme 2015 version 2.1;
2. The minimum habitable floor level and freeboard requirements for the development are as required by the relevant Council for the area. The Logan City Council planning document for flooding is the FHC which requires a minimum building floor level of 500mm above the DFE; and
3. Guideline 15 also requires compliance with the Council planning scheme requirements where the scheme has been endorsed by State Government.

In respect to Item 3 above, this necessitates an assessment of the development compliance against the Logan City Council FHC.

Compliance Summary

Key findings of the flood study in regard to the EDQ requirements are as follows: -

- The minimum floor levels at the site are readily achieved as has been outlined in Section 4.5.1; and
- The development has a large buffer and setback distance both laterally and is well above the Flagstone Creek DFE level.

In respect to the flood outcomes having regard to LCC's FHC, the majority of the specific outcomes are met by virtue of the development being well outside the mapped 1% AEP flood extent and with the provision of floor levels that are well above the minimum requirements.

The flood risk and flood evacuation aspects for the development need to be considered and are matters to be addressed as part of the various specific outcomes of the TLPI. It is considered that acceptable solutions will be available for these aspects given: -

- The development is located well above the level of the 1% AEP flood event;
- The development does not propose a significant flood risk or an isolated community which would otherwise be cut-off by flood waters and access is provided to the south and to areas of higher topography;

- Any flooding in Flagstone Creek will be relatively short in duration given the shorter time of concentration associated with the limited catchment area (as opposed to a much longer Logan River flood event); and
- There is no increase in the number of premises or infrastructure at risk from flooding in the 1% AEP event. In this regard, all proposed infrastructure associated with the development is located outside of the 1% AEP flood extent.

A review of the LCC FHC specific outcomes has been undertaken and is summarised in Table 7-1. Detailed responses to Council's Flood Hazard Overlay Code are also provided in Appendix F.

Table 7-1 Summary of Flood Hazard Overlay Code

Specific Outcome	Assessment and Comments
PO1	Building floor level requirements as outlined in Item 1 above.
PO2	No increase to the level of risk or evacuation
PO3	Development is above the DFE
PO4	No medium or high impact industry, or hazardous materials at the site
PO5	No car parking proposed below the DFE
PO6	All community infrastructure and uses are located to above the DFE
PO7	No loss of floodplain storage or conveyance
PO8	No adverse flood impacts to adjoining properties
PO9	No adverse flood impacts to adjoining properties
PO10	No loss of floodplain storage
PO11	No adverse changes to flood characteristics likely with provision of stormwater detention infrastructure
PO12	Stormwater quality devices located above 2% AEP regional flood level
PO13	Stormwater quantity devices located above 2% AEP and no change to floodplain storage
PO14	No filling or excavation below the 10% AEP
PO15	Vehicular access is proposed to above the DFE
PO16	Access areas provided

7.3 Stormwater Quantity / Peak Flow Management

The Greater Flagstone Development Scheme (GFDS) defines community safety and development constraint objectives and in respect to on-site management of stormwater quantity is stated as follows: -

> *"development ensures that stormwater run off at the site's boundary does not exceed that which presently exists and there is 'no net worsening' of flood conditions at the site's boundary".*

This requirement will ordinarily necessitate the use of on-site stormwater management measures to be incorporated into the development. In respect to stormwater quantity, this will typically involve the use of on-

site detention for the purposes of mitigating peak flows from the development to match with pre-development conditions.

Compliance Summary

In respect to the compliance requirements for stormwater management from the site (water quantity), it is considered that an acceptable solution is provided as: -

- The peak flow analysis of Flagstone Creek has indicated that provision of stormwater detention for the northern catchment is not required due to the timing of coincidence of peak flows in Flagstone Creek.

7.3.1 Water Quality

The requirements for compliance with stormwater quality for the development are outlined in Guideline 14 under Environmental Values and Strategies and is stated as follows: -

> *"Water discharge to on-site and adjacent water systems (freshwater, estuarine and marine) must meet water quality standards under current Queensland legislation."*

The references nominated for compliance to the requirement refer to the State Planning Policy (SPP) 4/10 : Healthy Waters. However, SPP 4/10 has since been replaced as part of the Queensland Government establishing a new SPP in July 2017. The latest revision of the SPP (July 2017) has now replaced multiple state planning policies and accordingly is the current standard on which water quality compliance is assessed.

The water quality design objectives as outlined in Appendix 2, Table B of the SPP include: -

- 80% minimum Total Suspended Solids (TSS) reduction in mean annual load from unmitigated development;
- 60% minimum Total Phosphorus (TP) reduction in mean annual load from unmitigated development;
- 45% minimum Total Nitrogen (TN) reduction in mean annual load from unmitigated development; and
- 90% minimum Gross Pollutant (GP) reduction in mean annual load from unmitigated development.

Further to the above points, the SPP includes a waterway stability management design objective of limiting the peak 1-year ARI event discharge within the receiving waterway to the pre-development peak 1-year ARI peak discharge.

Compliance Summary

The water quality analysis outlined in Section 6 of this report has demonstrated that the pollutant reduction design objectives outlined in the SPP can be achieved through the provision of bioretention systems.

In respect to limiting peak discharge of the 1-year ARI event within the receiving waterway, the analysis outlined in Section 5.2 of this report has demonstrated that there will be no fundamental change in peak discharge for the 1-year ARI event in Flagstone Creek as a result of the development. Note that suitable stabilisation works around any concentrated discharge points from the development will still be required to ensure suitable armouring and/or stabilisation to mitigate against any localised changes to flow conditions (i.e. erosion and scour potential).

8 CONCLUSION

Water Technology Pty Ltd (Water Technology) has been commissioned by Orchard (No. 10 Developments Pty Ltd (Orchard) to prepare a Stormwater Management Plan and Flood Assessment for a proposed residential development located immediately South of Mountain Ridge Road, South MacLean (real property description Lot 30 on SP309195) (The Site).

The site is located within the Logan City Council (LCC) local government area. However, the property is also located within the Greater Flagstone Priority Development Area (PDA) and is administered by Economic Development Queensland (EDQ). EDQ replaced the former Urban Land Development Authority (ULDA) and facilitates planning in areas which are declared as provisional or priority development areas, for which the subject property is located. EDQ is also the responsible agency for development assessment and compliance relating to any proposed development within the declared PDA areas.

The proposed development consists of residential development comprising approximately 517 individual lots and a child care centre and includes roads, park, drainage reserves and other related infrastructure provisions necessary to support the proposed development. This report provides a consolidated technical report covering all aspects of the site relating to flood and stormwater management.

A range of technical assessments have been prepared and are discussed as part of this report to support considerations of flooding and stormwater management for the development. This has included a number of WBNM hydrological models, TUFLOW hydraulic models as well as MUSIC models to demonstrate a compliant development outcome can be achieved for the site.

To support the proposed site development and to achieve compliance with the development guidelines in respect to flooding and stormwater management, the following summary is provided in respect to the development of the site: -

- Stormwater Quality: -
  - The basin sizes proposed for the development effectively mitigates the pollutant loads generated from the entire development site to the SPP pollutant load reduction targets, being multiple bioretention basins sized for the respective contributing catchment;
- Flood Assessment: -
  - The flood assessment has demonstrated that the site can readily comply with the stated LCC requirements in respect to flooding as follows: -
    - No works are being conducted within the defined flood extent and there will be no adverse flood impacts.
    - Design flood level provisions to the development can be readily demonstrated.
- Stormwater Quantity: -
  - In relation to discharge from the site to Flagstone Creek, the following is noted: -
    - The change in fraction imperviousness and catchment re-directions have no resulted in an increase in peak flow in the receiving waterway; and
    - Accordingly, the identified strategy that can be supported and is therefore recommended for the site is one that excludes on-site detention.

On the basis of the technical assessments prepared in respect to flooding and stormwater aspects for the proposed development, and on the basis of the development compliance assessment documented in this report, we believe that the development can be readily supported and approved subject to reasonable and relevant conditions.

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX A
REGIONAL WBNM SUB-CATCHMENT IMPERVIOUS AREAS

Sub-Catchment Name	Sub-Catchment Area (ha)	Existing Case Fraction Impervious (%)	Ultimate Case Fraction Impervious (%)
R1	183.35	0.00	0.00
R10	34.14	0.00	0.00
R11	43.15	0.00	0.00
R2	371.18	0.00	12.17
R9	173.16	0.00	0.00
R3	285.78	0.00	55.12
R12	94.87	0.00	82.97
R4	157.59	0.00	84.99
R5	164.56	0.00	85.00
R8	28.39	0.00	77.11
R6	164.75	16.23	56.60
R7	64.76	0.00	51.38
S1	277.25	0.00	0.00
S2	120.07	0.00	20.77
S3	47.41	0.00	0.00
S4	156.35	0.00	53.52
S5	156.68	0.00	1.91
S6	345.88	0.00	70.38
S7	161.04	0.00	79.55
S8	574.12	0.00	78.04
S9	99.56	0.00	85.00
S10	323.34	0.00	85.00
S10b	89.67	0.00	85.00
S11	236.30	20.20	29.56
S12	339.29	19.63	31.19
S13	176.42	11.84	33.04
S14	64.25	22.71	22.71
S15	23.32	18.99	18.99
S16	57.44	4.25	4.25
DS1	110.87	19.82	19.82
DS2	44.90	0.00	1.40
DS3	46.32	0.00	0.00
DS4	43.19	1.92	1.92
DS6	17.86	19.79	19.80
DS5	40.46	4.34	4.34
DS7	135.38	7.67	7.67
DS8	44.17	0.00	0.03
DS9	54.08	0.00	0.00
DS10	30.06	0.00	0.00

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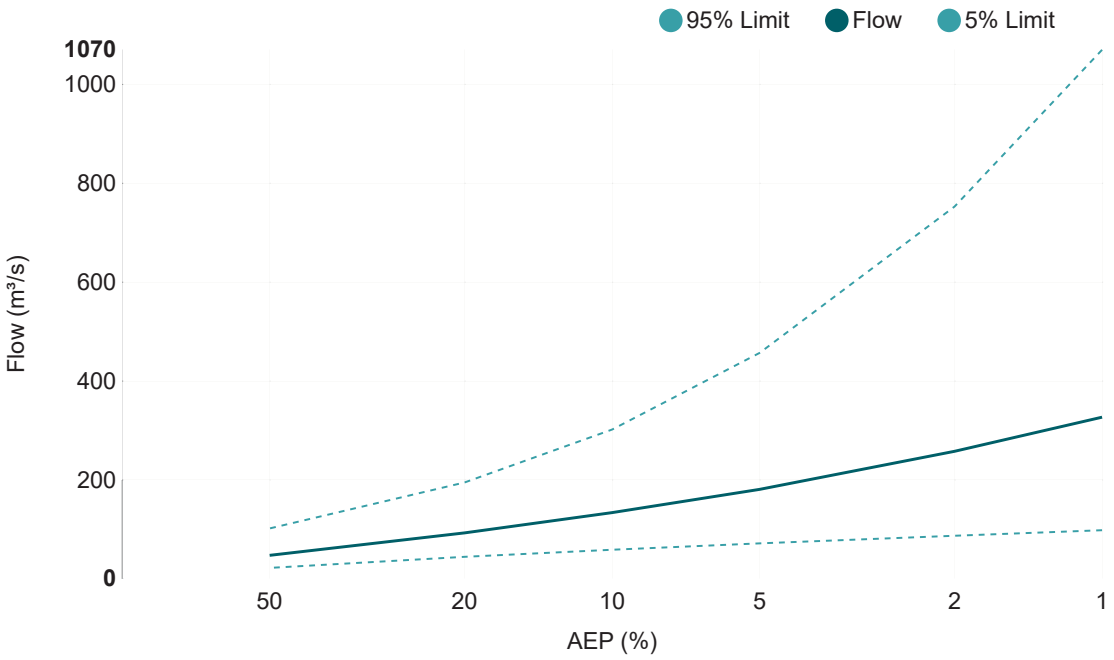
APPENDIX B
ARR16 REGIONAL FLOOD FREQUENCY ESTIMATION RESULTS

2019 Estimate - At Confluence with Logan River

Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	47.6	22.2	102
20	93.0	44.6	195
10	134	58.9	302
5	181	71.8	457
2	258	87.2	753
1	327	98.4	1070

Statistics

Variable	Value	Standard Dev
Mean	3.887	0.472
Standard Dev	0.687	0.312
Skew	0.111	0.030

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

Correlation

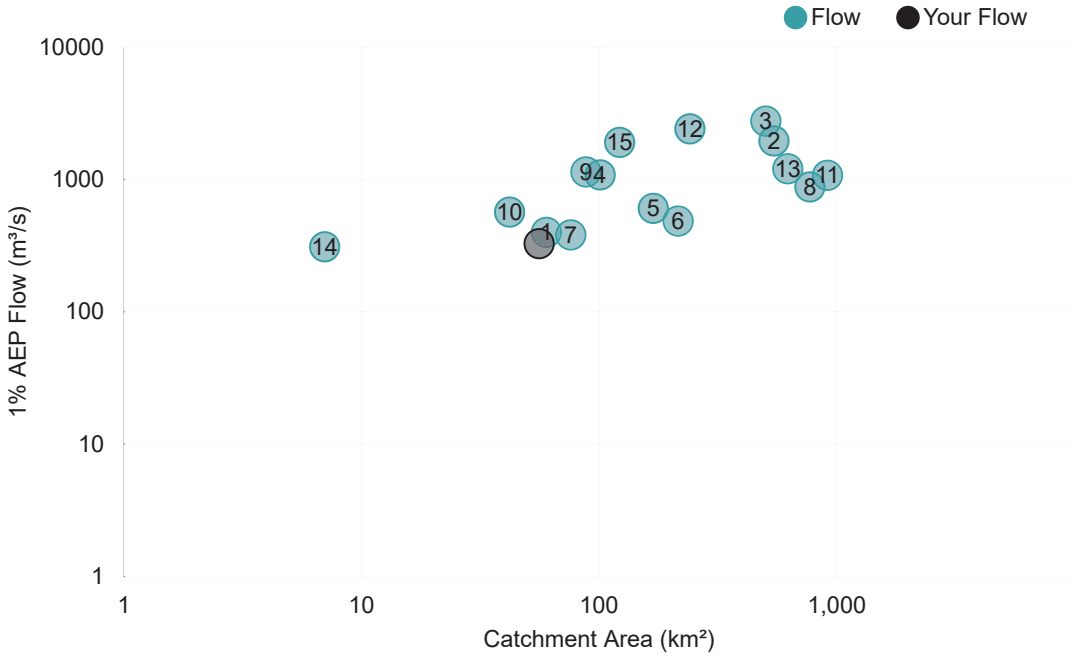
2019 Estimate - At Confluence with Logan River

Correlation

1.000		
-0.330	1.000	
0.170	-0.280	1.000

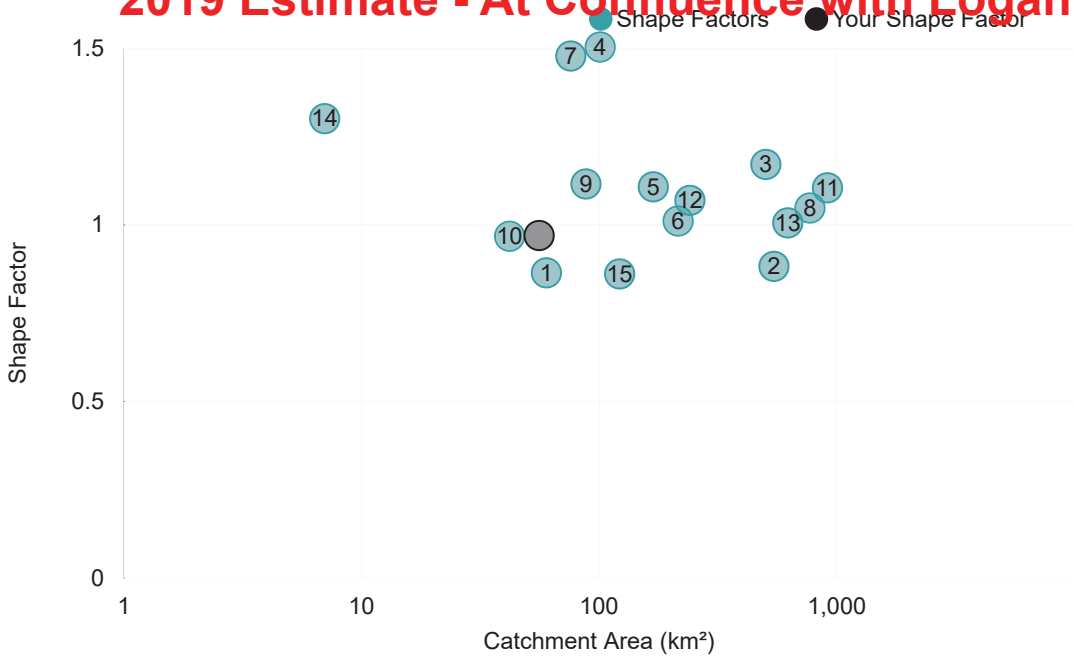
Note: These statistics are common to each region. Details.

1% AEP Flow vs Catchment Area

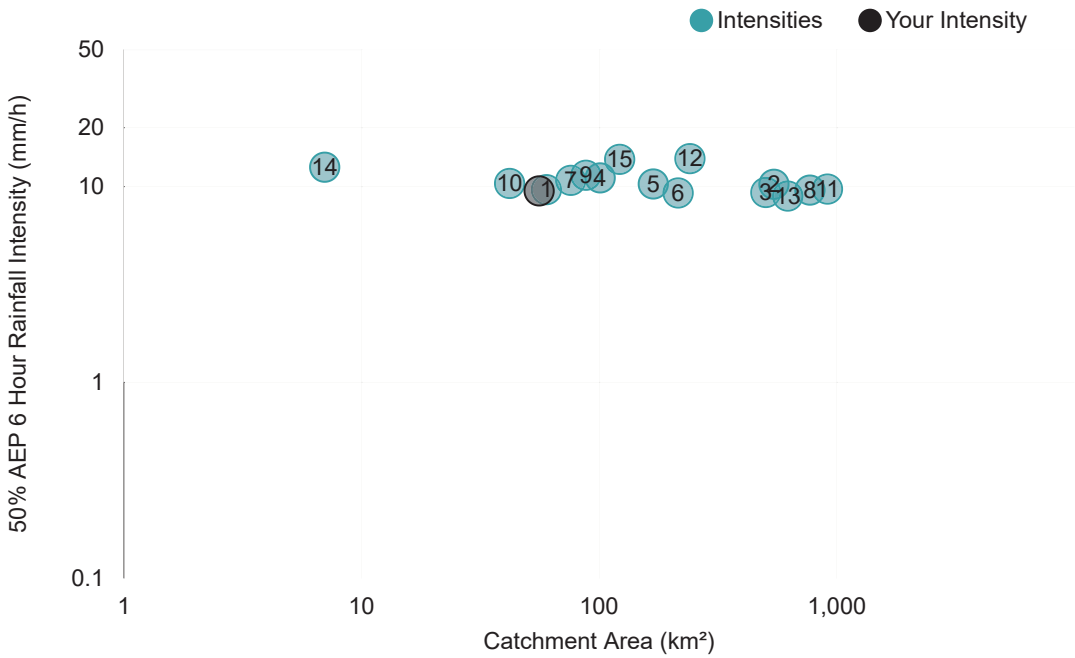


Shape Factor vs Catchment Area

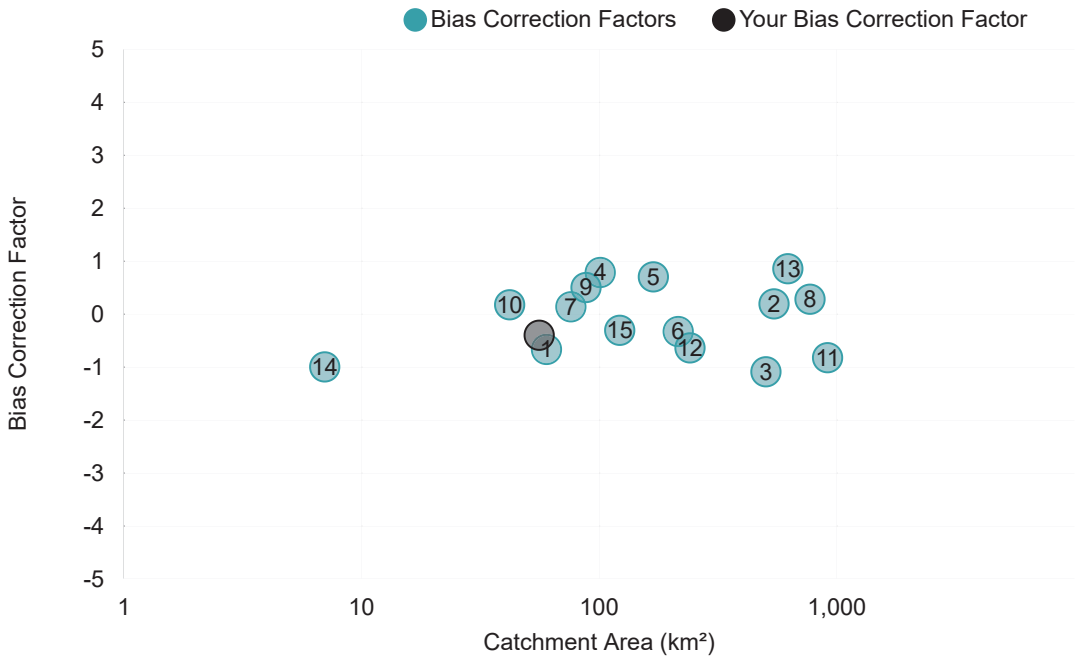
2019 Estimate - At Confluence with Logan River



Intensity vs Catchment Area



Bias Correction Factor vs Catchment Area



Download

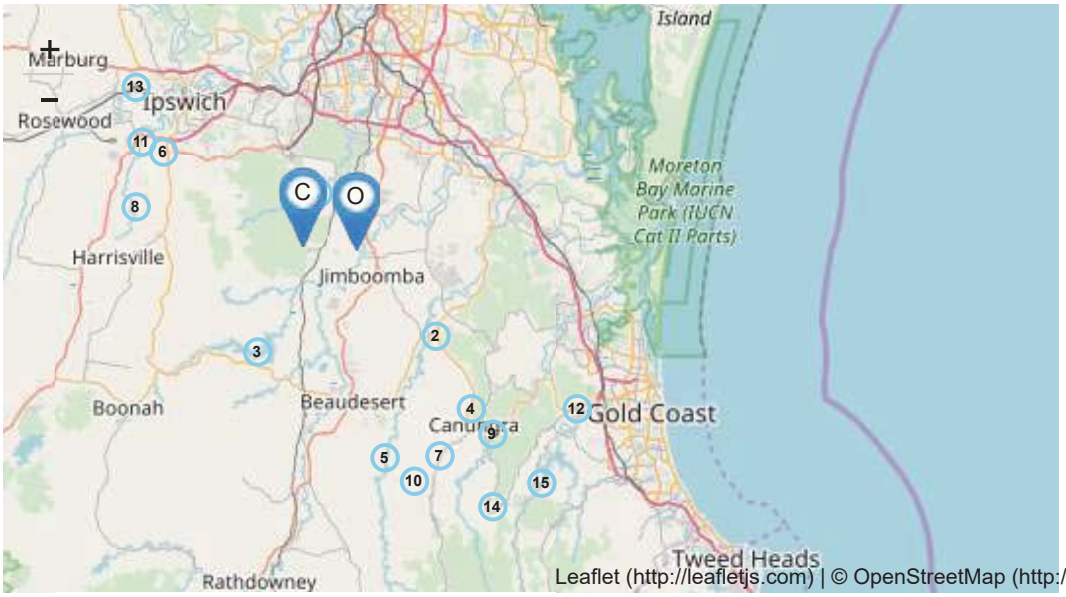
TXT Nearby JSON

Input Data

Date/Time	2019-02-01 16:14
Catchment Name	Flagstone
Latitude (Outlet)	-27.80155
Longitude (Outlet)	153.00075
Latitude (Centroid)	-27.79686
Longitude (Centroid)	152.92758
Catchment Area (km^2)	55.91
Distance to Nearest Gauged Catchment (km)	9.51
50% AEP 6 Hour Rainfall Intensity (mm/h)	9.510325
2% AEP 6 Hour Rainfall Intensity (mm/h)	22.859518
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast

Input Data

Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.97
Interpolation Method	Natural Neighbour
Bias Correction Value	-0.398



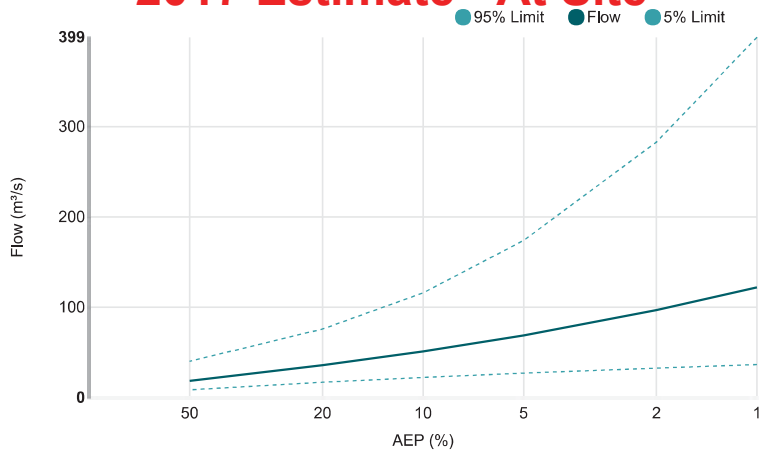
Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project. Full description of the project can be found at the project page (http://arr.ga.gov.au/revision-projects/project-list/projects/project-5) on the ARR website. Send any questions regarding the method or project here (mailto:admin@arr-software.org).

ENGINEERS AUSTRALIA (http://www.engineersaustralia.org.au)

WESTERN SYDNEY UNIVERSITY (http://www.uws.edu.au)

Results | Regional Flood Frequency Estimation Model

2017 Estimate - At Site



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	18.7	8.70	40.3
20	35.9	17.1	76.0
10	51.1	22.4	116
5	68.8	27.2	174
2	96.9	32.7	283
1	122	36.7	399

Statistics

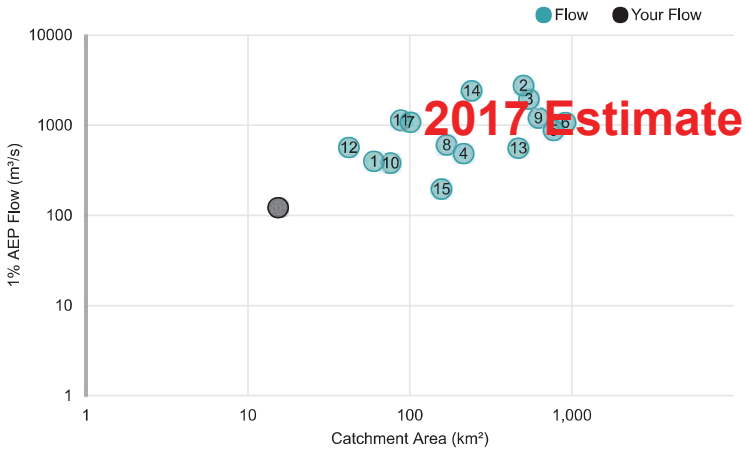
Variable	Value	Standard Dev
Mean	2.983	0.472
Standard Dev	0.687	0.312
Skew	0.111	0.030

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

Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

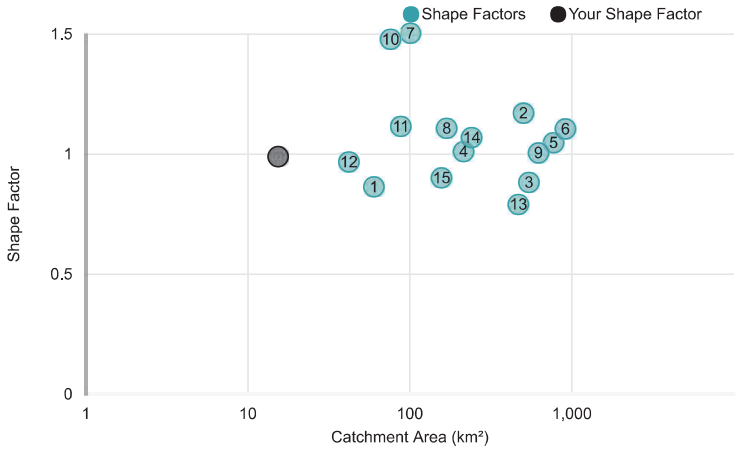
Note: These statistics are common to each region. Details.

1% AEP Flow vs Catchment Area

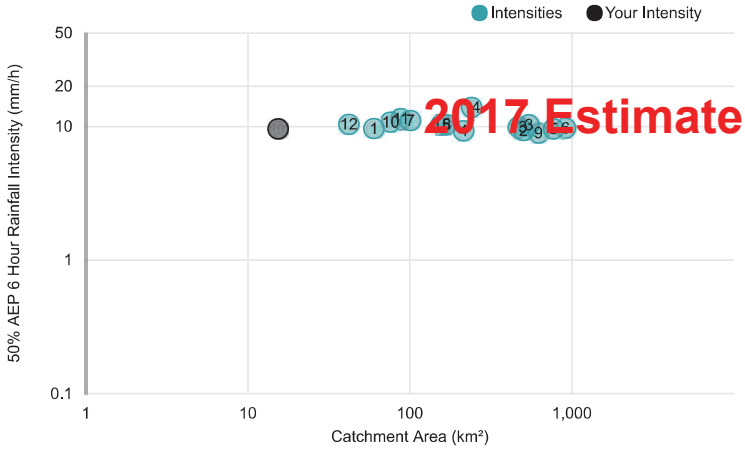


2017 Estimate - At Site

Shape Factor vs Catchment Area

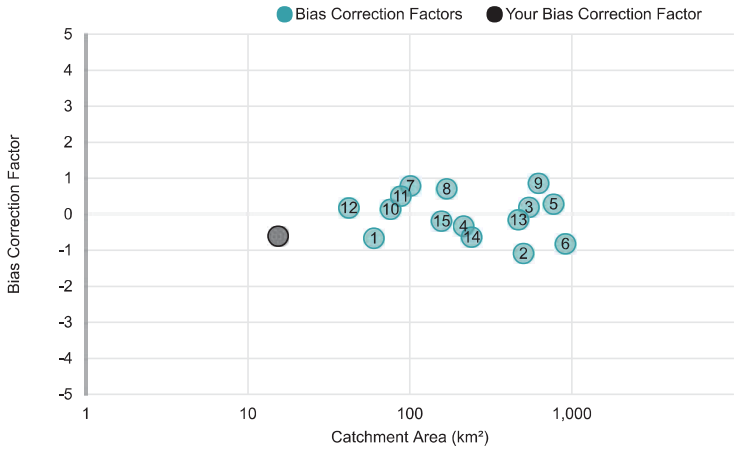


Intensity vs Catchment Area



2017 Estimate - At Site

Bias Correction Factor vs Catchment Area



Download

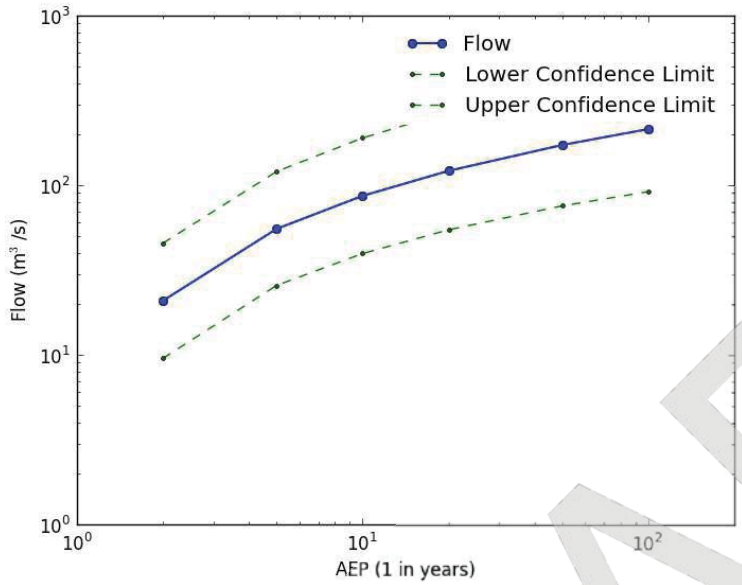
TXT PDF Nearby JSON

Input Data

Date/Time	2017-08-17 11:50

2014 Estimate - At Site

RESULTS - AUSTRALIAN REGIONAL FLOOD FREQUENCY MODEL



AEP (1 in years)	Flow (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
2	20.8	9.5	45.5
5	55.3	25.7	120.4
10	86.6	39.5	189.8
20	121.5	54.6	270.4
50	172.6	75.6	394.3
100	214.2	91.5	497.9

Input Data

Date and Time	Jul 15, 2014, 16:30:48
Catchment Name	230 Mountain Ridge Rd
Latitude	-27.793
Longitude	152.969
Catchment Area (sq km)	16.7
Distance to Nearest Gauged Catchment (km)	18.6
2y12h Rainfall Intensity (mm/h)	7.28
Rainfall Intensity Source (User/Auto)	Auto
Region	VIC + NSW + ACT + QLD
Region Version	0.1
Region Source (User/Auto)	Auto

CAUTION: THIS METHOD IS STILL UNDER DEVELOPMENT AND MUST NOT BE USED IN PRACTICE.

Method by Dr Ataur Rahman and Khaled Haddad from the University of Western Sydney for the Australian Rainfall and Runoff Project. Full project description of the project can be found here.

This method was made possible by financial support from DCCEE.

This document generated with software written by Peter Stensmyr at WMAwater 2012.

2014 Estimate - At Site

RESULTS FROM AUSTRALIAN REGIONAL FLOOD FREQUENCY MODEL ANALYSIS: ARR2012 METHOD - VERSION 0.1 ALPHA

Date: Jul 15, 2014, 16:30:48

Catchment name: 230 Mountain Ridge Rd

Latitude: -27.793

Longitude: 152.969

Catchment area (sq km): 16.710

Distance to nearest gauged catchment (km): 18.625

2 year 12 hour design rainfall intensity (mm/h): 7.275

Rainfall intensity source (User/Auto): Auto

Region: 1 (VIC + NSW + ACT + QLD)

Region version: 0.1

Region source (User/Auto): Auto

ESTIMATED FLOOD QUANTILES:

AEP (1 in y) Expected quantiles (m^3/s) 5% CL (m3^s) 95% CL (m3^s)

2 20.85 9.53 45.53

5 55.28 25.66 120.42

10 86.55 39.54 189.77

20 121.52 54.56 270.39

50 172.61 75.56 394.27

100 214.17 91.50 497.86

DATA FOR FITTING MULTI-NORMAL DISTRIBUTION FOR BUILDING CONFIDENCE LIMITS:

Mean (loge flow): 2.920

St dev (loge flow): 1.277

Skew (loge flow): -0.557

MOMENTS AND CORRELATIONS:

No Most probable Std dev Correlation

1 2.920 0.472 1.000

1 1.277 0.194 -0.210 1.000

1 -0.557 0.178 -0.040 -0.410 1.000

CAUTION: These results are for test purpose only and must not be used in design/practice!

APPENDIX C
LOGAN CITY COUNCIL PROPERTY FLOOD CERTIFICATES

Your Ref: 3533-03
Enquiry Phone: Ms N Bird (07) 3412 5282
Please Quote File: 1053557-1
Document Reference: 11287035/BirdN:MartinAs

LOGAN
CITY COUNCIL

29 August 2017

150 Wembley Road
Logan Central QLD 4114
PO Box 3226 Logan City DC QLD 4114

Council enquiries **07 3412 3412**
Email **council@logan.qld.gov.au**
Web **www.logan.qld.gov.au**
ABN 21 627 796 435

Greg Hansell
L3 43 Peel St
SOUTH BRISBANE QLD 4101

Dear Sir/Madam

Updated to Lot 30 SP309195 from February 2019

APPLICATION FOR PROPERTY INFORMATION - FLOODING
LOCATED AT: 176-228 MOUNTAIN RIDGE ROAD, SOUTH MACLEAN
PROPERTY DESCRIPTION: LOT 3 RP 133386

Thank you for your enquiry requesting information on the above property. Investigation shows that the property is identified as being at risk of flooding in a one percent Annual Exceedance Probability (AEP) flood event.

Table 1: Defined Flood Level for Property

Defined Flood Event	Flood level (m) Australian Height Datum
one percent AEP	29.32

The defined flood level in Table 1 has been compiled from the best available information presently available to Council and is in accordance with the Logan Planning Scheme 2015, Part 8 Overlays – 8.2.5 Flood hazard overlay code.

Council is required by State Legislation to identify and appropriately manage areas at risk of flooding. The Logan City Planning Scheme 2015 and the Flood Hazard Overlay effectively achieve this legislative requirement.

The flood overlay is based on a modelled flood event with a one percent (1 in 100) chance of being equalled or exceeded in any given year. This is known as one percent AEP. This is generally the standard used in assessment of development applications and building applications throughout South-East Queensland.

Please be aware, the flood levels and maps do not necessarily indicate flooding of properties in past events.

Changes to the topography and condition of the local creeks and waterways may alter the effects of flooding. In addition, further technical studies may be carried out in the future which may affect the advice provided in this letter. Consequently, there is no warranty given to the accuracy of this information.

Furthermore, you are advised that a development application under the *Sustainable Planning Act 2009* for development within the flooding area must also provide details in accordance with the provision of Council's local planning instruments and local laws. A copy of Council's policy, local planning instruments and local laws relevant to the advice are available from Council's Administration Centre or visit www.logan.qld.gov.au.

NOTE: Flood searches are valid for a period of six (6) months from date of issue.

If you have any further enquiries on this matter or require clarification, please do not hesitate to contact Council's Flood Management Officer, Ms Nardine Bird, on (07) 3412 5282.

Yours faithfully

William Prentice
River & Catchment Engineering Program Leader

Your Ref: 3533-03
Enquiry Phone: Ms N Bird (07) 3412 5282
Please Quote File: 846792-1
Document Reference: 11287036/BirdN:LynessJ

29 August 2017

LOGAN CITY COUNCIL

150 Wembley Road
Logan Central QLD 4114
PO Box 3226 Logan City DC QLD 4114

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Web **www.logan.qld.gov.au**
ABN 21 627 796 435

Greg Hansell
L3 43 Peel St
SOUTH BRISBANE QLD 4101

Dear Sir/Madam

APPLICATION FOR PROPERTY INFORMATION - FLOODING
LOCATED AT: 230 MOUNTAIN RIDGE ROAD, SOUTH MACLEAN
PROPERTY DESCRIPTION: LOT 6 RP 193185

Thank you for your enquiry requesting information on the above property. Investigation shows that the property is identified as being at risk of flooding in a one percent Annual Exceedance Probability (AEP) flood event.

Table 1: Defined Flood Level for Property

Defined Flood Event	Flood level (m) Australian Height Datum
one percent AEP	31.1

The defined flood level in Table 1 has been compiled from the best available information presently available to Council and is in accordance with the Logan Planning Scheme 2015, Part 8 Overlays – 8.2.5 Flood hazard overlay code.

Council is required by State Legislation to identify and appropriately manage areas at risk of flooding. The Logan City Planning Scheme 2015 and the Flood Hazard Overlay effectively achieve this legislative requirement.

The flood overlay is based on a modelled flood event with a one percent (1 in 100) chance of being equalled or exceeded in any given year. This is known as one percent AEP. This is generally the standard used in assessment of development applications and building applications throughout South-East Queensland.

Please be aware, the flood levels and maps do not necessarily indicate flooding of properties in past events.

Changes to the topography and condition of the local creeks and waterways may alter the effects of flooding. In addition, further technical studies may be carried out in the future which may affect the advice provided in this letter. Consequently, there is no warranty given to the accuracy of this information.

Furthermore, you are advised that a development application under the *Sustainable Planning Act 2009* for development within the flooding area must also provide details in accordance with the provision of Council's local planning instruments and local laws. A copy of Council's policy, local planning instruments and local laws relevant to the advice are available from Council's Administration Centre or visit www.logan.qld.gov.au.

NOTE: Flood searches are valid for a period of six (6) months from date of issue.

If you have any further enquiries on this matter or require clarification, please do not hesitate to contact Council's Flood Management Officer, Ms Nardine Bird, on (07) 3412 5282.

Yours faithfully

William Prentice
River & Catchment Engineering Program Leader

Your Ref: 3533-03
Enquiry Phone: Ms N Bird (07) 3412 5282
Please Quote File: 1019259-1
Document Reference: 11287011/BirdN:LynessJ

29 August 2017

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ABN 21 627 796 435

Greg Hansell
L3 43 Peel St
SOUTH BRISBANE QLD 4101

Dear Sir/Madam

APPLICATION FOR PROPERTY INFORMATION - FLOODING
LOCATED AT: LOT 9 PAULA ROAD, SOUTH MACLEAN
PROPERTY DESCRIPTION: LOT 9 SP 203507

Thank you for your enquiry requesting information on the above property. Investigation shows that the property is identified as being at risk of flooding in a one percent Annual Exceedance Probability (AEP) flood event.

Table 1: Defined Flood Level for Property

Defined Flood Event	Flood level (m) Australian Height Datum
one percent AEP	34.48

The defined flood level in Table 1 has been compiled from the best available information presently available to Council and is in accordance with the Logan Planning Scheme 2015, Part 8 Overlays – 8.2.5 Flood hazard overlay code.

Council is required by State Legislation to identify and appropriately manage areas at risk of flooding. The Logan City Planning Scheme 2015 and the Flood Hazard Overlay effectively achieve this legislative requirement.

The flood overlay is based on a modelled flood event with a one percent (1 in 100) chance of being equalled or exceeded in any given year. This is known as one percent AEP. This is generally the standard used in assessment of development applications and building applications throughout South-East Queensland.

Please be aware, the flood levels and maps do not necessarily indicate flooding of properties in past events.

Changes to the topography and condition of the local creeks and waterways may alter the effects of flooding. In addition, further technical studies may be carried out in the future which may affect the advice provided in this letter. Consequently, there is no warranty given to the accuracy of this information.

Furthermore, you are advised that a development application under the *Sustainable Planning Act 2009* for development within the flooding area must also provide details in accordance with the provision of Council's local planning instruments and local laws. A copy of Council's policy, local planning instruments and local laws relevant to the advice are available from Council's Administration Centre or visit www.logan.qld.gov.au.

NOTE: Flood searches are valid for a period of six (6) months from date of issue.

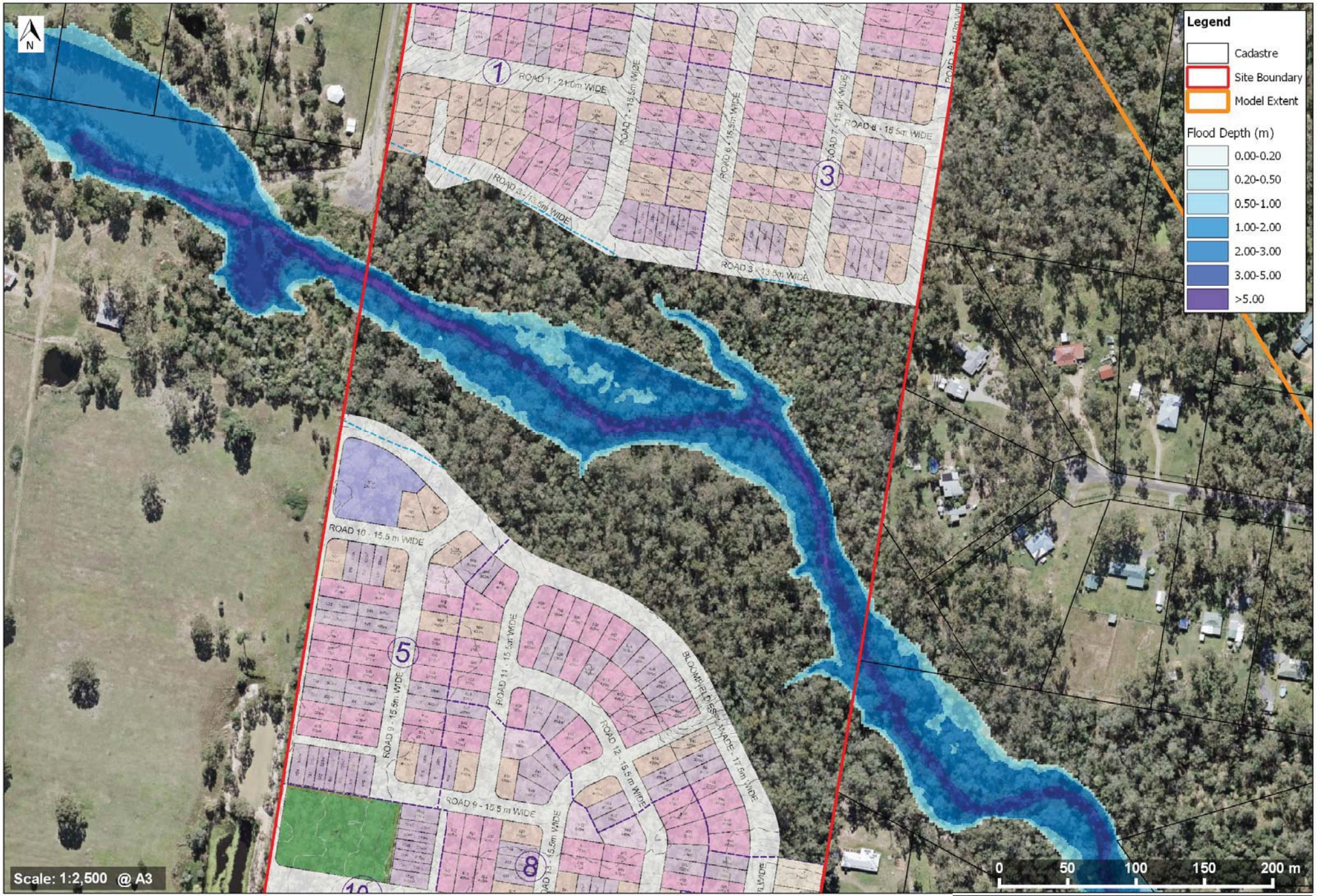
If you have any further enquiries on this matter or require clarification, please do not hesitate to contact Council's Flood Management Officer, Ms Nardine Bird, on (07) 3412 5282.

Yours faithfully

William Prentice
River & Catchment Engineering Program Leader

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX D
ULTIMATE CASE SCENARIO GIS FLOOD MAPS

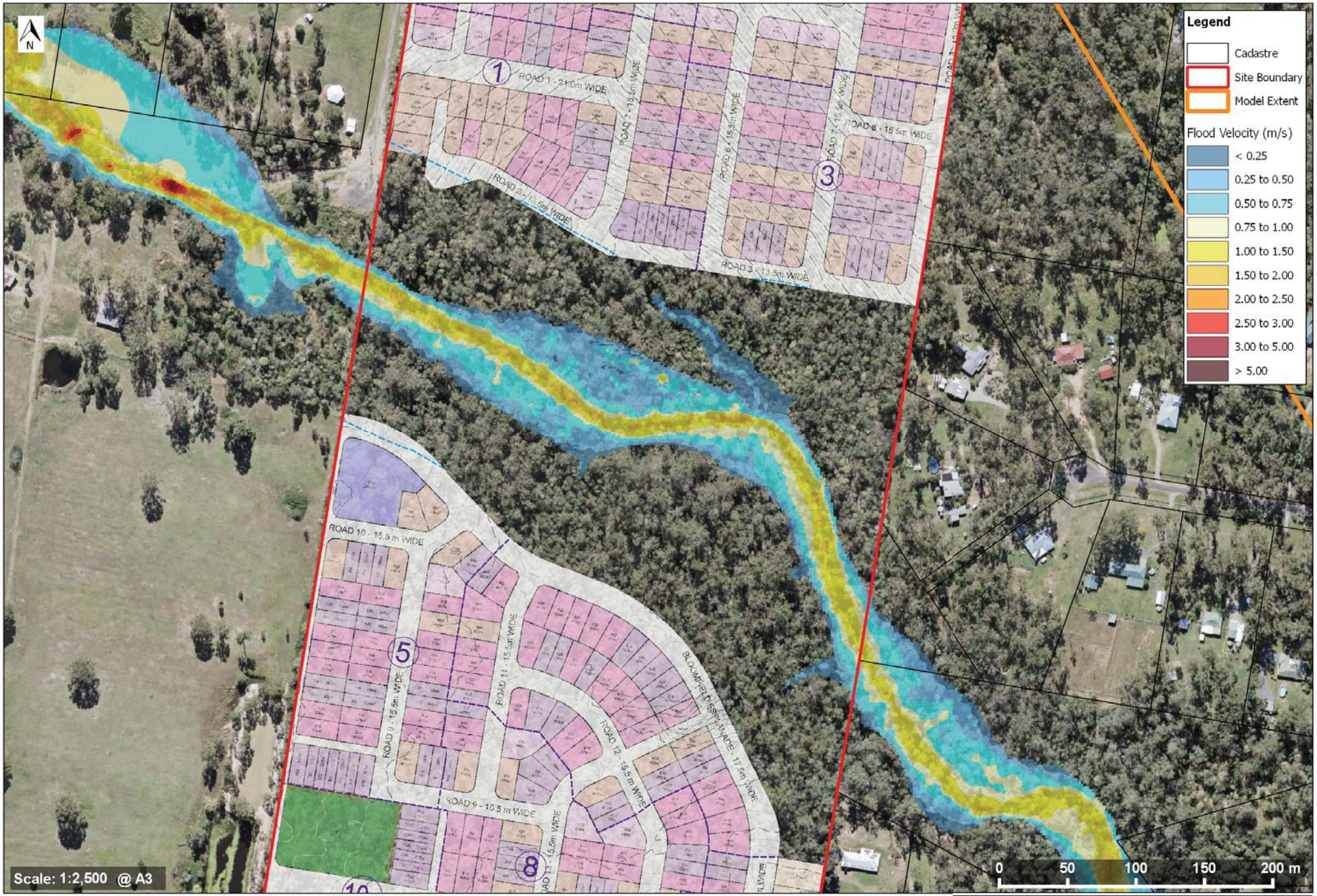


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
10% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Depth

WATER TECHNOLOGY

2019-08-15T04:35:34



Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
10% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Velocity

WATER TECHNOLOGY

2019-08-15T04:36:09

Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
10% AEP 120 minute - Ultimate Landuse Conditions - Peak Water Surface Level

WATER TECHNOLOGY

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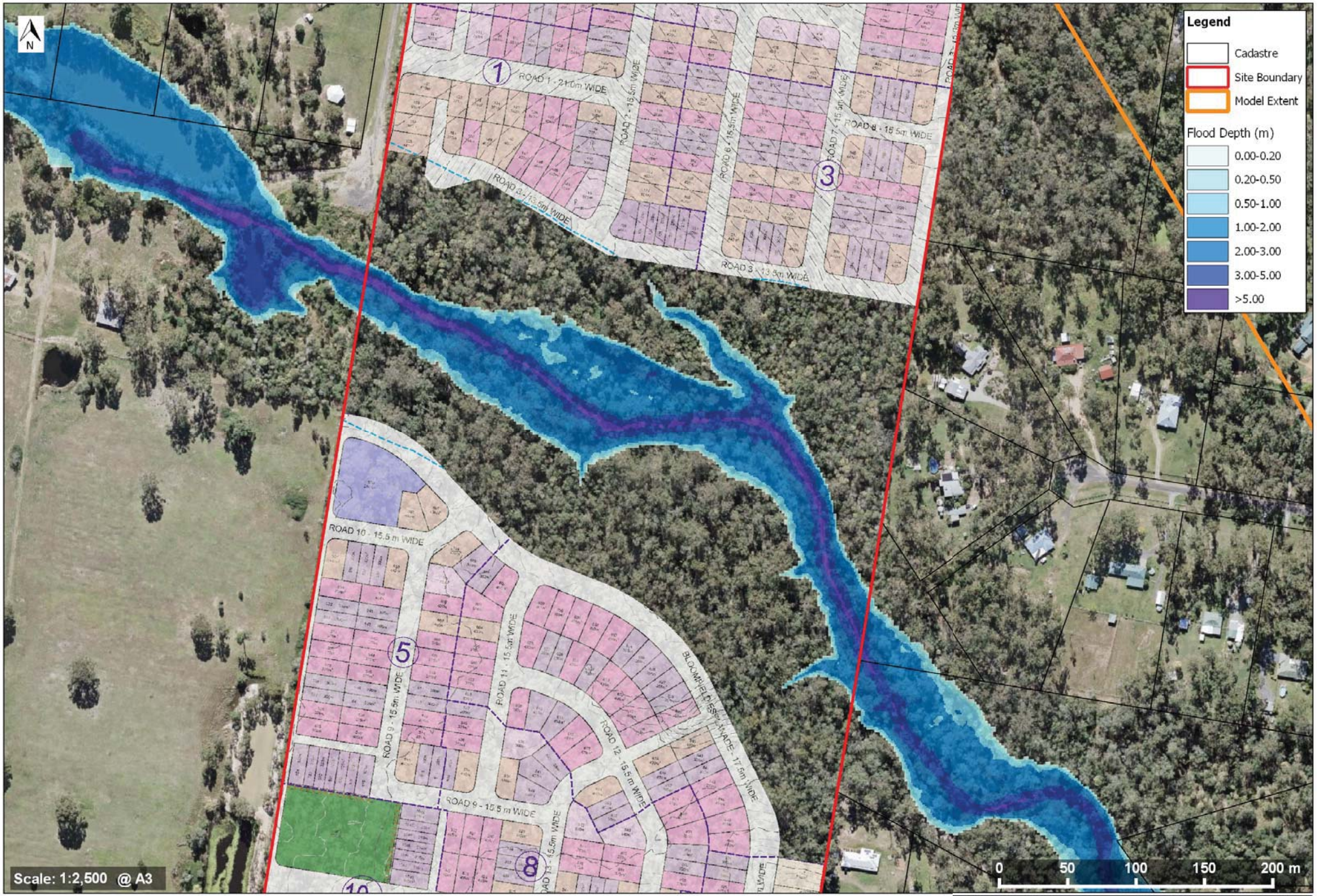

Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
5% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Depth

WATER TECHNOLOGY

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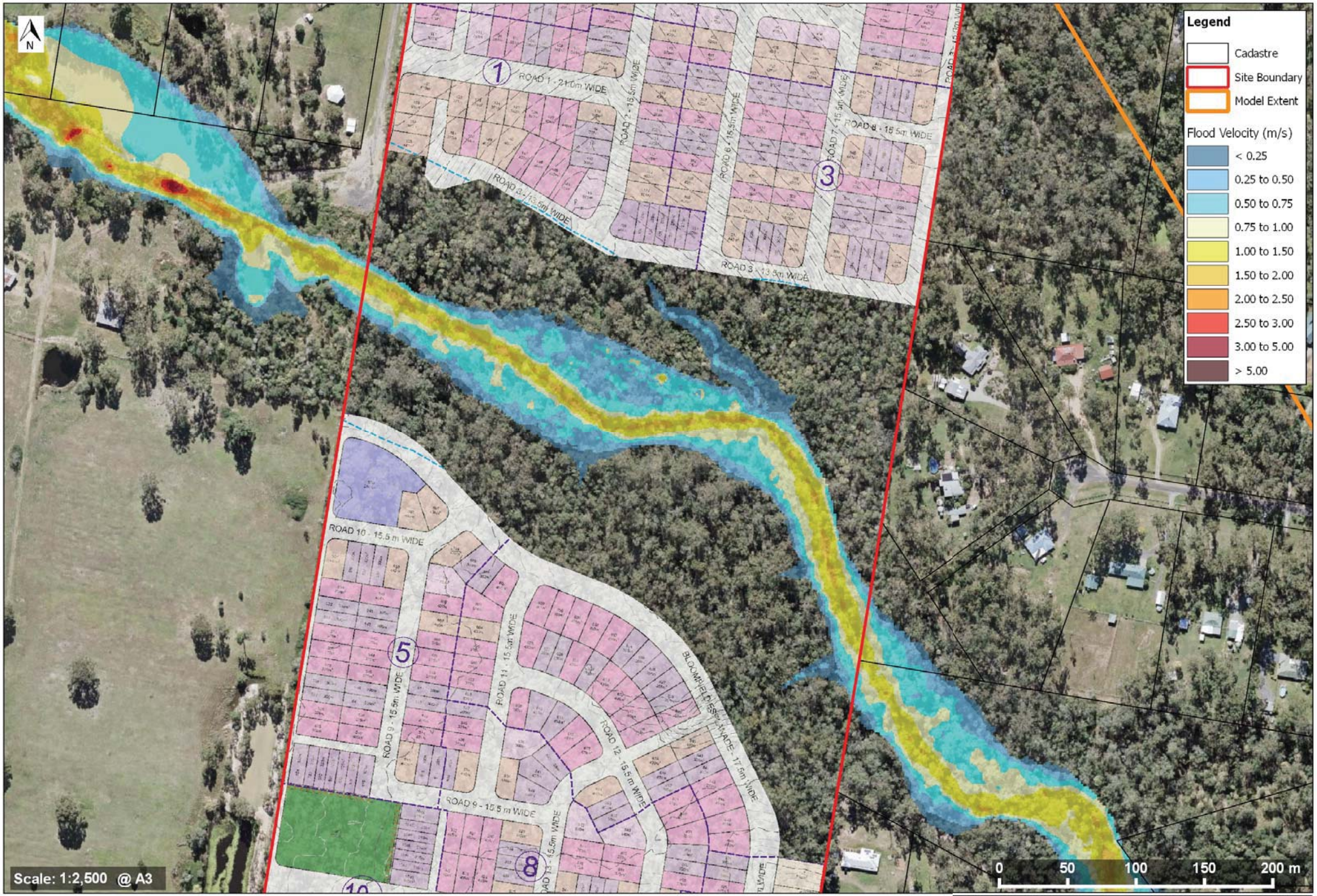
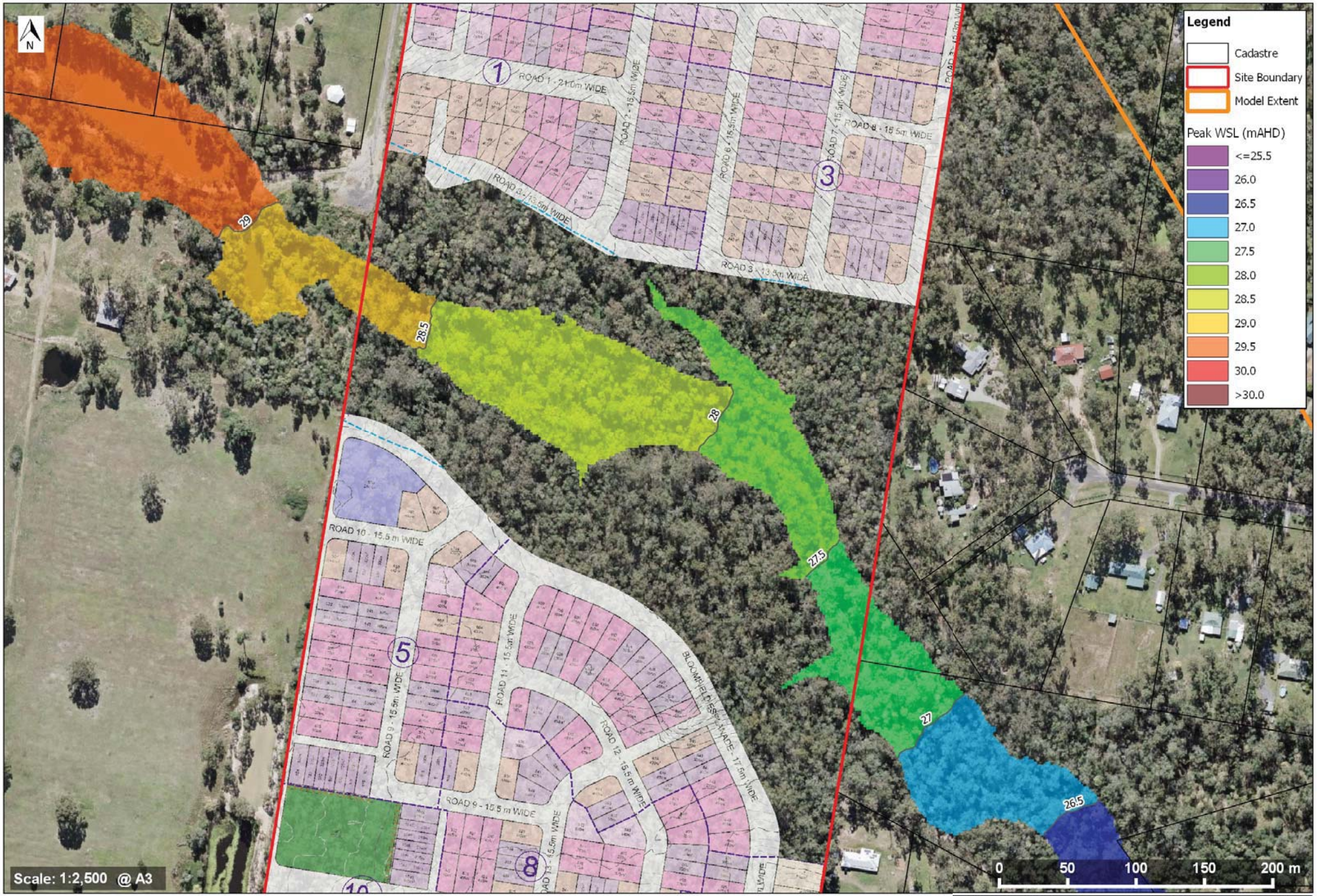


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
5% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Velocity

WATER TECHNOLOGY

2019-08-15T04:32:03



Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
5% AEP 120 minute - Ultimate Landuse Conditions - Peak Water Surface Level

WATER TECHNOLOGY

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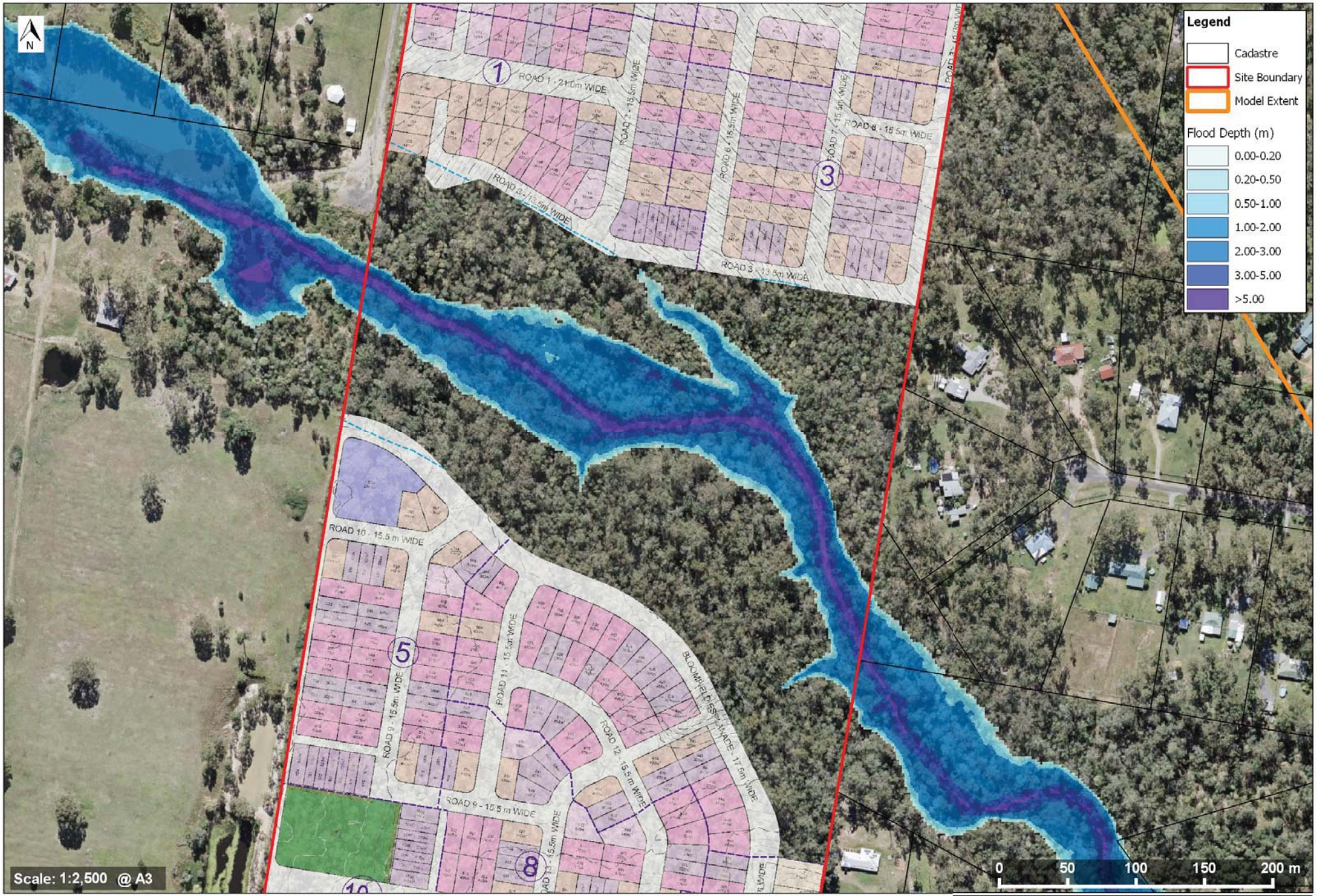
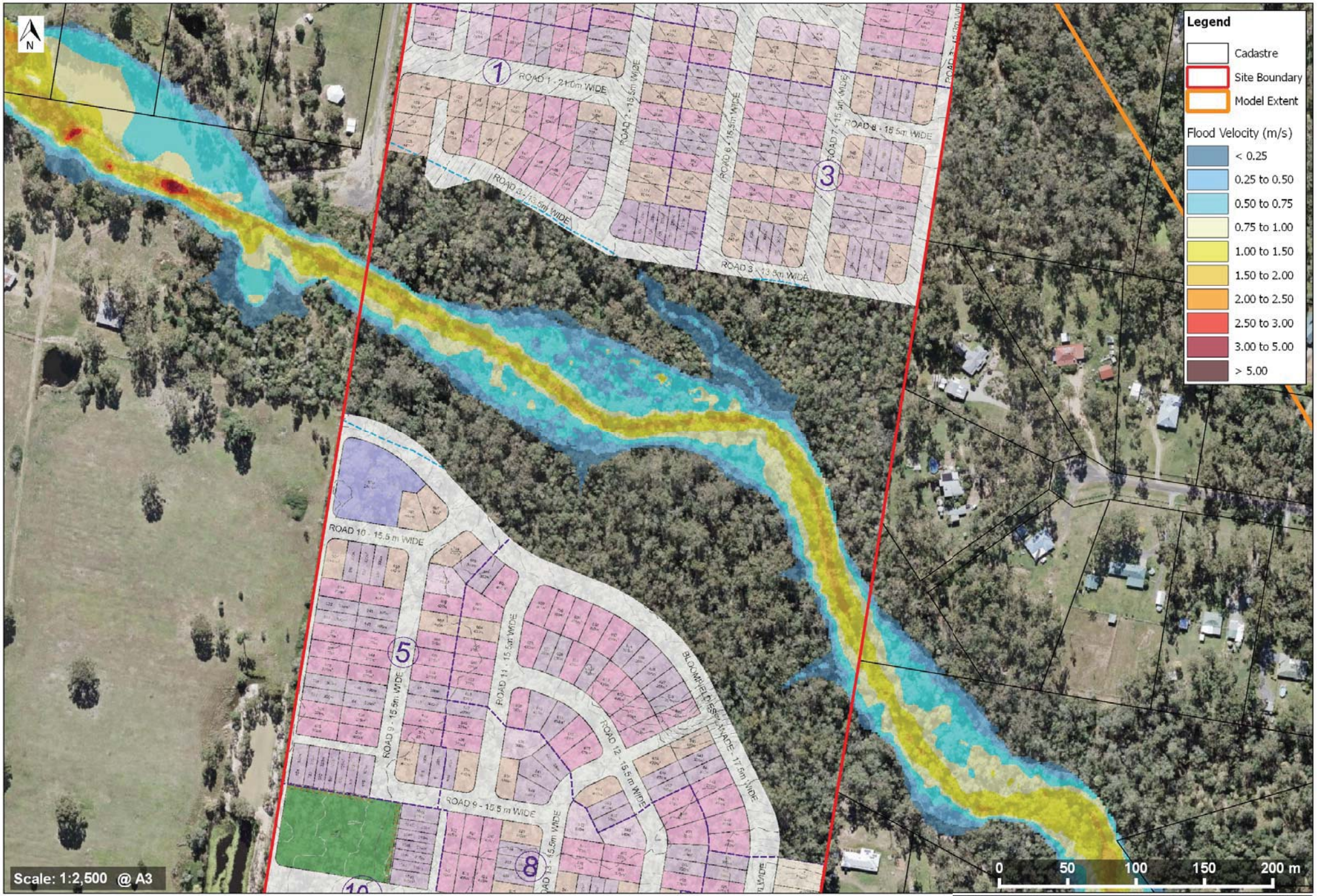


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
2% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Depth

WATER TECHNOLOGY

2019-08-15T04:33:49

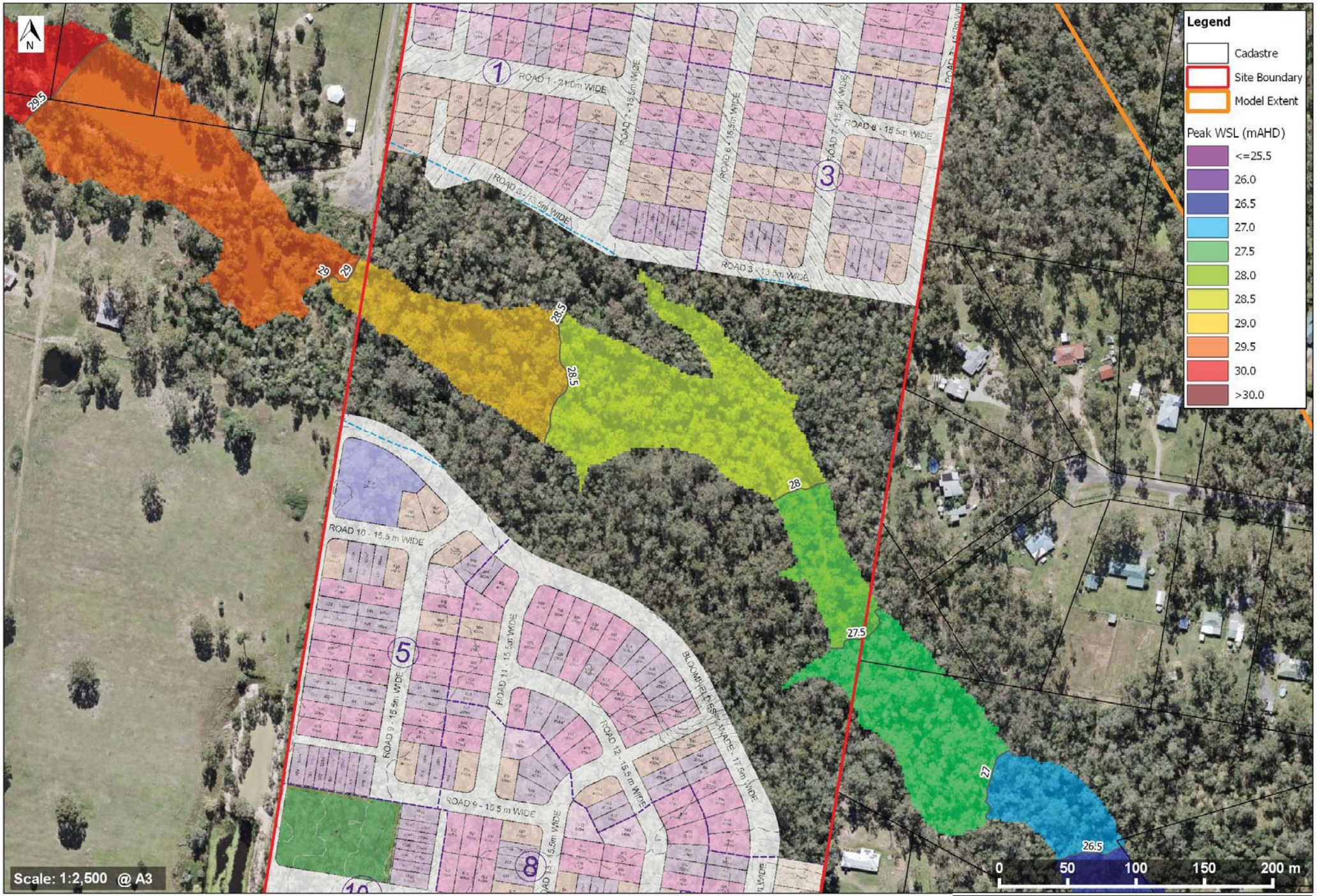


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
2% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Velocity

WATER TECHNOLOGY

2019-08-15T04:31:31

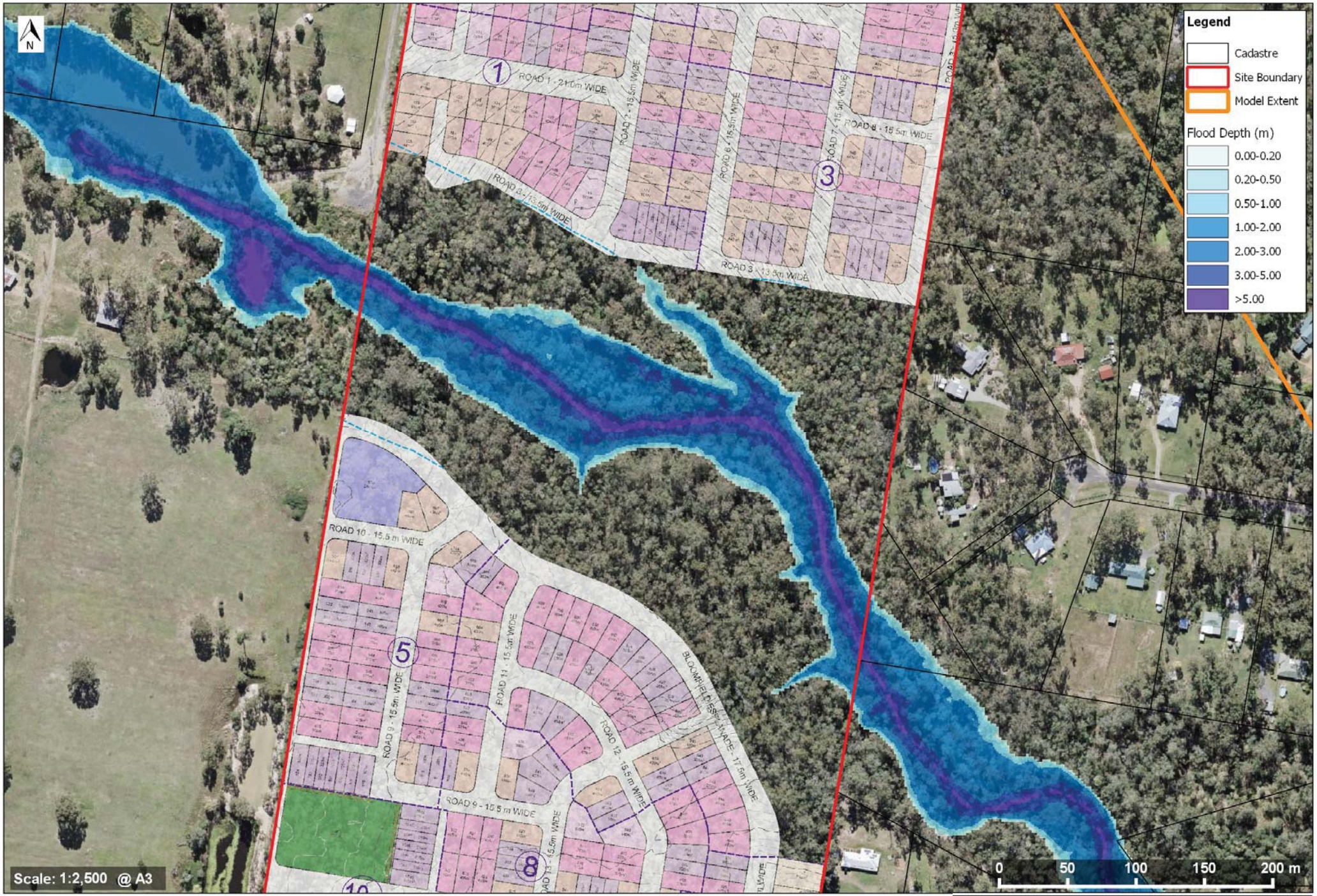


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
2% AEP 120 minute - Ultimate Landuse Conditions - Peak Water Surface Level

WATER TECHNOLOGY

2019-08-15T04:35:01

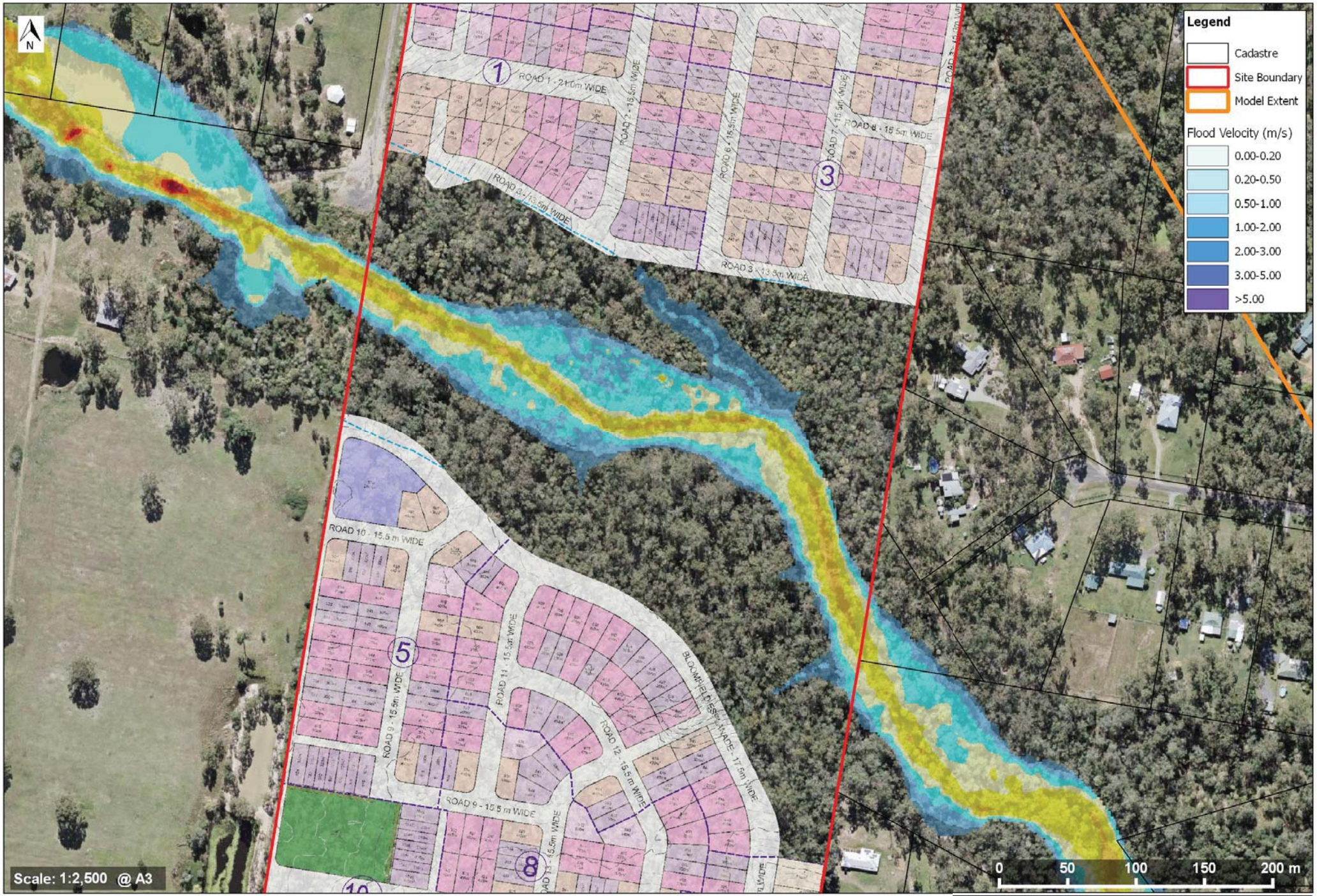


Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
1% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Depth

WATER TECHNOLOGY

2019-08-15T04:32:38



Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
1% AEP 120 minute - Ultimate Landuse Conditions - Peak Flood Velocity

WATER TECHNOLOGY

2019-08-15T04:35:28

Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road
1% AEP 120 minute - Ultimate Landuse Conditions - Peak Water Surface Level

WATER TECHNOLOGY

2019-08-15T04:36:48

APPENDIX E
1% AEP FLOOD PLANNING GIS MAP

Map Coordinates: GDA 1994
Water Technology Pty Ltd
Date: 15/08/2019

Stormwater Management Plan and Flood Assessment: 176-228 Mountain Ridge Road

1% AEP 120 minute (1% AEP Tailwater) - Ultimate Landuse Conditions - Peak Water Surface Level

WATER TECHNOLOGY

2019-08-15T04:34:23

APPENDIX F
LOGAN CITY COUNCIL FLOOD HAZARD OVERLAY CODE COMPLIANCE ASSESSMENT

Performance outcomes	Acceptable outcomes	Comments
For self-assessable and assessable development		
Risk to people and premises		
PO1 A building floor level of a habitable room has adequate allowance for the hydraulic gradient above the main floodway.	**AO1** A building has a finished habitable floor level a minimum of 500mm above the defined flood event.	Able to comply
PO2 Development must not increase the level of risk of injury to life or risk of damage to property or adversely affect flood evacuation procedures.	**AO2** Development: (a) does not result in any of the following: (i) an increase in the number of people at risk from flooding up to and including the defined flood event; or (ii) an increase in the number of people that need evacuation up to and including the defined flood event; or (iii) an increase in the number of premises or infrastructure at risk from flooding up to and including the defined flood event; or (iv) existing flood warning times being reduced for flood events up to and including the defined flood event; or (v) an adverse impact on the ability of traffic to use evacuation routes or unreasonably increase traffic volumes on evacuation routes; or (b) is located entirely within a development envelope area approved by an earlier development approval.	Able to comply

Performance outcomes	Acceptable outcomes	Comments
For assessable development		
Risk to people and premises		
PO3 Development provides a development envelope area that is above the flood level during the defined flood event.	**AO3** Development provides a development envelope area above the flood level during the defined flood event with a minimum size and dimension specified in Table 8.2.5.3.2–Development envelope area.	Able to comply
PO4 Public safety and the environment are not adversely affected by floodwater by: (a) locating a Medium impact industry or High impact industry to be able to function safely during and immediately after flood events; (b) safely storing hazardous materials.	**AO4** Development: (a) for a Medium impact industry or High impact industry is above the flood level specified in column 2 Table 8.2.5.3.3—Minimum flood levels; (b) involving the storage, sale or use of hazardous materials is located above the flood level during the defined flood event.	Not Applicable
PO5 A car park other than a Parking station is only located below the flood level during the defined flood event where there is no increase in risk to: (a) pedestrian and vehicular safety; (b) a building or other structure. Note—Section 4.1–Guidelines for satisfying flood hazard overlay code in planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO5** No acceptable outcome provided.	Not Applicable

Performance outcomes	Acceptable outcomes	Comments
PO6 Development for any of the uses identified in column 1 of Table 8.2.5.3.3—Minimum flood levels, are able to function effectively during and immediately after flood events. Note—Compliance with this performance outcome is to be demonstrated by a flood study report prepared in accordance with section 2.5.1 of planning scheme policy 5–Infrastructure Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO6** Development for any of the uses identified in column 1 of Table 8.2.5.3.3—Minimum flood levels is located above the flood level specified in column 2 of Table 8.2.5.3.3—Minimum flood levels.	Able to comply
Flood storage and discharge capacity		
PO7 An existing floodway is protected and maintained to ensure there are no losses of conveyance capacity of waterways and storage so as not to adversely affect other premises, infrastructure and the environment. Note—Compliance with this performance outcome is to be demonstrated by a flood study report prepared in accordance with section 2.5.1 of planning scheme policy 5–Infrastructure Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO7** No acceptable outcome provided.	The development is located outside of the waterway / floodplain.
PO8 The natural conveyance of flood waters and natural overland flow paths are protected and maintained without adversely affecting adjoining premises.	**AO8** No acceptable outcome provided.	Analysis has indicated that unmitigated stormwater discharge to Flagstone Creek does not create a worsening to adjoining premises.

Performance outcomes	Acceptable outcomes	Comments
Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5—Infrastructure provides guidance to achieve this outcome.		
PO9 Development (or development in combination with other development) for all flood events up to and including the defined flood event does not do any of the following: (a) cause or have the potential to cause damage; or (b) cause ponding of flood water; or (c) adversely affect the flood discharge capacity of the floodplain; or (d) decrease the flood resilience of properties and infrastructure; or (e) cause a cumulative increase in flood levels external to the premises. Note—Compliance with this performance outcome is to be demonstrated by a flood study report prepared in accordance with section 2.5.1 of planning scheme policy 5–Infrastructure Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO9** No acceptable outcome provided.	Refer to the Stormwater Management Plan and Flood Study. The analysis has indicated that the proposed development complies.
PO10 Any loss of floodplain storage is compensated with compensatory storage or excavation that: (a) is of equal volume, creating a balance of cut to fill; (b) is free draining; (c) is located within the premises;	**AO10** No acceptable outcome provided.	Able to comply

Performance outcomes	Acceptable outcomes	Comments
(d) does not adversely affect the hydraulic conveyance capacity of the flood channel or floodplain; (e) is provided to the corresponding flood level; (f) is landscaped to provide visual amenity and erosion control; (g) is solely for the purpose of compensatory storage. Note—Compliance with this performance outcome is to be demonstrated by a flood study report prepared in accordance with section 2.5.1 of planning scheme policy 5–Infrastructure Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.		
PO11 Development does not adversely change the following flood characteristics for all flood events up to and including the defined flood event: (a) peak flow; (b) flow of any part of the flood before the peak; (c) flood flow velocity; (d) level of flooding; (e) flood time to peak. Note—Compliance with this performance outcome is to be demonstrated by a flood study report prepared in accordance with section 2.5.1 of planning scheme policy 5–Infrastructure Note—Section 4.1–Guidelines for satisfying flood hazard overlay of planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO11** No acceptable outcome provided.	The Stormwater Management Plan and Flood Study has indicated no fundamental change to the flooding characteristics of Flagstone Creek.

Performance outcomes	Acceptable outcomes	Comments
PO12 A stormwater quality improvement device is located to retain existing flood plain storage capacity and ensure functionality of the stormwater quality improvement device.	**AO12** A stormwater quality improvement high flow outlet device is located: (a) above the five percent AEP flood event caused by local flooding; (b) above the two percent AEP flood event caused by regional flooding.	The water quality devices are located above the DFE.
PO13 A stormwater quantity management device is located to retain existing flood plain storage capacity and ensure functionality of the stormwater quantity management device.	**AO13** A stormwater quantity management high flow outlet device is located above the two percent AEP flood event.	The water quality devices are located above the DFE.
Filling and excavation		
PO14 Filling and excavation is carried out above the flood level of the 10 percent AEP event to protect in stream and banks of a waterway and wetland. Note—Section 4.1–Guidelines for satisfying flood hazard overlay code in planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO14.1** Earthworks are limited to areas where: (a) flooding is predominately due to backflow; (b) the peak depth average velocity is less than the maximum permissible velocity for considerable bare earth channels (typically 0.5m/sec) in accordance with Table 9.0.5.3 of the Queensland Urban Drainage Manual; (c) the cut/fill batter is not steeper than 1V:4H and the exposed earth surface is landscaped with erosion resistant vegetation cover.	Able to comply
	AO14.2 A filling and excavation plan is provided in accordance with section 2.2.2 of planning scheme policy 5–Infrastructure.	

Performance outcomes	Acceptable outcomes	Comments
Access		
PO15 Development provides vehicular access to a road network that is sufficient to enable safe access and egress. Note—Section 4.1–Guidelines for satisfying flood hazard overlay code in planning scheme policy 5–Infrastructure provides guidance to achieve this outcome.	**AO15** Development provides vehicular access to a road that is: (a) above the flood level during the defined flood event; or (b) below the flood level during the defined flood event where the road: (i) has a low flood hazard; (ii) remains trafficable until another road access to the development becomes trafficable; (iii) directly connects to a road that is above the defined flood event that provides access to the road network.	Able to comply.
PO16 Development provides an access area to a building or fill area on which a building is to be constructed where the access is located on land classified as a low flood hazard in the defined flood event.	**AO16** Development provides access to a building or fill area that has: (a) a maximum depth of inundation of 300 mm during all flood events up to and including the defined flood event; (b) a maximum distance of inundation of 200 metres during all flood events up to and including the defined flood event; (c) a depth multiplied velocity product of less than or equal to 0.4m^2/s. Note—Velocity in flood waters is measured as the average velocity over a column of water.	Development above DFE.

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Telephone 0438 510 240

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