FINAL Report

Quinzeh Creek Flood Study 2023

Logan City Council

28 June 2023

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28 June 2023

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Dear Janaka

Quinzeh Creek Flood Study 2023

We have pleasure in providing you with a copy of our final report prepared in relation to the above.

We trust that this is satisfactory. Should you have any queries, please don’t hesitate to contact the undersigned.

Yours sincerely

Alister Daly
Group Manager

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WATER TECHNOLOGY PTY LTD

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1 INTRODUCTION

Water Technology Pty Ltd (WT) have been commissioned by Logan City Council (LCC) (Council) to prepare the Quinzeh Creek Flood Study 2023. The subject catchment area is located predominantly in the suburbs of Logan Village and Yarrabilba and is bordered by Waterford-Tamborine Road and Logan River to the west and Albert River and Beaudesert-Beenleigh Road to the east. The location of the study area catchment is illustrated in Figure 1-1. The total area of the Quinzeh Creek catchment is approximately 4018 hectares (ha).

The most recent Quinzeh Creek Flood Study was delivered to Final status in 2021 by WT. There was recognition at the time of the study that there was a number of minor items required updating to finalise the study. Planning for the delivery of Council's new Planning Scheme is underway and it has been identified that additional modelling is required to meet the Planning Scheme requirements. For reasons of efficiency, the model update and additional items detailed in this report are delivered as the Quinzeh Creek Flood Study Finalisation 2023

The key objectives of this study are to provide Council with detailed flood mapping outcomes for the greater Quinzeh Creek catchment to fully quantify flood risk using current best practices and most recent topographical information. This is particularly critical given the current extensive development that has since occurred in the Yarrabilba Priority Development Area. In so doing, Council will then have a consolidated and consistent flood study information for the catchment which can be used to reliably guide future catchment development and land use planning outcomes that is based on current ARR2019 guidance. Separate to this flood study, the greater study additionally includes a Flood Management Plan to inform strategic land use planning to assist Council in preparing a Feasible Alternative Assessment Reporting (FARR) requirement. The Flood Management Plan is to be prepared as a separate and standalone report to this flood study report.

The flood study for the area will also provide additional benefits as follows:

- The existing (current) flood risk status of previously developed areas, particularly within the Yarrabilba Priority Development Area;
- Adherence to the recommendations following the Queensland Floods Commission of Inquiry;
- A mechanism for Council to control and co-ordinate all future development within the area with due regard to flood control and ensuring development compliance;
- An opportunity for Council to include the updated flood study outcomes into a future planning scheme amendment for the area;
- Currency in flood control which specifically utilises the most recent 2021 LiDAR data collected by Council;
- Updated flood information to support community awareness and Council's ongoing disaster management functions; and
- An opportunity to provide a higher level and functioning hydraulic model which can be utilised by Council to improve future flood forecasting initiatives.

Given the Planning Scheme setting that the outputs of this project will contribute to, it is critical that the flood study accurately quantifies all flood related inundation and risks occurring throughout the greater Quinzeh Creek catchment. The subsequent sections of this report aim to provide a detailed and comprehensive documentation relating to the assessment and outputs prepared in relation to the Quinzeh Creek Flood Study Finalisation 2023.

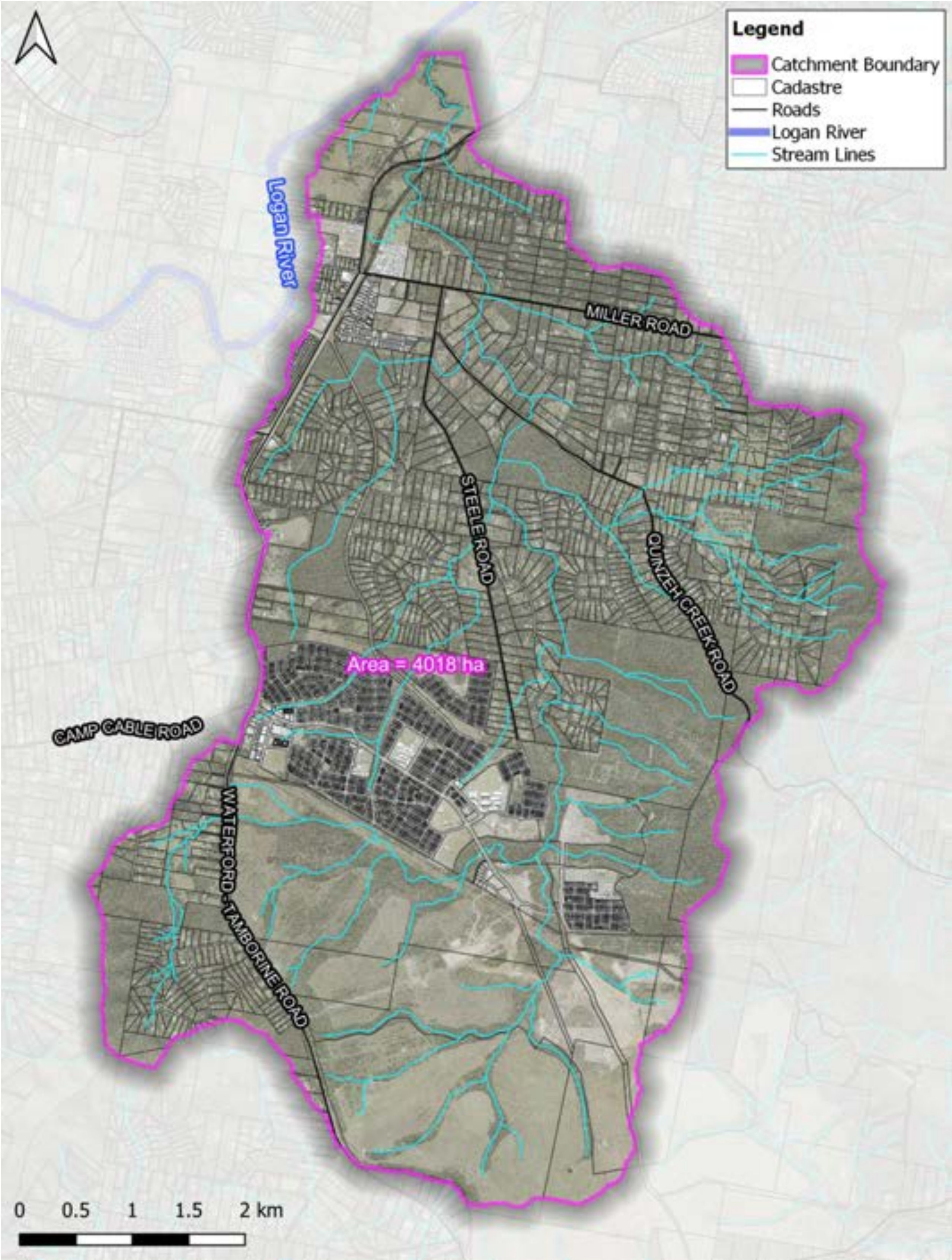

Figure 1-1 Study Catchment Area and General Locality

2 DATA REVIEW AND GAP ANALYSIS

2.1 Introduction

There is already extensive information available for the catchment as is outlined in the project brief. Specifically, this includes the previous studies (i.e. the Logan/Albert River, Quinzeh Creek Local, Logan Village and Yarrabilba studies), as well as related digital data, hydraulic structure information, calibration data and associated GIS data sets. Similarly, a regional detention basin, among others, has been constructed in the upper reaches of the catchment which is associated with the Yarrabilba development area.

Water Technology has undertaken a detailed and comprehensive information review of all background material and has prepared a gap analysis to identify any missing information. A summary of the data review undertaken, and subsequent gap analysis is documented separately below.

2.2 Previous Studies

A number of previous flood and drainage related studies have been prepared within the subject catchment study areas which were provided by Council. A brief summary of the relevant and pertinent studies previously prepared are discussed separately below.

Yarrabilba (Quinzeh Creek) Flood Study (DesignFlow, 2017)

This study was prepared in response to the Request for Information (RFI) issued by Economic Development Queensland (EDQ) pertaining to the development precincts proposed within the Quinzeh Creek Catchment by Lend Lease Communities (Yarrabilba) Pty Ltd. Both hydrological and hydraulics studies were completed to:

- Quantify flood depths within the catchment pre and post development of the Yarrabilba Lend Lease Communities as well as the ultimate developed catchment as per the LCC Planning Scheme; and
- Mitigate any adverse flood impacts by employing measures such as stormwater detentions basins.

Analysis was undertaken for the 39%, 5%, and 1% Annual Exceedance Probability (AEP) design events and concluded that the proposed development with the associated works proposed resulted in no adverse impact to adjoining properties.

Logan-Albert Rivers Flood Study (WRM, June 2014) (WRM, 2014)

The Logan-Albert Rivers hydraulic flood modelling was originally developed by Engeny in 2011 (Engeny 2011). The flood study was subject to a technical review which was undertaken by KBR in 2012 (KBR 2012). Following the technical review being completed, LCC commissioned WRM in 2016 to update the previously developed models informed from the KBR 2012 review, and to recalibrate the Logan and Albert River flood models based on recent historical flood events. Following the model update and re-calibration, WRM subsequently updated the design discharge and flood level estimates. The updated hydrologic and hydraulic models were calibrated to discharge and water level hydrograph records during three (3) significant flood events of 1974, 1990 and January 2013. A flood frequency analysis was also prepared, utilising four (4) of the available stream gauges and analysed for further calibration. The updated hydraulic model was used to estimate design flood levels from the Logan-Albert Rivers for all standard storm events ranging from the 39% to the 0.2% AEP, and additionally included assessment of the PMF flood event. The derived flood levels from the WRM hydraulic model are considered to be the most up to date estimates for the Logan and Albert River catchment and were adopted to inform all design planning across the LGA.

Quinzeh Creek Flood Study 2020\2021 (Water Technology, May 2021)

Water Technology previously completed the Quinzeh Creek Flood Study 2020 / 2021 in May 2021 as commissioned by LCC. LCC commissioned this study to develop local hydrologic and hydraulic models to ascertain design flood levels, flood planning levels and understand flood risks within the catchment. Water Technology conducted extensive investigations, utilising all previous modelling to develop the local XPRAFTS and TUFLOW models.

This study is the basis of the Quinzeh Creek Flood Study Finalisation 2023. As such, Water Technology utilised the previously completed works to advise the updated the Quinzeh Creek hydrologic and hydraulic modelling.

As a further note to the above and as at the time of this study, a further update of the Logan-Albert River Flood Study is currently being undertaken. This update has been commissioned to bring the study in-line with the current guidance under ARR2019 as well as updating the model based on the most recent topographical and channel bathymetry data. Council has commissioned WRM for the flood study update and this study is yet to be finalised.

2.3 Digital Flood Model Data

Digital copies of the relevant flood models to inform the current investigation were provided by Council. This has included:

- Digital copy of the Yarrabilba (Quinzeh Creek) Flood Study Hydraulic TUFLOW model (DesignFlow, 2017). The model files included setup files as well as a copy of the SMEC Failure Impact Assessment report conducted for the proposed mitigation works; and
- A digital copy of the Logan River regional TUFLOW hydraulic sub-model prepared by WRM (WRM 2016) based on ARR1987 procedures. The standard events included in the supplied model included the 39% to the 0.2% AEP events and contained the 6, 9, 12, 18, 24, 30, 36, 48 and 72-hour storm durations. The model files included the necessary setup files.

2.4 Topographic Data

The available topographic data provided by LCC includes the 2021 1m LiDAR data set. We understand that the 2021 LiDAR data represents the most current topographical data available for the catchment. The supplied 1-meter Digital Elevation Model (DEM) raster was used to inform all model development tasks undertaken for this study. The LiDAR data covers the full extent of the Quinzeh Creek catchment and is the most updated topographical data for the catchment and is therefore considered to be suitable for the purposes of this study. The 2021 LiDAR has been provided in Figure 2-1 below.

Lastly, the topographical information included in the Yarrabilba area was provided by DesignFlow and used to inform the model topography of the planned and current developments undertaken since the 2021 LiDAR capture.

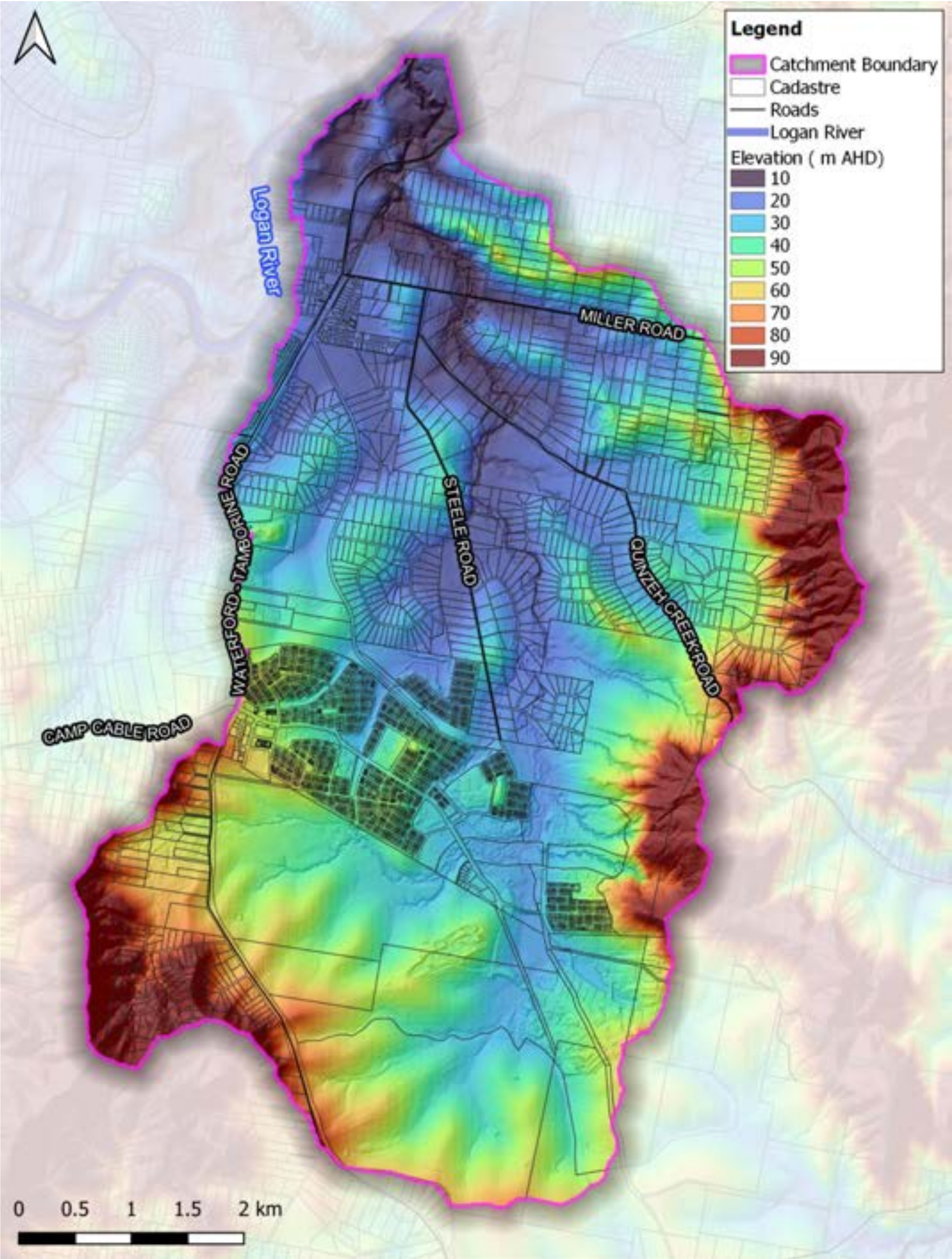

Figure 2-1 2021 LiDAR 1m DEM

2.5 GIS Data

A range of GIS data sets were provided in an ESRI geodatabase format by Council to inform this study. A summary of the supplied GIS data is provided in Table 2-1. All data has been reviewed and, where available, was found to be suitable to inform this investigation.

Table 2-1 LCC Supplied GIS Data

Filename	Description
SW_Culverts	Stormwater Culvert network
SW_Pipies	Stormwater Pipe Network
SW_Headwalls	Stormwater_Network_Headwalls
LPS_Zoning	Landuse As Per LCC 2015 Planning Scheme
SW_Pits	Stormwater Pits
Bld_Footprints	Building Footprints
Bridges	Bridge details
Road_parcels	Roads
SW_Open_Drain	Constructed Channels
Waterways	Waterways within data extract region

It is noted that the supplied stormwater network data does not provide a full and comprehensive data set with some missing information on the network including dimensions and elevations. Specifically, this includes:

- Several road culvert structures throughout the catchment were not included in the database (i.e. inspection of aerial imagery and LiDAR compared to provided data); and
- Invert level information included in the GIS data was incomplete and not available for some of cross drainage structures. Upon further review, the invert level information that was provided was not compatible with the topography in relatively new development areas.

As noted above, invert level information contained in the GIS data sets were incompatible with the model surface elevation. Considering the significant developments planned and undertaken in the Quinzeh Creek catchment since 2017, the model topography was locally altered to match pipe invert levels. This aspect is discussed separately in Section 2.8.

2.6 As Constructed and Survey Data

One (1) distinct sets of as-constructed details have been used as part of this study, the details of which are presented in Table 2-2. The as-constructed information relates to the Yarrabilba development area. The as-constructed data sets were used to provide topographical adjustments for the flood study revisions undertaken as part of this study.

Table 2-2 As Constructed Data Sets

Ref	Filename	Description
1	Yarrabilba Precinct – Wentland Avenue	Construction and drainage details of the new cross drain culverts under Wentland Avenue. Includes dimensions and elevations of each structure.

2.7 Rainfall and River Level Data

Rainfall and river level data for the Council selected 2013, 2015 and 2017 historical events were supplied for calibration purposes. This included a mixture of historical rainfall and river level data recorded at the following sites:

- Yarrabilba AL (Alert;)
- Upper Quinzeh AL (Alert);
- Lower Quinzeh AL (Alert); and
- Logan Village AL (Alert).

It should be noted the Logan Village AL gauge is located outside of Quinzeh Creek Catchment, with the water level data sets reflecting the Logan River and not Quinzeh Creek and thus could not be used directly in the calibration process. Additionally, the Upper Quinzeh AL gauge rainfall data and the Upper and Lower Quinzeh AL gauge water level data is not available for the 2013 flood event. The model calibration and validation aspects completed for this study are discussed separately in Section 6.

2.8 Structure Data Summary and Structure Database

Figure 2-2 provides an illustration of the extent of existing hydraulic structure data represented across the Quinzeh Creek catchment area which have been compiled based on the above supplied information as well as being confirmed via a series of site inspections undertaken by WT. The following additional comments are made in respect to the structure data:

- As noted previously, invert level data included in the supplied GIS geodatabase was found to be incompatible with model topography and could therefore not be directly used; and
- Where applicable, the invert data provided by Council was adopted and topography was locally edited to ensure flow conveyance.

The pipe data in Figure 2-2 has been compiled and consolidated into a single shapefile for inclusion in the hydraulic model. A copy of the structure database has also been provided in digital format to Council as a deliverable from this study. A copy of the same is also included in Appendix A.

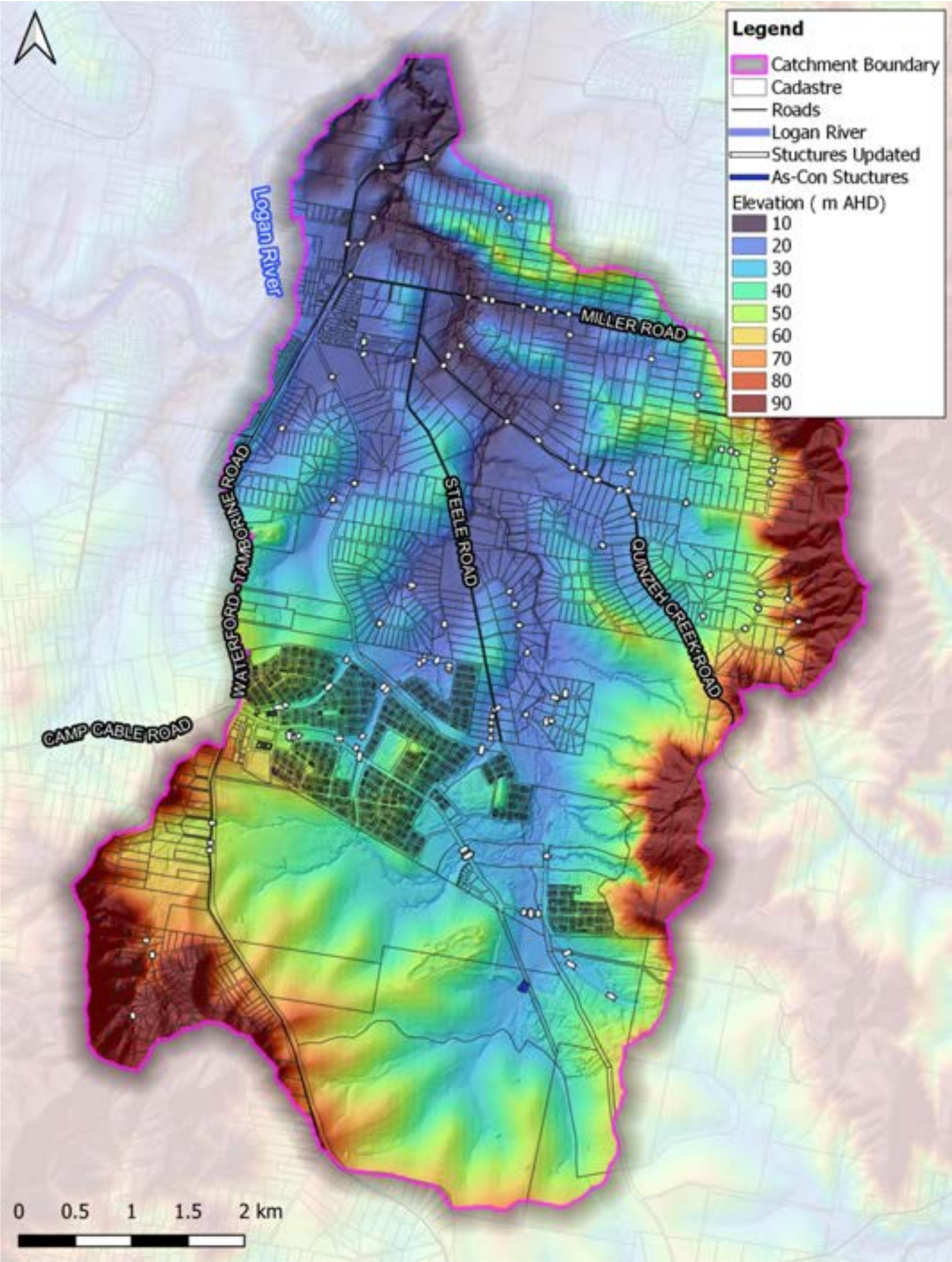

Figure 2-2 Structure Data Summary and Data Extent

2.9 Data Summary

The data review completed by WT shows that there is an extensive amount of background information that is suitable and can be readily used to inform the current investigation. The key limitation in respect to the background data sets however relates to the information available on the model topography and the integration of the existing stormwater network data. As discussed previously, the existing stormwater network represented within the local catchment areas were found to be incompatible in respect to structure details, be that sizes or invert level information. Attempts have since been made by WT to better address the missing or erroneous information through:

- A series of site inspections undertaken across the catchment areas which has included physical site measurements and observations;
- Inspections of high definition aerial imagery as provided by Metromap for visible confirmation of select large structures; and
- Inclusion of as-constructed information as provided by Design Flow.

Despite the above, and in the absence of detailed survey, it has been necessary to adjust the model topography to match the council provided invert level information for a large number of structures. It is considered however that due to time availability, overall costs and discussions with Council, altering the topography, informed by the pipe invert, is considered reasonable and appropriate for the purposes of informing this study.

Based on the comprehensive data review and subsequent gap analysis, and noting the structure invert level limitations outlined above, there are no undue gaps or missing information that would otherwise compromise the study outputs. As such, it is believed that all relevant and appropriate data as sourced and provided are sufficient for the purposes of this study.

3 MODEL PHILOSOPHY AND OVERVIEW

3.1 Modelling Approach

The modelling approach applied for this project is inclusive of the preparation of separate hydrology and hydraulic models for the Quinzeh Creek catchment. The development of separate hydrology and hydraulic models to inform the study represents a fully supported approach as part of the Australian Rainfall and Runoff (ARR) 2019 guidelines (ARR2019). An alternative approach could have included the use of a Rain-on-Grid (RoG) approach whereby rainfall is applied directly on the hydraulic model domain and to otherwise negate the need for a separate hydrological model. The project methodology selected excludes the use of a RoG approach given that this approach is stated as being premature and is not a recommended approach in ARR2019.

3.2 Software Platforms

In accordance with the project brief, the pre-approved software platforms for Council includes: -

- Hydrology – XP-RAFTS using Storm Injector;
- Hydraulics – TUFLOW;
- GIS – ArcGIS.

For the purposes of this study, all models have been prepared based on the following software platforms:

- All catchment hydrologic models have been developed using the standard XP-RAFTS platform (using Storm Injector); and
- All hydraulic modelling has been prepared using the TUFLOW HPC platform and GPU solver.

The model schematisation approach undertaken for this study has included a separate and discrete XP-RAFTS and TUFLOW model for the Quinzeh Creek catchment (i.e. 1 separate hydrology and 1 separate hydraulic model). The following sections provide further detail on the model development.

3.3 Hydrology Model Philosophy

The following points briefly outline the philosophy applied for the development of the hydrological models for this study. More detailed information in relation to the development of the XP-RAFTS models is presented separately in Section 4.

- All models have been prepared using XP-RAFTS and Storm Injector and are based on the current best practise guidelines represented in ARR2019;
- In accordance with ARR2019 recommendations and technical requirements outlined in the project brief, a Monte Carlo approach is not necessary or required for this study. Rather, the Ensemble Event (EE) approach has been adopted based on ARR2019 guidelines and is appropriate given the scale and nature of the catchment; and
- The methodology applied for the development of the XP-RAFTS models has included a detailed breakdown of sub-catchments for the Quinzeh Creek catchment.

3.4 Hydraulic Model Philosophy

The following points briefly outline the philosophy applied for the development of the hydraulic models for this study. More detailed information in relation to the development of the TUFLOW models is presented separately in Section 5.

- The hydraulic modelling philosophy is based on preparing a highly detailed 1D/2D hydraulic models to cover the majority of the entire catchment area;
- The TUFLOW HPC and Sub-Grid-Sampling (SGS) platform was adopted for this study as it represented the current software release. The SGS approach which has been adopted and included for the hydraulic model developed for this study. Additionally, the GPU solver beneficially aids in reducing simulation times;
- In defining the model structure and grid size, consideration has been given to the conflicting factors of model resolution and detail in accurately defining floodplain characteristics and the model run time. The TUFLOW SGS methodology allows greater grid sizes to be used without sacrificing model resolution by sampling the under lying elevation data at user specified intervals. This allows model terrain to be represented in high definition. Model schematisation and testing performed demonstrated that it was practical to utilise a detailed 4m grid resolution model with 1m LiDAR sampling whilst also resulting in practical model run times; and
- All TUFLOW hydraulic models have been prepared based on the current best practise guidelines represented in ARR2019.

4 HYDROLOGIC MODEL

4.1 Introduction

To assess local flooding characteristics for the Quinzeh Creek catchment, a hydrologic model has been developed using the XP-RAFTS software. The following sections of this report aims to provide a detailed summary of the XP-RAFTS hydrological model development and setup prepared for the Quinzeh Creek catchment.

It is noted that as a part of the hydrological deliverable of this study, WT has undertaken a hydrological sensitivity on the various land use scenarios for Yarrabilba (particularly for the eastern/southern area noting the western area is fully developed and the mitigation infrastructure completed). This has informed the finalisation of the flood study in terms of land-use to be applied to Yarrabilba and which flood mitigation infrastructure to include in the design event modelling. The land use sensitivity modelling has been tested based on the 1% AEP only, with the preferred land use scenario then adopted and assessed for the final flood study outputs for all design AEP events. The land use sensitivity is discussed further in Section 4.3.

4.2 XP-RAFTS Sub-Catchments

The sub-catchment delineation for the Quinzeh Creek catchment was informed using a 1m DEM prepared from the 2021 LiDAR data. As a guide sub-catchment areas were generally limited to an upper limit of 30 hectares. The XP-RAFTS sub-catchment delineation prepared for the Quinzeh Creek catchment is illustrated in Figure 4-1 and Figure 4-2 respectively for the lower and upper sections of the catchment. A summary of the sub-catchments applied for the study catchment is presented in Table 4-1.

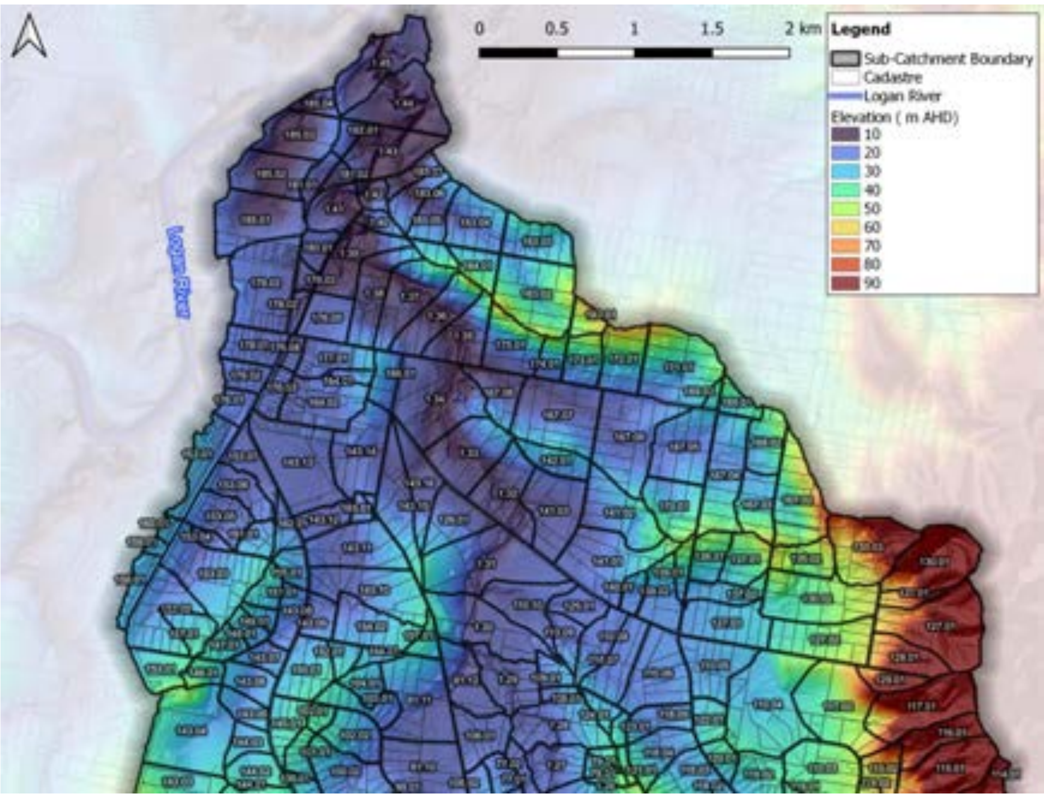

Figure 4-1 XP-RAFTS Sub-Catchments – Lower Quinzeh Creek

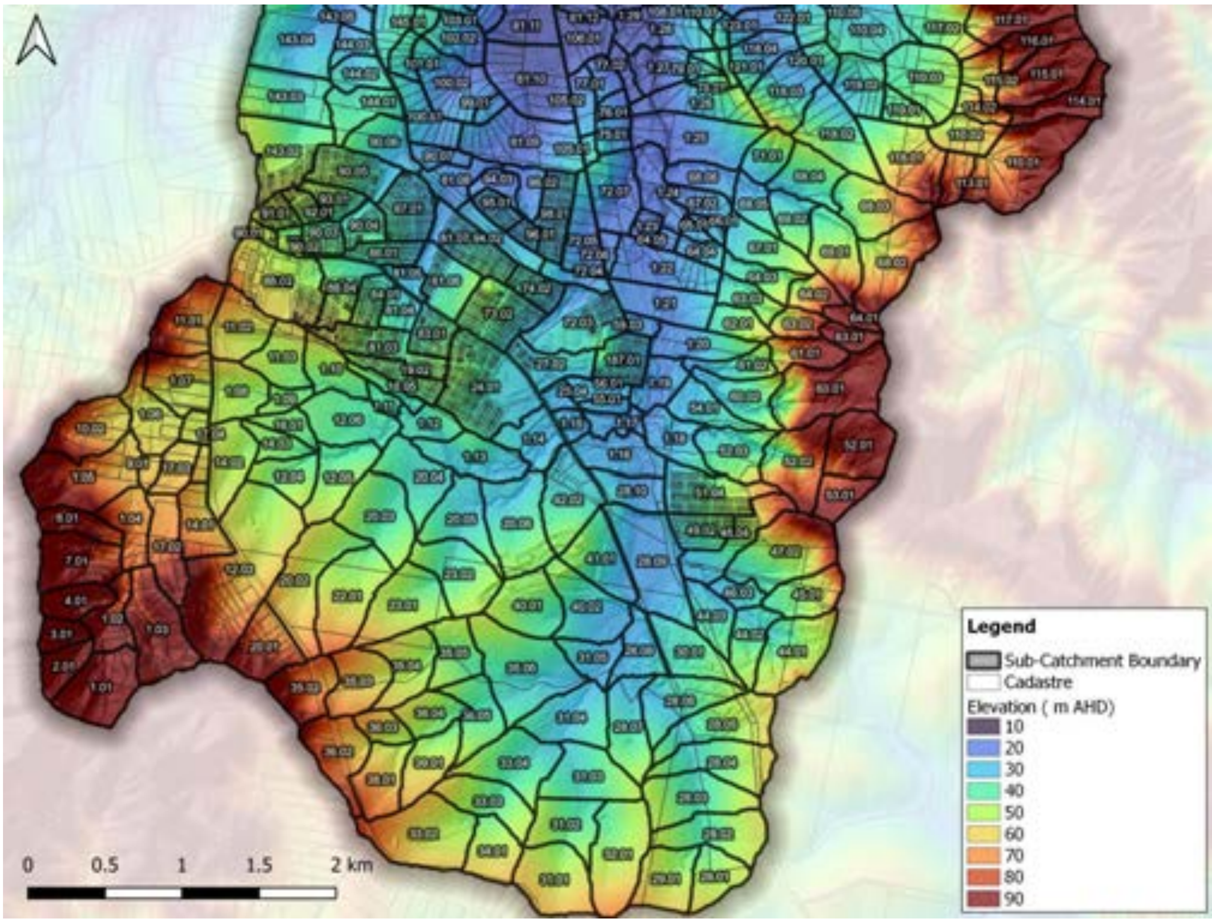

Figure 4-2 XP-RAFTS Sub-Catchment – Upper Quinzeh Creek

Table 4-1 XP-RAFTS Sub-Catchment Summary

Parameter	Quinzeh Creek
Overall Catchment Area (ha)	4018
Total number of sub-catchments	364
Largest sub-catchment area (ha)	51.44
Smallest sub-catchment area (ha)	0.67
Average sub-catchment area (ha)	11.04

4.3 Landuse Sensitivity

4.3.1 Landuse Modelling Description

Water Technology (WT) have completed a hydrological assessment of five (5) options that will in turn advise on the appropriate landuse to apply in the design event hydrologic modelling. It has been agreed that the representation downstream of Yarrabilba needs to be conservative; the challenge with that is not being overly conservative (the extreme example is full ultimate development in Yarrabilba with no mitigation) as this would suggest Yarrabilba has (incorrectly) worsened flooding (n.b. which does not accurately reflect the flood management provisions being analysed and assessed by Design Flow as part of the overall Yarrabilba Master Plan). The options and considerations to investigate can be seen in Table 4-2 below.

Table 4-2 Summary of Adopted Landuse Options for Investigation

Option #	Scenario	Comments – LCC	Comments – WT
Option 1	Pre-developed land use in Yarrabilba with no mitigation	The land use is conservative and will under-estimate run-off compared to current or future development. However, we know that any development is offset by mitigation infrastructure. At the moment the basins are ahead of development and reducing flood risk; in future it will return to the pre-developed run-off (in theory and in terms of peaks, recognising that flow regimes change). This could be challenged by the community if they are seeing the reduced flooding now. LCC preferred option but we'll see what WT recommend	Option ID: Op1_PRE • Landuse as per Table 4-3. • Considers landuse within Yarrabilba to be 0% impervious.
Option 2	Current land use and existing (already built) basins	This will under-estimate flood levels as more development occurs. At present, we think by the mitigation being ahead of development it is reducing levels but that will change.	Option ID: Op2_EXG_EB • Landuse as per Table 4-3. • Basin stage/storage was extracted for the Fauna Way basin from the provided LiDAR • Basin stage/discharge was calculated using the 0.05% AEP flows routed through the hydraulic model.
Option 3 (not considered any further)	Ultimate land-use and ultimate basins	This option is not preferred by Design-Flow as their future plans are not confirmed and may reduce in terms of flood mitigation	Option ID: Op3_EXG_UB • **This option has not been possible to complete due to the lack of information regarding ultimate basin details.**
Option 4	Current land-use and no basins	This will demonstrate a worsening by Yarrabilba potentially	Option ID: Op4_EXG • Landuse as per Table 4-3.

Option #	Scenario	Comments – LCC	Comments – WT
Option 5	Future land-use, current basins	This will demonstrate a worsening by Yarrabilba	Option ID: Op5_ULT_EB • Landuse as per Table 4-3. • Basin stage/storage was extracted for the Fauna Way basin from the provided LiDAR. • Basin stage/discharge was calculated using the 0.05% AEP flows routed through the hydraulic model.

4.3.2 Landuse XP-RAFTS Model Layout

The sub-catchment delineation for the Quinzeh Creek catchment was informed using the detailes as discussed in Section 4.2 and simulated for the 1% AEP only.

Details of the updated XP-RAFTS model developed are summarised as follows:

- Contains 364 individual sub-catchments.
- Full calculation and inclusion of all model routing links (i.e. flowpath lengths).
- Inclusion of impervious fraction and urbanisation based on land use mapping, new 2021 LiDAR and updated aerial photography spatial land use analysis. Option dependent landuse is discussed further in Section 4.3.2.2.

4.3.2.1 Catchment Storage

Storage within the catchment has been modelled using a stage storage and stage discharge curve derived from the hydraulic TUFLOW model. The major basin in this methodology has been applied for is the existing basin developed at the southern end of the current Yarrabilba development located upstream of Fauna Way. The locality of this basin has been provided in Figure 4-3. The stage storage curve and stage discharge curve have been provided in Figure 4-4 and Figure 4-5 respectively.

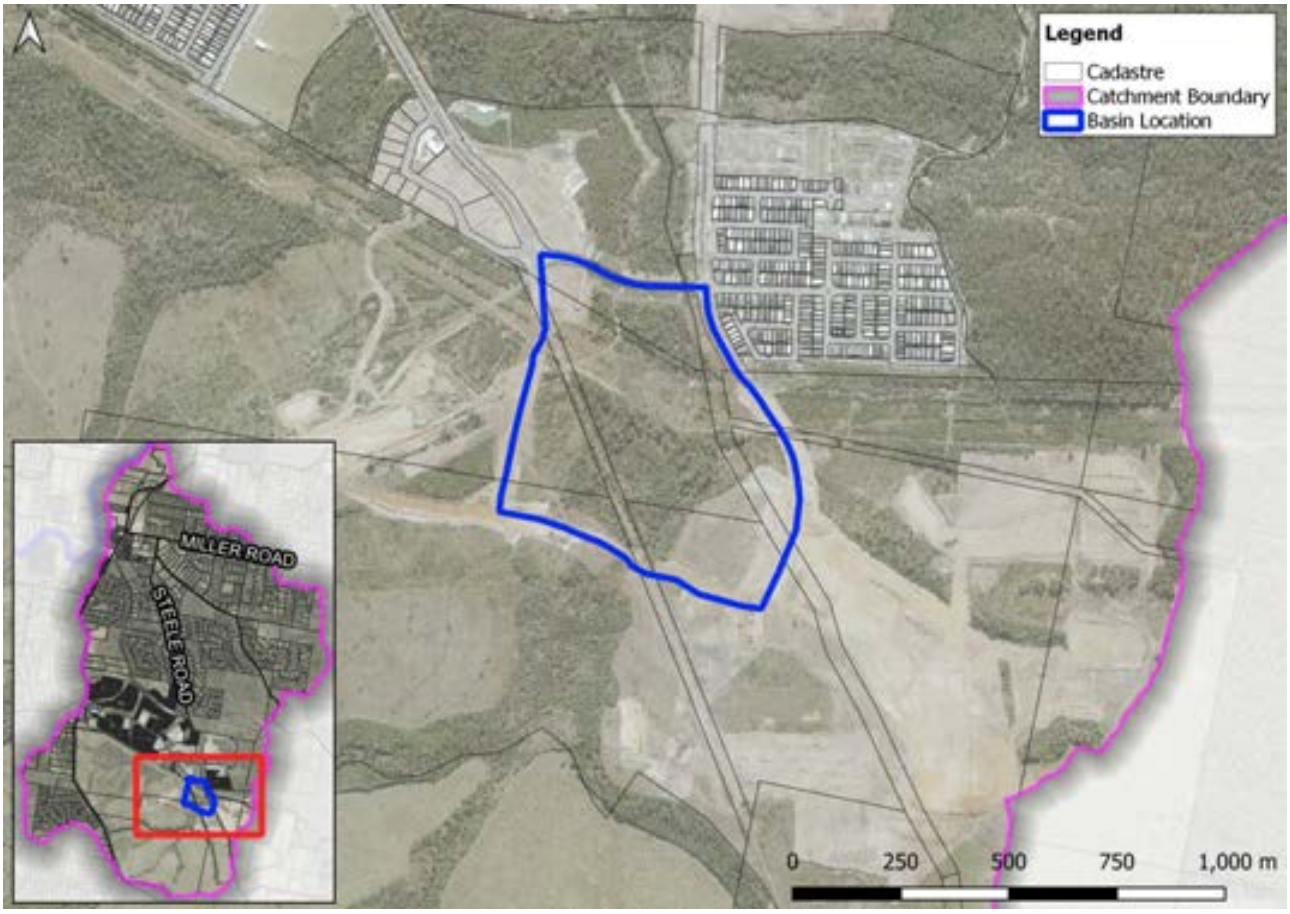

Figure 4-3 Basin Location

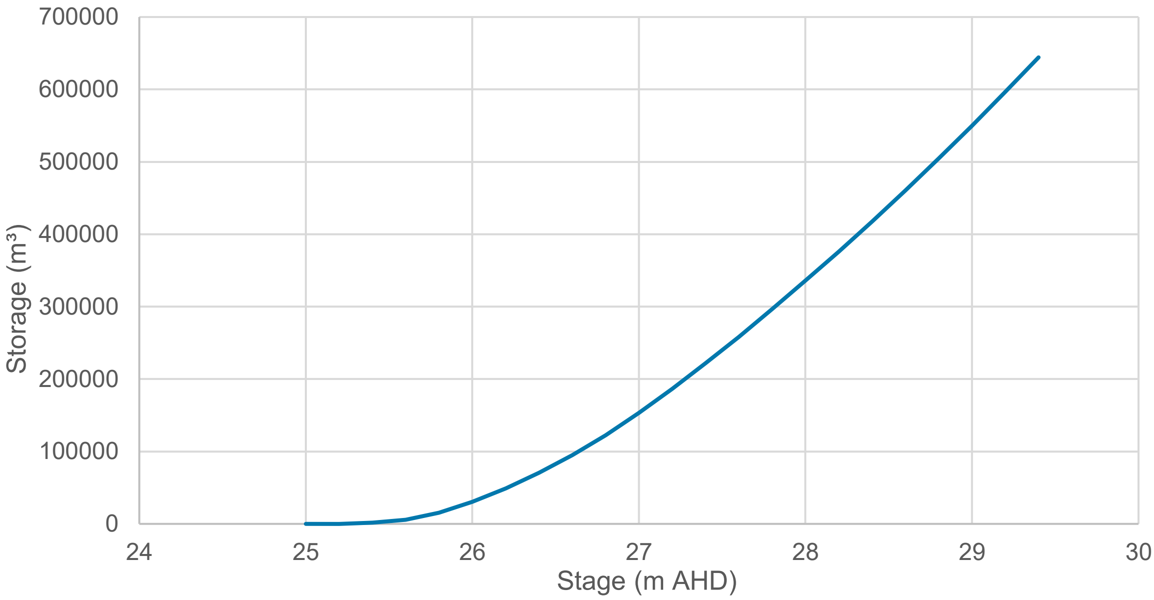

Figure 4-4 Stage Storage Curve at Basin

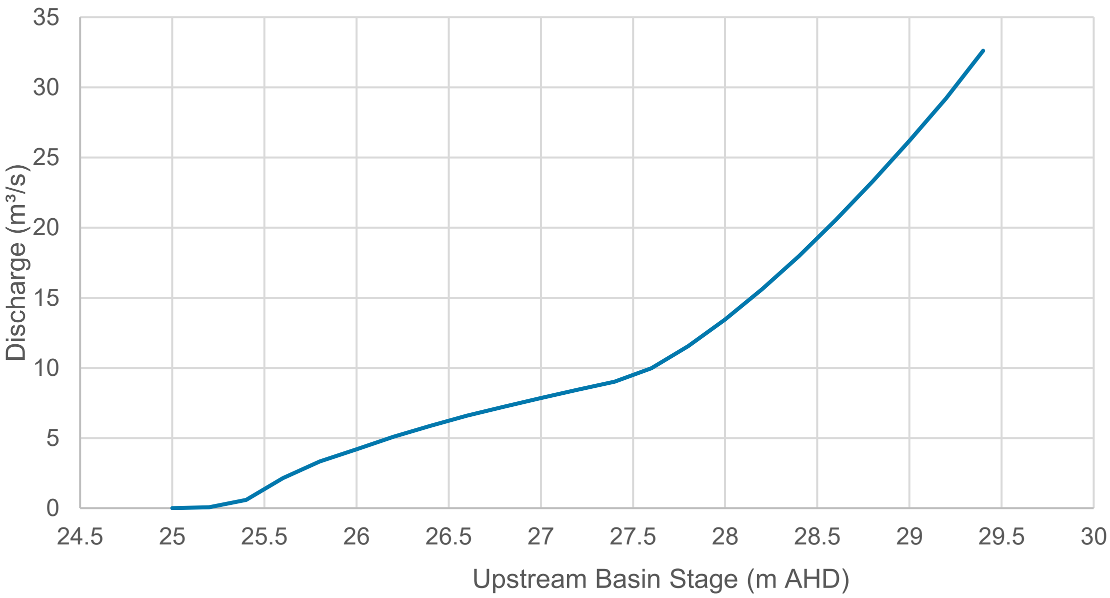

Figure 4-5 Stage Discharge Curve at Basin

4.3.2.2 Landuse Values

Landuse layers utilised in this assessment have been provided by Council and are based on the 2015 Logan Planning Scheme. Landuse area locality can be seen in Figure 4-6. Fraction imperviousness for each landuse area and option can be seen in Table 4-3. It is noted that for the pre-development scenario (option 1), catchments overlaying the Yarrabilba development have been considered to have a 0% imperviousness fraction.

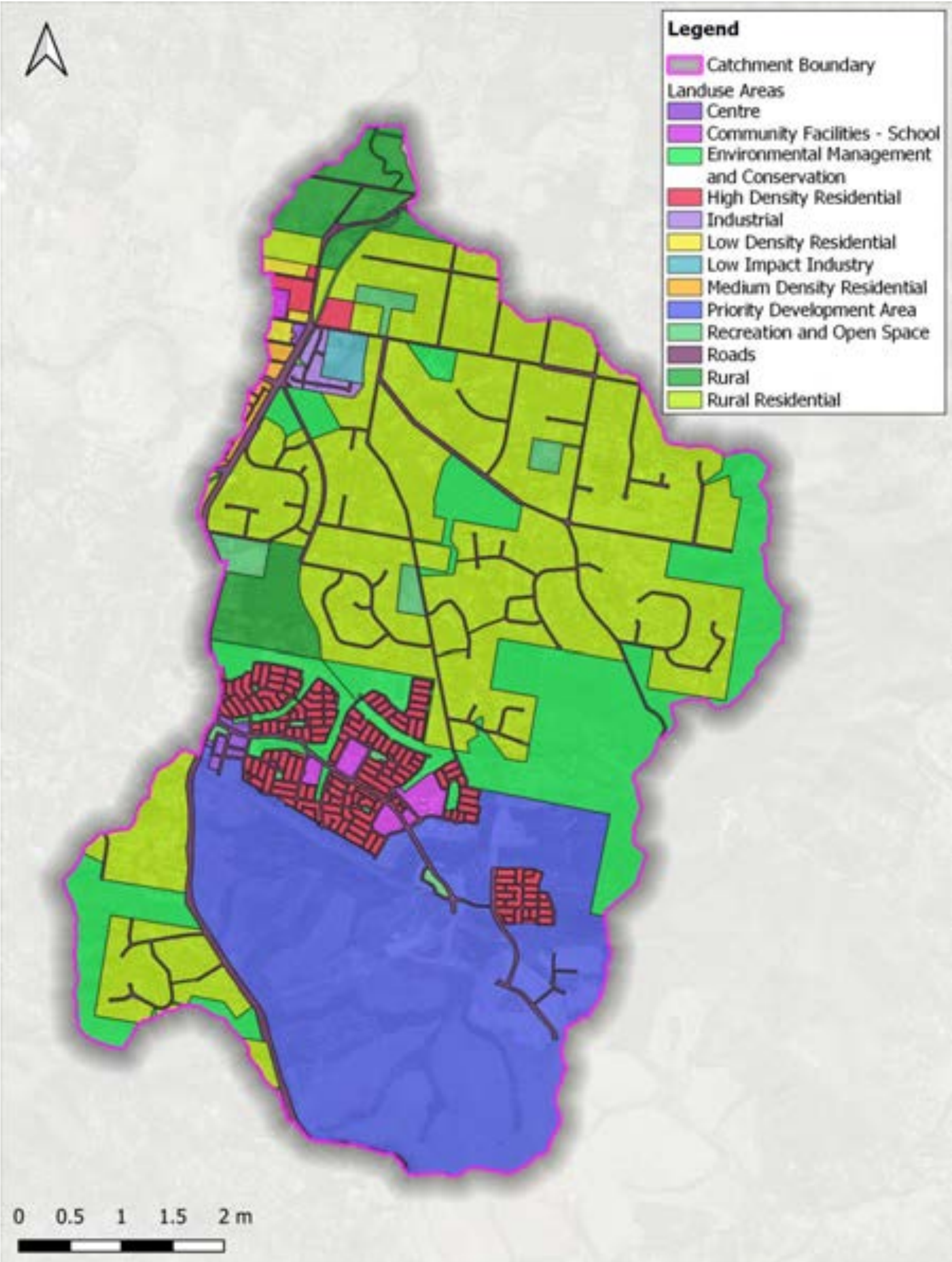

Figure 4-6 Landuse Area Locations

Table 4-3 Summary of Fraction Imperviousness for each Landuse Area and Option

Landuse Type	FI (%)				
	Op1_PRE	Op2_EXG_EB	Op3_EXG_UB	Op4_EXG	Op5_ULT_EB
Centre	90	90	-	90	90

Landuse Type	FI (%)				
	Op1_PRE	Op2_EXG_EB	Op3_EXG_UB	Op4_EXG	Op5_ULT_EB
Community Facilities - School	50	50	-	50	50
Environmental Management and Conservation	0	0	-	0	0
High Density Residential	90	90	-	90	90
Industrial	90	90	-	90	90
Low Density Residential	65	65	-	65	65
Low Impact Industry	5	5	-	5	5
Medium Density Residential	85	85	-	85	85
Priority Development Area	0	0	-	0	80
Recreation and Open Space	0	0	-	0	0
Roads	90	90	-	90	90
Rural	0	0	-	0	0
Rural Residential	5	5	-	5	5

4.3.3 Landuse Results

Results have been extracted from the Storm Injector model at four (4) locations of interest. The flows have been extracted from outlets at catchments 28.10, 1.20, 1.34 and 81.09. These have visually been provided in Figure 4-7. Peak flow at the locations of interest have been provided in Table 4-4 with critical durations and adopted temporal patterns summarised in Table 4-5.

The results show that peak flows recorded at Location 3 (downstream of Yarrabilba) are reduced to flows similar in the pre landuse scenario. Pre-development landuse and existing landuse upstream of Yarrabilba are very similar (almost 0% impervious), thus flows at Location 1 and 2 for scenarios not including the storage basin are very high.

Table 4-4 Summary of Peak 1% AEP Flows at Key Locations

Option #	ID	Peak Discharge (m^3/s)			
		Location 1 (Catch 28.10)	Location 2 (Catch 1.20)	Location 3 (Catch 1.34)	Location 4 (Catch 81.09)
Option 1	Op1_PRE	81.9	190.3	395.7	34.0
Option 2	Op2_EXG_EB	29.8	115.7	354.7	47.7
Option 3	Op3_EXG_UB	-	-	-	-
Option 4	Op4_EXG	80.7	183.5	402.2	47.7
Option 5	Op5_ULT_EB	33.5	131.0	393.6	47.2

Table 4-5 Summary of 1% AEP Critical Durations at Key Locations

Option #	ID	Duration and TP Selection			
		Location 1 (Catch 28.10)	Location 2 (Catch 1.20)	Location 3 (Catch 1.34)	Location 4 (Catch 81.09)
Option 1	Op1_PRE	1.5 hr TP5	1.5 hr TP5	2 hr TP5	1.5 hr TP3
Option 2	Op2_EXG_EB	12 hr TP3	6 hr TP10	2 hr TP3	45 min TP5
Option 3	Op3_EXG_UB	-	-	-	-
Option 4	Op4_EXG	1.5 hr TP3	1.5 hr TP5	2 hr TP6	45 min TP5
Option 5	Op5_ULT_EB	6 hr TP6	2 hr TP2	1.5 hr TP5	45 min TP10

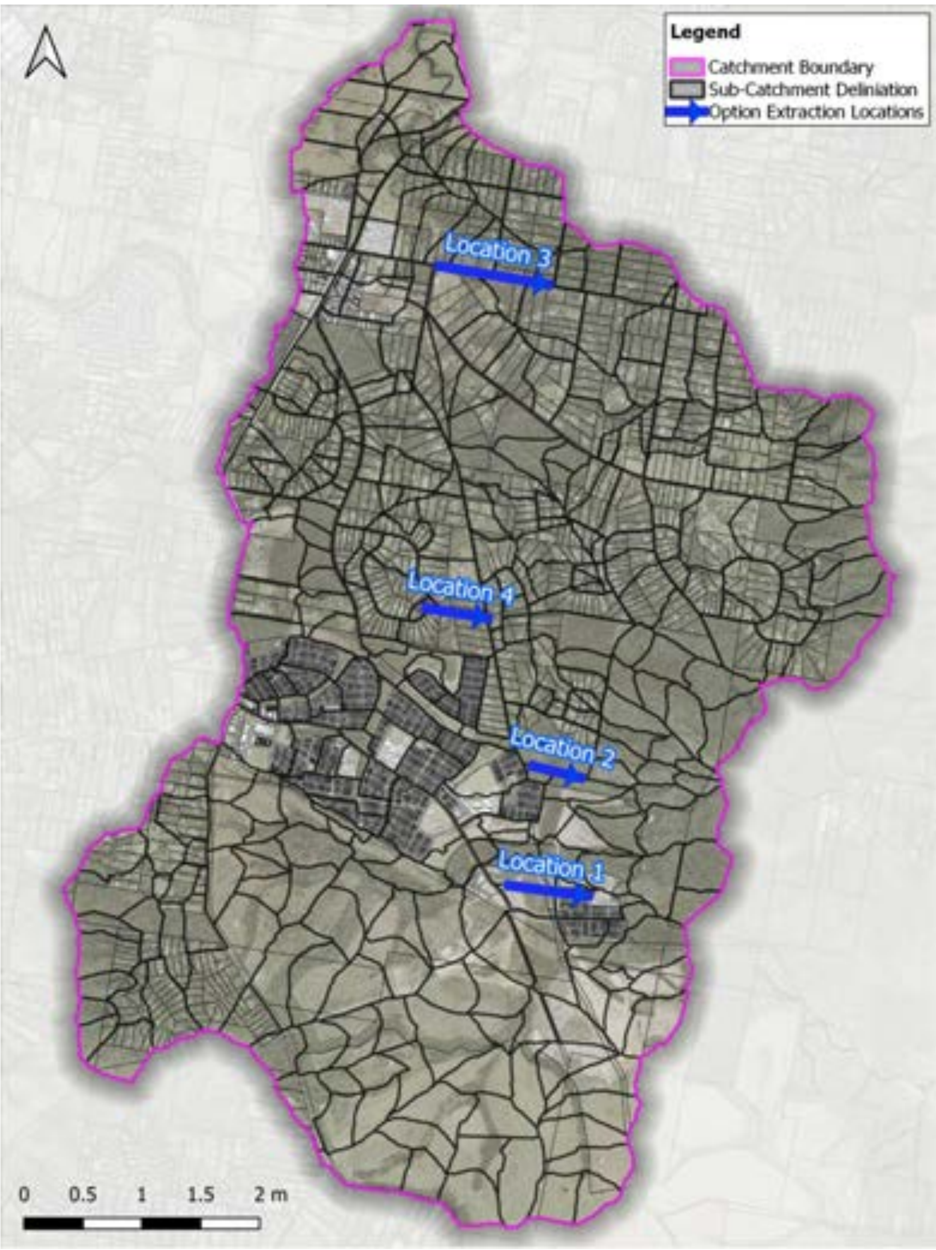

Figure 4-7 Option Flow Extraction Locations

4.3.4 Landuse Summary

It is noted that the hydraulic model will attenuate more flows as it takes into account local depressions and hydraulic structures. It is recommended that the landuse to be adopted for the design event hydrological and hydraulic modelling utilises the ultimate scenario landuse (Option 5) due to the inclusion on the storage basins in the LiDAR. Ultimate landuse upstream of existing Yarrabilba will achieve conservative representation downstream of Yarrabilba, without being overly conservative, due to the already designed and constructed storage basins.

4.4 Design Rainfall

4.4.1 Design Events up to the 0.05% AEP Event

IFD parameters adopted for the assessment have been sourced using the most recent IFD information prepared by the Bureau of Meteorology (BoM) and released in association with the ARR2019 revision. As the Quinzeh Creek catchment is greater than 20km^2, ARR2019 guidelines recommend using spatially varying rainfall. To satisfy this requirement, a series of sub-catchments were selected based on 2.5km^2 grids. These sub-catchments were processed using the Thiessen sampling approach and were sampled across the catchment and IFD data extracted for the centroid of each catchment. Sub-catchments within each grid were assigned the corresponding IFD data that was used in the generation of the design rainfall. The IFD Thiessen grid layout is illustrated in Figure 4-8. The actual IFD data sets applied for the analysis have been taken directly from the BOM as part of the ARR2019 procedures. An extract from the ARR2019 Data Hub is included in Appendix B and includes a summary of the IFD values adopted for this study.

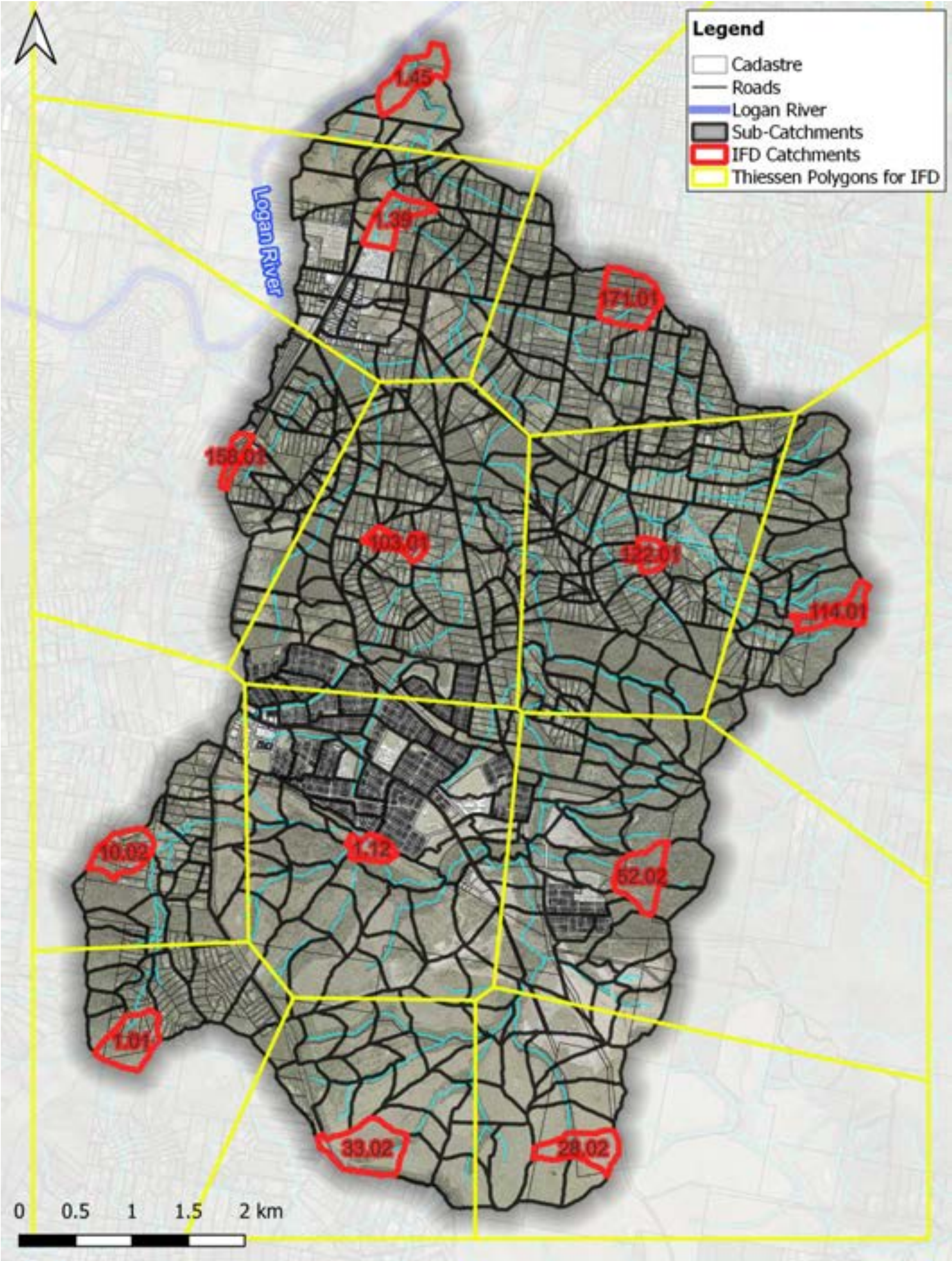

Figure 4-8 XP-RAFTS IFD Grids Layout

4.4.2 Preburst Depths

Preburst rainfall depths were applied in the Storm Injector model based on the preburst rainfall provided in ARR2019 Data Hub, a copy of which is included in Appendix B. The preburst rainfall depths were extracted from ARR Datahub on the central location from the total catchment. A summary of the median preburst rainfall depths based on duration and AEP are summarised in Table 4-6. Preburst depths applied for standard durations and events not represented in Table 4-6 has been interpolated and extrapolated as required by the software.

Table 4-6 ARR2019 Median Preburst Depths (Source – ARR2019)

Duration (mins)	Design AEP (%)					
	50	20	10	5	2	1
60	0.9	3	4.4	5.7	8.4	10.4
90	0.5	2.7	4.2	5.5	11.9	16.7
120	0.4	7	11.4	15.6	17.6	19.2
180	0.8	8.4	13.5	18.3	23.3	27
360	2.1	12.6	19.5	26.2	44.5	58.2
720	2.7	11	16.4	21.7	41.3	56

Preburst has been applied in the design event modelling (50% median values) process through subtraction from the Initial Loss values utilising the Storm Injector ARR2019 datahub toolbox. For events where the preburst exceeds the Initial Loss this excess rainfall has been accounted for through the application of initial water level grid which fills up all localised storages throughout the catchment.

4.4.3 Temporal Patterns

The point temporal pattern used the in hydrologic analysis of the Quinzeh Creek catchment has been derived from the ARR2019 Datahub and is constant for all sub-catchment, as the entire catchment falls within the North East Coast division. Areal temporal patterns have not been considered as critical storm duration throughout the catchments were less than 12 hours. Temporal pattern information determined from the ARR2019 Data Hub is included in Appendix B.

4.4.4 Probable Maximum Precipitation

An analysis of the Probable Maximum Flood (PMF) has been completed as part of this study. This assessment included an analysis of the Probable Maximum Precipitation (PMP) which was assessed using XP-RAFTS and Storm Injector based on the Generalised Short-Duration Method (GSDM). The requisite temporal pattern was determined utilising the derived design temporal distribution presented in Table 1 of Chapter 5 in the Bureau of Meteorology's GSDM methodology as presented in Table 4-7.

Table 4-7 Design Temporal Distribution of Short Duration PMP (Source – BOM, 2018)

% of time	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
% of PMP	0	4	10	18	25	32	39	46	52	59	64	70	75	80	85	89	92	95	97	99	100

4.4.5 Climate Change Increase in Rainfall Intensity

An analysis of climate change in respect to increases in rainfall intensity has been completed as part of this study. Specifically, this has included a sensitivity analysis undertaken for the 50% 20%, 10%, 5%, 2%, 1%, 1 in 200 and 1 in 500 AEP events to assess the effect of climate change via the application of increased rainfall intensities. These events have been selected and simulated for the ARR2019 climate change factors representing the year 2090 RCP 4.5 climate change scenario as a requirement for the LCC Flood Hazard Matrix as part of the FRMS. In addition, sensitivity on the 2090 RCP 6 and 2090 RCP 8.5 climate change scenarios has been undertaken for the 1% AEP event.

4.4.6 Rainfall Design Losses

Table 4-8 summarises the design losses applied in the XP-RAFTS model. The design losses were applied as a pervious and impervious loss separately within the XP-RAFTS model based on an Initial Loss (IL) and Continuing Loss (CL) rainfall loss model.

Table 4-8 lists the ARR2019 storm losses specified for each losses IFD grid. The losses chosen were initially based on ARR 2019 datahub values and were also guided by the calibration and validation undertaken as outlined in Section 6. Uniform storm losses for the catchment were desired due to its simplicity and adaptability to future developments. Hence, these values were adopted as it represents the holistic catchment. Lastly, as shown in Table 4-8 the PMF design AEP event has zero rainfall losses applied, except for a continuing loss of 1mm/hr.

Table 4-8 Summary of ARR2019 Design Losses

Design Event	Design Losses	
	Initial Loss (mm)	Continuing Loss (mm/hr)
Up to 1 in 2000 AEP	26	1.9
PMF	0	1

4.5 XP-RAFTS Links

The XP-RAFTS models have been prepared based on a link routing method using the Muskingum-Cunge routing methodology. The method derives the channel travel time (‘K’) and weighting coefficient (‘X’) from a user defined cross section. Multiple cross sections were extracted using the 2021 DEM and applied to the hydrologic routing links for the Quinzeh Creek catchment. The application of cross sections taken from the DEM allows physical representation of the catchment conditions which is then applied via the link routing to reflect catchment routing conditions more appropriately.

4.6 Catchment Land Use

In accordance with the project briefing requirements, the catchment land use scenario considered for the design flood estimates represents a fully developed catchment scenario in accordance with Council’s ultimate land use intent as articulated in the current Planning Scheme. This decision was also guided by the sensitivity undertaken in Section 4.3. As such, catchment land use for application in the XP-RAFTS models was determined in accordance with the planning scheme land use designation for which fraction impervious values in accordance with Section 4.05 of the Queensland Urban Drainage Manual (QUDM) were applied. Each of the sub-catchments in the XP-RAFTS model was determined based on the planning scheme zone classifications, with the overall percentage imperviousness for each sub-catchment prepared based on a spatially area averaged basis. The land use classifications were informed by the Zoning layer provided by the

LCC. Figure 4-9 illustrates the catchment land use map for the Quinzeh Creek catchment based on Council's current strategic plan. Fraction impervious values adopted for each of the respective land use zone classification are summarised in Table 4-9 and have been determined having regard to the guidance provided in the QUDM and for which represents the current guidance outlined in Council's planning scheme for land use fraction imperviousness.

Table 4-9 FI Values Adopted Based on Land Use Classification

Zone	Land Use	Fraction Impervious
Logan Planning Scheme	Centre	0.90
	Community Facilities - School	0.50
	Environmental Management and Conservation	0.00
	High Density Residential	0.90
	Low Density Residential	0.65
	Low Impact Industry	0.90
	Medium Density Residential	0.85
	Priority Development Area	0.80
	Recreation and Open Space	0.00
	Roads	0.90
	Rural	0.05
	Rural Residential	0.15
	Commercial	0.90
	Easement	0.15
	High Density Residential	0.90
	Open space	0.00
Yarrabilba Future Design	Priority Development Area	0.80
	Residential Retirement	0.85
	Residential Suburban	0.85
	Residential Urban	0.85
	Roads	0.90
	School	0.50
	Town Centre	1.00
	Community	0.90
	Commercial Mixed Use	0.90
	Suburban Residential	0.85
	Fauna Corridor	0.00
	Education	0.60
	Local Retail	0.90
	Enterprise Area	0.85

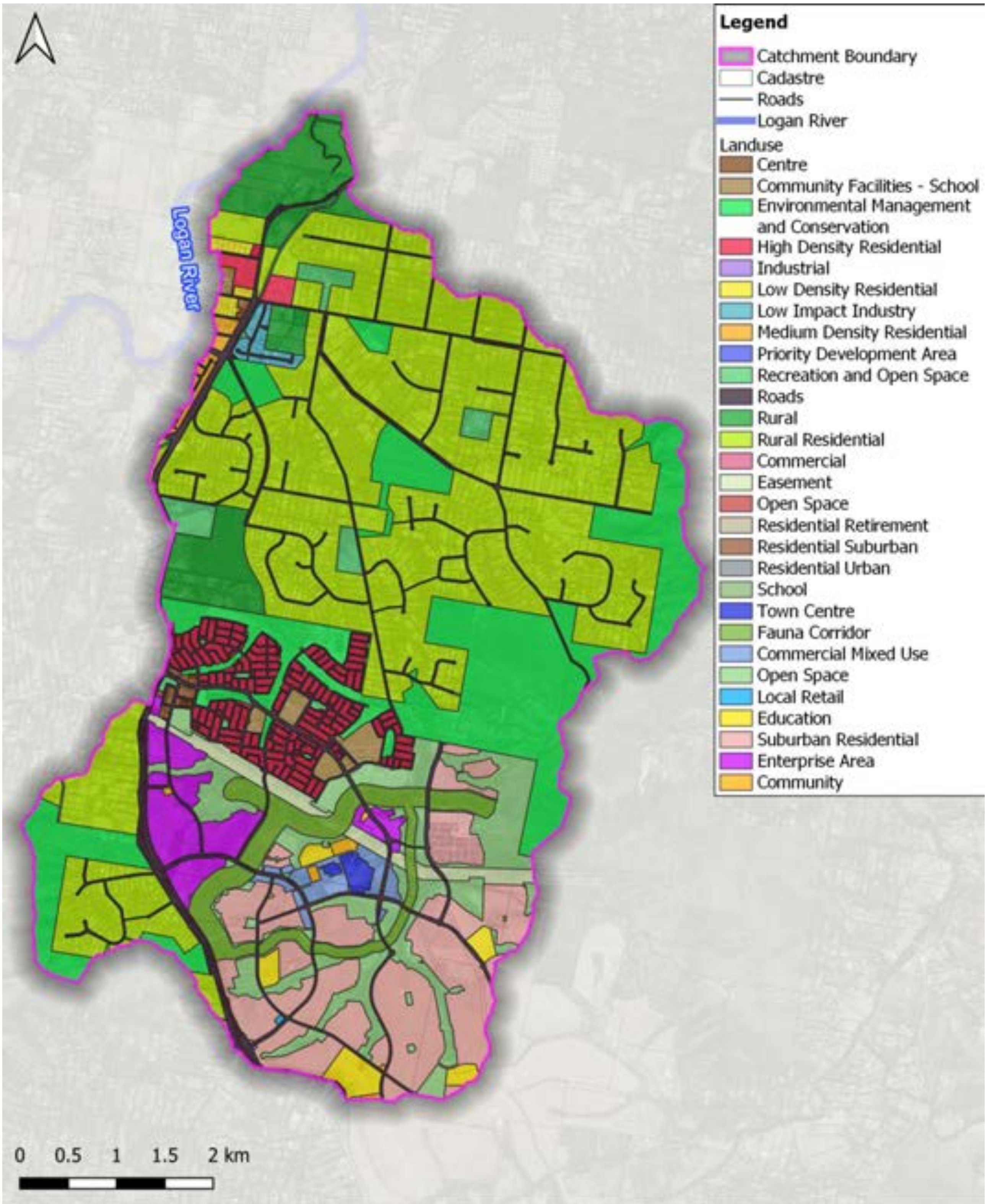

Figure 4-9 Landuse Classification Map – Quinzeh Creek

4.7 PERN Values

The PERN values for the model have been derived based on aerial data. The PERN values represent *"Mannings "n" representative of the average sub-catchment roughness"* (XP-Solutions, 2013). The PERN values applied have the effect of translating the catchment hydrograph modification factors (B modification values). Due to the PERN representing a hydrograph modification factor based on a representation of the catchment roughness for the pervious and impervious areas separately, broad scale values are appropriate and have subsequently been applied in the XP-RAFTS model. The PERN values adopted for the XP-RAFTS models are summarised in Table 4-10 and have been determined having regard to the hydraulic model and subsequent model calibration and validation approaches discussed separately in Section 6.

Table 4-10 PERN Model Parameters

XP-RAFTS Split Sub-Catchment	Sub-Catchment PERN Description	PERN Value
Pervious	Rural/Rural Residential	0.1
Impervious	Impervious Surfaces	0.025

4.8 Areal Reduction Factors

Rainfall over a catchment is spatially variable by nature. All parts of a large catchment (over 10km^2) generally do not experience rainfall intensity equally at a fixed point in time. Instead, it increases and decreases as the storm moves to and then away from the catchment. Therefore, using maximum rainfall intensities equally over a catchment is not accurate and in fact can overestimate the rainfall excess. The inclusion of Areal Reduction Factors (ARF) provides a correction factor for the catchment rainfall depth for a given combination of catchment area, AEP and rainfall duration.

The inclusion of ARF's is recommended in ARR2019 for catchments greater than 1km^2 in area to 30,000km^2, with partial storms recommended for catchments greater than 5,000km^2. As the Quinzeh Creek catchment has an area of approximately 40km^2, ARF's are to be applied as recommended in ARR2019.

Given the intent of the current study is to provide a future flood overlay map under the planning scheme and to derive flood planning levels upon which development compliance will be assessed, it may be appropriate to adopt an ARF of unity which does not adjust rainfall depths and results in a degree of conservatism. However, while this approach may be appropriate, it is strictly not in accordance with ARR2019. Accordingly, for the purposes of this study, ARF's have been applied to all storms as per ARR2019 guidance for durations less than or equal to 12-hours and for catchment areas of between 10 and 1000 km^2. The ARF's have been calculated based on the area to the centroid of each catchment. That is, ARF's based on an area of 20.09km^2 have been applied to the entire catchment area. A summary of the ARF's for all events are supplied in Table 4-11 and Table 4-12. As can be seen from Table 4-11, the subsequent reduction in rainfall depths are relatively minor (approximately 3-20%).

Table 4-11 Summary of Aerial Reduction Factors for Events up to 1% AEP

Duration (mins)	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
15	0.816	0.809	0.804	0.799	0.792	0.787
30	0.868	0.860	0.854	0.849	0.841	0.835
45	0.891	0.883	0.876	0.870	0.861	0.855
60	0.906	0.896	0.889	0.882	0.872	0.865
90	0.923	0.912	0.903	0.895	0.884	0.875
120	0.933	0.921	0.911	0.902	0.889	0.879
180	0.946	0.932	0.921	0.911	0.897	0.886
360	0.962	0.955	0.950	0.944	0.937	0.931
540	0.970	0.966	0.963	0.960	0.956	0.953
720	0.974	0.970	0.967	0.964	0.960	0.957

Table 4-12 Summary of Aerial Reduction Factors for Extreme Events

Duration (mins)	0.5% AEP	0.2% AEP	0.05% AEP
15	0.782	0.776	0.765
30	0.829	0.821	0.810
45	0.848	0.840	0.827
60	0.858	0.848	0.834
90	0.867	0.855	0.838
120	0.870	0.857	0.838
180	0.875	0.861	0.840
360	0.926	0.918	0.907
540	0.950	0.946	0.939
720	0.954	0.950	0.944

4.9 Design Event Modelling

The detailed XP-RAFTS runoff-routing hydrology model for Quinzeh Creek catchment has been adopted for the design event modelling for this study and was analysed for the full suite of storm durations and temporal patterns of the 50%, 10% and 1% AEP design events only, as well as the PMF event. The remaining AEP events (63% AEP through to 0.05% AEP events), were selected based on the critical duration and median temporal pattern selection, based on the frequent, intermediate and rare temporal pattern bins from ARR2019. Section 7 of this report provides a separate discussion on the hydraulic results (and critical duration selection) as well as the further assessments completed in respect to the model sensitivity assessments.

The results of the XP-RAFTS model and ensemble event analysis is presented as a series of box and whisker plots which graphically illustrate the range of flow estimates in terms of medians and upper and lower quartiles. The box and whisker plots are included in Appendix C for Quinzeh Creek catchment and comprise of the 1% AEP, 10% AEP and 50% AEP design events at each of the catchment reporting locations defined in

Figure 4-10 (i.e. QC01 through to QC04). A summary of the box and whisker plots is also presented in tabular form as follows:

- 1% AEP summary – Table 4-13;
- 10% AEP summary – Table 4-14; and
- 50% AEP summary – Table 4-15.

The critical storm durations for the Quinzeh Creek catchment were found to range from the 90-minute storm through to the 540-minute storm event depending on event and location.

In respect to storm durations and critical durations, the critical storm durations outlined above relate to the hydrological model durations only. We note that the ultimate determination of storm durations throughout both catchments will be dictated by the determination of the ensemble water surface levels through the hydraulic model and for which the full ensemble events will be modelled across the three (3) selected design AEP events, representing the frequent, intermediate and rare temporal pattern bins. A critical duration analysis using the hydraulic model has been undertaken for this purpose and is discussed separately in Section 7.2.6.

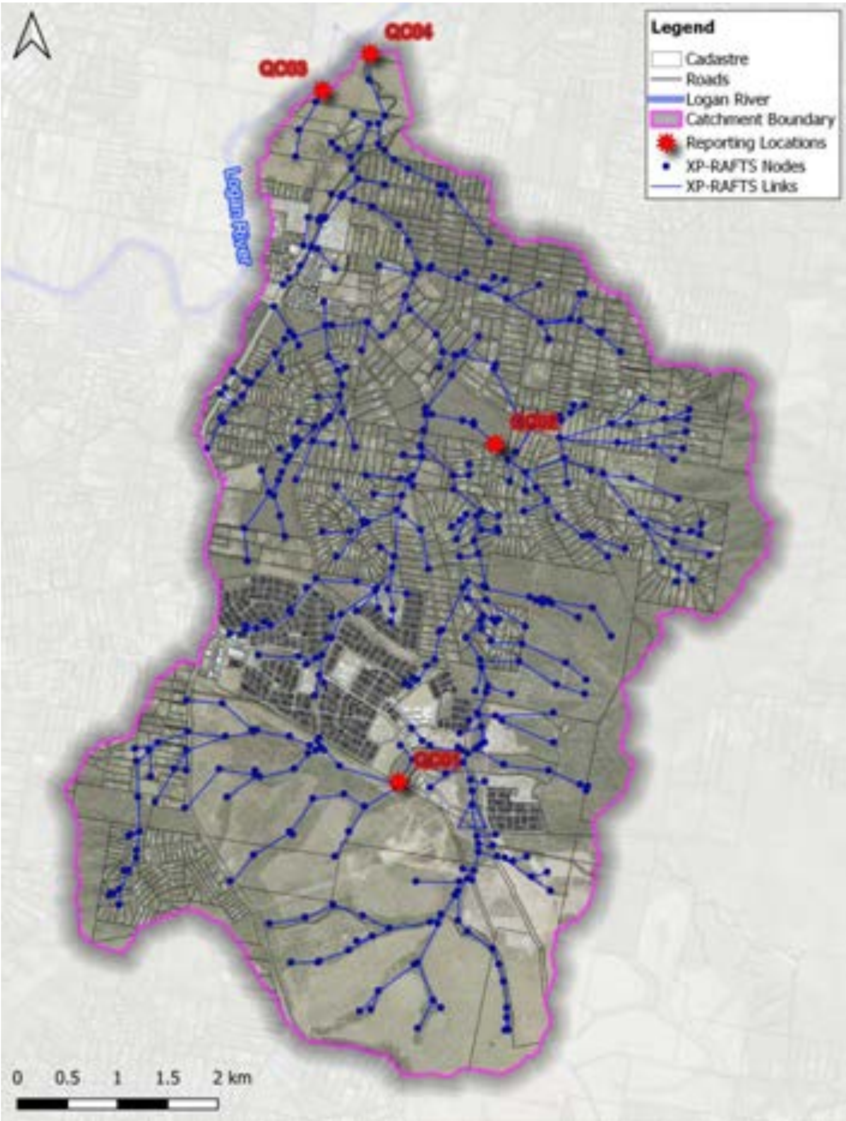

Figure 4-10 XP-RAFTS Reporting Location – Quinzeh Creek

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Table 4-13 Quinzeh Creek Temporal Pattern Summary – 1% AEP Event

Quinzeh Creek 1% AEP Critical Temporal Patterns				
Temporal Pattern	QC01	QC02	QC03	QC04
	120-Minute Peak Discharge (m^3/s)	90-Minute Peak Discharge (m^3/s)	120-Minute Peak Discharge (m^3/s)	90-Minute Peak Discharge (m^3/s)
TP1	83.2	75.5	6.3	364.1
TP2	95.4	89.4	5.9	399.1
TP3	85.8	90.1	6.2	400.6
TP4	82.9	67.9	5.9	328.3
TP5	84.2	84.2	6.0	382.0
TP6	92.4	94.9	6.1	416.6
TP7	83.7	77.7	6.0	367.3
TP8	87.2	79.1	6.2	353.9
TP9	88.8	94.7	6.7	397.3
TP10	93.5	99.7	7.2	411.8
Max Flow	**95.4**	**99.7**	**7.2**	**416.6**
Min Flow	**82.9**	**67.9**	**5.9**	**328.3**
Median Flow	**86.5**	**86.8**	**6.2**	**389.7**
Mean Flow	**87.7**	**85.3**	**6.2**	**382.1**
Critical Flow	**87.2**	**84.2**	**6.3**	**382.0**

Table 4-14 Quinzeh Creek Temporal Pattern Summary – 10% AEP Event

Quinzeh Creek 10% AEP Critical Temporal Patterns				
Temporal Pattern	QC01	QC02	QC03	QC04
	180-Minute Peak Discharge (m^3/s)	120-Minute Peak Discharge (m^3/s)	180-Minute Peak Discharge (m^3/s)	180-Minute Peak Discharge (m^3/s)
TP1	37.7	53.8	2.9	185.7
TP2	39.4	49.7	2.8	205.4
TP3	41.0	38.8	2.9	190.8
TP4	48.2	41.9	3.6	221.5
TP5	37.6	48.9	3.0	178.6
TP6	47.2	45.4	3.6	220.7
TP7	49.8	46.4	3.9	232.8
TP8	47.5	49.0	3.5	218.7
TP9	49.3	48.9	3.6	229.2
TP10	53.7	47.0	4.0	238.6
Max Flow	**53.7**	**53.8**	**4.0**	**238.6**
Min Flow	**37.6**	**38.8**	**2.8**	**178.6**
Median Flow	**47.3**	**47.9**	**3.5**	**219.7**
Mean Flow	**45.1**	**47.0**	**3.4**	**212.2**
Critical Flow	**47.2**	**47.0**	**3.5**	**218.7**

Table 4-15 Quinzeh Creek Temporal Pattern Summary – 50% AEP Event

Quinzeh Creek 50% AEP Critical Temporal Patterns				
Temporal Pattern	QC01	QC02	QC03	QC04
	540-Minute Peak Discharge (m^3/s)	1080-Minute Peak Discharge (m^3/s)	540-Minute Peak Discharge (m^3/s)	540-Minute Peak Discharge (m^3/s)
TP1	25.3	8.6	1.8	119.2
TP2	10.4	25.9	0.7	53.5
TP3	22.4	19.9	1.5	99.6
TP4	21.6	11.5	1.5	103.1
TP5	22.7	8.3	1.6	102.1
TP6	22.1	12.0	1.5	99.5
TP7	20.5	11.1	1.4	96.1
TP8	14.8	24.0	1.1	68.6
TP9	16.9	14.2	1.3	90.0
TP10	18.7	25.6	1.2	84.6
Max Flow	**25.3**	**25.9**	**1.8**	**119.2**
Min Flow	**10.4**	**8.3**	**0.7**	**53.5**
Median Flow	**21.0**	**13.1**	**1.4**	**97.8**
Mean Flow	**19.5**	**16.1**	**1.4**	**91.6**
Critical Flow	**20.5**	**19.9**	**1.4**	**90.0**

5 HYDRAULIC MODEL

5.1 Introduction

To assess hydraulic characteristics for the Quinzeh Creek catchment, a single discrete 1D/2D TUFLOW model has been developed. The following section of this report aims to provide a detailed summary of the TUFLOW hydraulic model development and setup prepared for the catchment.

5.2 Model Updates and Revision Summary

5.2.1 Boundaries

5.2.1.1 Code Boundary

The prepared model code boundary for this study contains the major streams and flow paths of the Quinzeh Creek catchment. It has been developed to contain the PMF flood extent and spans from the junction of Williamson Road and Waterford Tamborine Road down to the confluence with the Logan River. The downstream outflow boundary of this hydraulic model extent has been placed at the catchment outlet, slightly upstream of the Logan River along with two additional outflow boundaries. The eastern boundary extends from outlet of the Quinzeh Creek catchment to Waterford-Tamborine Road, along the upstream reaches of the Quinzeh Creek and the Ooah Creek Catchment. The second boundary is the outlet of the small creek catchment adjacent to the Quinzeh Creek Catchment as illustrated in Figure 5-1.

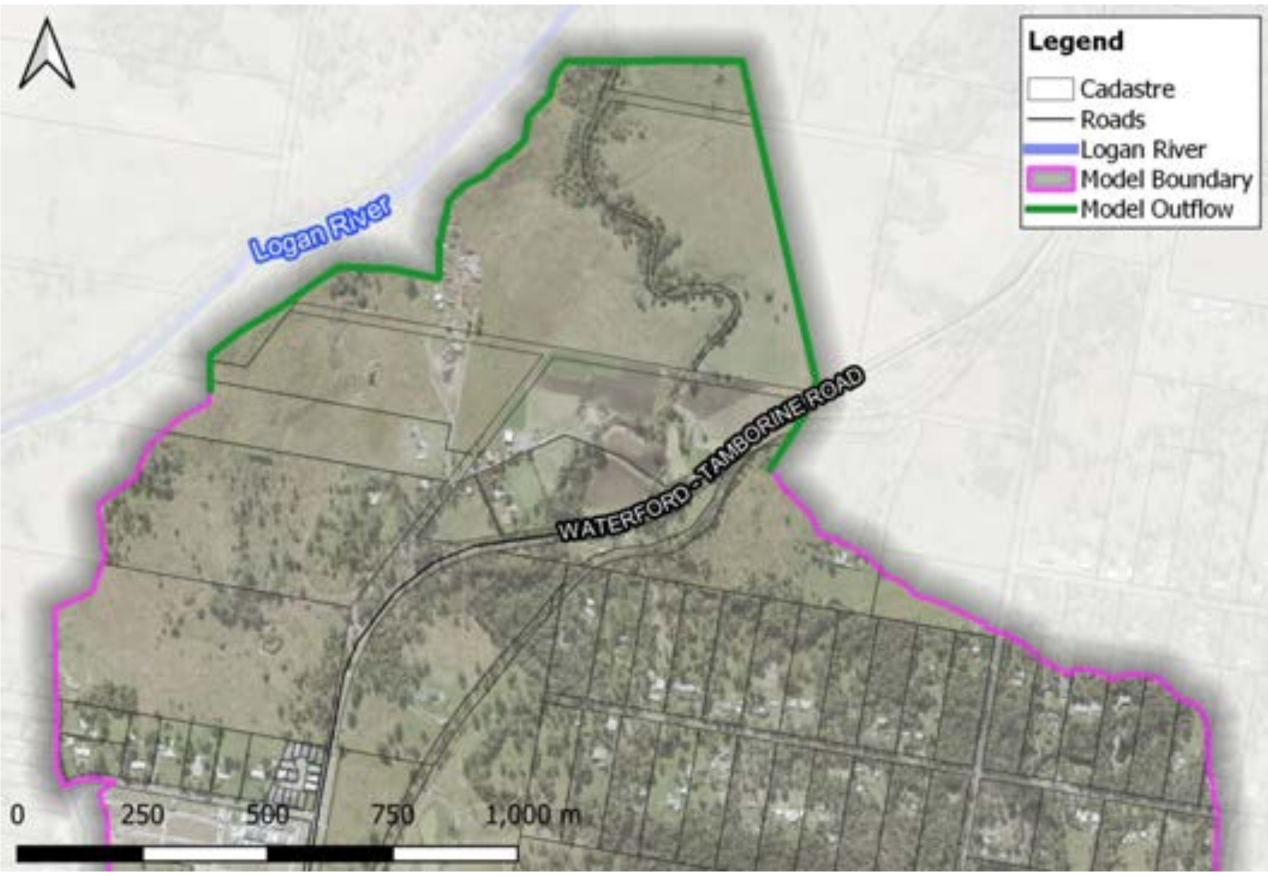

Figure 5-1 Quinzeh Creek Catchment Outflow Boundaries

5.2.1.2 Inflow Boundaries

Model inflows have been based on the sub-catchment breakdown for the Quinzeh Creek catchment XP-RAFTS hydrologic models. The inflows have been represented in the hydraulic model as a series of local and total catchment Source Area (“SA”) inflow boundaries. In an urbanised setting, the model’s inflows are represented as total flows, where water is directly added to the waterway corridor.

5.2.2 Tailwater Boundaries and Coincident Flooding Considerations

It is acknowledged that the lower portions of the Quinzeh Creek catchment are significantly impacted by regional flooding from the Logan River, with the Logan River completely dominating flood planning levels in the downstream reaches. The respective catchment sizes of the Logan River to that of the Quinzeh Creek catchment are vastly different. Note that the Logan River catchment area to the Yarrahappini gauge situated near the study area catchments is approximately 2416 km^2 compared to the local catchment study area of approximately 40km^2. The Quinzeh Creek catchment represents less than 2% of the Logan River catchment to the confluence of the two systems

Given the distinctly different catchment areas, the discharge estimates between the regional and local catchments will also be vastly different. For example, the peak discharge for the 2015 event at the Yarrahappini gauge approached 4000m^3/s based on the Department of Natural Resources, Mines and Energy (DNRME) gauge records, with Quinzeh Creek catchment 1% AEP peak flows estimated to be within the range of 270m^3/s. The local catchment 1% AEP flow therefore represents only approximately 7% in total peak discharge at the confluence point.

Given the vastly different catchment areas and subsequent peak flows, along with the significant differences in catchment timing, it is unlikely that coincident flooding would occur between the regional and local catchment systems. That is, a 1% AEP local flood event would likely occur in combination with a low water level in the regional Logan River. However, design planning levels at least in the lower portion of the local catchment will be set based on regional logan river levels. As such, the Quinzeh Creek model has used coincident levels based on the ratio of the local catchment to regional catchment size to define the 1% AEP coincident regional level. The ratio of local to regional catchment areas and resultant 1% AEP regional tailwater levels have been calculated using Table 5-1 below.

Table 5-1 Coincident Regional Flood Events for Local Tributary Modelling (Ipswich City Council Implementation Guideline)

Ratio ff Local to Regional Catchment Area (A_L/A_R)	Regional Event Combination to Define 1% AEP Flood Level in Local Tributary (AEP)
<0.001	50%
0.001-0.01	20%
0.01-0.1	5%
0.1-0.2	2.5%
>0.2	1%

The remaining AEP’s have been scaled down (or up) as necessary. The Local River tailwater levels for each AEP have been summarised below in Table 5-2.

Table 5-2 Design Logan River Tailwater Levels

Quinzeh Creek Design Event	Proposed DS level (m AHD)	Description (LAFS, WRM 2021)
63.2%	-	Normal depth boundary
50%	-	Normal depth boundary
50% RCP 4.5	-	Normal depth boundary
20%	-	Normal depth boundary
20% RCP 4.5	-	Normal depth boundary
10%	7.0	50% AEP regional flood event at confluence
10% RCP 4.5	7.0	50% AEP regional flood event at confluence
5%	10.5	20% AEP regional flood event at confluence
5% CC RCP4.5	10.5	20% AEP regional flood event at confluence
2%	12.9	10% AEP regional flood event at confluence
2% CC RCP4.5	12.9	10% AEP regional flood event at confluence
1%	14.9	5% AEP regional flood event at confluence
1% CC RCP4.5	14.9	5% AEP regional flood event at confluence
1% CC RCP6	14.9	5% AEP regional flood event at confluence
1% CC RC.8.5	14.9	5% AEP regional flood event at confluence
0.5%	14.9	5% AEP regional flood event at confluence
0.5% CC RC.4.5	14.9	5% AEP regional flood event at confluence
0.2%	14.9	5% AEP regional flood event at confluence
0.2% CC RC.4.5	14.9	5% AEP regional flood event at confluence
0.05%	17.2	1% AEP regional flood event at confluence
PMP	17.2	1% AEP regional flood event at confluence

5.2.3 Model Topography

The model topography represented in the hydraulic model is based on 2021 LiDAR data supplied by Council and forms the base elevations of Quinzeh Creek catchment hydraulic model. Further topographic modifications have been made to amend misrepresented ground levels around road crossings, culvert inlets/outlets and other significant areas within the model. Additionally, elevation adjustment datasets provided by Council or as sourced from DTMR have also been applied as are outlined in Table 5-3. This dataset provides the best information to inform local topography within this area and has subsequently been applied in the hydraulic model.

Table 5-3 Model Topography Adjustment Datasets

Dataset	Description
17-211_tin_P04A_B_C_6D_DESIGN_221010_MGA20.asc	South Yarrabilba Design Crossing - as Provided by Design Flow. Construction Completed after LiDAR capture.
2d_zsh_QZH_Road_Fix_009_R.shp	Removal of Bridges in 2021 LiDAR
2d_zsh_Road_Enforce_014_L.shp 2d_zsh_Road_Enforce_014_P.shp	Road break lines sampled on 2021 LiDAR.
2d_zsh_Topo_Mods_009_L.shp 2d_zsh_Topo_Mods_009_P.shp	Streamline to enforce Quinzeh Creek channel due to dense vegetation.
2d_zsh_QZH_Culvert_Fix_012_R.shp	Culvert Aprons at Yarrabilba Detention Basins.

5.2.4 Floodplain Roughness

Floodplain roughness values were derived based on the latest available Google imagery and high resolution 10cm aerial imagery flown in conjunction with the 2021 LiDAR for the catchment. A summary of the adopted roughness values based on classification type is presented in Table 5-4. Figure 5-2 illustrates the spatial variation in floodplain roughness applied in the hydraulic model. The model roughness for this study has been updated and informed with consideration of the XP-RAFTS hydrology model in a joint calibration process which is discussed separately in Section 6. It is acknowledged that design event simulations consider ultimate landuse in the hydrologic model, it was determined in agreement with LCC that without detailed information of future developments that there would be no changes to the floodplain roughness. This assumption is that the waterway corridors would be maintained in future development scenarios

A sensitivity assessment has additionally been undertaken on the floodplain roughness. The results of this sensitivity assessment are discussed separately in Section 7.2.7.

Table 5-4 Adopted Floodplain Roughness Values

Roughness Classification	Manning's 'n'
0.025	Road and Road Reserve
0.045	Waterways
0.040	Farmland, Open Space
0.060	Light Vegetation
0.070	Medium Dense Vegetation
0.080	Dense Vegetation
0.300	Buildings
0.030	Cleared and Compacted Pre-Developed Open Space

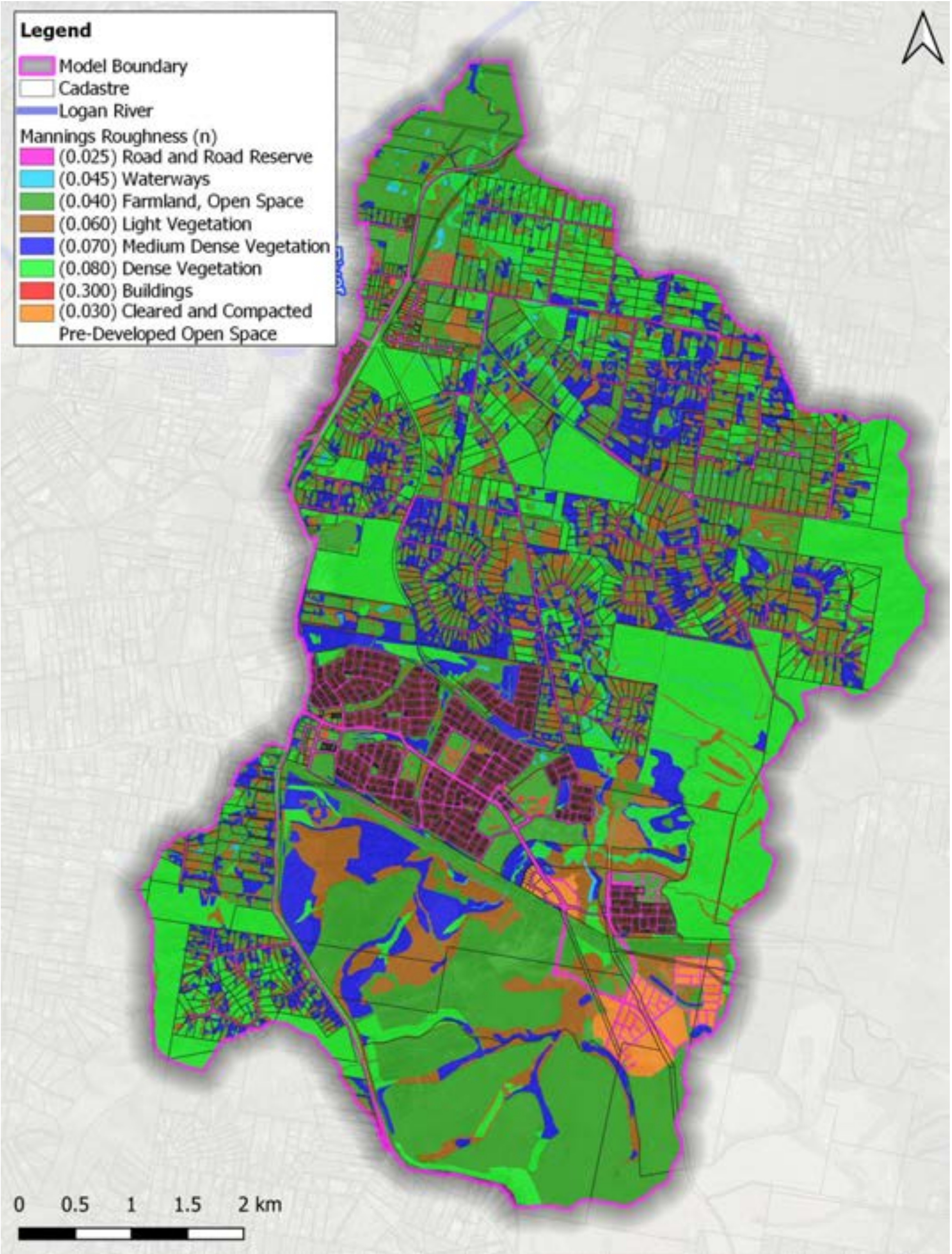

Figure 5-2 Quinzeh Creek Spatial Roughness

5.2.5 Hydraulic Structures

5.2.5.1 Bridge Structures

Quinzeh Creek is intersected by the Waterford Tamborine Road in the lower reaches of the catchment which comprises of a concrete bridge crossing. The structure, as illustrated in Figure 5-3, includes 2-column, square edged pier groups. The bridge crossing was represented in the hydraulic model as a layered flow constriction with and a 100% blockage applied for the deck and handrail structure. Other than this bridge structure, there were a further five (5) other bridges represented within the Quinzeh Creek catchment. There are no at site photography available at bridge locations. The hydraulic model parameters were approximated using a combination of Aerial photography, Google Street view and Council provided bridge datasets. Figure 5-4 provides the locality of the bridge structures included within the hydraulic model.

Figure 5-3 Waterford-Tamborine Road Bridge Structure (Source – WT, 2019)

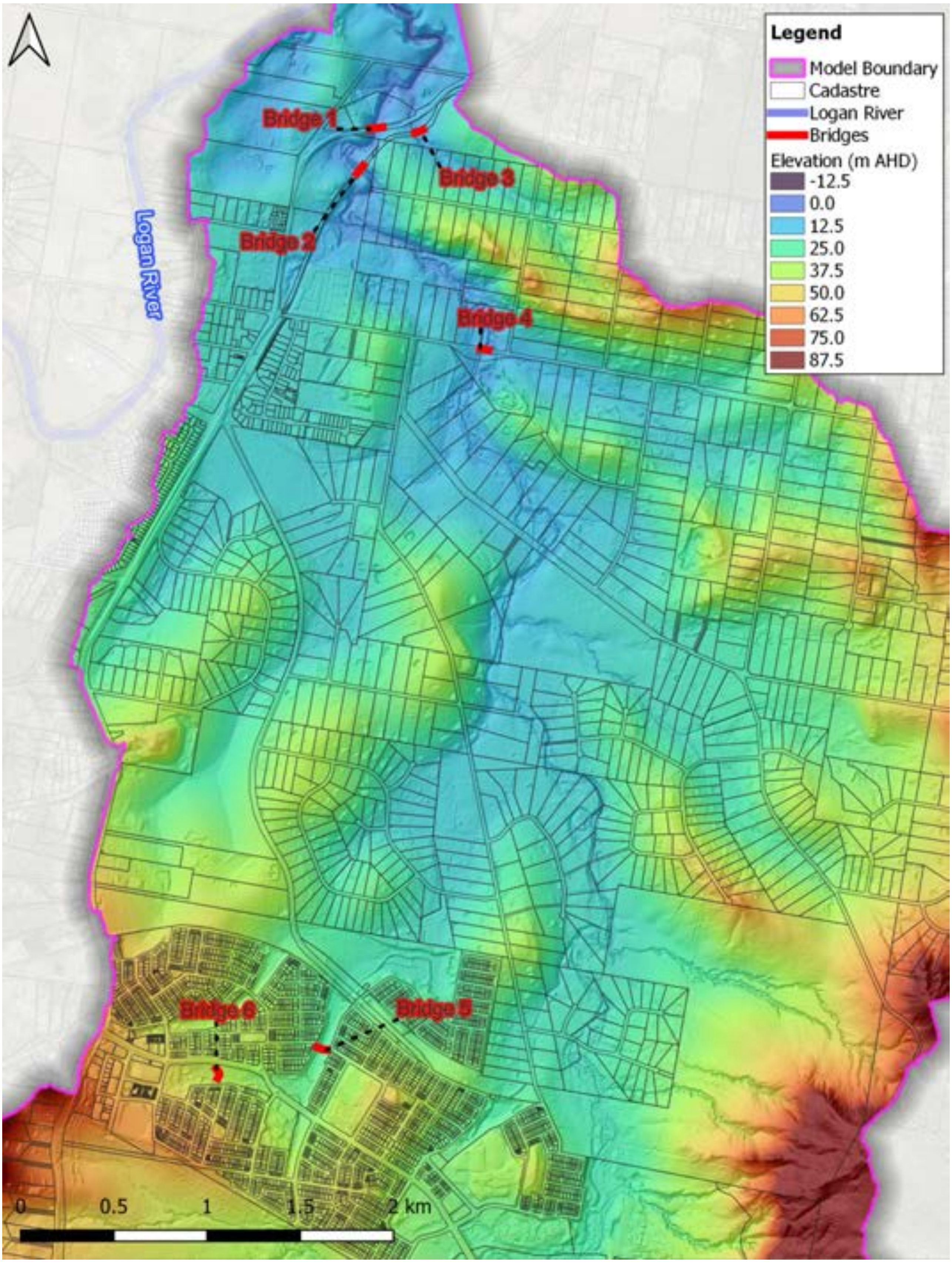

Figure 5-4 Modelled Bridge Structure Locations

5.2.5.2 Stormwater Pipes and Culverts

Council provided a partial GIS stormwater structure database containing structure types, sizes and elevations, along with multiple sets of as constructed design drawings containing relevant structure data as part of the base study information. The data sets were subject to review as part of this study for which has been discussed previously in Section 2. To fully represent the effect of the stormwater network structures, WT conducted a series of site inspections to physically observe and measure a range of existing culvert structures represented within the greater catchment area. As stated previously in Section 2.8, invert level data was adopted using the supplied 2021 LiDAR survey data for all structures in the absence of surveyed information.

5.2.5.3 Hydraulic Structure Design Losses and Blockage Conditions

The hydraulic model prepared for the Quinzeh Creek catchment included the following structure losses and blockage factors based on the ARR2019 Blockage Assessment. The catchment has been classified as medium for debris potential and adopting an L_{10} of 2 metres based on imagery and site observations. These blockage values have been applied to both the current climate and climate change scenarios.

Table 5-5 ARR2019 Blockage Matrix

AEP	$W < L_{10}$	$L_{10} \leq W \leq 3*L_{10}$	$W > 3*L_{10}$
50% to 10%	25	0	0
5% to 0.5%	50	10	0
0.2% to PMF	100	20	10

5.3 Hydraulic Design Event Modelling

The detailed TUFLOW model for Quinzeh Creek catchment has been used for the design event modelling for this study and was analysed for the full suite of storm durations and temporal patterns of the 50%, 10% and 1% AEP design evets only. These AEP events were chosen as they apply the frequent, intermediate and rare temporal pattern bins from ARR2019. The critical storms were selected as the median (6^{th} ranked) storm across the catchment. This subset of storms represents the probability neutral flood surface across the catchment and reduces the necessity to simulate all temporal patterns and durations for ARR2019 design.

As previously stated, the remaining AEP events (63% AEP through to 0.05% AEP events), were selected based on the critical duration and median temporal pattern selection, based on the frequent, intermediate and rare temporal pattern bins from ARR2019. Section 7 of this report provides a separate discussion on the hydraulic results (and critical duration selection) as well as the further assessments completed in respect to the model sensitivity assessments.

6 MODEL CALIBRATION AND VALIDATION

6.1 Introduction

As part of the previously completed Quinzeh Creek Flood Study, three (3) historical events were selected for calibration. These include:

- January 2013;
- April/May 2015; and
- March/April 2017.

The previously calibrated model became the basis of this overall Flood Study finalisation and as such the previous calibration has been provided in Appendix D.

During this study an additional validation event (February 2022) occurred and has been considered in the model updates which is contained and outlined in the following section. The following section outlines the model updates and results for the February 2022 event calibration for the XP-RAFTS and TUFLOW models for the Quinzeh Creek catchment.

6.2 Data Available

6.2.1 Stream Gauge Data

Water levels in Quinzeh Creek were recorded during the event at the Lower Quinzeh Alert (540688) and Yarrabilba Alert (12313) stream gauging stations. Figure 6-1 shows the recorded water level at the Lower Quinzeh Alert during the event. As evident from Figure 6-1, water levels started rising rapidly in Quinzeh Creek on Thursday 24 February 2022 and peaked at 15.05m AHD at 0700 hours on 1 March 2022.

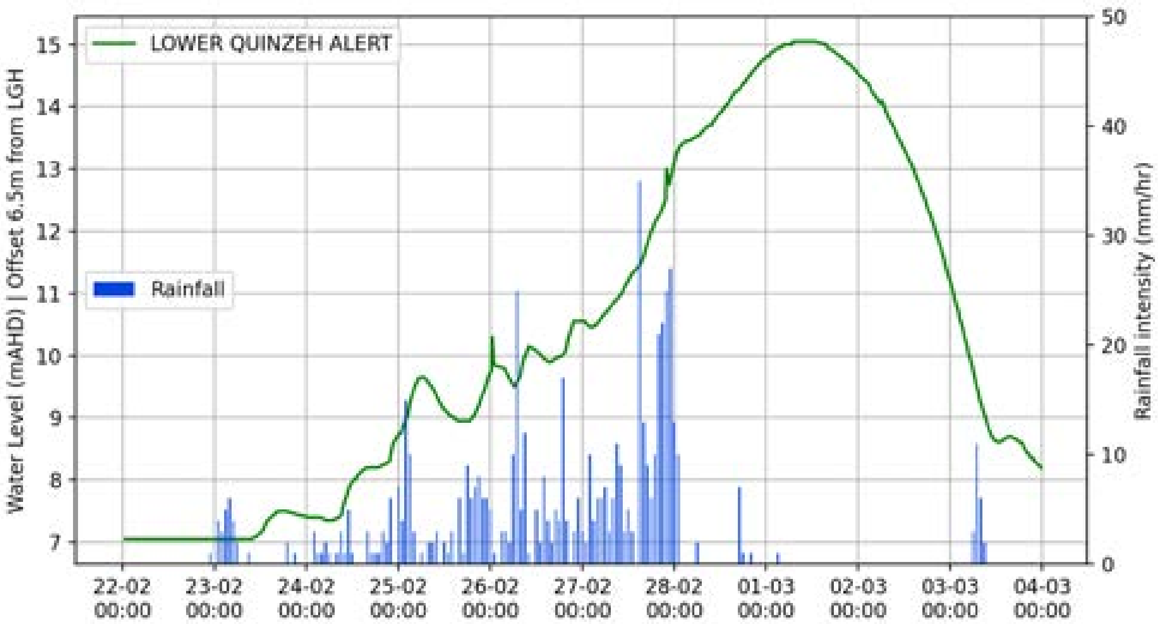

Figure 6-1 Water Level and Hourly Rainfall at Lower Quinzeh Alert (Gauge 540688) 22 February – 4 March 2022

6.2.2 Rainfall Data

6.2.2.1 Gauge Data

The Lower Quinzeh Alert (540688) rainfall station is located in the middle of the Quinzeh Creek catchment. Figure 6-2 shows the rainfall hyetographs and cumulative rainfall recorded at this rainfall station for the February 2022 event.

The available information indicates that the Lower Quinzeh Alert station recorded around 600mm of rainfall in the period 22 February to 4 March 2022. Hourly rainfall totals indicate that several storm events occurred during this period with the 3-day period from 25 February to 28 February 2022 being the most notable.

Table 6-1 and Figure 6-3 shows the recorded rainfall intensities and their estimated Annual Exceedance Probability (AEP) at the Lower Quinzeh Alert (540688). AEPs were estimated by comparing the recorded rainfalls to design rainfall intensities from the Bureau of Meteorology's Intensity-Frequency-Duration (IFD) rainfall data for storm durations of up to 96-hours. The data indicates the following:

- Rainfall intensities for storm durations of less than 3-hours had an Annual Exceedance Probability of up to 1 in 5 AEP;
- Rainfall intensities for the 6-hour – 24 hour storms had an Annual Exceedance Probability of 1 in 10 – 1 in 50 AEP;
- Rainfall intensities for storm durations of greater than 48 hours had an Annual Exceedance Probability of up to 1 in 100 AEP.

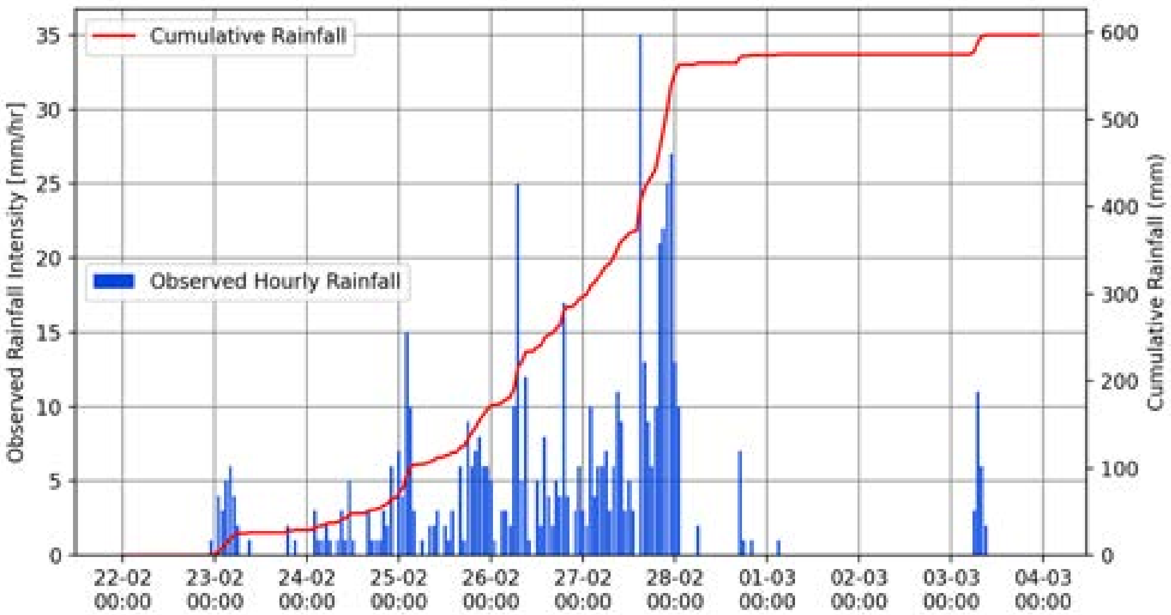

Figure 6-2 Hourly Rainfall Totals at Lower Quinzeh Alert (540688) 22 February – 4 March 2022

Table 6-1 IFD Table for Lower Quinzeh Alert (540688) 22 February – 4 March 2022

Duration		Max Rainfall	Intensity	Observed AEP
(hrs)	(mins)	(mm)	(mm/hr)	(AEP)
1	60	18	72	1 in 2
2	120	25	50	1 in 5
3	180	36	36	1 in 5 – 1 in 10
6	360	60	30	1 in 10 – 1 in 20
12	720	78	26	1 in 20 – 1 in 50
24	1440	122	20.3	1 in 20 – 1 in 50
48	2880	191	15.9	1 in 50
72	4320	264	11	1 in 100
96	5760	390	8.1	1 in 100

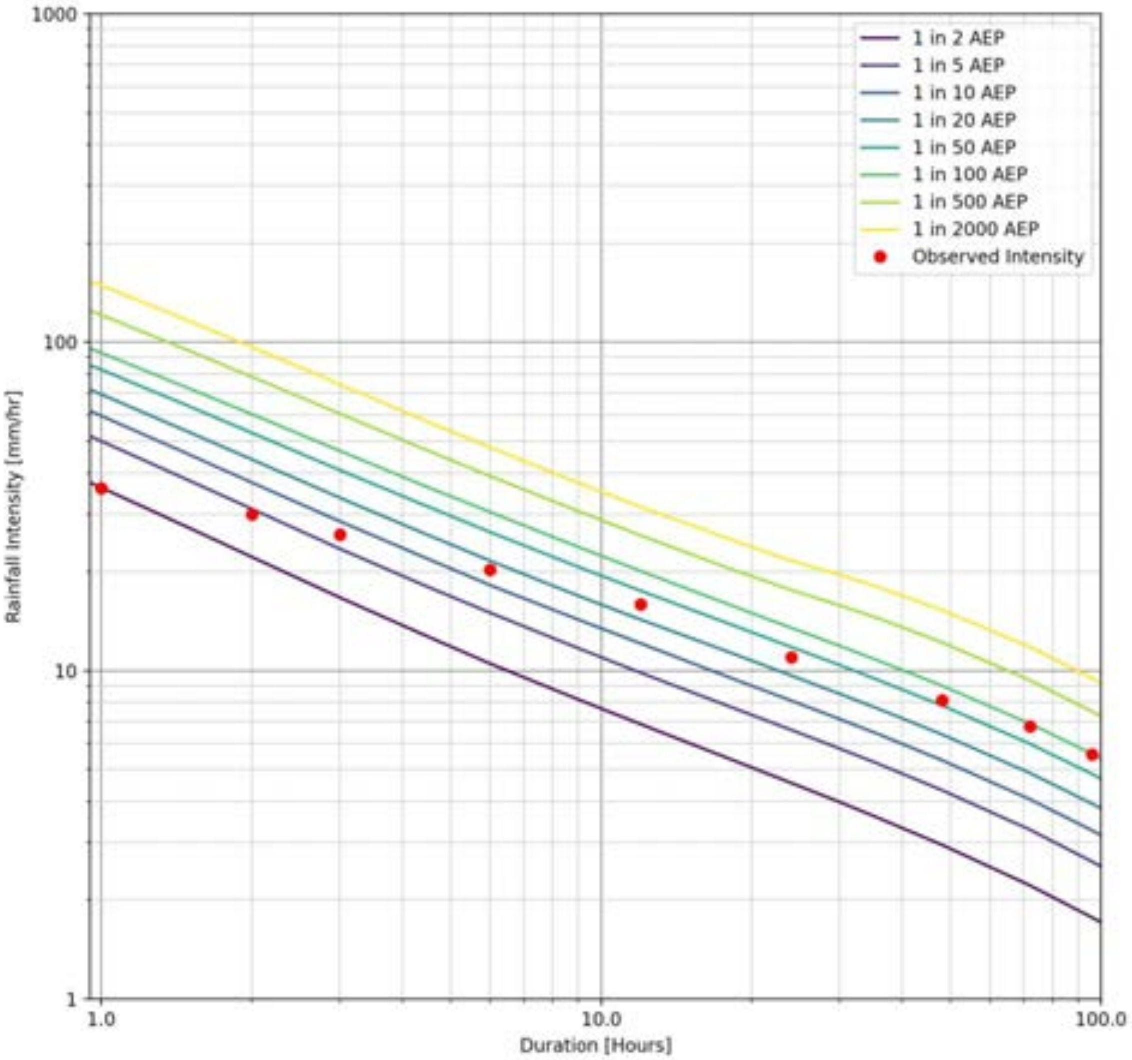

Figure 6-3 IFD Chart for Lower Quinzeh Alert (540688) 22 February – 4 March 2022

6.2.2.2 Calibrated RADAR

Given the limited number and spatial variability of catchment-based rainfall gauges, calibration for the Quinzeh Creek catchment has been undertaken using calibrated RADAR rainfall data sourced from HydroNET. The calibrated radar rainfall totals have been compared with the at-site rainfall gauges for both the Yarrabilba and Lower Quinzeh Rain gauges as illustrated in Figure 6-4 for the February 2022 event. Event total rainfall depths based on the calibrated radar rainfall data are found to compare favourably to the rain gauge totals. Given the outcomes from the rainfall event total comparisons above, along with the fact that the calibrated RADAR data provides a detailed account of rainfall temporal and spatial variability across the full extent of the catchment based on a 1km^2 grid, calibration of the February 2022 event has been prepared using calibrated RADAR rainfall only.

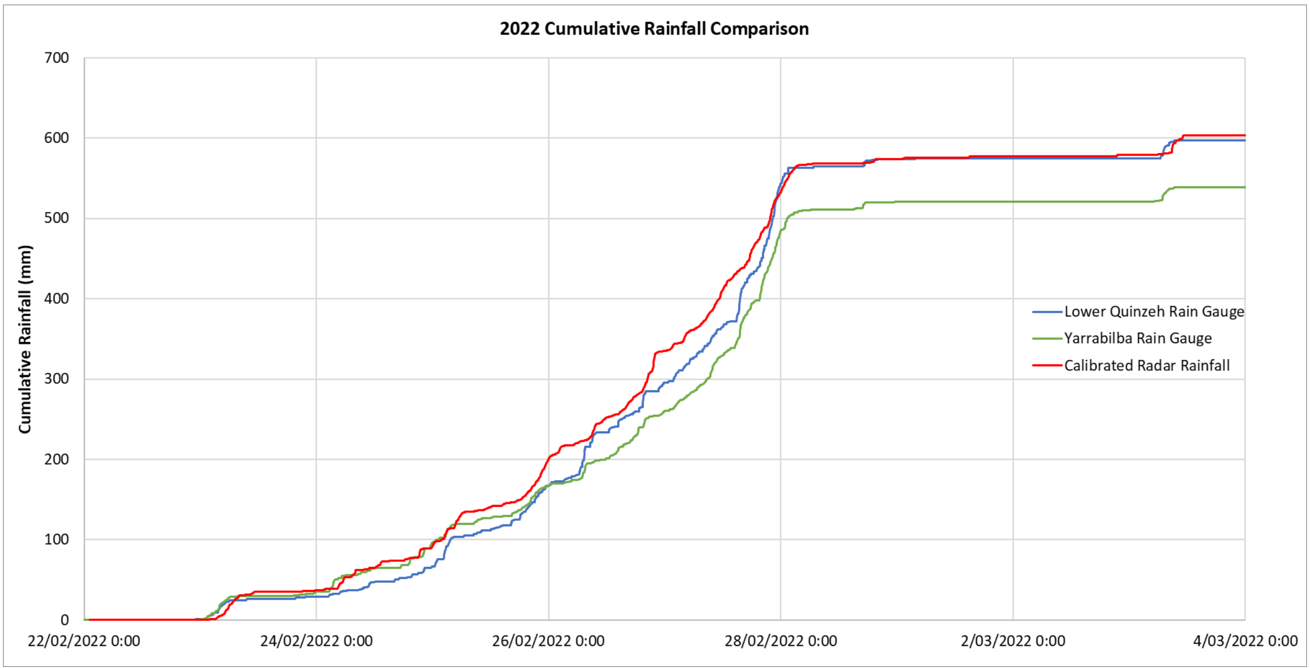

Figure 6-4 Cumulative Rainfall Comparison For 2022 Event

6.2.3 Tailwater Boundary

A downstream HT boundary was applied to the TUFLOW model and was based on the Logan Village Alert (540596) gauge along the Logan River. The Logan Village Alert gauge is located approximately 3500 metres upstream of the Quinzeh Creek and Logan River confluence. Based on the distance of the gauge from the outlet of Quinzeh Creek, the adopted downstream boundary condition was linearly adjusted between the Logan Village Alert (540596) gauge and the Waterford Alert (040878) gauge which is located further downstream. In addition, the adopted tailwater level was smoothed to reduce any potential model instabilities. Figure 6-5 presents the adopted tailwater level applied for the February 2022 calibration at the confluence of the Logan River and Quinzeh Creek.

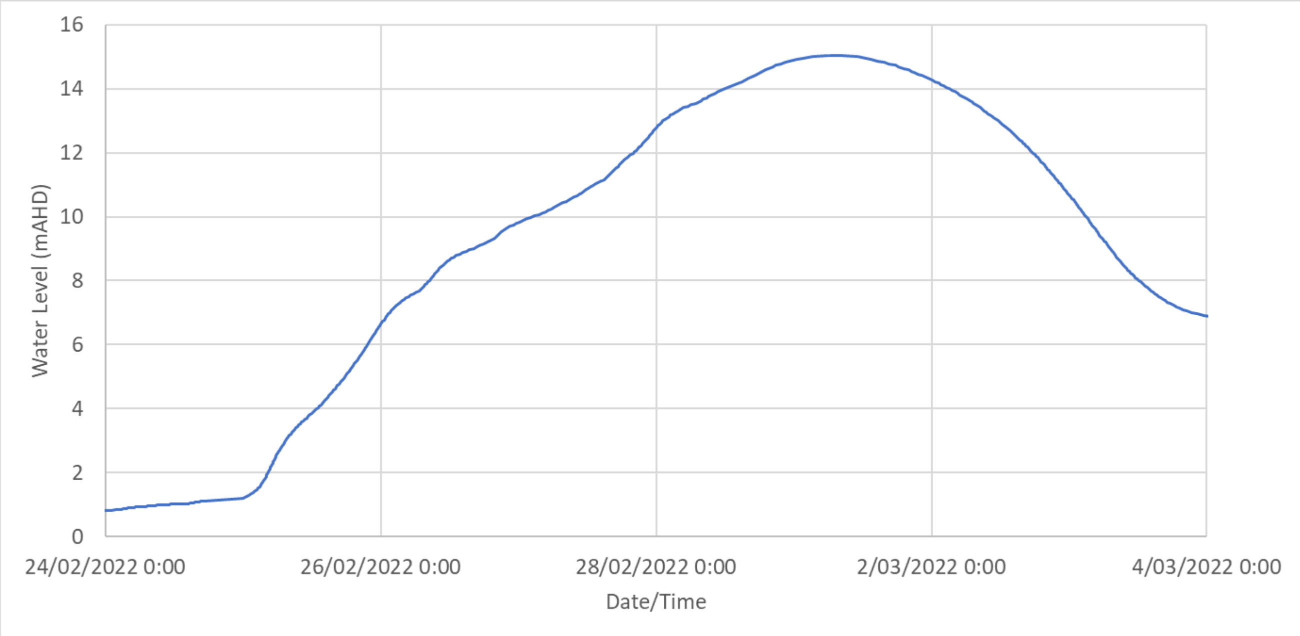

Figure 6-5 Adopted Dynamic Tailwater Level Applied to February 2022 Validation Event

6.3 Hydrological Modelling

6.3.1 Calibration Approach

The XP-RAFTS hydrologic model has been built to predict and inform the complementary TUFLOW hydraulic model of the flow discharging from each sub-catchment. This model has been adopted and adapted for the historical calibration. Calibrated radar rainfall has been applied in the model for the February 2022 event. The following sections briefly describe other changes adopted for the hydrologic model. Given the complexity of the catchment with significant storage no calibration flows have been compared to rated discharges in the hydrology model with all calibration undertaken by comparing TUFLOW water levels to recorded stream gauges.

6.3.2 Losses

Table 6-2 summarises the rainfall losses applied in the XP-RAFTS February 2022 calibration model. The storm losses were applied using an Initial Loss (IL) and Continuing Loss (CL) rainfall loss model. The ARR Datahub suggests an initial loss of 26mm for design event simulation. This is lower compared to the calibration values identified in this study and may be more appropriate for an urban catchment. However, it is considered that the initial loss observed in the calibration process is consistent and is reflective of the heavily vegetated catchment areas represented in the Quinzeh Creek catchment for which higher initial losses would be appropriate. In respect to continuing loss, the AR&R 2019 “data hub” recommends a continuing loss of 1.9mm/hr for the Quinzeh Creek catchment which is similar to the 2.0 mm/hr adopted for the calibration. Storm losses for the calibration events have been applied uniformly across the catchment.

Table 6-2 Summary of Adopted Rainfall Losses for Calibration and Design

Flood Event	Pervious Initial Loss (mm)	Continuing Loss (mm/hr)
2022 Event	80	2.0
ARR Datahub	26	1.9

6.4 Hydraulic Modelling

6.4.1 Calibration Results

Figure 6-6 and Figure 6-7 presents the TUFLOW modelled water level comparison to the recorded stream gauge levels at both the Lower Quinzeh Creek Alert gauge and Yarrabilba Alert Gauge respectively for the February 2022 event. In general, the model has represented the catchment response quite well with a good correlation in water level time series shapes for both rising and receding limbs. The model has slightly overpredicted water levels within the rising limb, however, has a good match to peak water levels at the Lower Quinzeh Alert gauge. The model has underpredicted the peak water level by approximately 650mm at the Yarrabilba Alert gauge which is subject to further discussions below.

Figure 6-8 presents the peak depth results from the TUFLOW model spatially mapped. As can be seen the event lead to widespread inundation across the catchment with inundation of several properties.

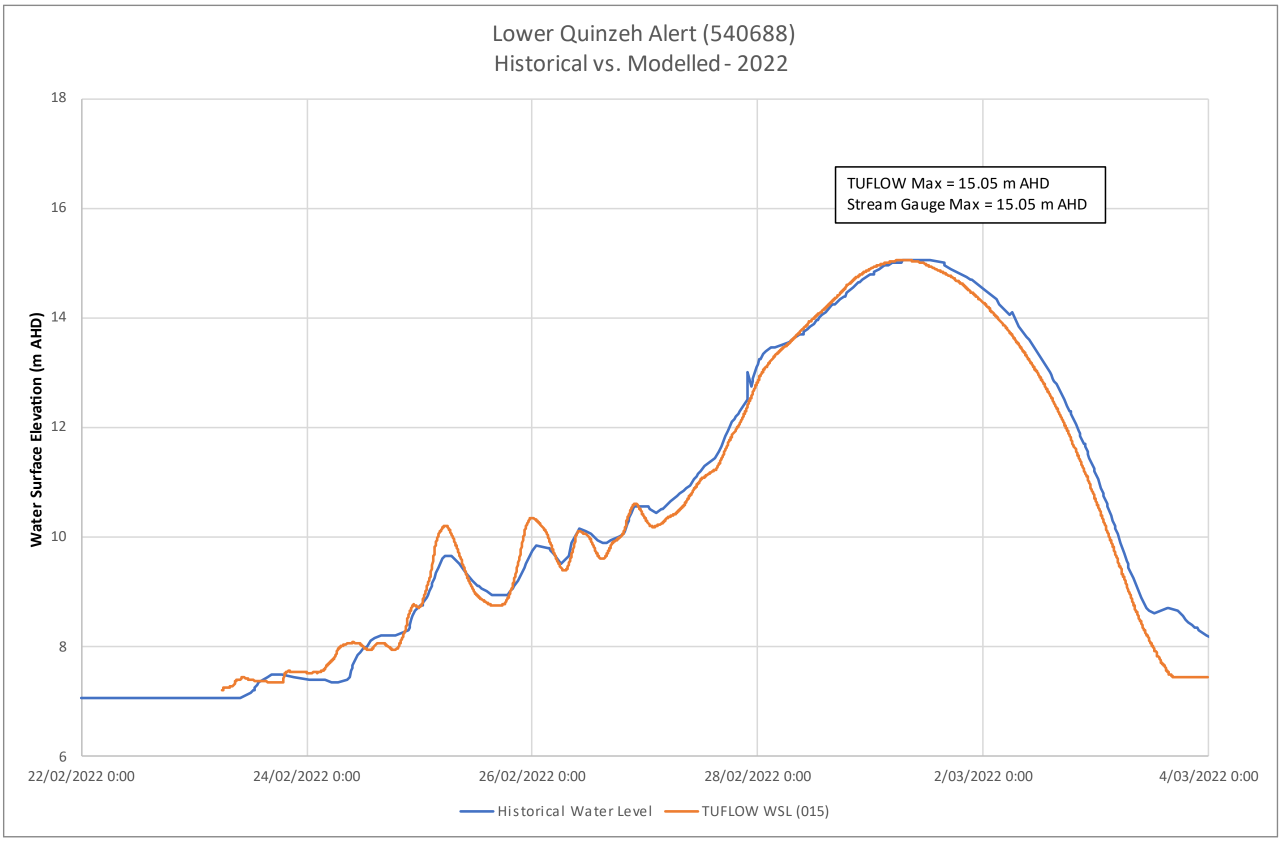

Figure 6-6 Recorded vs TUFLOW Modelled Levels at the Lower Quinzeh Alert Gauge

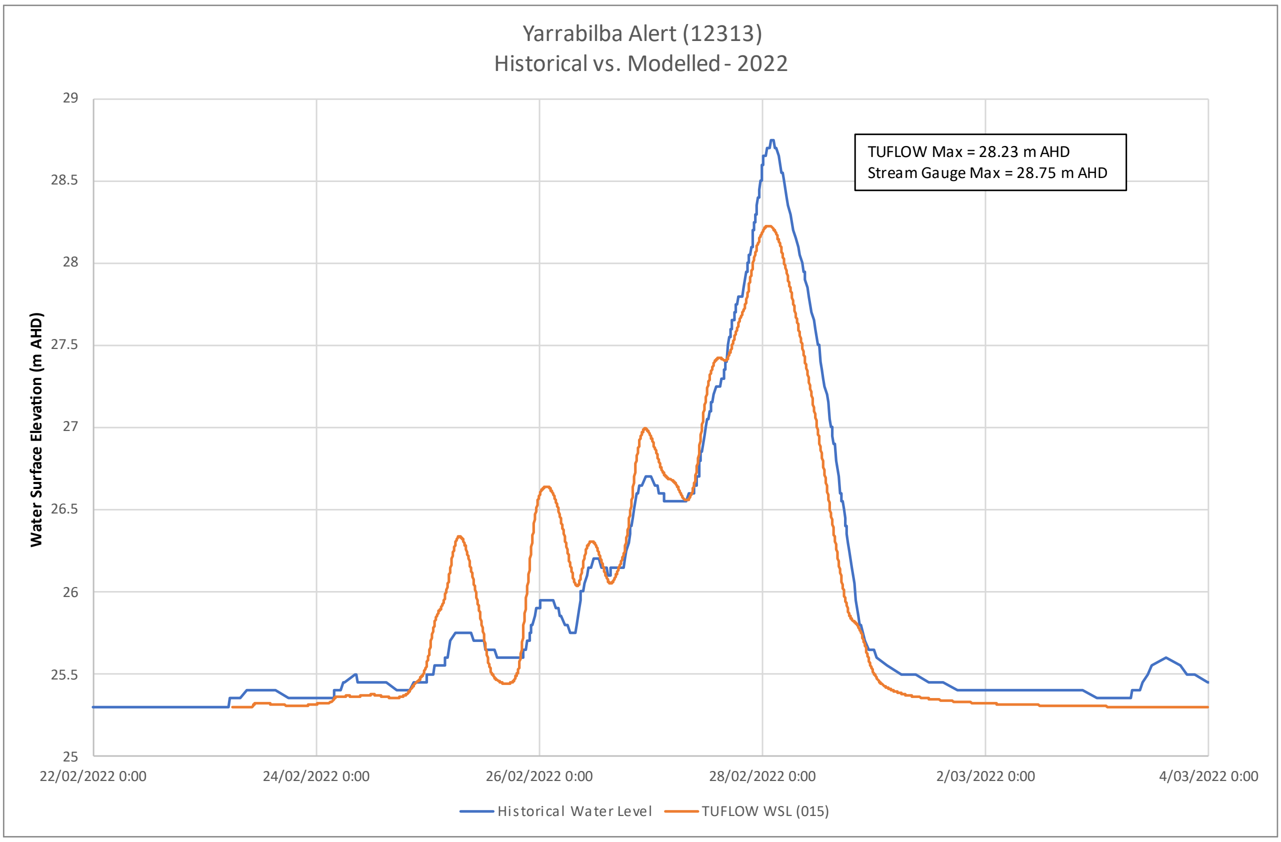

Figure 6-7 Recorded vs TUFLOW Modelled Levels at the Yarrabilba Alert Gauge

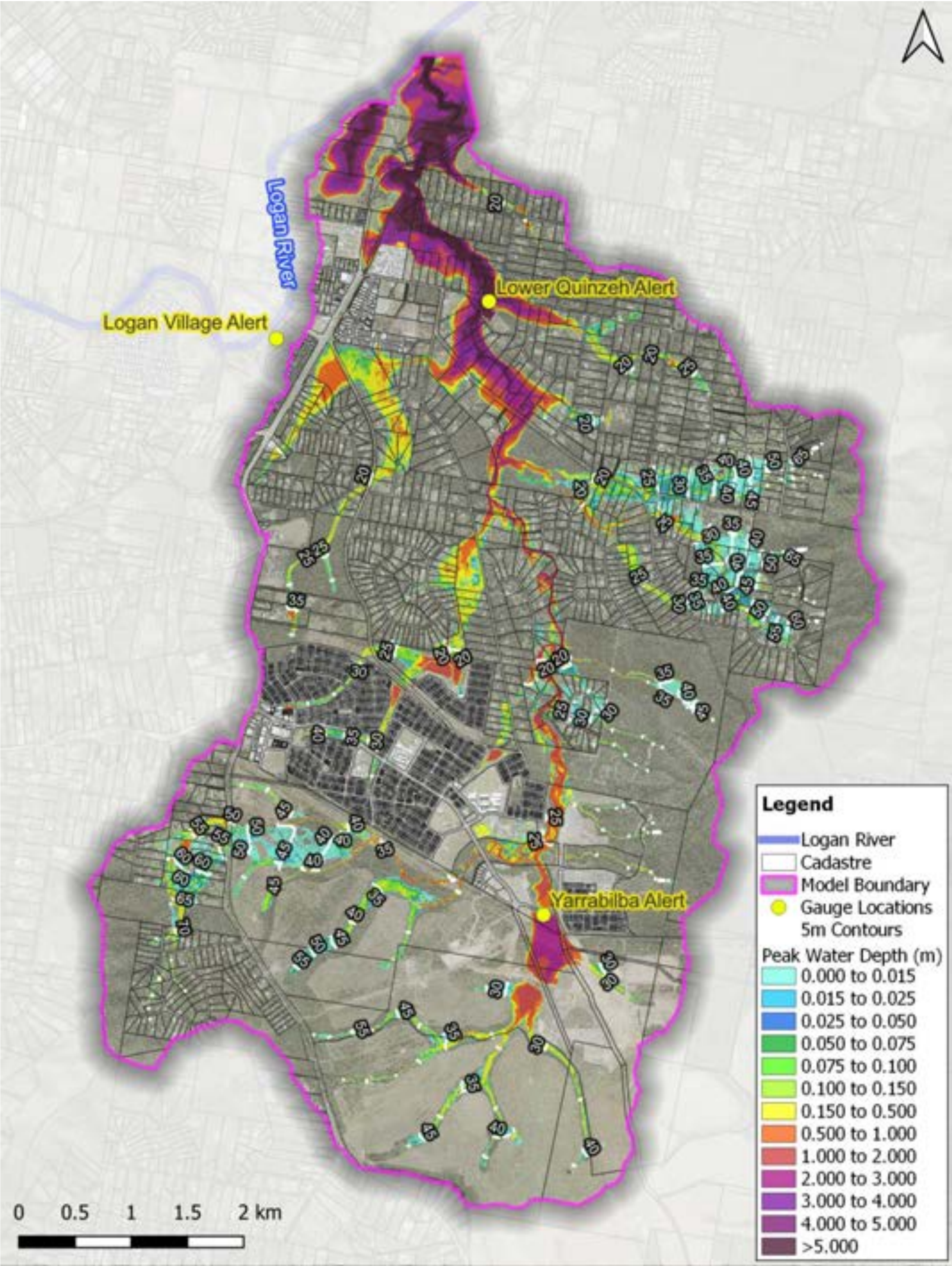

Figure 6-8 Quinzeh Creek February 2022 Peak Depth and Water Level

With respect to the Yarrabilba Alert gauge comparisons, it is known that at the time of the February 2022 event, the levels within the Yarrabilba detention basin did not overtop Fauna Way. As a consequence, the modelled results showing water levels being lower compared to the gauge could really only occur due to two (2) possible reasons as follows:

- An underestimate of flows for the February 2022 event; or
- The specific topographic and structure arrangements applicable for the Yarrabilba detention basin upstream of Fauna Way given that the gauge is co-located within the basin.

In respect to the first item, it is very unlikely that the calibration flow estimates are underestimated particularly given the following:

- The application of detailed February 2022 rainfall data based on the calibrated RADAR rainfall data which provides a detailed account of rainfall temporal and spatial variability across the full extent of the catchment based on a 1km^2 grid, with the data validated and providing a good cumulative correlation with the point rain gauge data;
- A reduced initial loss compared to that otherwise recommended by the AR&R 2019 “data hub”, with the overall effect being a modest increase in flows; and
- Ultimately, a very good match being achieved for the calibration to the downstream Lower Quinzeh Alert gauge.

Given the above, we consider that the differences shown to occur at the Yarrabilba Alert gauge are as a result of specific topographic and structure arrangements applicable for the Yarrabilba detention basin upstream of Fauna Way.

The Yarrabilba detention area, being located upstream of Fauna Way, was and still is under some form of construction during the February 2022 event. Specifically, major earthworks were in-progress for a major road connection across Quinzeh Creek as at the time of the event. This creates a degree of uncertainty in the specific arrangements having regard to the stage of construction of the upstream road and moreover aspects such as construction erosion and sediment control measures including the potential for blockage of the downstream Fauna Way structures.

As a result of the above, various sensitivity assessments were tested comprising mannings roughness, initial loss and continuing loss values as well as structure blockages to understand the impacts to water levels within the Yarrabilba basin. Following extensive investigations and noting that roughness and losses had little effect in raising modelled water levels, it was found that the greatest effect on levels within the basin were dependent on the outlet configuration applied to the detention facility and specifically the existing culverts under Fauna Way. This is part due to the complex outlet structures under Fauna Way which comprised staged outlets at various elevations. Blockages of these culverts were applied as 20% , which is in accordance with the ARR2019 blockage assessment recommending blockage factors of between 10%-50% be applied. The sensitivity assessment identified that an imposed 20% blockage of the Fauna Way culverts provides modelled water levels that are much closer to that recorded during the event, as seen in Figure 6-7.

The outcome of the sensitivity assessment has shown that the culvert arrangements and associated blockages applicable to the Fauna Way culverts are the dominant factors in achieving the calibration match. The only issue however is that the precise arrangements that existed as at the time of the February 2022 event are not precisely known. Partial blockages could likely have applied at the time given the upstream construction works and requirements for erosion and sediment control during construction. To fully quantify this aspect, an exhaustive investigation is likely required to define the conditions that existed at the time of the event and this would likely necessitate discussions with the site works crews. Such an exercise is outside of the scope of this study and does not add any value to design event modelling outcomes.

Separate to the above, the analysis since completed including sensitivity assessments to provide a high degree of confidence in the results as well as the likely issues resulting in the differences observed at the Yarrabilba Alert gauge. On this basis, and given the uncertainties involved, it is considered that the current results are fundamentally acceptable.

6.4.2 Joint Calibration

The comparison of discharge for the XP-RAFTS hydrologic model has been extracted at the location of the old Upper Quinzeh Alert gauge. This location has been selected as the Lower Quinzeh Alert gauge is dominated by the tailwater, and the Yarrabilba Alert gauge is located directly upstream of a large basin. The comparison of discharge between the XP-RAFTS and the TUFLOW hydraulic model for the February 2022 event is presented in Figure 6-9. The discharges from both the hydrologic and hydraulic models compare relatively well with up to 28m³/s difference at the location. There are challenges in the XP-RAFTS model replicating the TUFLOW model discharges upstream with the significant storages in the upper catchment. Generally, the TUFLOW model is consistently lower compared to the XP-RAFTS model with localised depressions and basin storages not accounted for in the XP-RAFTS model. The shape of the hydrographs is however consistent highlighting the hydrologic model is representing the routing reasonably well.

The joint calibration outcomes suggest that the XP-RAFTS should not be relied upon for extraction of flows at downstream locations given the complexities and storages not been accounted for in the simplistic hydrologic model. Furthermore, the TUFLOW model should be utilised for assessment of critical durations and temporal patterns.

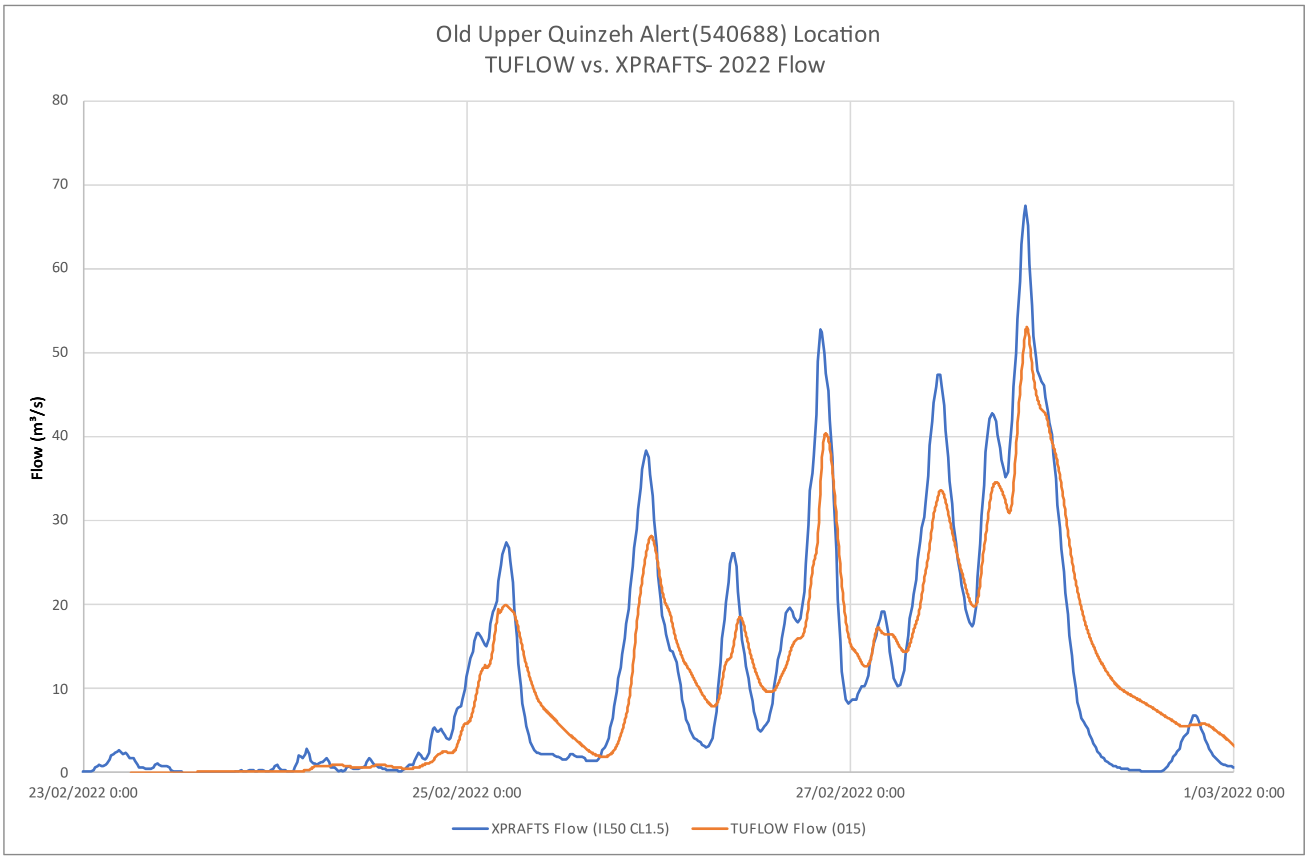

Figure 6-9 XP-RAFTS VS TUFLOW Discharge Comparison for February 2022 Event at the Old Upper Quinzeh Alert Gauge Location

6.5 Calibration Summary

The calibration and validation methodology and results detailed above have improved the confidence of the modelling outputs throughout the Quinzeh Creek catchment. Specifically, through comparison of modelled peak levels and gauged hydrographs there is increased confidence in both the hydrologic and hydraulic model parameters adopted. The catchment analysis is however limited by the continual development of the Yarrabilba locality including constant changing. It is recommended that as more development continues and future calibration events become available, that the model parameters are reconsidered and confirmed for suitability.

Overall, the models replicated the February 2022 event which based on IFD analysis was estimated to be over a 2% AEP event for the 24-hour duration. This calibration has added significant confidence that both the XP-RAFTS and TUFLOW models are representing the catchments hydraulic response for large flooding events.

7 STUDY RESULTS AND DISCUSSION

7.1 Hydraulic Results and GIS Maps

7.1.1 Design Events

As discussed previously in Section 5.3, the detailed TUFLOW model for Quinzeh Creek catchment was analysed for the full suite of storm durations and temporal patterns of the 50%, 10% and 1% AEP design events only, as well as the PMF event. Storm duration from 20 minutes to 1440 minutes were selected to be run hydraulically to understand median temporal patterns and critical durations. The remaining AEP events (63% AEP through to 0.05% AEP events), were selected based on the critical duration and median temporal pattern selection, based on the frequent, intermediate and rare temporal pattern bins from ARR2019.

A total of 420 separate hydraulic model simulations have been analysed for the catchment using a highly detailed 4m grid, to inform the critical durations and median temporal patterns only.

7.2 Critical Duration and Temporal Pattern Selection

7.2.1 Approach

The detailed hydraulic results for the 50%, 10% and 1% AEP events have been subject to post-processing for the purposes of selecting critical storm events. In order to achieve the overall envelope of flood results, consideration of multiple storm durations as well as the ensemble temporal patterns (i.e. 10 patterns per duration) needed to be considered for each of the respective design events. In this regard, the TUFLOW "asc_to_asc" utility only returns a mean value when all 10 ensemble input grids have numeric cell values. For cells located at the edge of the flood extent, the resultant grids may not include numerical values across all 10 ensembles which otherwise provides an inaccurate determination of the flood extent. To address this aspect and provide a more representative flood extent, the envelope processing based on the TUFLOW asc_to_asc utility has been processed based on the median as opposed to the mean to minimise the return of null grid cells and therefore attain a better representation of the flood extent.

The general process for the grid enveloping for the model result files is summarised as follows:

- The TUFLOW asc_to_asc utility has been used to extract the respective water levels based on the median grid value. The process was used across all 10 ensemble events per storm duration and design AEP to provide a single envelope grid per storm duration and AEP event;
- The TUFLOW asc_to_asc utility was then used to prepare the maximum envelope grid across the combination of the multiple storm duration ensemble temporal pattern envelope grids from the above; and
- The process enables several critical duration flood envelope grids to be prepared per design AEP
- Critical storms were then selected from observation of dominant storms.

7.2.2 Critical Duration GIS Maps

A critical duration analysis was completed using the hydraulic model results based on the process discussed previously in Section 7.2.1 and using the median water surface level grids. The critical duration analysis has considered multiple storm durations for each design AEP event. The critical duration GIS maps for the 50%, 10% and 1% AEP events are included in Appendix F with the median temporal pattern GIS maps. Figure 7-1 illustrates the critical duration map for the 1% AEP event, from which the following comments are made:

- The critical duration for Quinzeh Creek is dominated by the 90-minute duration for the majority of the catchment. As expected, shorter durations comprising 20, 25 and 45-minutes dominate the most upstream reaches of the catchments depending on catchment parameters such as degree of urbanisation and channelisation of the waterways;
- Longer durations comprising 120-minute, 270-minute and 360-minute were found to occur in the lower reaches and along the Quinzeh Creek; and
- Critical Durations in the basin upstream of Fauna Way are dominated by the 720-minute duration.

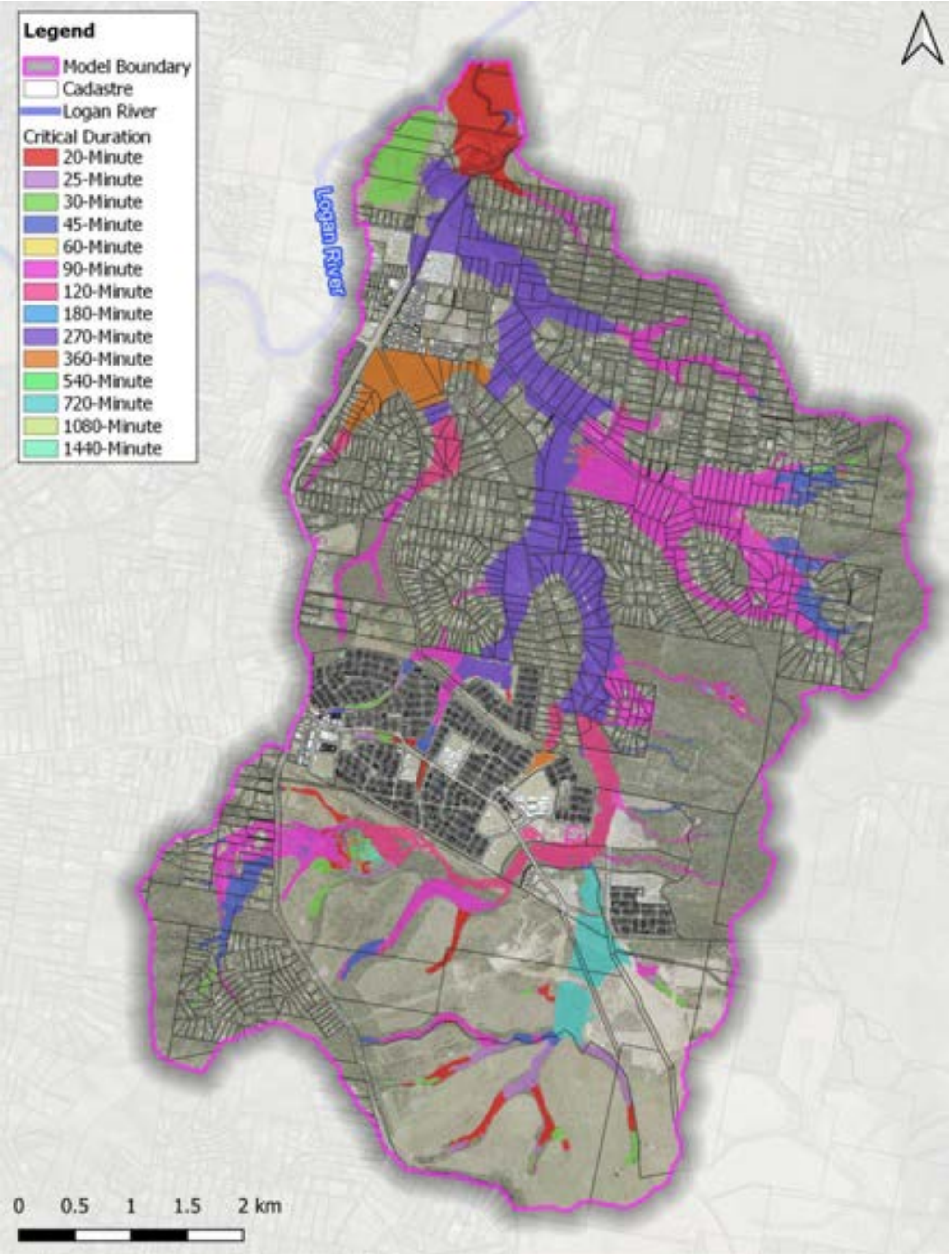

Figure 7-1 Quinzeh Creek 1% AEP Critical Duration Map

7.2.3 Selected Storm Events

A summary of the critical durations and median temporal patterns for all events is presented below in Table 7-1. Filtering of all storms was undertaken to select a single representative temporal pattern for each applicable duration. Results were compared to the total ensemble results, and results were generally within 50mm. This was deemed a reasonable difference in the context of the uncertainties associated with the flood study.

Table 7-1 Critical Storms Modelled Per Design Event

AEP	Durations	Temporal Pattern Bin
Current Climate 2020		
63.2%, 50%, 20%	25min TP02, 30min TP05, 45min TP08, 270min TP05, 540min TP06, 720min TP04	Frequent (Point)
10%, 5%	20min TP06, 30min TP06, 120min TP08, 180min TP08, 360min TP10, 540min TP04, 720min TP07	Intermediate (Point)
2%,1%,0.5%, 0.2%, 0.05%	25min TP09, 30min TP09, 45min TP03, 90min TP03, 120min TP05, 270min TP07, 360min TP03, 720min TP03	Rare (Point)
PMF	15min, 30min, 45min, 90min, 150min	GSDM
Future Climate 2090 RCP4.5 (9.5% rainfall increase)		
50, 20%	25min TP02, 30min TP05, 45min TP08, 270min TP05, 540min TP06, 720min TP04	Frequent (Point)
10%, 5%	20min TP06, 30min TP06, 120min TP08, 180min TP08, 360min TP10, 540min TP04, 720min TP07	Intermediate (Point)
2%,1%,0.5%,0.2%	25min TP09, 30min TP09, 45min TP03, 90min TP03, 120min TP05, 270min TP07, 360min TP03, 720min TP03	Rare (Point)
Future Climate 2090 RCP6 (11.5% rainfall increase)		
1%	25min TP09, 30min TP09, 45min TP03, 90min TP03, 120min TP05, 270min TP07, 360min TP03, 720min TP03	Rare (Point)
Future Climate 2090 RCP8.5 (19.7% rainfall increase)		
1%	25min TP09, 30min TP09, 45min TP03, 90min TP03, 120min TP05, 270min TP07, 360min TP03, 720min TP03	Rare (Point)

We note that embedded bursts can exist in long duration storm temporal patterns where periods of rainfall can exceed the annual exceedance probability rare than the burst as a whole. This is sometimes seen in 24-hour storms. The hydrological box plots in Appendix C demonstrate that the critical duration for the lowest parts of the catchment is less than the 24-hr storm which is not unexpected given the size of the catchment. No obvious anomalies indicating that embedded bursts will be problematic are noted in the plots. Furthermore, all of these durations have been simulated hydraulically and long durations were not found to be dominant downstream of basins. We therefore have no reason to suspect that embedded bursts are artificially and adversely affecting the final flood surfaces seen in the hydraulic modelling.

7.2.4 GIS Flood Maps

A collection of GIS maps illustrating the resulting processed critical storm duration envelope grids for the Quinzeh Creek catchment have been prepared as mapping deliverables for this project. The GIS maps prepared as part of this study are summarised as follows:

- Appendix E – Design event flood mapping for all simulated design events (including water depth, water level, velocity and Hazard (ZAEM1));
- Appendix F – Hydraulic critical durations and median temporal pattern mapping for all simulated design events (including 50% AEP, 10% AEP, 1% AEP and PMF); and
- Appendix G – Longitudinal profile and profile plan of the primary flow path in Quinzeh Creek showing the 1% AEP flood levels, ground elevations and hydraulic and bridge structure locations.

7.2.5 Box and Whisker Plots

As stated previously in Section 4.9, box and whisker plots have been prepared using the XP-RAFTS hydrologic models for the Quinzeh Creek catchment and is included in Appendix C. Box and whisker plots aim to show the variation of hydrologic flows between temporal patterns at each location, as well as aiding in the determination of the median flow at a point of interest which is typically adopted for design event modelling.

All temporal patterns and storm durations up to 1440-minutes have been analysed hydraulically for the 50% AEP, 10% AEP and 1% AEP only as part of this study. Given the extensive analytical approach undertaken for this study, the box and whisker plots have less relevance compared to the hydraulic results and full assessment of floodplain storage and conveyance characteristics. Accordingly, the hydraulic model results should be used for any future results extraction as opposed to reliance on the box and whisker plots which have been included primarily for completeness.

7.2.6 Hydrologic and Hydraulic Similarity

The model validation discussion presented in Section 6 was based on a comparison of discharge estimates and was limited to consideration of the hydrological model outcomes against a range of calibration to specific events. As a further check on model validation and overall model performance, a direct comparison of discharges between the hydrologic and hydraulic models for the Quinzeh Creek catchment has also been undertaken.

To aid this comparison, the 1% AEP hydraulic models for the Quinzeh Creek has been hydraulically assessed for a range of storm durations and using the full set of ten (10) ensemble events as outlined in ARR2019. Specifically, this includes durations of 20, 25, 30, 45, 60, 90, 120, 180, 270, 360, 540, 720, 1080 and 1440-minute storm events, each having been hydraulically analysed based on the ten (10) ensemble events.

The above simulations were also used to provide a comparison of critical durations throughout the catchment derived using the hydraulic model and for comparison to that determined using the hydrological model. The hydraulic simulation of a full range of durations and ensembles provides greater confidence in the critical durations throughout the catchment in a hydraulic sense and to specifically include storage and conveyance aspects as well as that associated with front and rear loaded temporal patterns.

Peak discharges at each of the previously defined reporting locations in the Quinzeh Creek catchment have been extracted from the hydraulic model and compared to the peak flows from the XP-RAFTS hydrologic model. The flow comparison is presented in Table 7-2 for the Quinzeh Creek catchment.

Table 7-2 Quinzeh Creek Flow Comparison

Quinzeh Creek Model Validation (1% AEP)				
Reporting Location	QC01	QC02	QC03	QC04
XP-RAFTS Critical Duration	90-Minute	90-Minute	90-Minute	120-Minute
XP-RAFTS Model	93.5 m³/s	94.8 m³/s	6.4 m³/s	425.9 m³/s
Hydraulic Critical Duration	120-Minute	90-Minute	-	-
Hydraulic Critical TP	TP 5	TP 3	-	-
Hydraulic Model	79.4 m³/s	84.8 m³/s	-	-
% Difference	-15.1	-10.5	-	-

Note

1. QC01 and QC04 are dominated by the regional Logan River tailwater conditions in the hydraulic analysis.

The comparison of discharge estimates between the hydrological and hydraulic models illustrates that the discharge estimates from the hydraulic model are consistently lower compared to the hydrological model. This result is expected and is a typical outcome which reflects the differences in approaches and methods between the hydrological and hydraulic models. More specifically, the differences occur as a result of the storage and routing effects within the catchment which are represented to varying degrees within the models. For example, the routing methodology employed within the hydrological model represents a simplified approach that is unable to account for the full storage effects, despite the use of the more rigorous Muskingum-Cunge routing methodology. Conversely, the hydraulic model provides a much more rigorous account of storage effects through the very nature of representation of the full topography within the model, which in this instance includes a highly detailed 4m grid and 1m sub-grid sampling.

By virtue of the fundamental differences in routing methodologies and approaches applied within the models, it is virtually impossible to precisely match discharge estimates across multiple locations, durations and spatially throughout the catchment. The discharge comparisons presented in Table 7-2 do however show there to be consistency in peak discharge estimates between the hydrology and hydraulic models for the majority of the reporting points, with the larger difference at QC01 showing that the hydrological model provides a significant underestimate of the catchment routing compared to the hydraulic model. This large difference is attributed to the floodplain storage characteristics represented particularly upstream of major structures of the catchments which are not able to be accurately accounted for within the hydrological model and associated routing approach. This can be readily modified in the XP-RAFTS model without affecting the hydraulic results (and given the application of SA inflows) and for the purposes of maintaining a closer match in a joint calibration approach. However, the relative differences in peak flow estimates between the hydrology and hydraulic models are considered acceptable and typically within the general range expected for a catchment wide study such as this.

7.2.7 Model Sensitivity Assessments

The hydraulic model was simulated for three (3) sensitivity scenarios and included simulation of the critical storm events for the relevant AEP. The scenarios included the following:

- Increased roughness (1% AEP and 20% AEP):
  - +20% vegetation roughness (SEN1);
  - Increase waterway roughness value of 0.15 (SEN2); and
- Enveloped flood surface of structure blockage (1% AEP and 20% AEP):
  - 100% blockage (SEN3); and

  - No blockage (SEN4)
- Tailwater sensitivity (1% AEP only) (SEN5).

Each of the above sensitivity scenarios are discussed and presented separately below.

7.2.7.1 Floodplain Roughness Sensitivity

The floodplain roughness applied in the Quinzeh Creek model has been discussed previously in Section 5.2.3.

7.2.7.1.1 Mannings Increase - +20%

In order to assess the sensitivity of model water surface level results to a change in roughness condition, a sensitivity analysis has been completed by increasing the roughness by 20% globally across the catchment. The results of the sensitivity assessments are presented as the difference in water surface level plots for the 20% AEP and 1% AEP events and is illustrated in Figure 7-2 and Figure 7-3 respectively. The results of the sensitivity assessment are summarised as follows:

- As expected, water levels have been increased across all areas of the catchment when a 20% increase in roughness condition is applied;
- Water levels in the majority of the catchment are only increased by up to 100mm in the 1% AEP as a result of the 20% increase in roughness, the magnitude of which is important as this would be readily accommodated within the building freeboard provisions; and

The resulting change in water levels as a result of the increase in floodplain roughness is therefore not considered to be overly sensitive and is unlikely to compromise building freeboard provisions in the catchment.

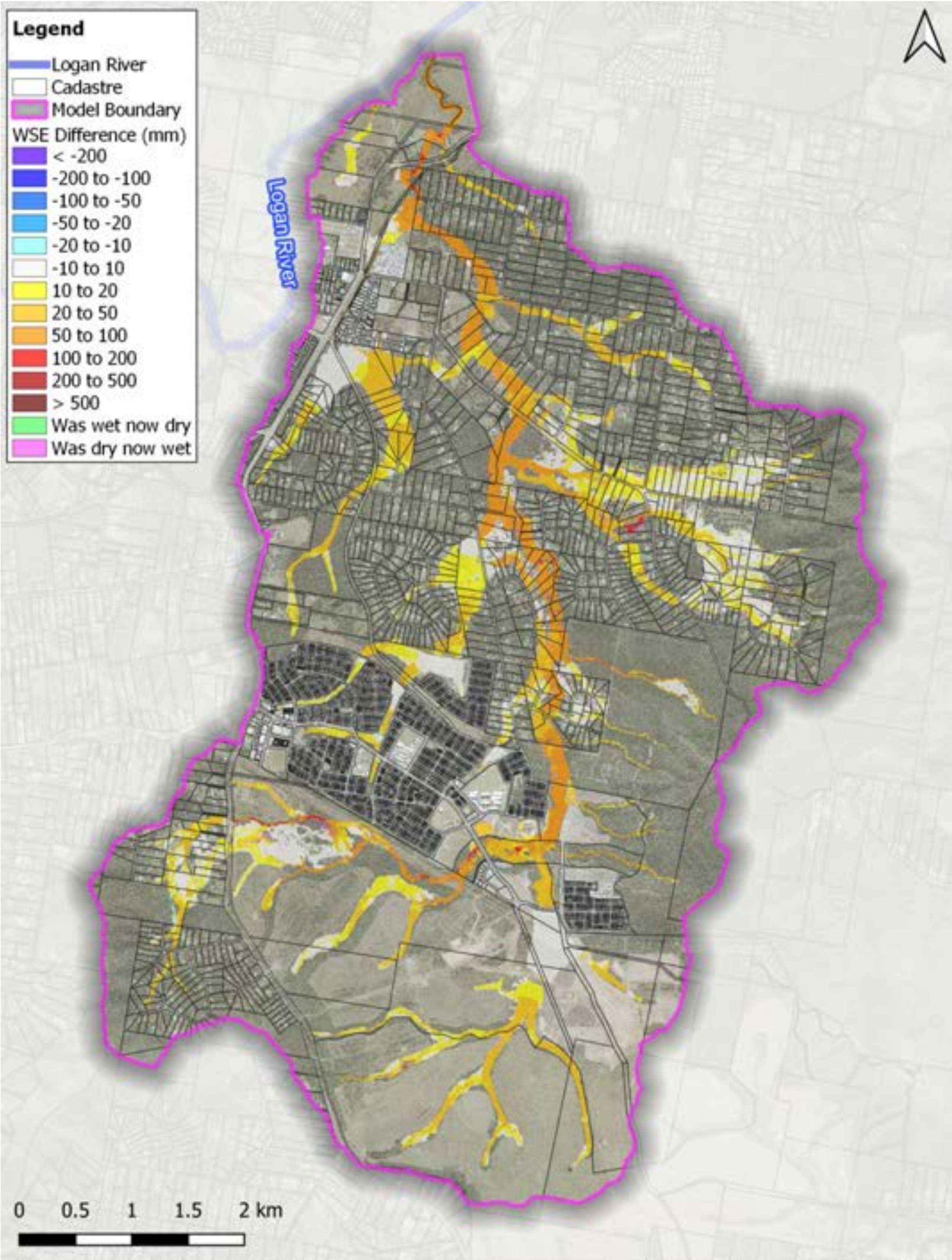

Figure 7-2 20% AEP Peak Water Level Difference Map – Increased Roughness +20%

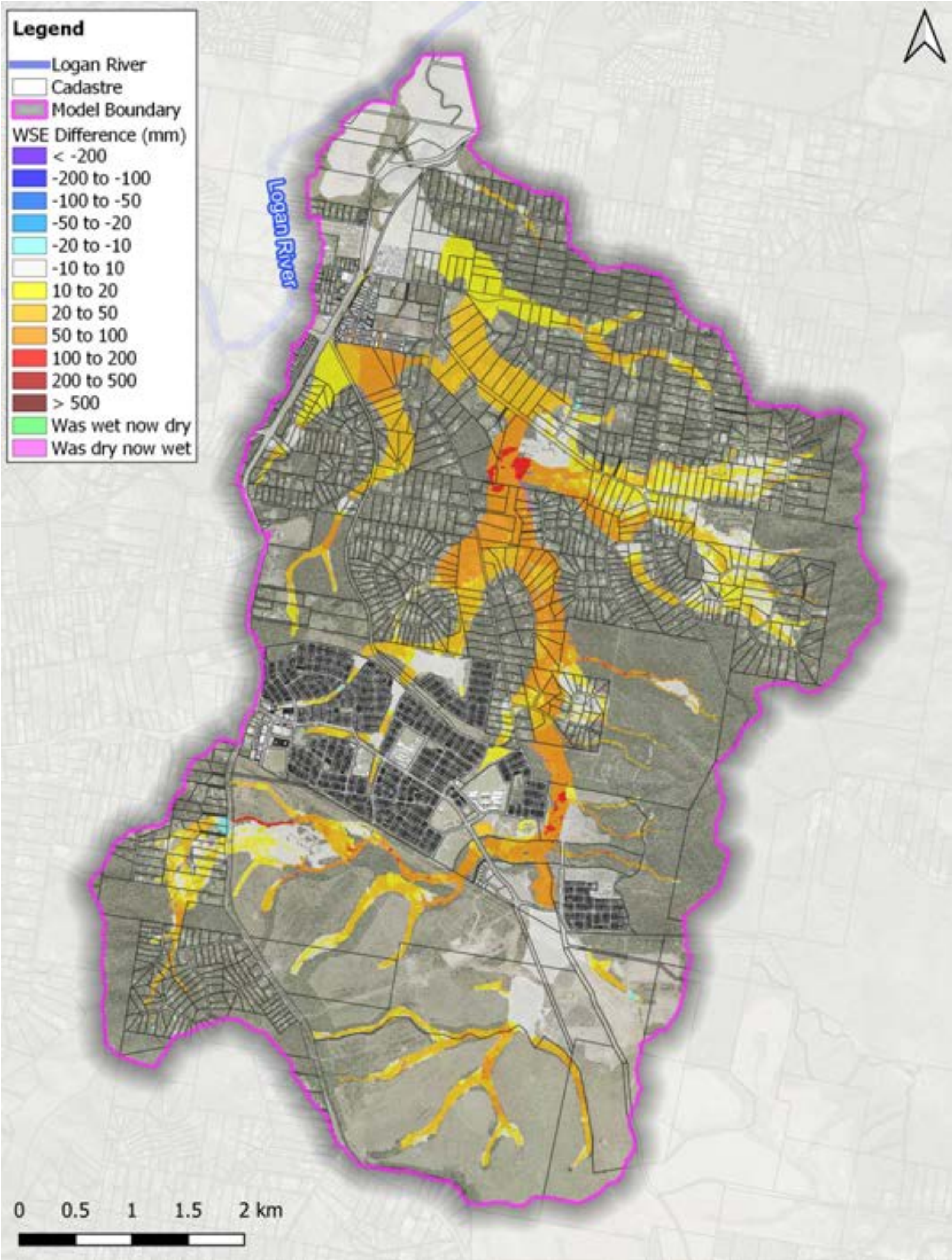

Figure 7-3 1% AEP Peak Water Level Difference Map – Increased Roughness +20%

7.2.7.1.2 WATERWAY REVEGETATION

Figure 7-4 and Figure 7-5 present the difference in peak water levels for the 20% AEP and 1% AEP events respectively, caused by an increased waterway roughness value of 0.15. The increased waterway roughness was limited to the provided waterway corridors. As a result localised reductions in water surface levels are seen in the upper reaches of the catchment.

The lower parts of the catchment is affected by Logan River backwater in the 1% AEP. For this reason, revegetation of the waterway corridor did not affect peak water levels significantly in the lower reaches of the catchment in the 1% AEP. For the 20% AEP in the lower reaches of the catchment, there is significant increases in water levels of up to 1m where there is a higher conveyance of flow.

Through the mid sections of the catchment, flows are highly channelised. As a result, waterway restoration has a major impact in this area, of up to 800 mm in both the 20% and 1% AEP events. An increased flood extent impacting multiple properties throughout the catchment is also seen. This is related to the flat nature of Quinzeh Creek.

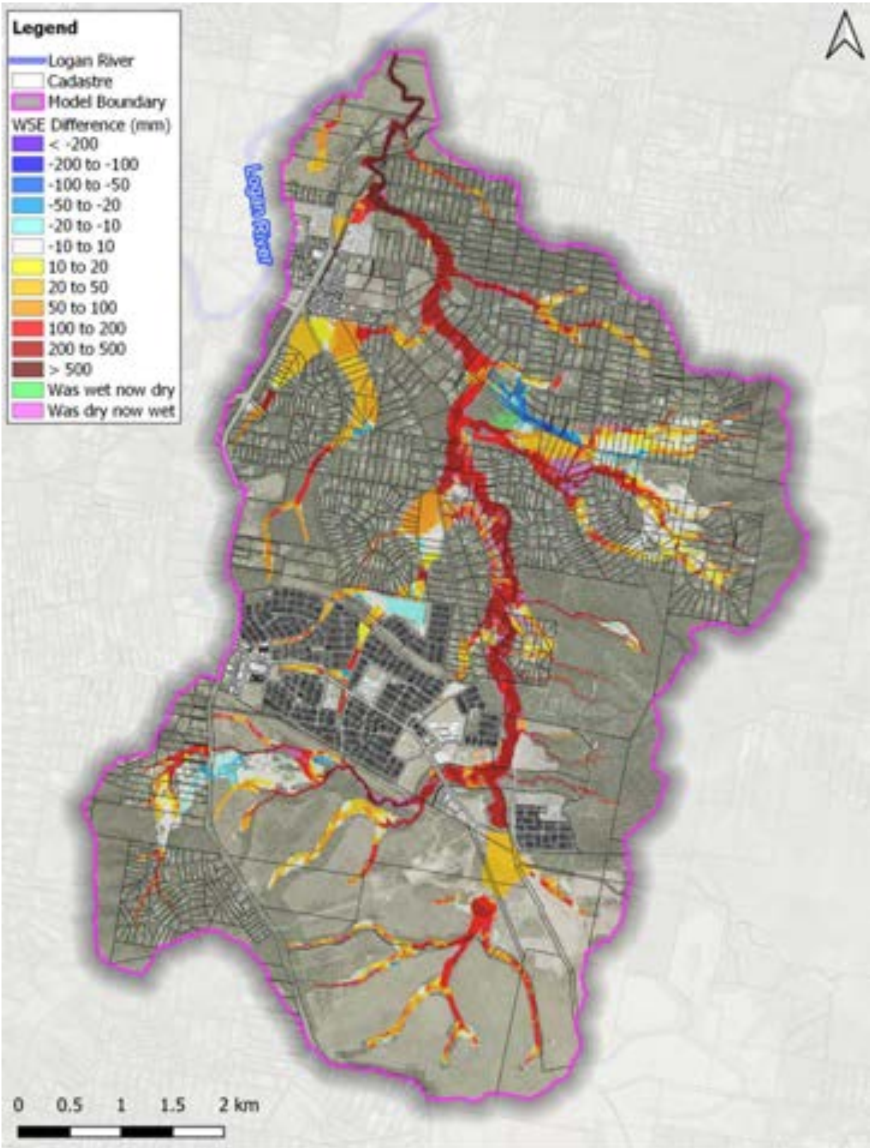

Figure 7-4 20% AEP Peak Water Level Difference Map – Increased Waterway Roughness

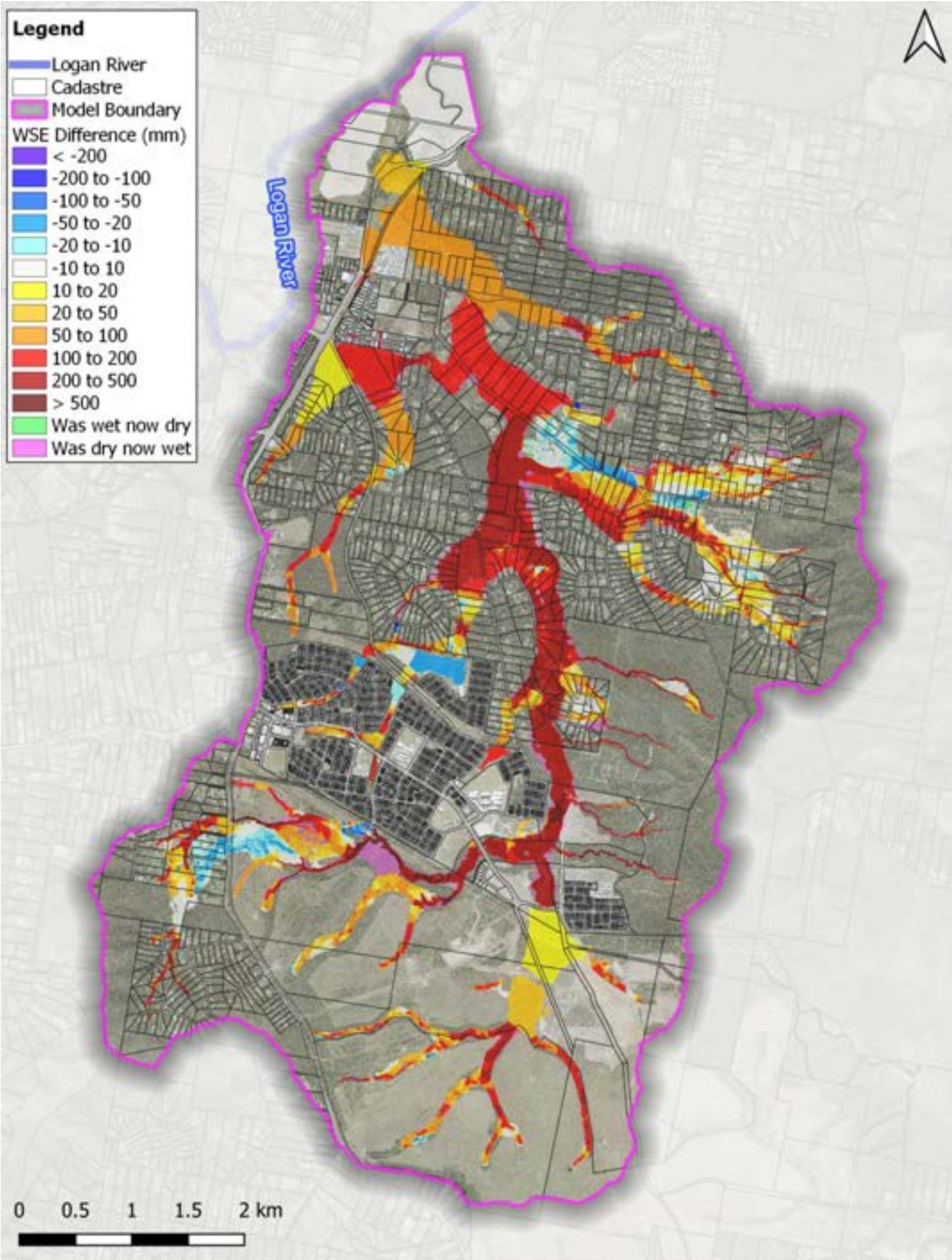

Figure 7-5 1% AEP Peak Water Level Difference Map – Increased Waterway Roughness

7.2.7.2 Blockage Sensitivity

Figure 7-6 and Figure 7-7 present the difference in peak water levels for the 20% AEP and 1% AEP events respectively, from the fully blocked/unblocked culverts scenario. The blockage assessment shows that isolated areas located upstream of fully blocked culverts are subject to additional flooding for majority of the catchment. The most sensitive locations within the catchment were upstream of Yarrabilba at Yarrabilba Drive and Fauna Way, where upstream flood levels increased by up to 3.5m in the 20% AEP and 2.9m in the 1% AEP. As a general comment, Quinzeh Creek structures have high immunity and therefore flood levels in the 20% and 1% AEP events were overly sensitive to blockage. Results from the 1% AEP no blockage scenario have also shown that opening or completely blocking the structures under Fauna Way results in an decrease of up to 100mm within the Fauna Way basin. Opening the structures through Quinzeh Creek also results in higher water levels within the Quinzeh Creek channel for majority of the catchment.

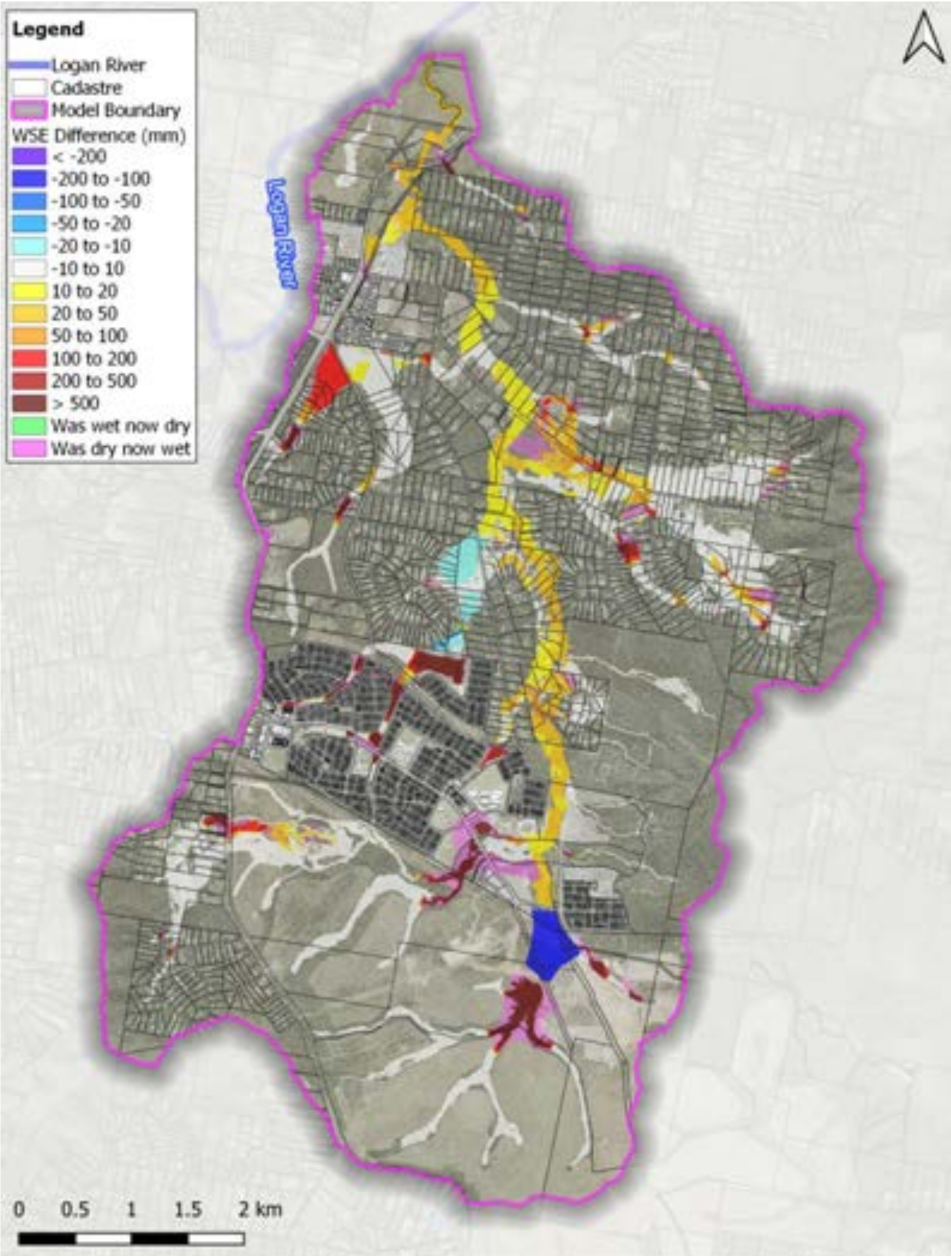

Figure 7-6 20% AEP Peak Water Level Difference Map – Blockage Scenario

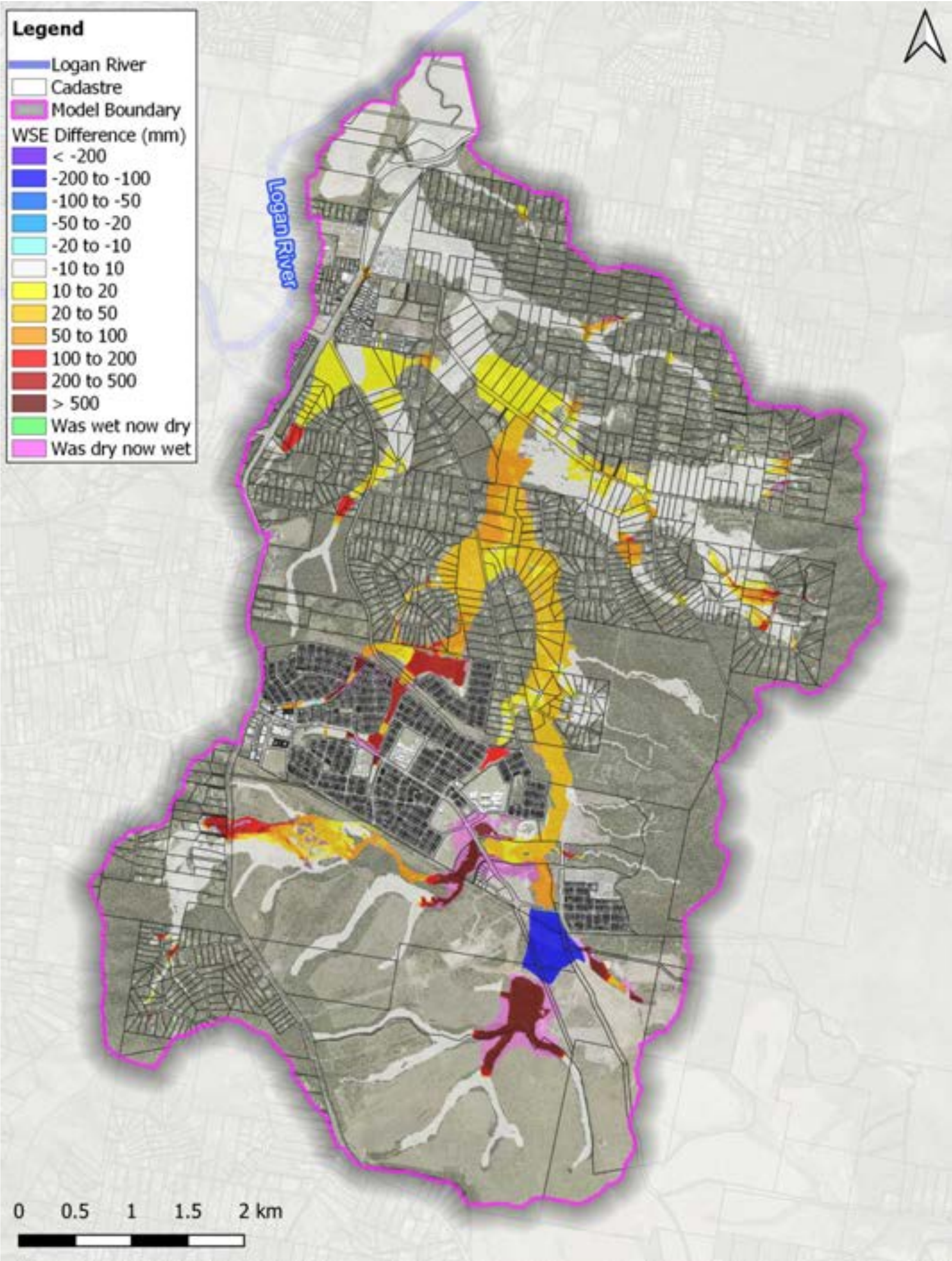

Figure 7-7 1% AEP Peak Water Level Difference Map – Blockage Scenario

7.2.7.3 Tailwater Sensitivity – Joint Probability Zone

7.2.7.3.1 OVERVIEW

Joint probability is a statistical measure that calculates the likelihood of two events occurring at the same time. ARR 2019, Book 6, Chapter 5 describes this concept within respect to the interaction between coastal and catchment flooding. In estuarine regions, flooding can be caused independently by either extreme rainfall or elevated ocean levels (generated by storm surge and/or HAT), or it can be caused by a combination of both.

When both processes are statistically dependent, their interaction needs to be considered to account for areas where design flood levels are influenced by both processes. This region is defined as the 'joint probability zone'. Figure 7-8 (sourced from ARR2019) described this concept through schematic longitudinal section of an estuary.

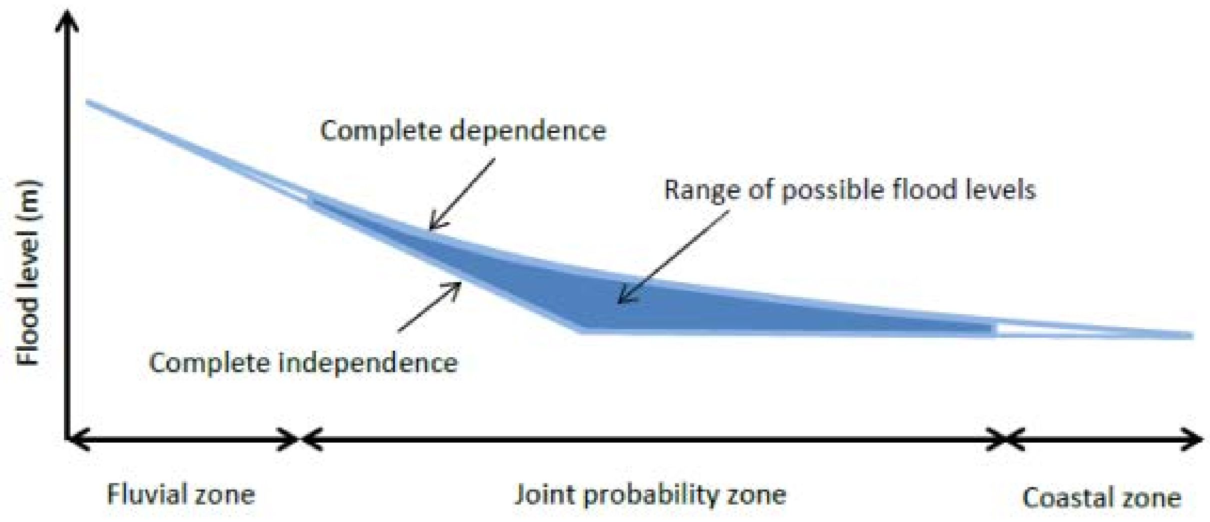

Figure 7-8 Schematic Showing the 'Joint Probability Zone'

7.2.7.3.2 PRE-SCREENING ANALYSIS

The joint probability concept can be applied to the Quinzeh Creek catchment to consider the likelihood of both regional (Logan River) and local flooding occurring together.

ARR2019, (Book 6, Chapter 5, Section 5) presents a four-step process for practical implementation of assessment of joint probability termed the design variable method. The first step involves a pre-screening analysis to identify areas within the joint probability zone.

The purpose of the pre-screening analysis is to calculate the outer envelope of flood estimates obtained from the joint probability method, to identify areas where there is a difference between independence and full dependence and to quantify the magnitude of those differences.

7.2.7.3.3 METHODOLOGY

The 1 in 100 AEP design event has been adopted for the pre-screening analysis, which has been undertaken using the following method:

- **Completely independent case**
  - **Independent fluvial only case**: 1 in 100 AEP local creek flood behaviour was assessed by running the hydraulic model for the 1 in 100 AEP design rainfall event for the local catchment in the absence of any tailwater influence (i.e. using a normal depth downstream boundary).
  - **Independent tailwater only case**: the 1 in 100 AEP Logan River flood level (17.2 mAHD) was provided by LCC at the junction of Quinzeh Creek and Logan River and used to determine the extent of tailwater-based inundation across the local catchment.
  - The flood surfaces for both the independent cases were merged to create a flood surface representative of the **complete independent case**.
- **Completely dependent case**
  - Flood behaviour was assessed by running the hydraulic model for the 1 in 100 AEP design rainfall event with a 1 in 100 AEP tailwater boundary.
- **Joint probability zone (JPZ)**
  - A comparison of the peak flood levels for the completely independent and completely dependent cases was used to identify the spatial and vertical extent of the joint probability zone.
  - A tolerance level of 0.1 m was adopted. Areas with a vertical difference in flood level below the tolerance level were considered to be outside the JPZ.

Figure 7-9 presents the difference in flood levels from the analysis. Results within Quinzeh Creek show an area of approximately 35ha within the western tributary south of Centenary Place and approximately 66ha west of Ellen Court, within the JPZ. The area is mainly confined to the waterway corridor of Quinzeh Creek with minore increased of up to 137mm on Centenary Place. It is noted that the differences observed within the JPZ of the catchment is generally lower than standard freeboard provisions.

In conclusion, a more extensive joint probability analysis should not be required for design flood levels within the catchment as the current assumptions are considered reasonable for planning purposes.

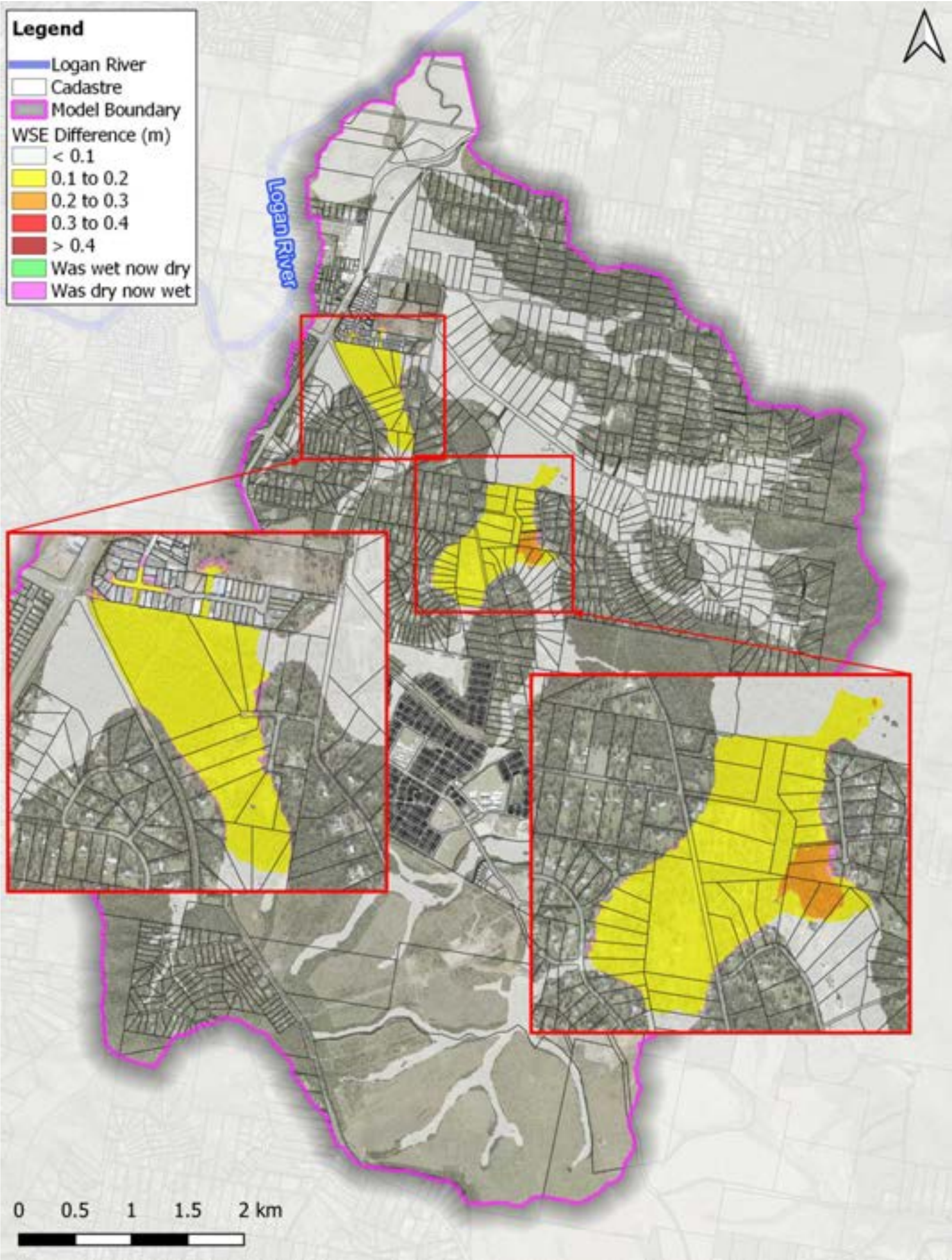

Figure 7-9 Tailwater Sensitivity Change in Water Level

7.2.8 Climate Change and Increased Rainfall Intensity

An analysis of climate change in respect to increases in rainfall intensity has been completed as part of this study. Specifically, this has included an analysis undertaken for the 50% 20%, 10%, 5%, 2%, 1%, 1 in 200 and 1 in 500 AEP events to assess the effect of climate change via the application of increased rainfall intensities. These events have been selected and simulated for the ARR2019 climate change factors representing the year 2090 RCP 4.5 climate change scenario as a requirement for the LCC Flood Hazard Matrix as part of the FRMS. Maps illustrating the climate change results for Quinzeh Creek are provided in Appendix E, and includes a series of GIS maps for water surface levels, depths, velocities and hazard..

In addition, sensitivity on the 2090 RCP 6 and 2090 RCP 8.5 climate change scenarios has been assessed for the 1% AEP. The change in water surface level for the 1% AEP with and without climate change are illustrated in Figure 7-10 and Figure 7-11 for the RCP 6 and RCP 8.5 sensitivity scenarios respectively. The results of the sensitivity assessment are summarised as follows:

- The Quinzeh Creek Tributary sees an approximate peak increase of 120 mm (RCP 6) and 210 mm (RCP 8.5) within the main channel areas, with peak increases seen west of Ellen Court in both events;and
- The Quinzeh Creek Tributary sees an approximate peak increase of 200 mm (RCP 6) and 300 mm (RCP 8.5) within the storage areas at upstream of Fauna Way.

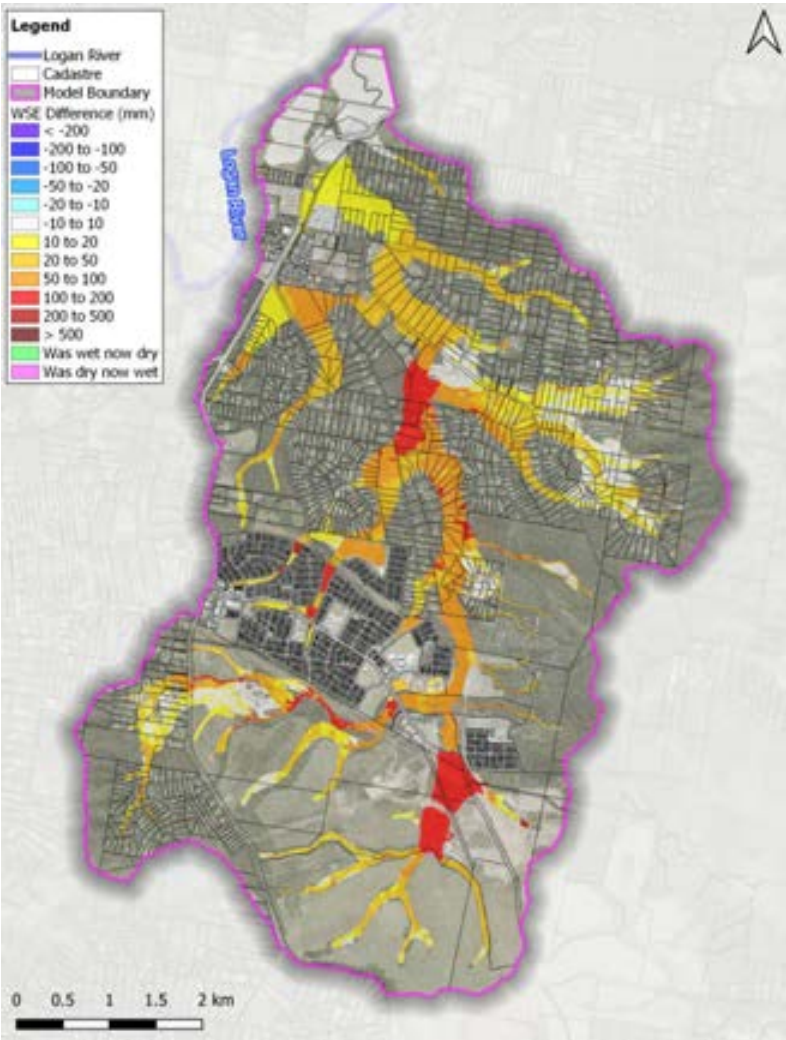

Figure 7-10 1% AEP Climate Change Scenario RCP 6 - Change in Water Surface Levels

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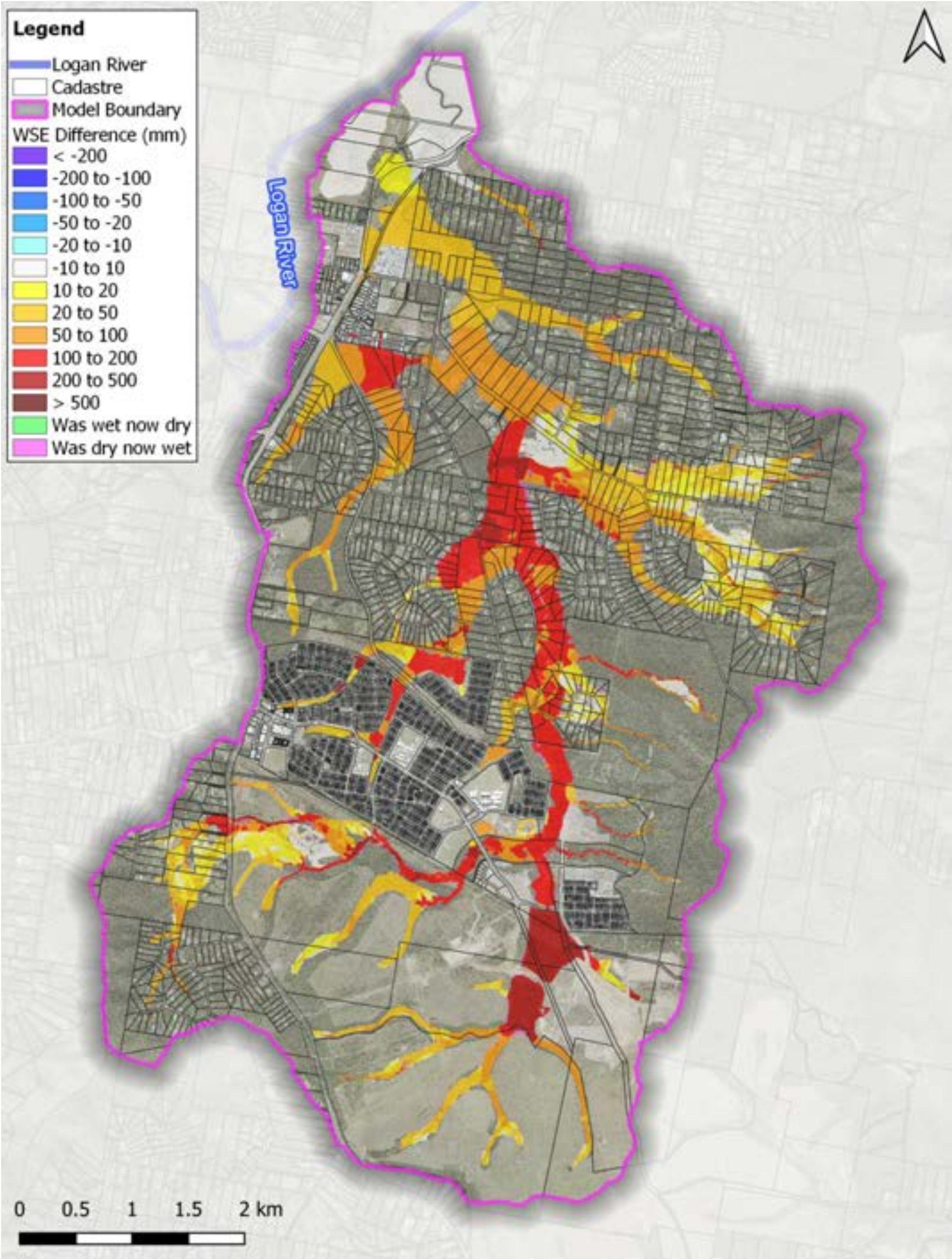


Figure 7-11 1% AEP Climate Change Scenario RCP 8.5 - Change in Water Surface Levels

7.2.9 Catchment Inundation Summary

7.2.9.1 1% AEP Results Summary

The following provides a brief summary of the results of the Quinzeh Creek model, specifically from the 1% AEP design event:

- Overtopping at the Dollabird Drive and Tel Court, with flood depths up to 300mm.
- Waterford-Tamborine Road, north of Waterford-Tamborine Road and Dollarbird Drive intersection, overtopped at multiple locations with multiple properties nearby affected. Water was predicted to pond to depths in excess of 2m.
- Flooding along Fauna Way crossing up to 75mm.
- Flooding along Culgoa Crescent and Georgina Drive with multiple properties impacted by sheet flow.
- Overtopping at the junction of Pineview Road and Steele Road. To the east of the junction, along Pineview Road, significant flooding with multiple properties severely impacted.
- Railway Parade near Buxton Park overtopped with over 500mm depth.
- Sheet flow affected multiple properties at Conifer Court. The road is impacted and overtopped.
- Properties between Maranoa Drive and Daintree Drive severely impacted by flood waters.
- Steele Road, between Wandearah Road and Maranoa Drive, inundated by over 1m of flood waters.
- Quinzeh Creek Road affected by flood at various locations. Notably between Hinchcliffe Road and Steele Road, at two locations, by over 1m of flood depth.
- Condamine Road overtopped at various locations with significant depths and multiple properties affected by flood water.
- Diamentina Road overtopped; multiple properties downstream of the road severely impacted by flood waters.
- Buena Vista Drive overtopped at two locations with the overland flow affecting properties through to Quinzeh Creek, overtopping at the junction of Swanborough Road, Latimer Road and Quinzeh Creek Road.
- Hinchcliffe Road overtopped near Quinzeh Creek Road intersection and two properties affected by the flooding.
- Benjamin Road overtopped by less than 4mm depth with property immediately upstream of road affected by the flooding.
- Pioneer Drive overtopped by approximately 40mm near Waterford-Tamborine Road.
- Railway Parade overtopped by over 800mm near Wandearah Road.
- Multiple Properties significantly impacted at the northern reach of Maloo Court.
- Waterford-Tamborine Road overtopped at multiple locations downstream of the southern Pioneer Drive and Waterford-Tamborine Road intersection.
- Significant depth, up to 200mm along Centenary Place.
- Significant ponding (depth over 2m) in the road corridor between Waterford-Tamborine Road and Opal Gardens.
- Hinchcliffe Road near Miller Road Bridge overtopped with couple of properties upstream of road affected by flooding.

- Miller Road Bridge overtopped near Minehan Road.
- Overtopping at Fryar Road near Lavelle Drive with significant ponding depth (greater than 1.5m).
- The following roads were also overtopped but with no other impacts to neighbouring properties:
  - Naylor Drive near Wedge Tail Court,
  - Teal Court,
  - Eucalypt Road,
  - Wandearah Road overtopped at multiple locations,
  - Murray Road near Miller Road Bridge, and
  - Latimer Road near Miller Road Bridge.

7.2.10 Digital Data

The following provides a summary of the digital datasets, along with a brief description, provided to LCC with the completion of the Quinzeh Creek Flood Study 2023.

- Complete XP-RAFTS hydrology model simulation and result files for the Quinzeh Creek catchment;
- Complete TUFLOW hydraulic model simulation and results files for the Quinzeh Creek catchment. Result files include the following FLT grid files;
  - Peak water surface level
  - Peak depth
  - Peak velocity
  - Peak velocity x depth product (Z0)
  - Peak hazard classification (ZAEM1 and ZQRA)
  - Time of peak water surface level

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This study represents the most up to date flood study revision that has been prepared for the Quinzeh Creek catchment. The update has been informed by previous studies and has been significantly expanded to include a full and detailed refinement of hydrologic and hydraulic models for both catchments using the current ARR2019 guidance.

The models prepared as part of this 2023 update have been subjected to rigorous calibration and validation procedures and have subsequently been adopted to inform new design flood estimates for the catchment. The methodology has additionally included consideration of most recent ARR2019 guidelines which account for the full ensemble of temporal patterns (for the 3 temporal patter bins) and their hydraulic impact across the catchment. Key aspects of the work have included:

- Development of detailed and catchment wide XP-RAFTS hydrology model in compliance to the ARR2019 guidelines;
- The preparation of a highly detailed TUFLOW hydraulic model based on the current software release and included sub-grid sampling approaches, with the model being used to hydraulically assess the full suite of design AEP events;
- Development of a catchment wide baseline flood risk assessment to be used by Council to control and coordinate all future development activities and having due regard to flood control and ensuring development compliance;
- An extensive model sensitivity analysis in regards to development in the Yarrabilba precinct;
- The assessment of an extensive range of model events, storm durations and temporal patterns to provide comprehensive outputs to better inform flooding and flood risk in the catchment; and
- The preparation of detailed reporting, extensive GIS maps and digital data sets.

8.2 Recommendations

The following recommendations are made in respect to the flood study update:

- The hydraulic models should be updated with the most recent and relevant topographic and structure data as is becomes available. It is recommended that data collected from the following sources should be implemented to better inform the hydraulic model when available:
  - Topographic data gathered from future LIDAR projects;
  - Topographic and stormwater structure data proposed with future development applications; and
  - Surveyed topographic and structure data including surveyed culvert and pit inlet levels and sizes.
- We recommend that Council undertake a further investigation of development control with respect to the Yarrabilba development area;
- General Flood Study Recommendations: -
  - LCC formally adopt this study to define flooding in the Quinzeh Creek catchment; and
  - LCC adopt the design flood outcomes for all future catchment planning and development related outcomes.

9 REFERENCES

1. Australian Rainfall and Runoff (ARR) (2019): A guide to flood estimation, Commonwealth of Australia (Geoscience Australia), 2019.
2. Australian Rainfall and Runoff (ARR) Revision Project 5: Regional Flood Methods Stage 2 Report, June, 2012.
3. IEAust (2012) Australian Rainfall and Runoff Revision Project 15: Two Dimensional Modelling in Urban and Rural Floodplains Stage 1 & 2 Report, November, 2012.
4. IEAust (1998), Australian Rainfall and Runoff, A Guide to Flood Estimation, Volume 1 and 2, Editor in Chief DH Pilgrim, Institution of Engineers.
5. DesignFlow (2017) Yarrabilba (Quinzeh Creek) Flood Study, DesignFlow 2017.
6. IPWEA (2017), Queensland Urban Drainage Manual, Volume 1, Fourth Edition IEAust (2017);
7. WRM Water + Environment (WRM) (2021), Logan-Albert Rivers Flood Study, August 2021;
8. XP Software (2018), XP-RAFTS, XS Software, Florida, USA.

APPENDIX A
STRUCTURE DATABASE

Structure Database

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
16	Box Culvert	1.2	0.6	18.083	4	17.08	16.99
185	Circular Pipe	1.65	N/A	9.9	4	13.82	13.72
21	Box Culvert	1.2	0.6	20.558	5	16.6	16.45
45	Circular Pipe	1.5	N/A	18.5	2	5.96	5.86
Cul164a	Circular Pipe	2.1	N/A	11.162	1	8.38	8.23
Cul164b	Circular Pipe	1.65	N/A	14.071	2	8.62	8.53
Culvert1B	Circular Pipe	0.375	N/A	4.16	1	22.88	22.77
Culvert1C	Circular Pipe	0.375	N/A	6.2	3	22.2	22.19
Culvert1D	Circular Pipe	0.375	N/A	4.6	2	21.9	21.8
Culvert1E	Circular Pipe	0.375	N/A	4.44	1	21.1	21.09
Culvert1H	Circular Pipe	0.75	N/A	10.75	5	17.59	17.45
Culvert1J	Circular Pipe	0.375	N/A	16	6	14.92	14.82
FL16_Hi_FC	Box Culvert	3.6	3	35.38	1	27.15	26.85
FL16_Lo	Box Culvert	3.6	2.1	50.02	6	26.3	26
FL1_Hi	Circular Pipe	1.2	N/A	23.2	5	24.1	24
FL1_Lo	Circular Pipe	0.825	N/A	30.5	3	24	23.9
FL3_Lo	Circular Pipe	1.05	N/A	18.75	5	28.88	28.77
FL6-A_Lo-orif	Box Culvert	1.2	0.5	6	1	20.53	20.53
FL6-B_Lo-orif	Box Culvert	1.2	0.5	6	1	20.49	20.49
FL9_Lo-orif	Box Culvert	0.6	0.45	6	1	24.29	24.29
FL9_Pipes	Circular Pipe	0.825	N/A	34.16	2	24.29	24.09
Fut25_Hi_FC	Box Culvert	3.6	3	45.14	1	26.7	26.4
Fut25_Lo	Box Culvert	1.8	1.2	81.74	3	25.5	24.75
Hyde_Dr_01	Circular Pipe	1.2	N/A	46.8	4	32.6	31.75
McKenny_01	Box Culvert	2.4	1.2	45.14	3	28.1	27.8
McKenny_02	Box Culvert	1.5	0.9	34.16	5	27.8	27.7
MS1	Circular Pipe	0.6	N/A	13.952	2	34.4	33.75
MS10	Circular Pipe	0.45	N/A	12.156	2	11.6	11.45
MS11	Circular Pipe	1.05	N/A	22.223	1	11.25	11.2
MS17	Circular Pipe	0.675	N/A	11.157	2	41.18	41.14
MS2	Circular Pipe	0.6	N/A	17.851	4	28.54	28.46
MS28	Box Culvert	0.375	0.28	15.891	2	53.9	53.7
MS29	Circular Pipe	0.425	N/A	12.211	1	53.6	53.3
MS3	Circular Pipe	1.4	N/A	12	4	22	21.9

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
MS35	Circular Pipe	0.375	N/A	13.316	6	19.9	19.3
MS36	Box Culvert	0.375	0.9	26.025	1	17.3	17
MS38	Box Culvert	0.65	0.45	25.294	1	10.9	10
MS39	Box Culvert	0.6	0.45	16.472	1	10.8	10
MS50	Circular Pipe	0.375	N/A	13.566	1	17.2	16.9
MS51	Box Culvert	0.6	0.475	13.024	1	17.8	17.55
MS52	Circular Pipe	0.375	N/A	13.908	1	20.05	19.3
MS53	Circular Pipe	0.45	N/A	24.504	1	19.5	19.45
MS54	Circular Pipe	0.375	N/A	8.986	1	19.9	19.5
MS55	Box Culvert	1.2	0.475	18.399	2	21.14	21
MS56	Circular Pipe	0.375	N/A	11.628	1	20.2	20.1
MS57	Circular Pipe	0.45	N/A	15.904	1	19.4	19.3
MS58	Circular Pipe	0.375	N/A	20.833	1	16.6	16.3
MS6	Circular Pipe	0.575	N/A	15.411	1	43.6	43.4
MS62	Box Culvert	1.8	0.575	7.234	2	45.7	45.5
MS7	Circular Pipe	0.525	N/A	15.46	2	11.3	11.1
MS8	Circular Pipe	0.375	N/A	12.576	2	13.26	12.8
PineviewRd	Box Culvert	3.6	1.8	19	4	19.1	18.91
SC1108	Box Culvert	1.2	0.75	8.6	5	35.8	35.73
SC224869	Box Culvert	2.4	0.6	42.94	2	29.8	29.62
SC490226	Box Culvert	1.2	0.45	6.35	1	23.31	23.27
SC494631	Box Culvert	4.2	3	34.16	1	27.28	27.08
SC494632	Box Culvert	3.6	2.4	51.24	1	26	25.7
SC494633	Box Culvert	3.6	2.4	51.24	1	26	25.7
SC494634	Box Culvert	3.6	2.4	51.24	1	26	25.7
SC494635	Box Culvert	3.6	2.4	51.24	1	26	25.7
SC494636	Box Culvert	3.6	2.4	51.24	1	26	25.7
SC498628	Box Culvert	2.4	1.5	6.891	3	10.5	10.45
SC500478	Box Culvert	3	2.4	19.36	1	27.45	27.18
SC500479	Box Culvert	1.2	0.9	38.72	1	24.79	24.57
SC500480	Box Culvert	3	2.4	19.33	1	27.45	27.21
SC500481	Box Culvert	1.2	0.9	38.72	1	24.79	24.58
SC500482	Box Culvert	1.2	0.9	38.55	1	24.79	24.56
SC522470	Box Culvert	1.2	0.45	17.238	3	20.7	20.59
SC54683	Box Culvert	1.8	1.2	22.7	1	16.16	16.05
SC54684	Box Culvert	1.8	1.2	22.7	1	16.16	16.05

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
SC54685	Box Culvert	1.8	1.2	22.7	1	16.16	16.05
SC56566	Box Culvert	2.1	0.6	14.4	3	19.94	19.84
SC56998	Box Culvert	1.2	0.9	17.4	1	22.05	21.93
SC56999	Box Culvert	1.2	0.9	17.4	1	22.05	21.93
SC57000	Box Culvert	1.2	0.9	18.99	2	22.8	22.65
SC57001	Box Culvert	1.2	0.9	18.99	2	22.8	22.65
SC63666	Box Culvert	0.9	0.3	16.3	1	43.9	43.8
SC997	Box Culvert	2.4	0.9	15.79	1	18.9	18.8
SD37654	Circular Pipe	1.2	N/A	10	1	20.01	19.99
SD37655	Circular Pipe	1.2	N/A	10	1	20.01	19.99
SD37656	Circular Pipe	1.2	N/A	10	1	20.01	19.99
SD37657	Circular Pipe	1.2	N/A	10	1	20.01	19.99
SD37658	Circular Pipe	1.2	N/A	10	1	20.01	19.99
SD37679	Circular Pipe	0.6	N/A	10	1	30.4	30.2
SD37680	Circular Pipe	0.6	N/A	10	1	30.4	30.2
SD37691	Circular Pipe	1.65	N/A	13	1	71.9	71.84
SD37694	Circular Pipe	1.65	N/A	21	1	91.1	91
SD37741	Circular Pipe	0.6	N/A	9	1	21.6	20.9
SD37742	Circular Pipe	0.6	N/A	9	1	21.6	20.9
SD37832	Circular Pipe	0.45	N/A	11	1	31.55	31.4
SD37833	Circular Pipe	0.45	N/A	11	1	31.55	31.4
SD37834	Circular Pipe	0.45	N/A	11	1	31.55	31.4
SD39004	Circular Pipe	0.375	N/A	34.4	1	22.29	22
SD39005	Circular Pipe	0.9	N/A	12.3	1	22.56	22.46
SD39006	Circular Pipe	0.9	N/A	12.3	1	22.56	22.46
SD39007	Circular Pipe	0.6	N/A	12.3	1	22.6	22.43
SD39008	Circular Pipe	0.6	N/A	37.3	1	22.4	21.98
SD39009	Circular Pipe	0.6	N/A	11	1	23.67	23.46
SD39010	Circular Pipe	0.6	N/A	34	1	23.46	22.84
SD39245	Circular Pipe	1.65	N/A	19.3	1	71.85	71.75
SD39246	Circular Pipe	1.65	N/A	19.3	1	71.85	71.75
SD39247	Circular Pipe	1.65	N/A	19.3	1	71.85	71.75
SD39256	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93
SD39257	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93
SD39258	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93
SD39259	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
SD39260	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93
SD39261	Circular Pipe	0.9	N/A	10.98	1	17.01	16.93
SD39330	Circular Pipe	1.2	N/A	13.4	1	54.82	54.55
SD39331	Circular Pipe	1.2	N/A	13.4	1	54.82	54.55
SD39332	Circular Pipe	0.675	N/A	14.64	1	57	56.38
SD39333	Circular Pipe	1.2	N/A	12.2	1	58.01	57.86
SD39334	Circular Pipe	1.2	N/A	12.2	1	58.01	57.86
SD39387	Circular Pipe	0.675	N/A	10	1	36.6	36.55
SD39388	Circular Pipe	0.675	N/A	10	1	36.6	36.55
SD39525	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39526	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39527	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39528	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39529	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39530	Circular Pipe	1.05	N/A	12.2	1	49.57	49.45
SD39533	Circular Pipe	0.675	N/A	15.86	1	49.95	49.58
SD39534	Circular Pipe	0.675	N/A	15.86	1	49.95	49.58
SD39535	Circular Pipe	0.675	N/A	15.86	1	49.95	49.58
SD39536	Circular Pipe	0.675	N/A	15.86	1	49.95	49.58
SD39537	Circular Pipe	1.5	N/A	17.08	1	48.4	48.08
SD39538	Circular Pipe	1.5	N/A	17.08	1	48.4	48.08
SD39539	Circular Pipe	1.05	N/A	12.8	1	23.37	23.24
SD39556	Circular Pipe	0.45	N/A	12.2	1	24.25	24
SD39557	Circular Pipe	0.45	N/A	12.2	1	24.25	24
SD39558	Circular Pipe	0.45	N/A	12.2	1	24.25	24
SD39572	Circular Pipe	1.2	N/A	15.86	1	20.93	20.77
SD39573	Circular Pipe	1.2	N/A	15.86	1	20.93	20.77
SD39574	Circular Pipe	1.2	N/A	15.86	1	20.93	20.77
SD39575	Circular Pipe	1.2	N/A	15.86	1	20.93	20.77
SD39660	Circular Pipe	1.2	N/A	10	1	14.5	14.4
SD39661	Circular Pipe	1.2	N/A	10	1	14.5	14.4
SD39662	Circular Pipe	1.2	N/A	10	1	14.5	14.4
SD39663	Circular Pipe	1.2	N/A	10	1	14.5	14.4
SD39664	Circular Pipe	1.2	N/A	10	1	14.5	14.4
SD39665	Circular Pipe	0.9	N/A	10	1	14.9	14.7
SD39666	Circular Pipe	0.9	N/A	10	1	14.9	14.7

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
SD39667	Circular Pipe	0.9	N/A	10	1	14.9	14.7
SD39668	Circular Pipe	0.9	N/A	10	1	14.9	14.7
SD39711	Circular Pipe	0.525	N/A	12.2	1	18.43	18.25
SD39712	Circular Pipe	0.525	N/A	12.2	1	18.43	18.25
SD39713	Circular Pipe	0.525	N/A	12.2	1	18.43	18.25
SD39714	Circular Pipe	0.525	N/A	12.2	1	17.92	17.82
SD39715	Circular Pipe	0.525	N/A	12.2	1	17.92	17.82
SD39716	Circular Pipe	0.375	N/A	13.42	1	17.4	17.1
SD39717	Circular Pipe	0.375	N/A	13.42	1	17.4	17.1
SD39735	Circular Pipe	0.9	N/A	10	1	19.2	18.9
SD39736	Circular Pipe	0.9	N/A	10	1	19.2	18.9
SD39737	Circular Pipe	1.2	N/A	15	1	15.75	15.6
SD39738	Circular Pipe	0.75	N/A	26	1	14.8	14.6
SD39739	Circular Pipe	0.75	N/A	20	1	11.5	11.25
SD45199	Circular Pipe	1.2	N/A	10	1	14.42	14.22
SD45200	Circular Pipe	1.2	N/A	10	1	14.42	14.22
SD45201	Circular Pipe	0.75	N/A	4.88	1	14.47	14.42
SD45202	Circular Pipe	0.75	N/A	4.88	1	14.47	14.42
SD45203	Circular Pipe	0.75	N/A	4.88	1	14.47	14.42
SD45204	Circular Pipe	0.75	N/A	4.88	1	14.47	14.42
SD45205	Circular Pipe	1.2	N/A	3.66	1	14.22	14.2
SD45206	Circular Pipe	1.2	N/A	3.66	1	14.22	14.2
SD45944	Circular Pipe	1.2	N/A	84.41	1	41.28	40.99
SD46171	Circular Pipe	1.2	N/A	32.89	4	32.81	32.63
SD490218	Circular Pipe	0.675	N/A	20.19	1	21.93	21.8
SD490219	Circular Pipe	0.675	N/A	16.04	1	21.92	21.85
SD498726	Circular Pipe	0.675	N/A	9.38	2	20.34	20.3
SD51554	Circular Pipe	0.6	N/A	11.89	1	29.7	29.6
SD51563	Circular Pipe	1.2	N/A	12.2	6	28.05	28
SD522455	Circular Pipe	1.2	N/A	27.15	4	20.51	20.45
SD522460	Circular Pipe	1.2	N/A	27.18	4	20.47	20.4
SD540180	Circular Pipe	0.6	N/A	9.72	1	18.99	18.85
SD540181	Circular Pipe	0.6	N/A	9.72	1	18.99	18.85
SD540182	Circular Pipe	0.6	N/A	9.72	1	18.99	18.85
SD540183	Circular Pipe	0.6	N/A	9.72	1	18.99	18.85
SD540184	Circular Pipe	0.6	N/A	9.72	1	18.99	18.85

ID	Type	Width/Dia (m)	Height (m)	Length (m)	No of Cells	US Invert (m AHD)	DS Invert (m AHD)
SD540186	Circular Pipe	0.6	N/A	10.53	1	16.42	16.31
SD540187	Circular Pipe	0.6	N/A	10.53	1	16.42	16.31
SD540188	Circular Pipe	0.6	N/A	10.53	1	16.42	16.31
SD540189	Circular Pipe	0.6	N/A	10.53	1	16.42	16.31
SD54652	Circular Pipe	0.375	N/A	17.81	1	15.76	15.66
SD57002	Circular Pipe	0.9	N/A	22.24	1	20.5	20.2
SD57003	Circular Pipe	0.9	N/A	22.24	1	20.5	20.2
SD57004	Circular Pipe	0.9	N/A	22.24	1	20.5	20.2
SD57005	Circular Pipe	0.6	N/A	12.2	1	23.8	23.32
SD57006	Circular Pipe	0.6	N/A	12.2	1	23.8	23.32
SD57516	Circular Pipe	0.9	N/A	9	1	58.56	58.32
SD57517	Circular Pipe	0.9	N/A	9	1	58.56	58.32
SD57519	Circular Pipe	0.6	N/A	9	1	59.78	59.42
SD57520	Circular Pipe	0.6	N/A	9	1	59.78	59.42
SD57521	Circular Pipe	0.6	N/A	9	1	59.78	59.42
SD57522	Circular Pipe	0.6	N/A	9	1	59.78	59.42
SD57523	Circular Pipe	0.6	N/A	9	1	59.78	59.42
SD57524	Circular Pipe	0.75	N/A	17.13	1	74.19	72.64
SD57525	Circular Pipe	0.75	N/A	17.13	1	74.19	72.64
SD62152	Circular Pipe	0.75	N/A	12.83	1	40.53	40.45
SD63645	Circular Pipe	0.15	N/A	8.31	1	43.6	43.55
SD63646	Circular Pipe	0.15	N/A	5.47	1	43.55	43.5
SD63647	Circular Pipe	0.15	N/A	19.17	1	43.8	43.7
SD63648	Circular Pipe	0.45	N/A	33.78	1	43.5	43.1
SD63649	Circular Pipe	0.45	N/A	33.78	1	43.5	43.1
SD63652	Circular Pipe	0.6	N/A	8.2	1	42.5	42.4
SD63827	Circular Pipe	0.375	N/A	8.62	1	9.31	9.13
SD63828	Circular Pipe	0.375	N/A	6.49	1	9.11	9
unknown3	Circular Pipe	0.39	N/A	9.723	1	12.35	11.7
unknown4	Circular Pipe	0.39	N/A	14.159	1	11.5	11.25
WTR	Circular Pipe	1.8	N/A	16.5	5	51.96	51.72
YBDr_OUT	Box Culvert	2.4	0.75	31.72	3	32.01	31.91

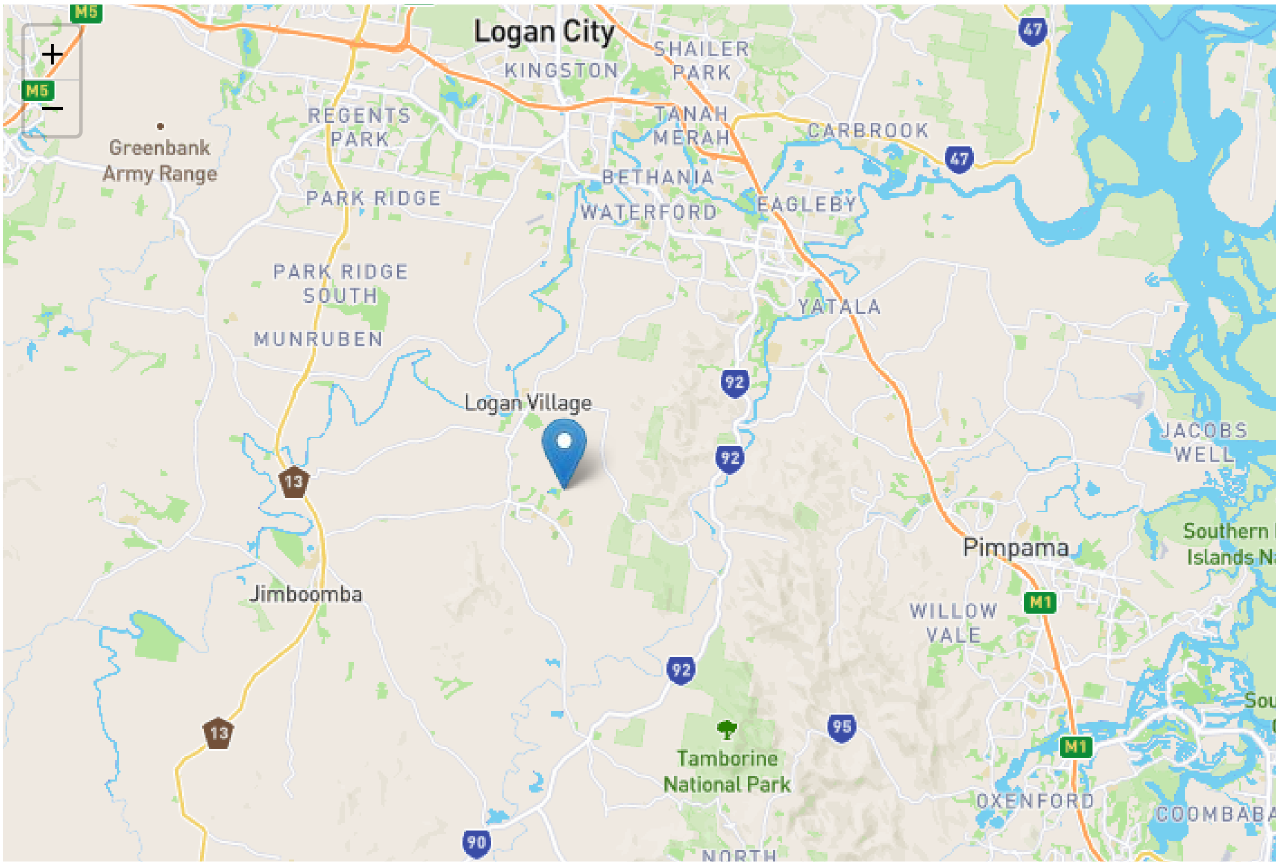
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX B
ARR2019 DATA HUB OUTPUTS

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	153.12
Latitude	-27.797
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show



Data

River Region

Division	North East Coast
River Number	45
River Name	Logan-Albert Rivers

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2016_v1

ARF Parameters

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

Zone	a	b	c	d	e	f	g	h	i
East Coast North	0.327	0.241	0.448	0.36	0.00096	0.48	-0.21	0.012	-0.0013

Short Duration ARF

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

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

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

ID	5092.0
Storm Initial Losses (mm)	26.0
Storm Continuing Losses (mm/h)	1.9

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2016_v1

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

code	ECnorth
Label	East Coast North

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2016_v2

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

code	ECnorth
arealabel	East Coast North

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-27.7974&longitude=153.1205&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	01 May 2023 05:10PM

Median Preburst Depths and Ratios

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

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.9 (0.026)	3.0 (0.061)	4.4 (0.075)	5.7 (0.084)	8.4 (0.103)	10.4 (0.114)
90 (1.5)	0.5 (0.014)	2.7 (0.049)	4.2 (0.062)	5.5 (0.070)	11.9 (0.126)	16.7 (0.156)
120 (2.0)	0.4 (0.009)	7.0 (0.114)	11.4 (0.154)	15.6 (0.180)	17.6 (0.169)	19.2 (0.161)
180 (3.0)	0.8 (0.017)	8.4 (0.121)	13.5 (0.160)	18.3 (0.184)	23.3 (0.193)	27.0 (0.195)
360 (6.0)	2.1 (0.033)	12.6 (0.141)	19.5 (0.180)	26.2 (0.204)	44.5 (0.283)	58.2 (0.322)
720 (12.0)	2.7 (0.033)	11.0 (0.094)	16.4 (0.114)	21.7 (0.127)	41.3 (0.197)	56.0 (0.233)
1080 (18.0)	2.3 (0.024)	11.9 (0.085)	18.3 (0.107)	24.4 (0.120)	36.4 (0.146)	45.4 (0.159)
1440 (24.0)	3.6 (0.033)	7.7 (0.049)	10.3 (0.053)	12.9 (0.056)	29.2 (0.103)	41.4 (0.128)
2160 (36.0)	0.0 (0.000)	4.6 (0.025)	7.6 (0.033)	10.5 (0.038)	22.7 (0.068)	31.8 (0.083)
2880 (48.0)	0.0 (0.000)	1.2 (0.006)	2.0 (0.008)	2.8 (0.009)	13.1 (0.035)	20.8 (0.048)
4320 (72.0)	0.0 (0.000)	0.1 (0.000)	0.2 (0.001)	0.3 (0.001)	4.7 (0.011)	8.1 (0.016)

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

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

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

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

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

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.2 (0.004)	0.4 (0.006)	0.5 (0.007)	0.5 (0.006)	0.5 (0.006)
90 (1.5)	0.0 (0.000)	0.2 (0.003)	0.3 (0.004)	0.4 (0.005)	1.0 (0.011)	1.5 (0.014)
120 (2.0)	0.0 (0.000)	0.8 (0.012)	1.3 (0.017)	1.7 (0.020)	1.3 (0.013)	1.0 (0.009)
180 (3.0)	0.0 (0.000)	0.2 (0.003)	0.4 (0.005)	0.5 (0.005)	0.8 (0.007)	1.0 (0.007)
360 (6.0)	0.0 (0.000)	0.6 (0.007)	1.0 (0.009)	1.4 (0.011)	4.0 (0.026)	6.0 (0.033)
720 (12.0)	0.0 (0.000)	2.1 (0.018)	3.6 (0.025)	4.9 (0.029)	8.6 (0.041)	11.4 (0.048)
1080 (18.0)	0.0 (0.000)	1.9 (0.014)	3.1 (0.018)	4.3 (0.021)	6.2 (0.025)	7.6 (0.027)
1440 (24.0)	0.0 (0.000)	0.1 (0.000)	0.1 (0.001)	0.2 (0.001)	4.2 (0.015)	7.2 (0.022)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.4 (0.001)	0.7 (0.002)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

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

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	16.8 (0.471)	28.4 (0.576)	36.2 (0.614)	43.6 (0.636)	39.8 (0.489)	37.0 (0.404)
90 (1.5)	14.6 (0.363)	23.0 (0.410)	28.6 (0.425)	33.9 (0.431)	65.5 (0.694)	89.2 (0.834)
120 (2.0)	10.6 (0.242)	29.6 (0.484)	42.3 (0.572)	54.4 (0.627)	93.7 (0.895)	123.1 (1.034)
180 (3.0)	30.2 (0.611)	49.4 (0.709)	62.1 (0.736)	74.2 (0.746)	112.9 (0.934)	141.9 (1.026)
360 (6.0)	32.4 (0.520)	51.6 (0.581)	64.3 (0.594)	76.4 (0.595)	117.9 (0.751)	149.0 (0.826)
720 (12.0)	37.7 (0.462)	59.1 (0.504)	73.2 (0.510)	86.8 (0.508)	112.1 (0.536)	131.1 (0.546)
1080 (18.0)	21.8 (0.226)	51.6 (0.370)	71.4 (0.417)	90.3 (0.443)	109.2 (0.438)	123.3 (0.431)
1440 (24.0)	28.9 (0.267)	47.5 (0.301)	59.7 (0.308)	71.5 (0.309)	84.8 (0.300)	94.7 (0.292)
2160 (36.0)	12.6 (0.099)	24.8 (0.133)	32.8 (0.143)	40.5 (0.148)	60.3 (0.180)	75.0 (0.195)
2880 (48.0)	12.9 (0.091)	27.2 (0.131)	36.7 (0.143)	45.8 (0.149)	62.4 (0.167)	74.9 (0.174)
4320 (72.0)	0.2 (0.001)	10.6 (0.045)	17.5 (0.060)	24.1 (0.069)	45.7 (0.107)	62.0 (0.125)

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

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

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	62.6 (1.755)	98.4 (1.992)	122.1 (2.072)	144.8 (2.116)	135.1 (1.659)	127.7 (1.395)
90 (1.5)	51.1 (1.270)	76.1 (1.357)	92.7 (1.377)	108.5 (1.379)	190.8 (2.021)	252.5 (2.361)
120 (2.0)	37.0 (0.845)	76.9 (1.255)	103.4 (1.400)	128.7 (1.485)	190.3 (1.819)	236.4 (1.985)
180 (3.0)	70.6 (1.428)	108.2 (1.552)	133.0 (1.577)	156.9 (1.576)	241.6 (1.998)	305.2 (2.206)
360 (6.0)	59.6 (0.955)	106.5 (1.200)	137.6 (1.271)	167.3 (1.302)	245.1 (1.561)	303.4 (1.682)
720 (12.0)	88.8 (1.089)	125.2 (1.068)	149.3 (1.040)	172.4 (1.009)	220.3 (1.054)	256.2 (1.067)
1080 (18.0)	57.8 (0.599)	95.5 (0.685)	120.4 (0.704)	144.4 (0.708)	179.0 (0.719)	205.0 (0.717)
1440 (24.0)	77.7 (0.716)	103.3 (0.655)	120.3 (0.621)	136.6 (0.591)	166.3 (0.589)	188.6 (0.582)
2160 (36.0)	37.6 (0.295)	76.9 (0.412)	102.9 (0.448)	127.8 (0.466)	149.7 (0.447)	166.0 (0.432)
2880 (48.0)	44.2 (0.313)	75.2 (0.362)	95.7 (0.374)	115.4 (0.376)	147.8 (0.394)	172.1 (0.400)
4320 (72.0)	14.4 (0.090)	40.5 (0.172)	57.7 (0.198)	74.3 (0.212)	94.1 (0.219)	109.0 (0.221)

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

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

Layer Info

Time Accessed	01 May 2023 05:10PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Download TXT (downloads/962311ce-745c-40c1-a674-03d538d92f09.txt)

Download JSON (downloads/e4426f86-cf5c-4ef3-84ff-cef89b84a03d.json)

Generating PDF... (downloads/ee0dbd62-a688-4d53-9142-f6c2b720ae0a.pdf)

APPENDIX C
BOX AND WHISKER PLOTS

QUINZEH CREEK

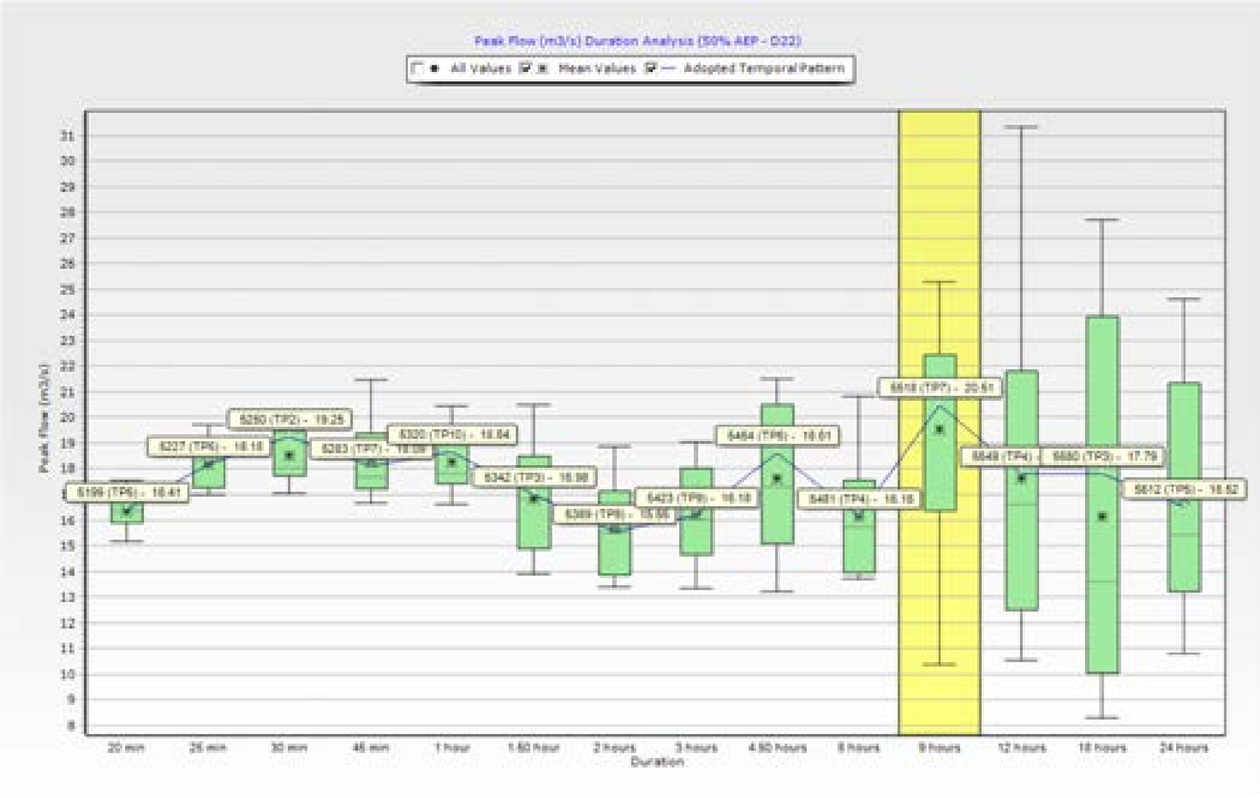


Figure C-1 Comparison of Storm Ensembles of different durations for AEP = 50% - QC01

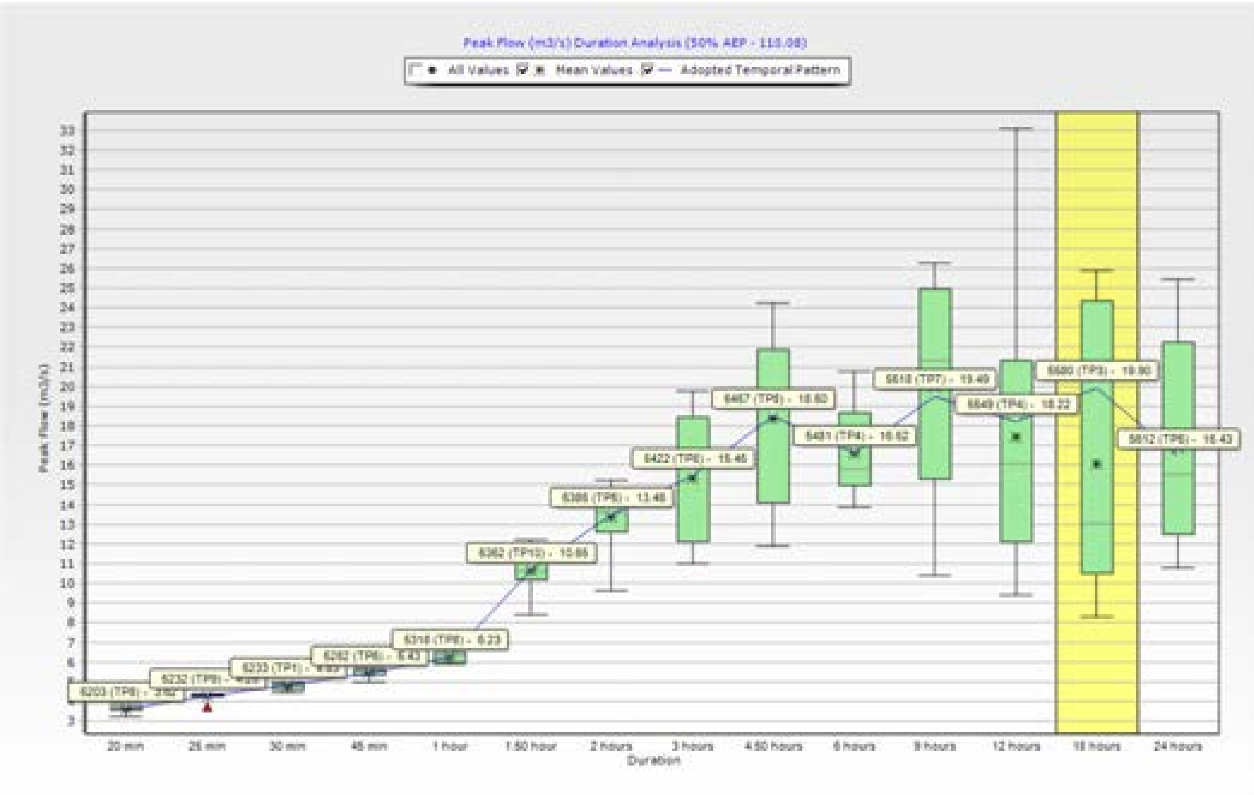


Figure C-2 Comparison of Storm Ensembles of different durations for AEP = 50% - QC02

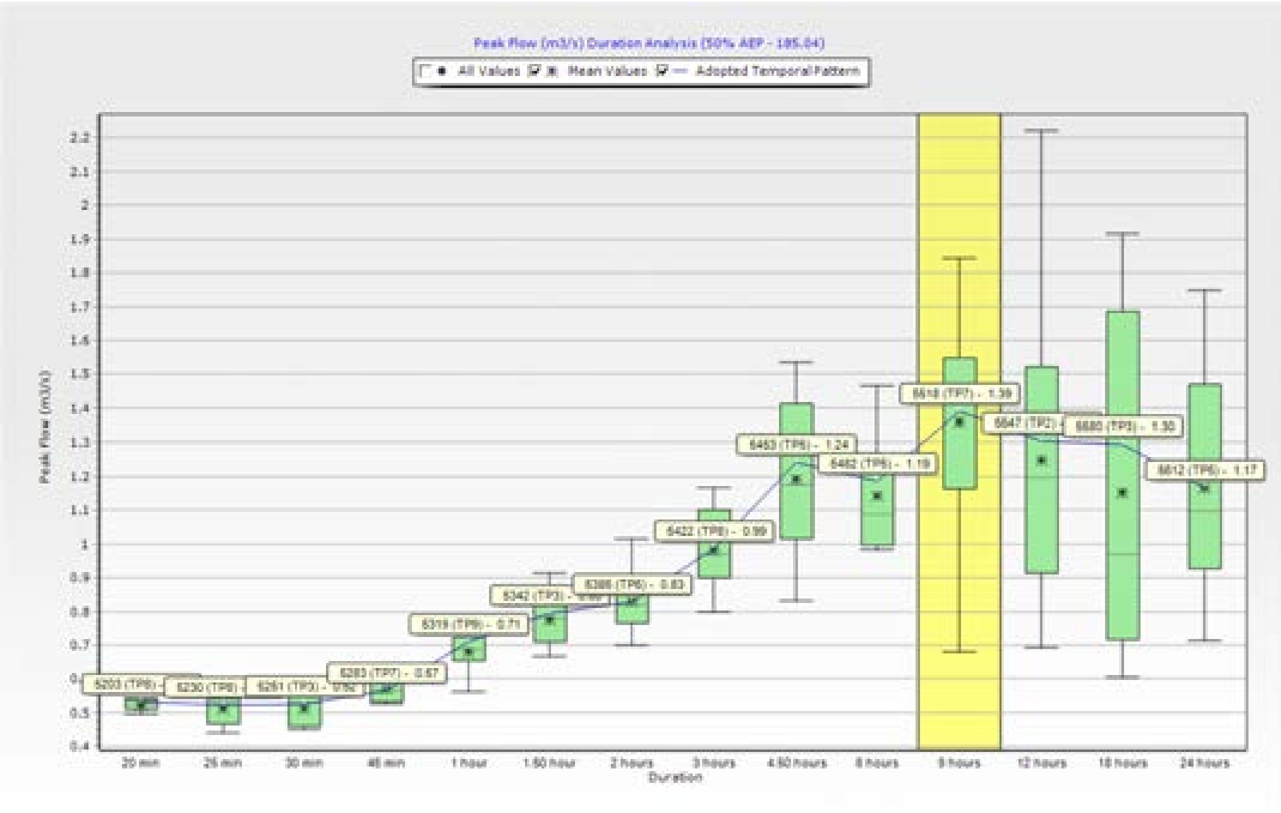


Figure C-3 Comparison of Storm Ensembles of different durations for AEP = 50% - QC03

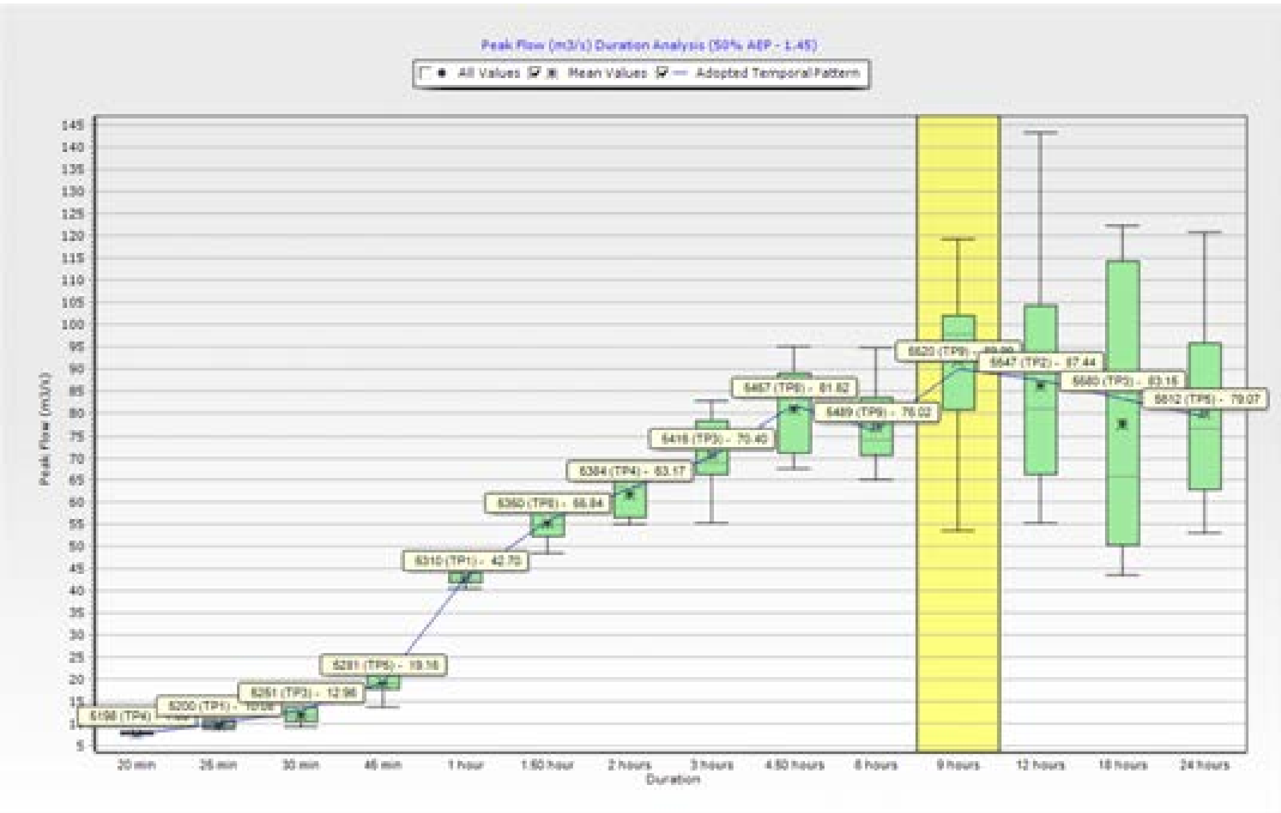


Figure C-4 Comparison of Storm Ensembles of different durations for AEP = 50% - QC04

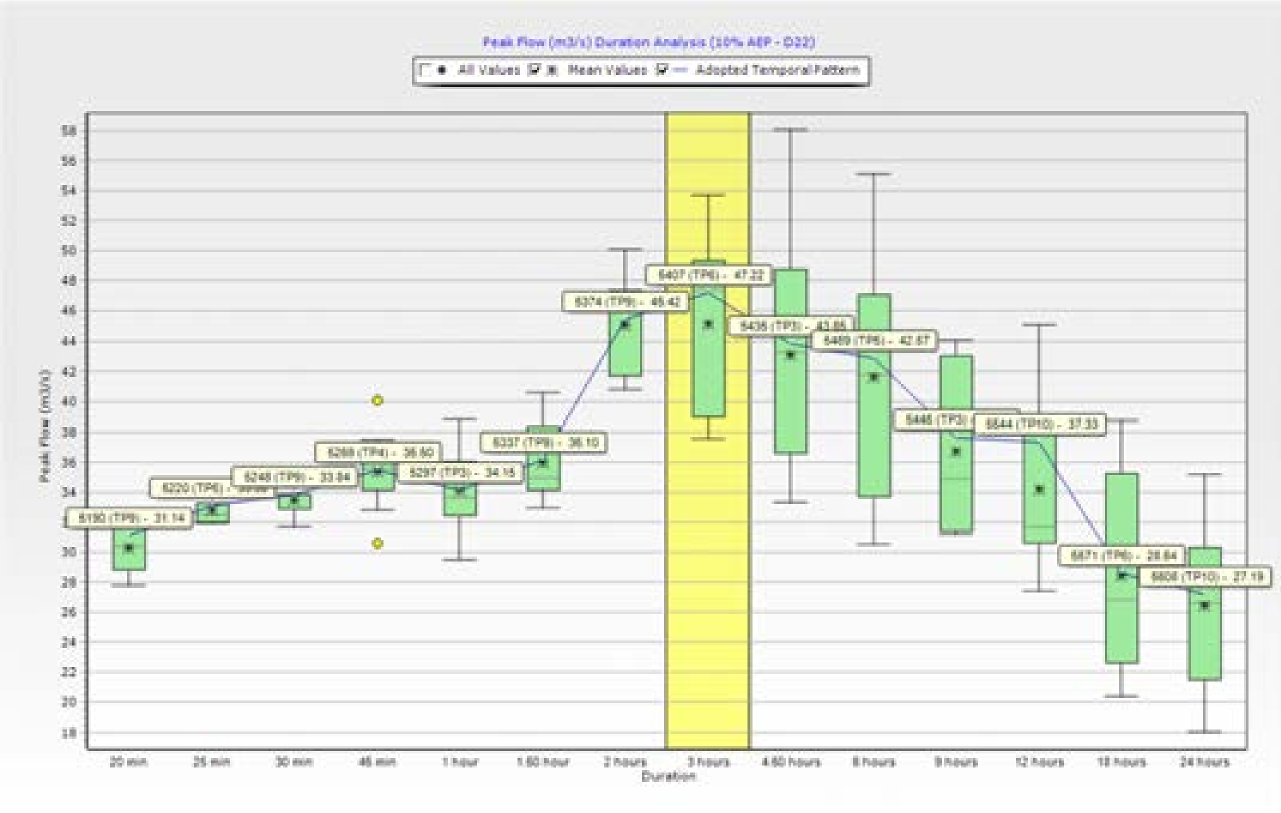


Figure C-5 Comparison of Storm Ensembles of different durations for AEP = 10% - QC01

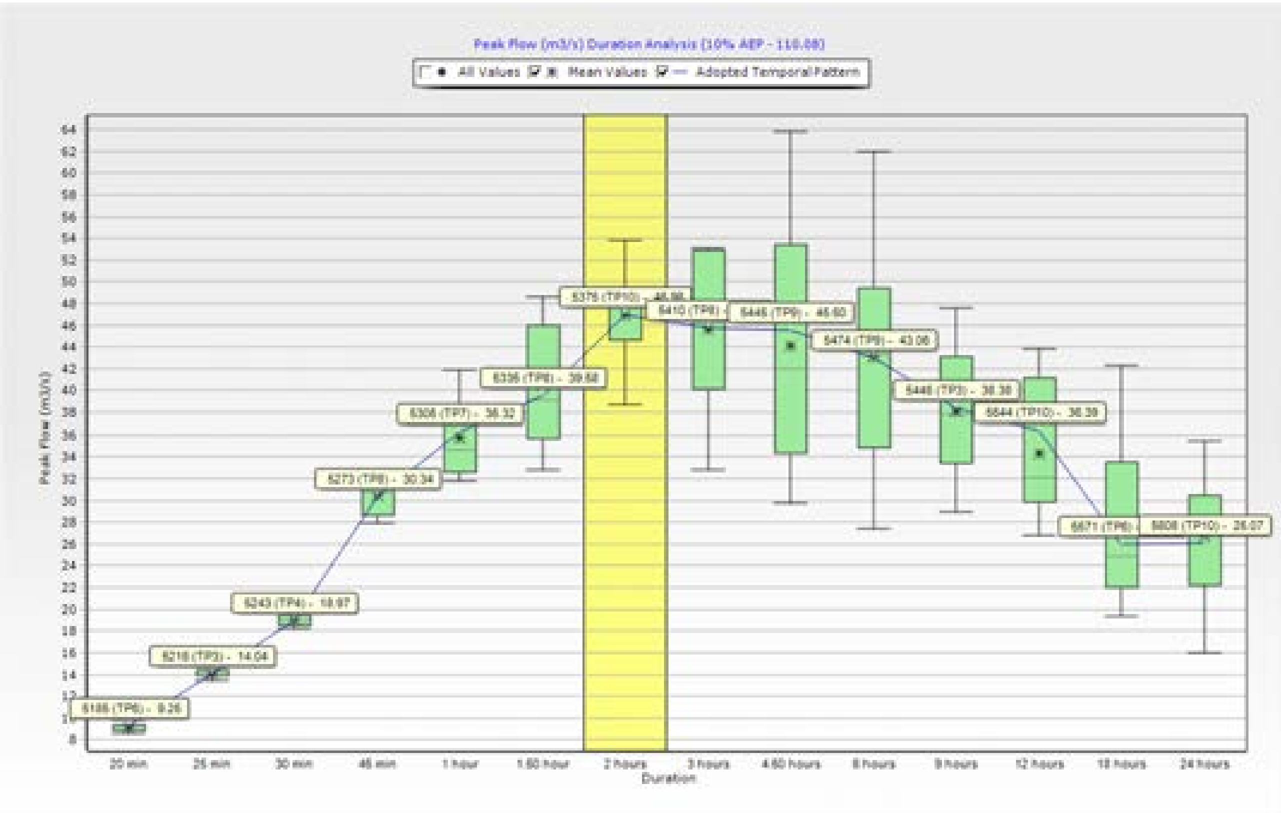


Figure C-6 Comparison of Storm Ensembles of different durations for AEP = 10% - QC02

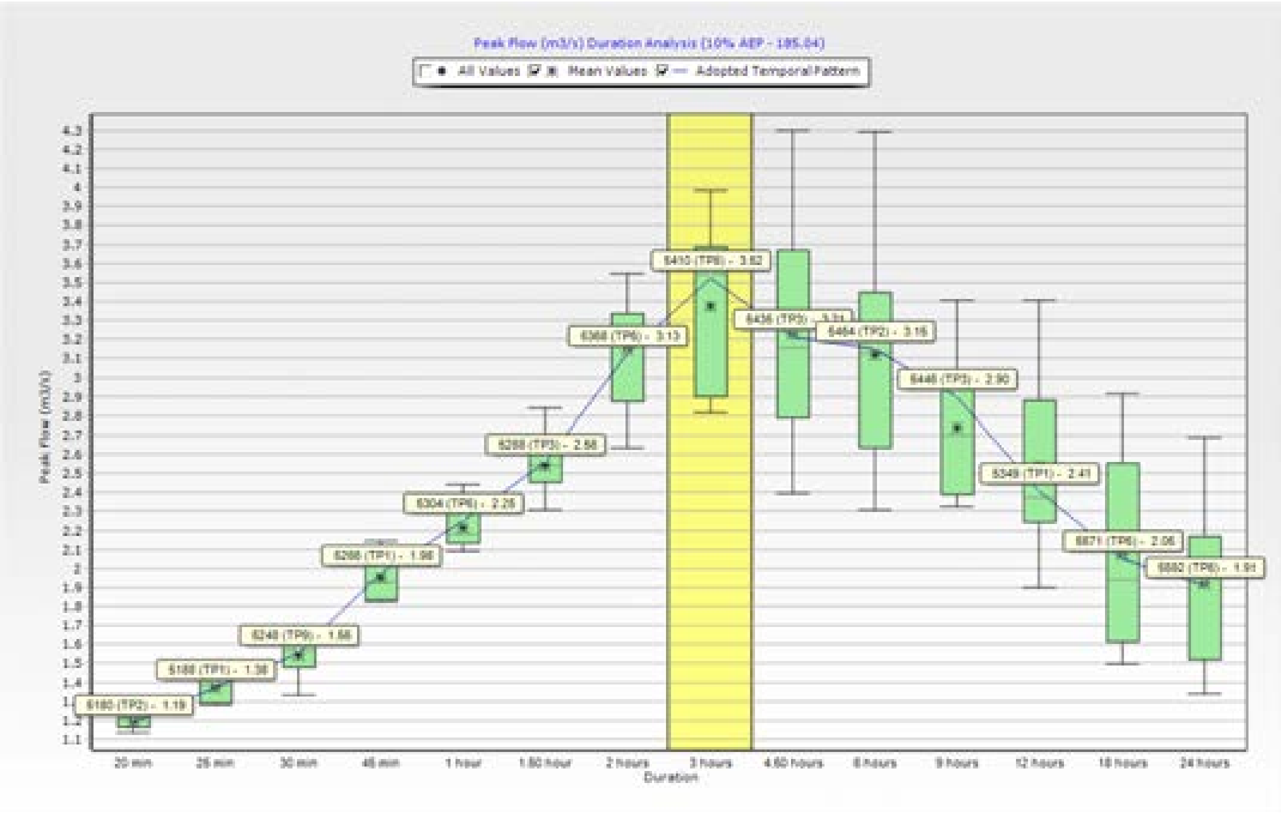


Figure C-7 Comparison of Storm Ensembles of different durations for AEP = 10% - QC03

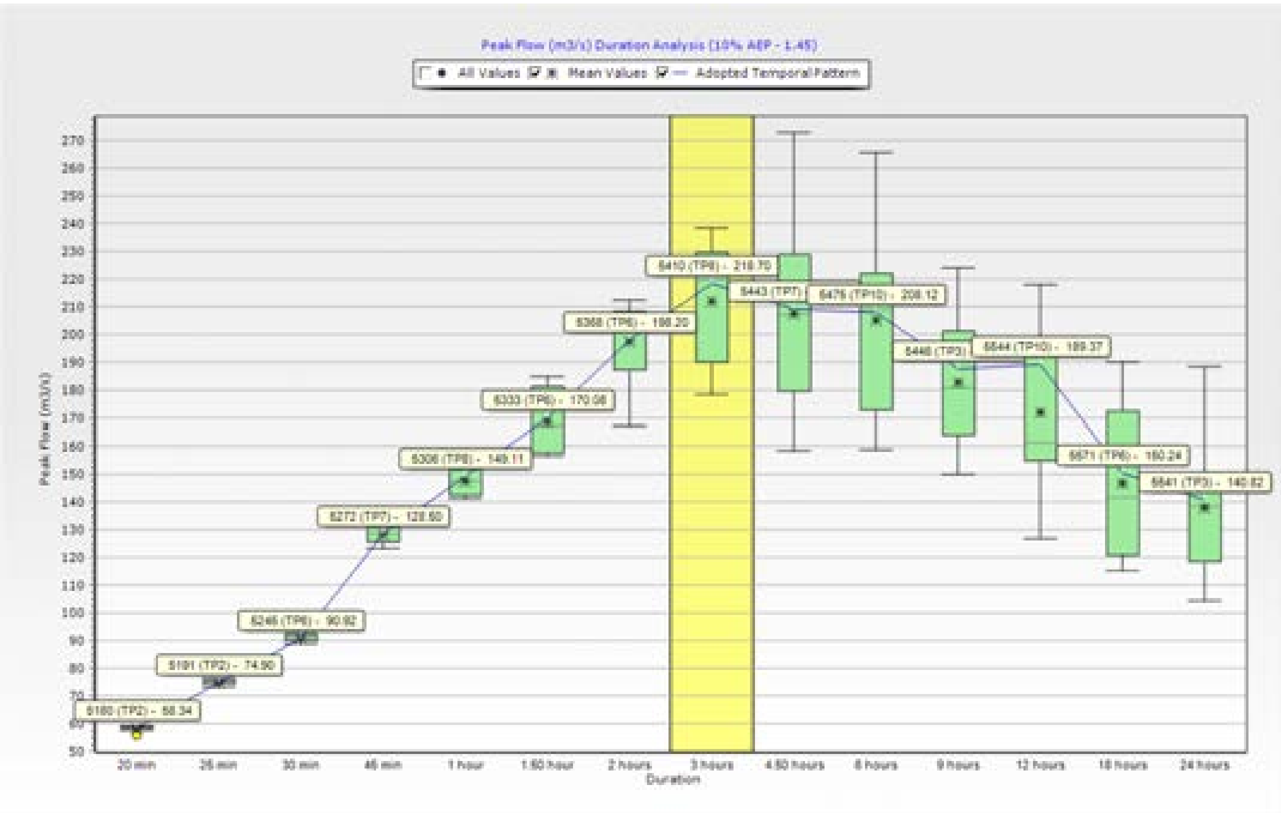


Figure C-8 Comparison of Storm Ensembles of different durations for AEP = 10% - QC04

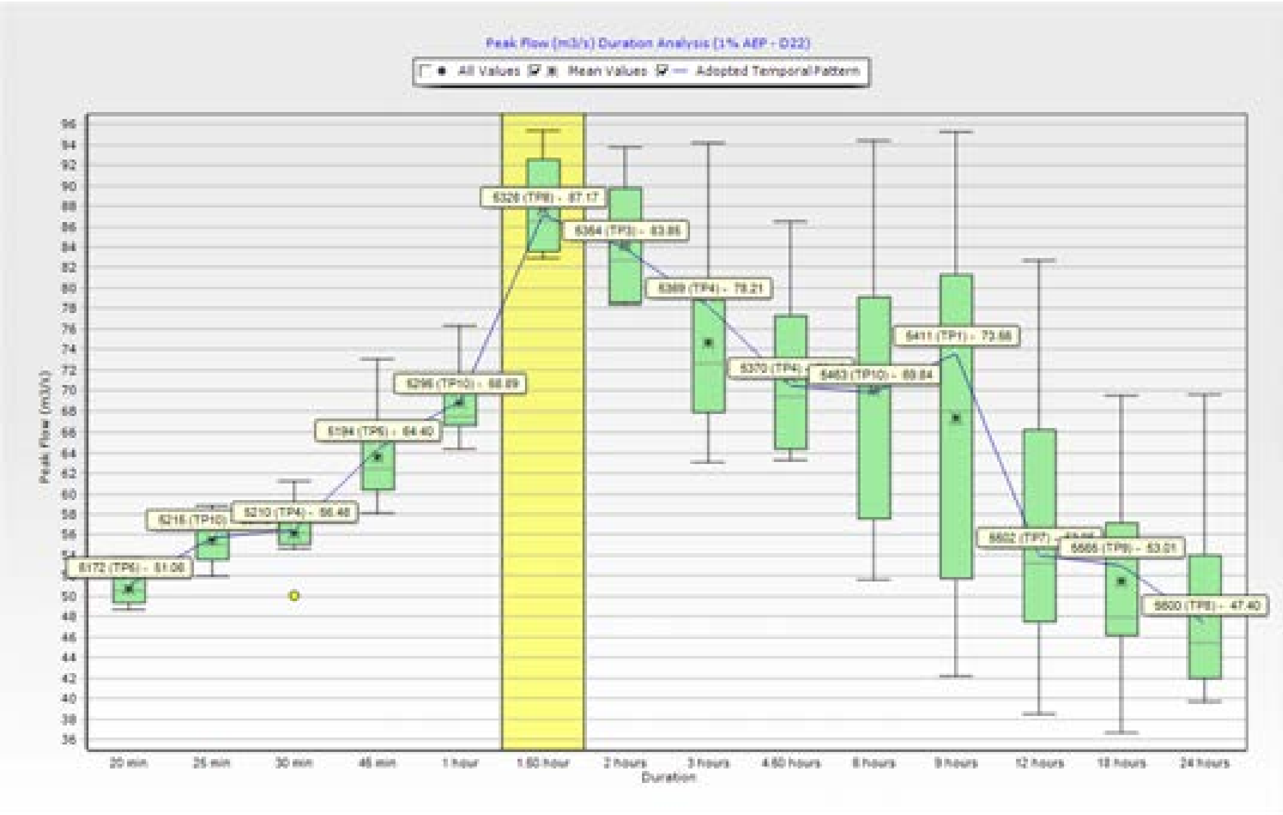


Figure C-9 Comparison of Storm Ensembles of different durations for AEP = 1% - QC01

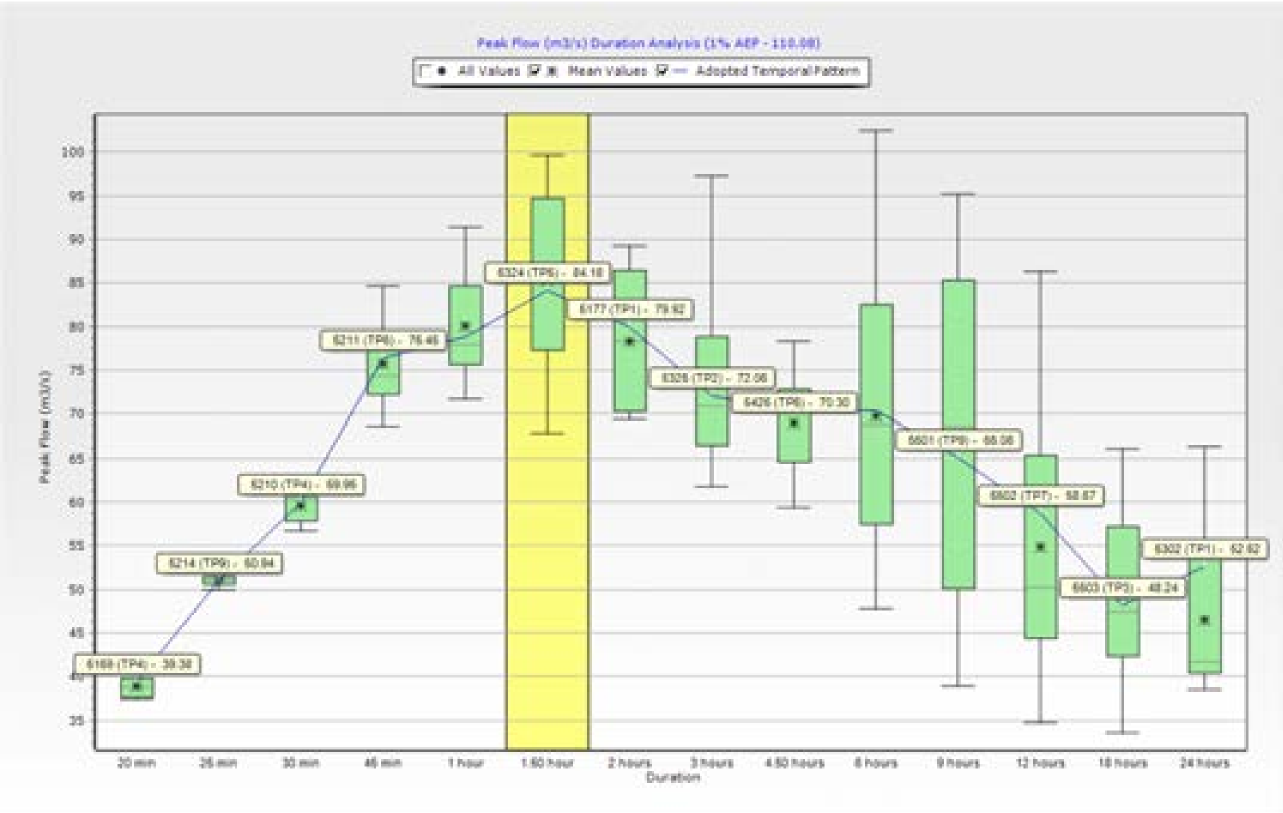


Figure C-10 Comparison of Storm Ensembles of different durations for AEP = 1% - QC02

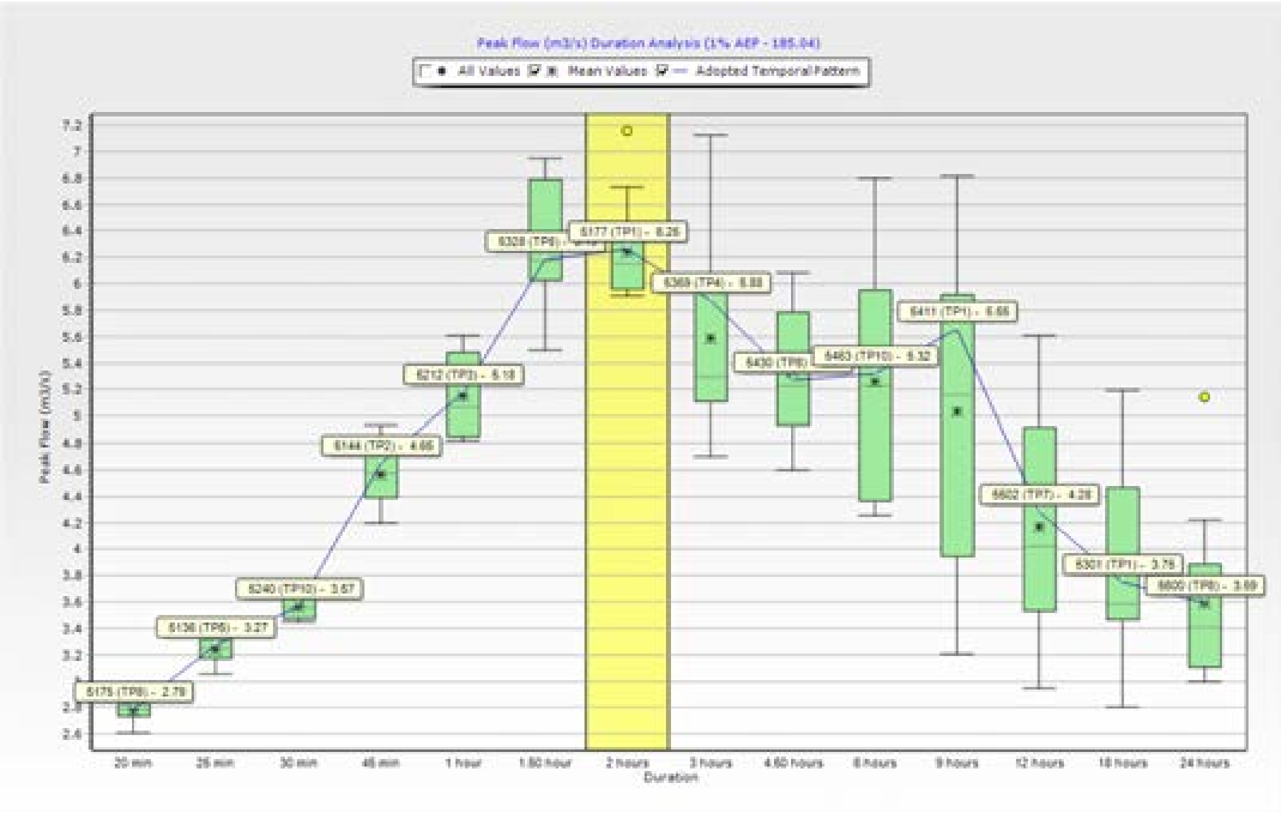


Figure C-11 Comparison of Storm Ensembles of different durations for AEP = 1% - QC03

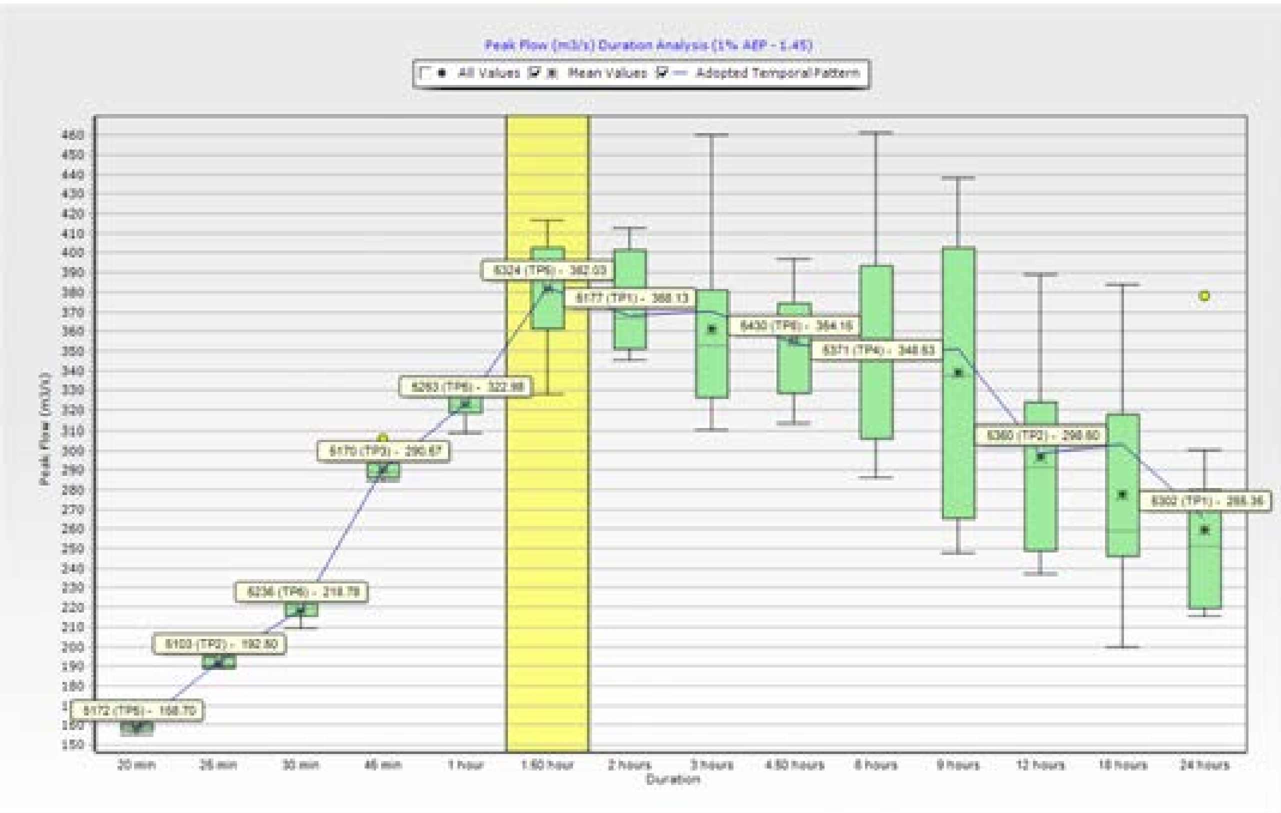


Figure C-12 Comparison of Storm Ensembles of different durations for AEP = 1% - QC04

APPENDIX D
PREVIOUS MODEL CALIBRATION AND VALIDATION

D PREVIOUS MODEL CALIBRATION AND VALIDATION

D.1 Introduction

Calibration is the process of adjusting parameters to result in an accurate measurement or representation. For flood studies, this includes: -

- Hydrology – Calibration of flows to ensure adequate representation of catchment rainfall to runoff conversion processes; and
- Hydraulics – Calibration of water surface levels based on the calibrated flows generated from the hydrological model.

Calibration of the hydrologic and hydraulic models prepared for Quinzeh Creek has been undertaken for three (3) historical events. These include:

- January 2013;
- April/May 2015; and
- March/April 2017.

The following provides a summary of the calibration methodology and results.

D.2 Calibration Datasets

D.2.1 At-Site Gauge Datasets

Table D-1 provides a summary of the available historical gauge data for the Quinzeh Creek catchment for each of the 2013, 2015 and 2017 calibration events, all data for which was provided by Council. The locations of the existing gauges are illustrated in Figure D-1. Table D-1 provides a summary of the available gauge data sets available for each of the calibration events.

Table D-1 Summary of Available Historical Data

Data Set	2013 Event	2015 Event	2017 Event
Rainfall – Logan Village Gauge	Yes	Yes	Yes
Rainfall – Lower Quinzeh gauge	Yes	Yes	Yes
Rainfall – Upper Quinzeh River gauge	No	Yes	Yes
Water Level – Logan Village gauge	Yes	Yes	Yes
Water Level – Millers Road gauge	No – Note 1	Yes	Yes
Water Level – Upper Quinzeh River gauge	No – Note 1	Yes	Yes

Notes

1. Water level gauge time series data was not provided for the 2013 event. However, peak water levels for the 2013 event were provided by Council via email dated 13 July 2020.

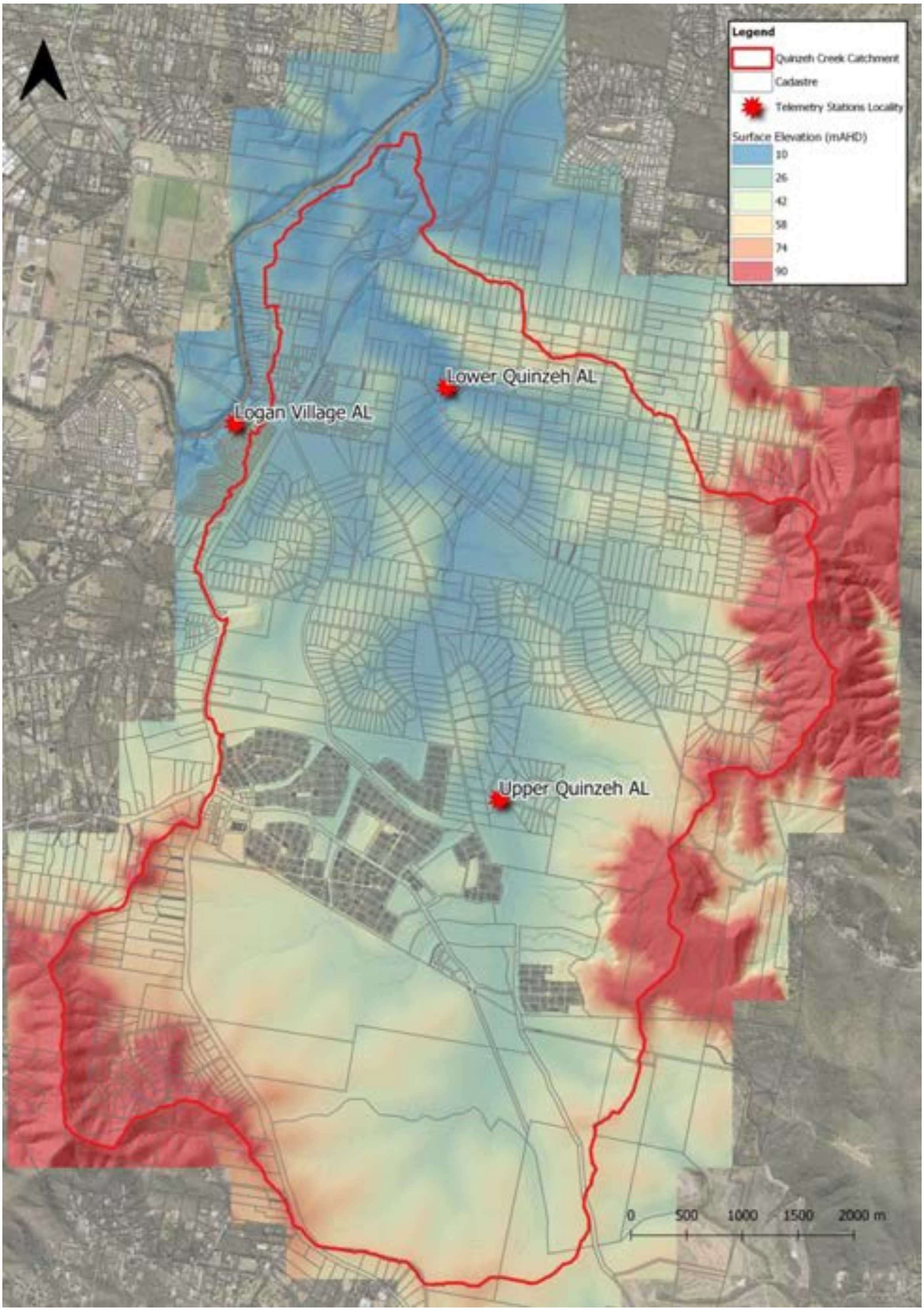


Figure D-1 Existing Gauge Locations (Source – LCC 2019)

The following comments are made in respect to the existing gauge data sets:

- For the 2013 event, calibration could only be undertaken against a peak gauge record given that there were no time series gauge data available.
- There are locally available rainfall and water level data within the Quinzeh Creek catchment for each of the 2015 and 2017 events. The calibration of the Quinzeh Creek models is therefore focused primarily on these more recent events which have more extensive historical data; and
- Although there are three (3) locally available rainfall gauges within the catchment for the 2015 and 2017 events, there are only two (2) gauges located within the Quinzeh Creek catchment itself. Having a total of only three (3) rainfall gauges reduces the ability to quantify spatial rainfall variability across the catchment.

Peak intensities over various durations were calculated for each of the rainfall gauge datasets provided by the Council. The results and discussion pertaining to this IFD analysis is presented below for each of the calibration events.

D.2.1.1 2013 Rainfall IFD Analysis

Figure D-2 and Figure D-3 illustrates the IFD analysis undertaken at the Logan Village and Lower Quinzeh gauges respectively for the 2013 flood event. The plots show that the rainfall at Logan Village and Lower Quinzeh gauges were approximately equivalent to a 10% AEP event for durations from 6-hours to 48-hours. As the critical duration for the Quinzeh Creek catchment is 6-hours at the outlet, the 2013 historical event is estimated to be a 10% AEP event based on the rainfall IFD.

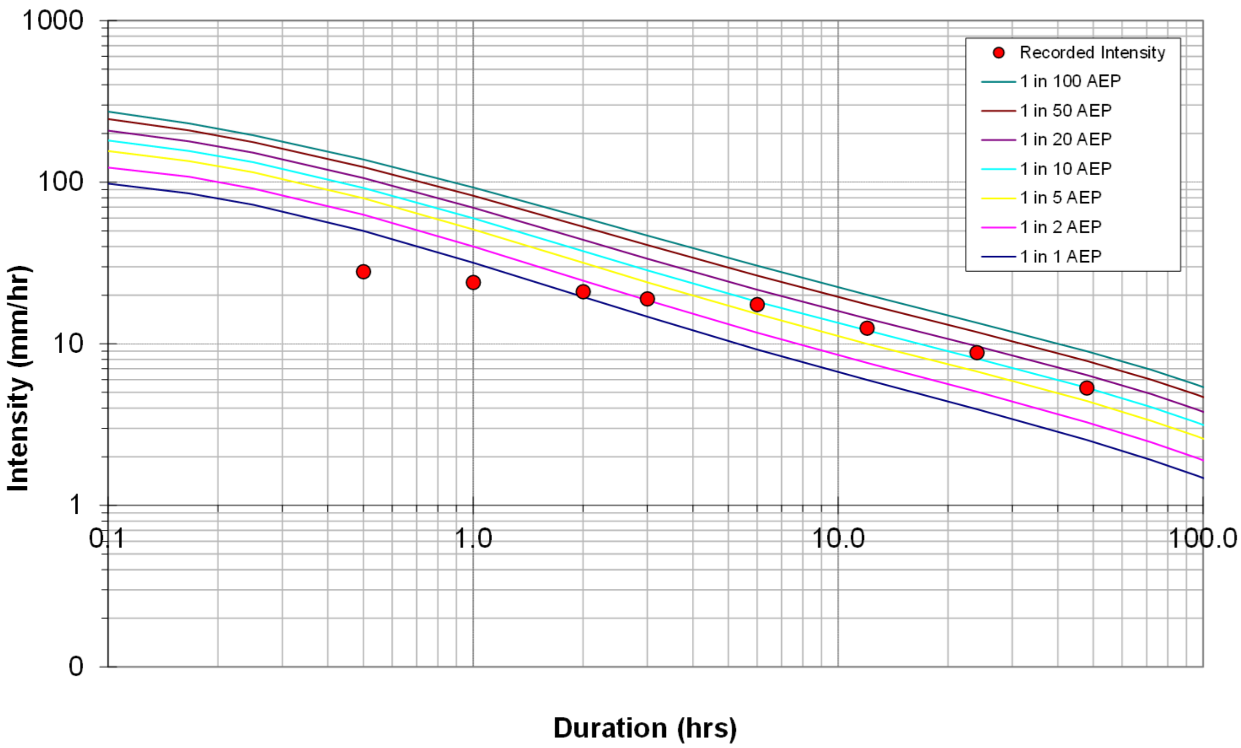


Figure D-2 2013 Logan Village Gauge Peak Intensities

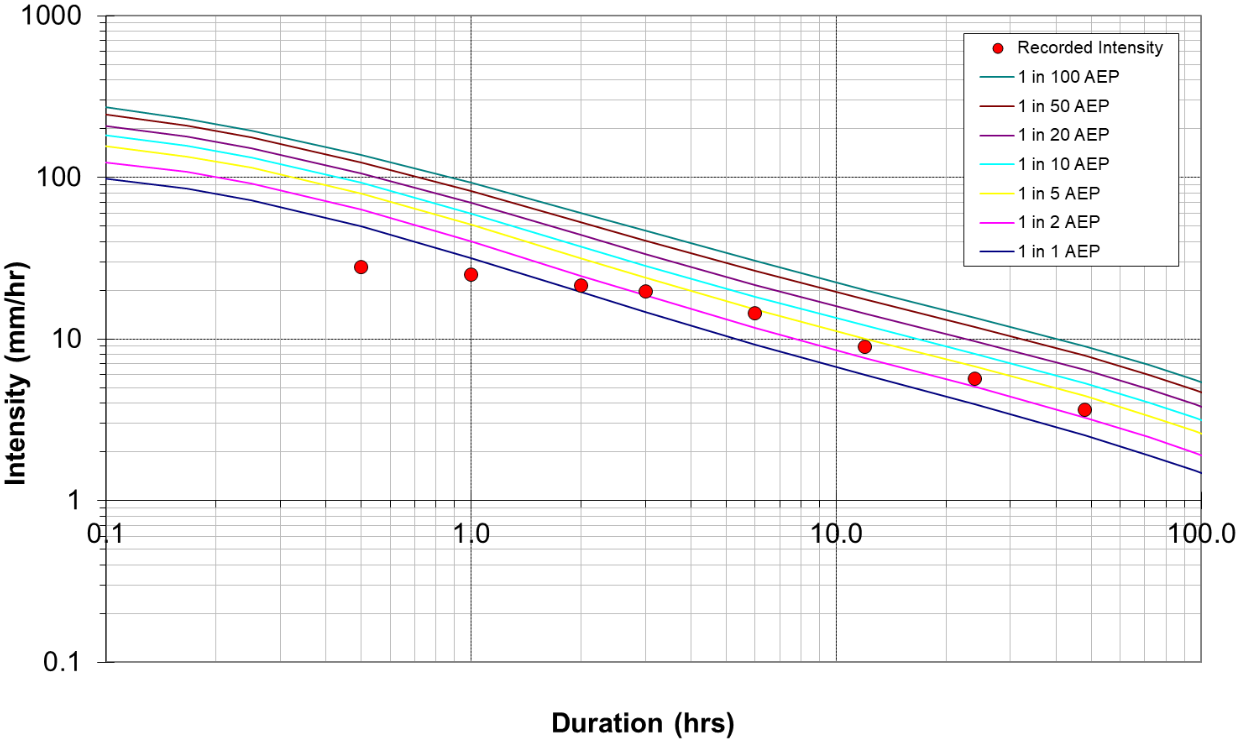


Figure D-3 2013 Lower Quinzeh Gauge Peak Intensities

D.2.1.2 2015 Rainfall IFD Analysis

The IFD analysis was also conducted on all three rainfall gauge datasets provided by the Council for the 2015 historical rainfall event and the results are summarised in Figure D-4 2015 Logan Village Gauge Peak IntensitiesFigure D-4, Figure D-5 and Figure D-6 for each of the Logan Village, Lower Quinzeh and Upper Quinzeh gauge locations respectively. The 6-hour durations for this event are shown to be up to a 1% AEP event based on the rainfall IFD. As the critical duration for the Quinzeh Creek catchment is 6-hours at the outlet, the 2015 historical event is estimated to be equivalent to a 1% AEP event based on the rainfall IFD.

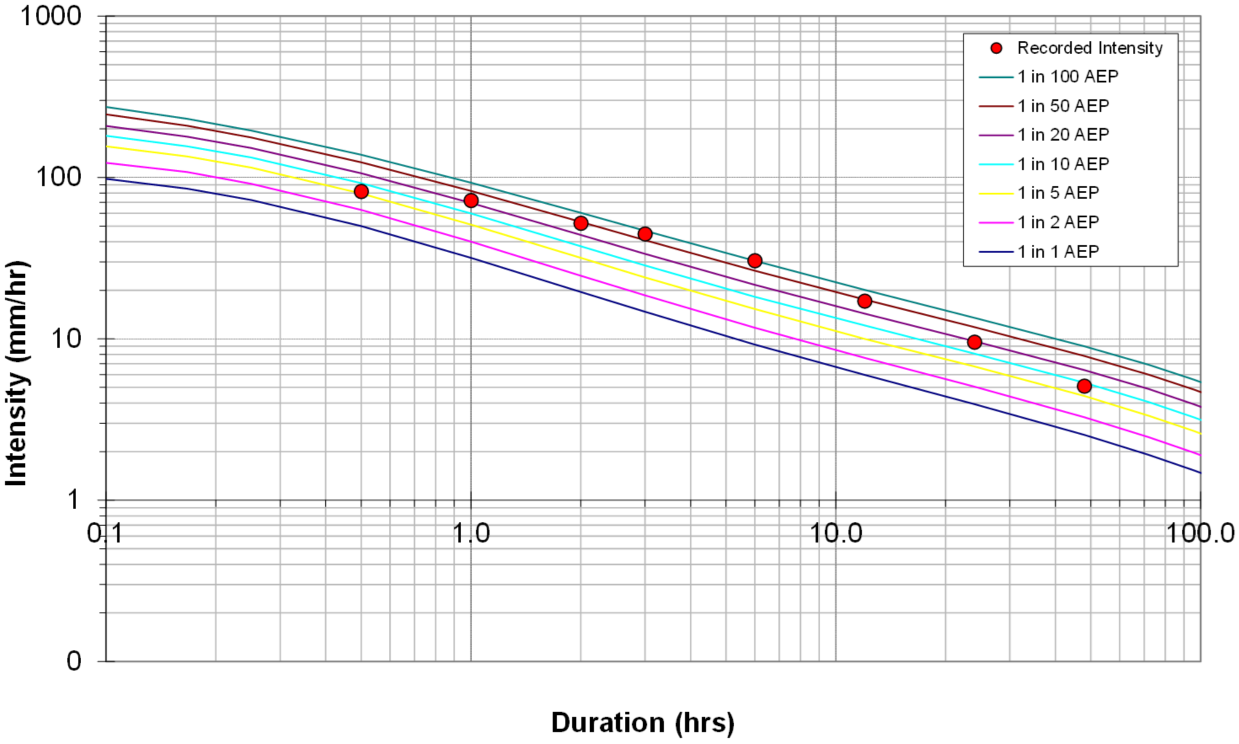


Figure D-4 2015 Logan Village Gauge Peak Intensities

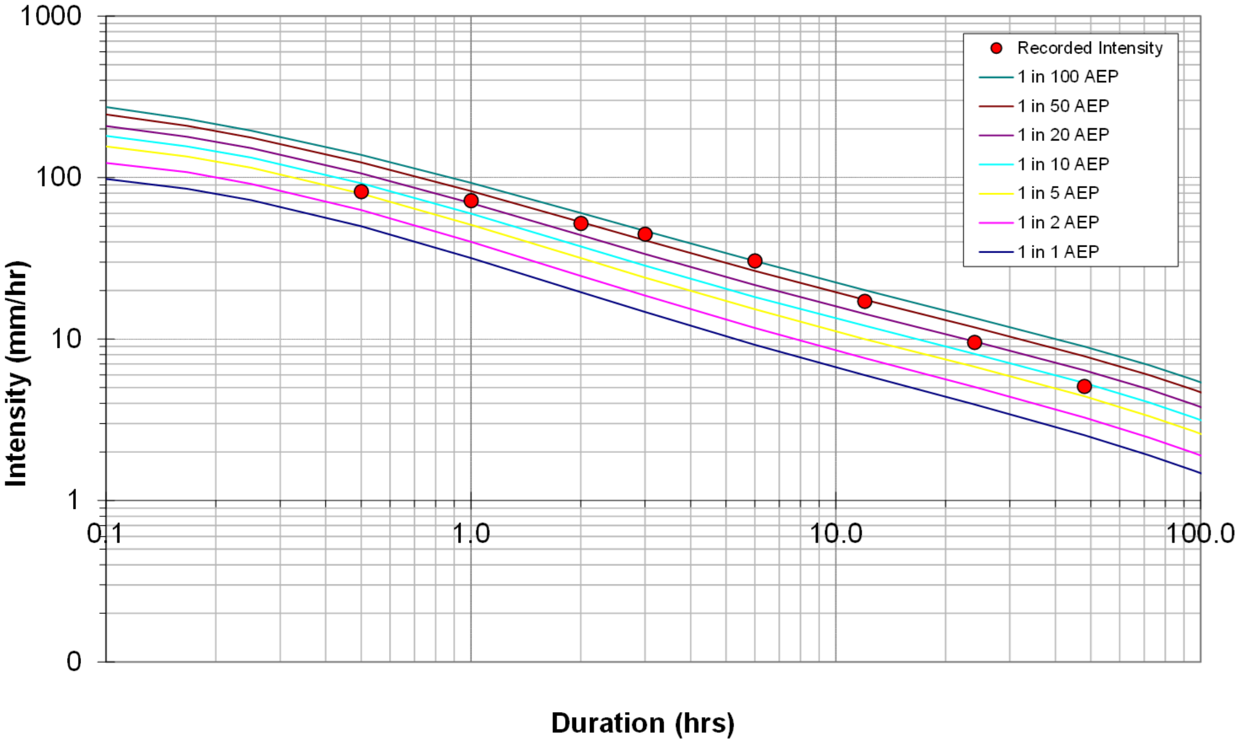


Figure D-5 2015 Lower Quinzeh Gauge Peak Intensities

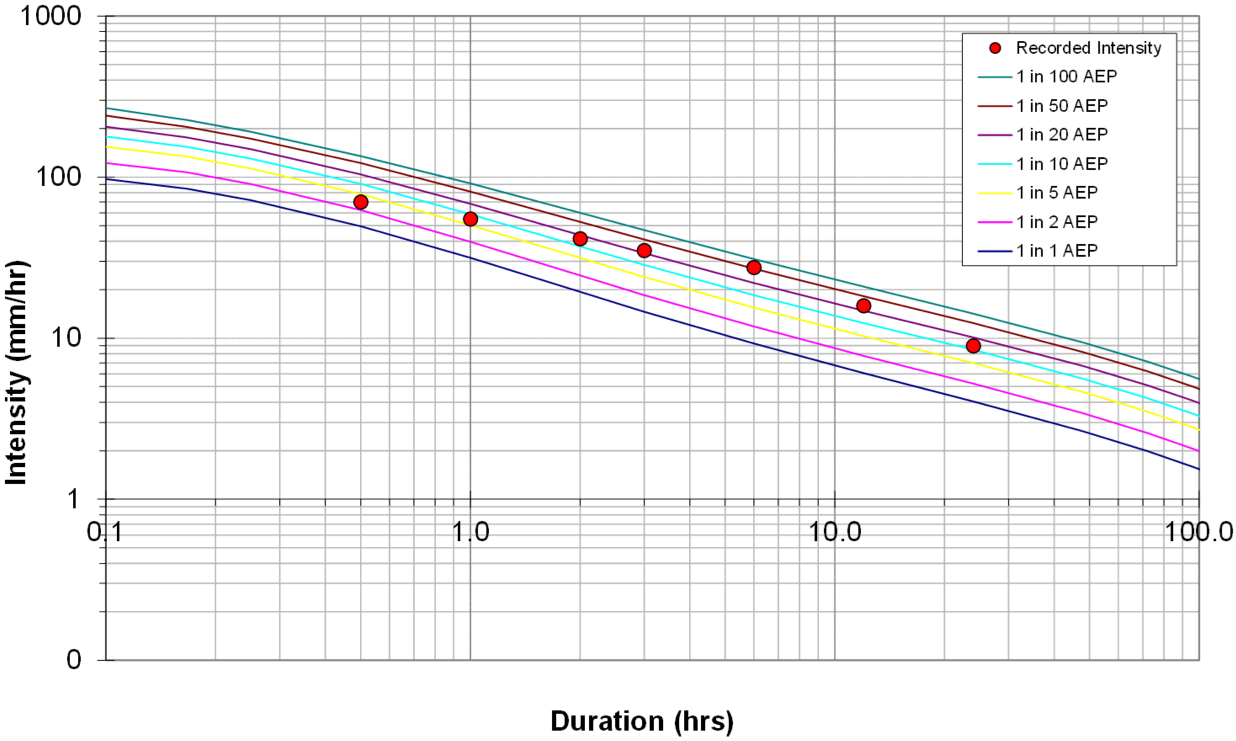


Figure D-6 2015 Upper Quinzeh Gauge Peak Intensities

D.2.1.3 2017 Rainfall IFD Analysis

The IFD analysis was conducted on all three (3) rainfall gauge datasets provided by the Council for the 2017 historical rainfall event and the results are summarised in Figure D-7, Figure D-8 and Figure D-9 for each of the Logan Village, Lower Quinzeh and Upper Quinzeh gauge locations respectively. The Lower Quinzeh gauge recorded a 6-Hour 5% AEP intensity rainfall event while the Upper Quinzeh and Logan Village gauges recorded just over and just under the 6-Hour 5% AEP rainfall event respectively. As the critical duration for the Quinzeh Creek catchment is 6-hours at the outlet, the 2017 historical event is estimated to be somewhere in the order of a 5% AEP to 2% AEP event based on the rainfall IFD.

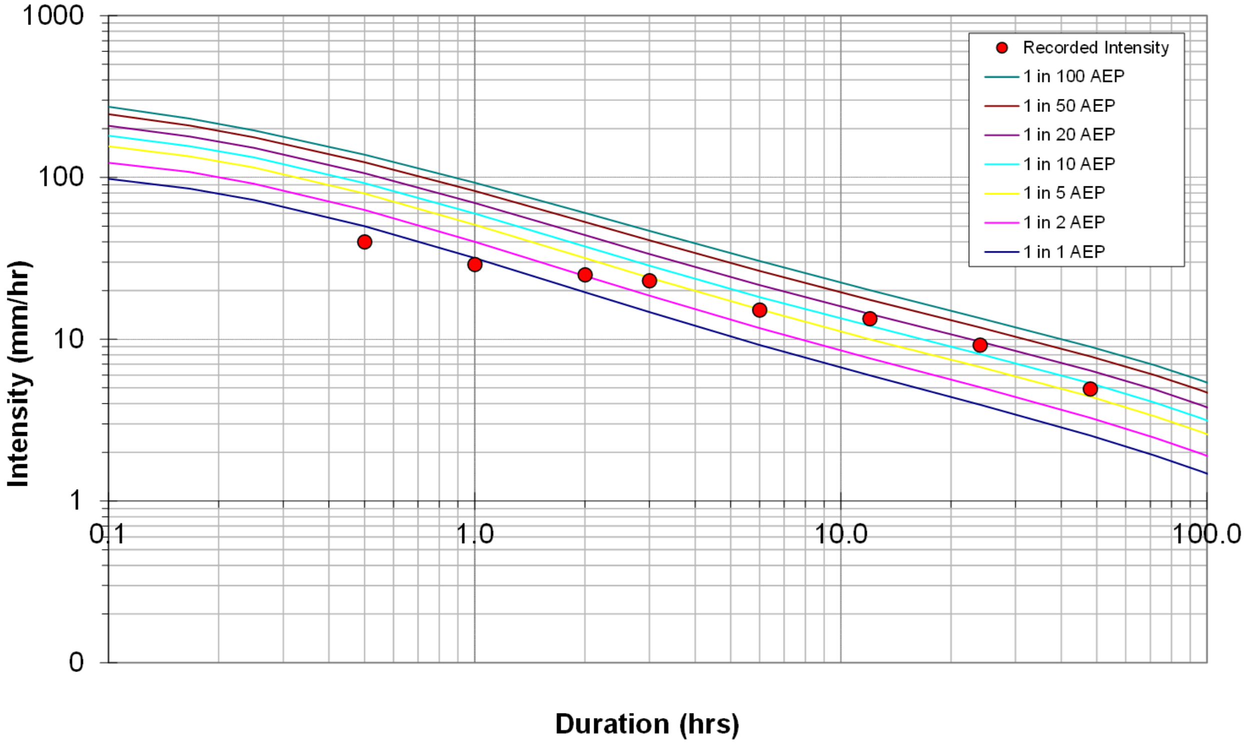


Figure D-7 2017 Logan Village Gauge Peak Intensities

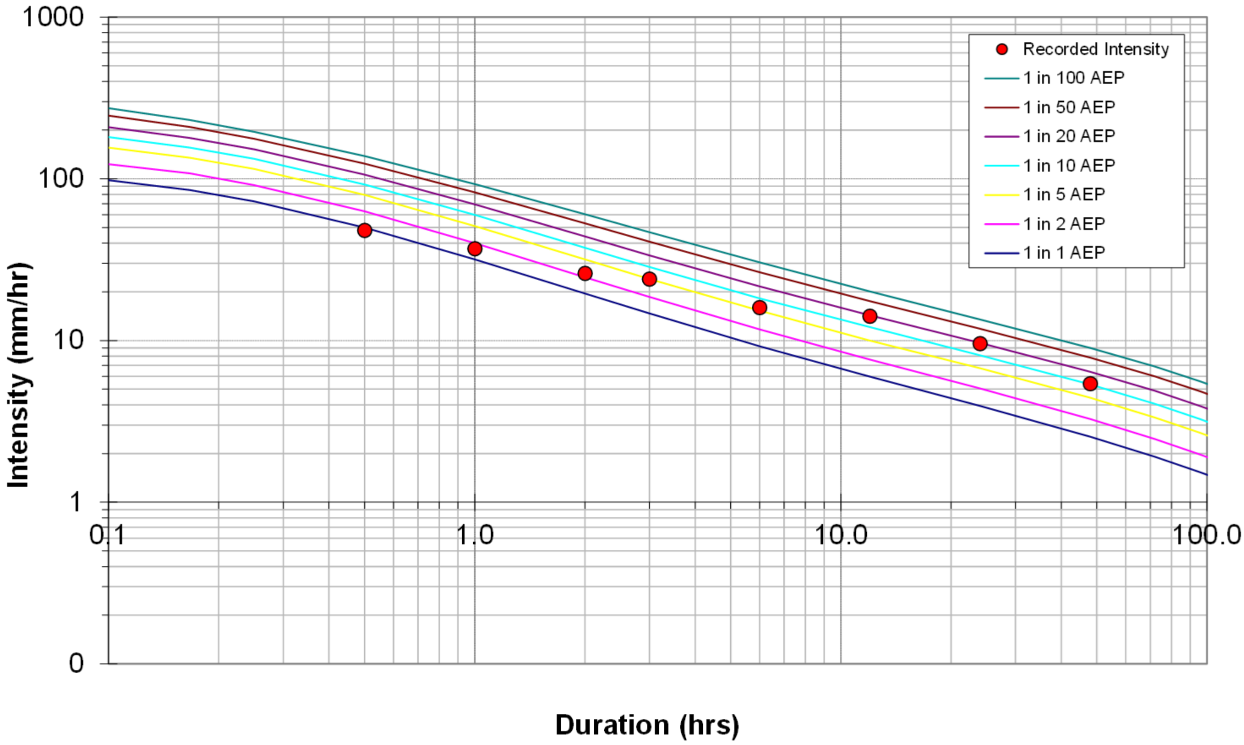


Figure D-8 2017 Lower Quinzeh Gauge Peak Intensities

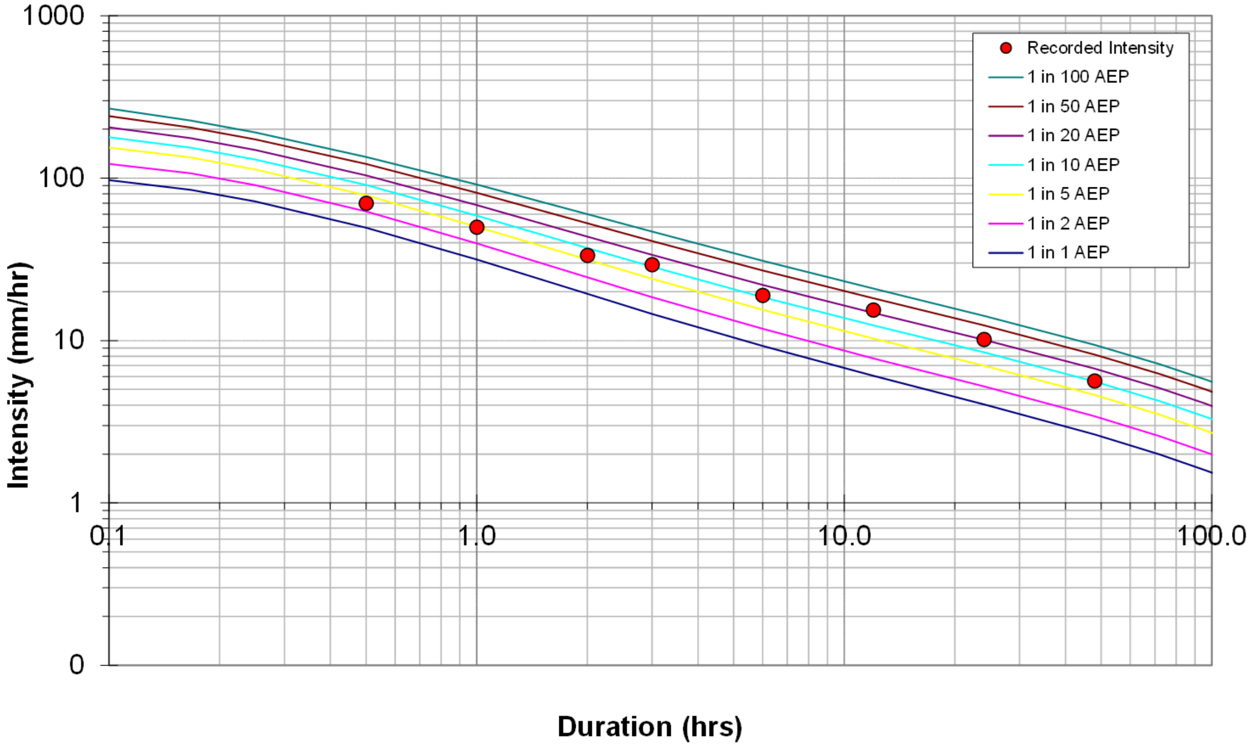


Figure D-9 2017 Upper Quinzeh Gauge Peak Intensities

D.2.2 Calibrated RADAR Rainfall Data

Given the limited catchment-based gauges and consideration of rainfall spatial variability, calibration for the Quinzeh Creek catchment has been undertaken using calibrated RADAR rainfall data sourced from HydroNET. Figure D-10, Figure D-11 and Figure D-12 illustrates the event rainfall totals across the catchment based on the calibrated radar rainfall data for the 2013, 2015 and 2017 events respectively. The calibrated radar rainfall totals have also been compared with the at-site rainfall gauges for both the Upper and Lower Quinzeh River gauges as illustrated in Figure D-13 and Figure D-14 respectively for the 2015 and 2017 events.

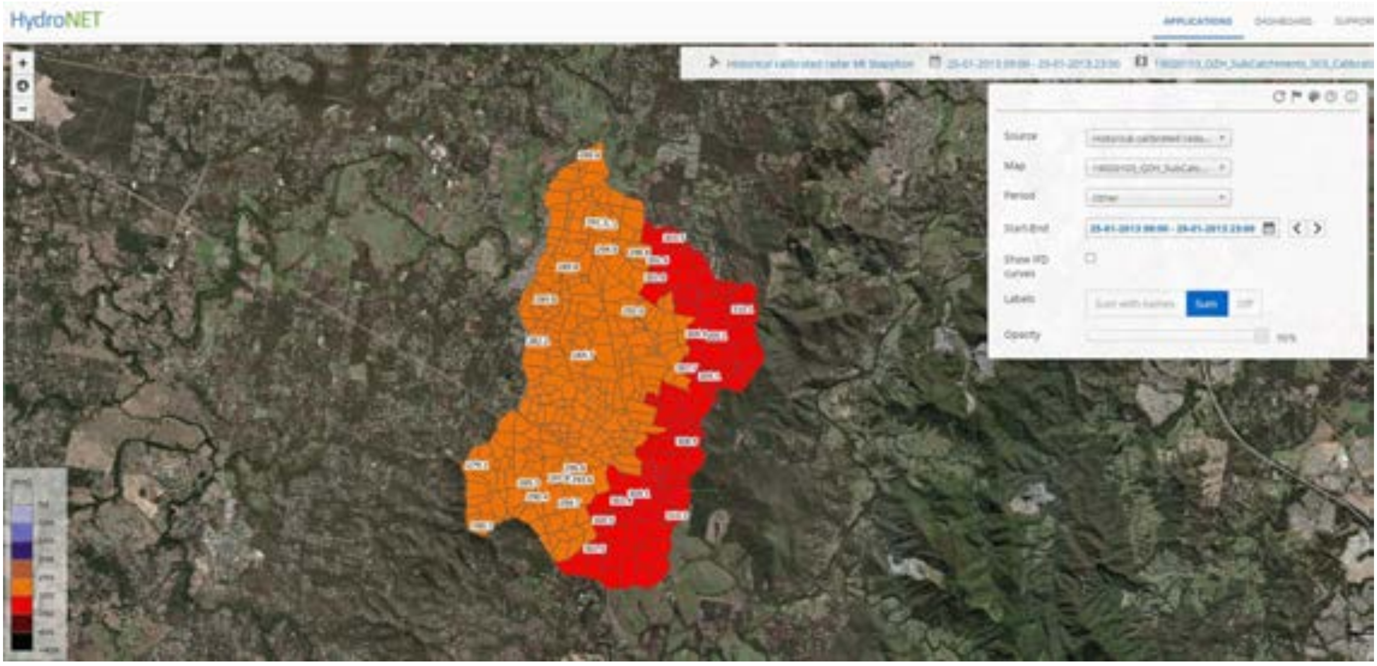


Figure D-10 2013 Total Rainfall Spatial Map from Hydronet (Source – WT 2020)

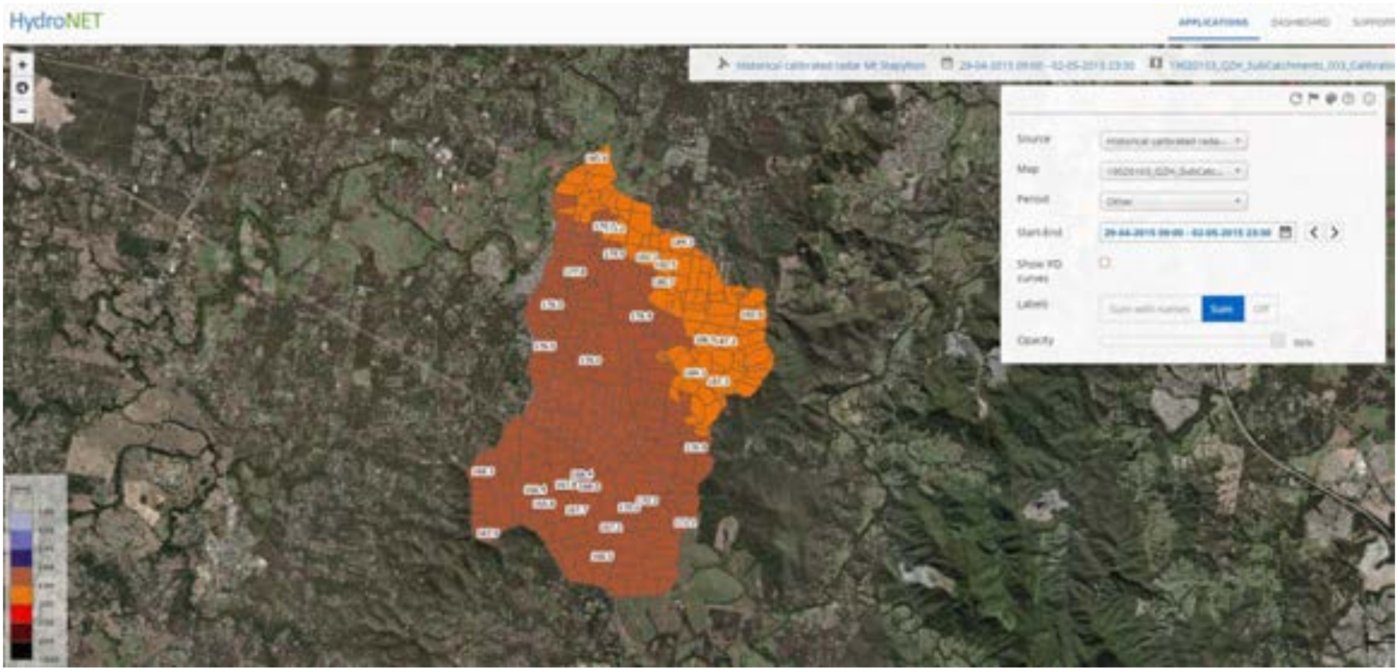


Figure D-11 2015 Total Rainfall Spatial Map from Hydronet (Source – WT 2020)

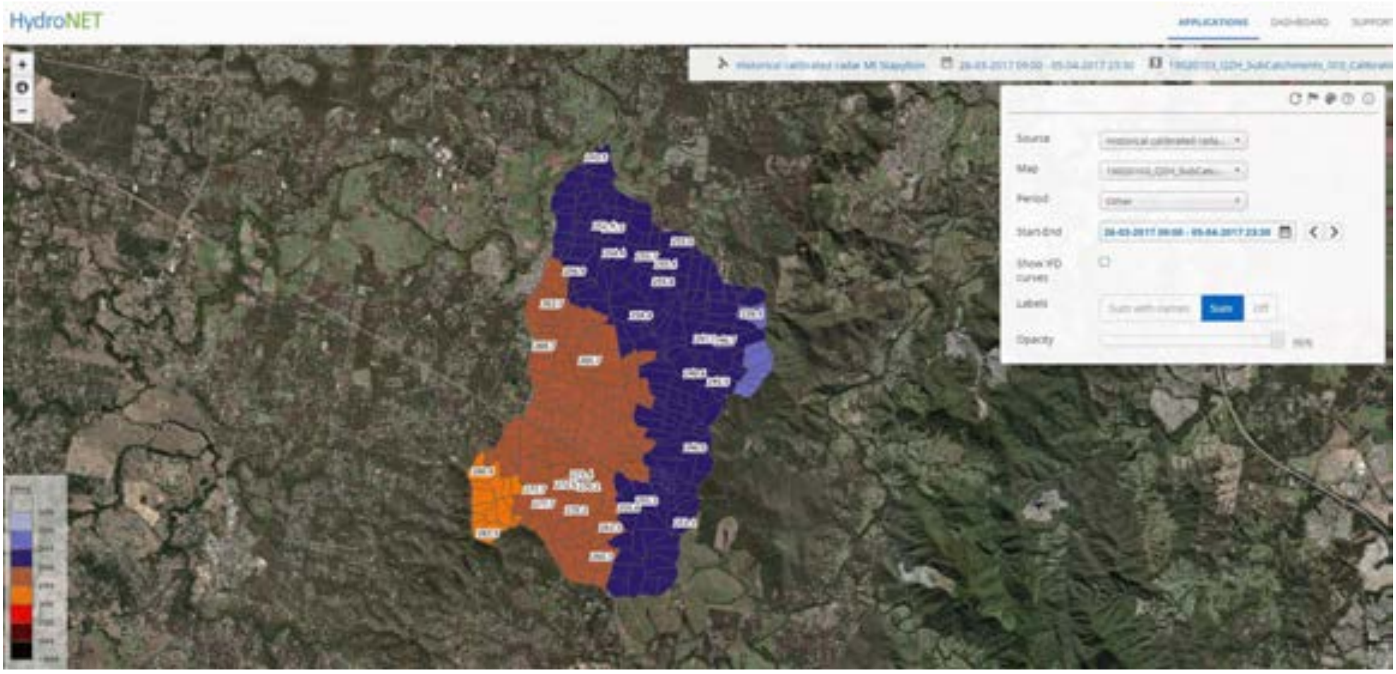


Figure D-12 2017 Total Rainfall Spatial Map from Hydronet (Source – WT 2020)

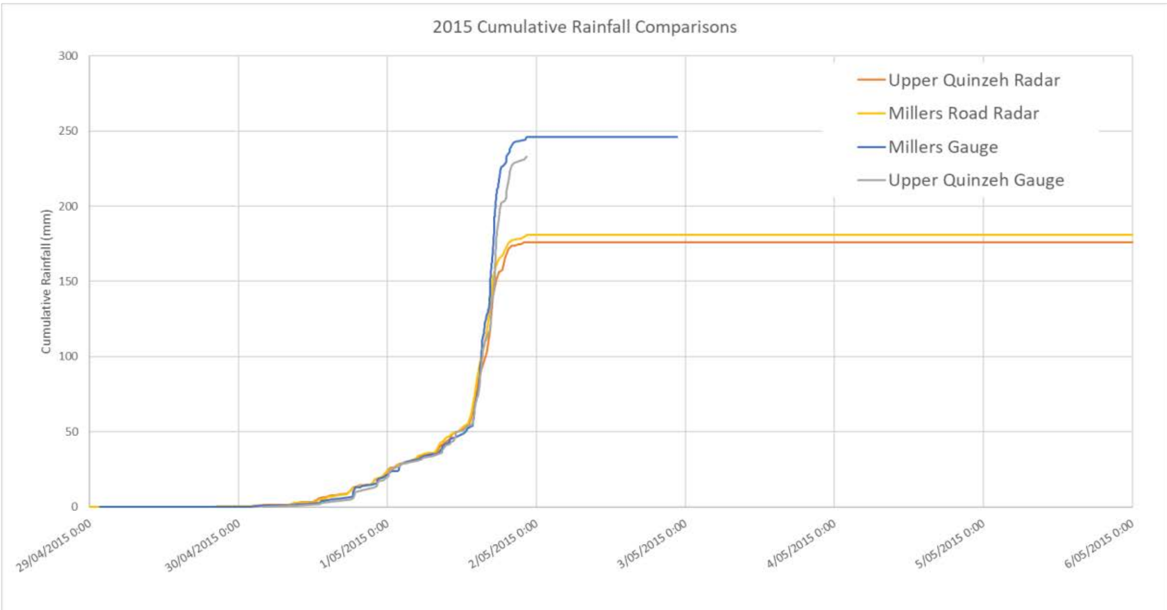


Figure D-13 Cumulative rainfall comparison for 2015 event

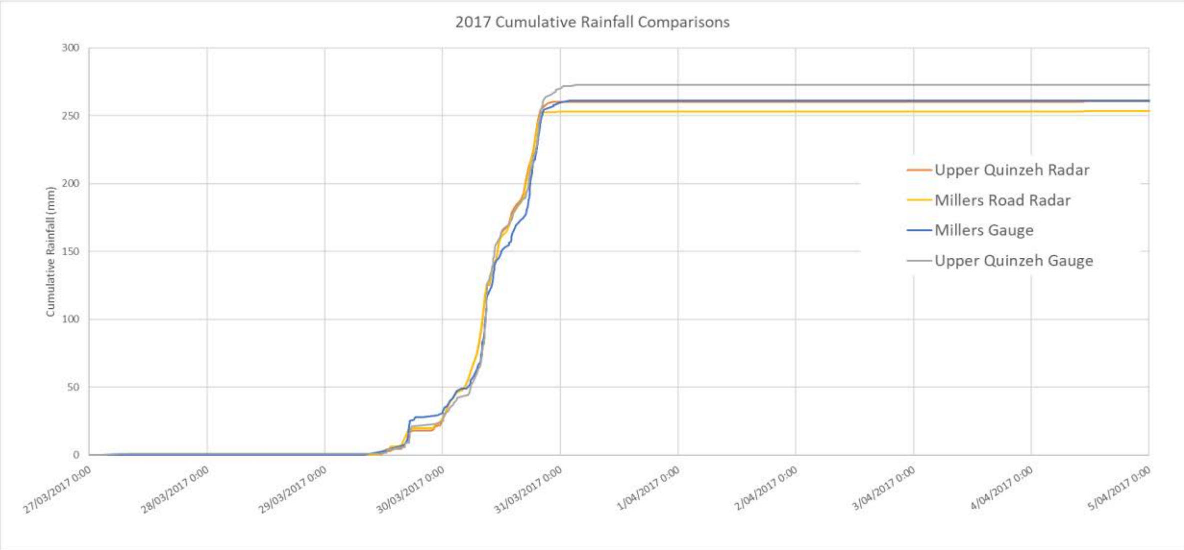


Figure D-14 Cumulative rainfall comparison for 2017 event

The following comments are made in relation to the comparison of the calibrated radar rainfall versus rain gauge data sets:

- Event total rainfall depths for the 2015 event are some 60mm lower in the calibrated radar rainfall data compared to the rain gauge totals, which represents a difference of approximately 25%. The difference in the totals only occurs at the end of the event as there is a good correlation in the cumulative rainfall up until that point; and
- For the 2017 event, event total rainfall depths in the calibrated radar rainfall data compared very closely to the rain gauge totals.

Given the outcomes from the rainfall event total comparisons above, XP-RAFTS models for the calibration have been developed as follows:

- 2015 event – Two (2) separate XP-RAFTS models have been prepared as follows:
  - One employing calibrated radar rainfall only; and
  - One employing a traditional Theisen polygon approach based on rain gauge data only; and
- 2017 event has been prepared using calibrated radar rainfall only.

D.3 Hydrologic Calibration Modelling

The XP-RAFTS hydrologic model has been built to predict and inform the complementary TUFLOW hydraulic model of the flow discharging from each sub-catchment. This model has been adopted and adapted for the historical calibration. A combination of calibrated radar rainfall and rain gauge data has been applied in the model for each of the three (3) historical events as outlined previously in Section D.2. The following sections briefly describe other changes adopted for each of the historical model.

D.3.1 Calibrated RADAR Rainfall Data Catchment Land Use

As Council's ultimate land use represented in the design model does not represent the catchment land use at the time of the historical rainfall events, three (3) separate land use layers based off aerial imagery from 2013, 2015 and 2017 were used. This resulted in high catchment perviousness, consistent with a lower level of development within the catchment as compared to the land use scenario adopted for the design event simulations and particularly with respect to the ongoing development of the Yarrabilba area.

D.3.2 Sub-Catchment Layout and Discharge Point

Comparison of 2013 LiDAR sourced from Elevation Information System (ELVIS) and Council provided 2017 LiDAR datasets showed that ground elevations have been changed in areas of high development such as the Yarrabilba priority development area. With the arrival of new roads and building pads, the flow paths have been adjusted to facilitate the construction of and to reduce risk of inundations to newly developed properties. Consequently, the sub-catchment layout and discharge points have been changed within the Yarrabilba development to represent appropriate flow paths and quantities within the calibration models.

D.3.3 Channel Routing Links

As sub-catchments and discharge locations were amended to better represent the calibration catchments, the channel links used for flow routing was also adjusted. Multiple cross-sections were extracted from the older LiDAR dataset for the then undeveloped sub-catchments in 2013 and 2015 events.

D.3.4 Calibration Rainfall Losses

Table D-2 provides a summary of the rainfall loss parameters that have been adopted for the historical calibration in terms of the rainfall initial and continuing losses applied in the XP-RAFTS model. Table D-2 additionally summarises the rainfall losses from the ARR2019 DataHub at three (3) spatially varying locations across the Quinzeh Creek catchment. Of specific note is the consistency in rainfall loss parameters across the various historical events which in this instance were found to match with the ARR2019 DataHub loss recommendations.

Table D-2 Summary of storm losses for calibration and ARR2019 design losses

Data Set	Storm Initial Loss (mm)	Storm Continuing Loss (mm)
2013 Calibration Event	26.0	1.9
2015 Calibration Event	26.0	1.9
2017 Calibration Event	26.0	1.9
DataHub @ Yarrabilba	26.0	1.9
DataHub @ Logan Village	26.0	1.9
DataHub @ Quinzeh Creek Road	26.0	1.9

D.4 Hydraulic Calibration Modelling

The design TUFLOW model for the Quinzeh Creek catchment as discussed in Section 5 has been adopted for calibration with minor changes in regards to the difference in catchment characteristics. Modifications made in the establishment of the calibration models for 2013, 2015 and 2017 events are detailed in the subsequent sections.

D.4.1 Floodplain Roughness

The high catchment roughness was represented in the design hydraulic model within the Yarrabilba Development, as a result of the ultimate land use representation of the catchment. However, calibration models are depended on the catchment condition at the time of the storm event. Accordingly, catchment roughness was adjusted for each of the historical calibration events as informed by historical aerial imagery.

D.4.2 Hydraulic Structures

After inspection of the aerial imagery for each of the three (3) calibration events, hydraulic structures were modified to better reflect what existed at the time of the historical event. A series of structures including pipes were removed from the design model and resulting in three (3) separate stormwater infrastructure layers for each of the calibration events. This ensures the appropriate representation of structures for the calibration events and subsequently flow characteristics throughout the catchment

D.4.3 Model Topography

The elevation dataset used for design model is not appropriate for use in the calibration model. Accordingly, the 2017 LiDAR data was adjusted to preclude development for the 2017 calibration event. Additionally, for each of the 2013 and 2015 events, the 2013 base LiDAR 1m grid as sourced from ELVIS has been applied to better reflect the catchment conditions that existed at the time.

D.4.4 Boundary Conditions

D.4.4.1 Model Inflows

Model inflows for each of the calibration hydraulic models have been based on the sub-catchment breakdown for the Quinzeh Creek catchment XP-RAFTS hydrologic calibration models respectively. The inflows are represented, similar to the design model, as SA polygons and SA pits in urbanised settings.

D.4.4.2 Tailwater Boundary Condition

The Quinzeh Creek catchment is affected by backwater from the Logan River. For the 2013 and 2015 calibration events, these events were a localised event for the Quinzeh Creek catchment and in the absence of any backwater effects from the Logan River. Accordingly, a static water level boundary condition was applied to represent effectively a normal depth tailwater boundary condition. For the 2017 calibration event however, flooding in the Quinzeh Creek catchment occurred with flooding in the Logan River catchment. As such, a tailwater boundary condition was applied for this event which was informed by the water levels recorded at the Logan Village gauge to ensure consistency in event combinations for calibration purposes.

D.5 Calibration Model Results

D.5.1 2015 Calibration Event

A summary of the TUFLOW calibration results for the 2015 calibration event is presented in Table D-3 and Table D-4. Figure D-15, Figure D-16, Figure D-17 and Figure D-18 illustrate the comparisons of the historical and the TUFLOW modelled results at each of the Upper and Lower Quinzeh gauges for both the Radar rainfall and traditional Theisen gauge rainfall calibration methodologies.

Table D-3 Summary of 2015 Calibration to Radar Rainfall

Gauge Location	Recorded Peak Water Level (m, AHD)	Modelled Peak Water Level (m, AHD)	Difference (m)
Lower Quinzeh Gauge	11.65	11.44	-0.21

Gauge Location	Recorded Peak Water Level (m, AHD)	Modelled Peak Water Level (m, AHD)	Difference (m)
Upper Quinzeh Gauge	22.30	22.17	-0.13

Table D-4 Summary of 2015 Calibration to Gauge Rainfall

Gauge Location	Recorded Peak Water Level (m, AHD)	Modelled Peak Water Level (m, AHD)	Difference (m)
Lower Quinzeh Gauge	11.65	12.39	0.74
Upper Quinzeh Gauge	22.30	22.49	0.19

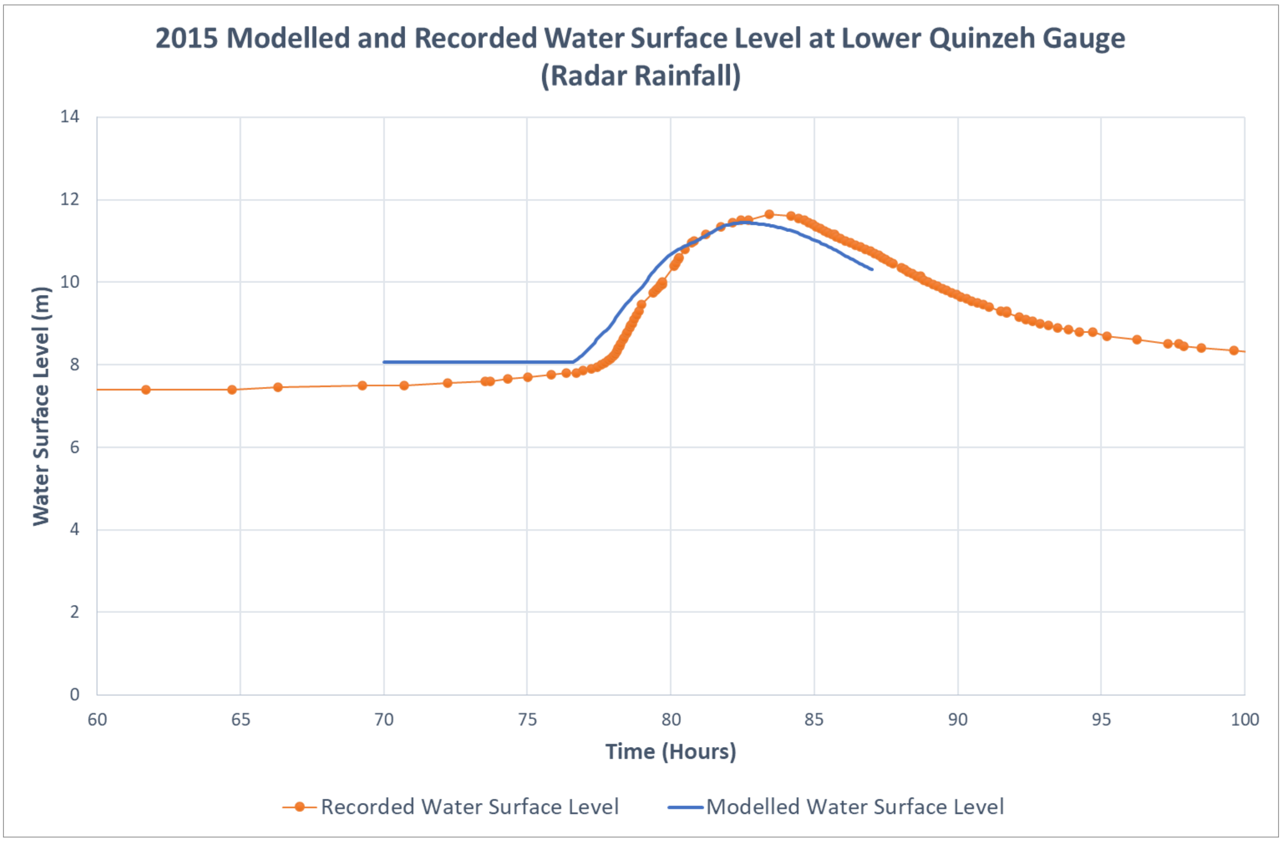


Figure D-15 Water Level time Series at Lower Quinzeh Gauge – 2015 Event (Calibrated RADAR Rainfall)

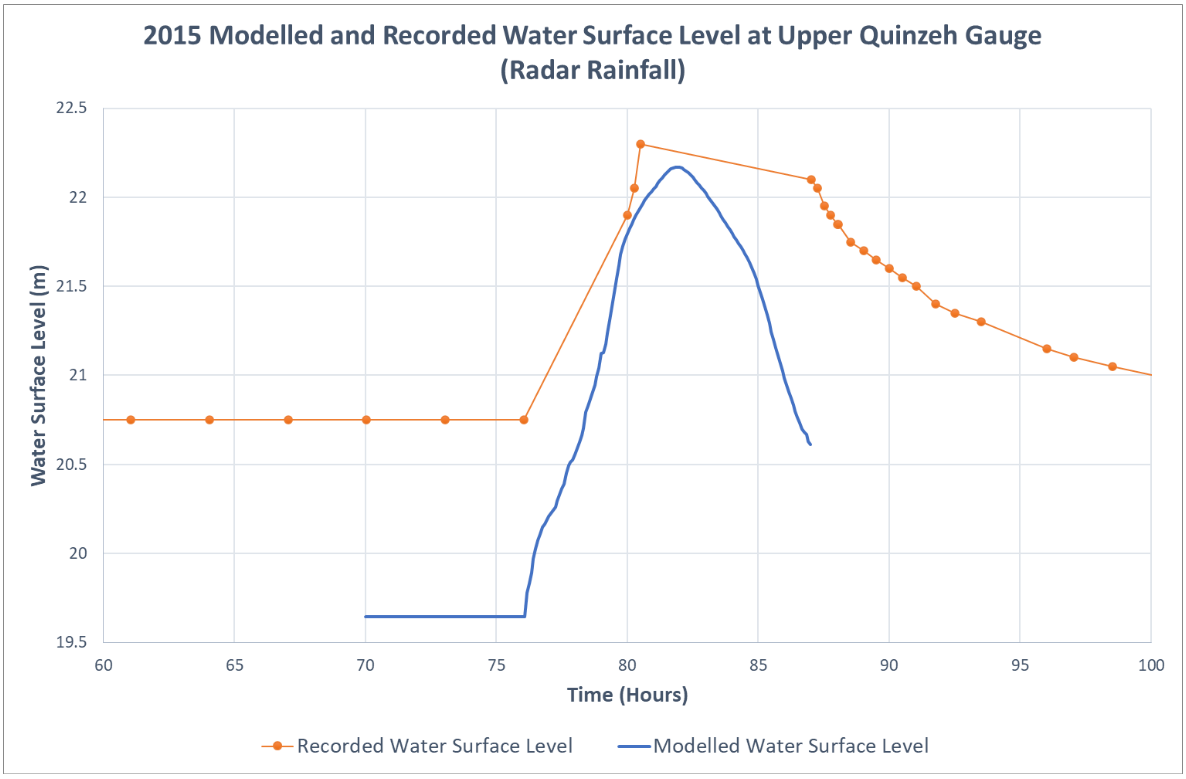


Figure D-16 Water Level time Series at Upper Quinzeh Gauge – 2015 Event (Calibrated RADAR Rainfall)

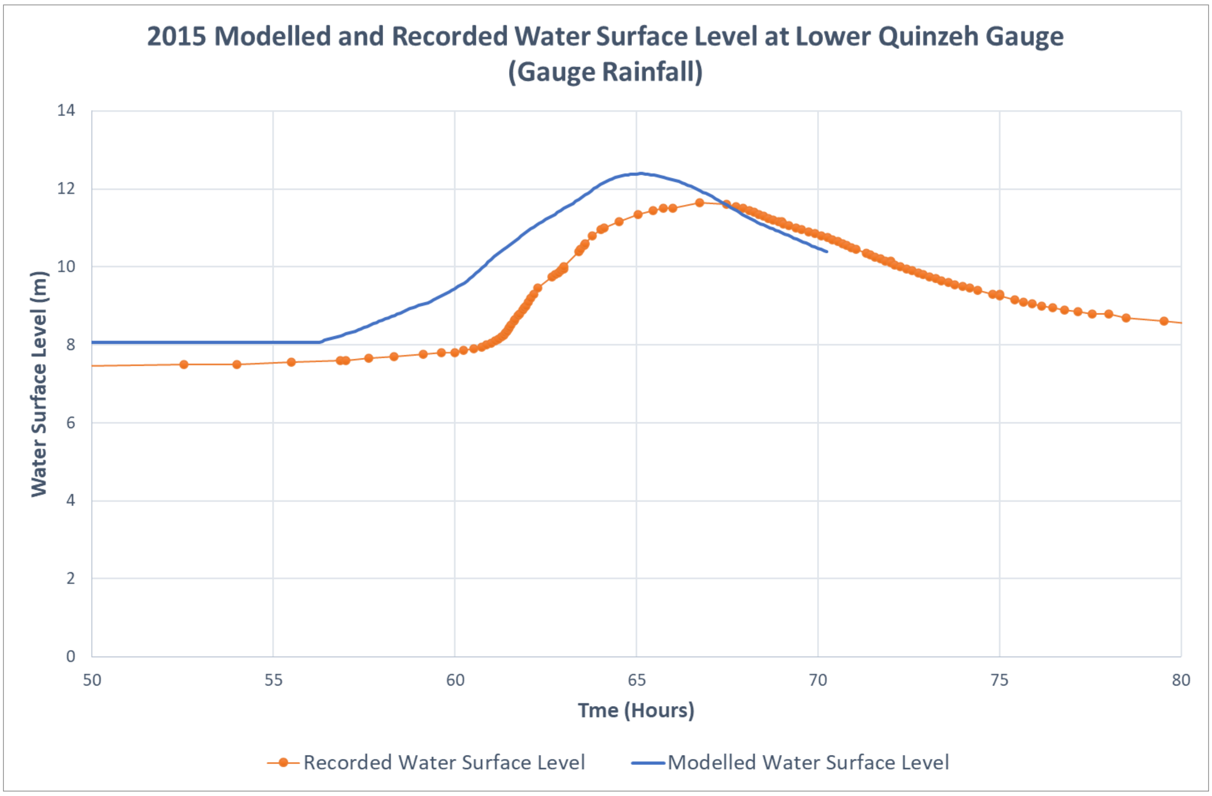


Figure D-17 Water Level time Series at Lower Quinzeh Gauge – 2015 Event (Calibrated Gauge Rainfall)

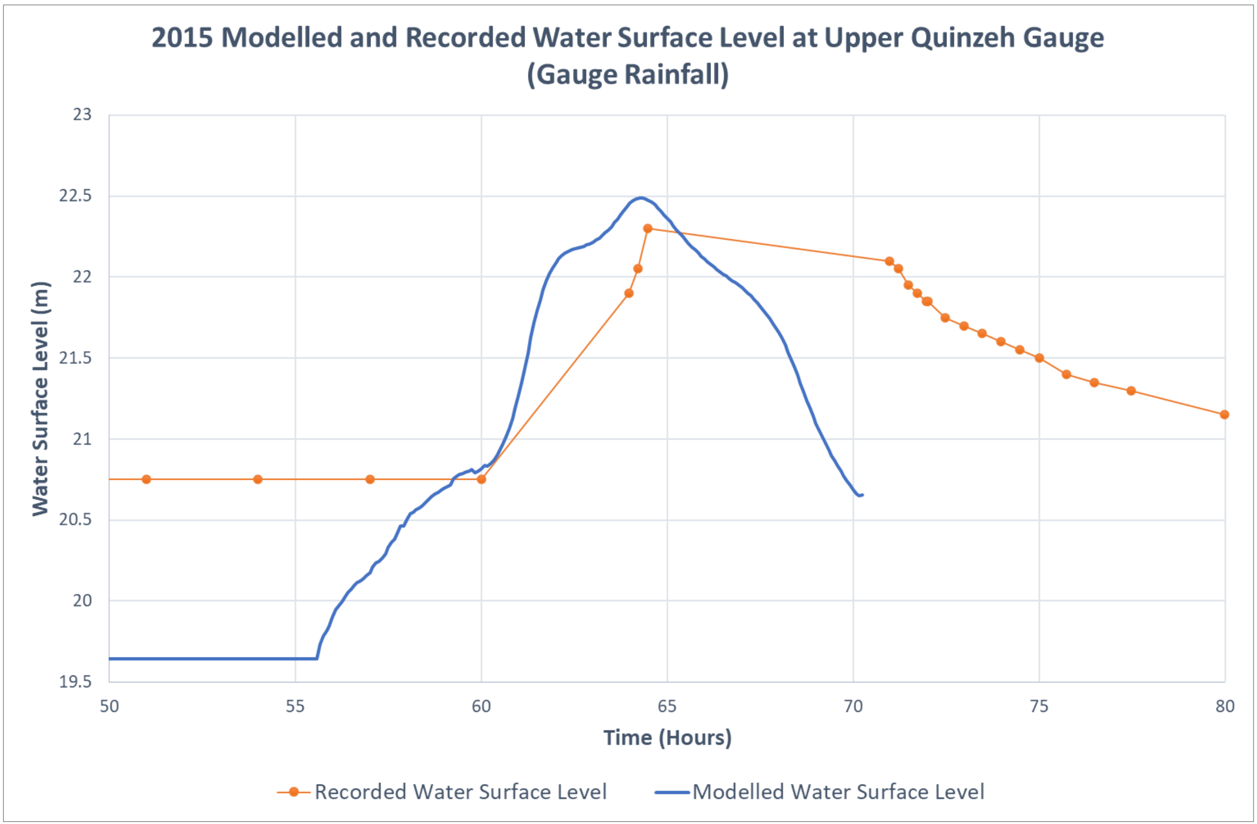


Figure D-18 Water Level time Series at Upper Quinzeh Gauge – 2015 Event (Calibrated Gauge Rainfall)

D.5.2 2017 Calibration Event

A summary of the TUFLOW calibration results for the 2017 calibration event is presented in Table D-5. Figure D-19 and Figure D-20 present comparisons of the historical and the TUFLOW modelled results at each of the Upper and Lower Quinzeh Gauges.

Table D-5 Summary of 2017 Calibration

Gauge Location	Recorded Peak Water Level (m, AHD)	Modelled Peak Water Level (m, AHD)	Difference (m)
Lower Quinzeh Gauge	14.5	14.50	0.00
Upper Quinzeh Gauge	22.0	22.13	0.13

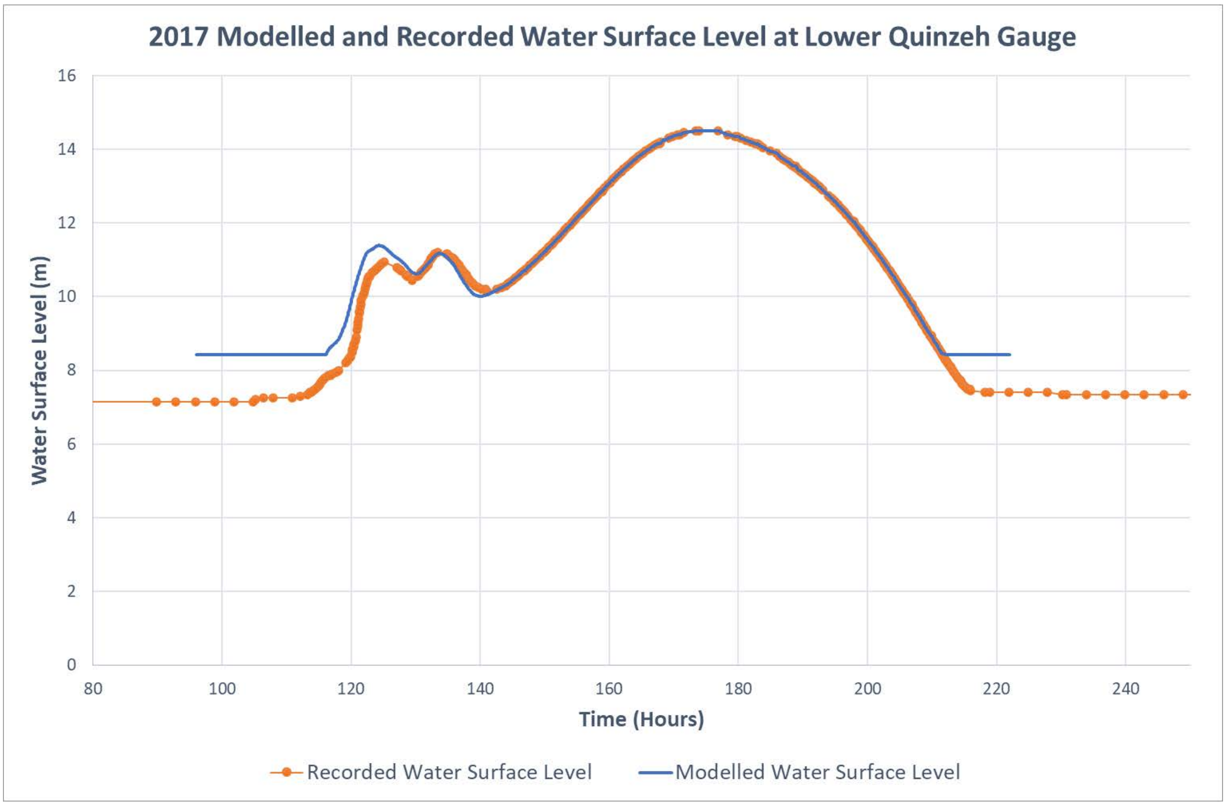


Figure D-19 Water Level time Series at Lower Quinzeh Gauge – 2017 Event

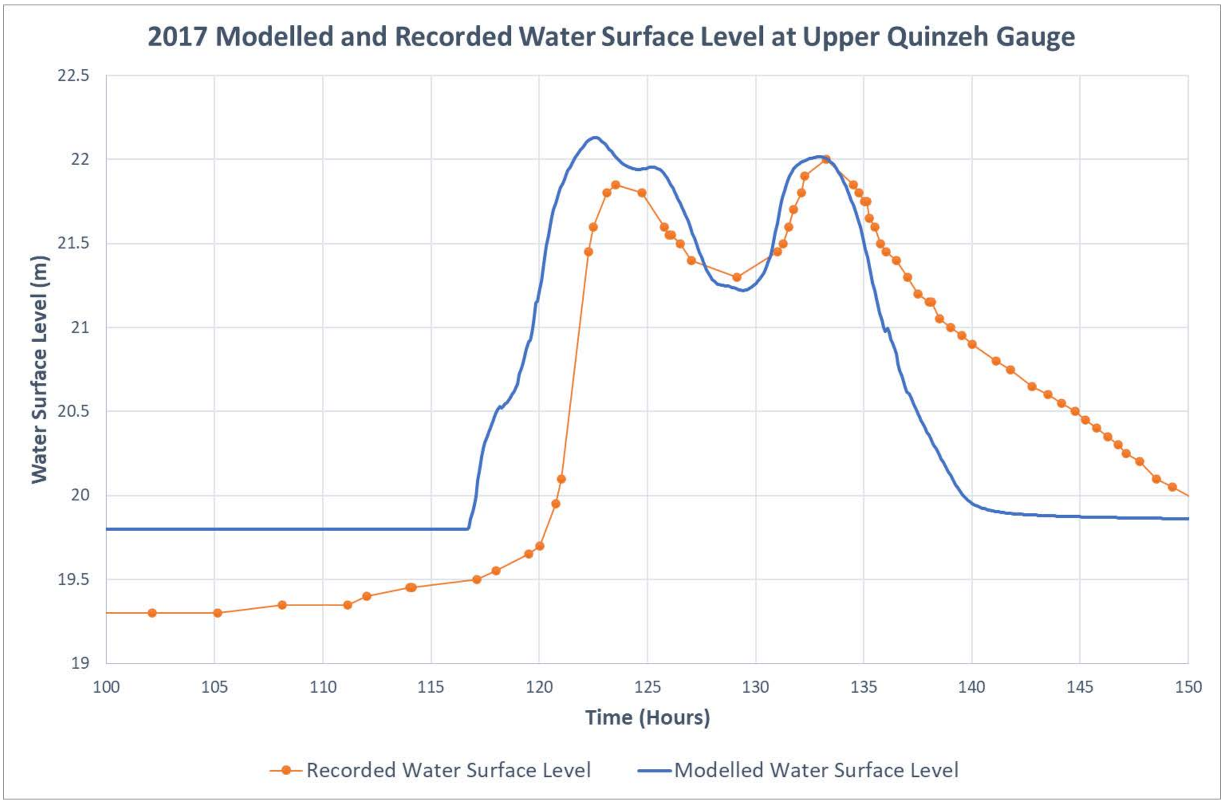


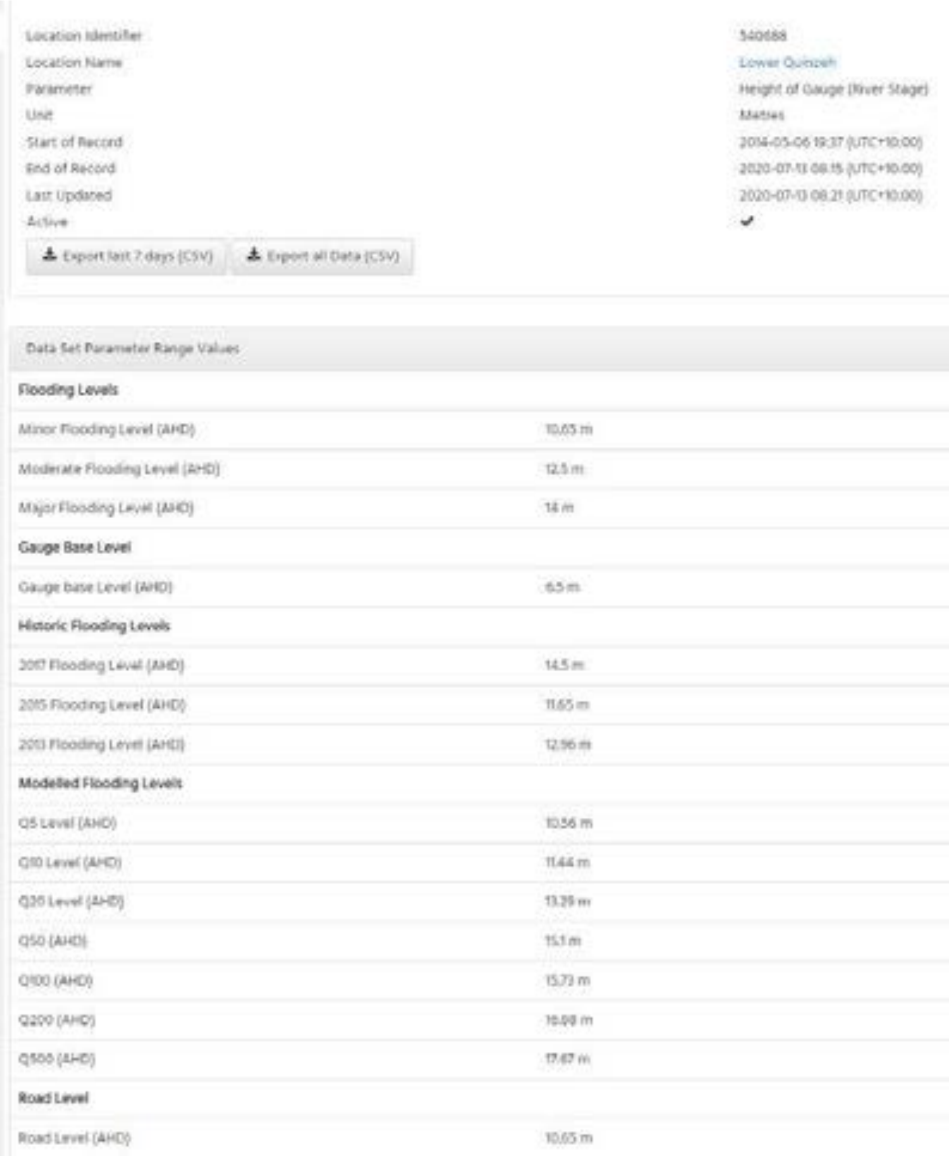
Figure D-20 Water Level time Series at Upper Quinzeh Gauge – 2017 Event

D.5.3 2013 Calibration Event

A summary of the TUFLOW calibration results for the 2013 calibration event is presented in Table D-6. A comparison of the water level time series was unable to be generated due to unavailability of the recorded datasets for this event. Council did however provide a peak water level record at each gauge for this event which is illustrated in Figure D-21 and Figure D-22 respectively for the Lower and Upper Quinzeh gauges and for which the comparison shown in Table D-6 is based.

Table D-6 Summary of 2013 Calibration

Gauge Location	Recorded Peak Water Level (m, AHD)	Modelled Peak Water Level (m, AHD)	Difference (m)
Lower Quinzeh Gauge	12.96	11.17	-1.79
Upper Quinzeh Gauge	21.71	21.96	0.25



Location Identifier	540688
Location Name	Lower Quinzeh
Parameter	Height of Gauge (River Stage)
Unit	Metres
Start of Record	2014-05-06 19:37 (UTC+10:00)
End of Record	2020-07-13 08:15 (UTC+10:00)
Last Updated	2020-07-13 08:21 (UTC+10:00)
Active	✔

Export last 7 days (CSV) Export all Data (CSV)

Data Set Parameter Range Values

Flooding Levels	
Minor Flooding Level (AHD)	10.65 m
Moderate Flooding Level (AHD)	12.5 m
Major Flooding Level (AHD)	14 m
Gauge Base Level	
Gauge base Level (AHD)	6.5 m
Historic Flooding Levels	
2017 Flooding Level (AHD)	14.5 m
2015 Flooding Level (AHD)	11.65 m
2013 Flooding Level (AHD)	12.96 m
Modelled Flooding Levels	
Q5 Level (AHD)	10.56 m
Q10 Level (AHD)	11.44 m
Q20 Level (AHD)	13.29 m
Q50 (AHD)	15.1 m
Q100 (AHD)	15.73 m
Q200 (AHD)	16.08 m
Q500 (AHD)	17.67 m
Road Level	
Road Level (AHD)	10.65 m

Figure D-21 Lower Quinzeh AL Gauge Record (Source – LCC 2020)

Location Identifier	540726
Location Name	Upper Quinzeh Al
Parameter	Height of Gauge (River Stage)
Unit	Metres
Start of Record	2015-03-10 19:18 (UTC+10:00)
End of Record	2020-07-13 11:05 (UTC+10:00)
Last Updated	2020-07-13 11:11 (UTC+10:00)
Active	✔

Export last 7 days (CSV) Export all Data (CSV)

Data Set Parameter Range Values	
Flooding Levels	
Minor Flooding Level (AHD)	21.5 m
Moderate Flooding Level (AHD)	22 m
Major Flooding Level (AHD)	22.5 m
Gauge Base Level	
Gauge base Level (AHD)	19.2 m
Historic Flooding Levels	
2017 Flooding Level (AHD)	22 m
2015 Flooding Level (AHD)	22.3 m
2013 Flooding Level (AHD)	21.71 m
Road Level	
Road Level (AHD)	21.6 m

Figure D-22 Upper Quinzeh AL Gauge Record (Source – LCC 2020)

D.5.4 Calibration Discussion

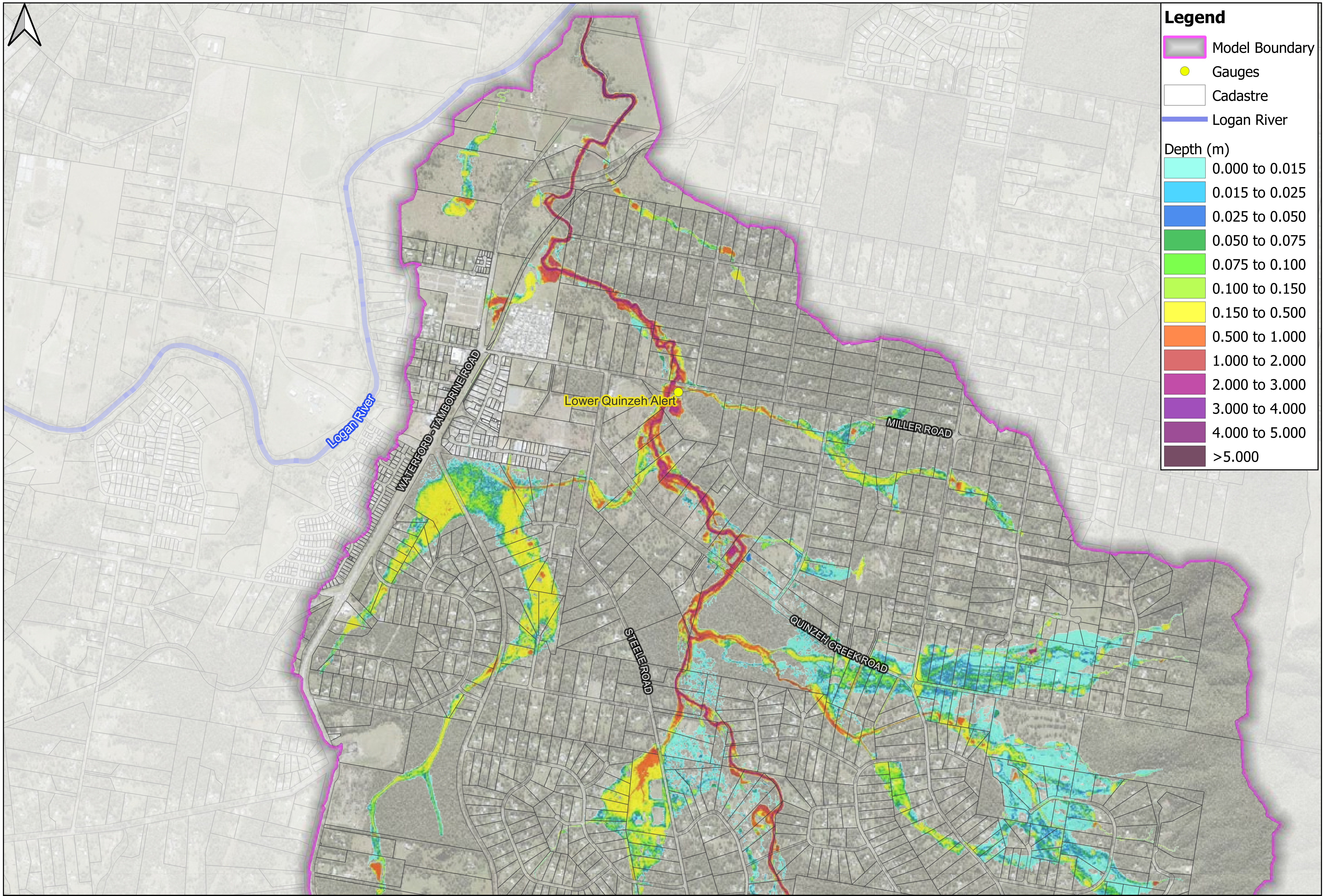
The following discussion on the calibration results is made:

- The 2013 event calibrated very well against the peak water surface level at the Upper Quinzeh Creek gauge. There was a large variation in water level at the Lower Quinzeh gauge. This variation is attributed to the peak level record of 12.96m AHD being attributed to the higher Logan River flood event as opposed to the local Quinzeh Creek catchment flood event. We note that this level seems to equate to the gauge level of 14.16m AHD recorded at the Logan Village Gauge located upstream of the Quinzeh Creek confluence, and is also comparable with the reported flood debris survey of 12.83m AHD at location reference L29 in the draft Logan and Albert River Flood Study prepared by WRM in 2020. There is no water level time series data available for the 2013 event and as such model calibration to the available peak water levels is considered to be satisfactory;
- For the 2015 event and owing to the differences in total event rainfall associated with the calibrated radar rainfall discussed previously in Section D.2.2, the modelled water surface levels were found to be generally lower at the Upper Quinzeh gauge compared to those recorded. Modelled water levels were also found to be lower by 210mm compared to the Lower Quinzeh gauge. This is consistent with the differences in the total event rainfall and despite the rainfall differences, water levels were still found to be within 210mm and with similarity maintained in the water level time series;

- For the 2015 event which included the rain gauge data (i.e. comprising the higher total rainfall depths compared to the calibrated radar data discussed previously in Section D.2.2), modelled levels were consistently higher being 190mm at the Upper Quinzeh gauge and a much larger 740mm at the Lower Quinzeh gauge. The comparison of water level time series does however show that a generally good calibration fit has been achieved for the 2015 event;
- When considering both of the 2015 calibration outcomes and noting the different rainfall data applied, the 2015 calibration outcomes have been found to provide overall consistency and despite the limitations in the rainfall data sets used (i.e. lower total rainfalls based on the calibrated radar data versus reduced clarity in the spatial catchment rainfall based on the rain gauge data). The main comment that can be made for the 2015 calibration results is that the outcomes achieved are highly reliant of the rainfall applied in the model. In this instance, the RADAR based rainfall is known to be low while the Theisen based gauge rainfall is likely to be high, with the overall calibration therefore likely to fit somewhere in between that modelled. There are no additional in-catchment rainfall gauges that could be used to provide a better representation of spatial and temporal rainfall variability for this event. Despite this, the results are however considered to appropriately demonstrate that the model is producing representative results based on the 2015 calibration event as well as considering the other calibration event results; and
- Calibration results for the 2017 event were found to match very well with the recorded gauge data in both peak level as well as matching the dual peaks which occurred for this event. Peak levels were matched at the Lower Quinzeh gauge and were also within 130mm at the Upper Quinzeh gauge. Note that the Upper Quinzeh gauge reached a much larger peak water level which again attributed to the higher Logan River flood event as opposed to the local Quinzeh Creek catchment flood event.

The calibration results achieved for each of the 2013, 2015 and 2017 historical events demonstrate that the Quinzeh Creek XP-RAFTS and TUFLOW models are providing a good match with the recorded data and demonstrate that the model is producing representative results across all three (3) events. Additionally, these results have been achieved based on a consistent rainfall loss parameter set as discussed previously in Section D.3.4. For these reasons, we believe that the models can be adopted and used for the design flood estimation required as part of the study.

APPENDIX E
DESIGN EVENT FLOOD MAPS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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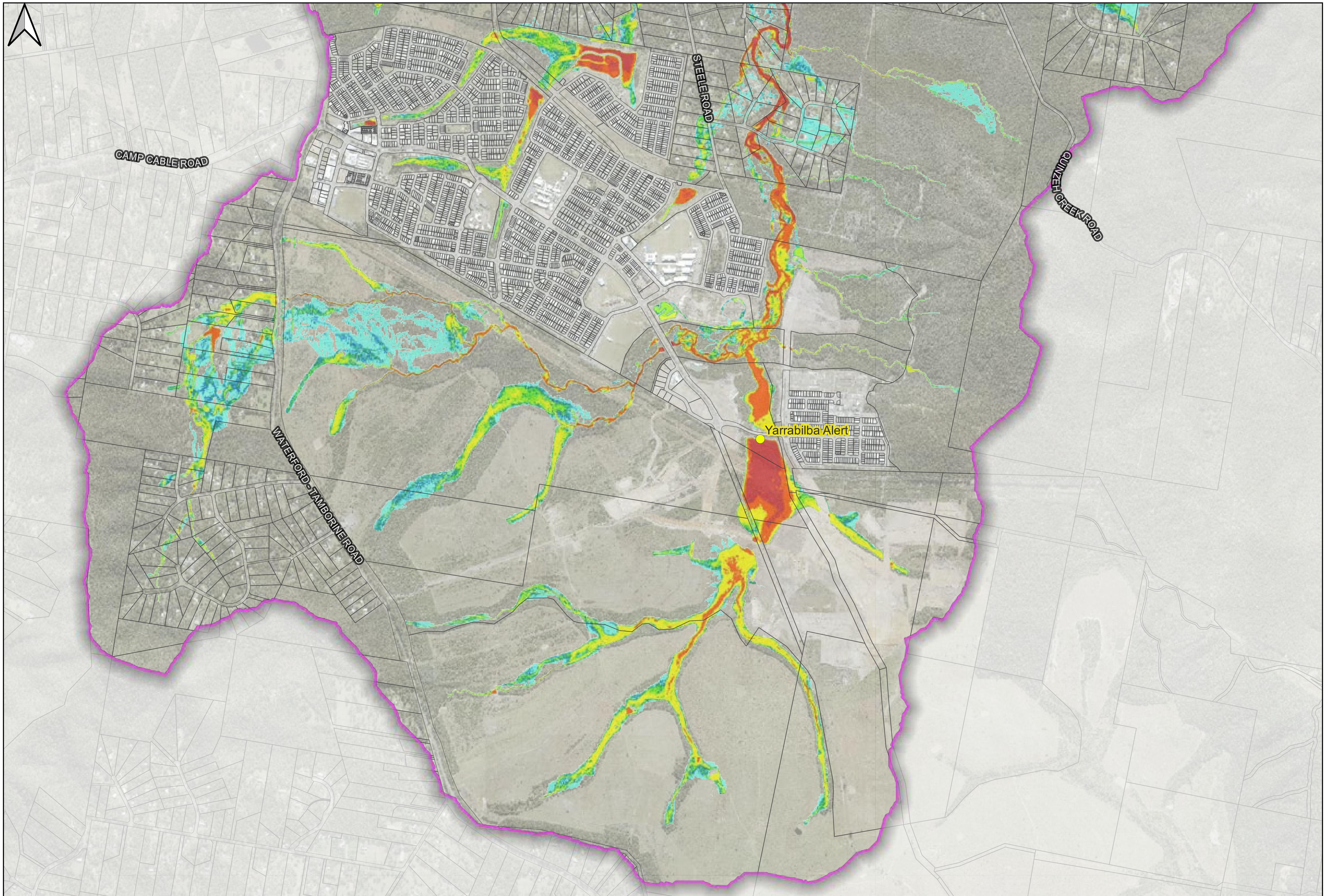
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Depth - Inset 1



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Imagery Source: LCC
Water Technology Pty Ltd

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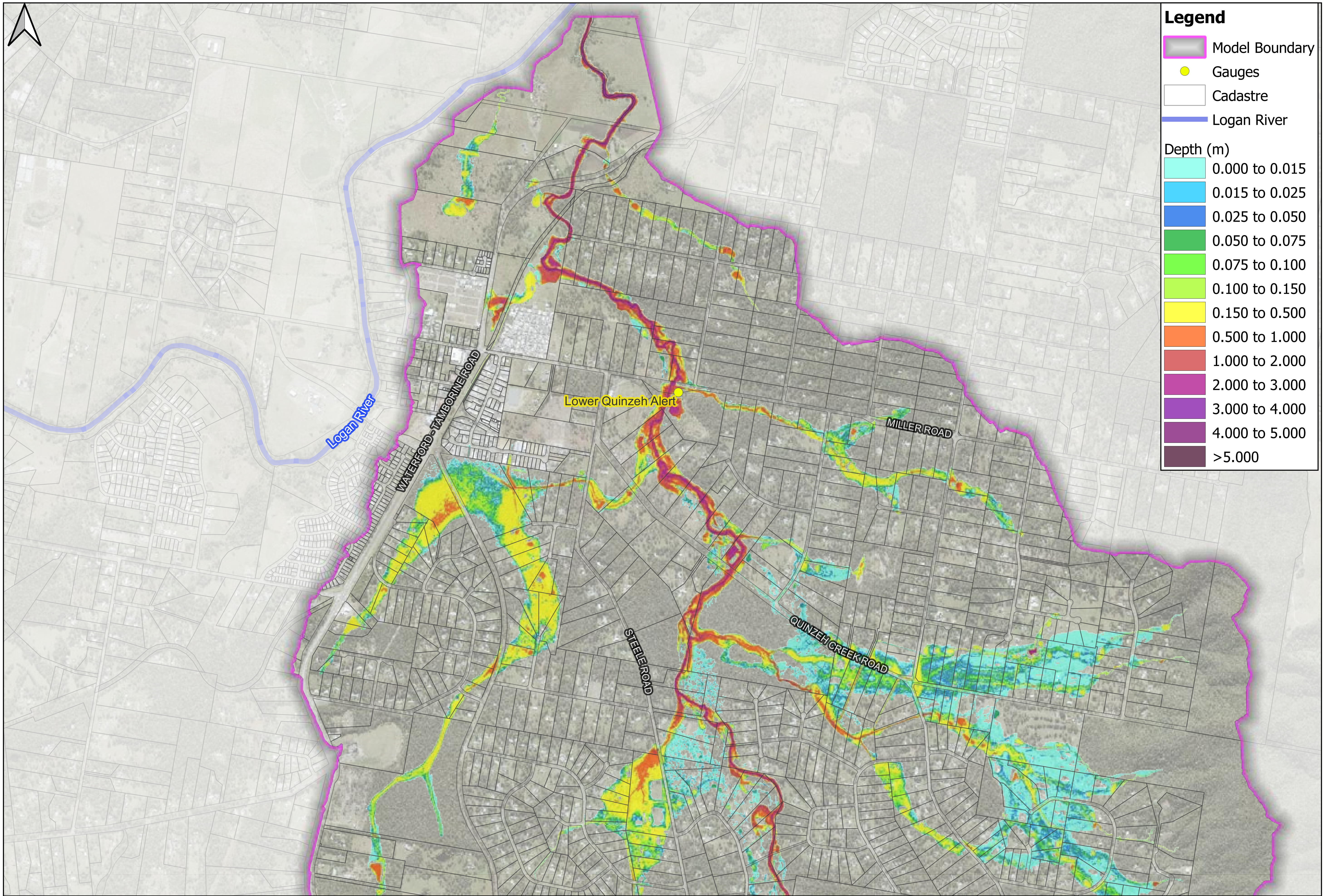
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Depth - Inset 2



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Water Technology Pty Ltd

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Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Peak Water Depth - Inset 1

WATER TECHNOLOGY
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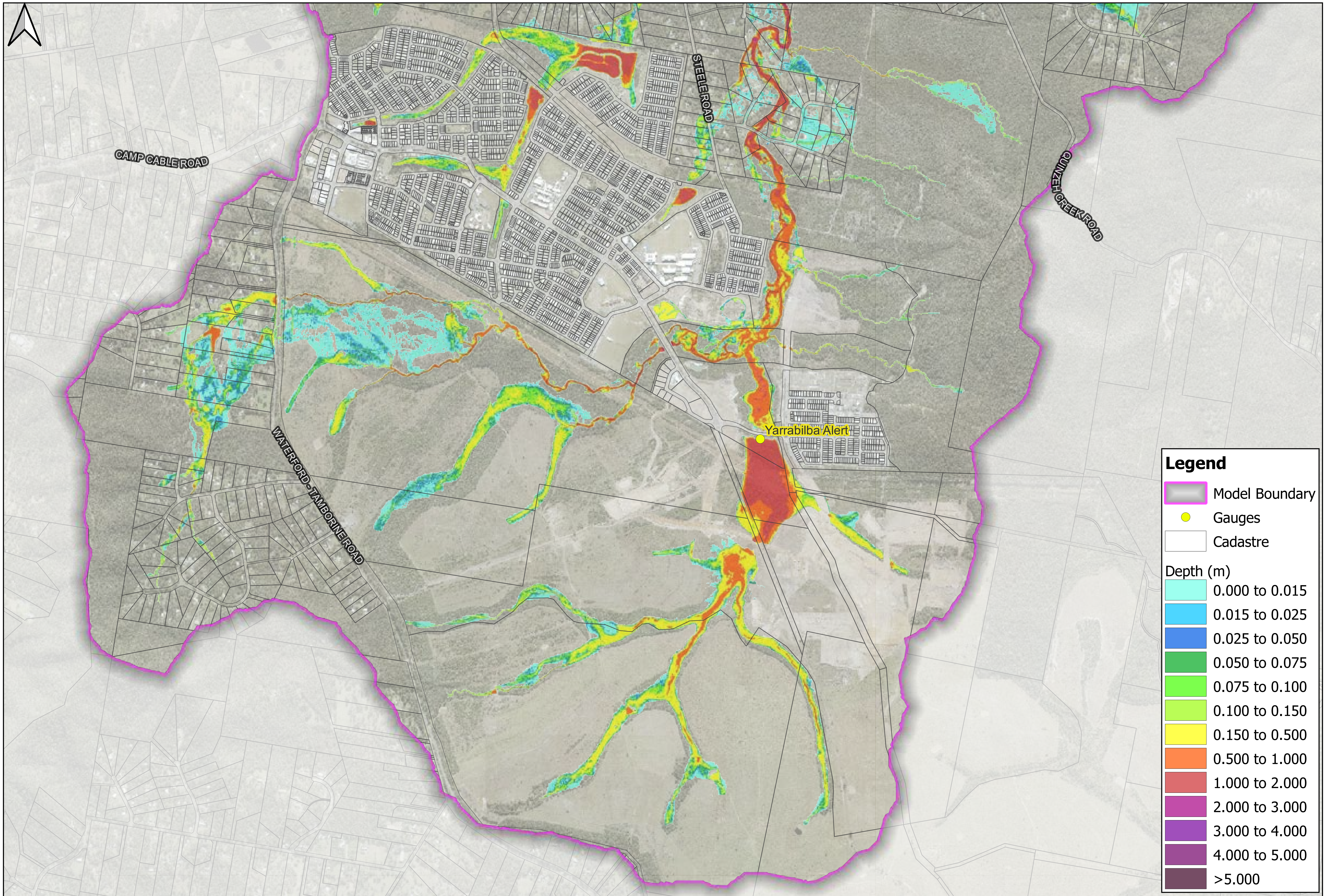

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Water Technology Pty Ltd

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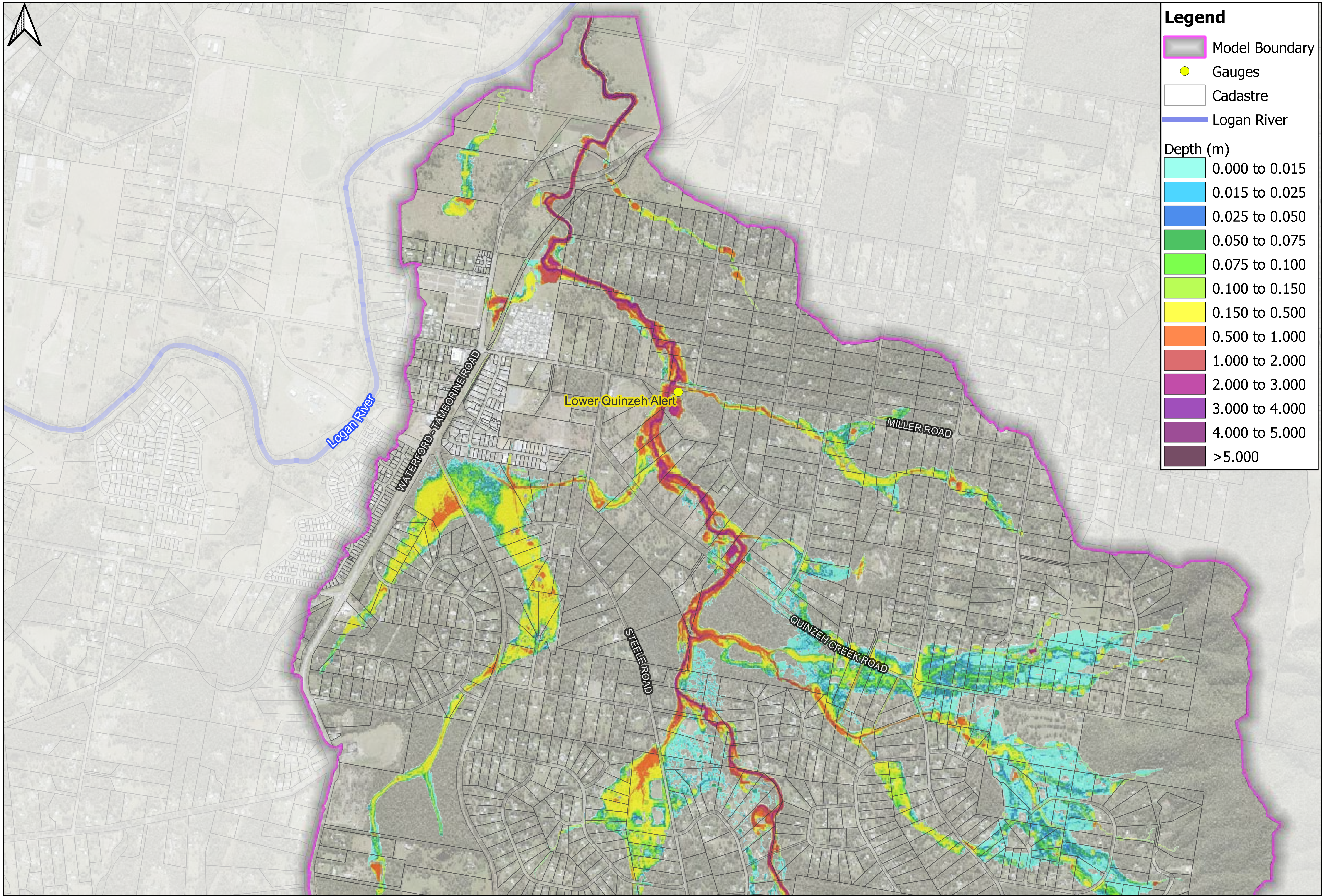
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Peak Water Depth - Inset 2

WATER TECHNOLOGY



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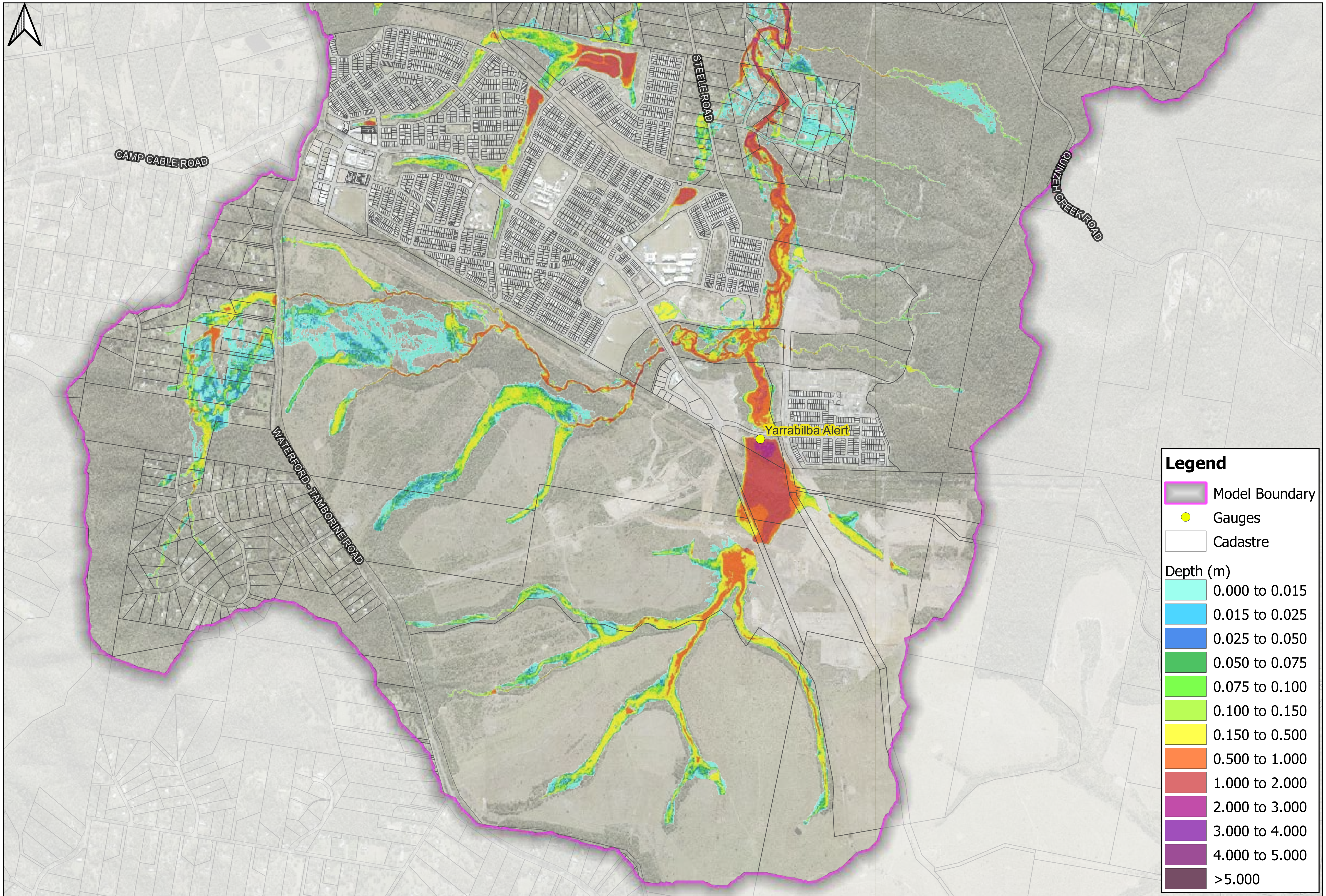
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Depth - Inset 1



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Water Technology Pty Ltd

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Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY
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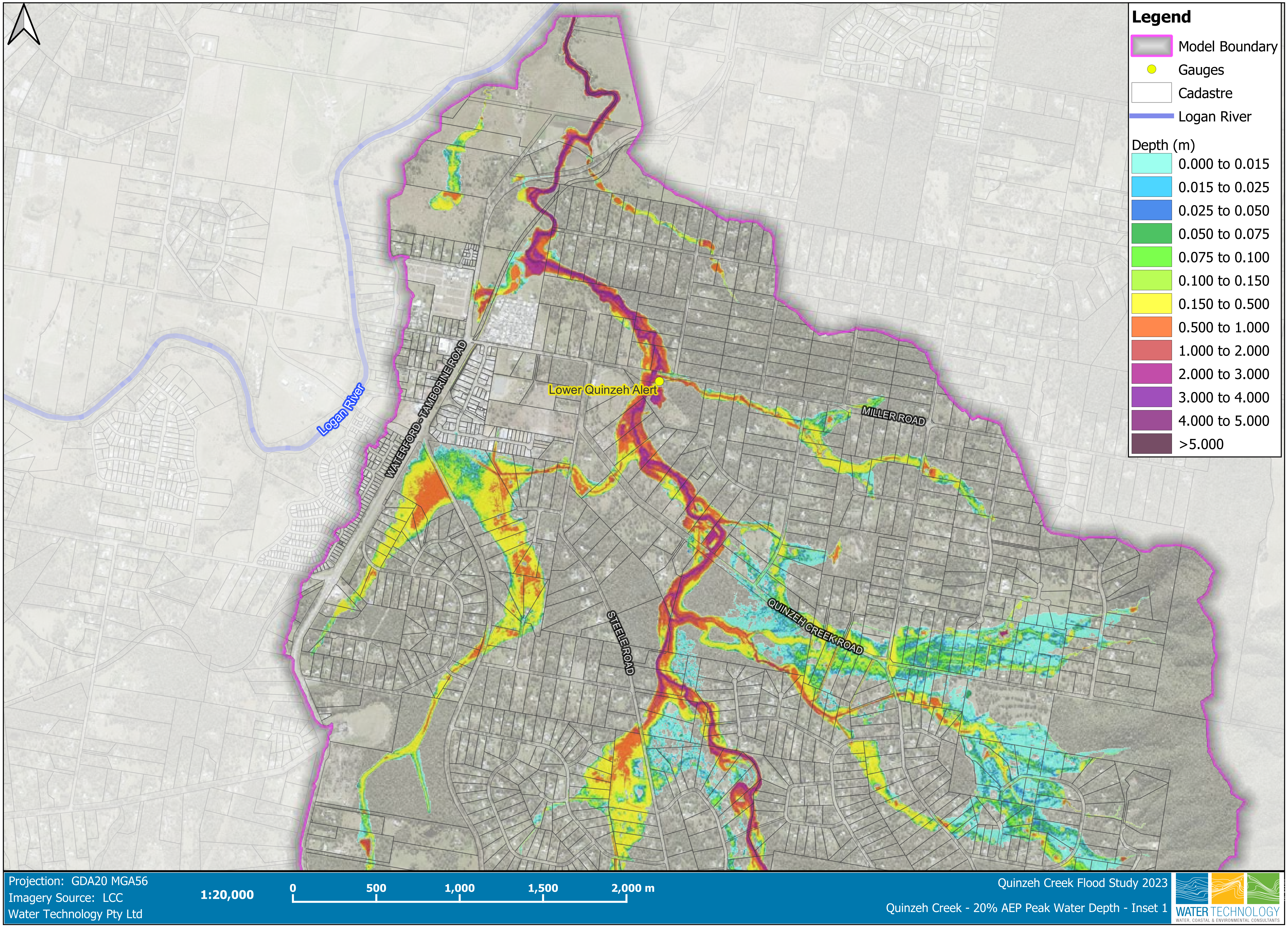
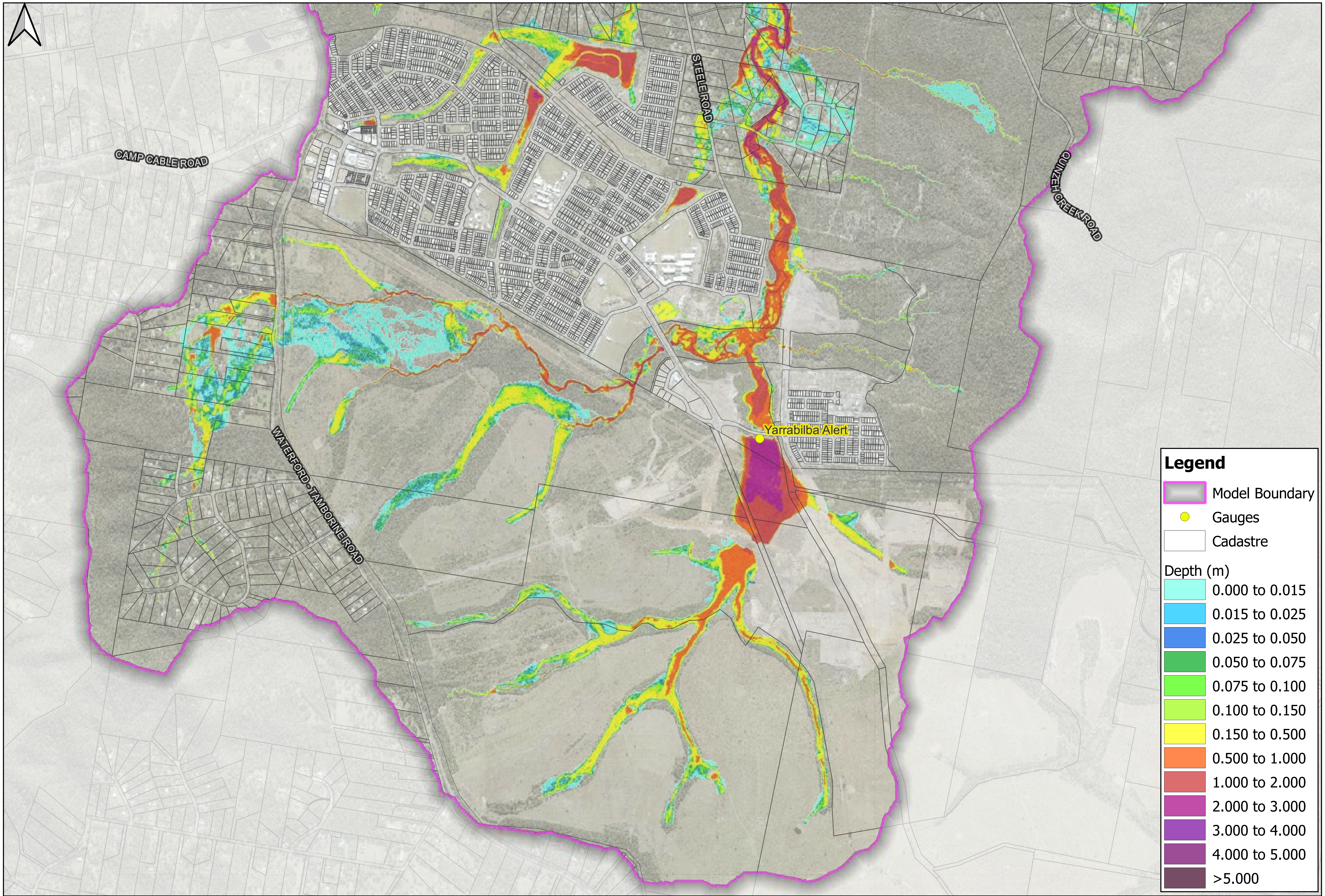

Legend
Model Boundary
Gauges
Cadastre
Logan River
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 20% AEP Peak Water Depth - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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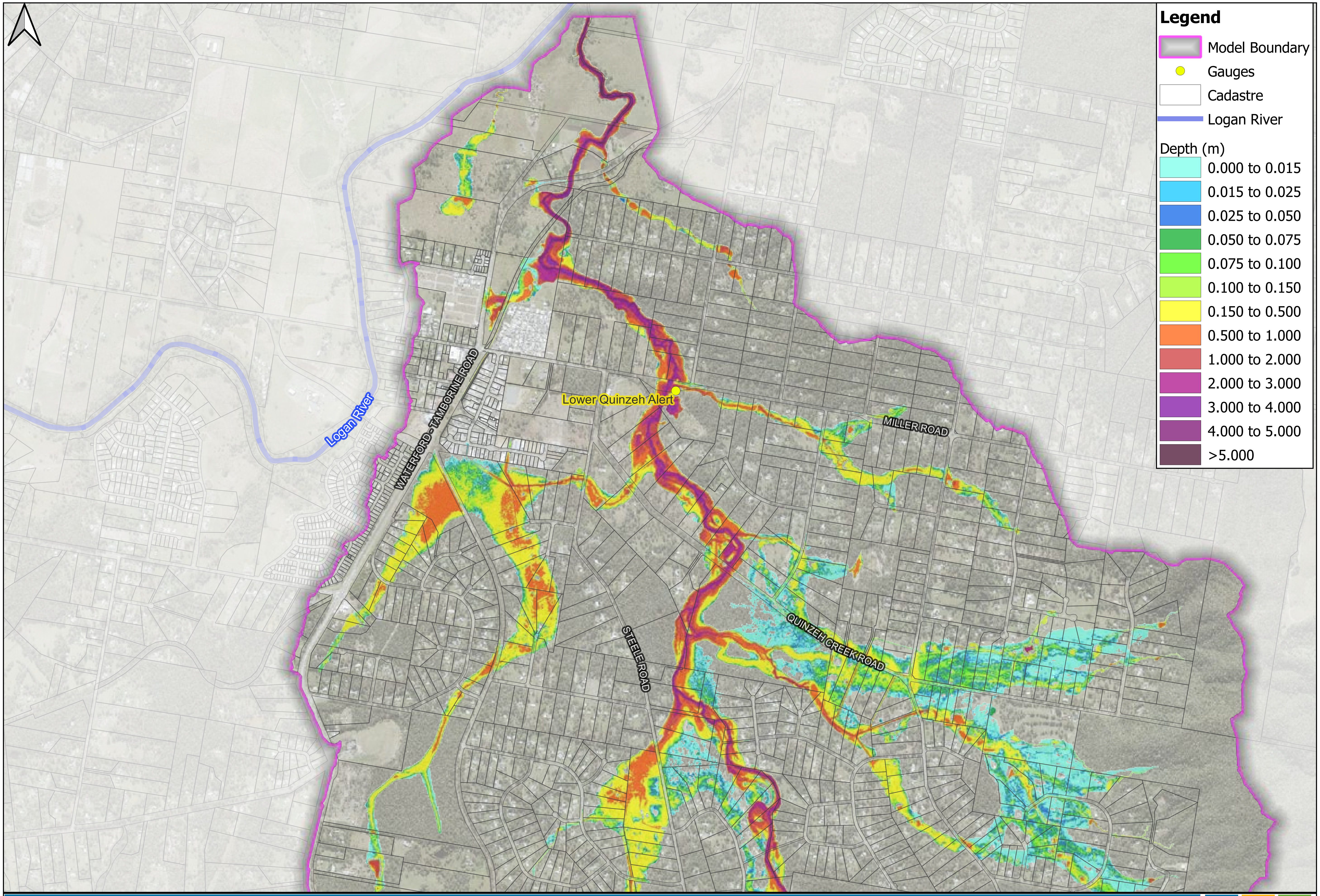
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Depth - Inset 2

WATER TECHNOLOGY



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Water Technology Pty Ltd

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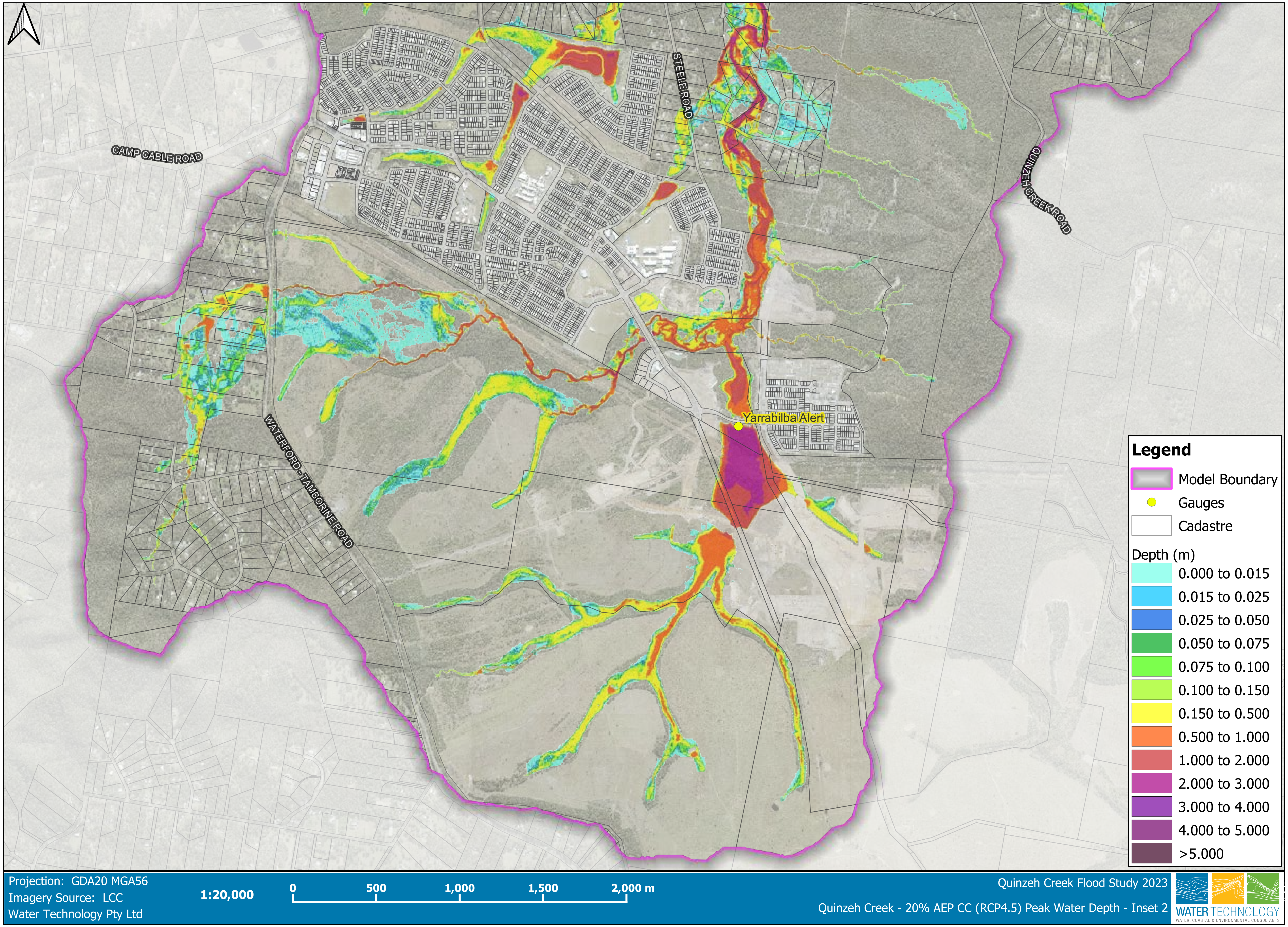
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
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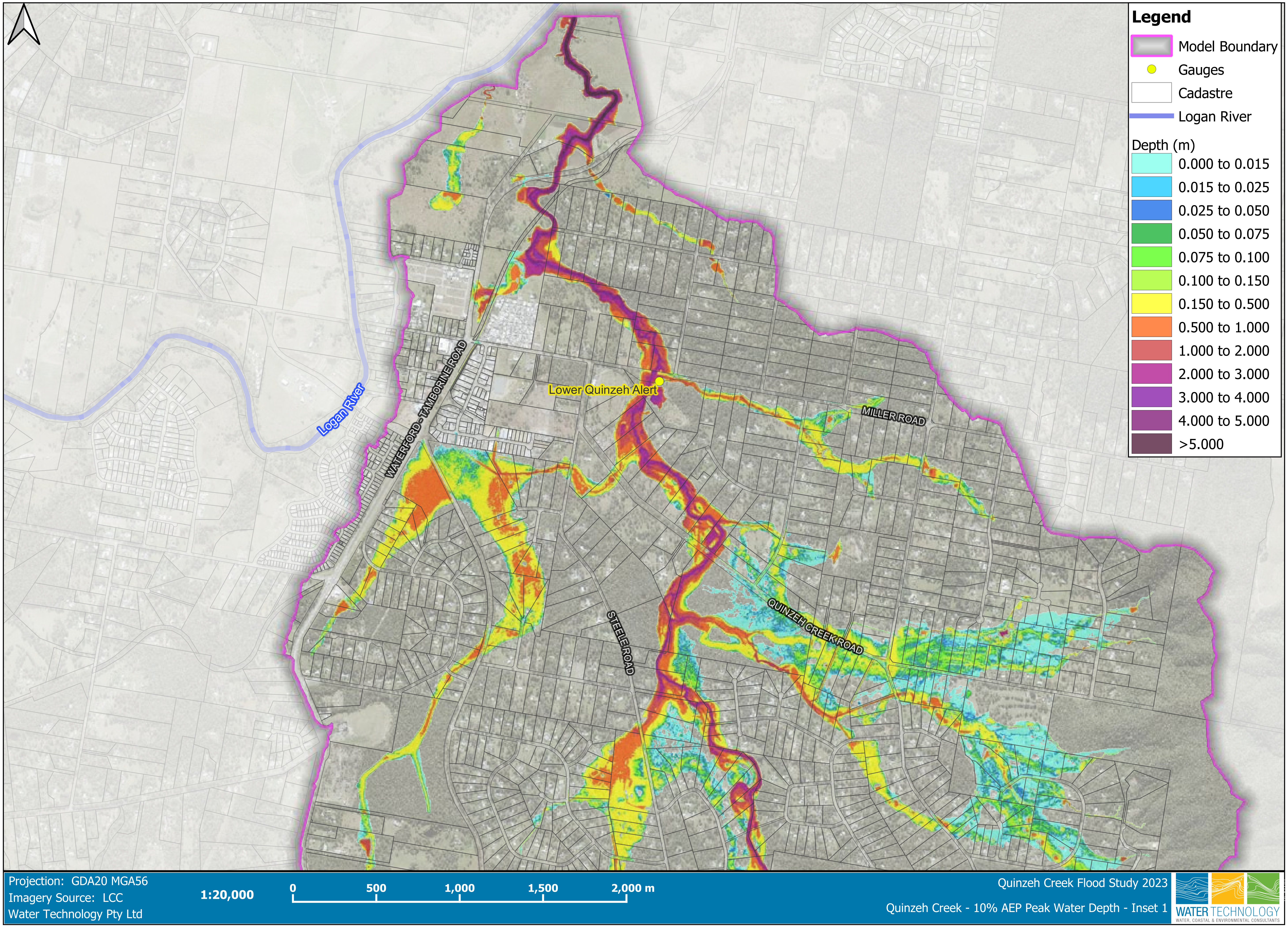
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Depth - Inset 2
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


Legend
Model Boundary
Gauges
Cadastre
Logan River
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
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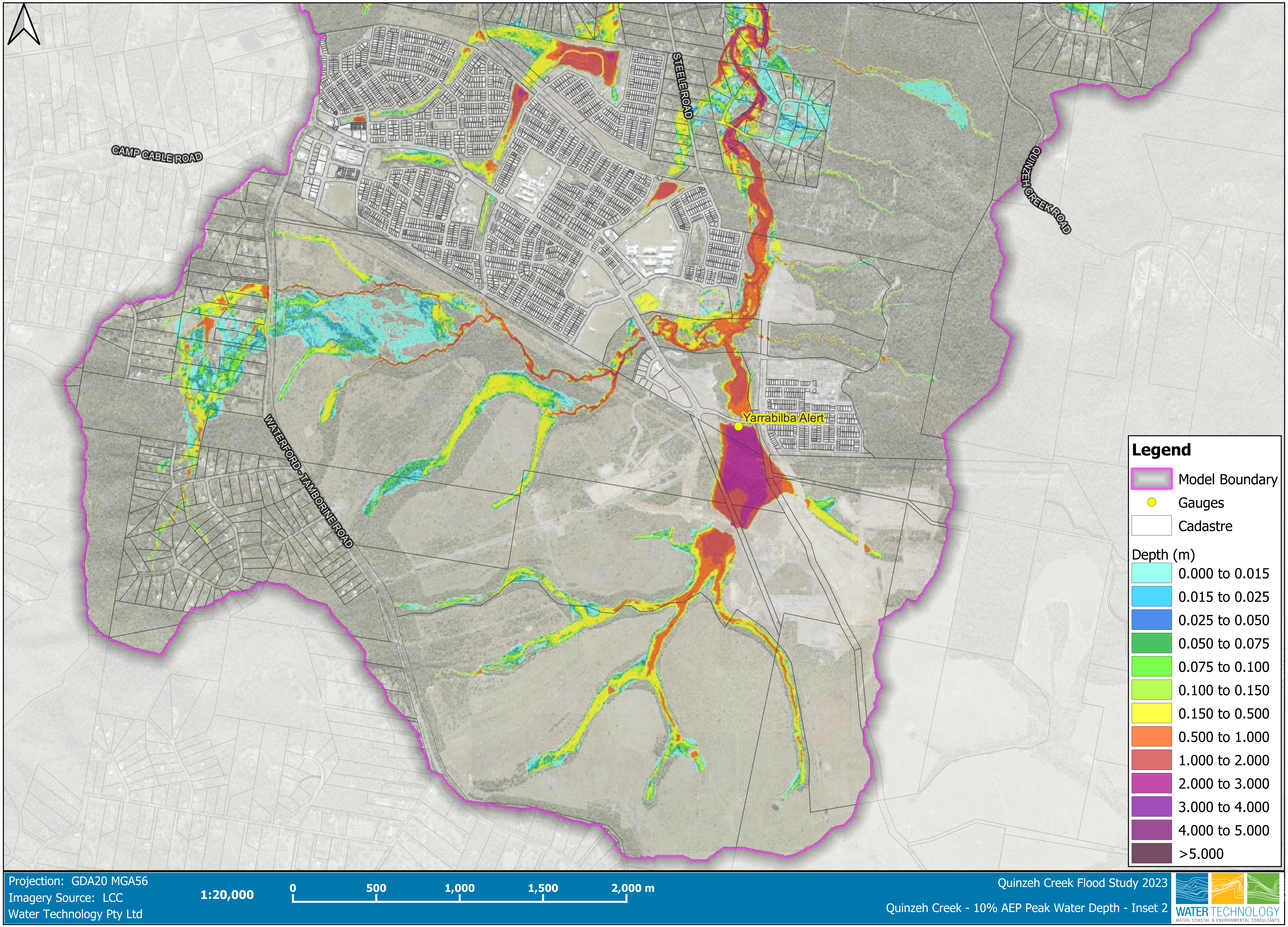
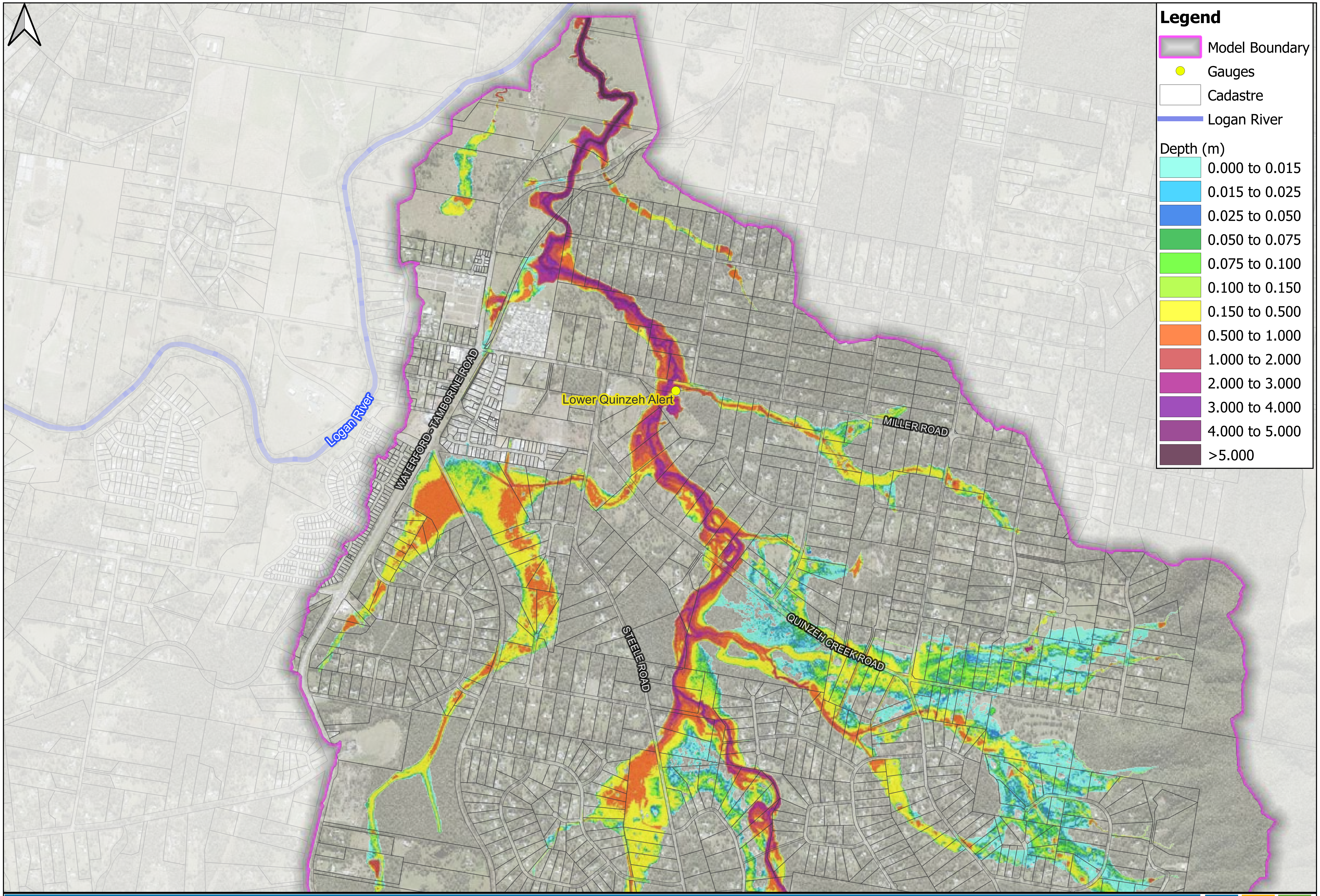
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP Peak Water Depth - Inset 1
WATER TECHNOLOGY



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP Peak Water Depth - Inset 2
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY
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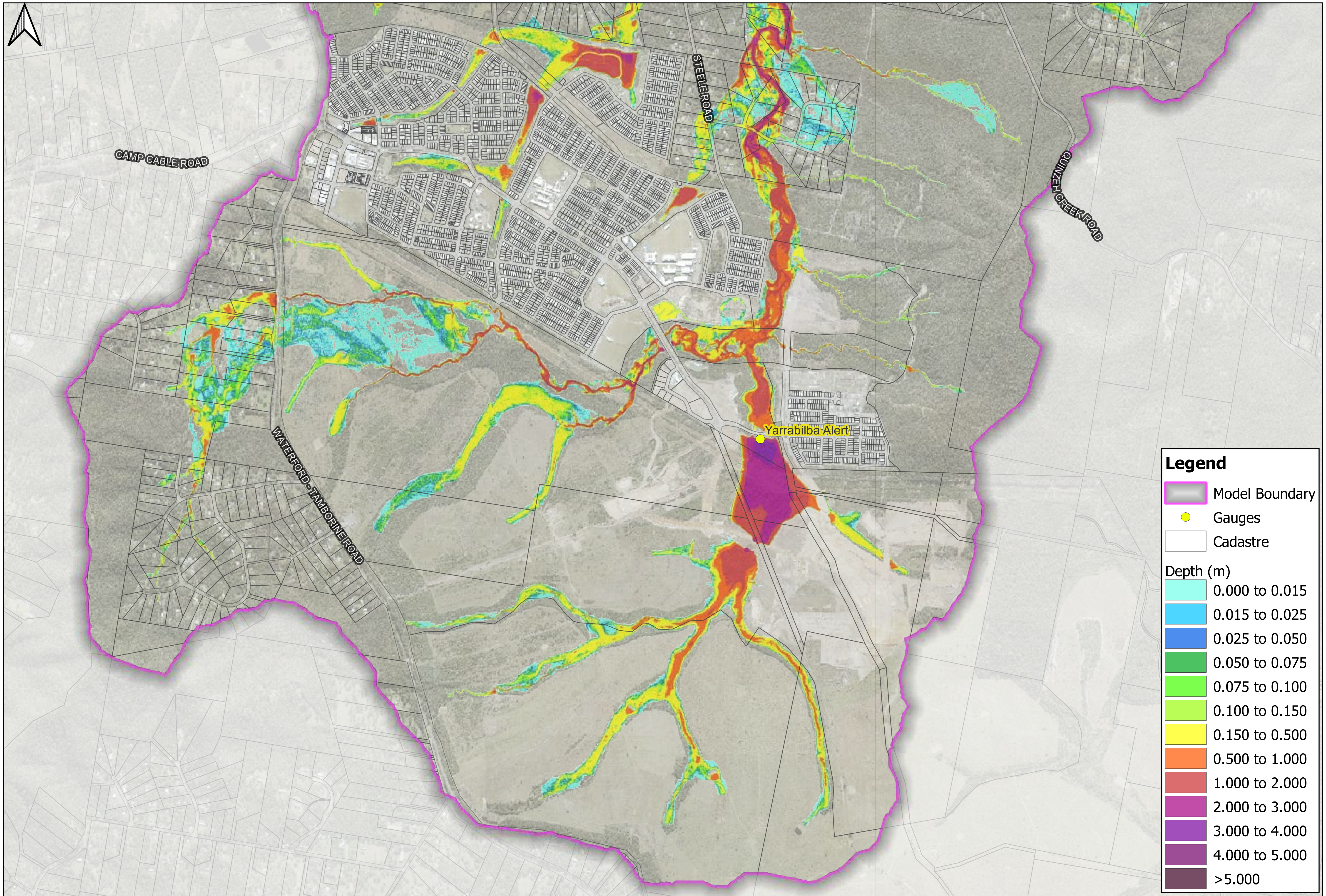

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Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY
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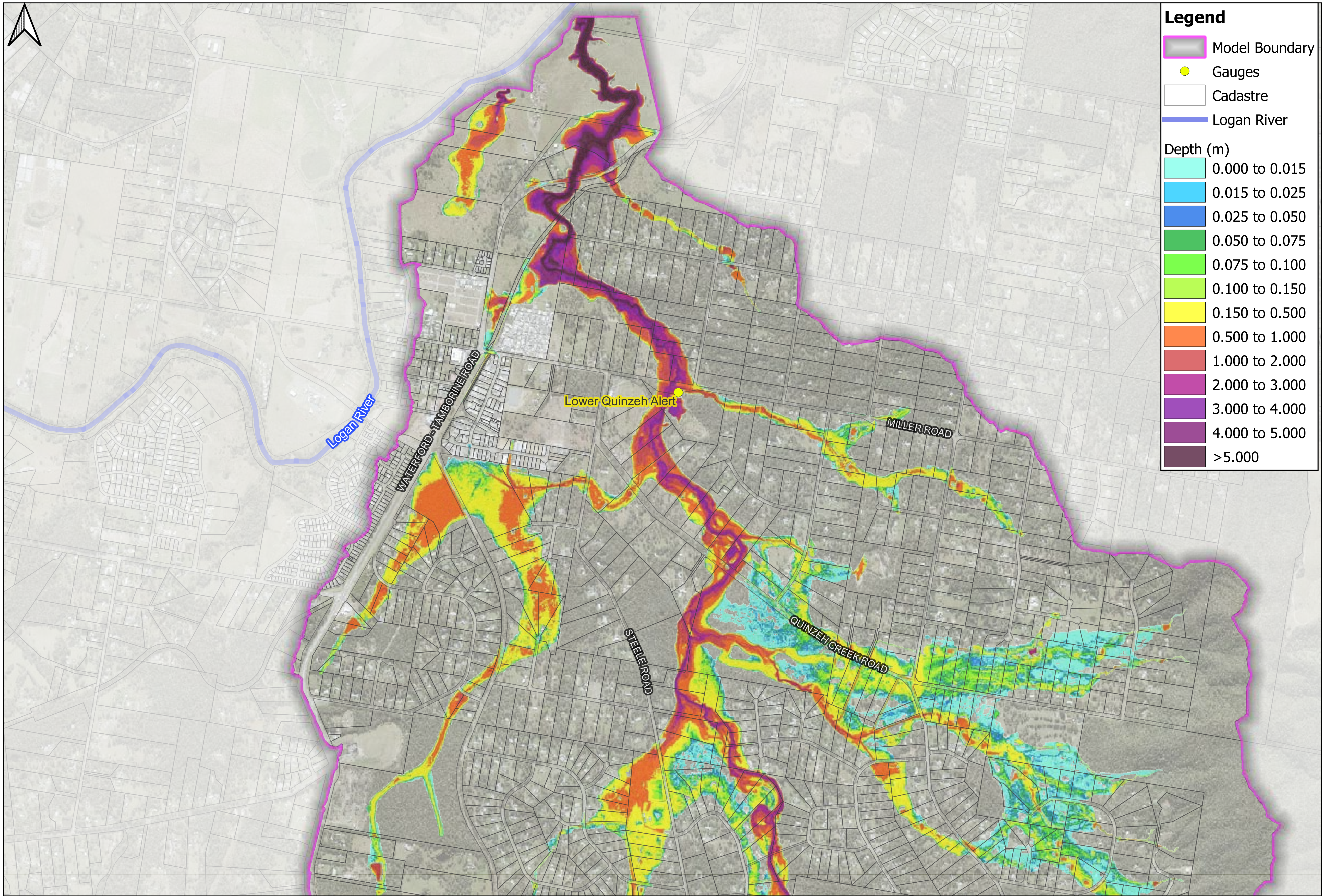

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Water Technology Pty Ltd

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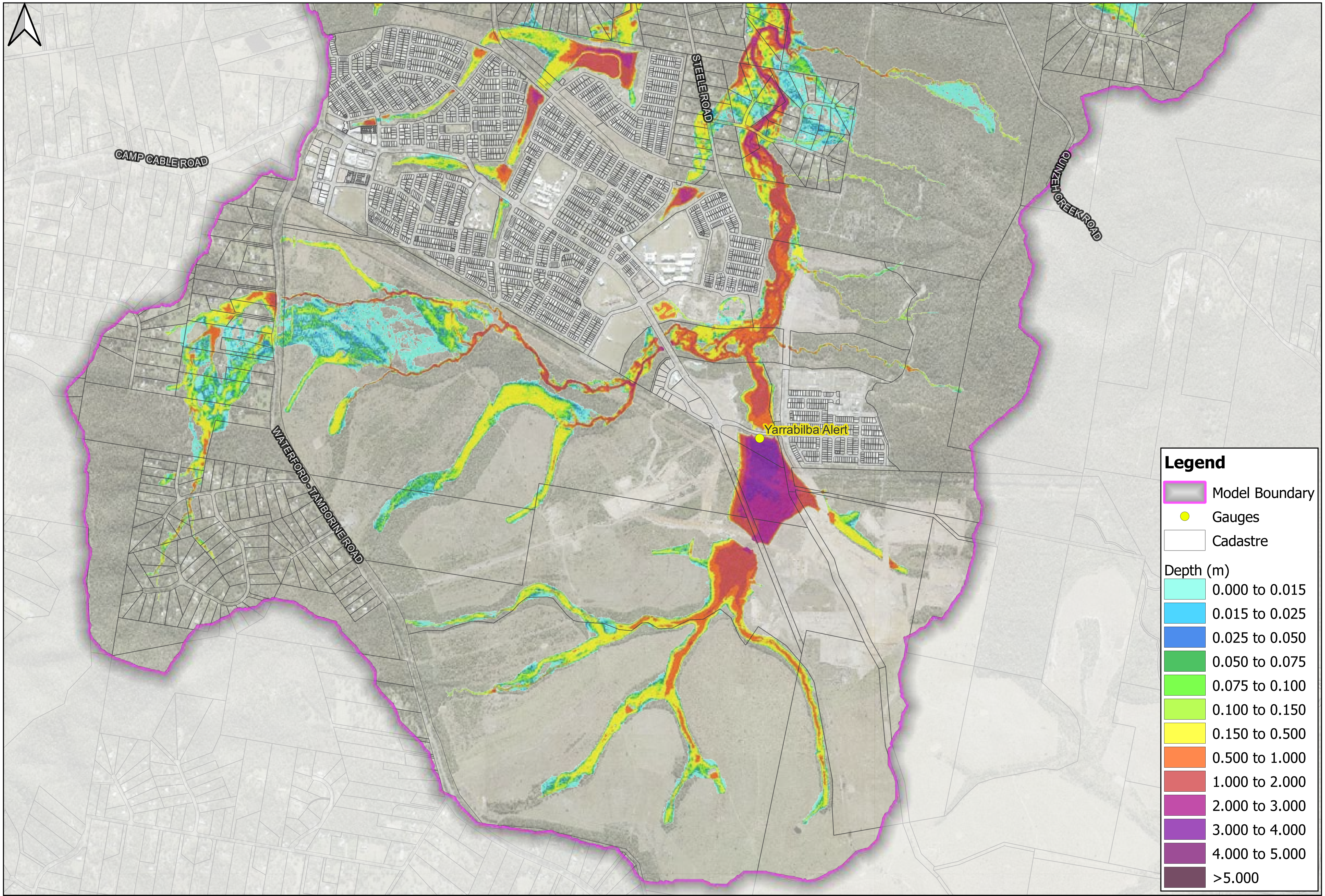
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP Peak Water Depth - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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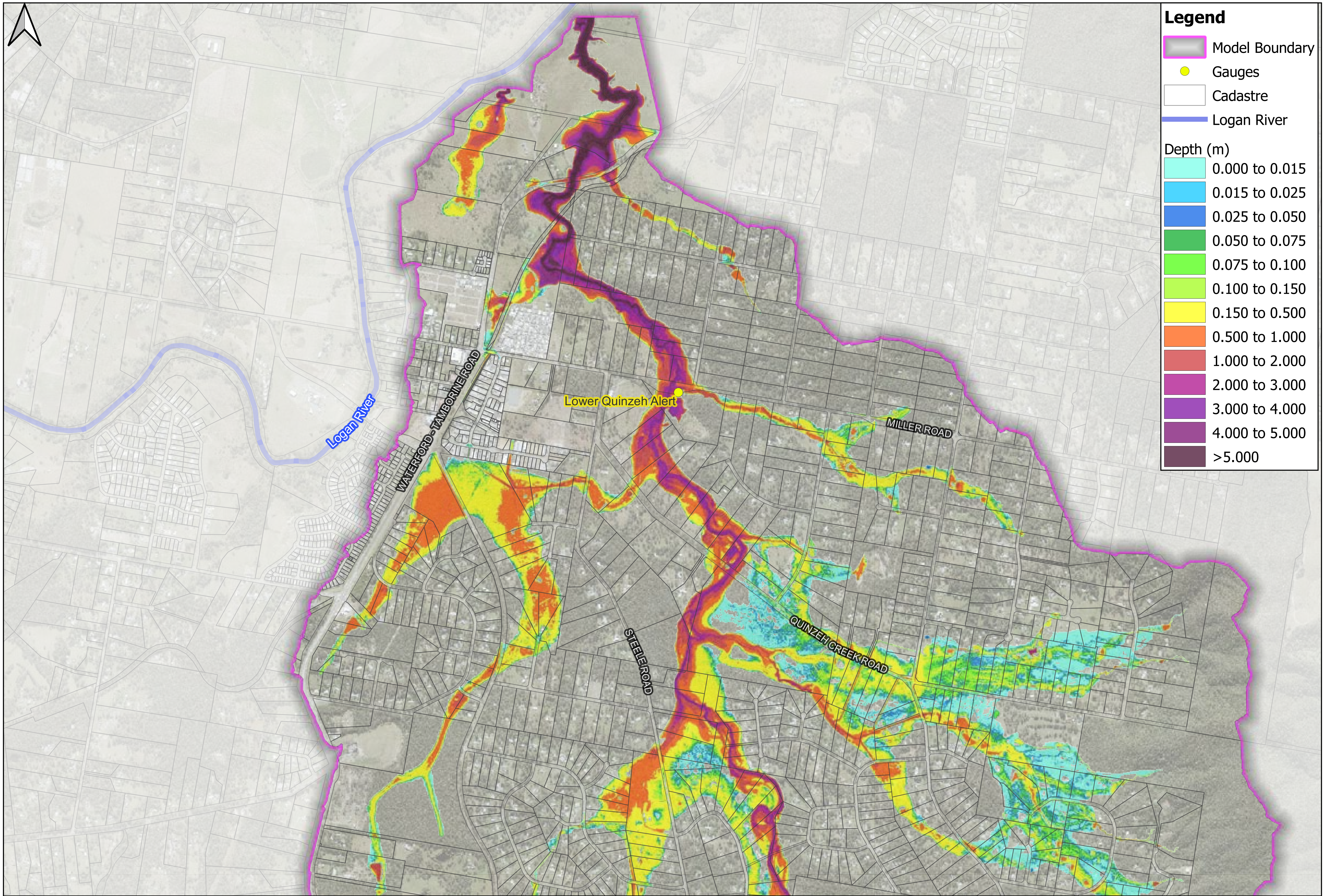
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 5% AEP Peak Water Depth - Inset 2



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Water Technology Pty Ltd

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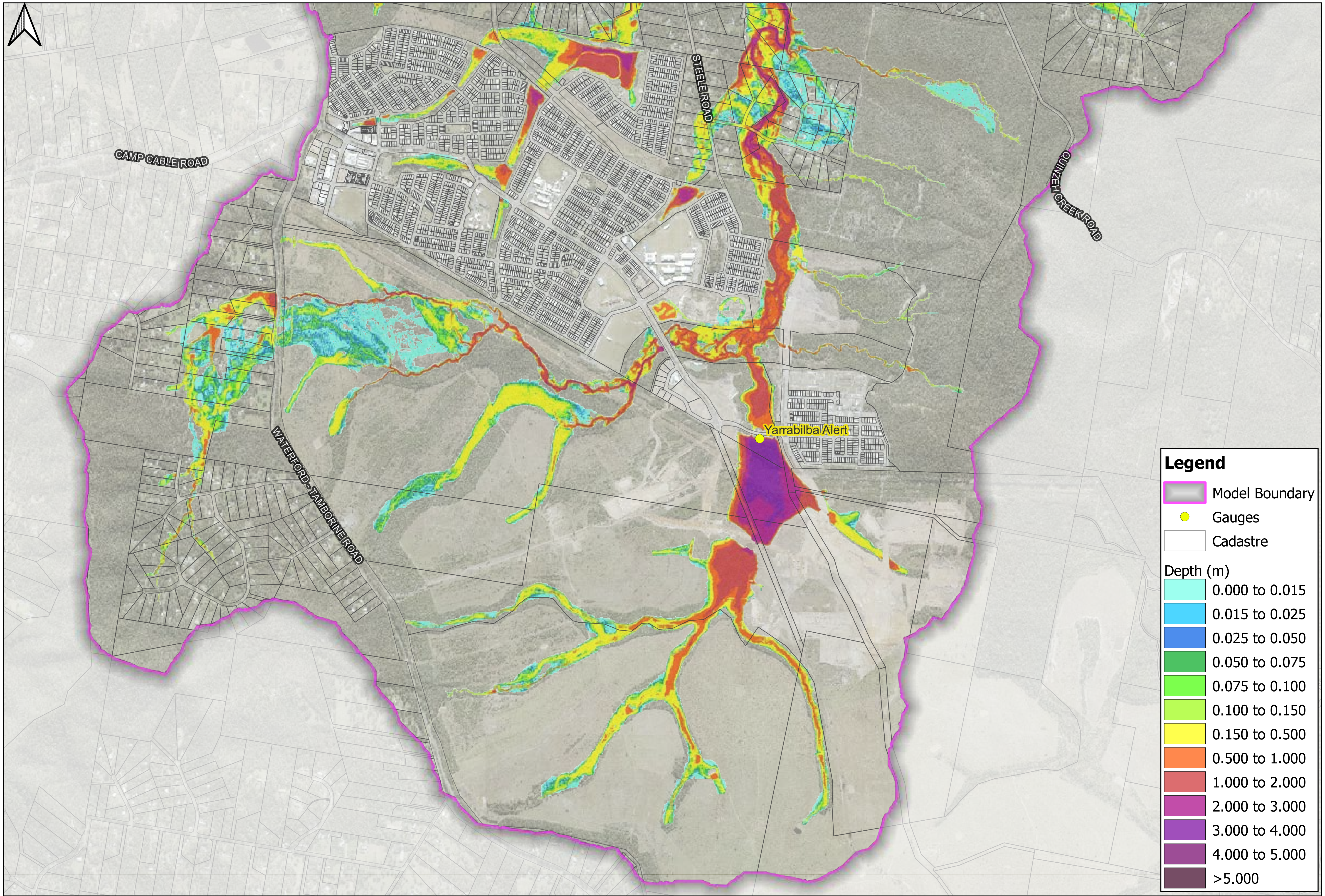
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY



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Water Technology Pty Ltd

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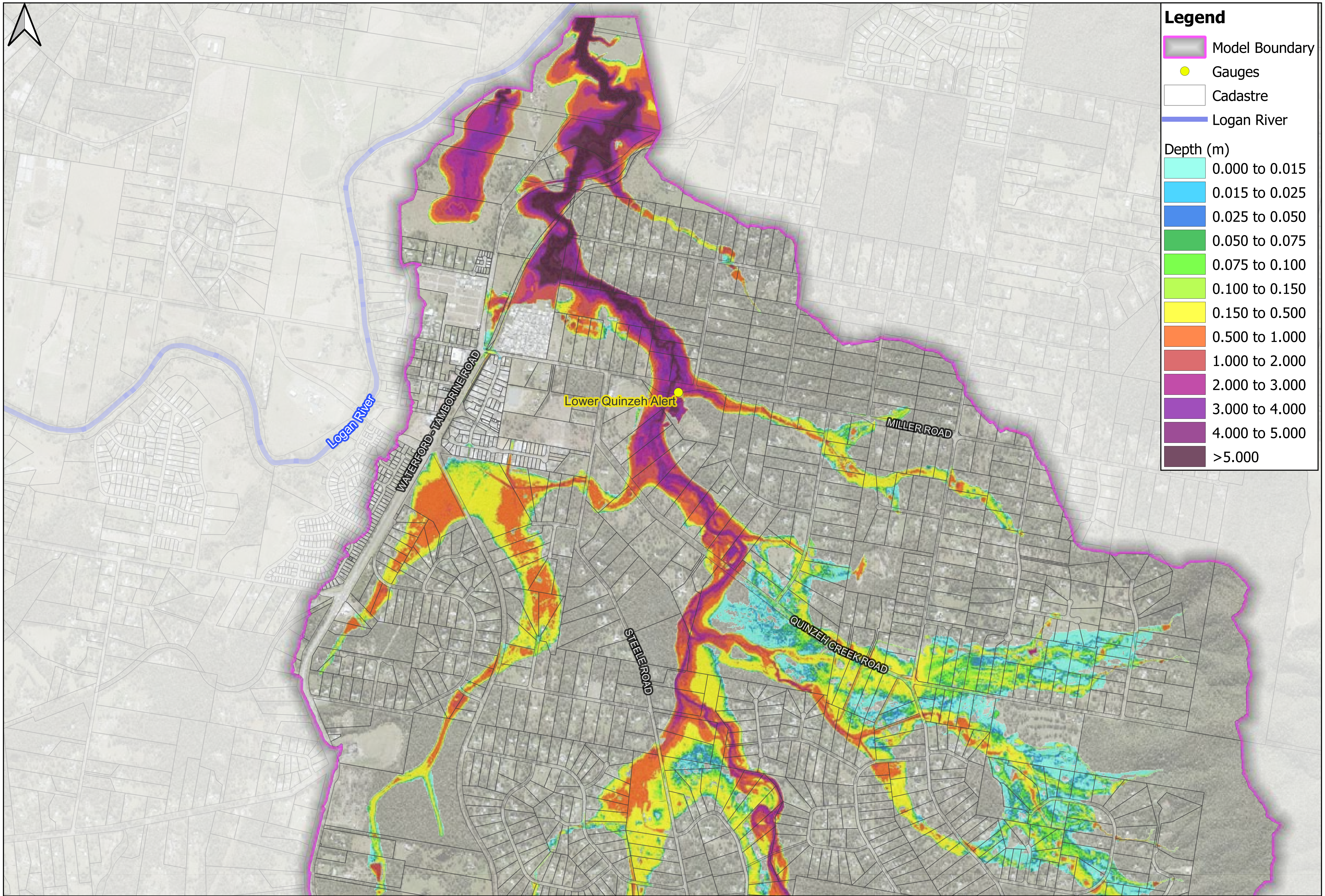
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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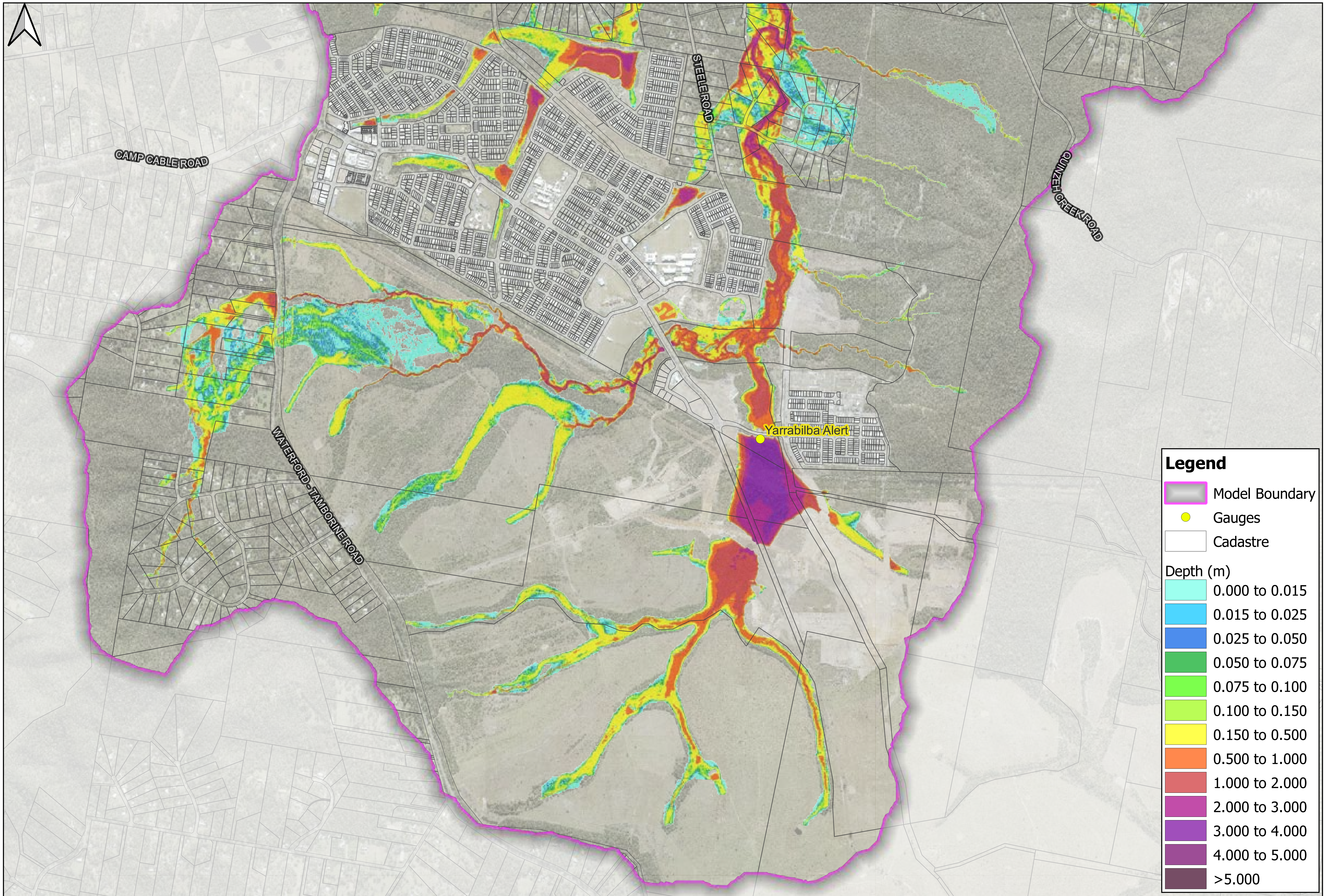
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Depth - Inset 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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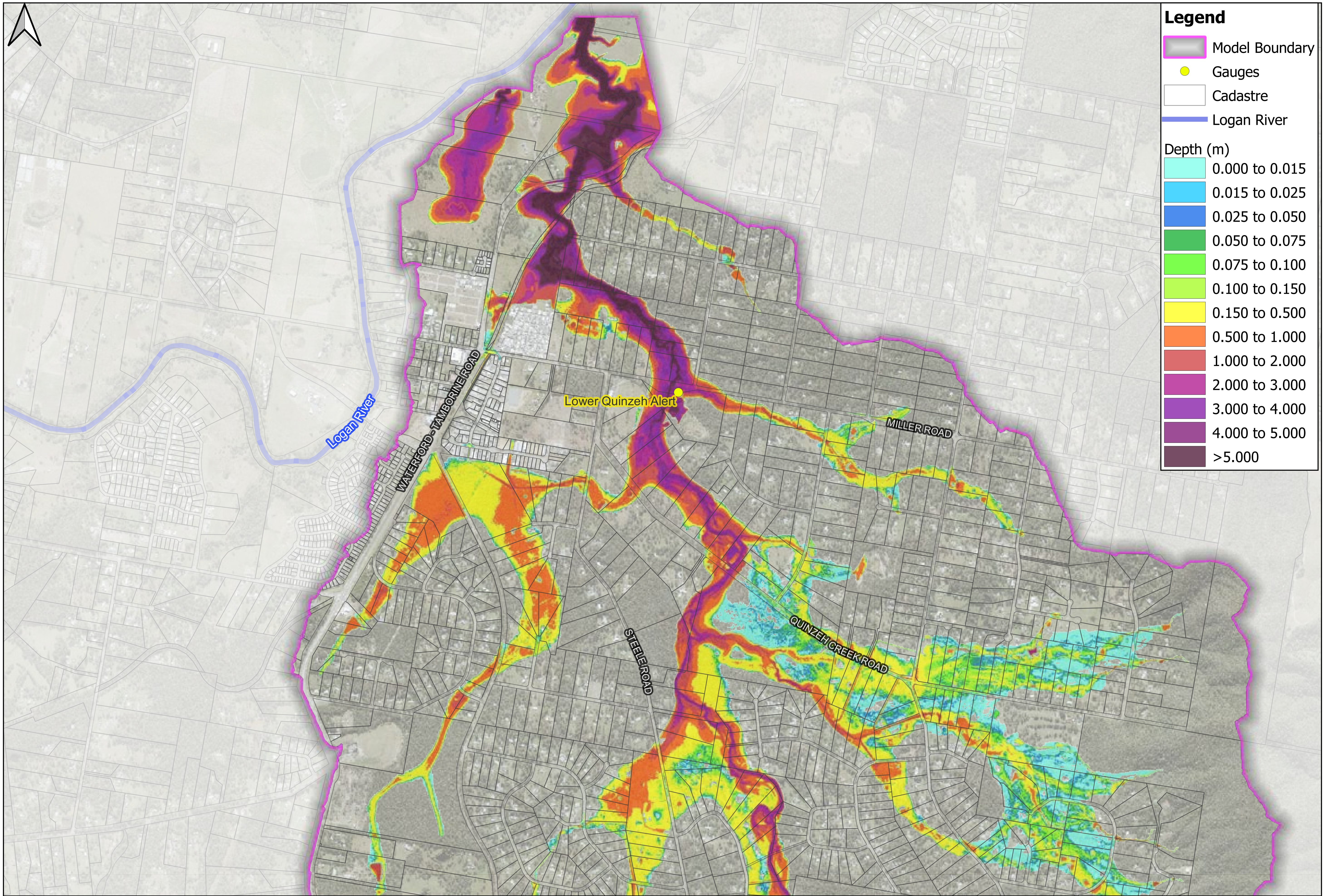
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Depth - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY
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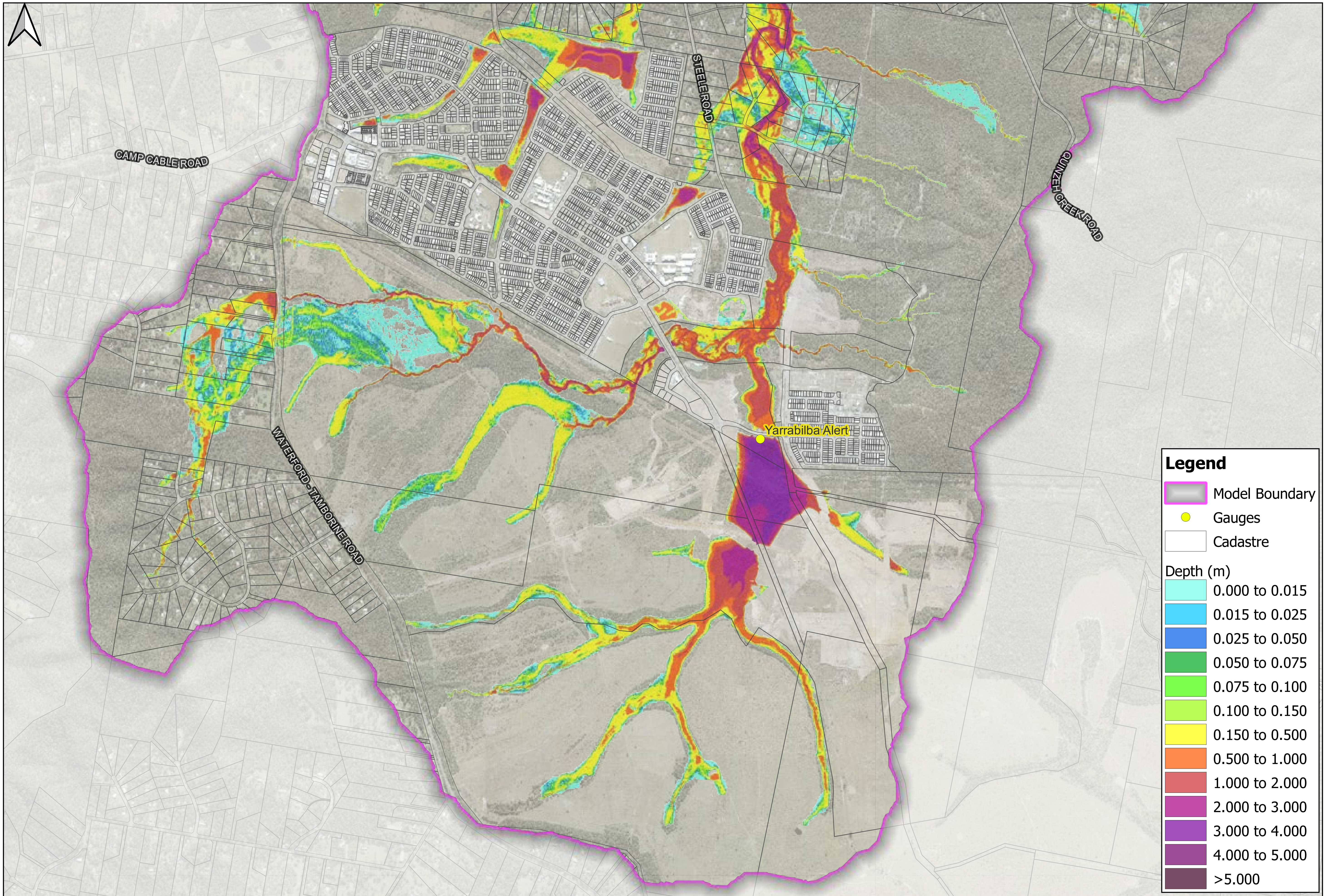

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Imagery Source: LCC
Water Technology Pty Ltd

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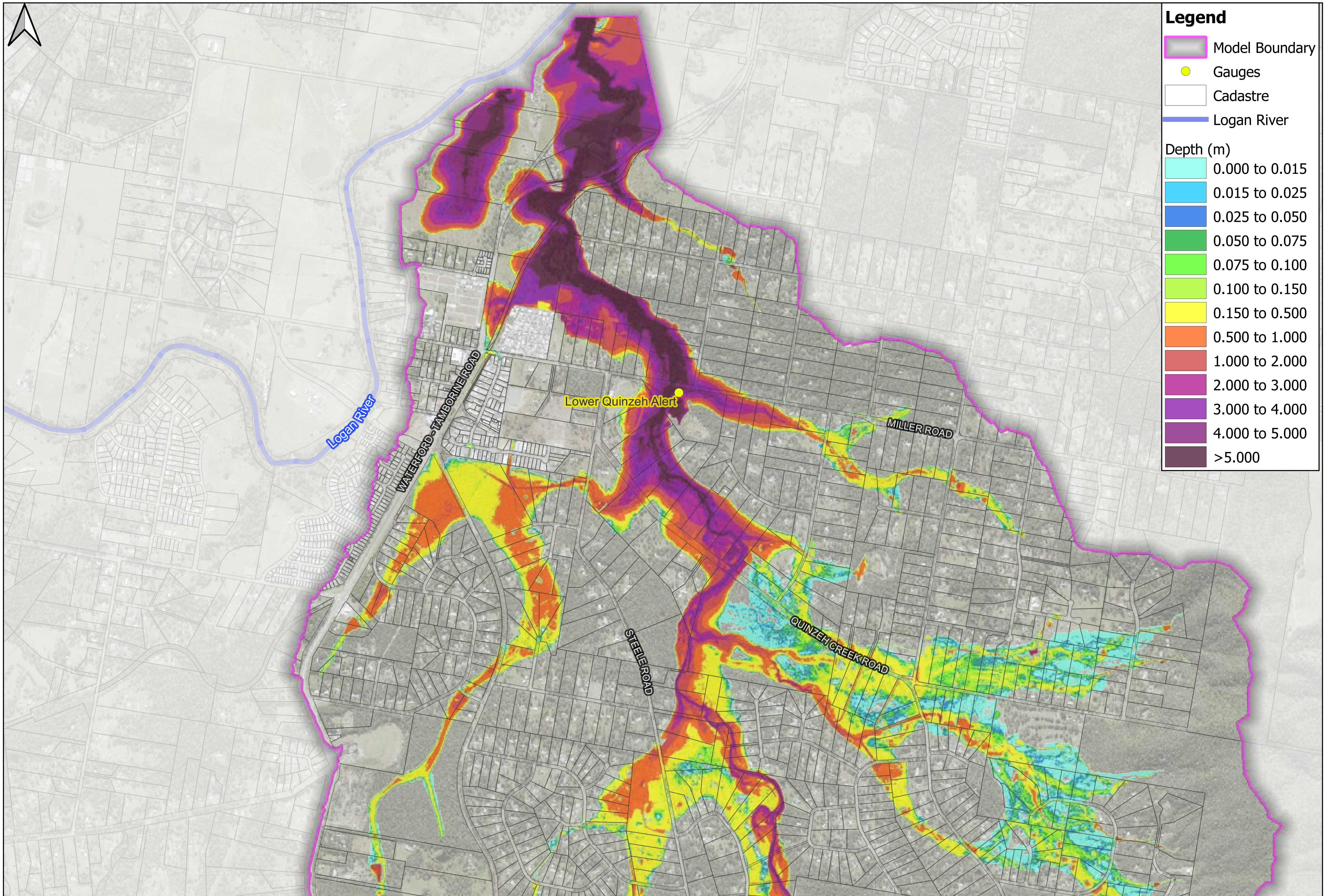
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

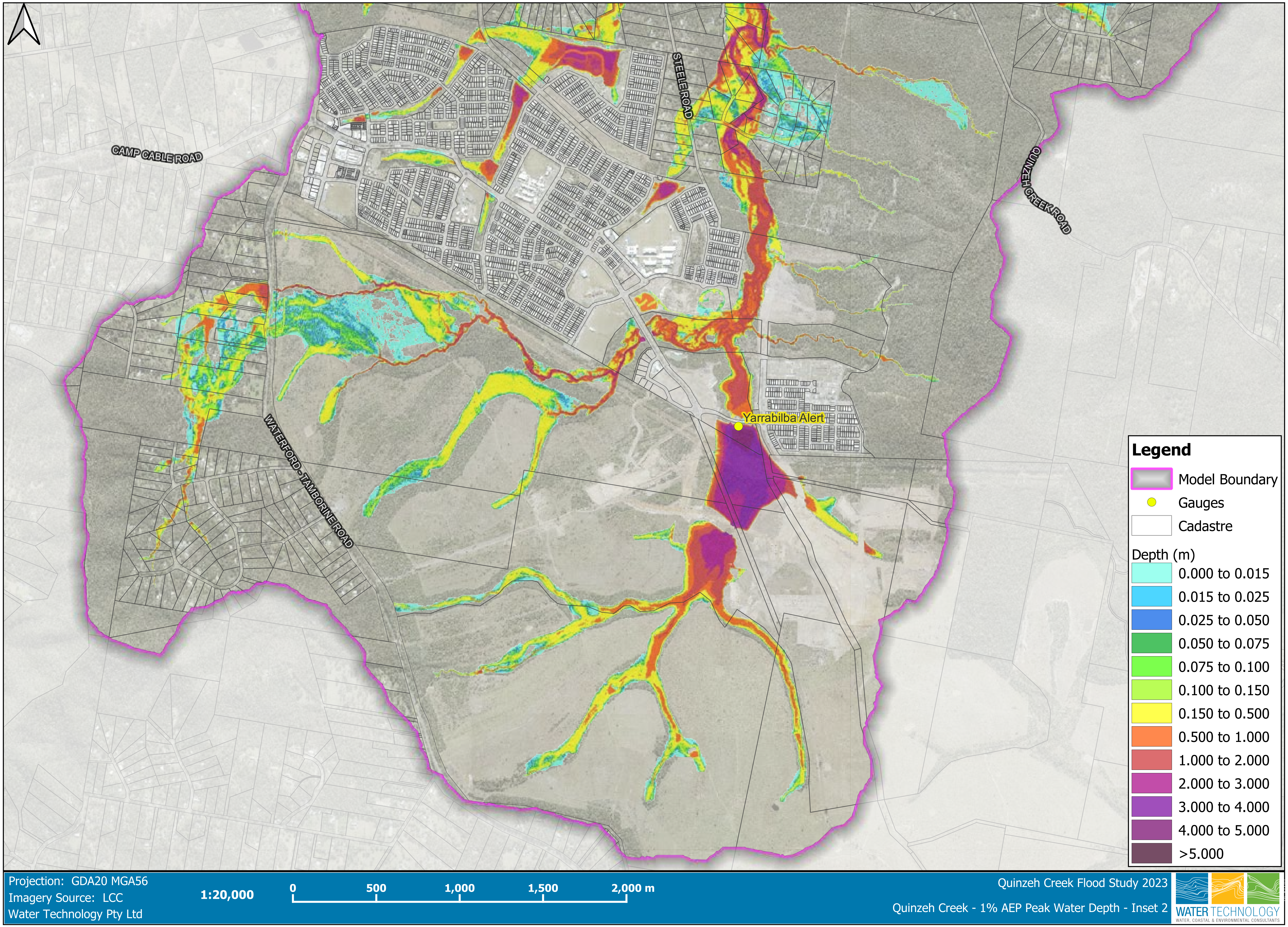


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

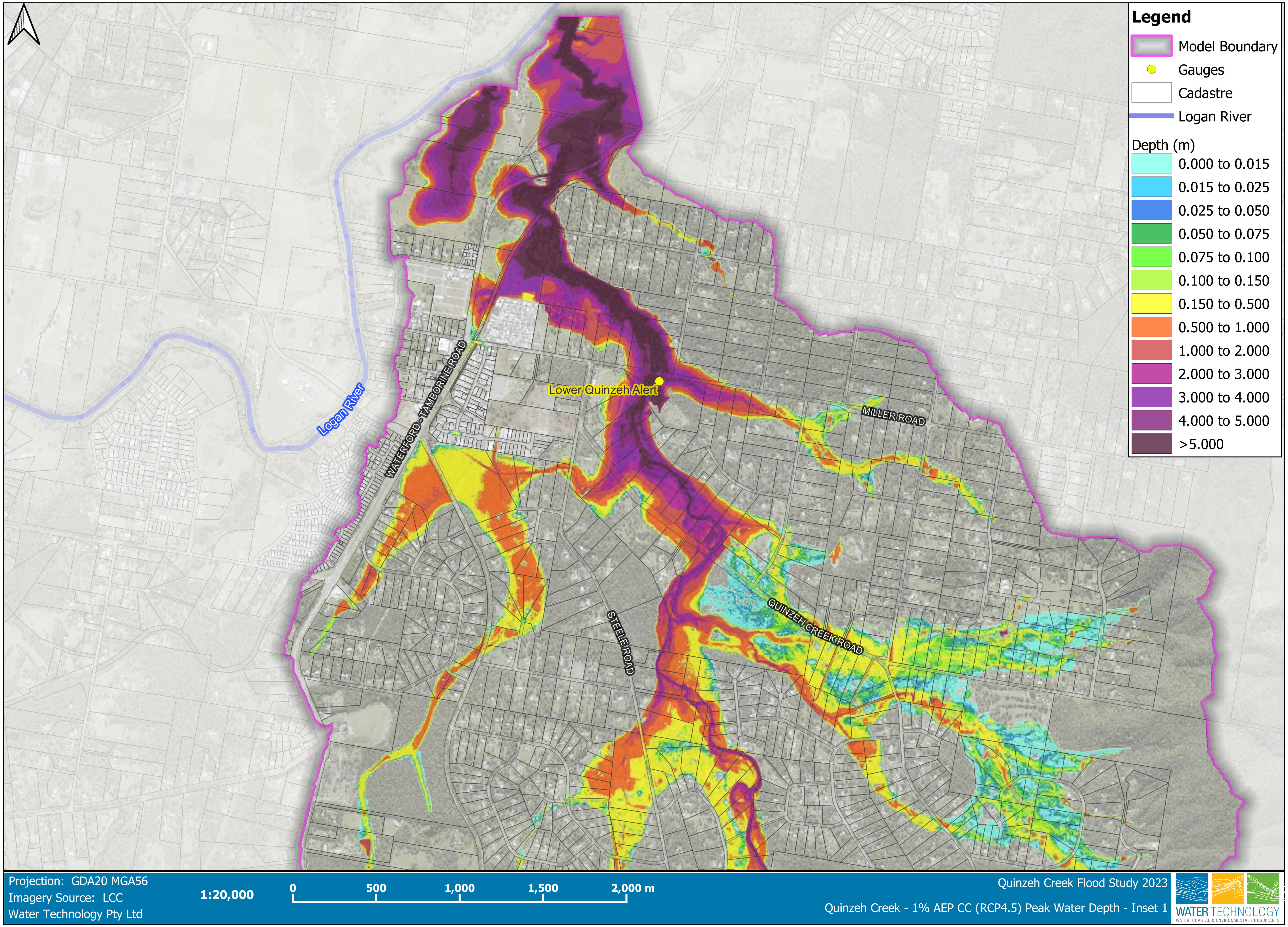
1:20,000

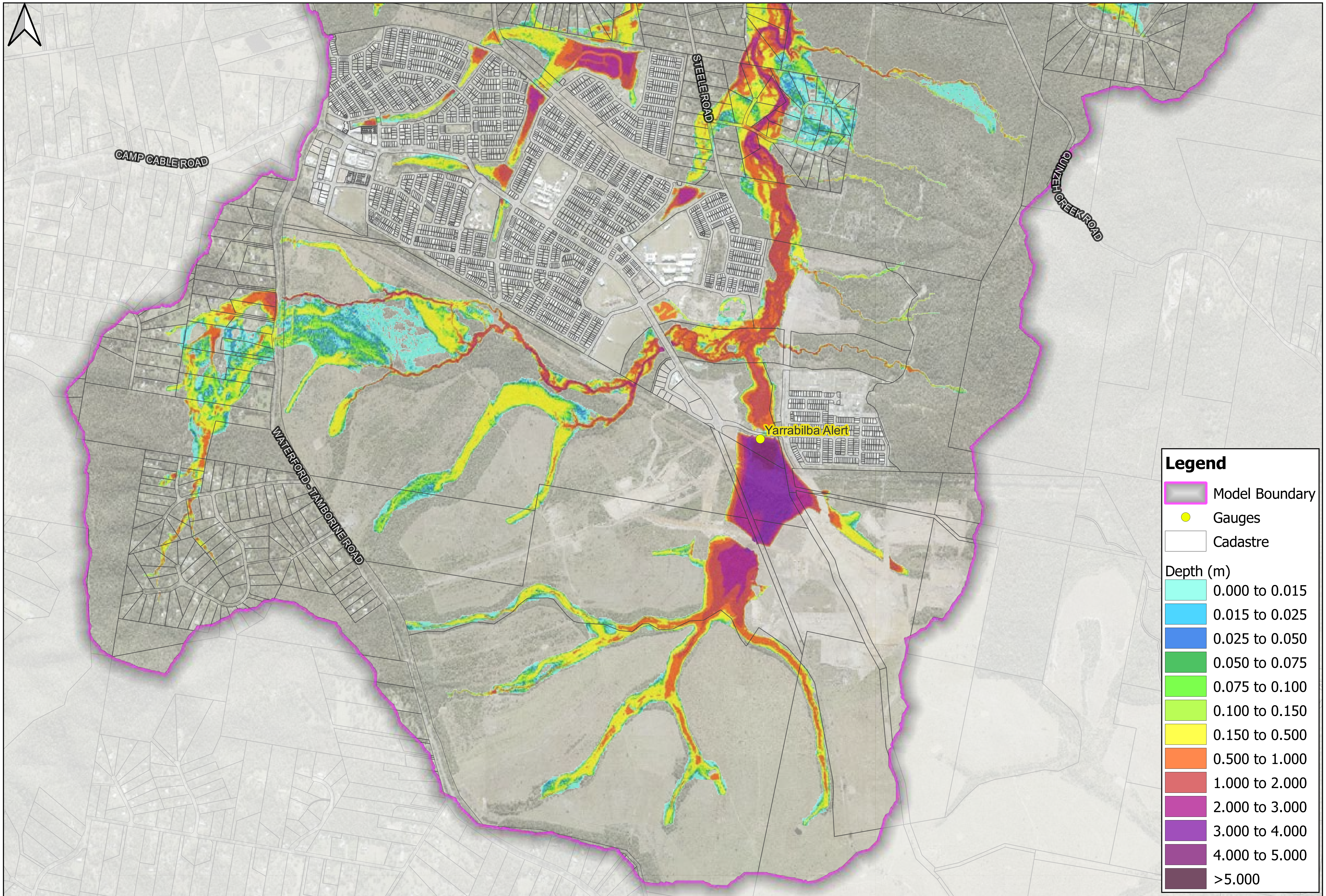
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Depth - Inset 1



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP Peak Water Depth - Inset 2
WATER TECHNOLOGY


Legend
Model Boundary
Gauges
Cadastre
Logan River
Depth (m)
0.000 to 0.015
0.015 to 0.025
0.025 to 0.050
0.050 to 0.075
0.075 to 0.100
0.100 to 0.150
0.150 to 0.500
0.500 to 1.000
1.000 to 2.000
2.000 to 3.000
3.000 to 4.000
4.000 to 5.000
>5.000
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Depth - Inset 1
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

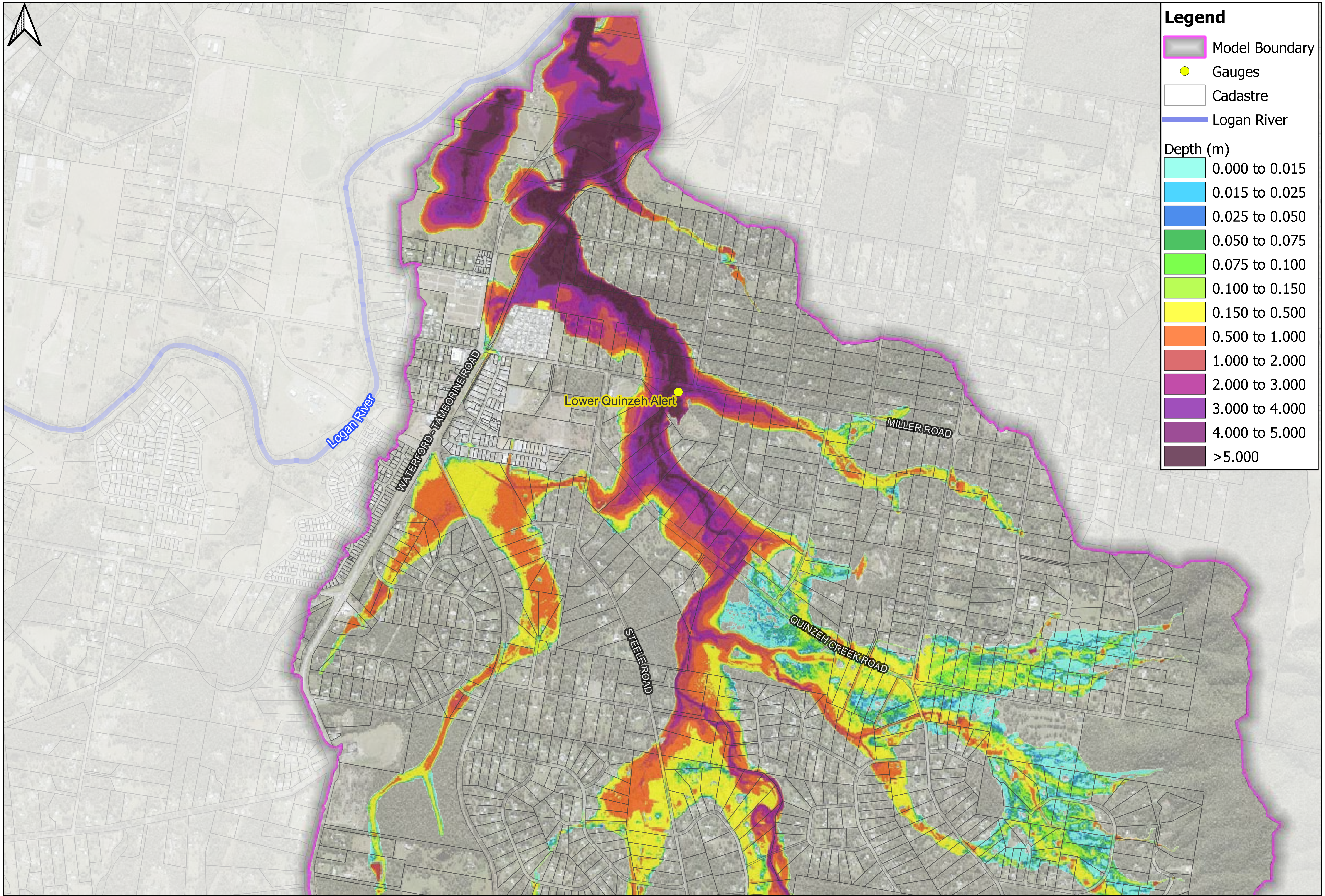
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

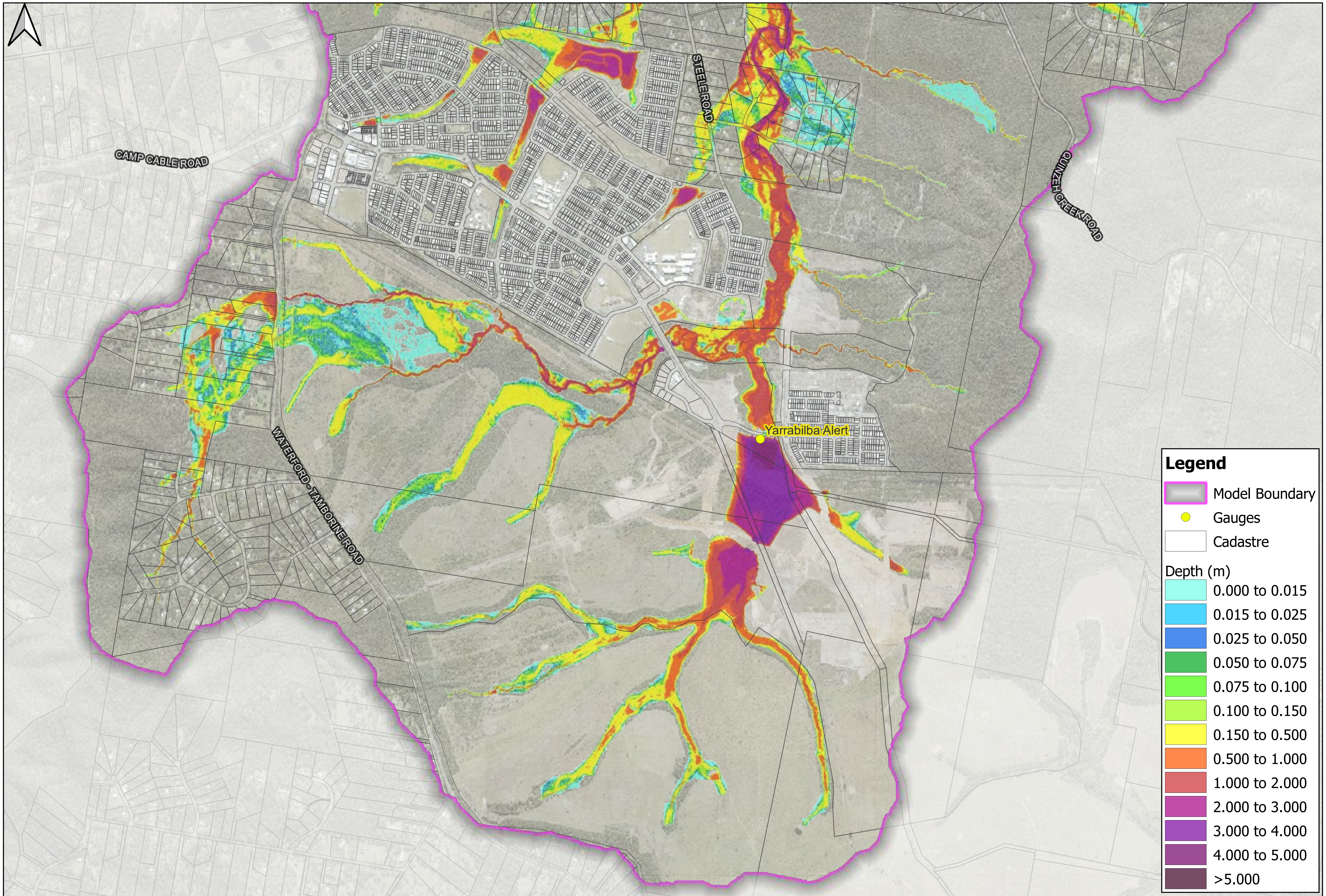
Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.5% AEP Peak Water Depth - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

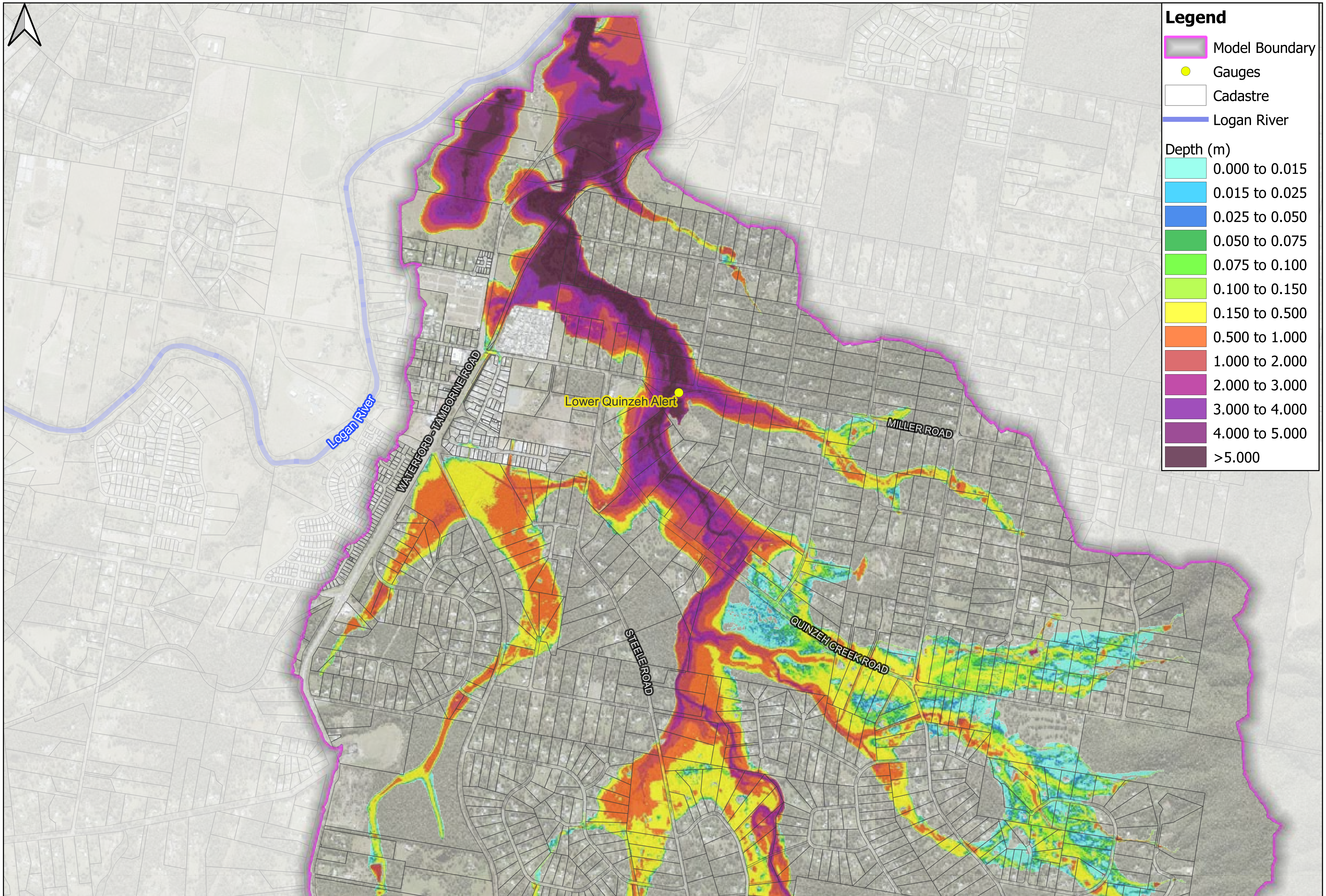
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Depth - Inset 2

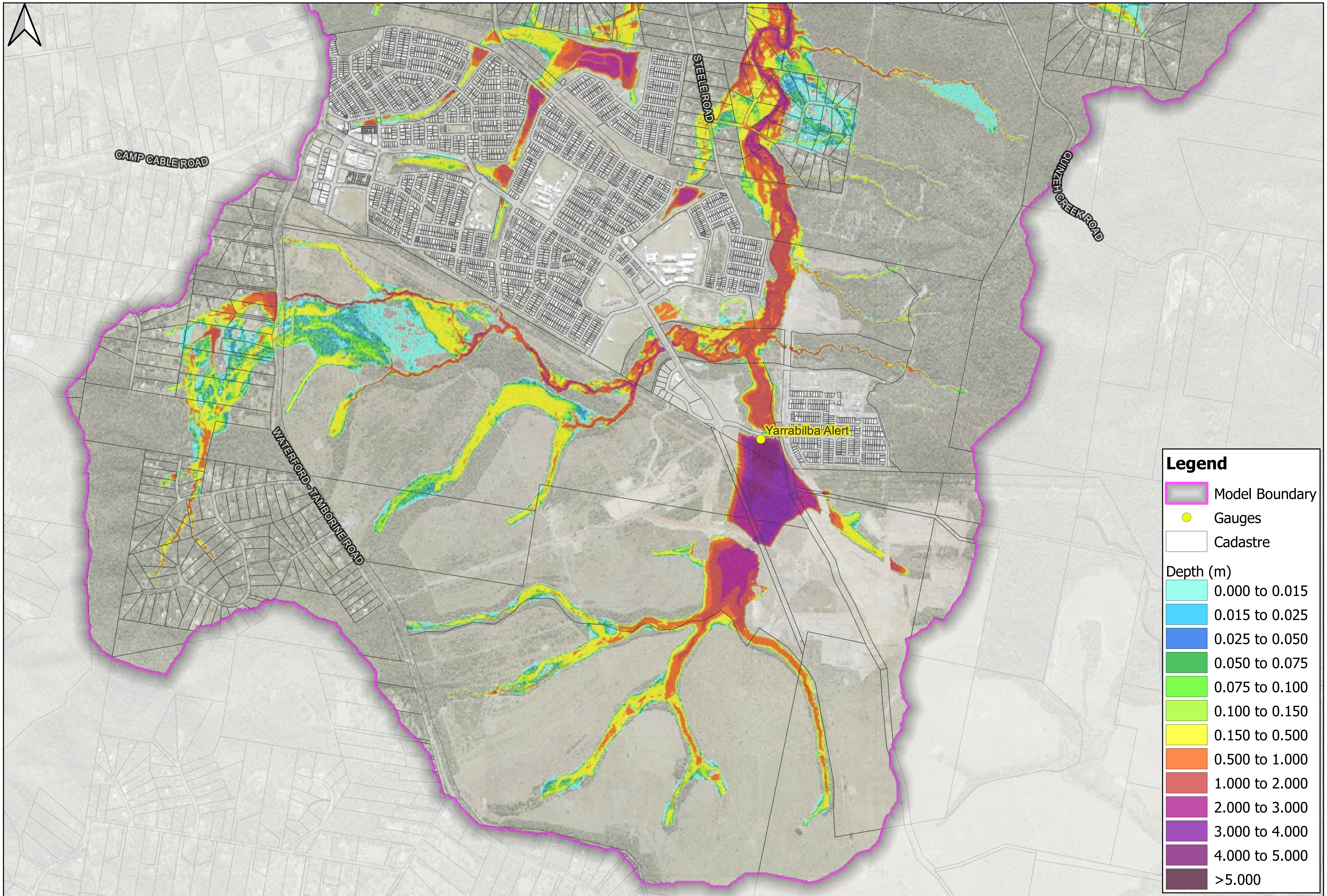
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY



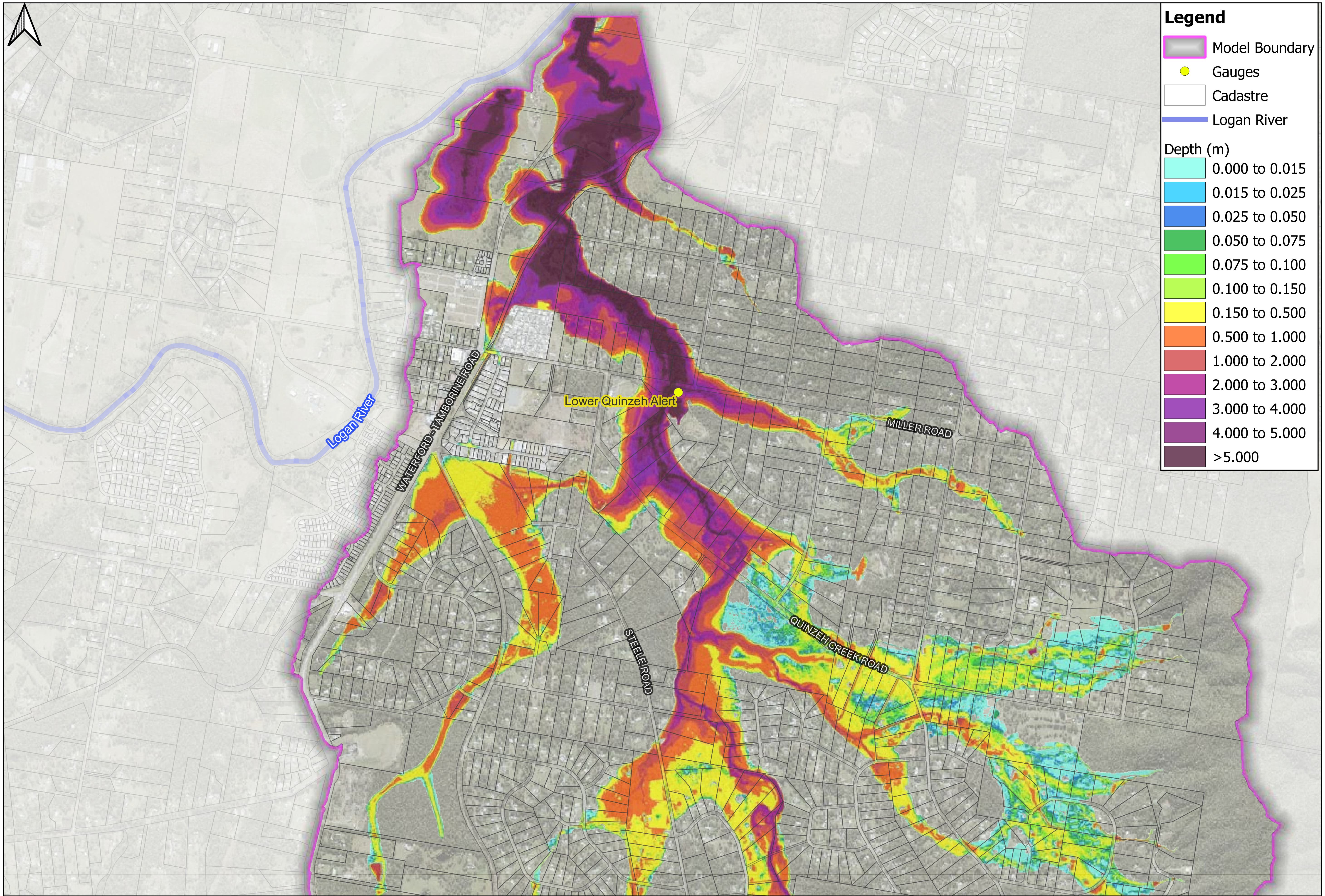
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

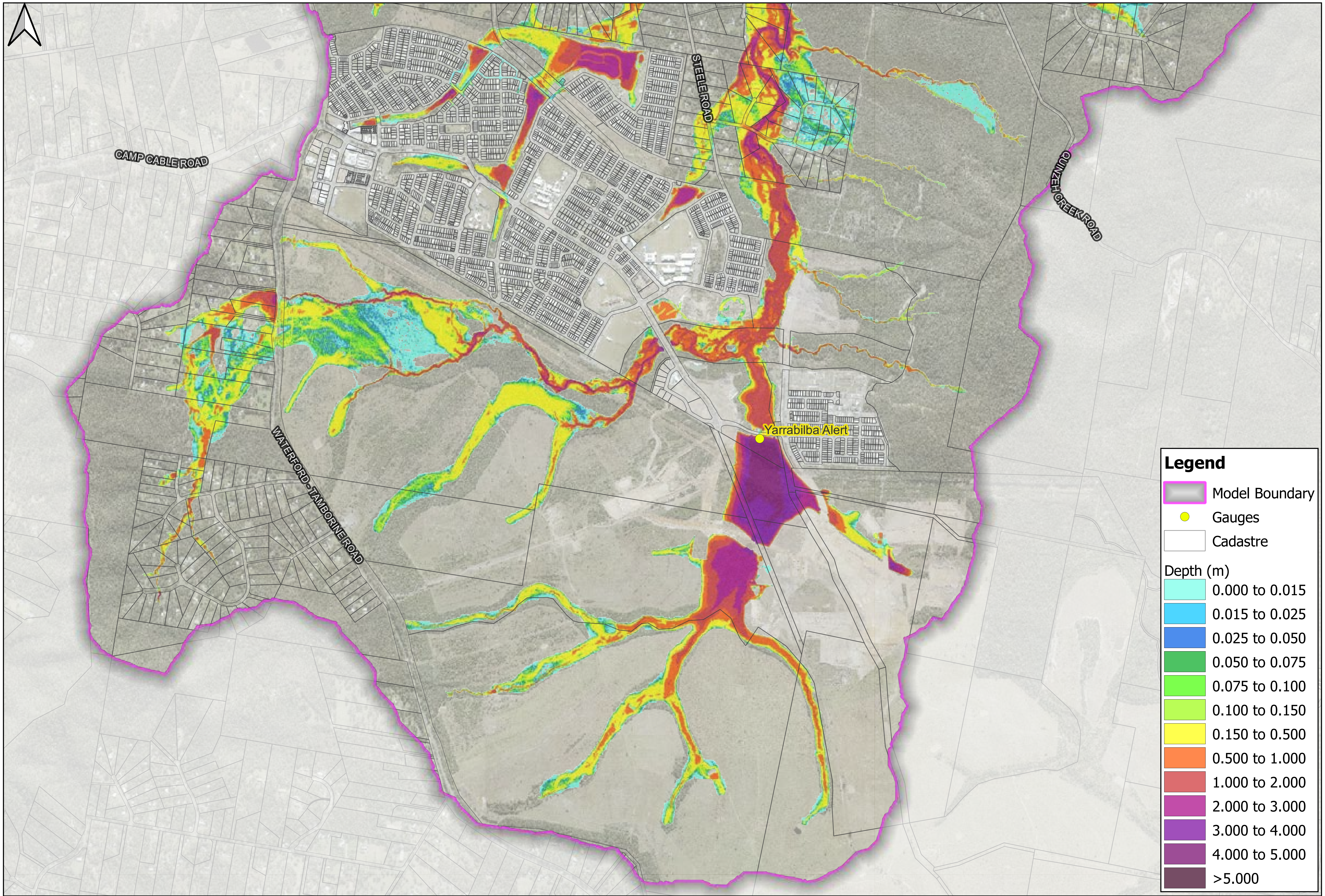
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Depth - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.2% AEP Peak Water Depth - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

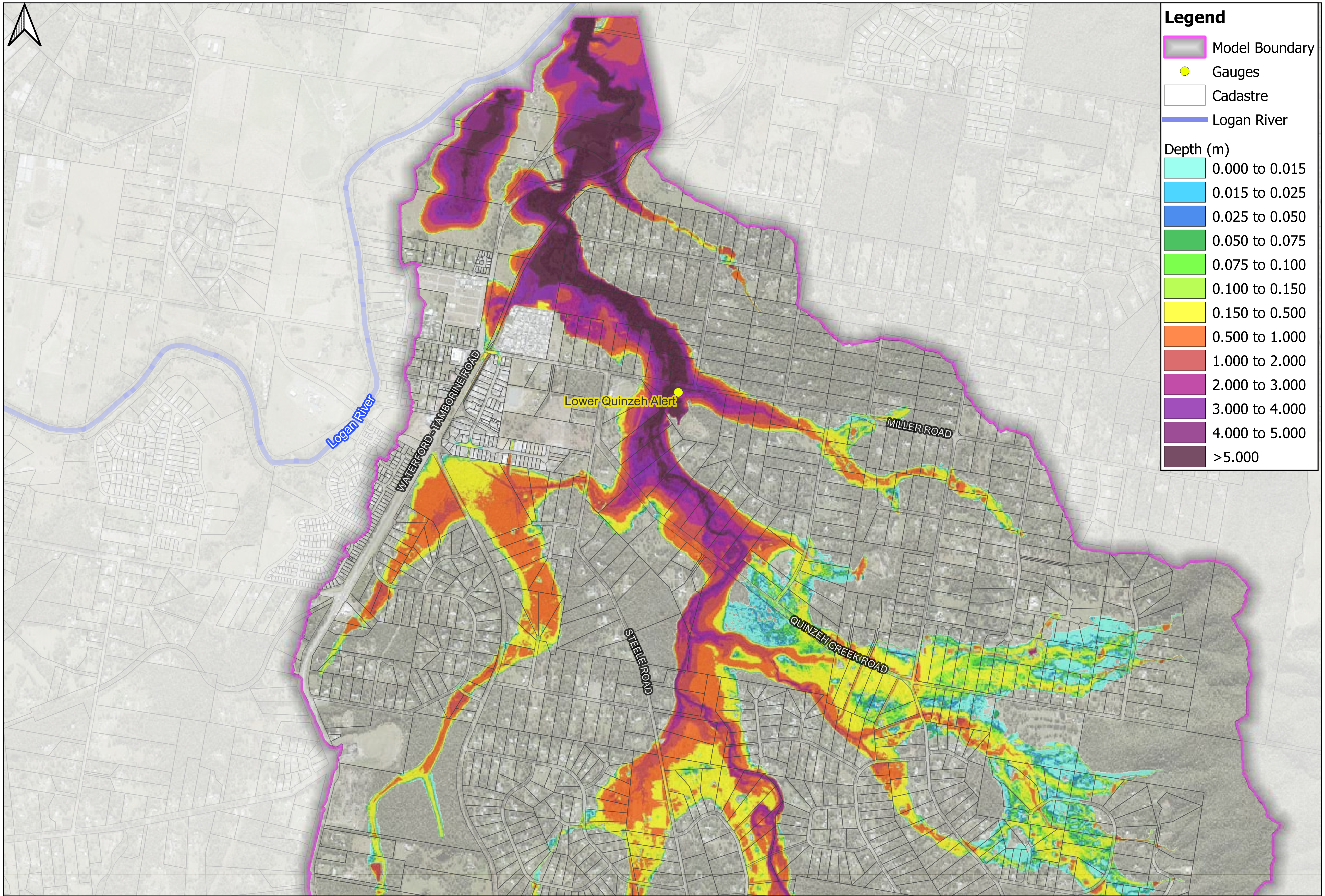
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Depth - Inset 2

WATER TECHNOLOGY



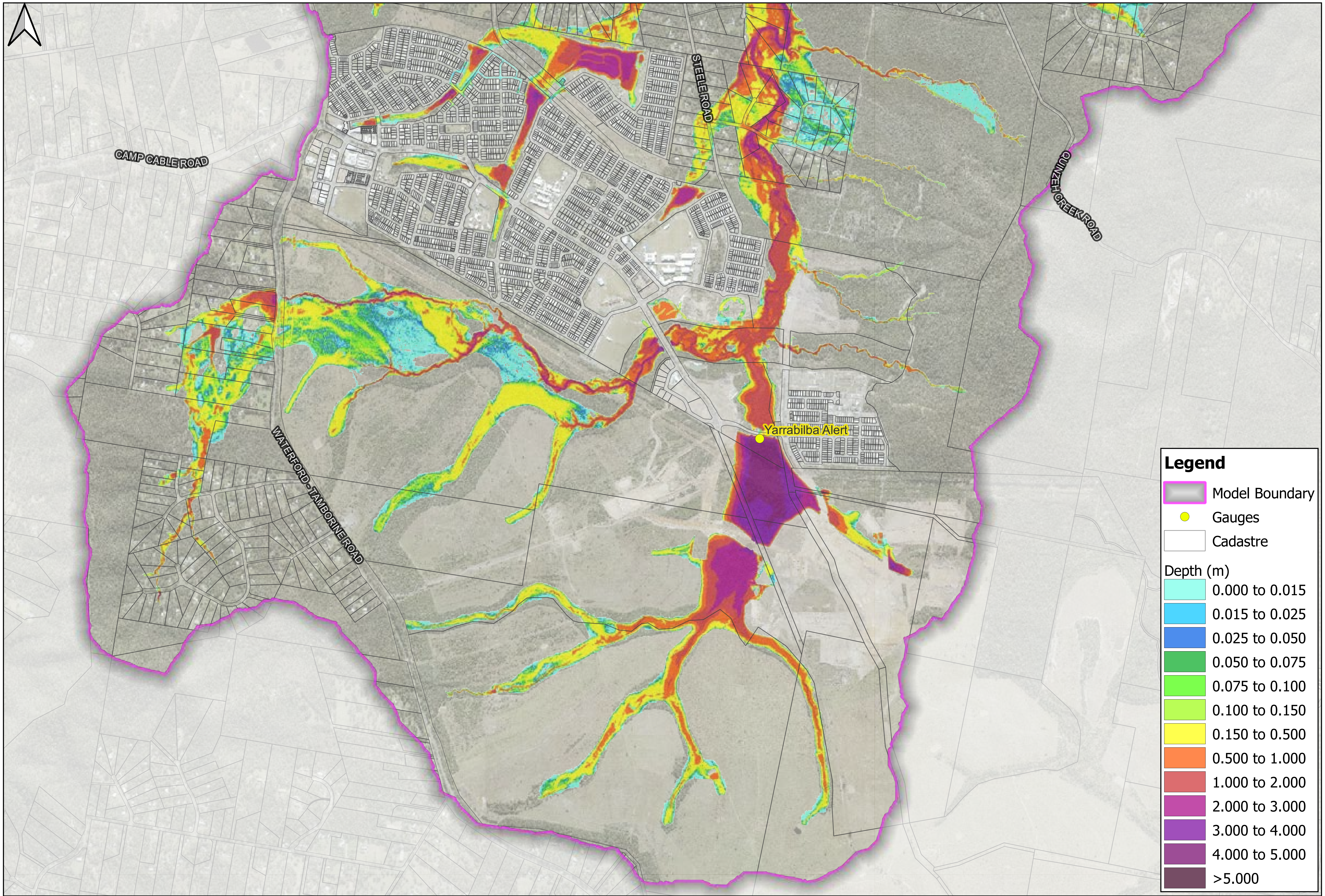
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Depth - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

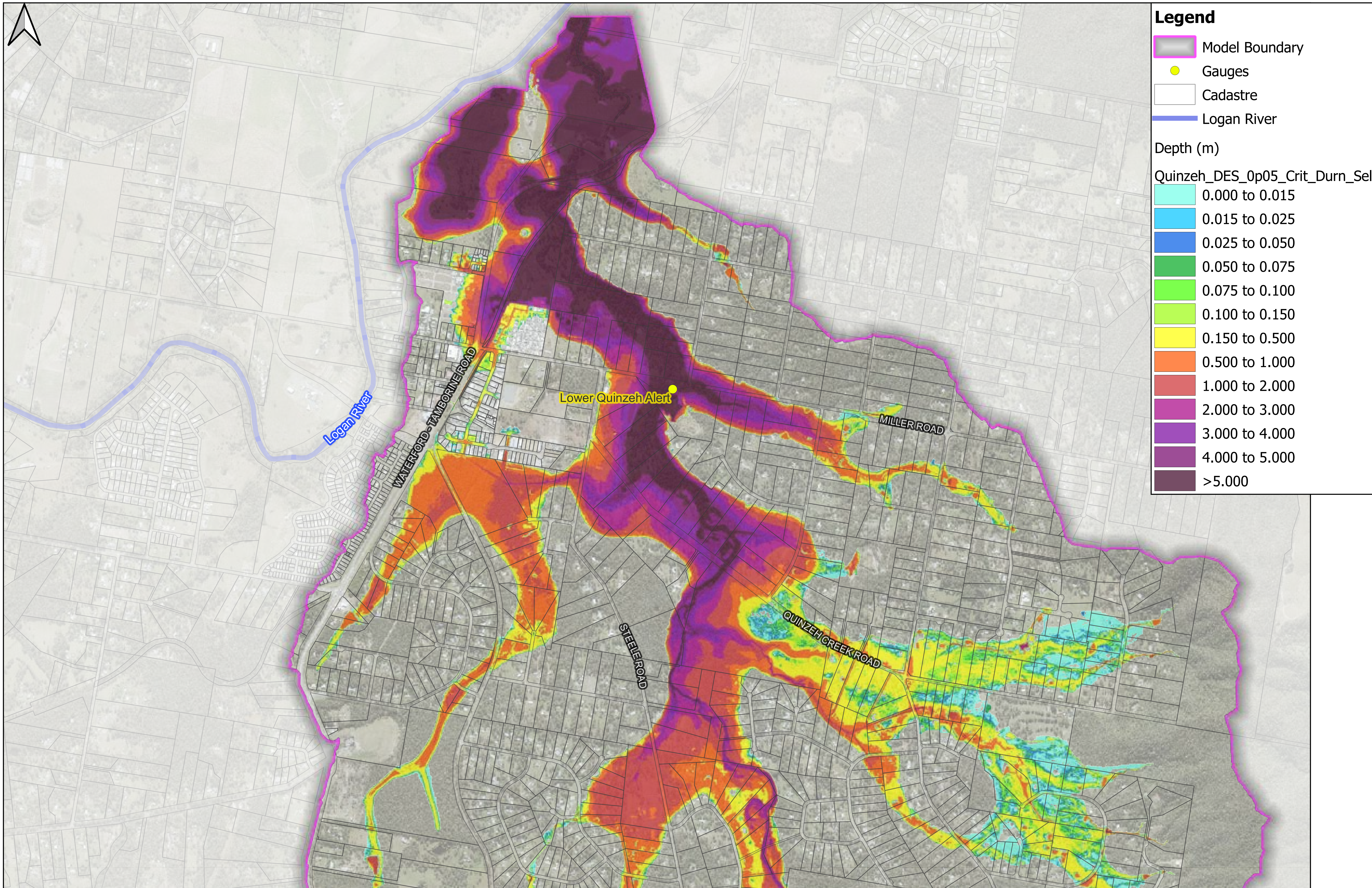
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Depth - Inset 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

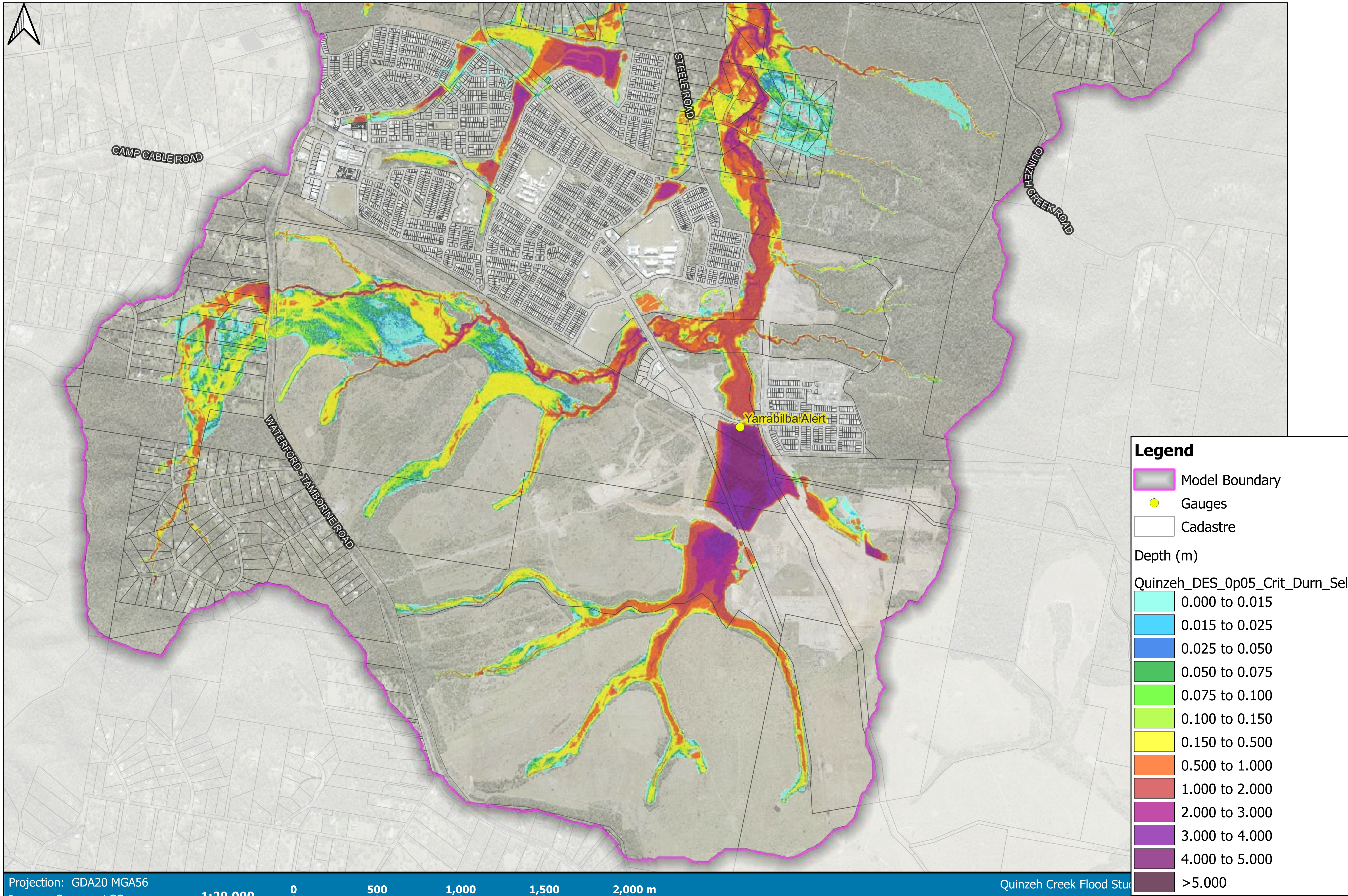
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.05% AEP Peak Water Depth - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

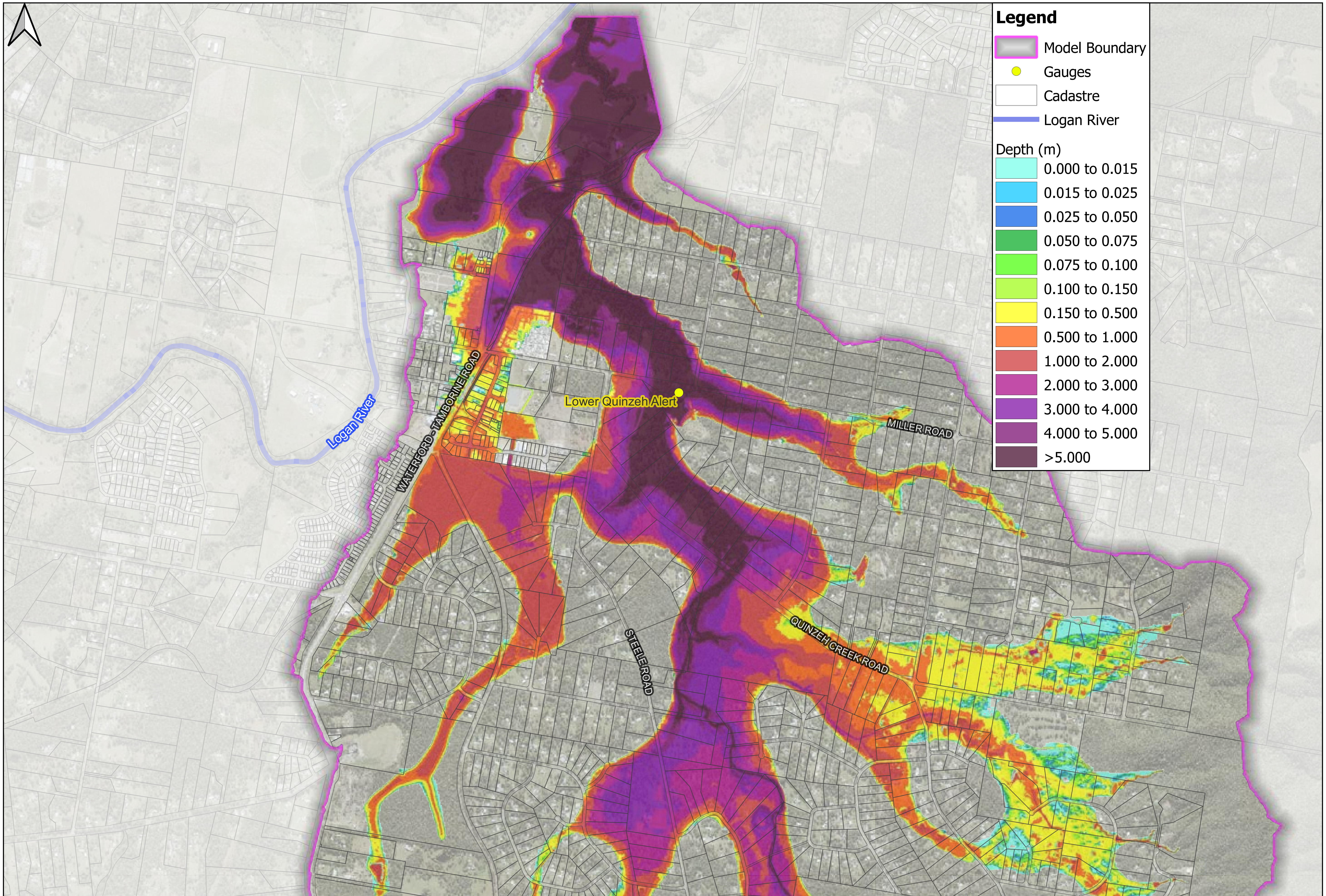


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Stu

Quinzeh Creek - 0.05% AEP Peak Water Depth - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

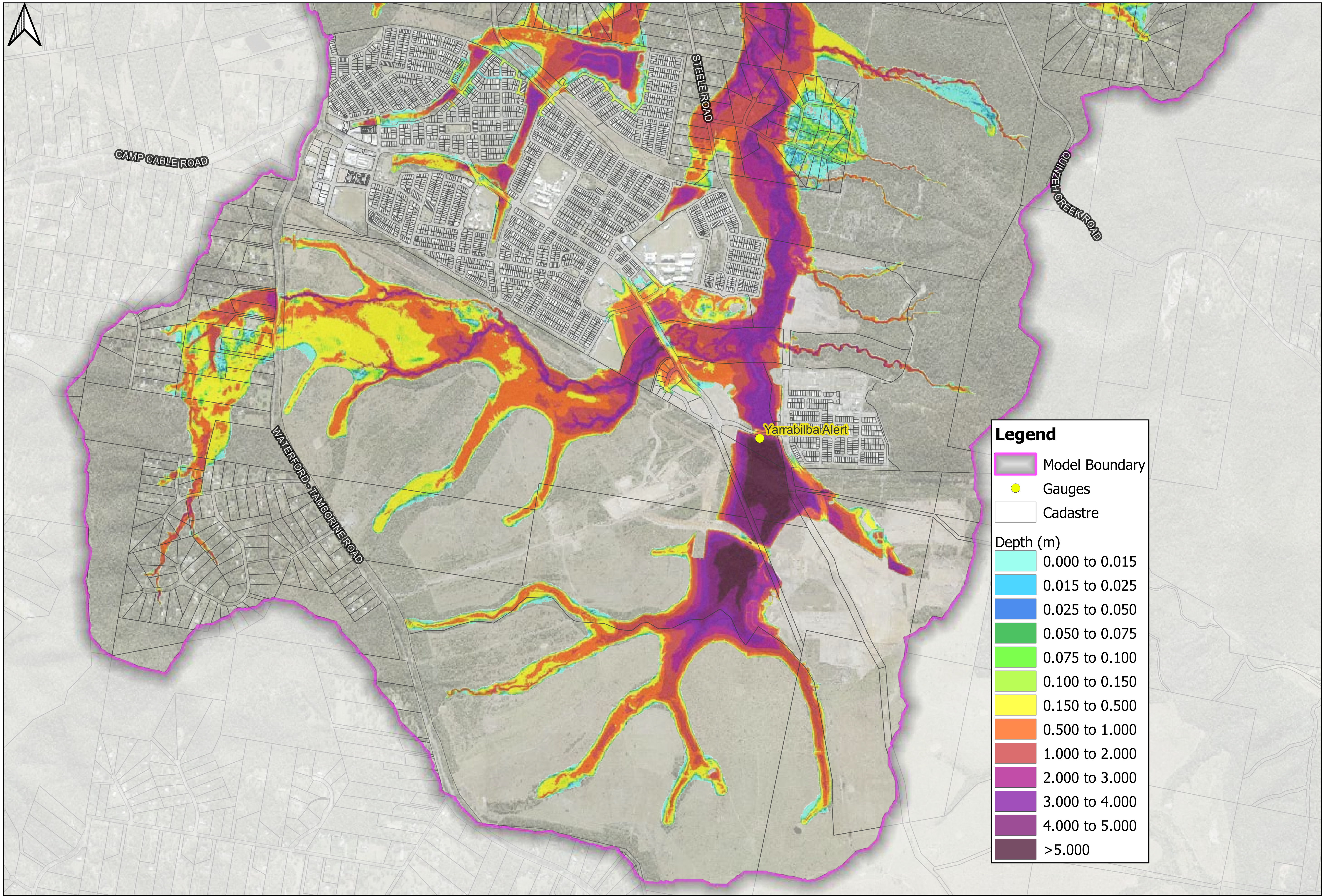
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Depth - Inset 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

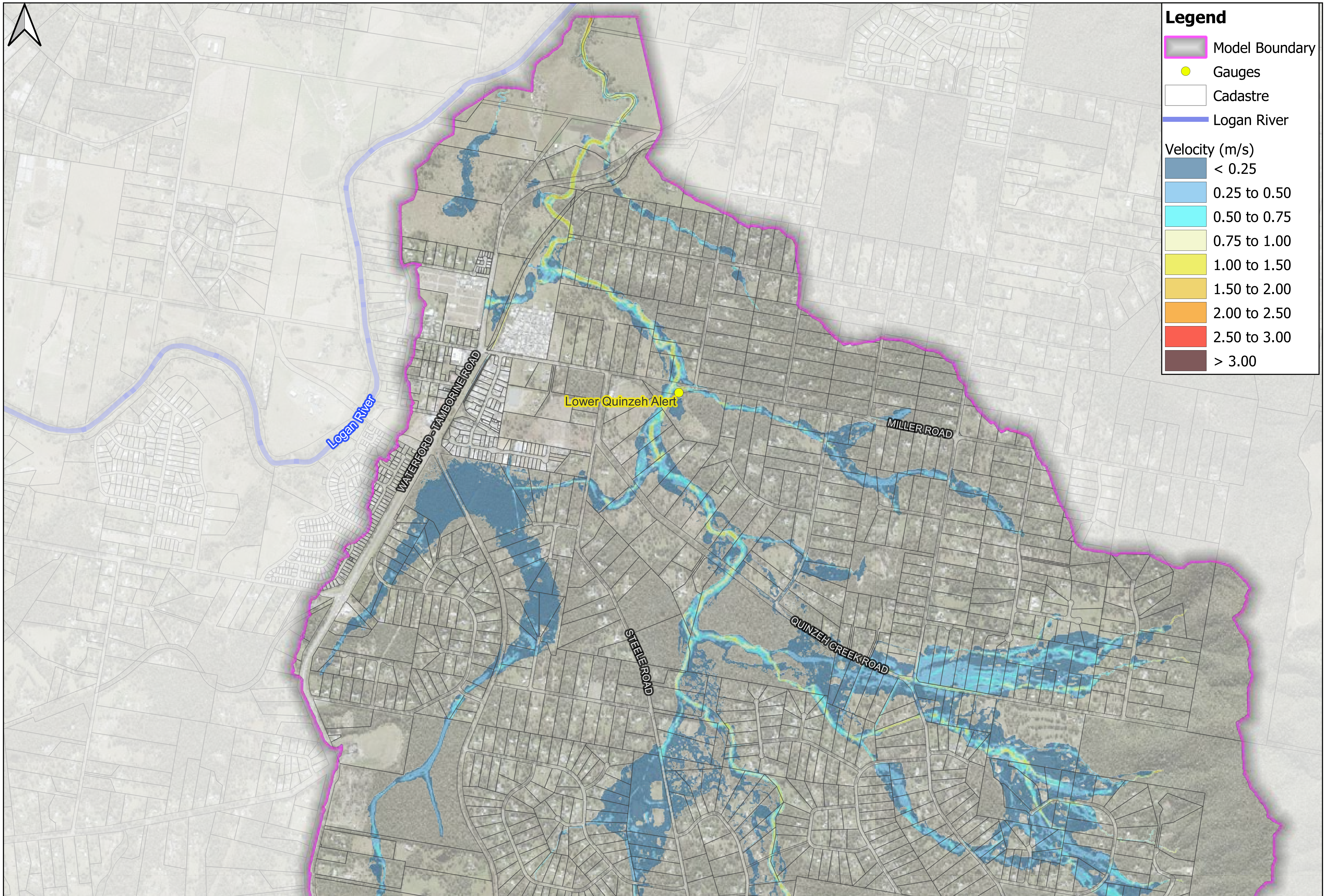
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Depth - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Velocity - Inset 1

WATER TECHNOLOGY

Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

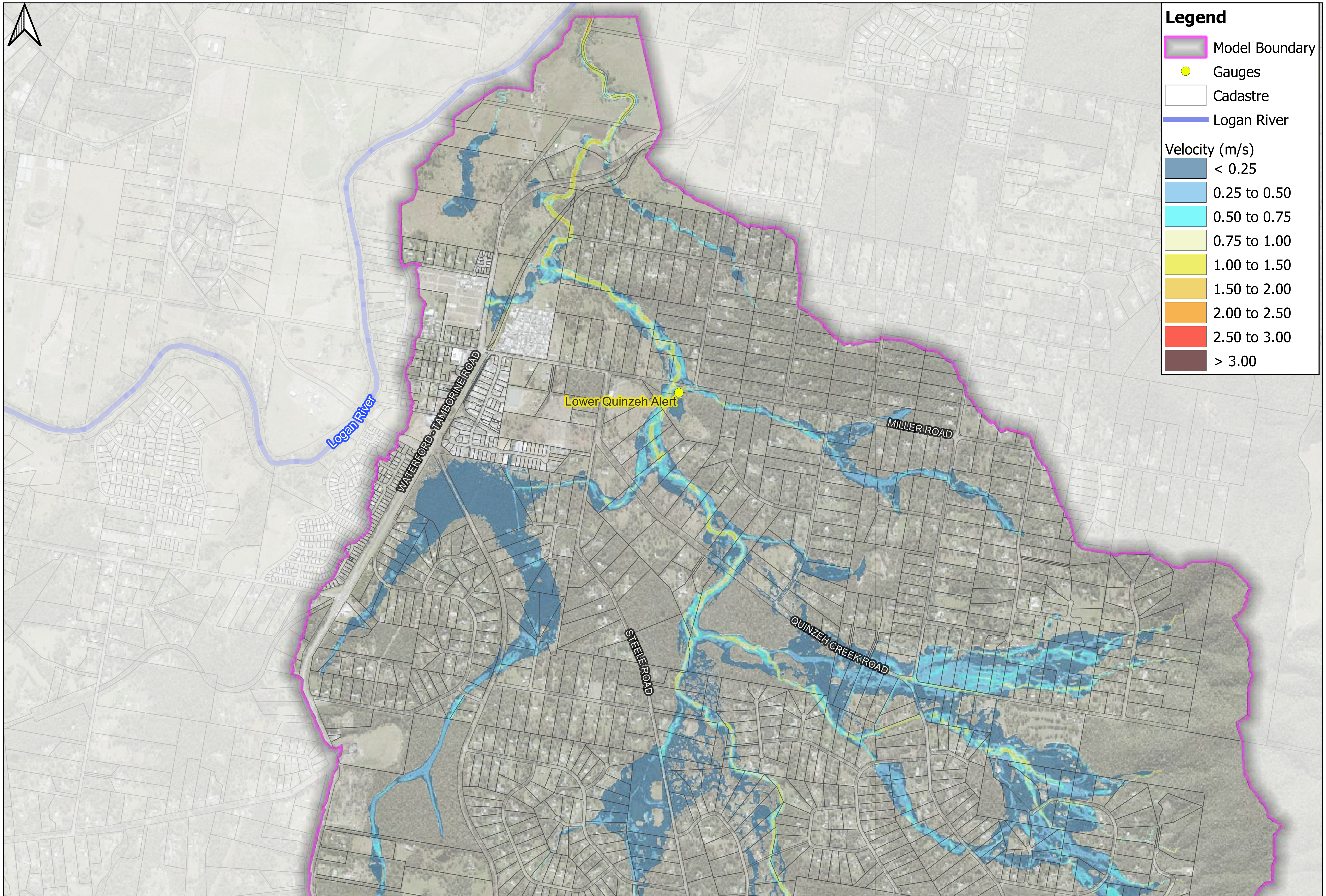
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

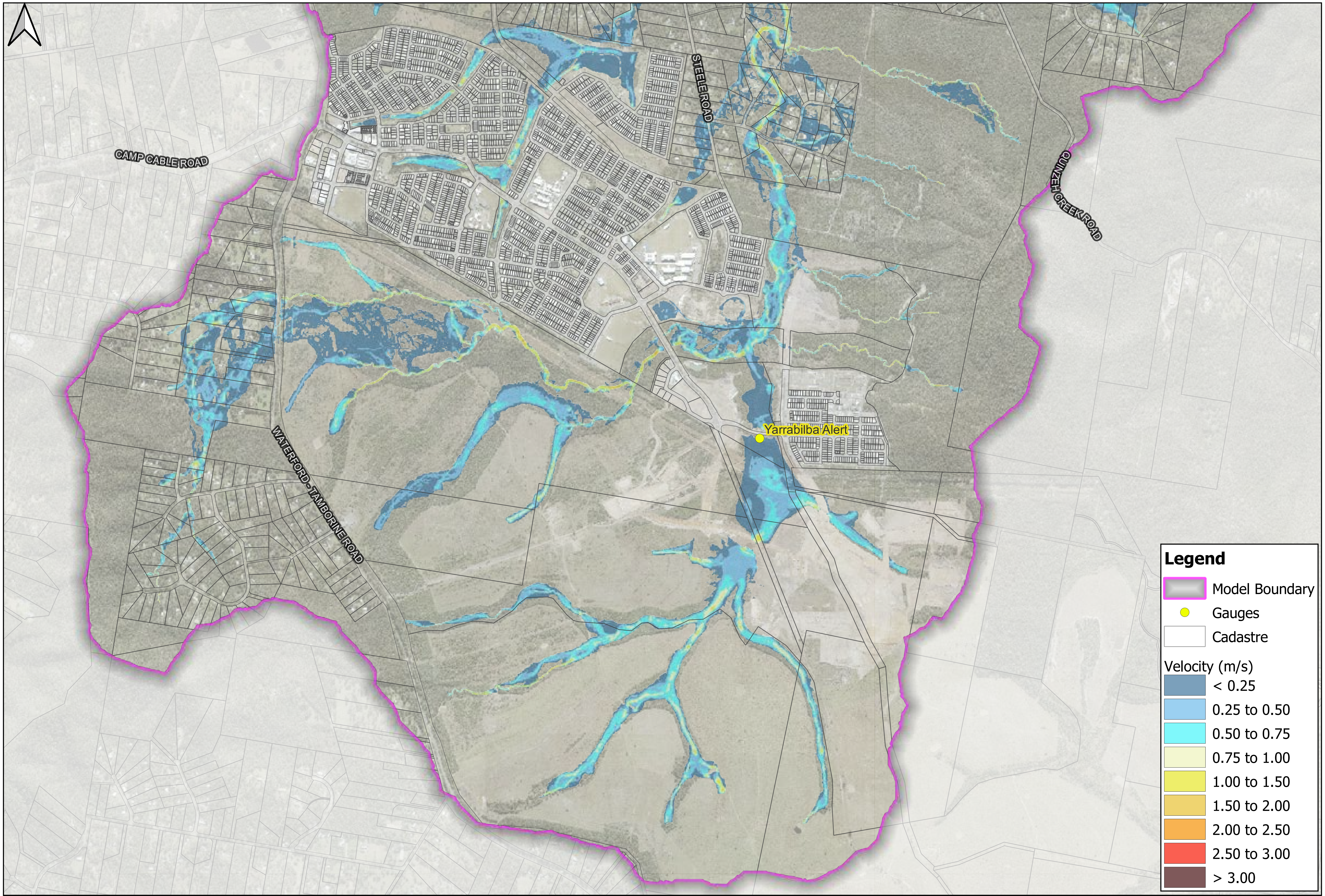
Quinzeh Creek - 63.2% AEP Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

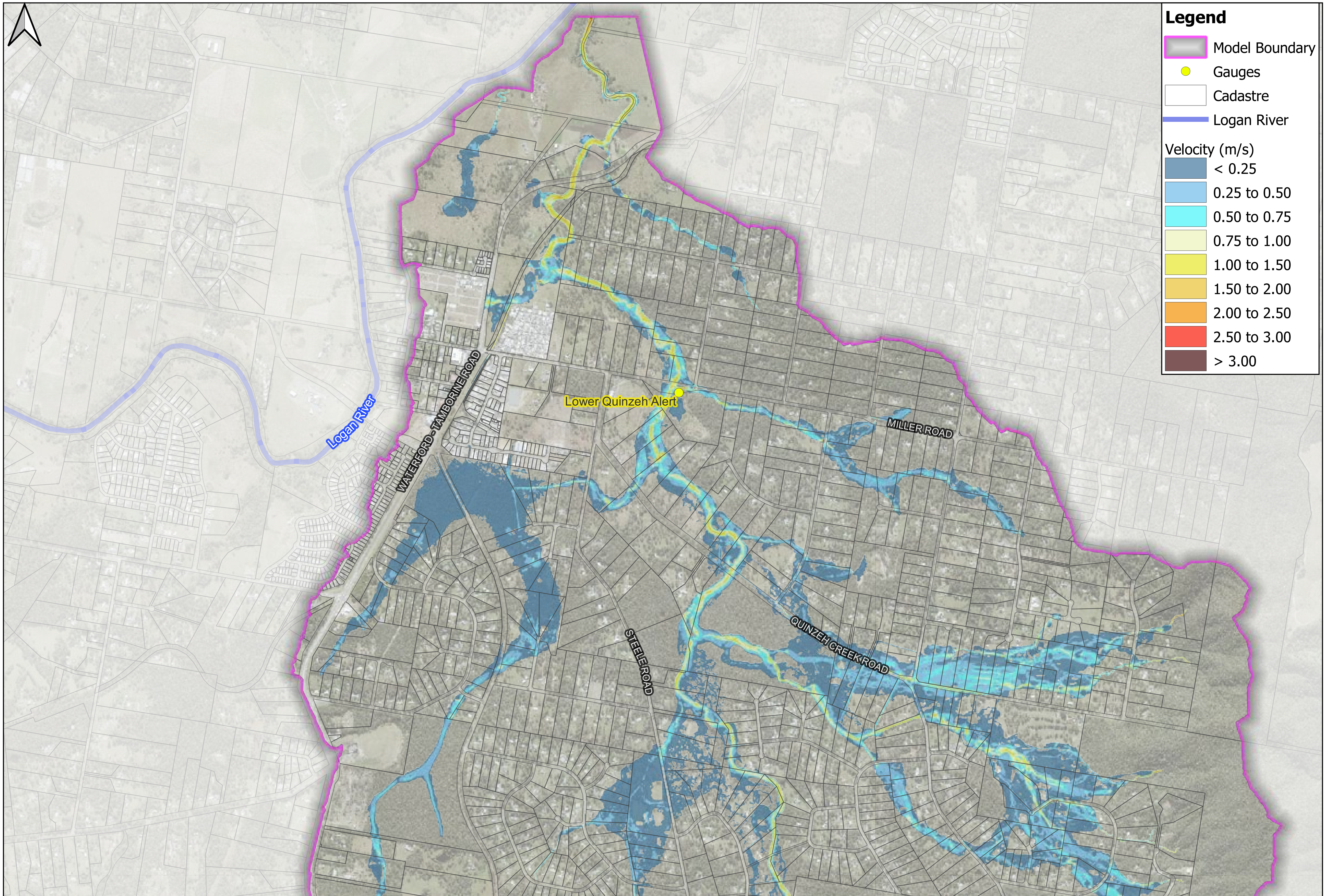
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 50% AEP Peak Water Velocity - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 50% AEP Peak Water Velocity - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

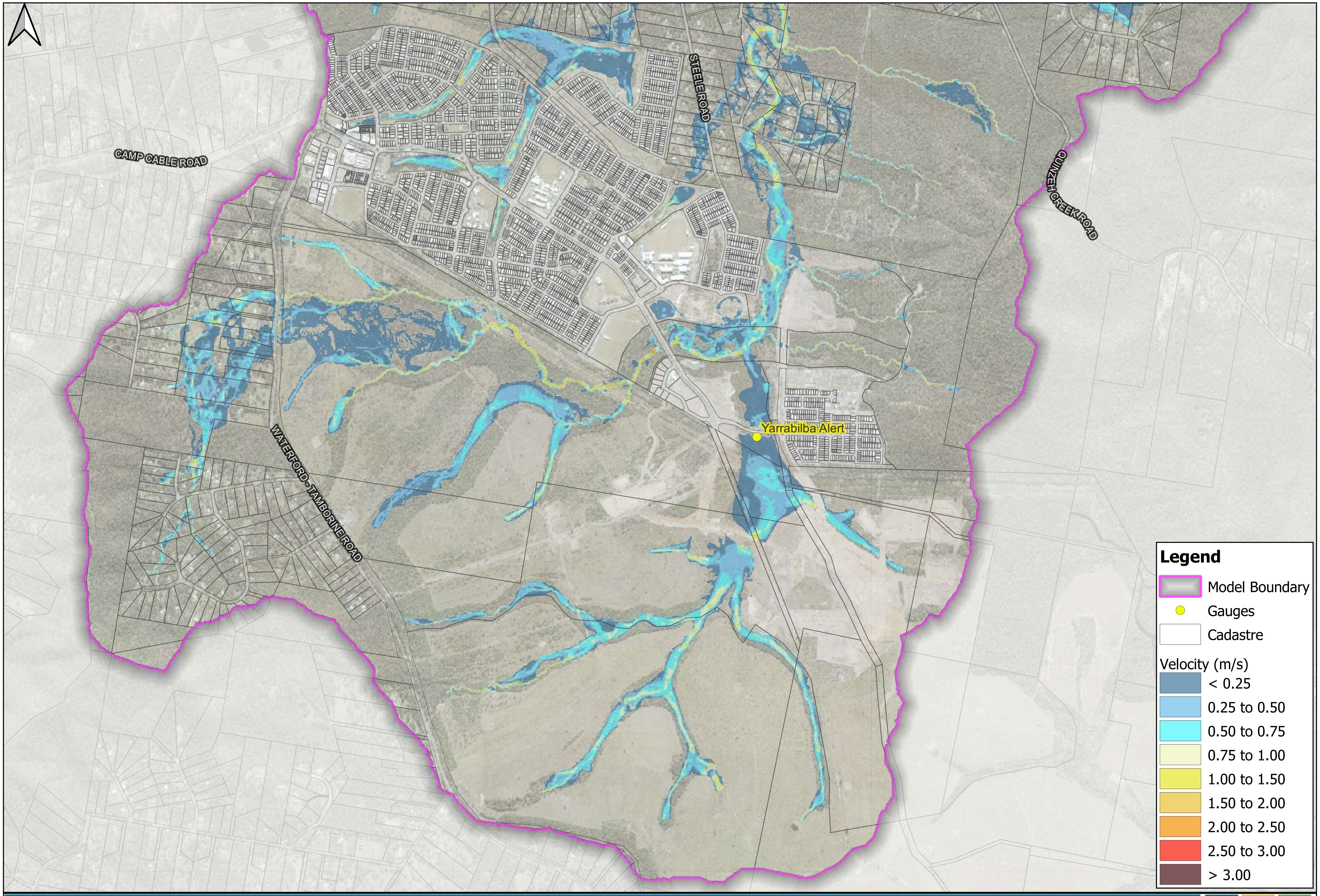
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Velocity - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

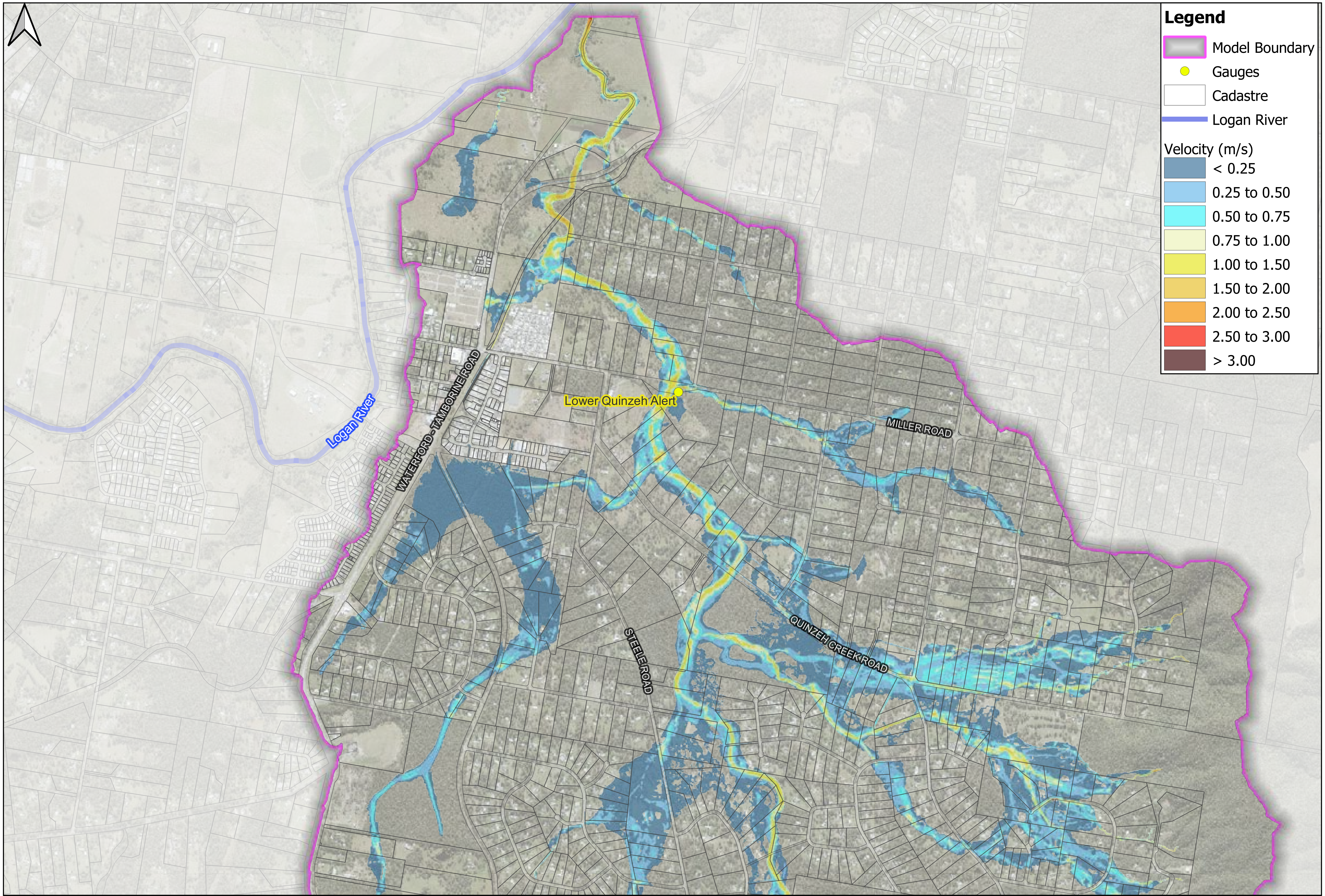
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



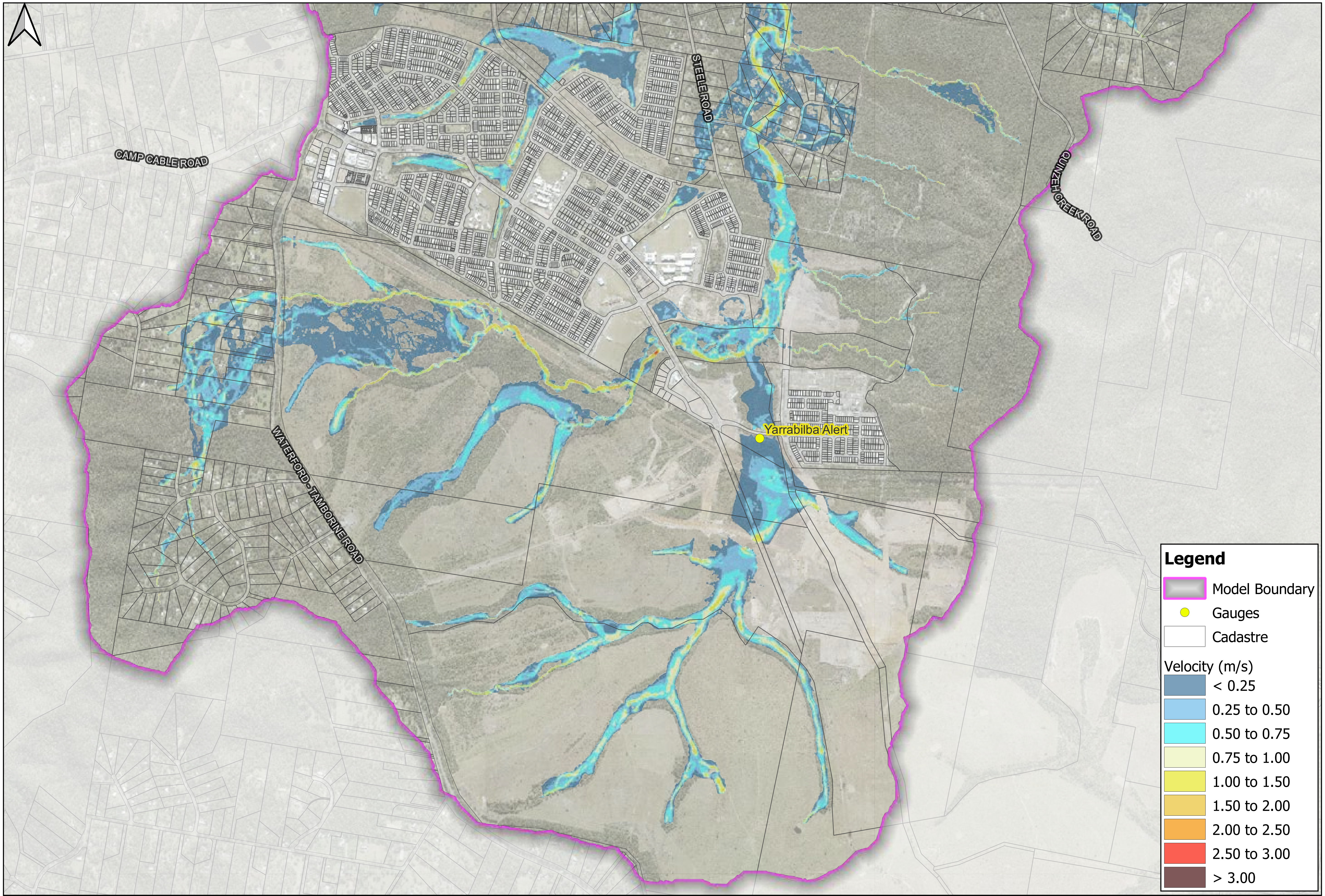
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Velocity - Inset 1

WATER TECHNOLOGY

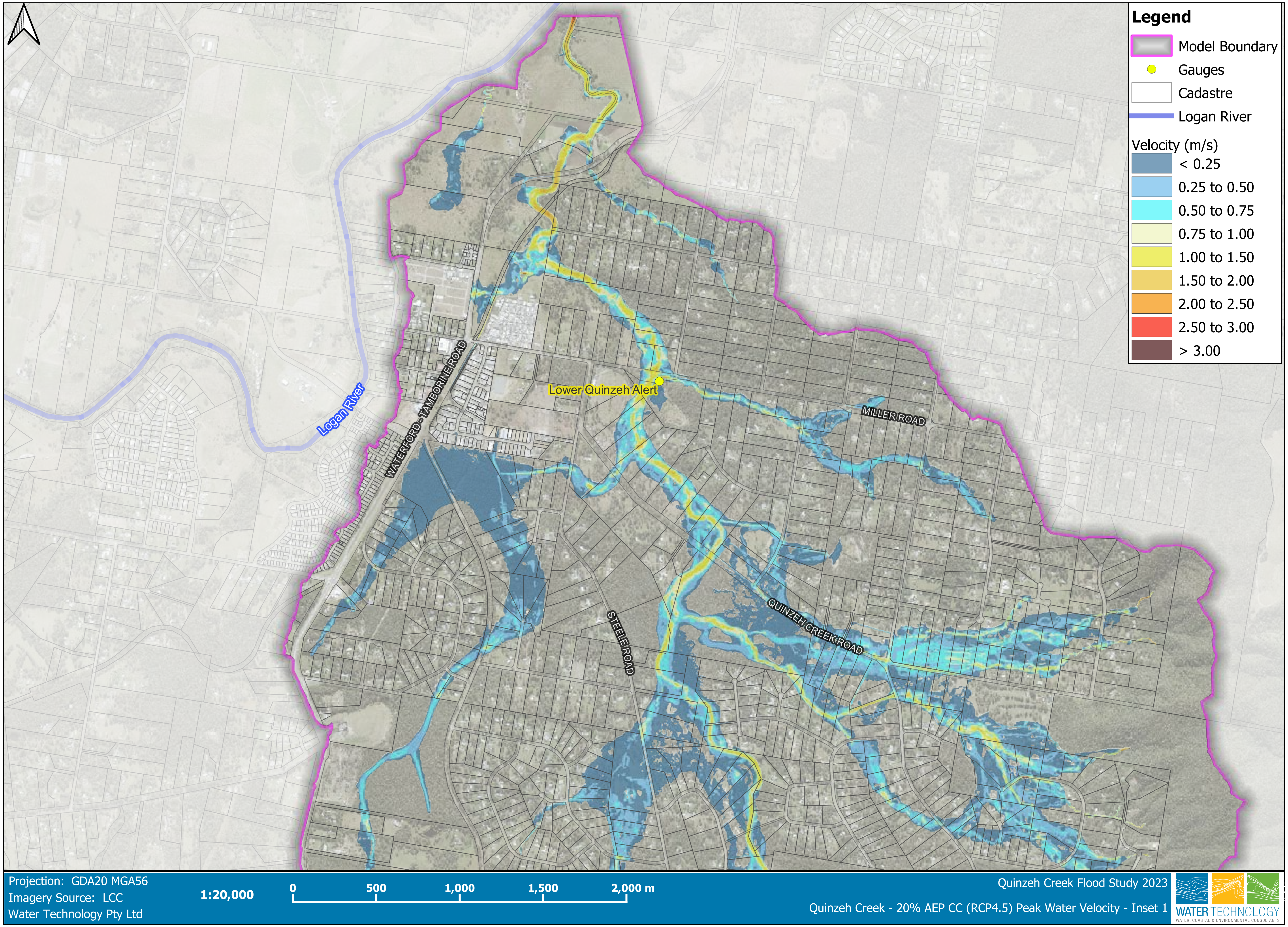


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

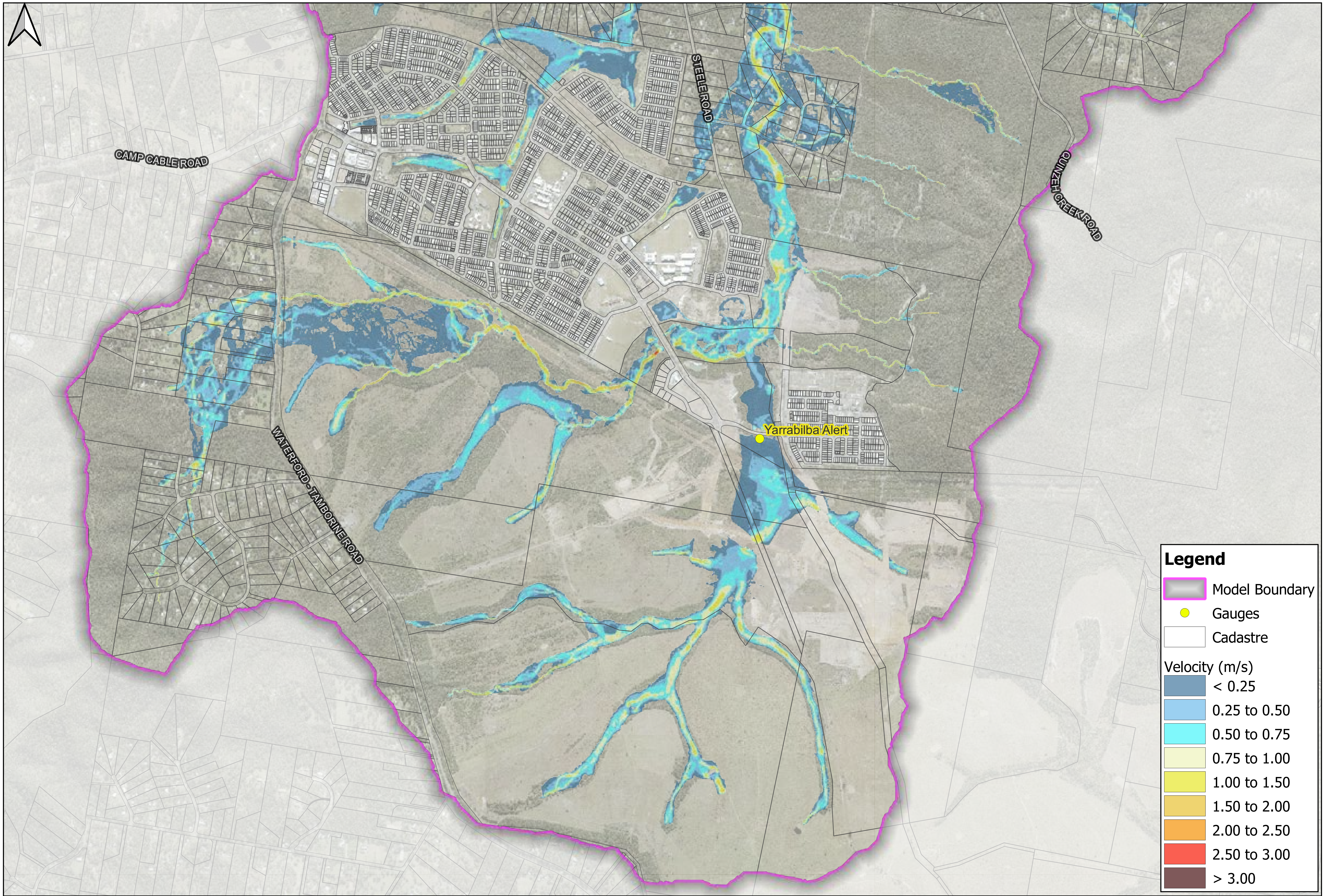
1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Velocity - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Logan River
Lower Quinzeh Alert
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Velocity - Inset 1
WATER TECHNOLOGY



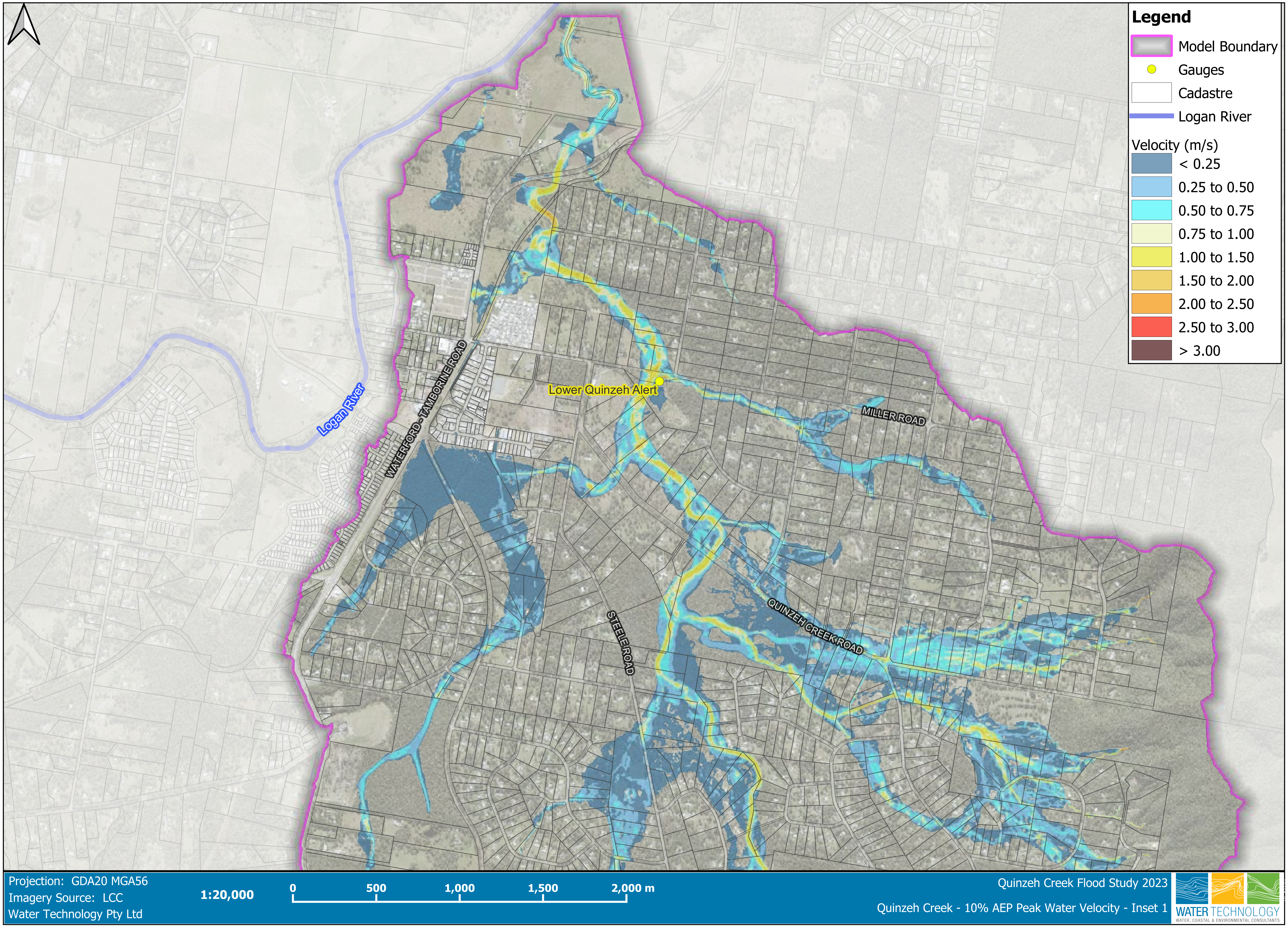
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

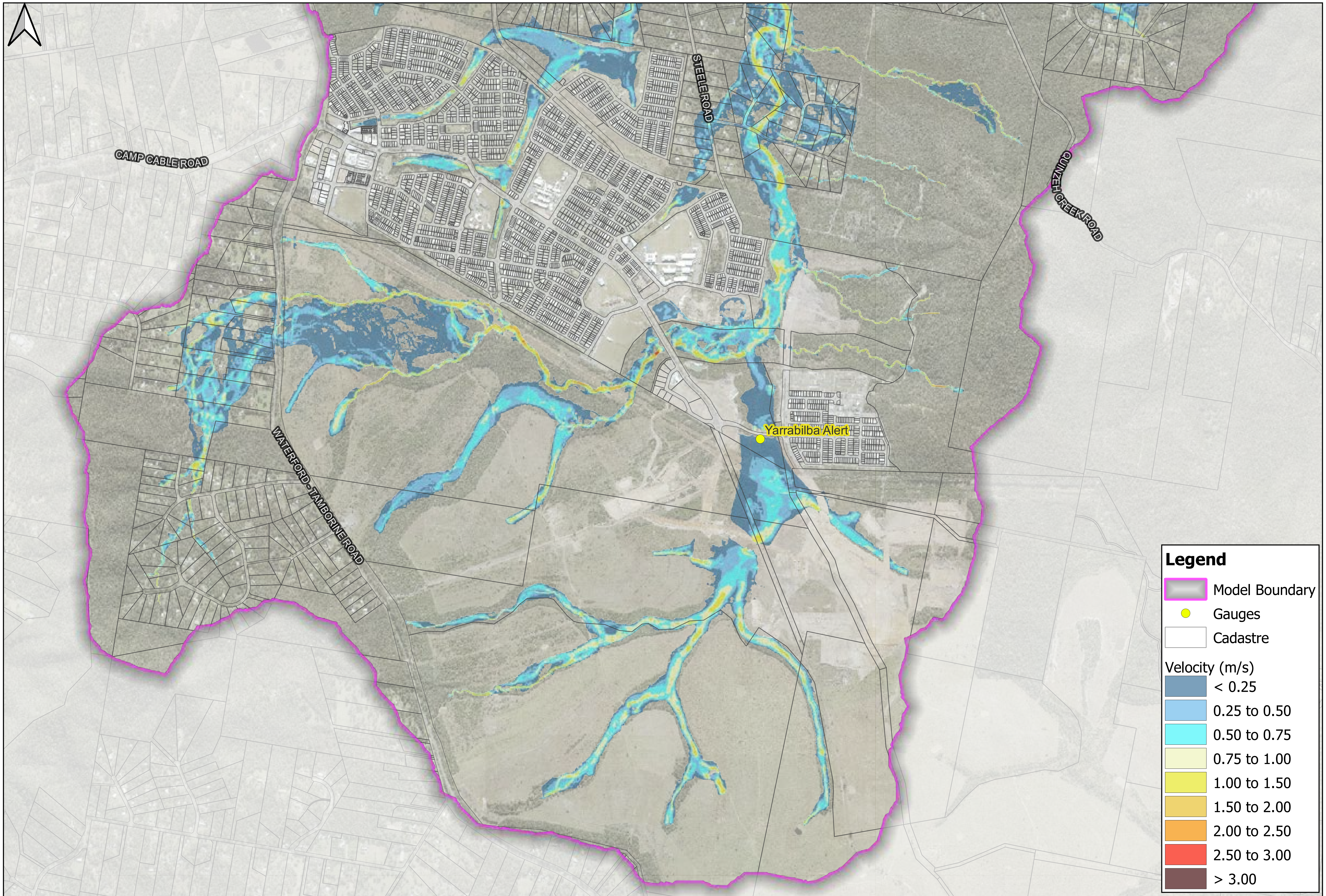
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Velocity - Inset 2


Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP Peak Water Velocity - Inset 1
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



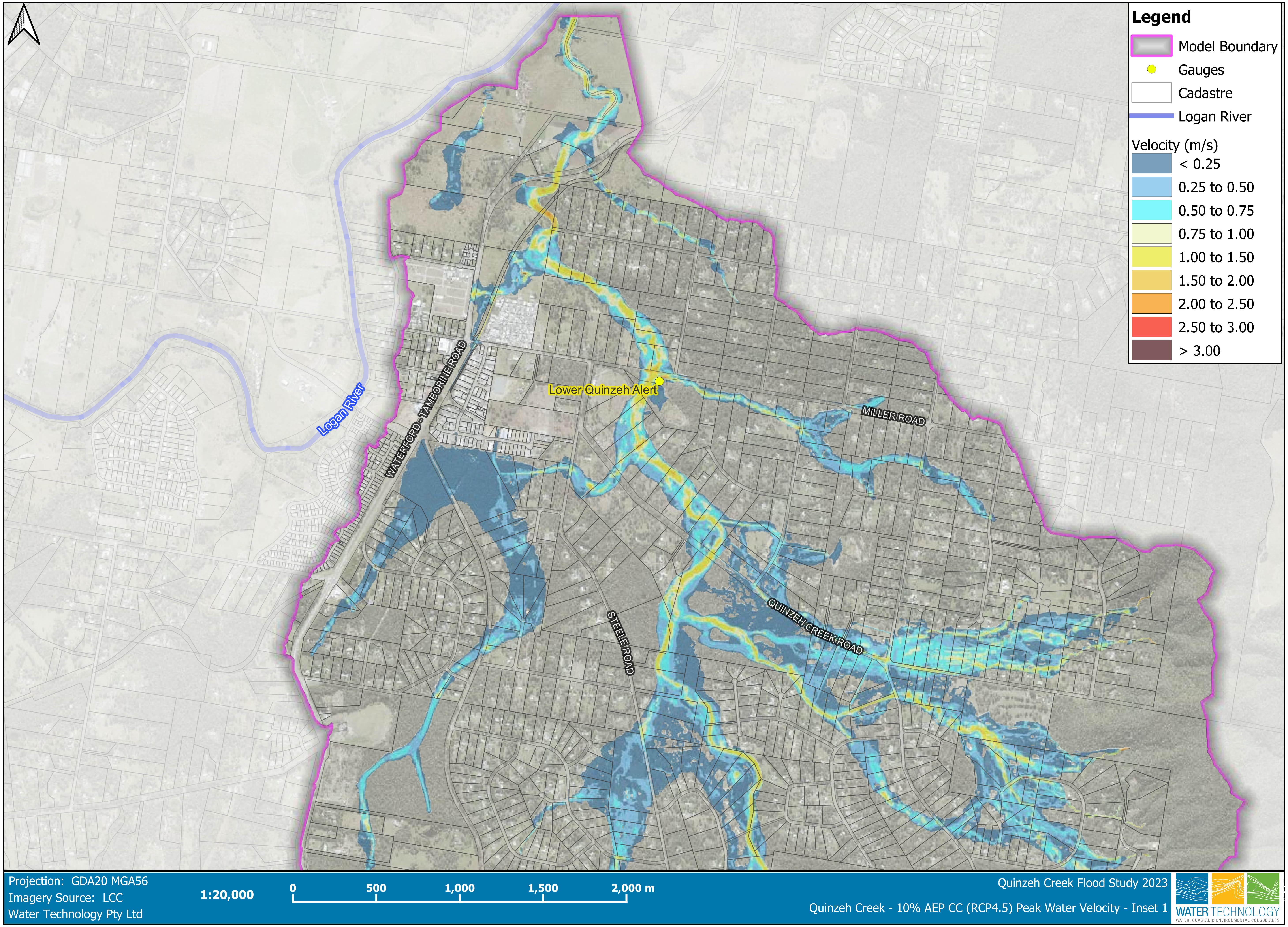
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

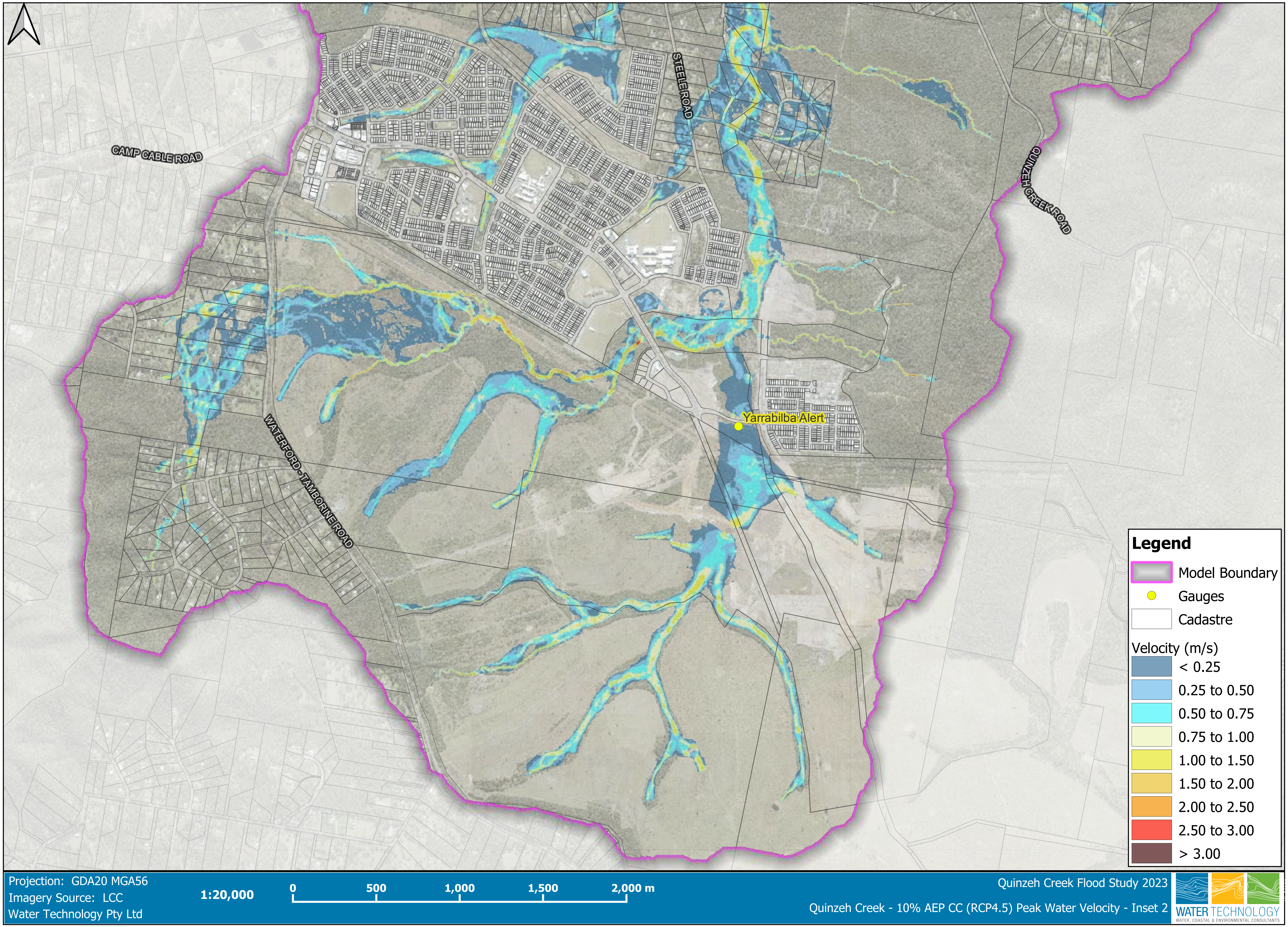
0 500 1,000 1,500 2,000 m

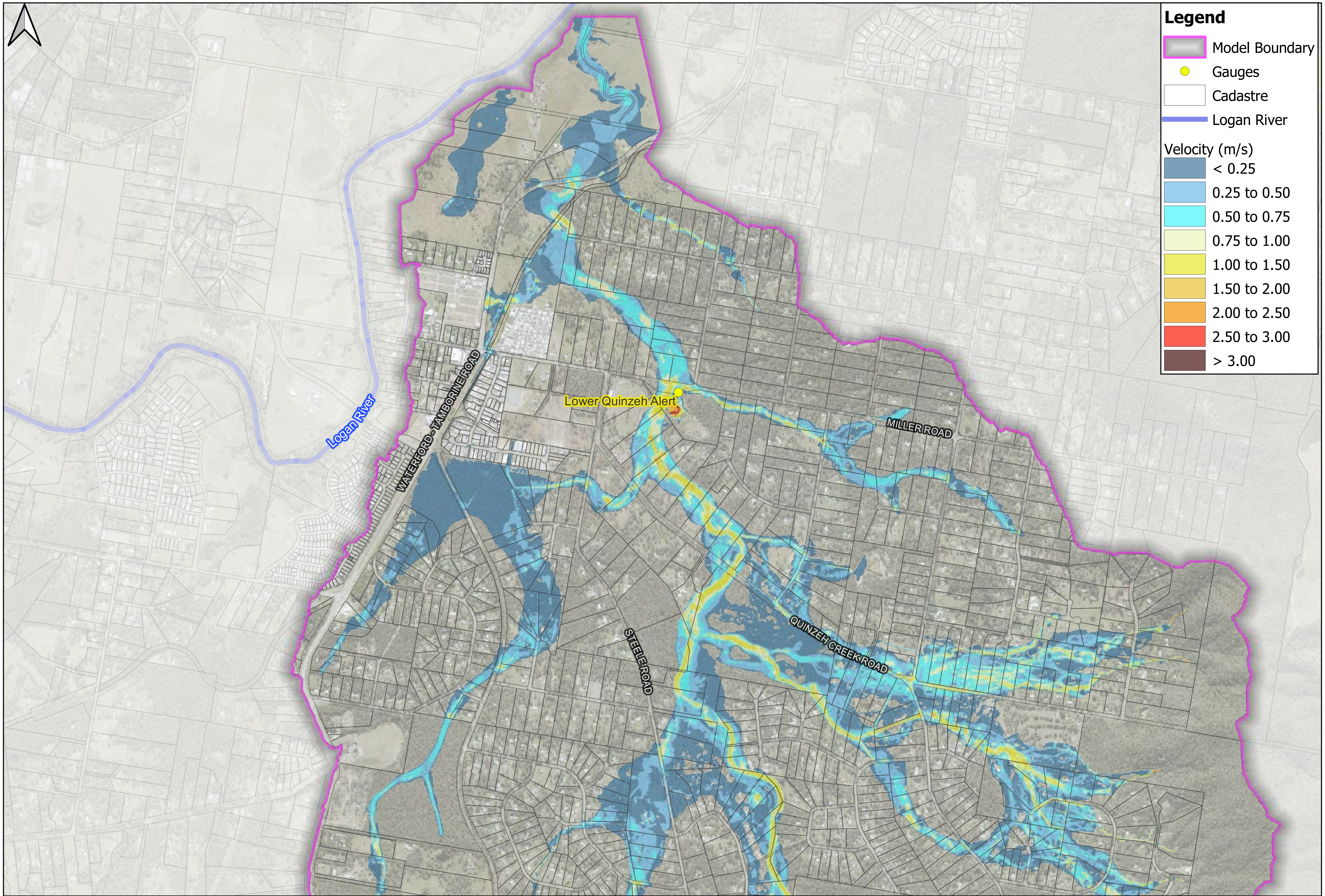
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Peak Water Velocity - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Velocity - Inset 1
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Velocity - Inset 2
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

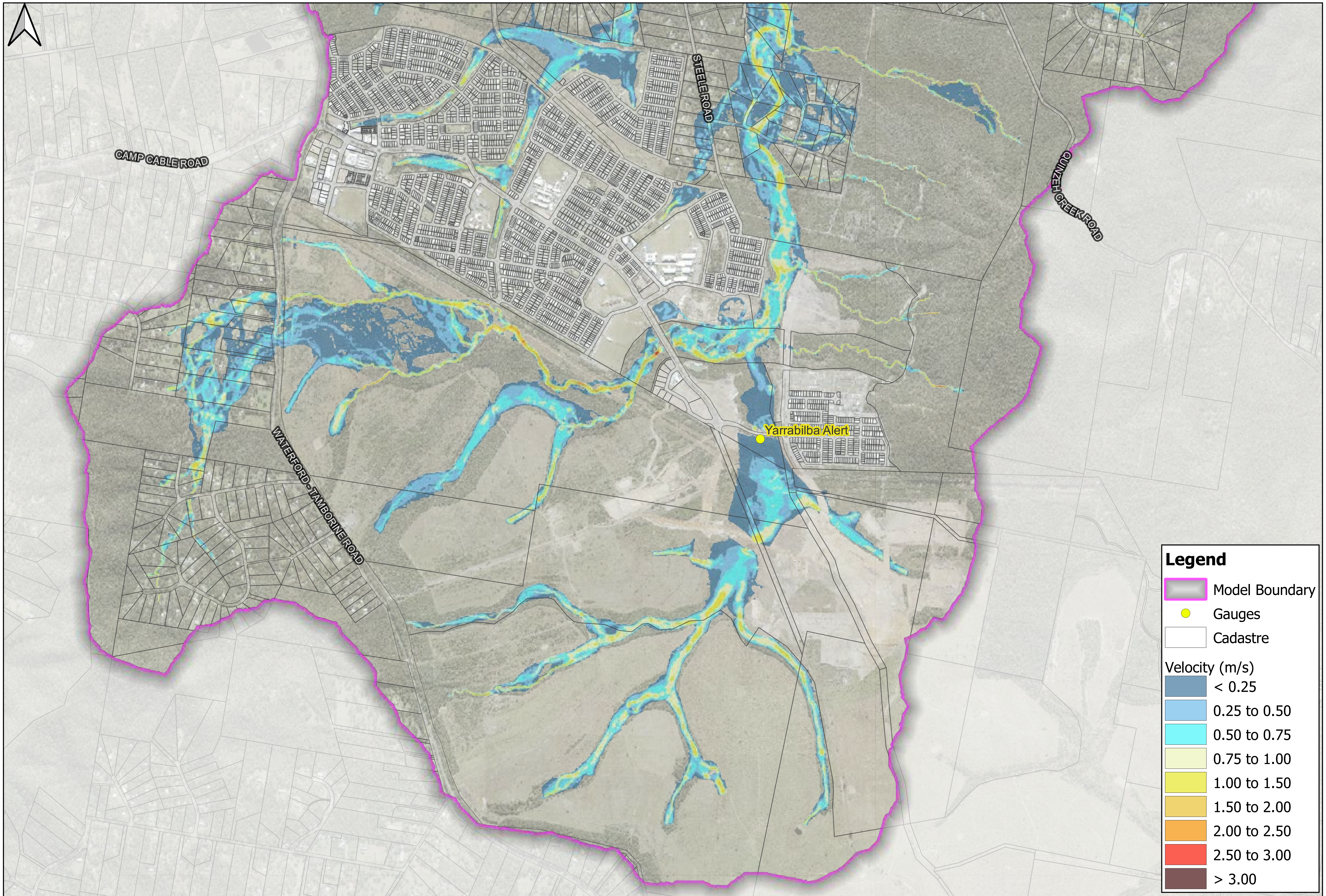
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP Peak Water Velocity - Inset 1

WATER TECHNOLOGY



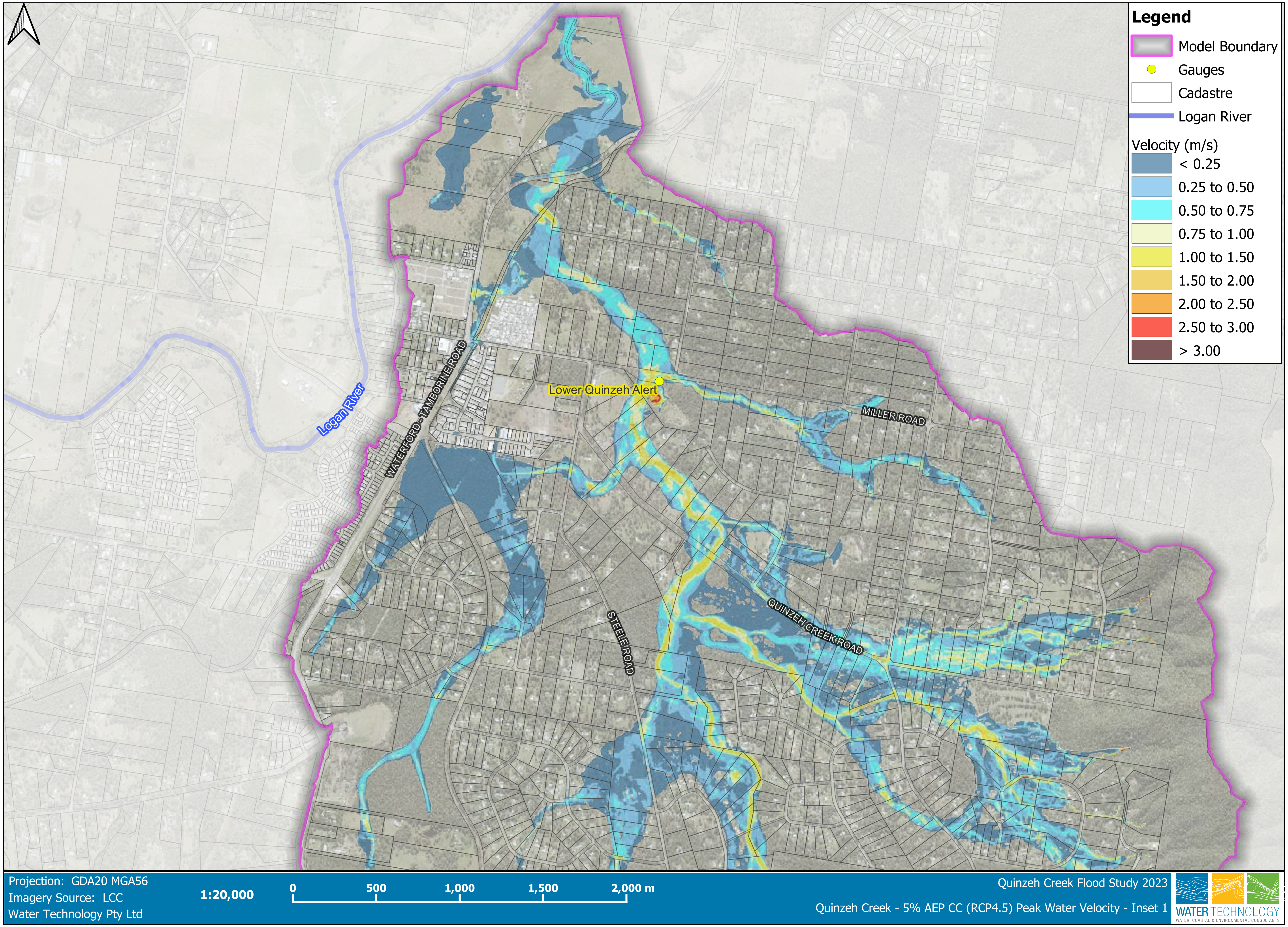
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

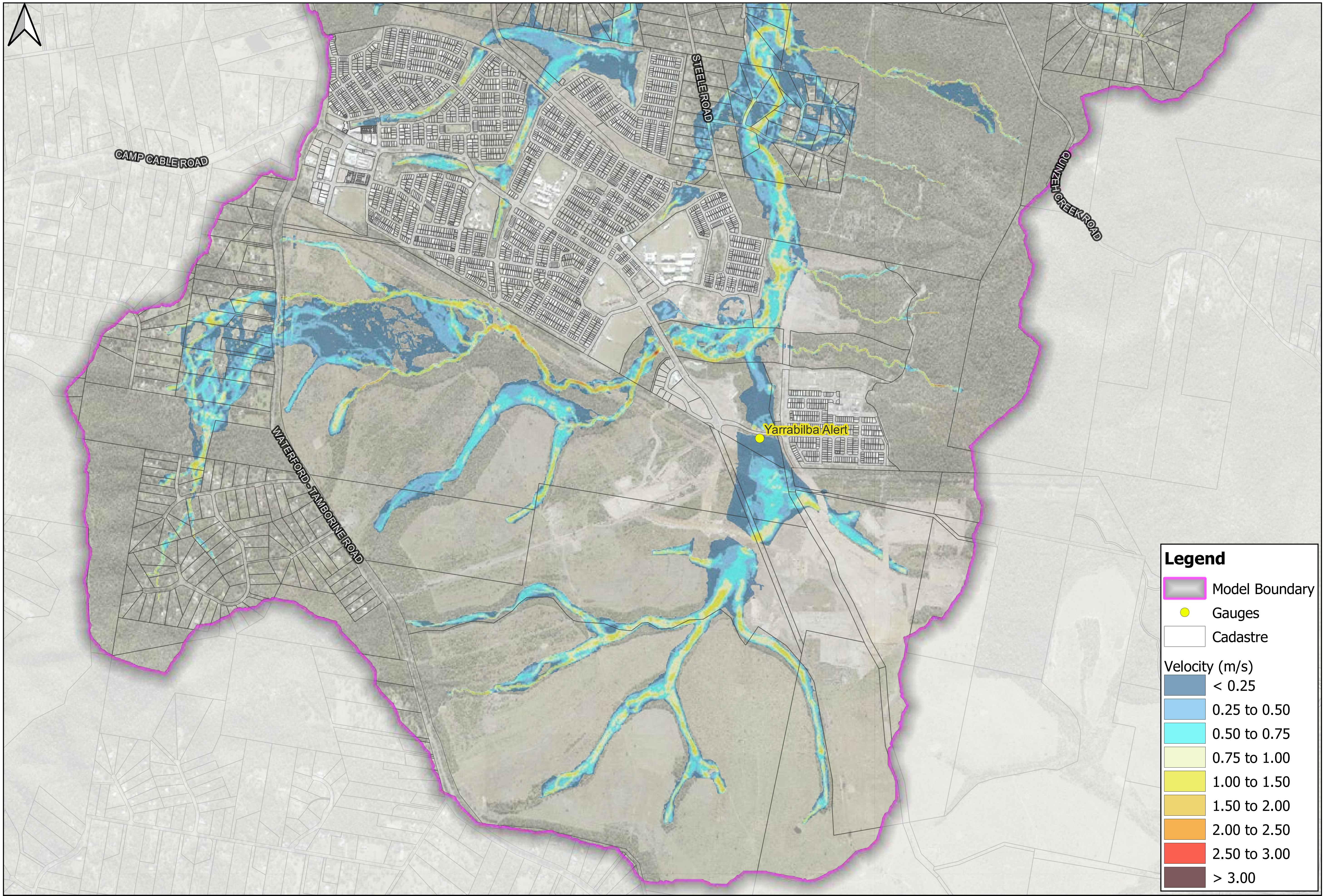
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP Peak Water Velocity - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Velocity - Inset 1
WATER TECHNOLOGY

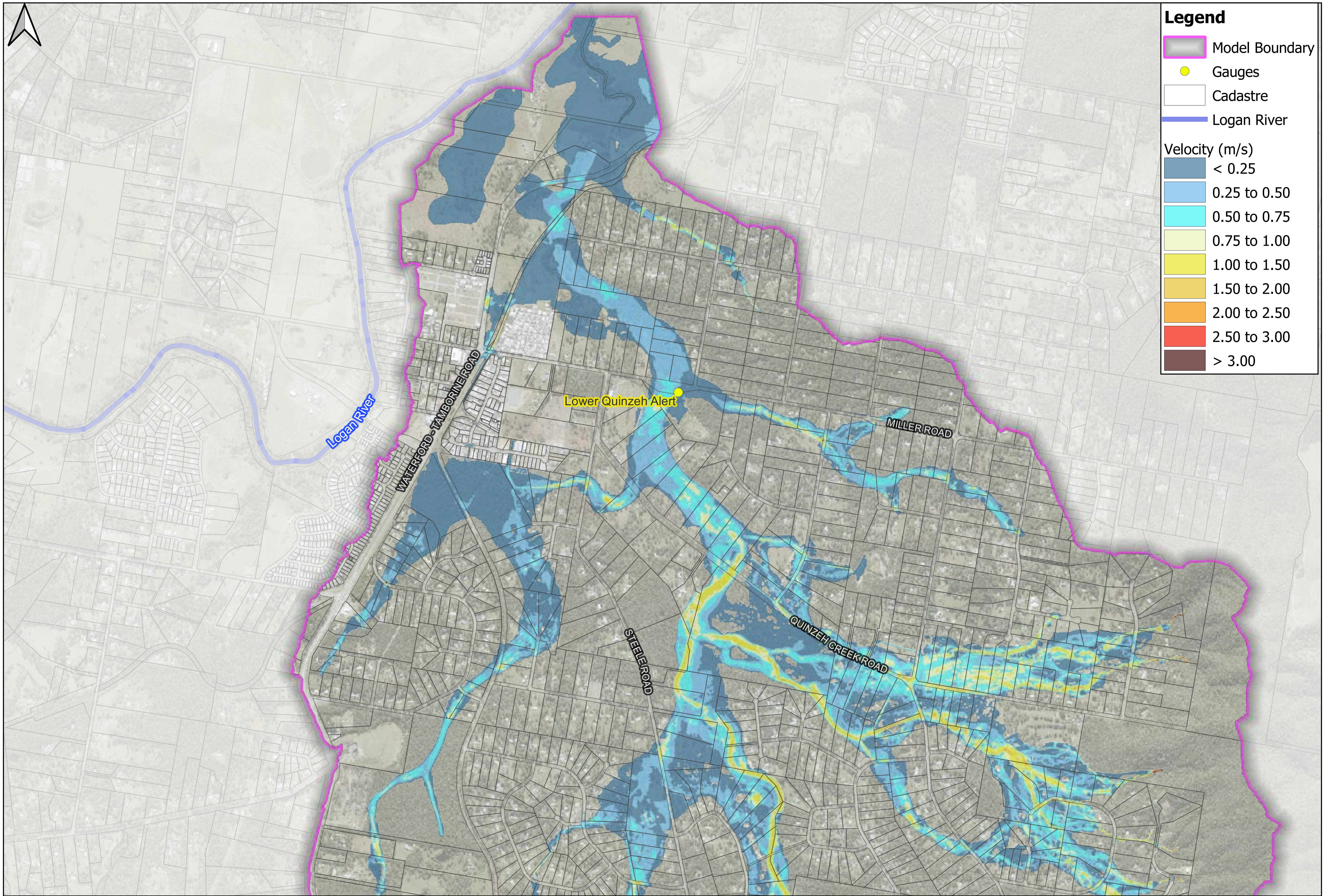


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Velocity - Inset 2



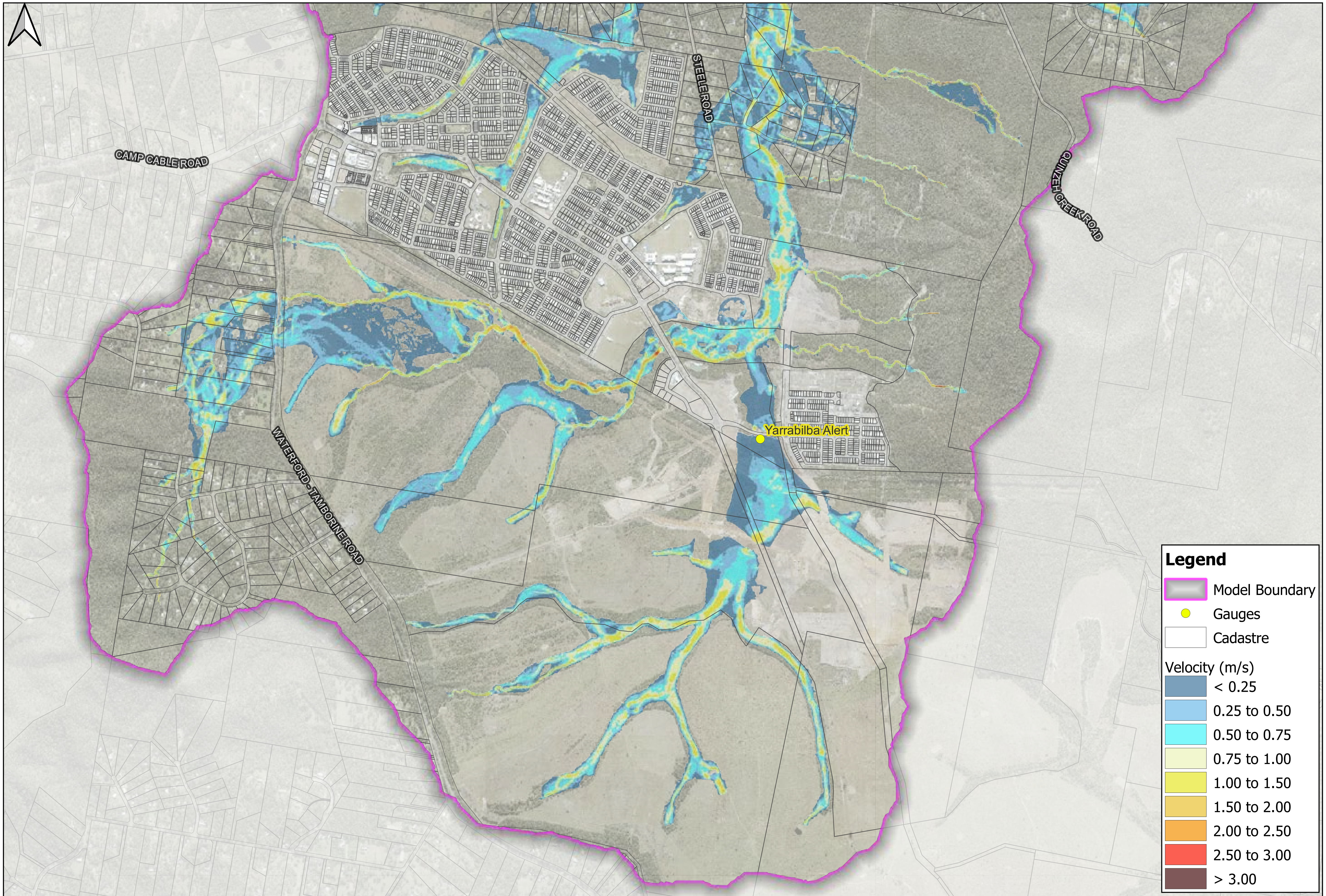
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Velocity - Inset 1

WATER TECHNOLOGY



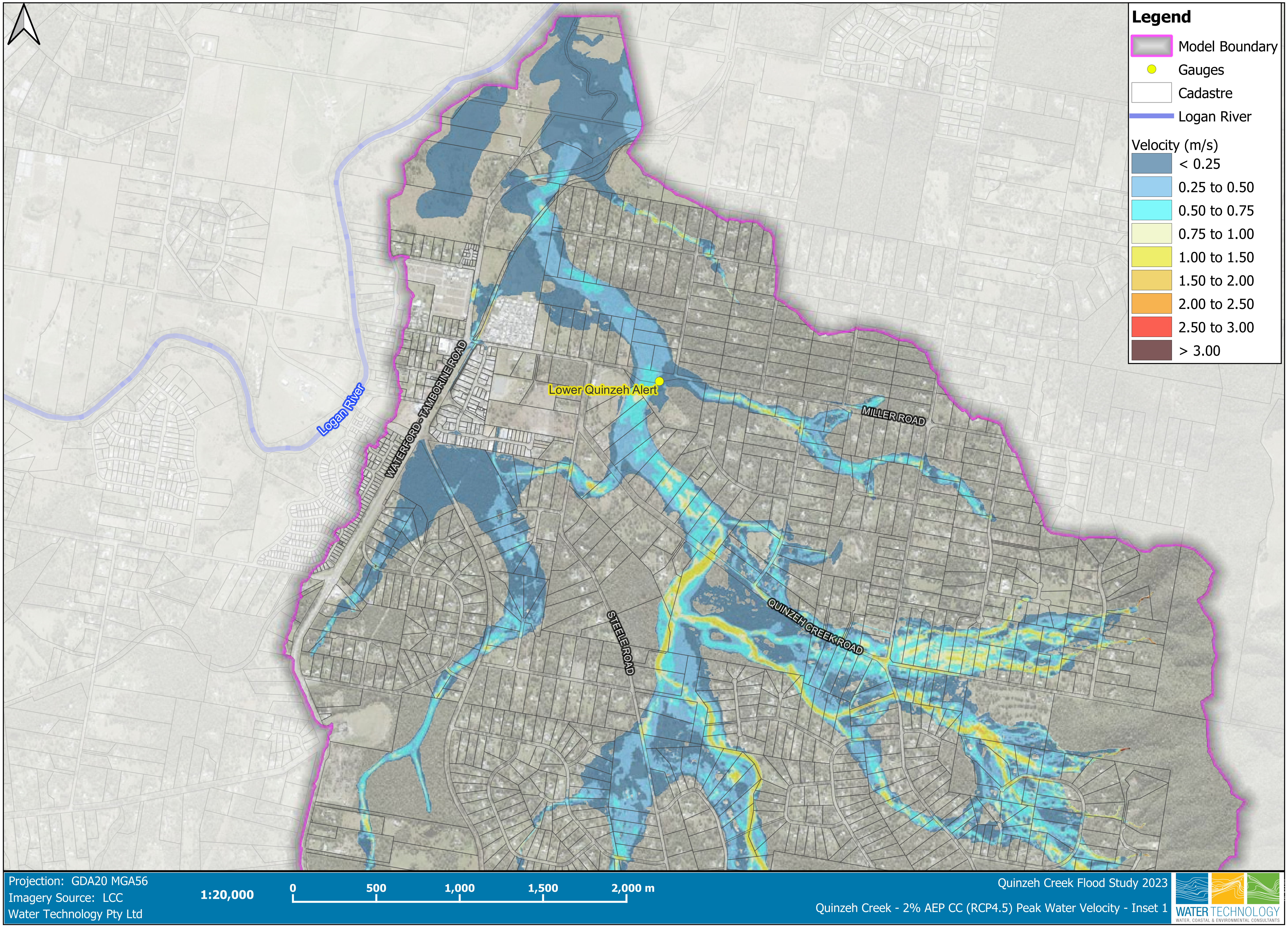
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

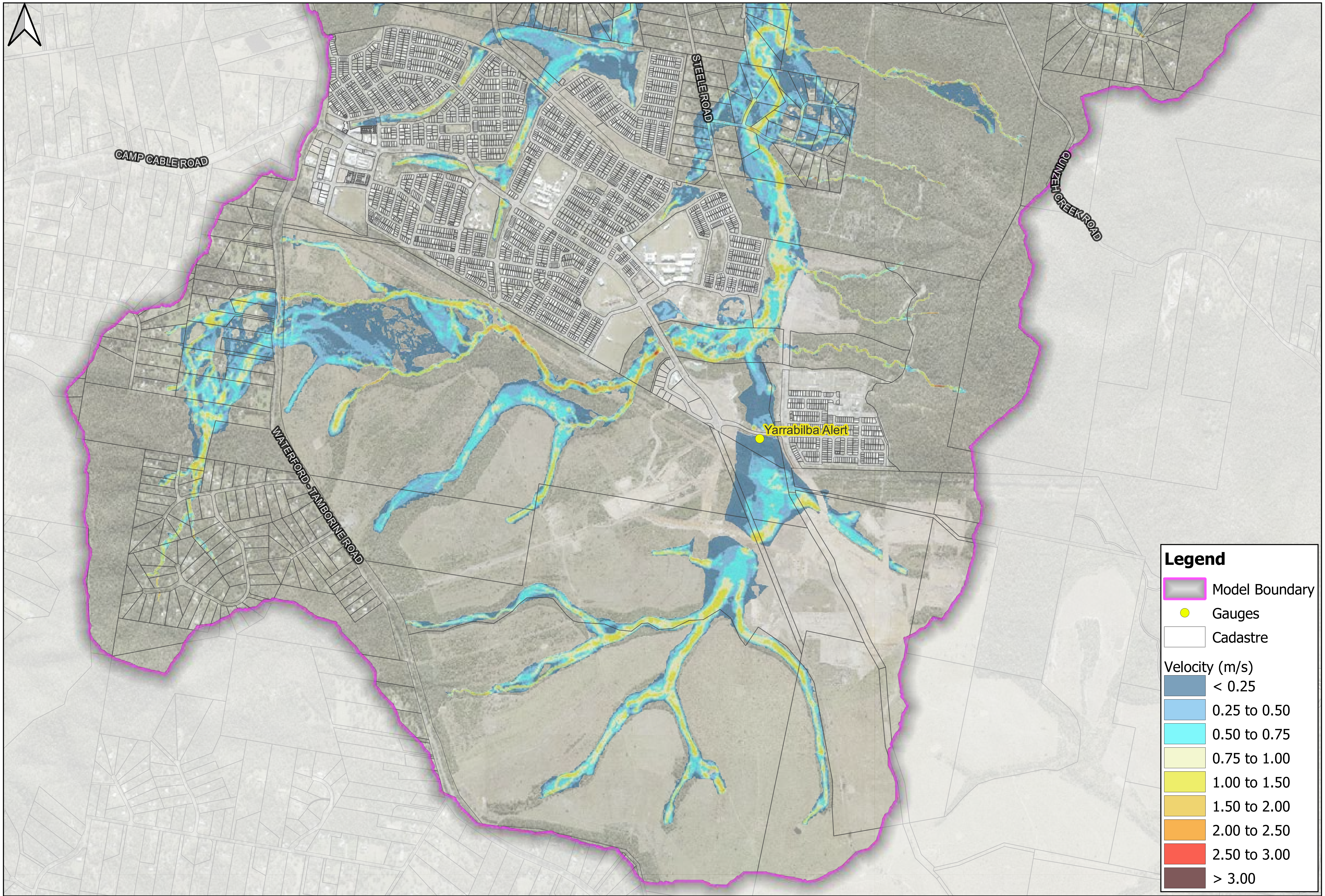
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Velocity - Inset 2


Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Velocity - Inset 1
WATER TECHNOLOGY



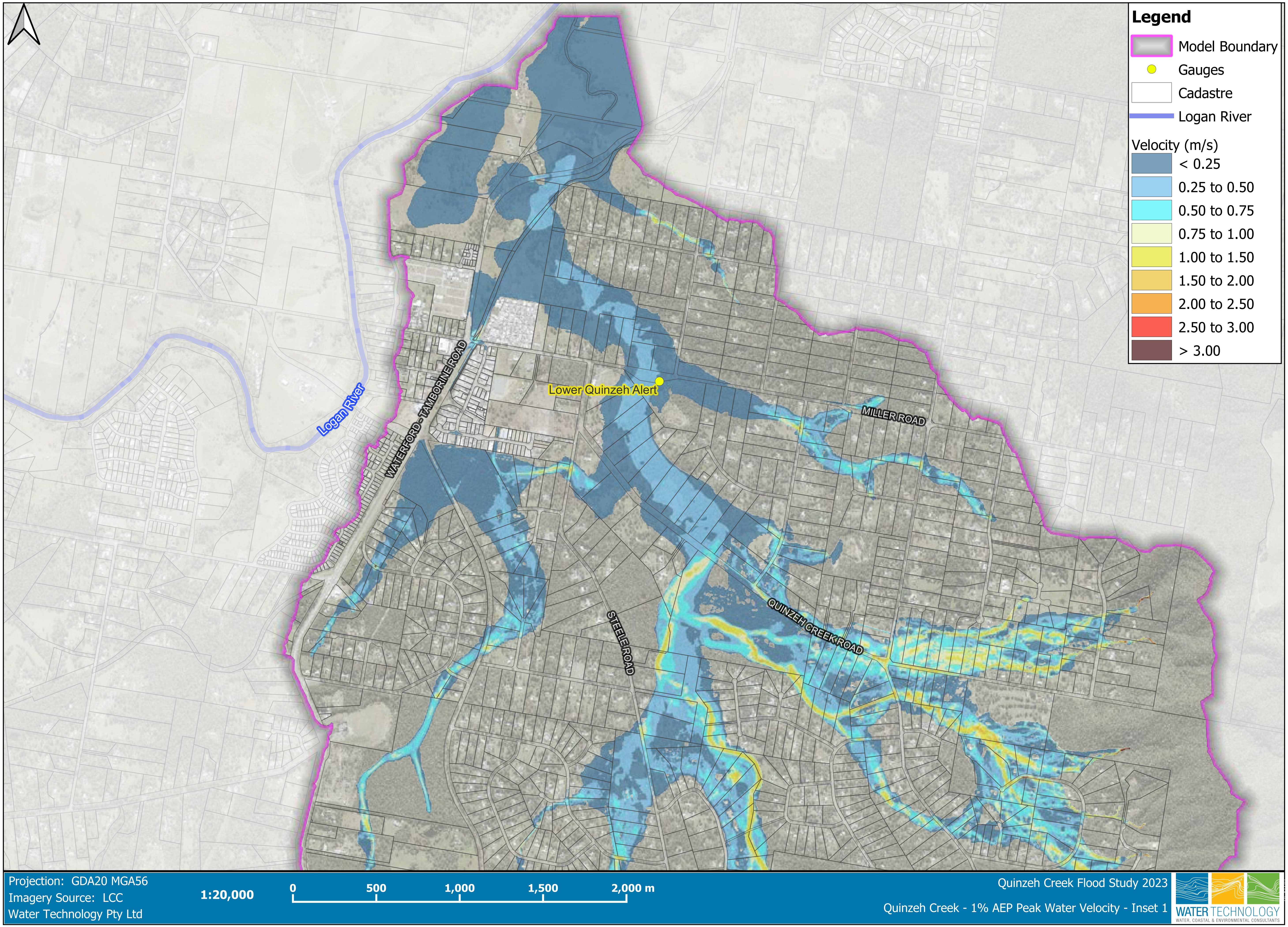
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

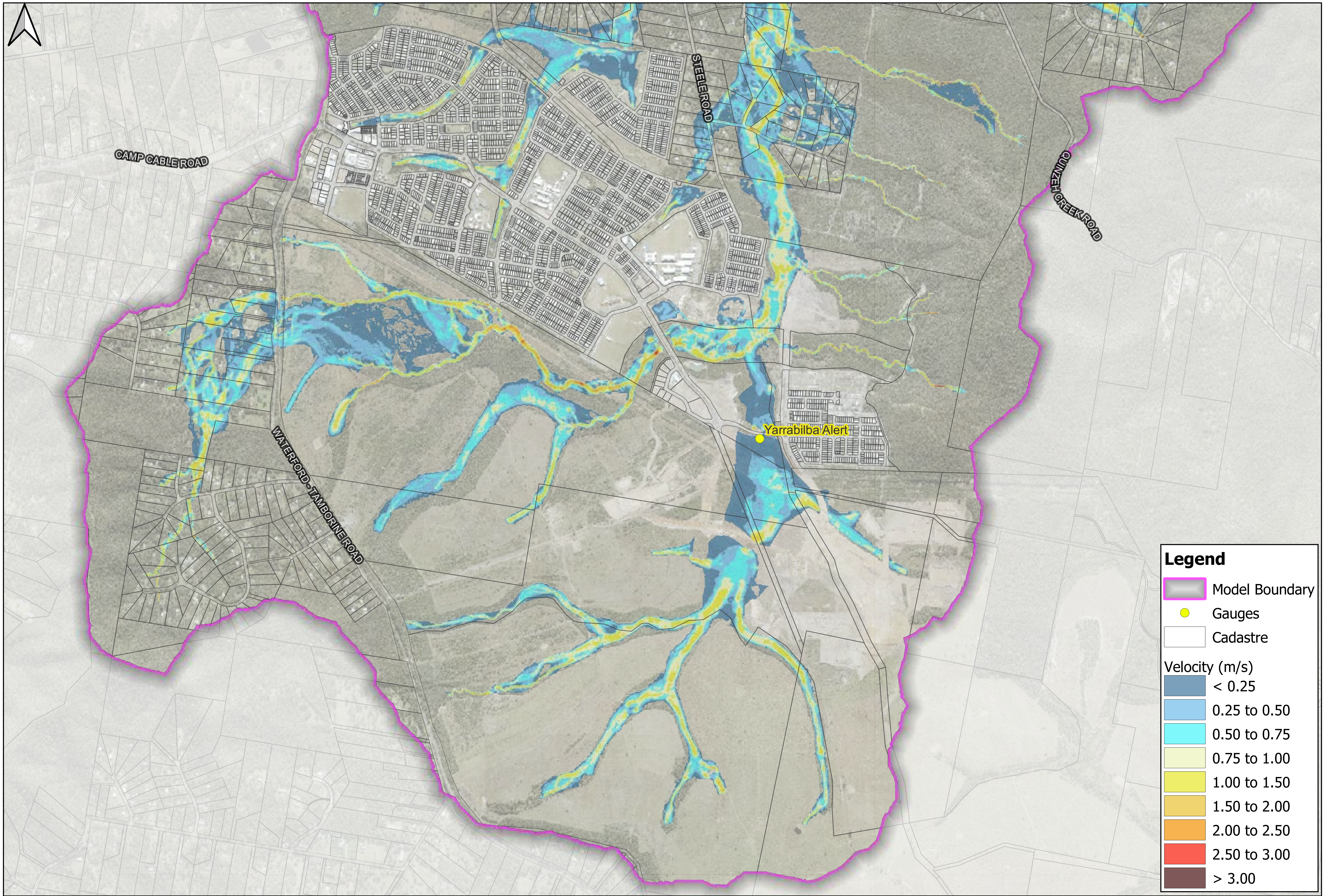
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Velocity - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Logan River
WATERFORD - TAMBORINE ROAD
Lower Quinzeh Alert
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP Peak Water Velocity - Inset 1
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

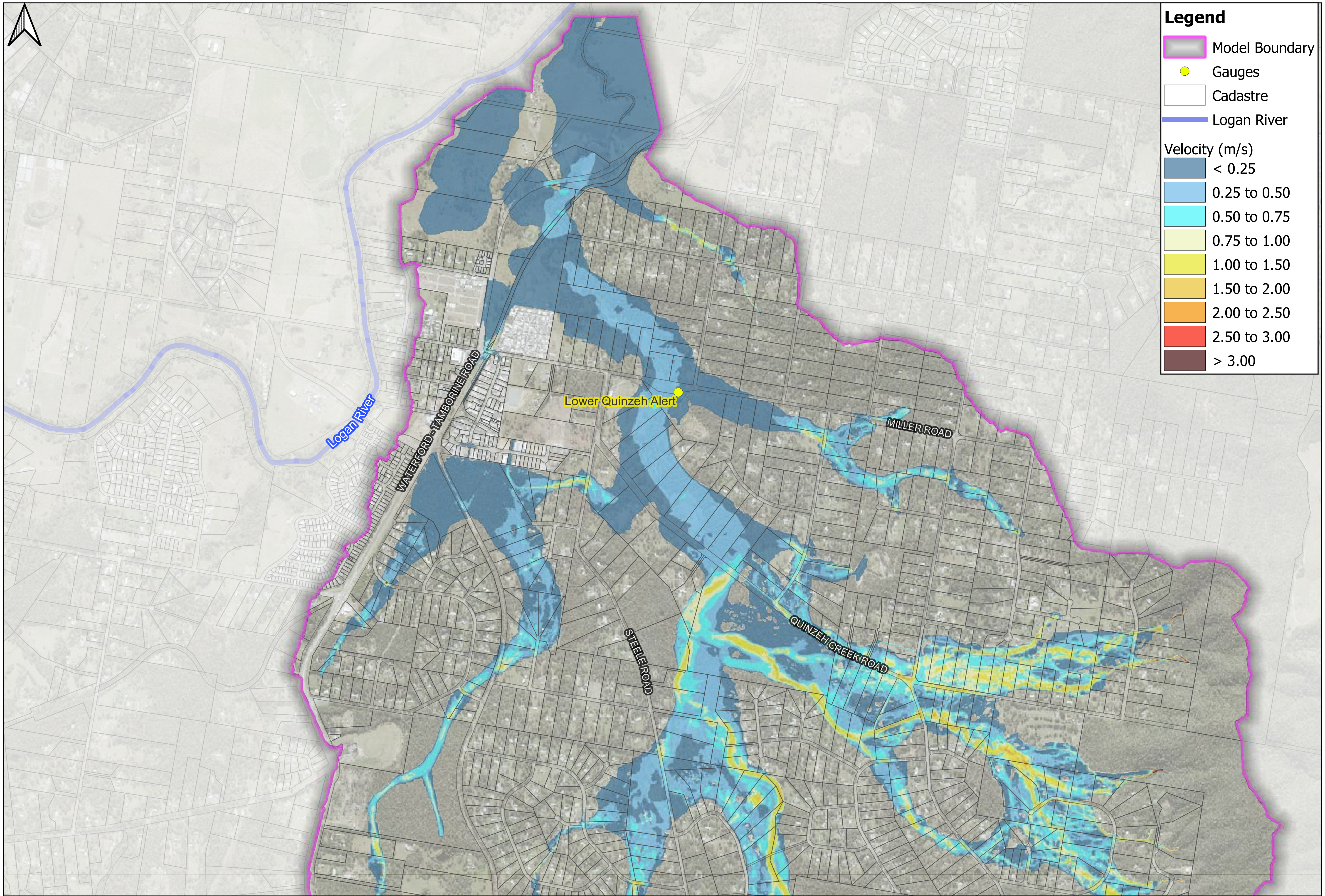
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

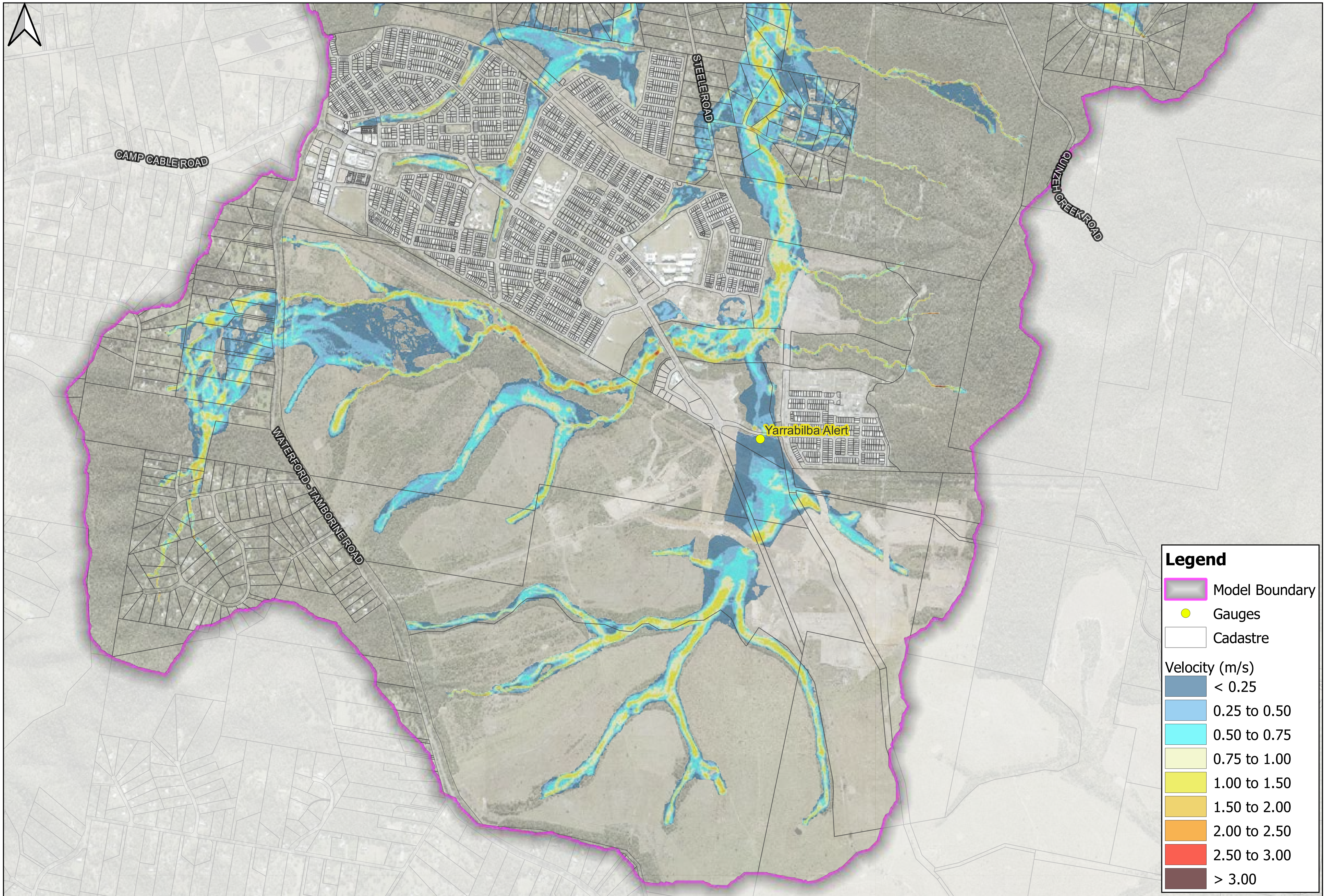
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Velocity - Inset 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

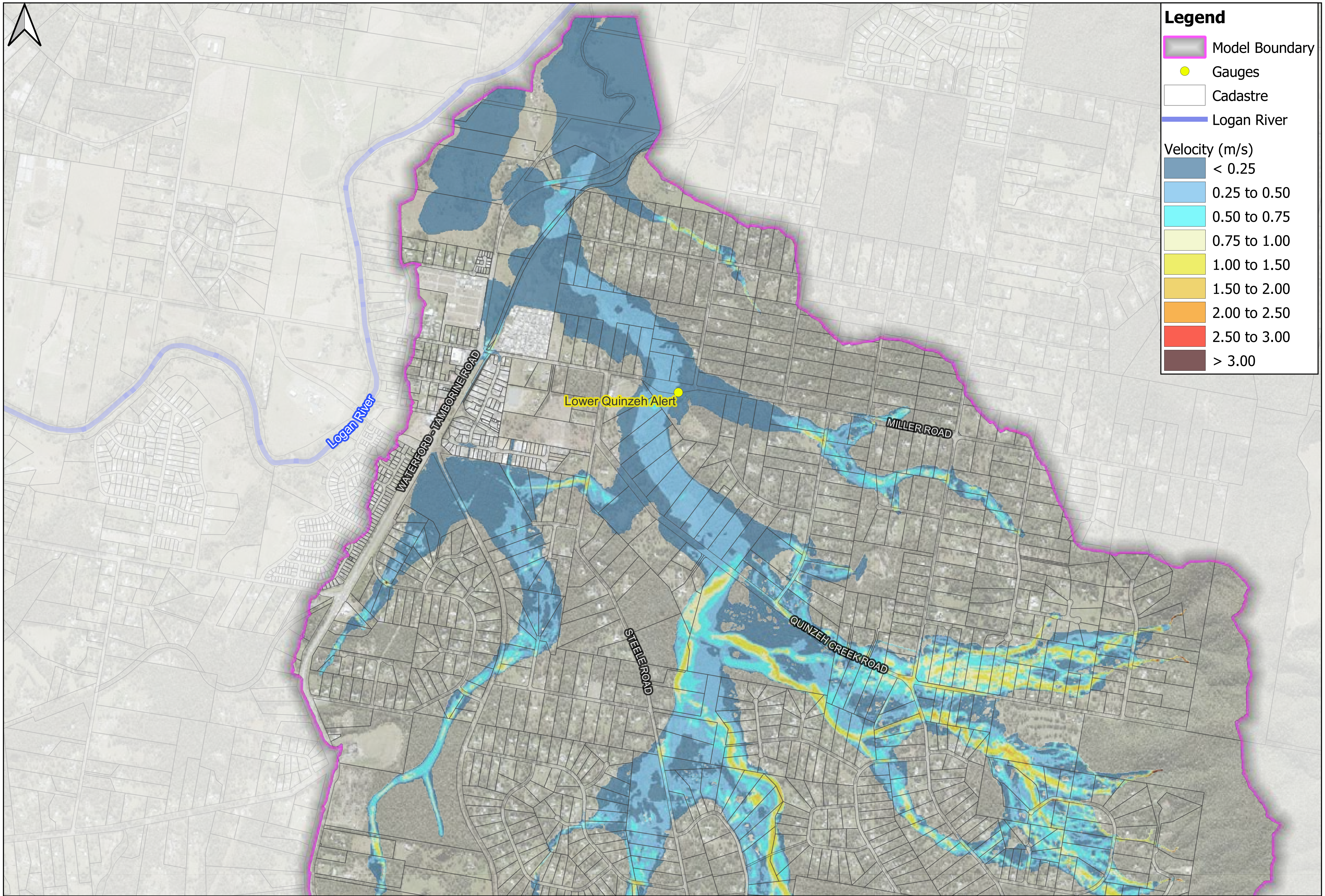
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Velocity - Inset 2

WATER TECHNOLOGY



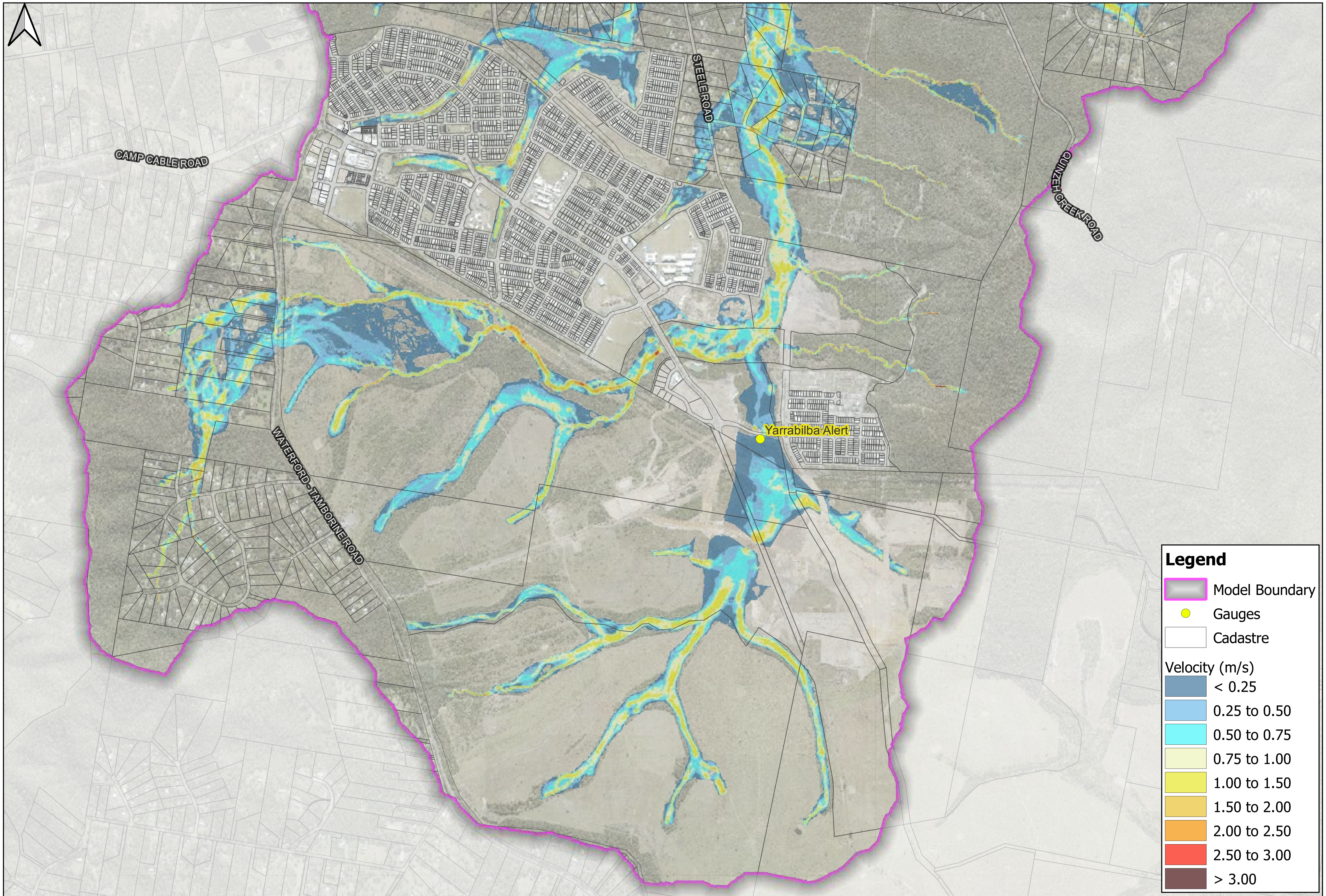
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Velocity - Inset 1



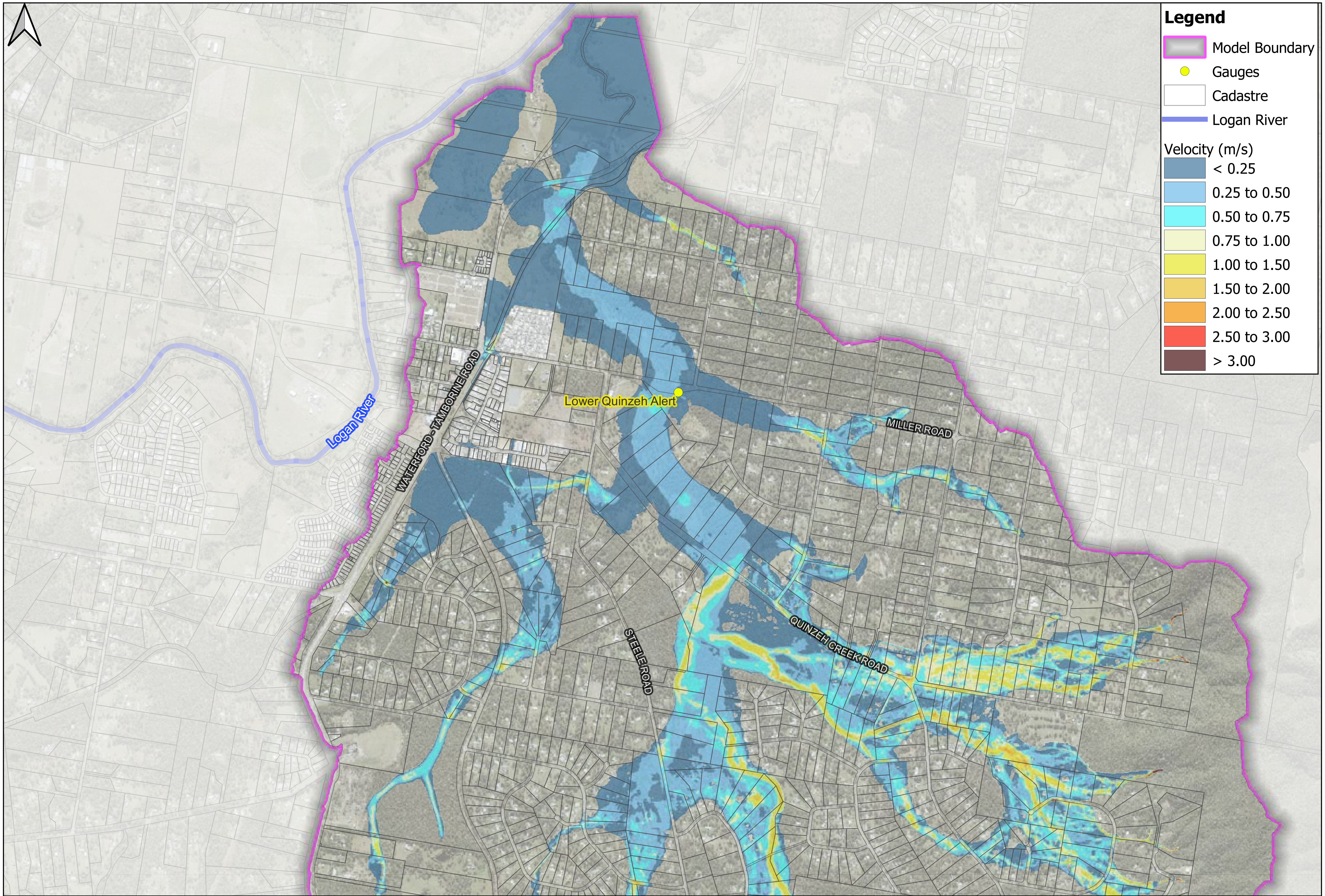
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

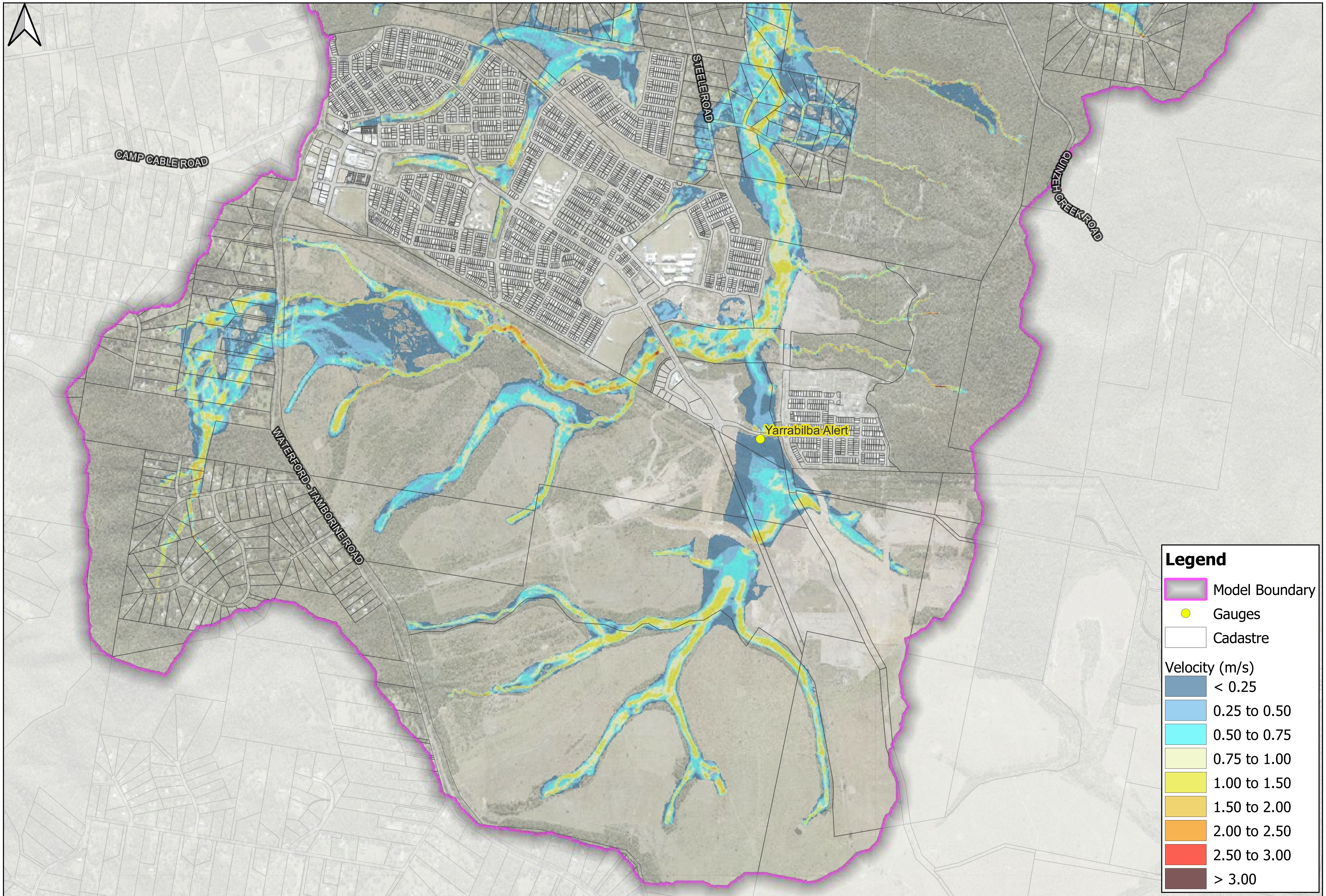
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Velocity - Inset 1

WATER TECHNOLOGY



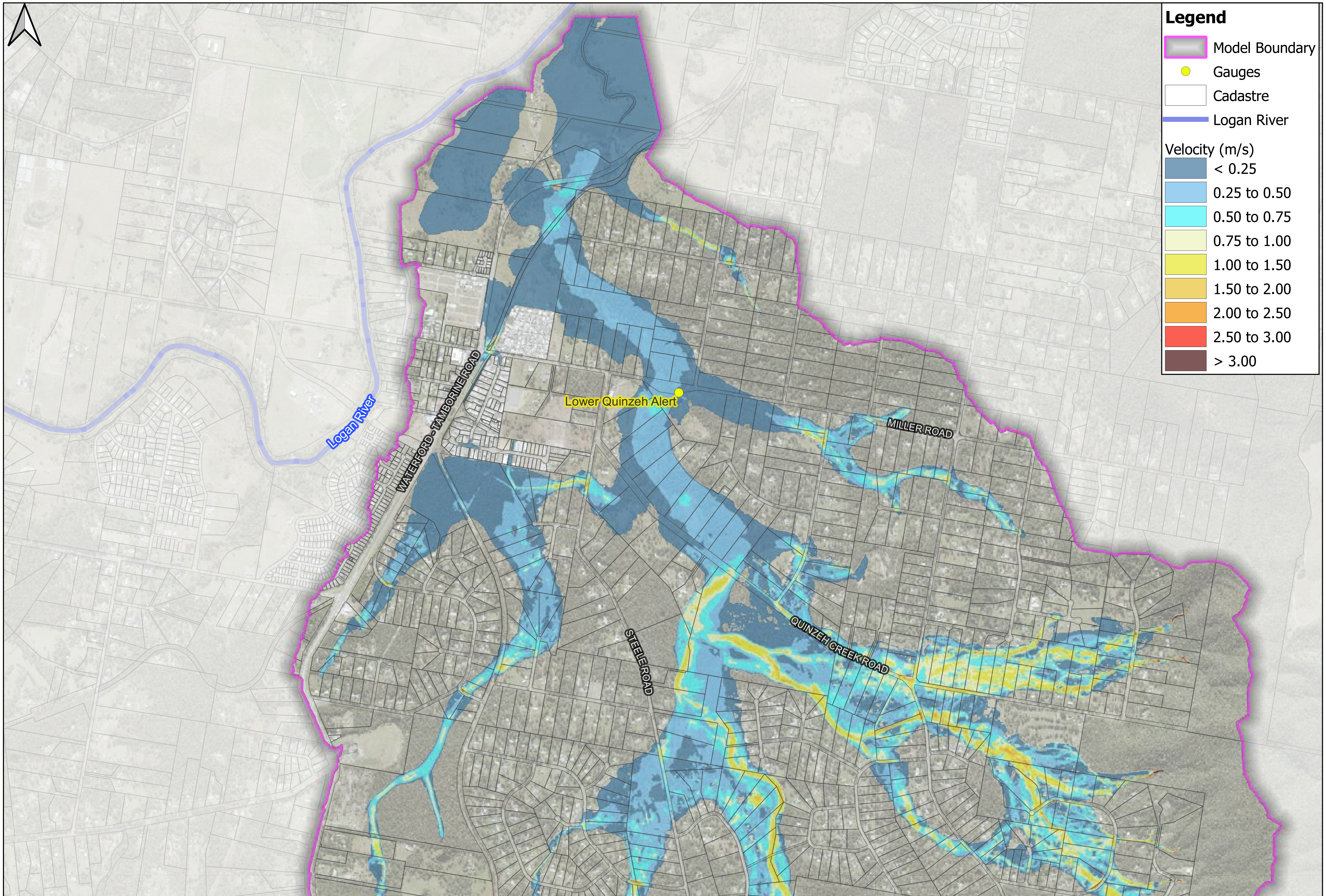
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Velocity - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

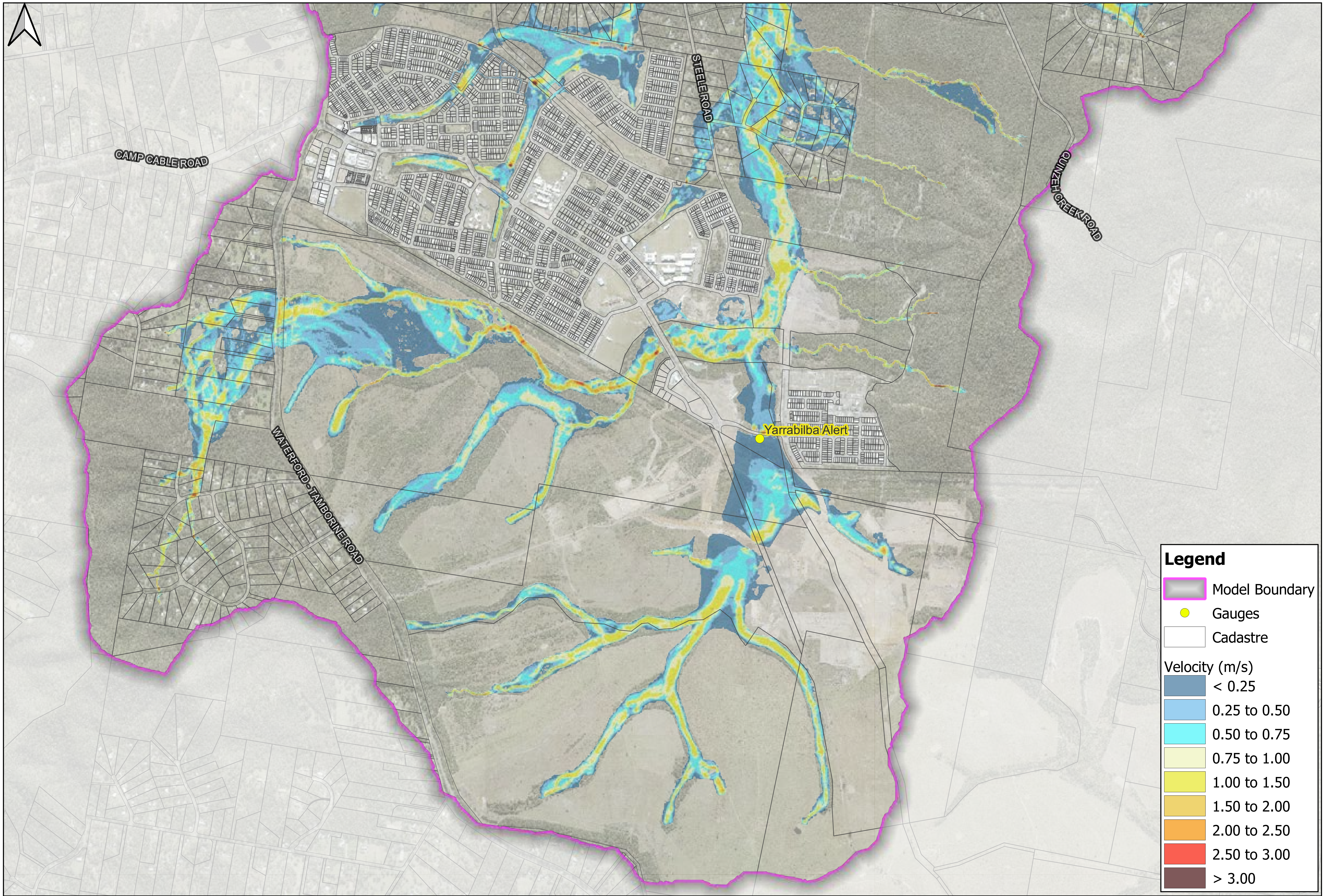
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Velocity - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

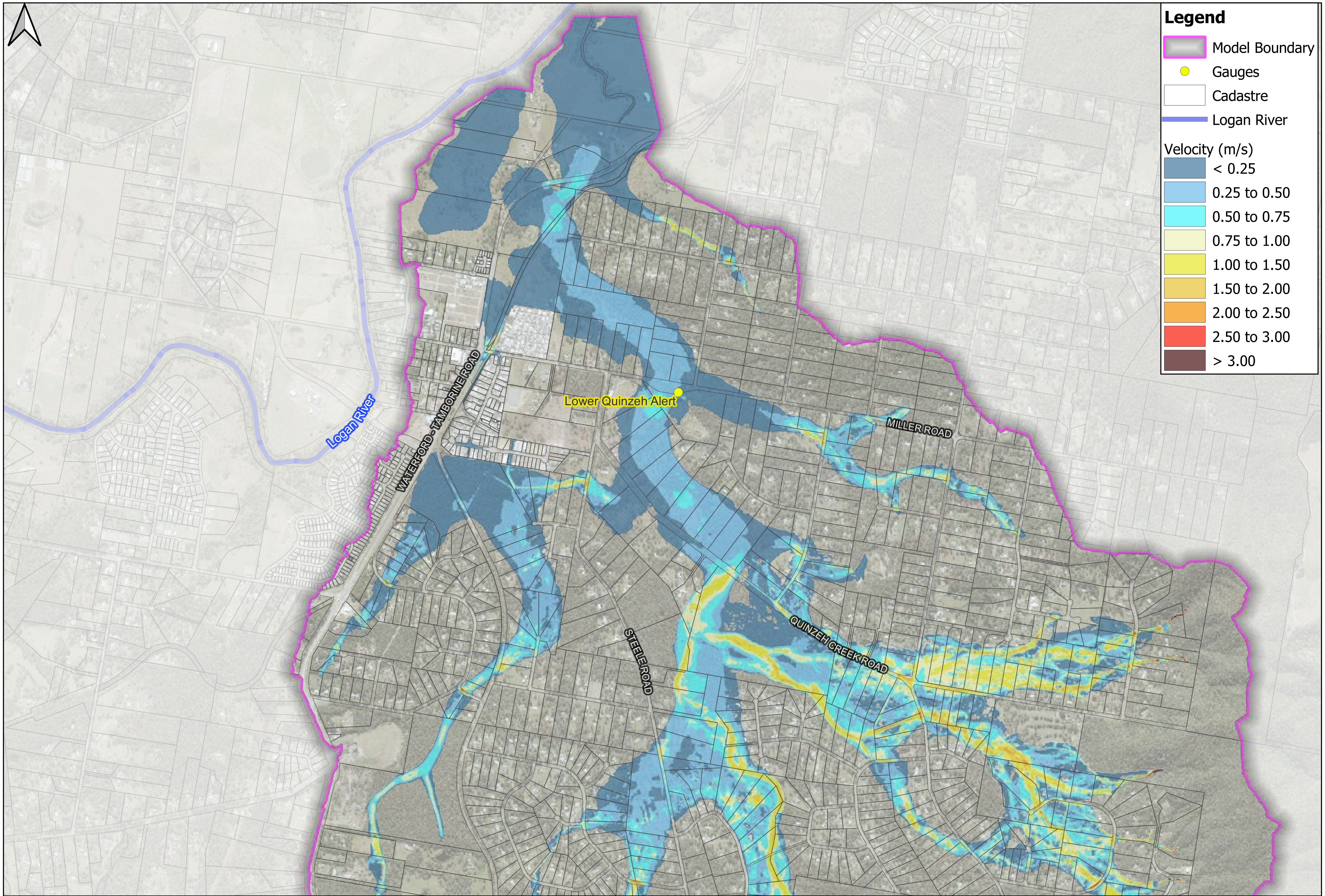


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Velocity - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

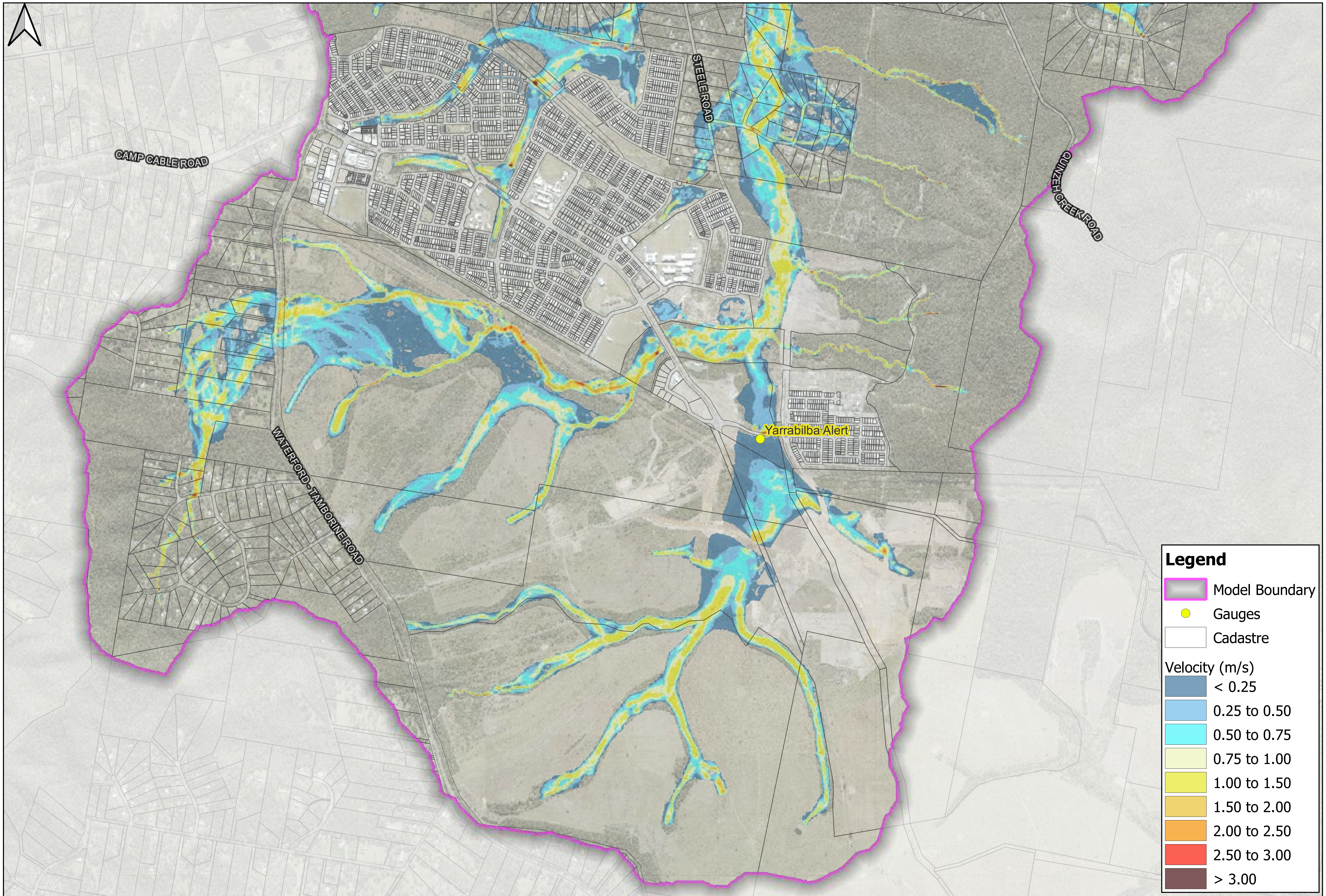
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Velocity - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



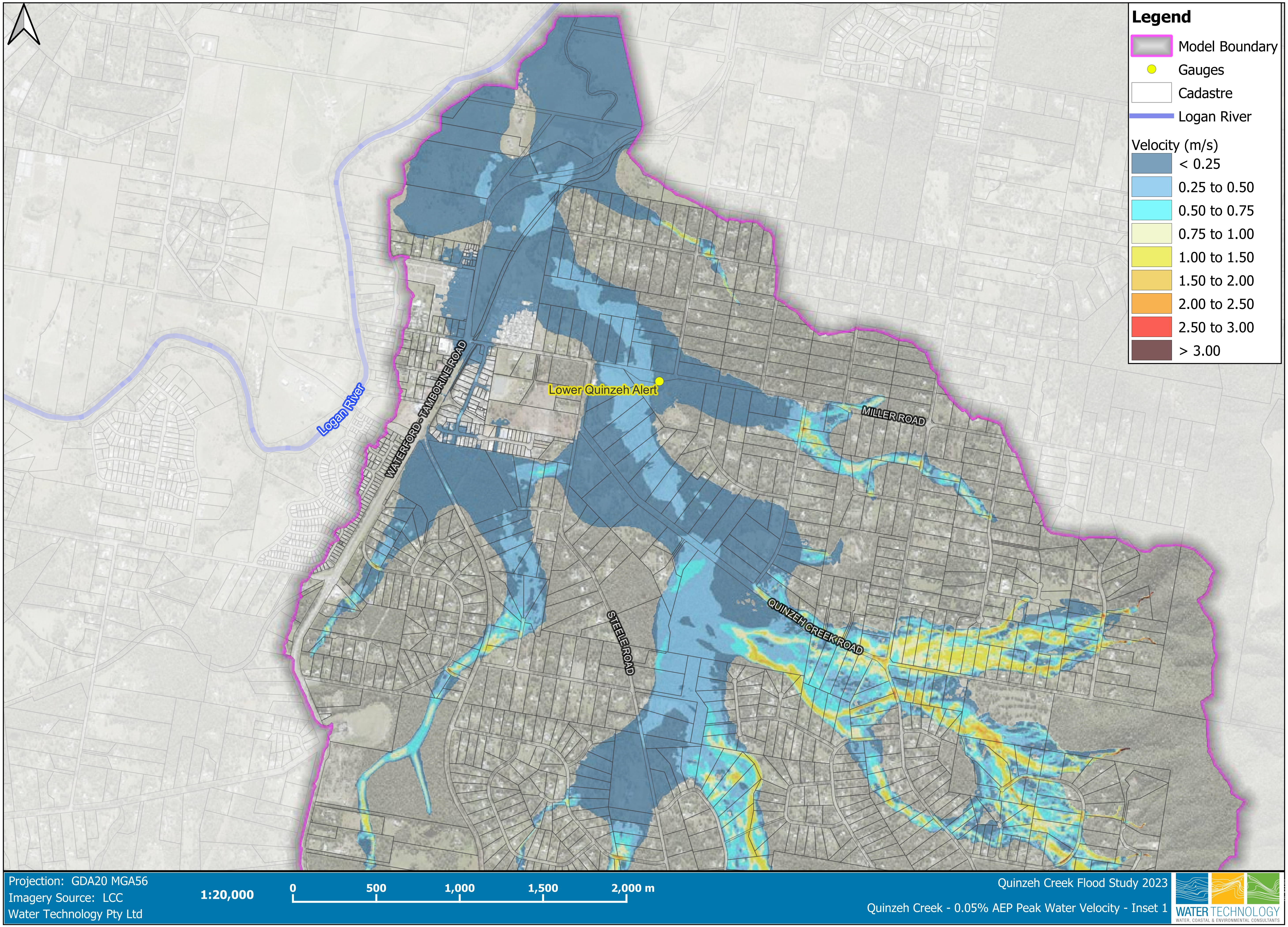
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

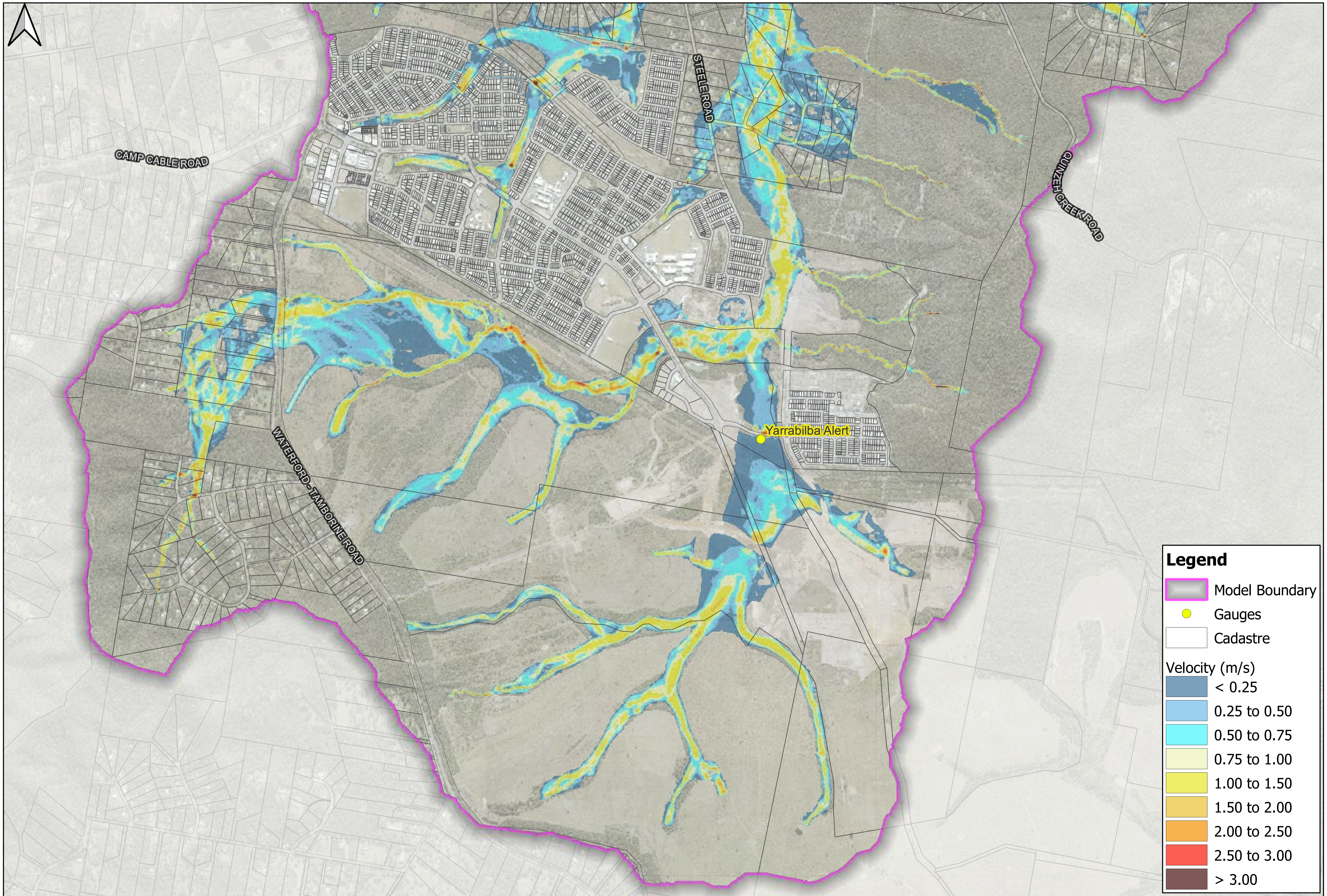
1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


Legend
Model Boundary
Gauges
Cadastre
Logan River
Velocity (m/s)
< 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 1.50
1.50 to 2.00
2.00 to 2.50
2.50 to 3.00
> 3.00
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.05% AEP Peak Water Velocity - Inset 1
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



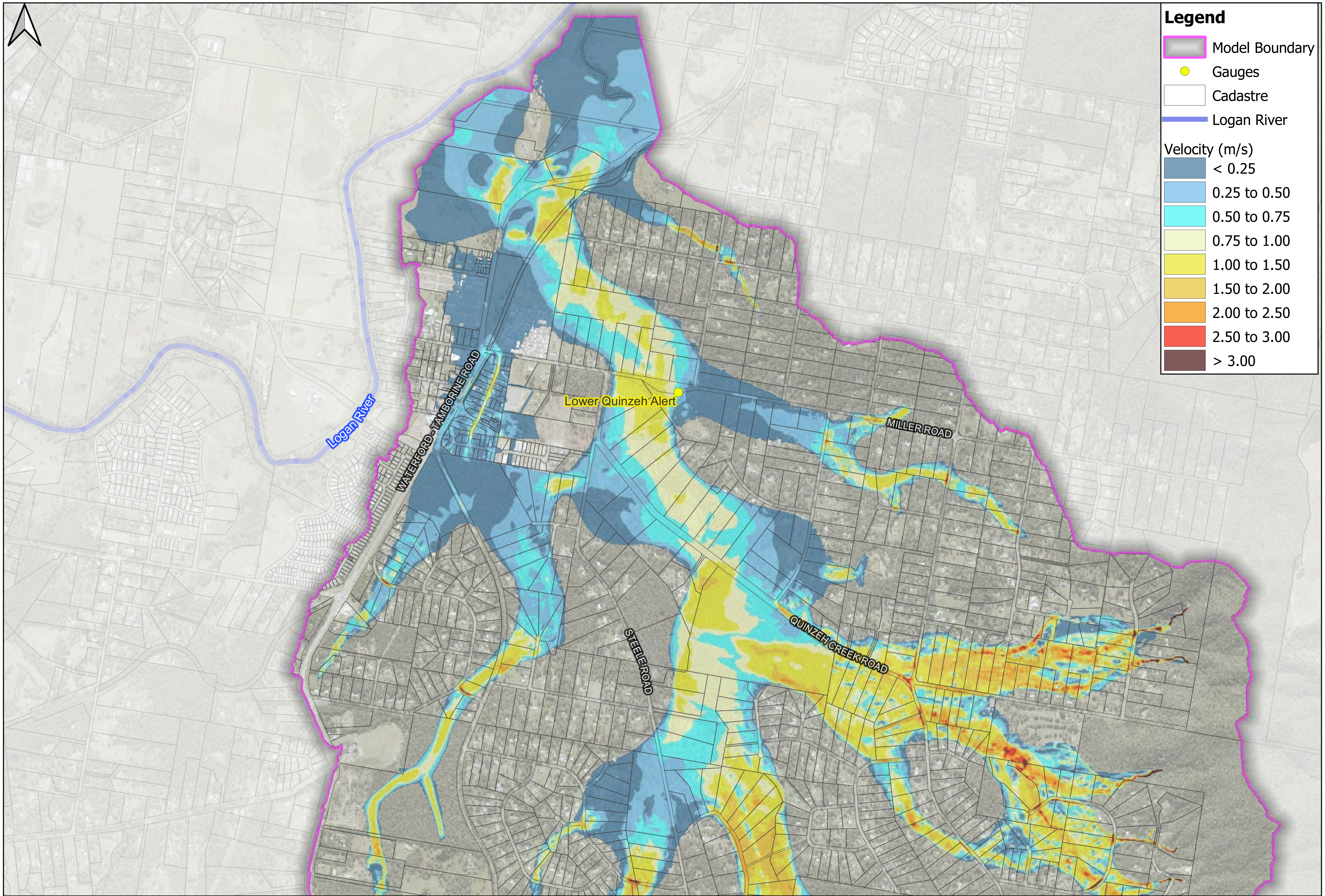
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.05% AEP Peak Water Velocity - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

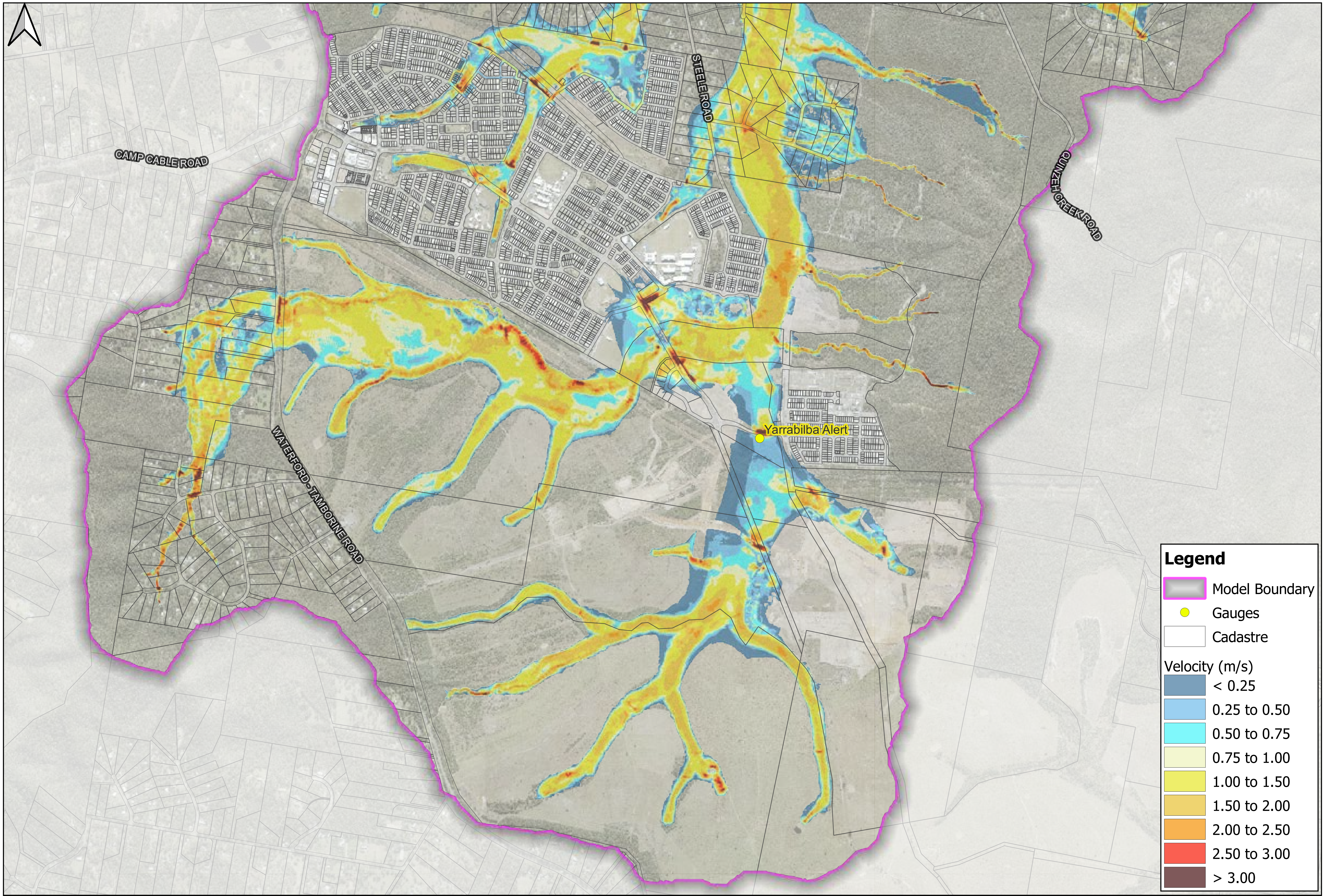
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Velocity - Inset 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

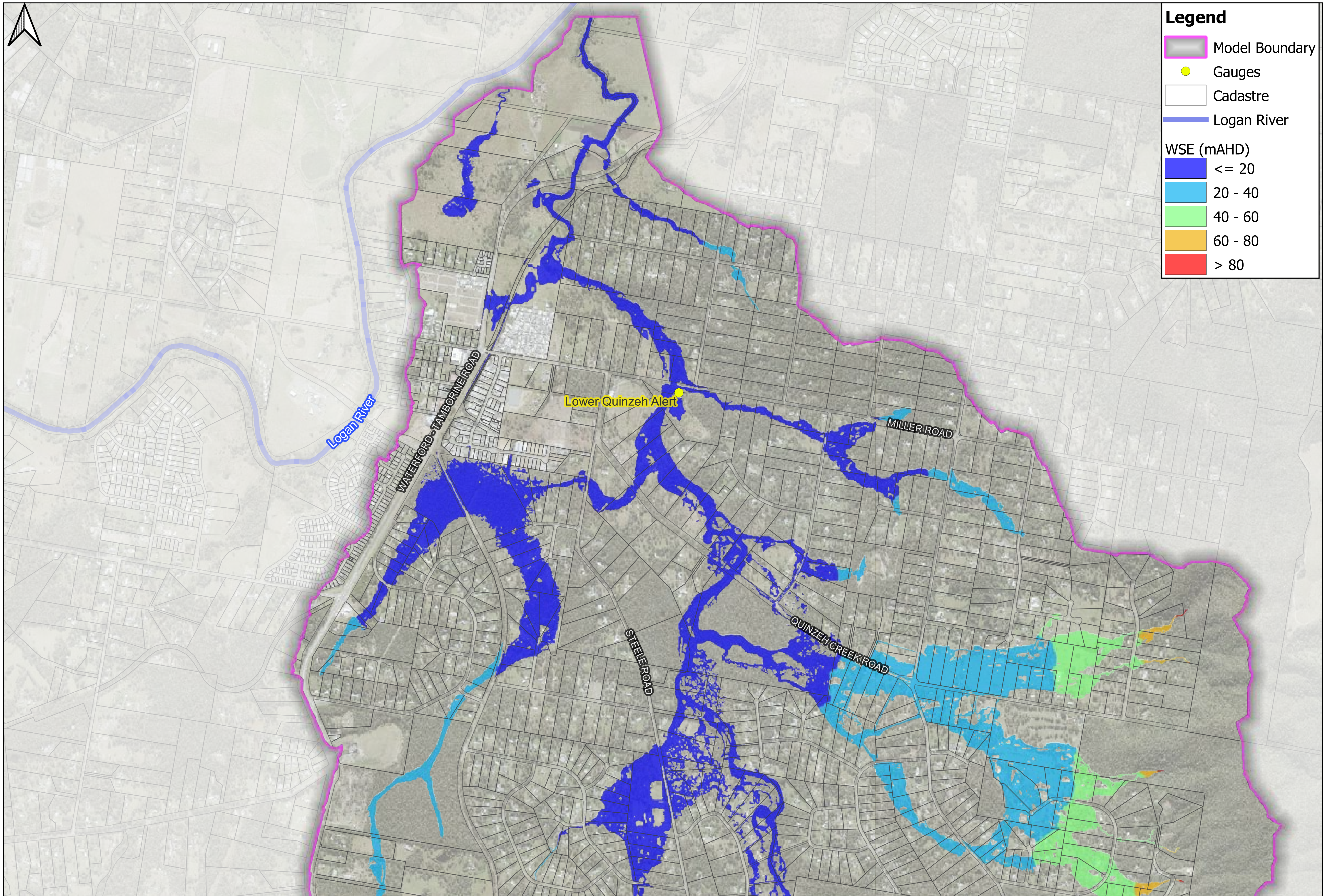
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Velocity - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

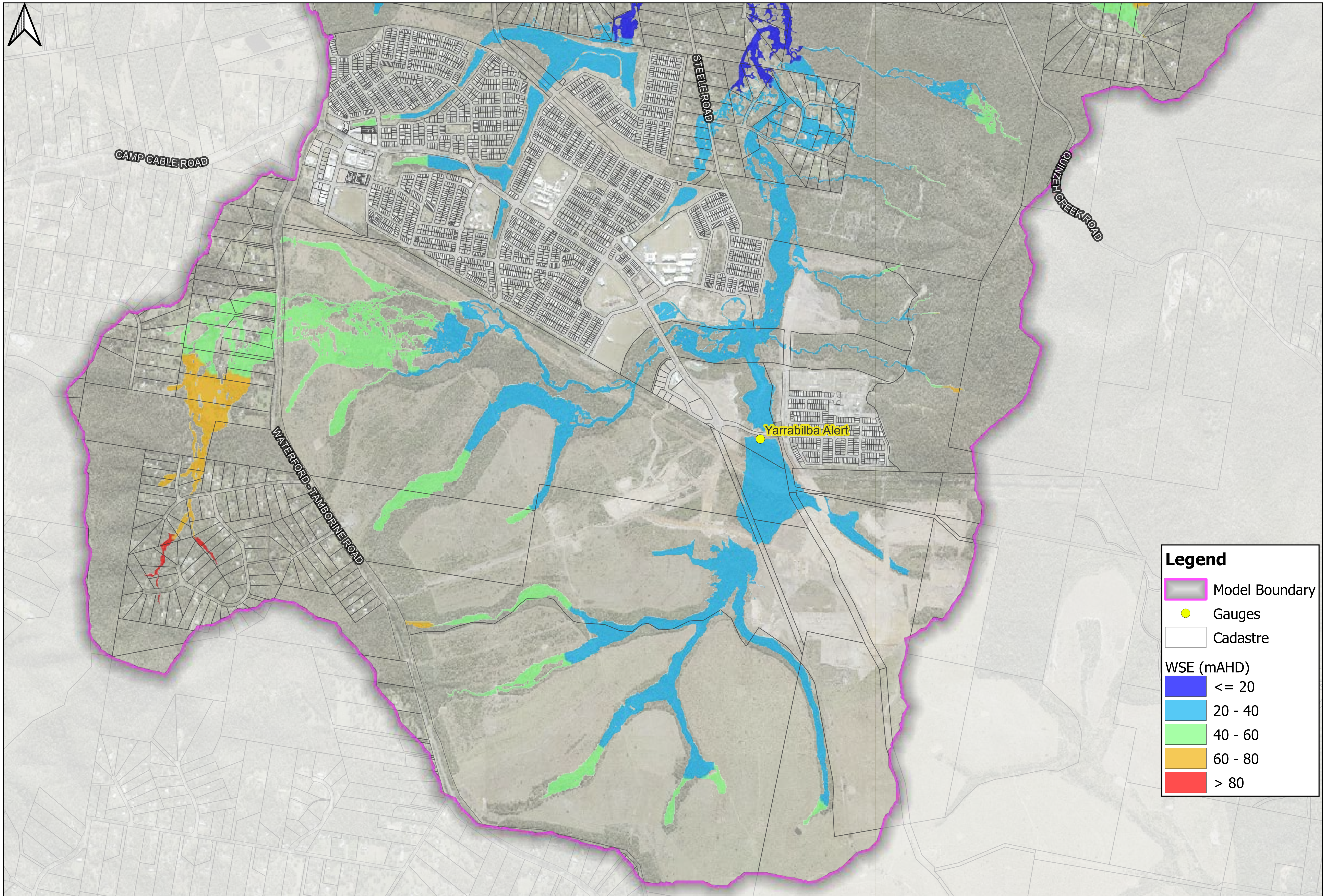
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

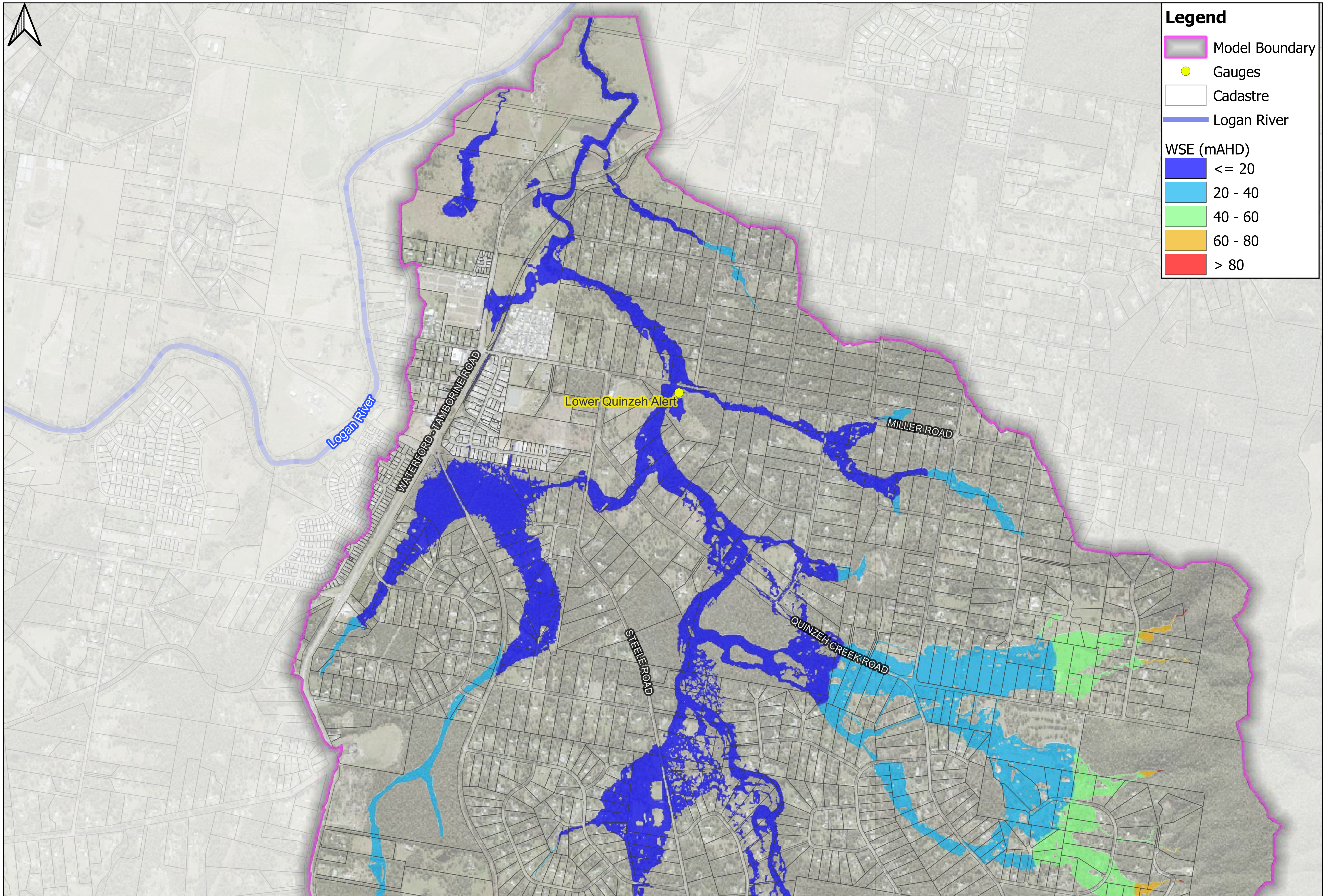
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

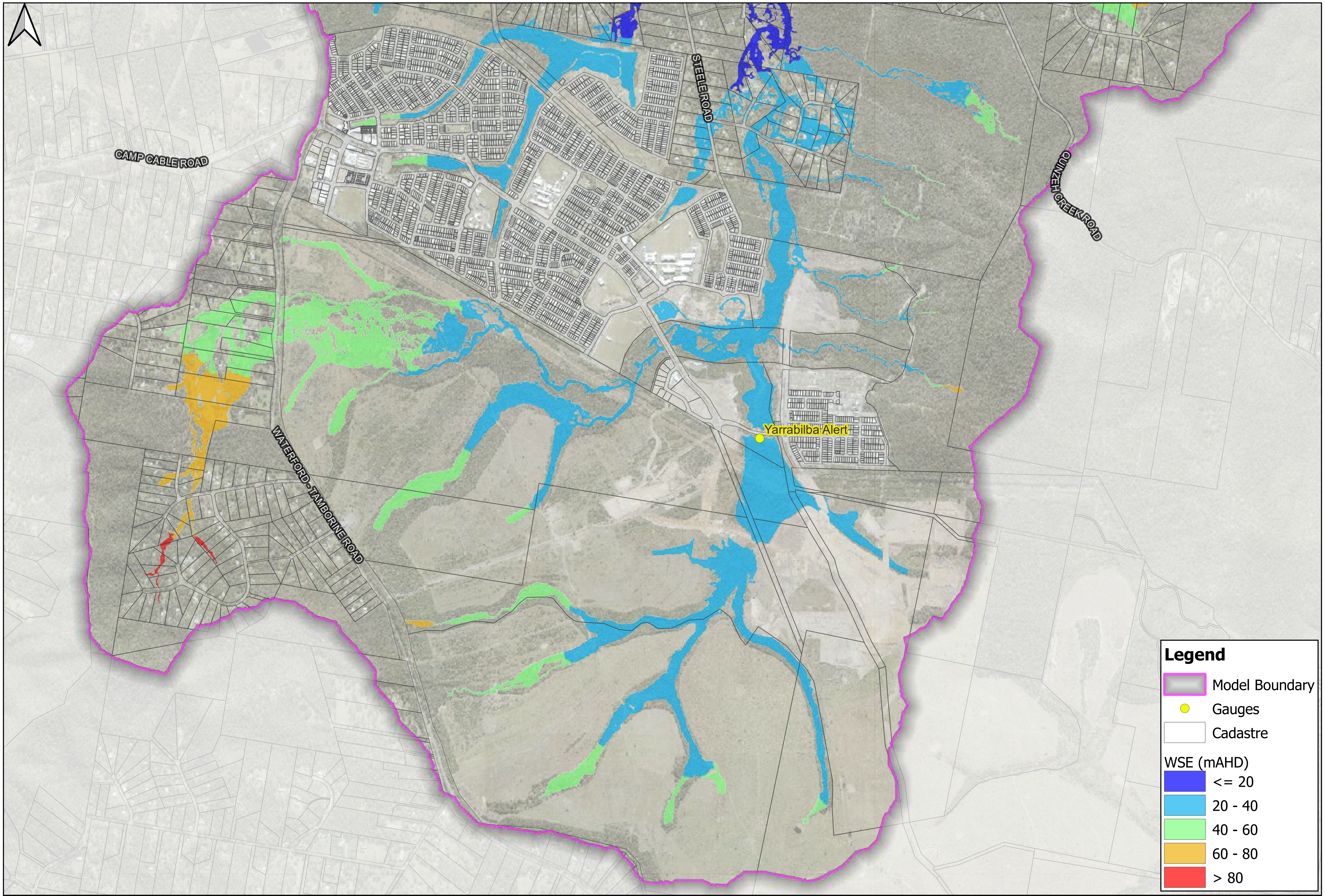
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

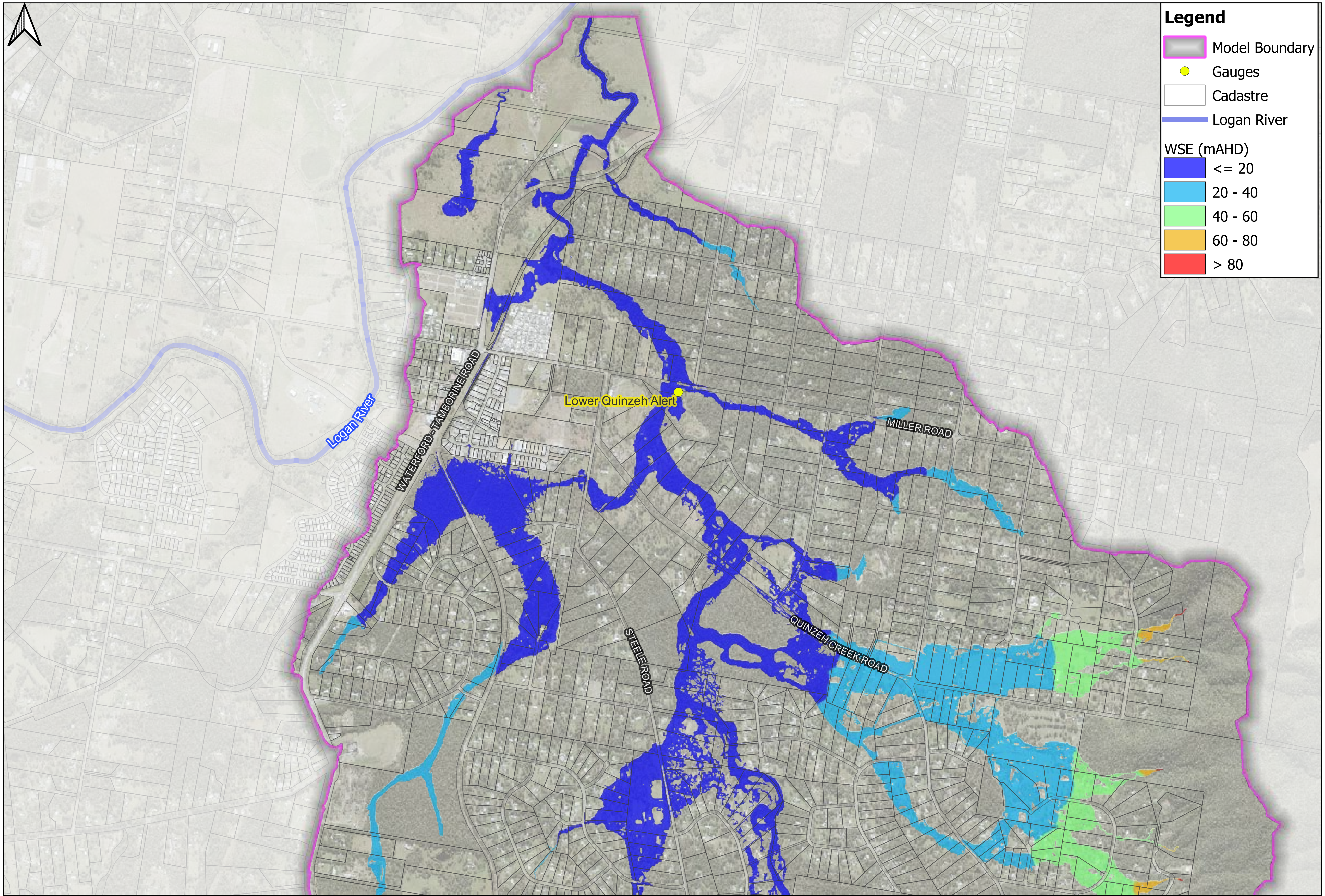
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



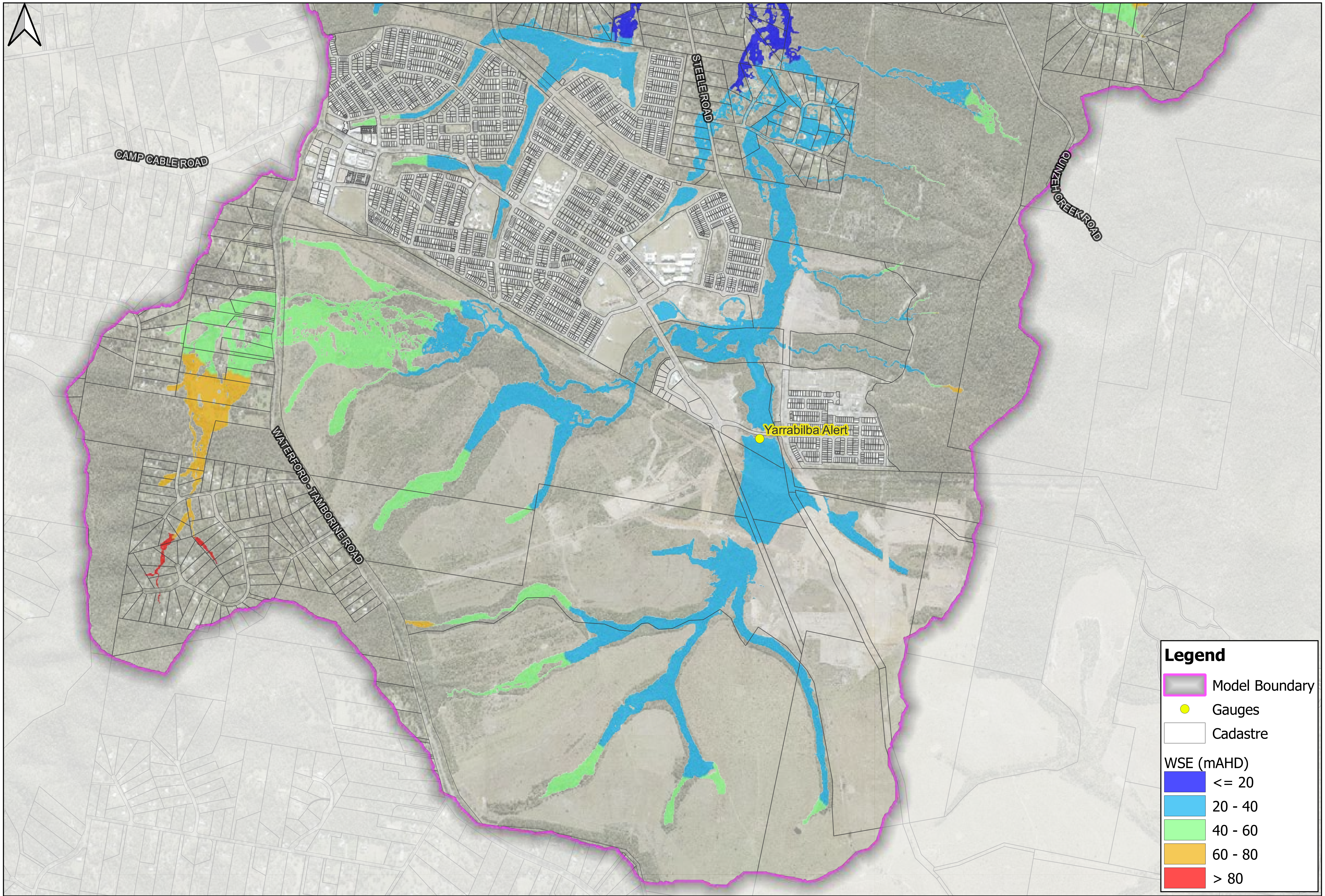
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

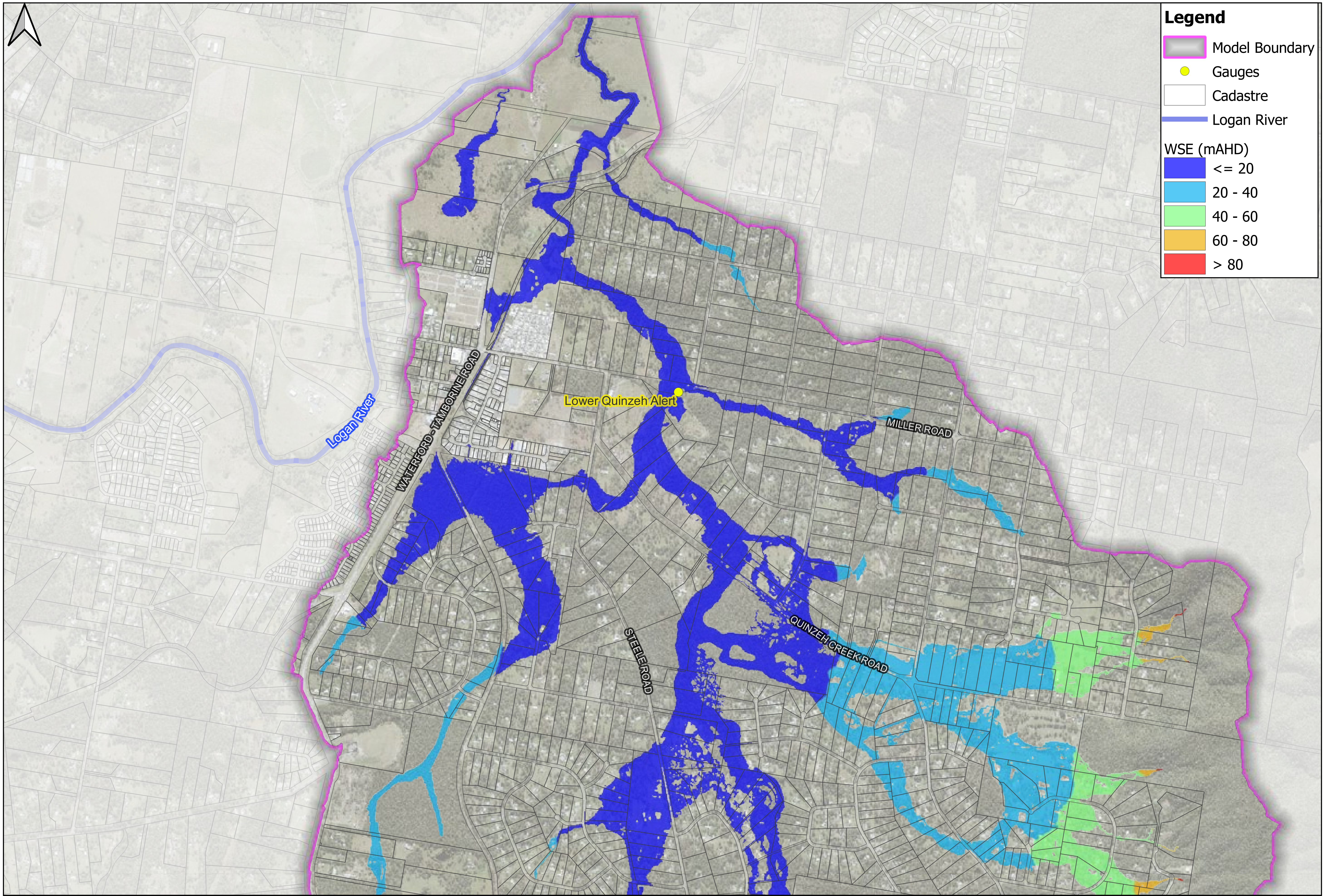
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

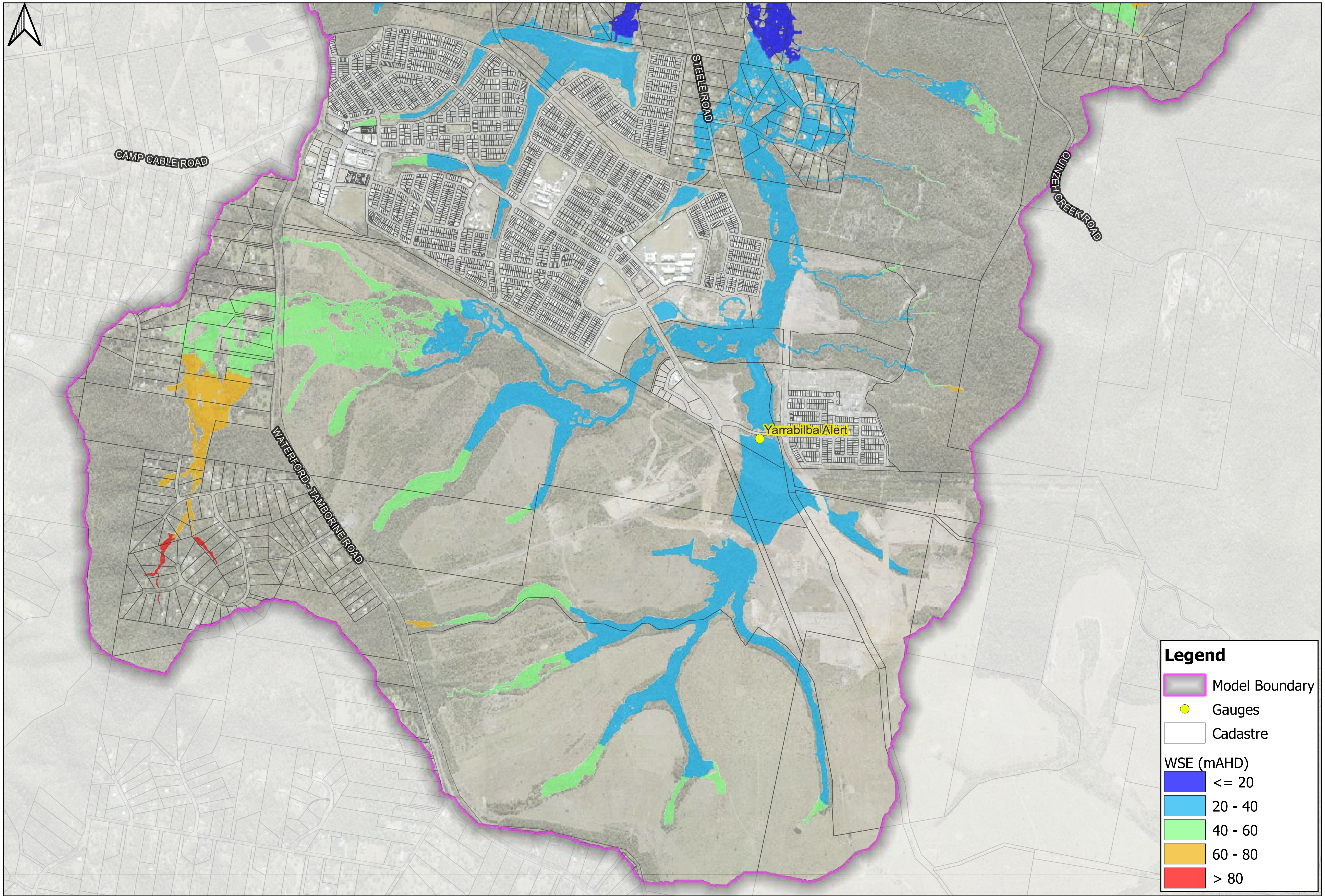


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

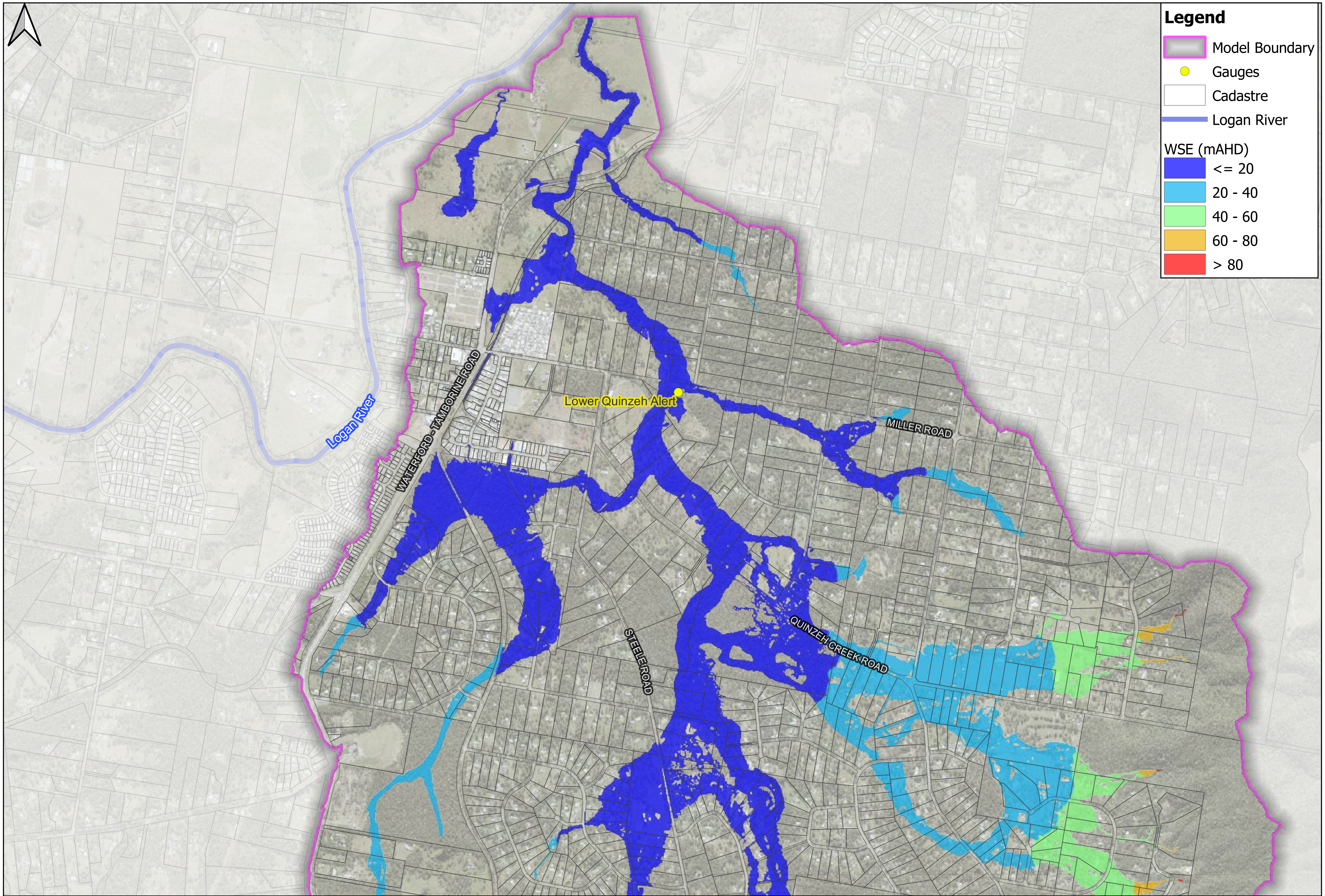
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

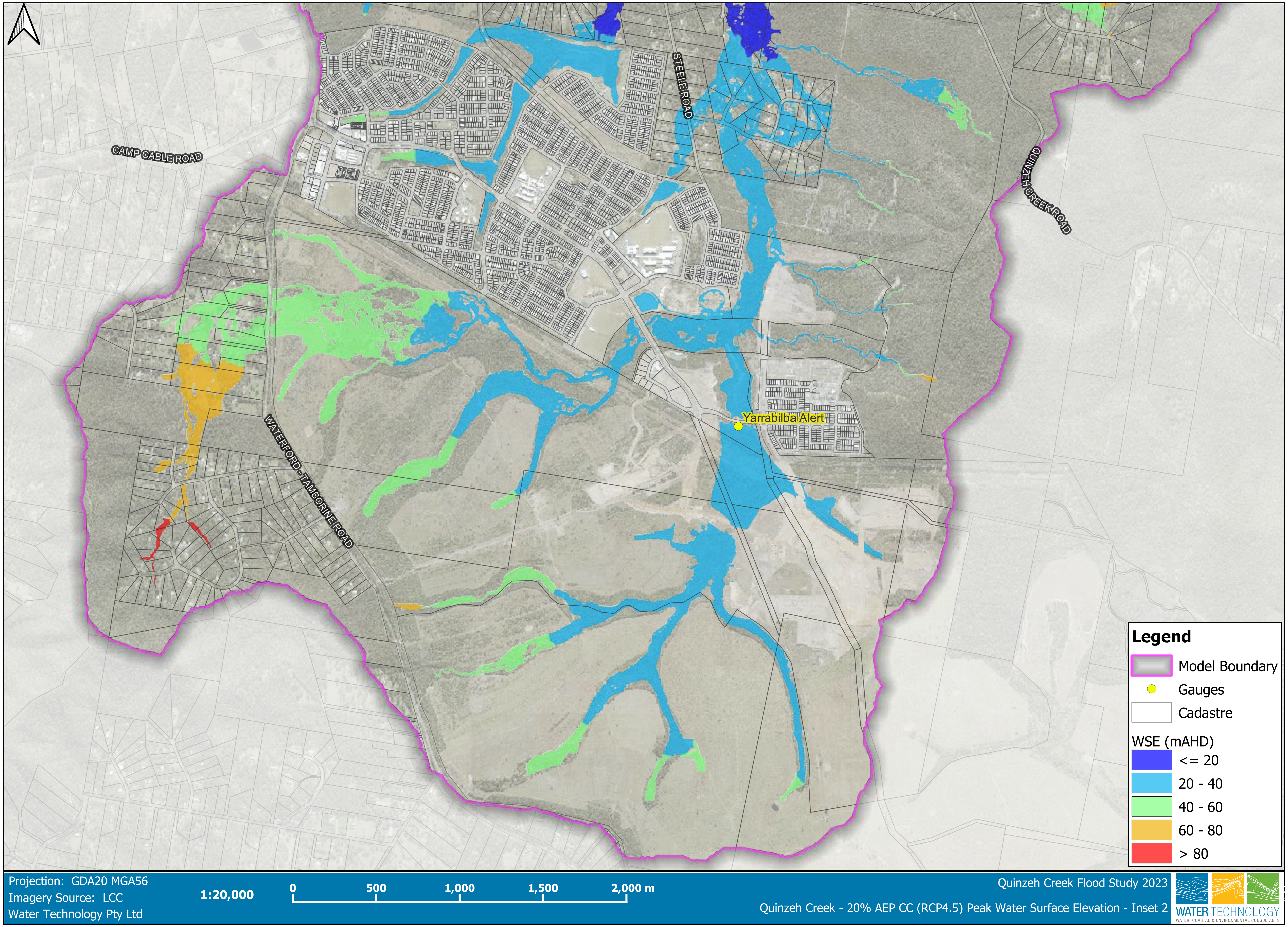
1:20,000

0 500 1,000 1,500 2,000 m

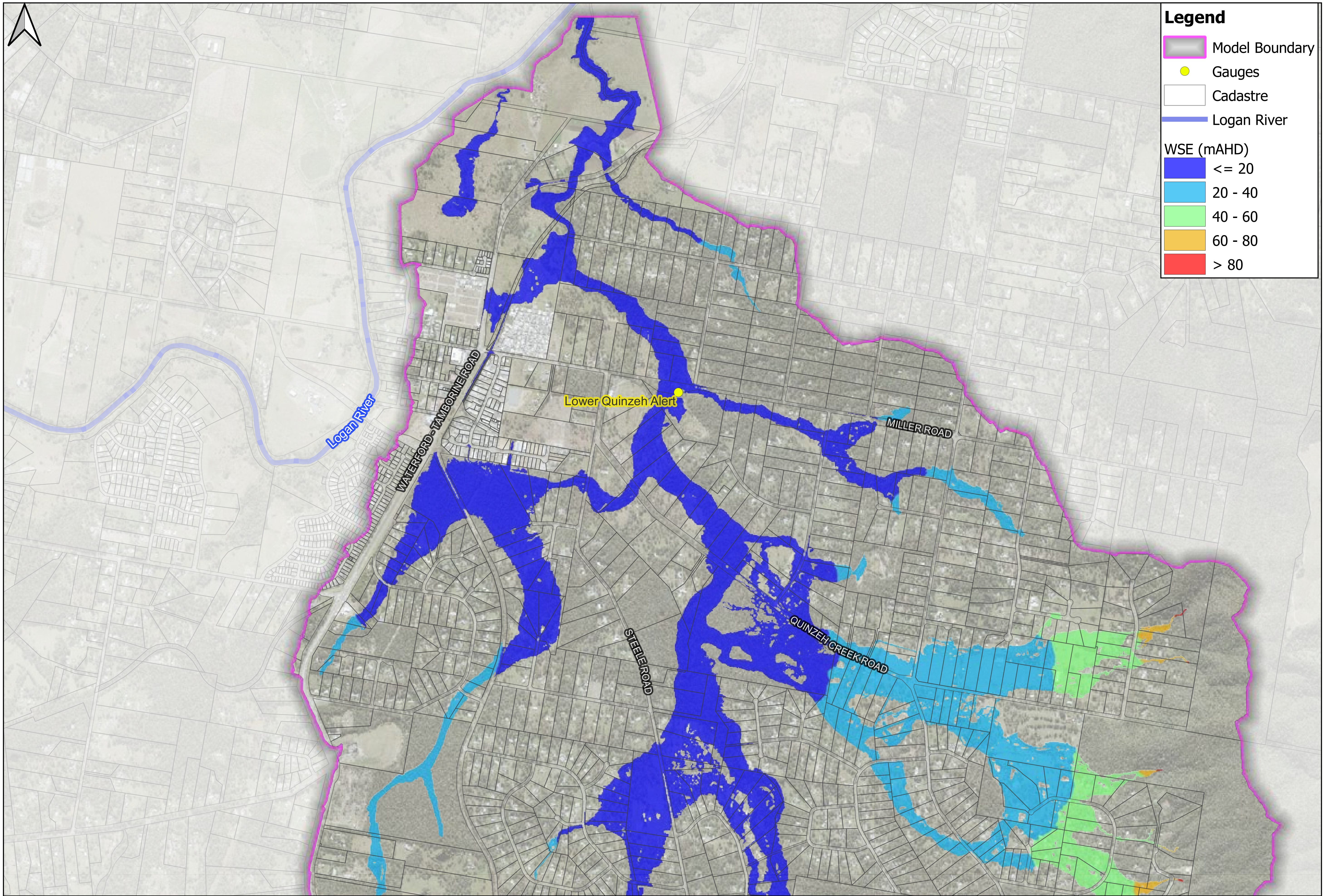
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
WSE (mAHD)
<= 20
20 - 40
40 - 60
60 - 80
> 80
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

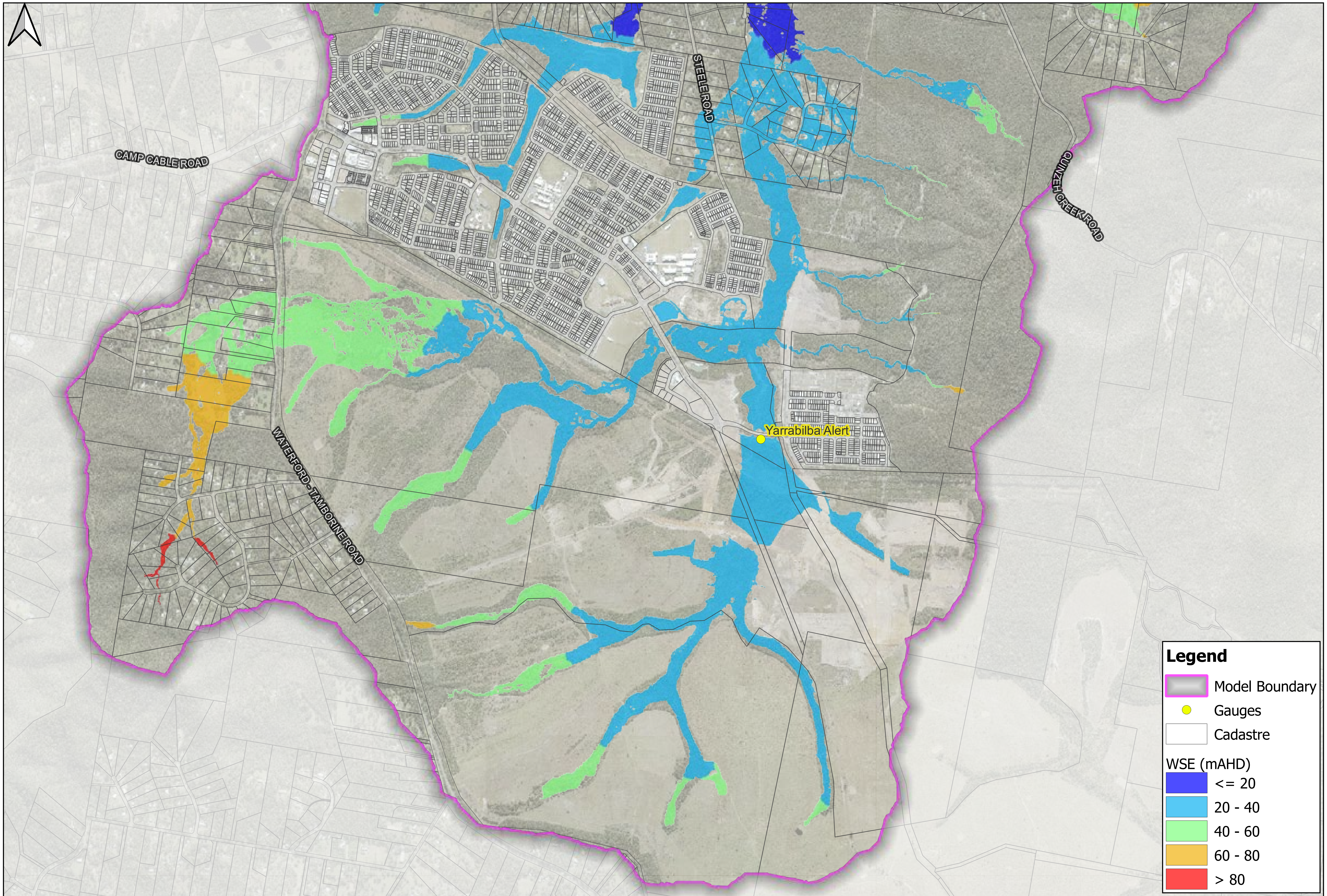
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY



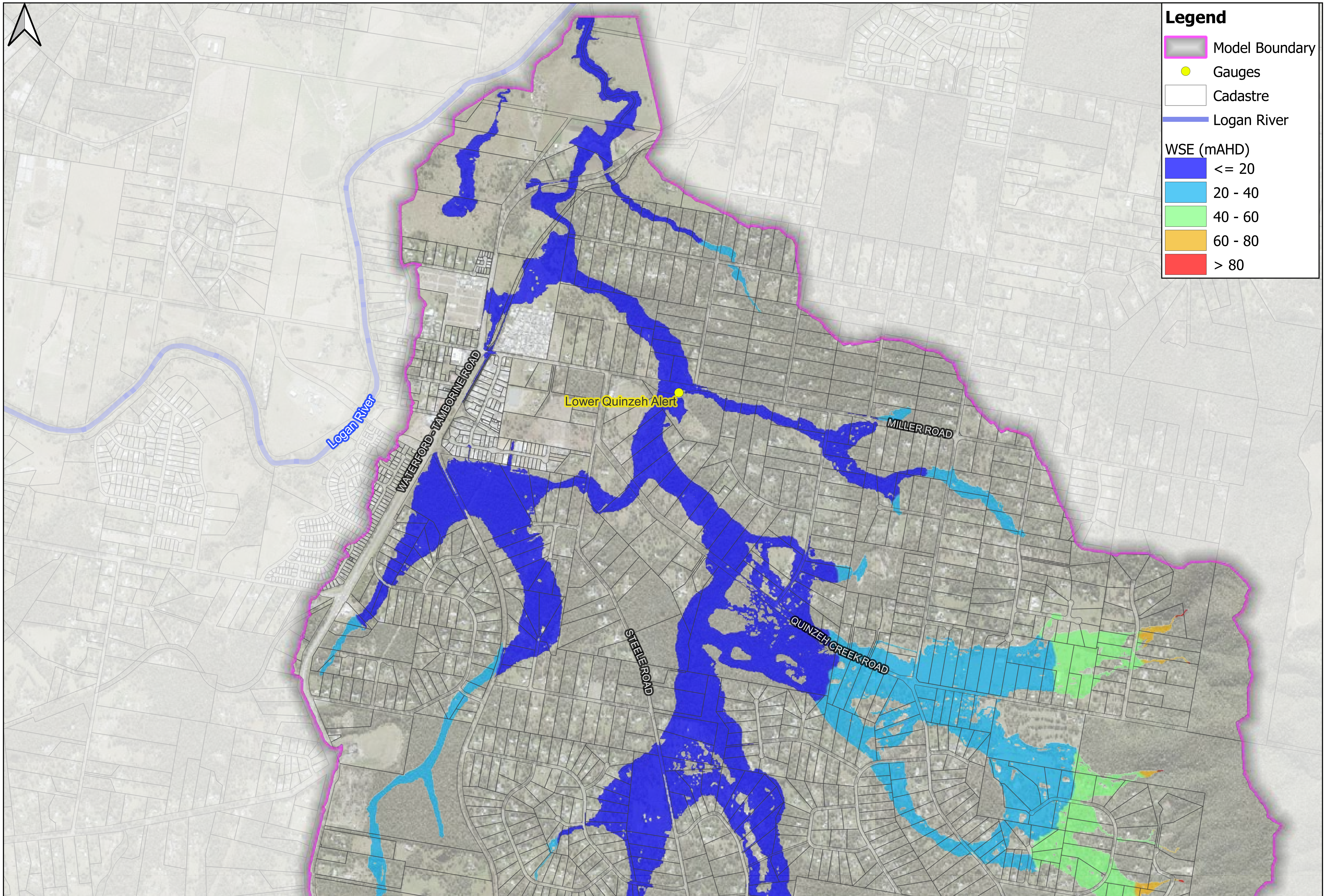
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Peak Water Surface Elevation - Inset 2



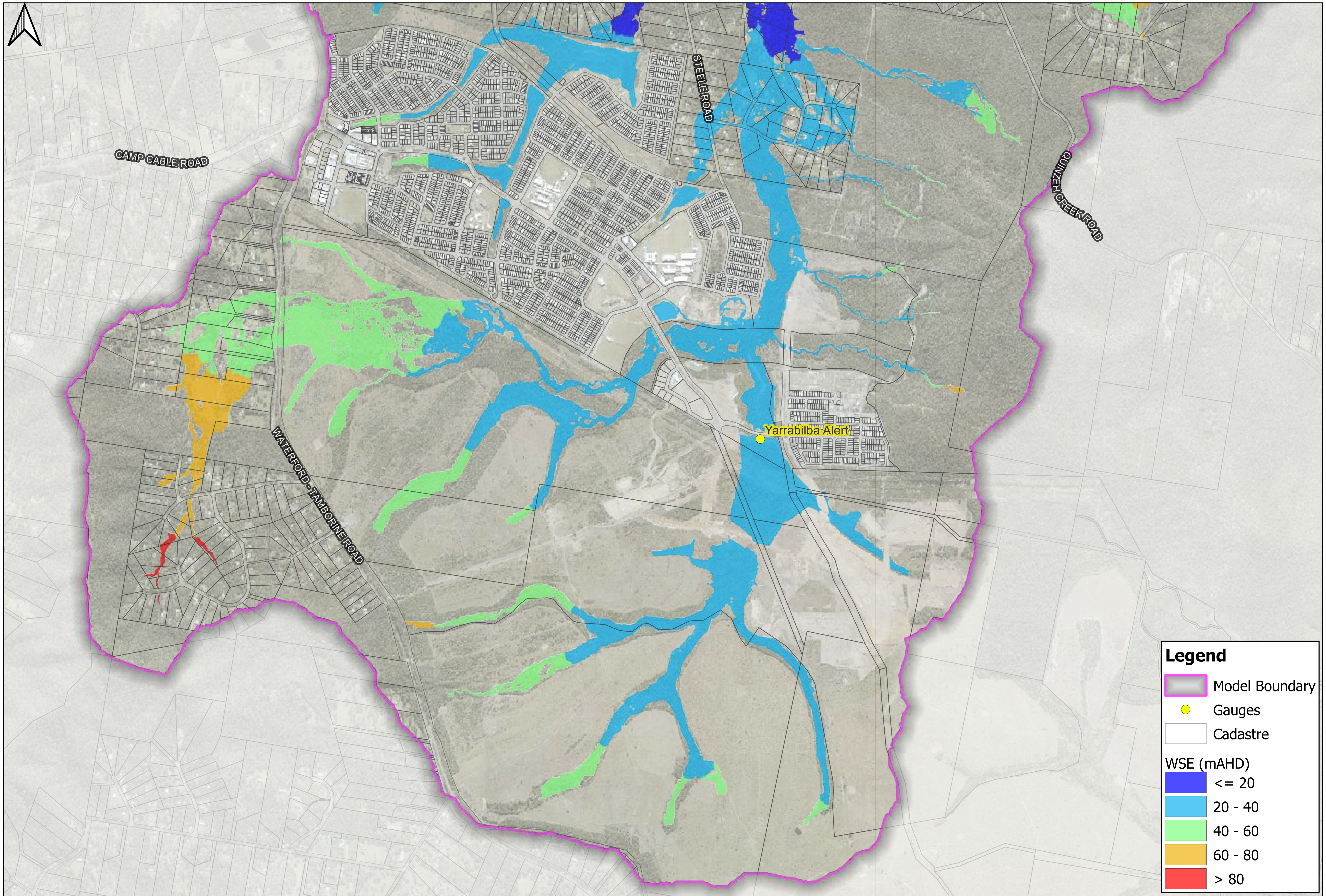
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1



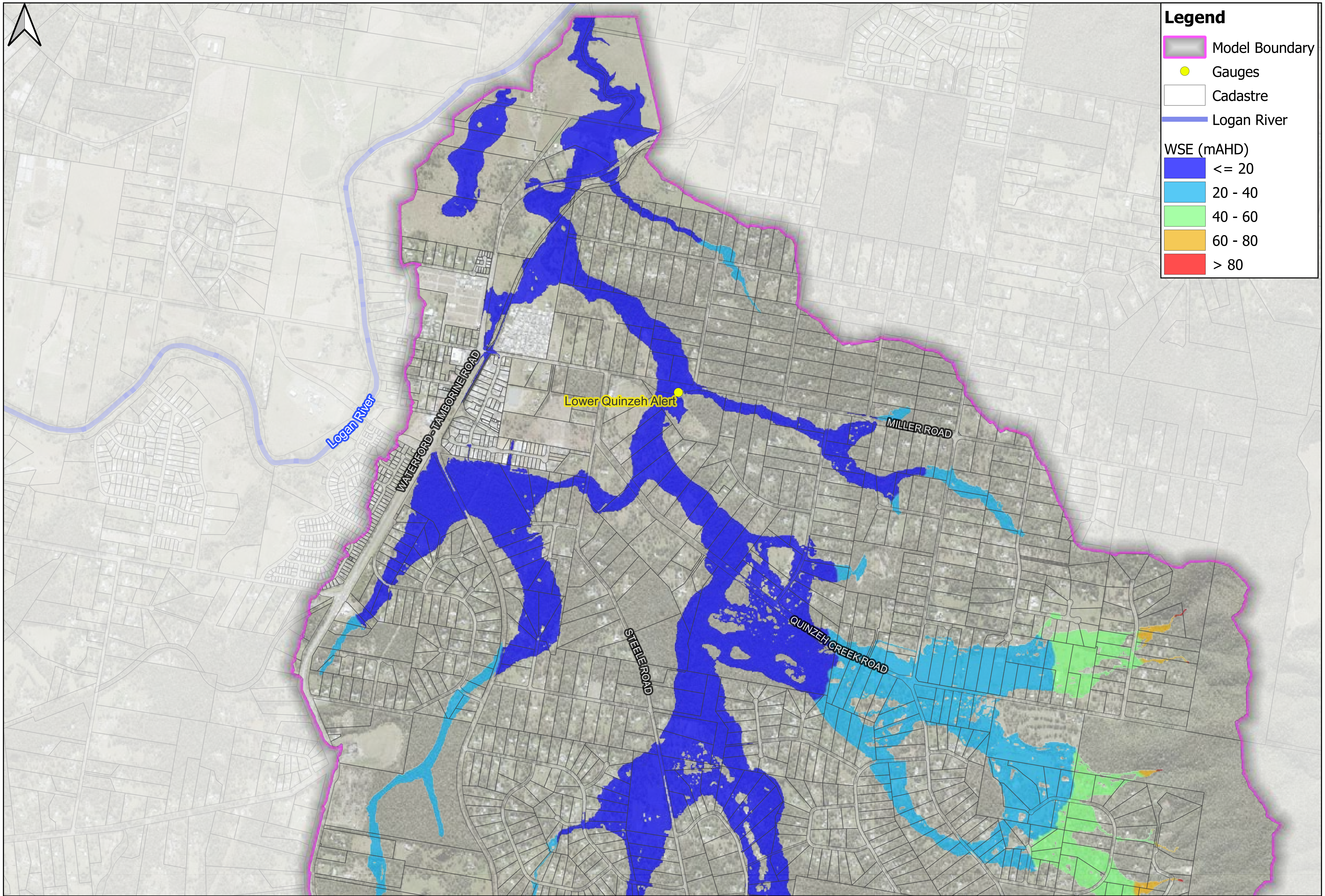
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2



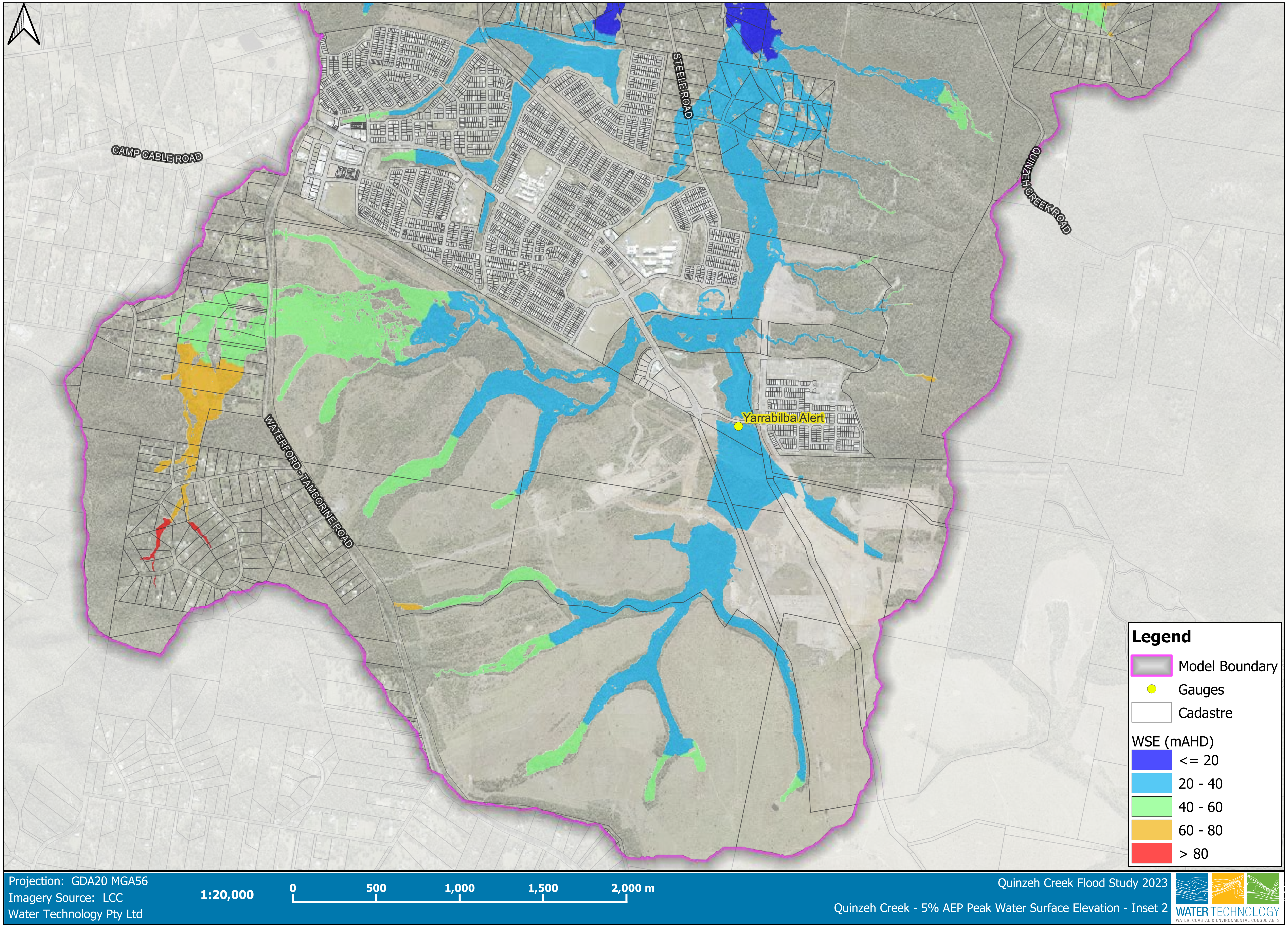
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

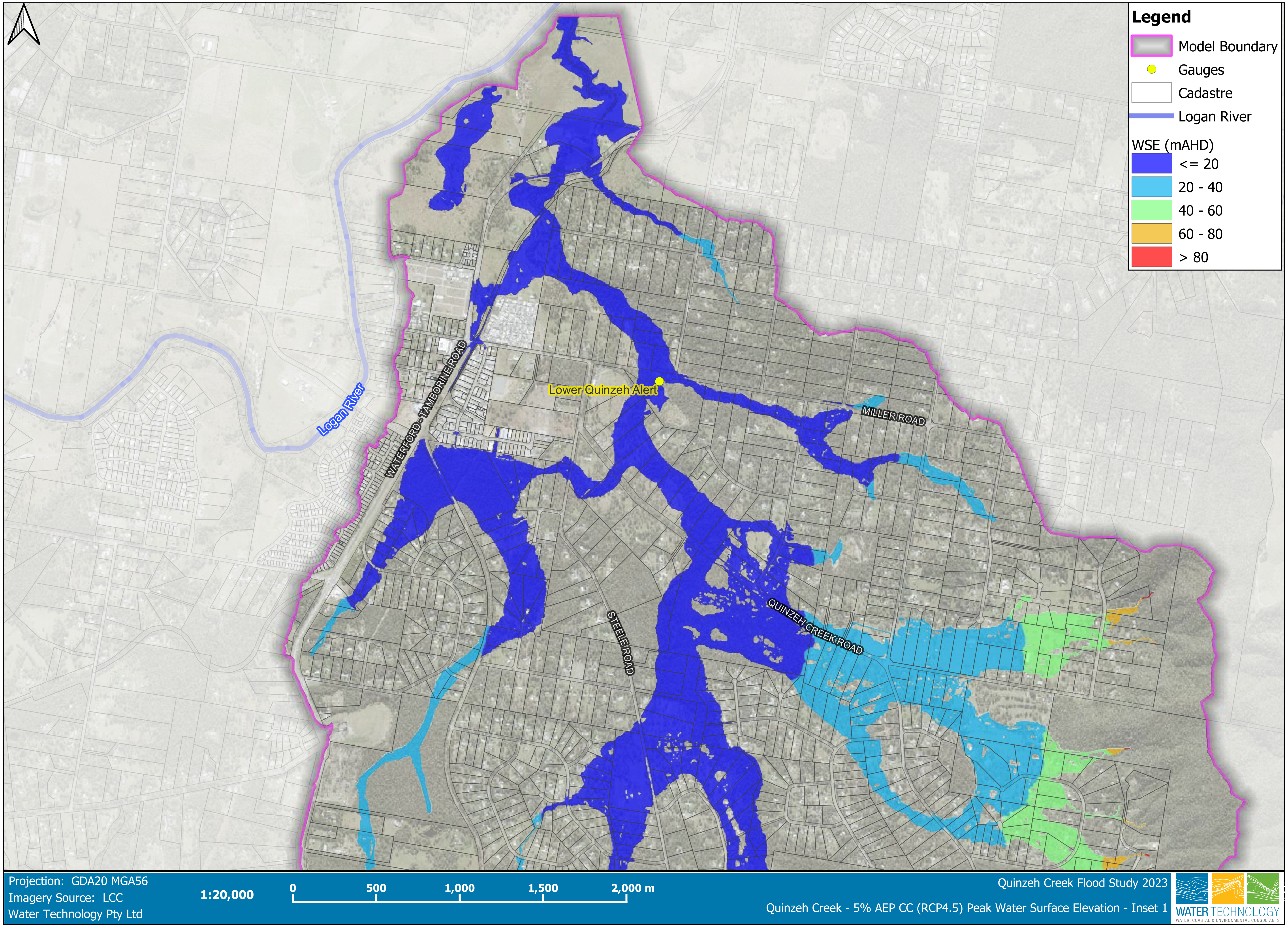
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

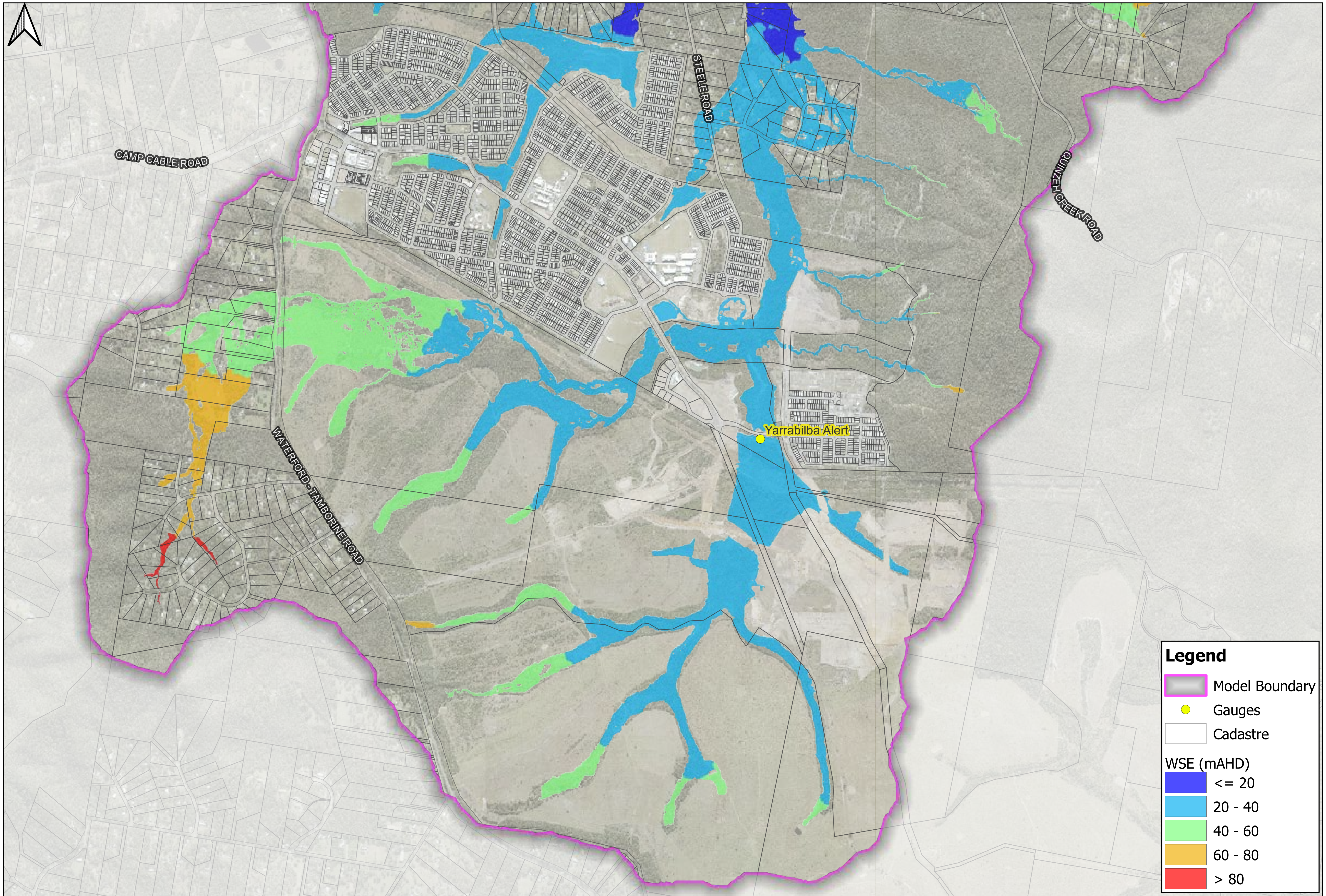
Quinzeh Creek - 5% AEP Peak Water Surface Elevation - Inset 1



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
WSE (mAHD)
<= 20
20 - 40
40 - 60
60 - 80
> 80
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 5% AEP Peak Water Surface Elevation - Inset 2
WATER TECHNOLOGY



Legend
Model Boundary
Gauges
Cadastre
Logan River
WSE (mAHD)
<= 20
20 - 40
40 - 60
60 - 80
> 80
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

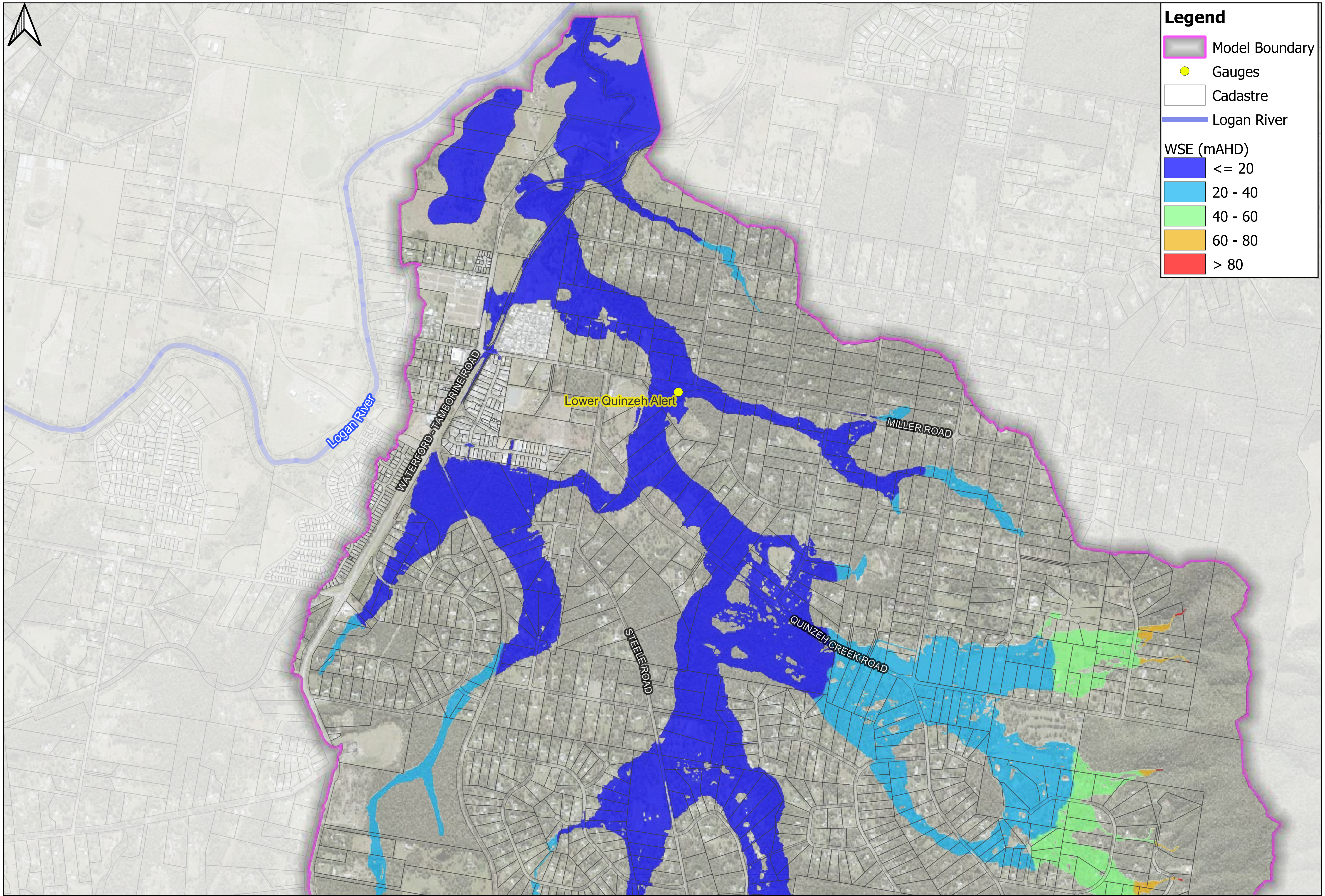
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY



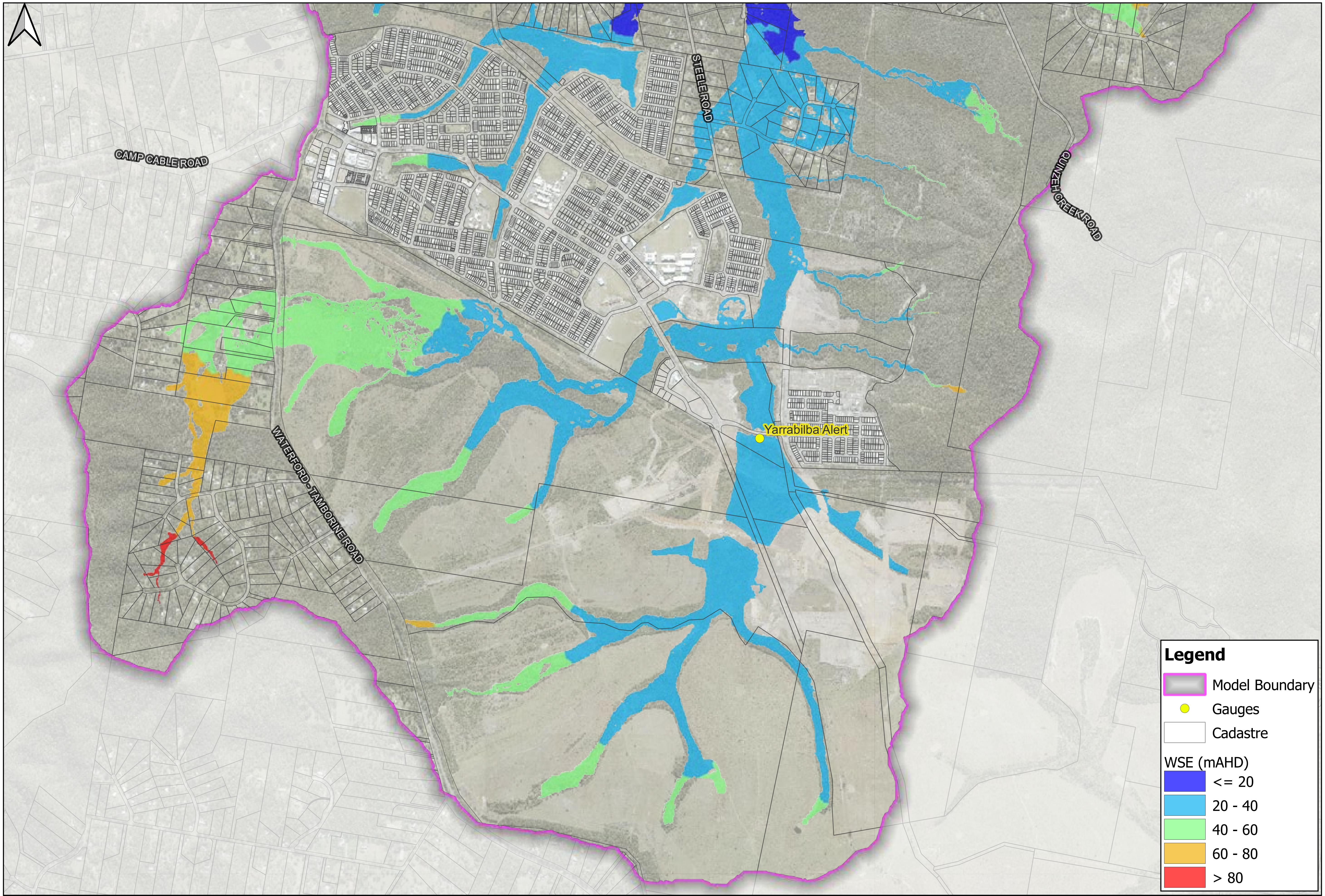
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Surface Elevation - Inset 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

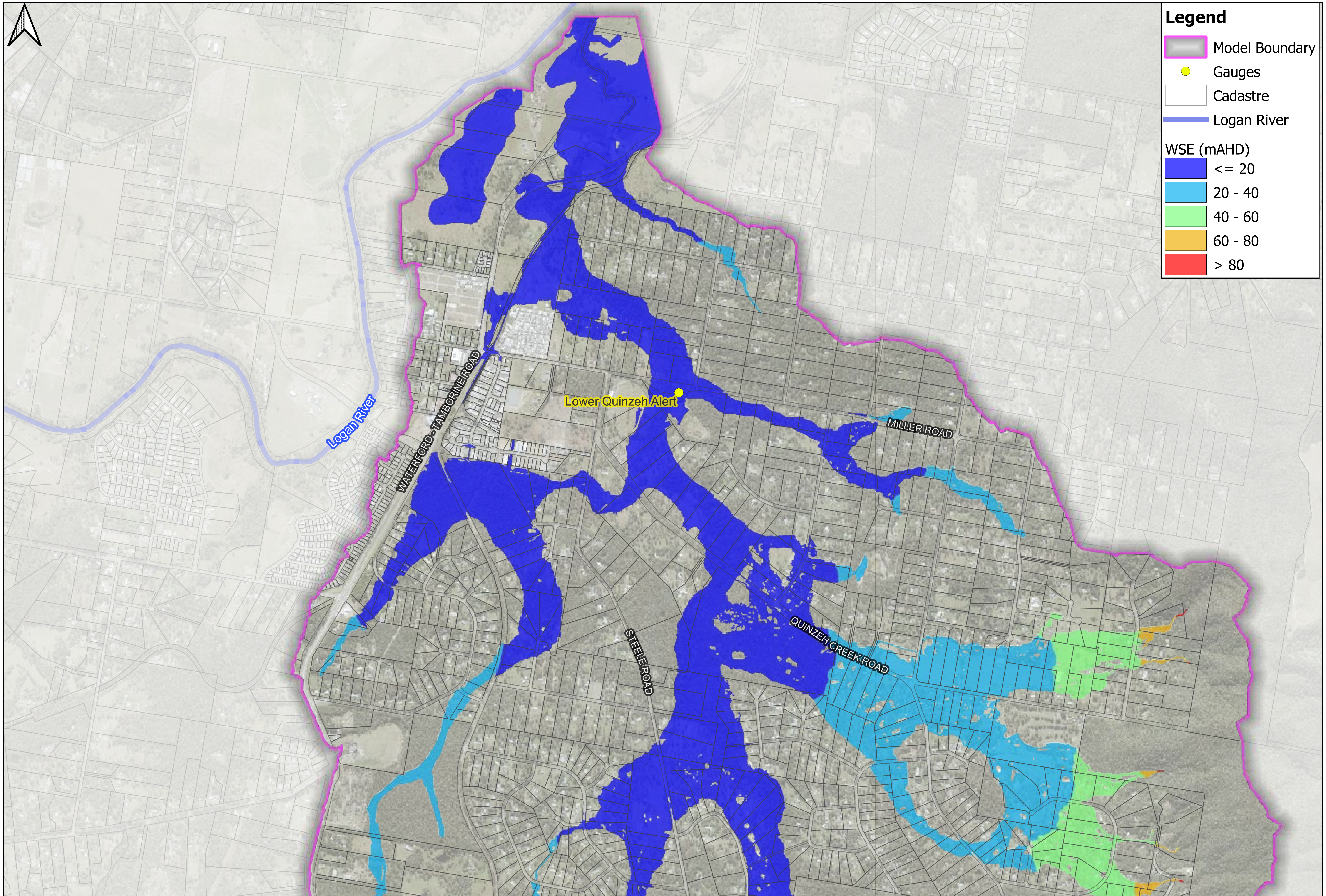
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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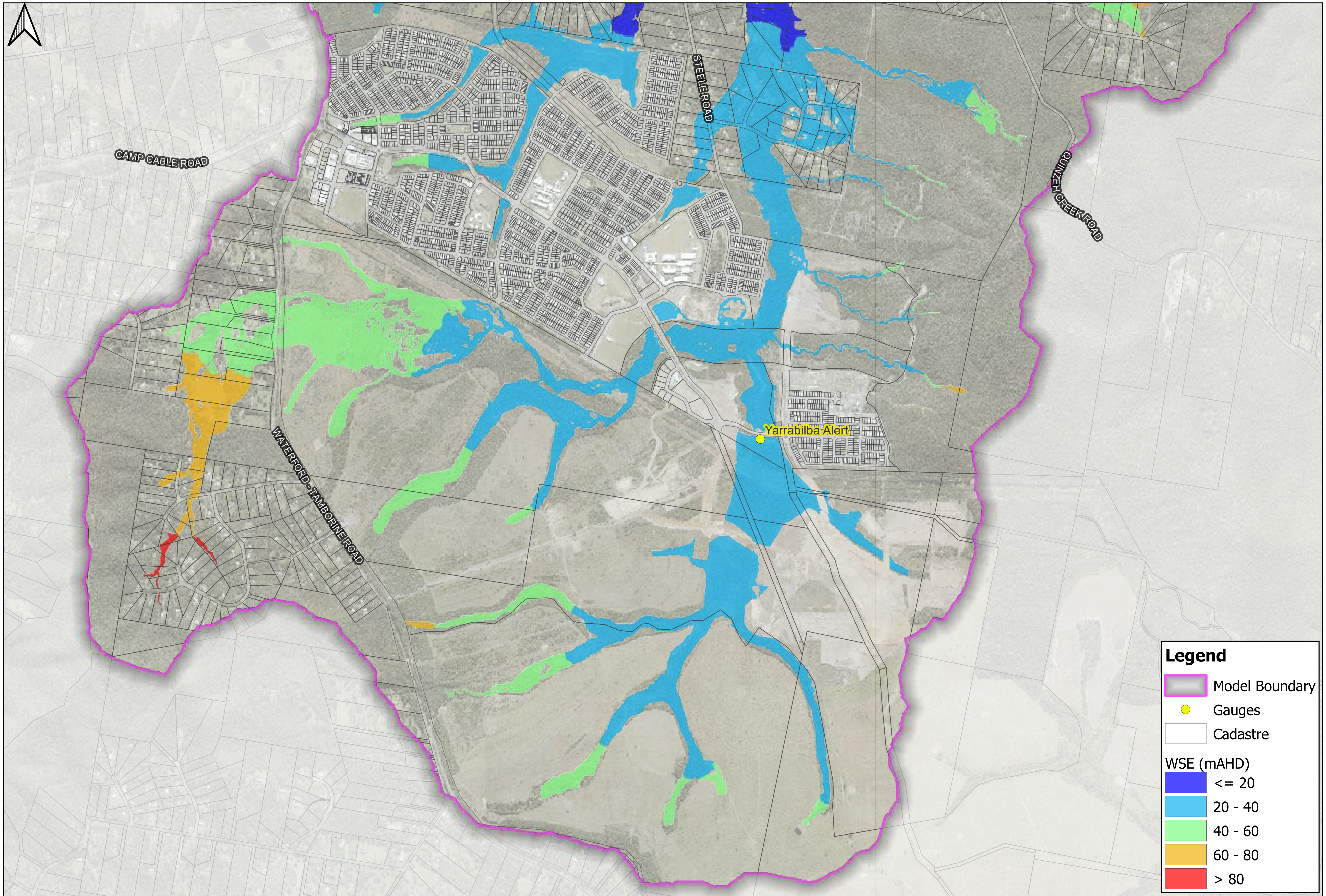
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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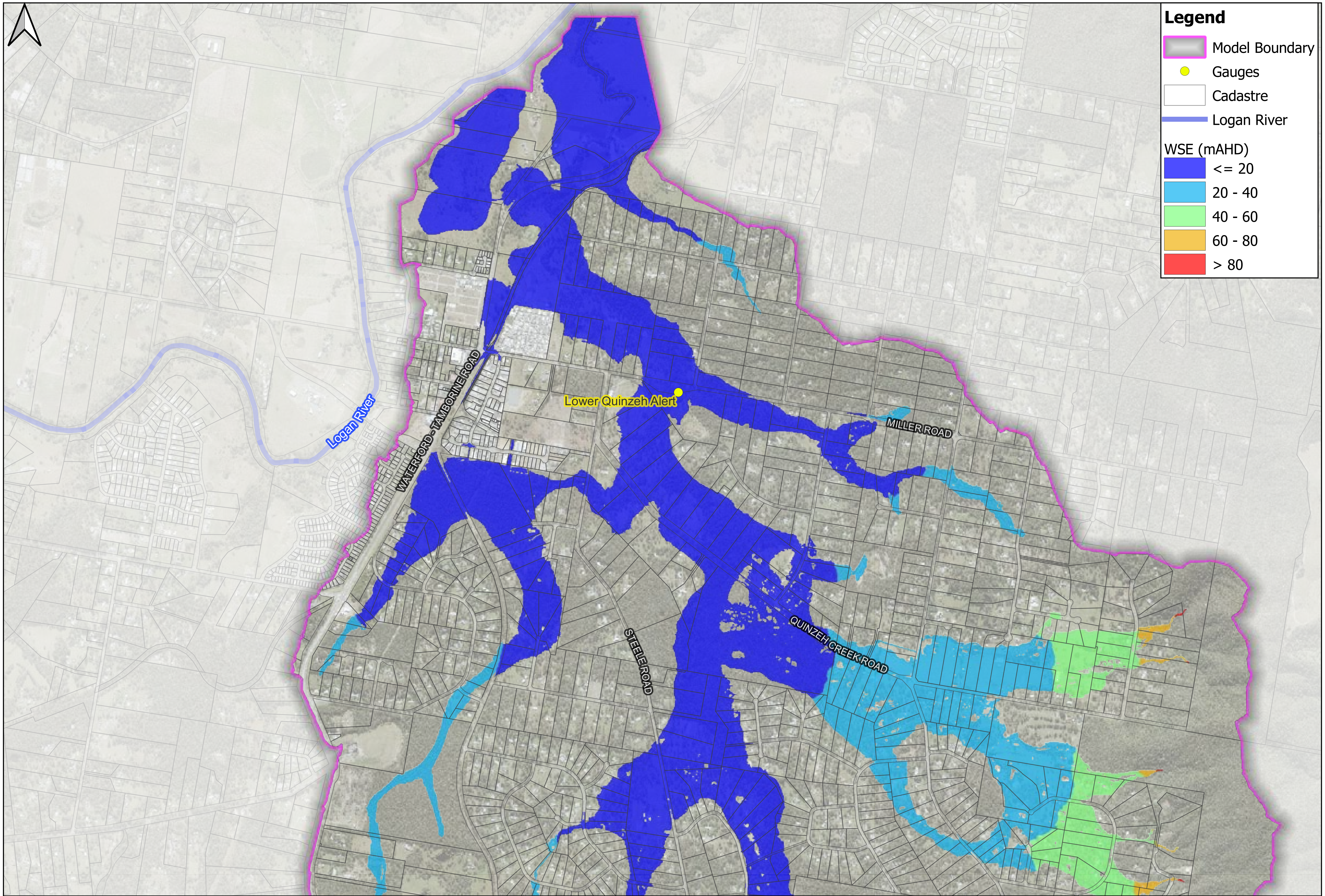
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2



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Water Technology Pty Ltd

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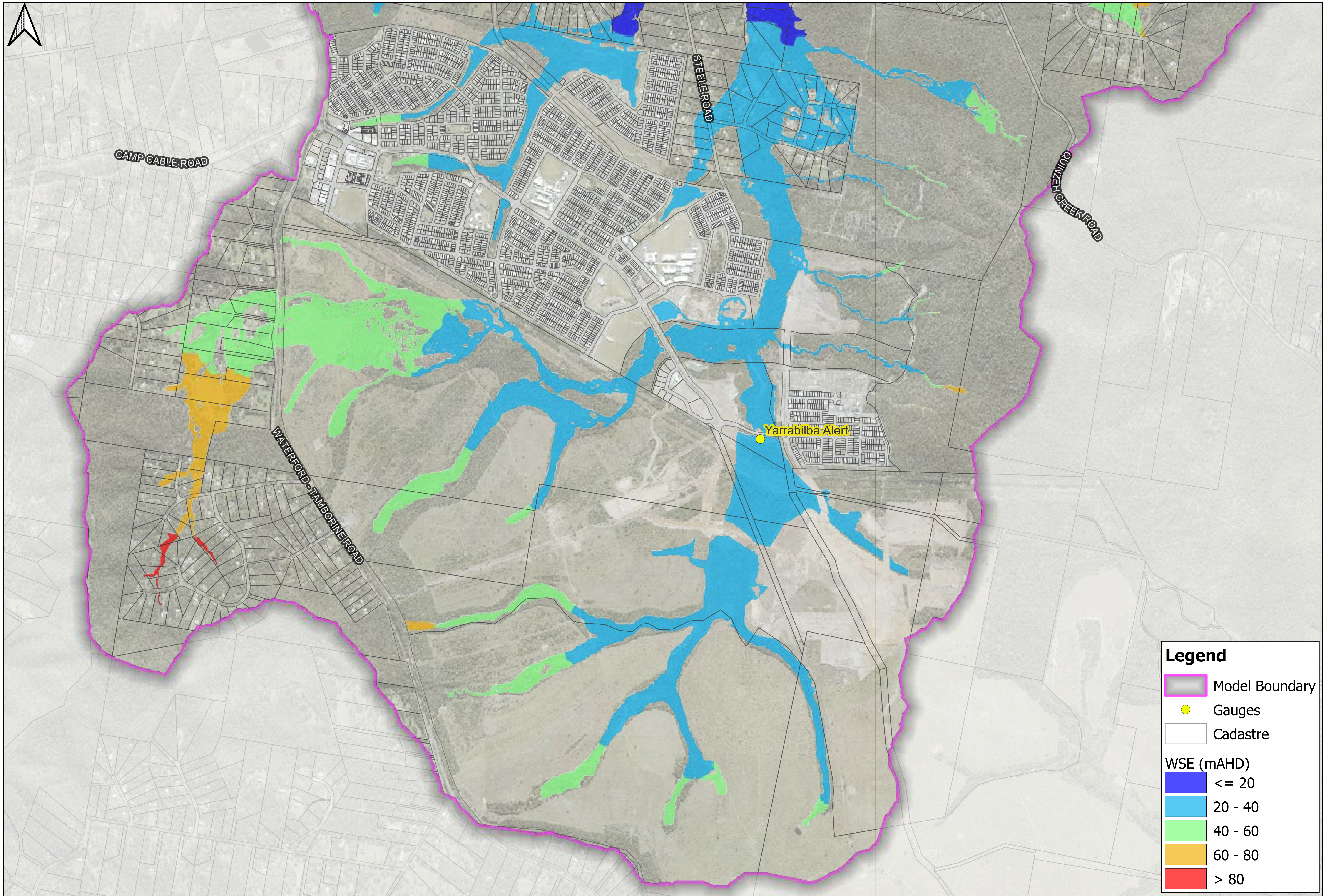
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Surface Elevation - Inset 1



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Water Technology Pty Ltd

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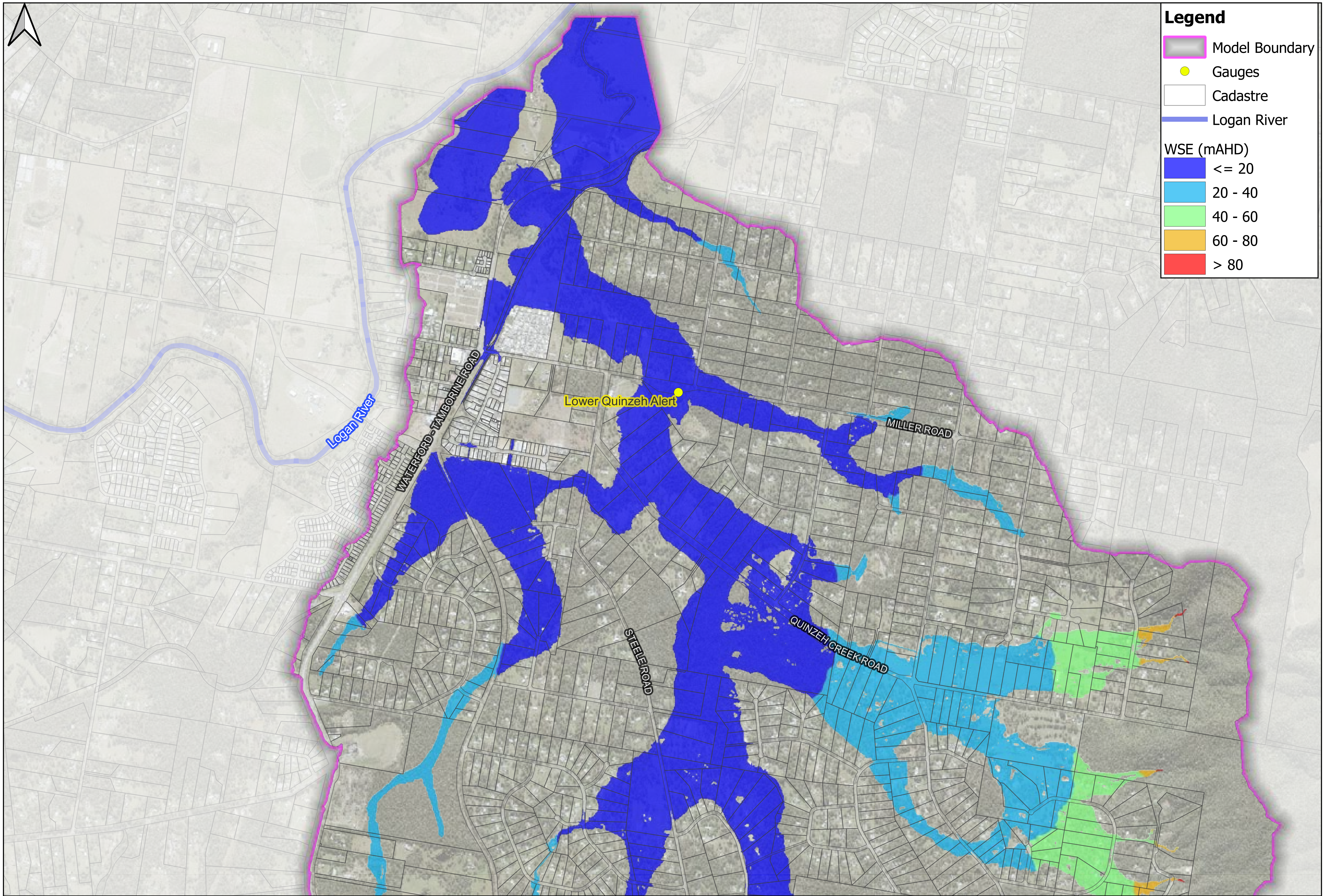
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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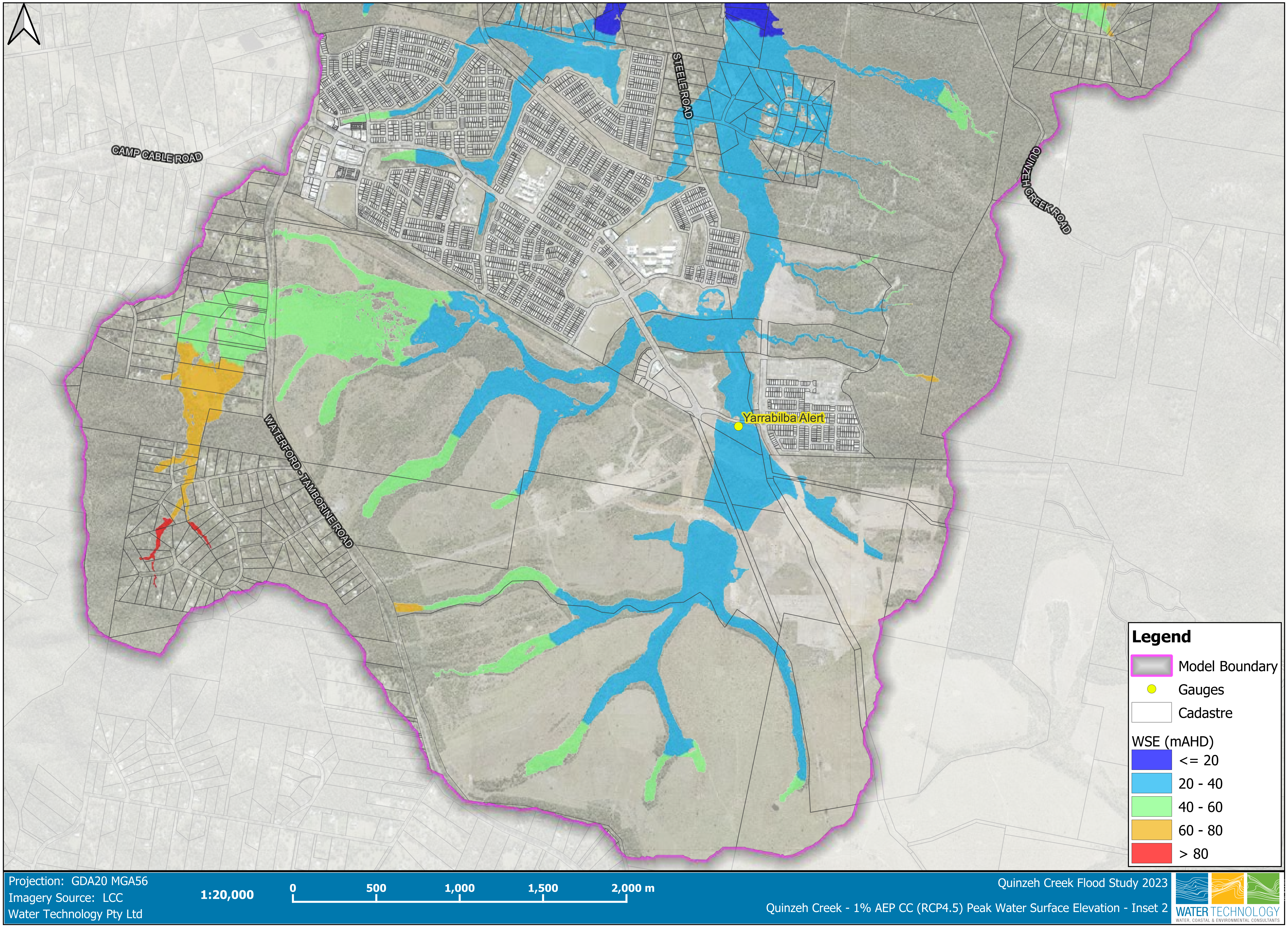
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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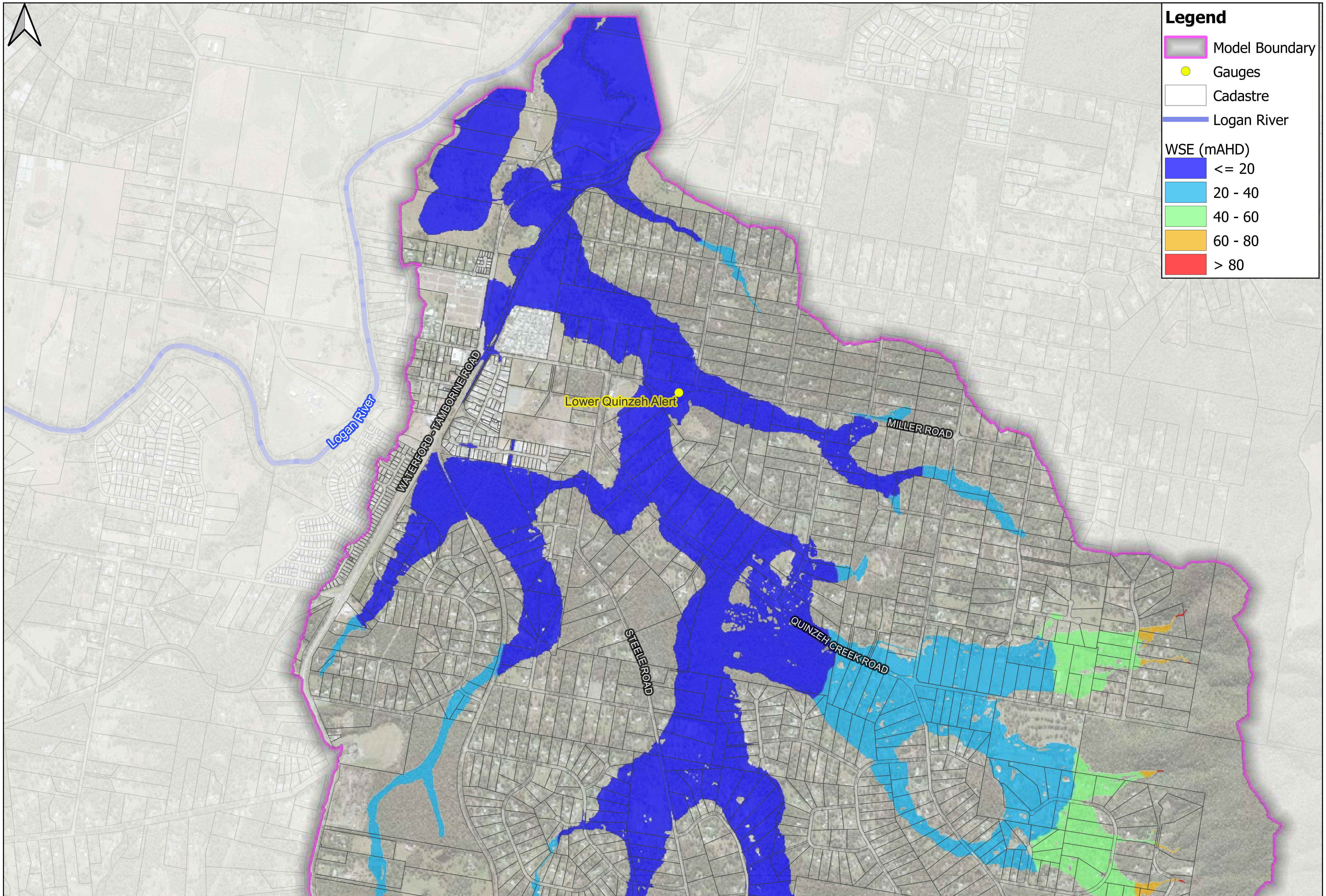
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2



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Water Technology Pty Ltd

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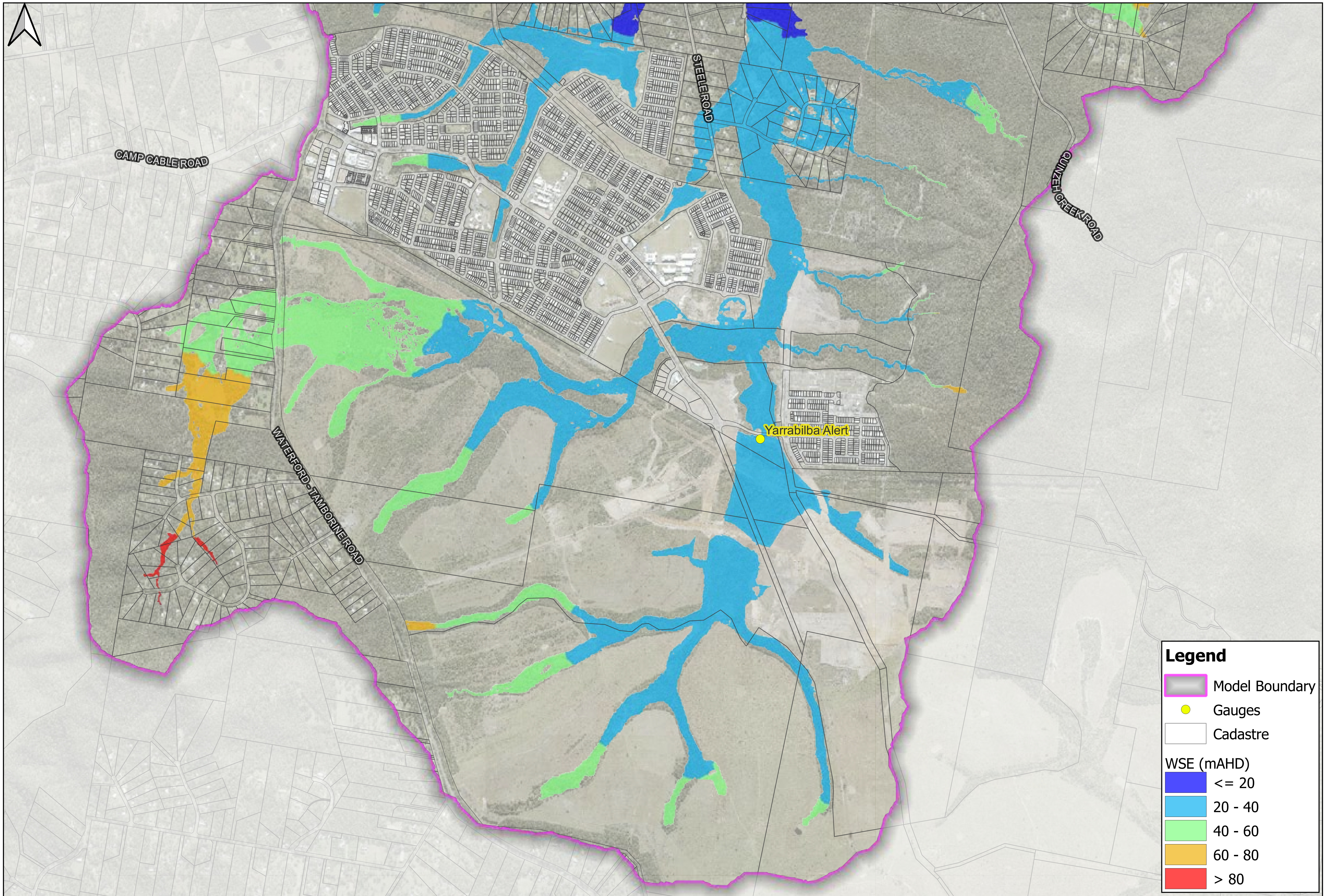
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Surface Elevation - Inset 1



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Water Technology Pty Ltd

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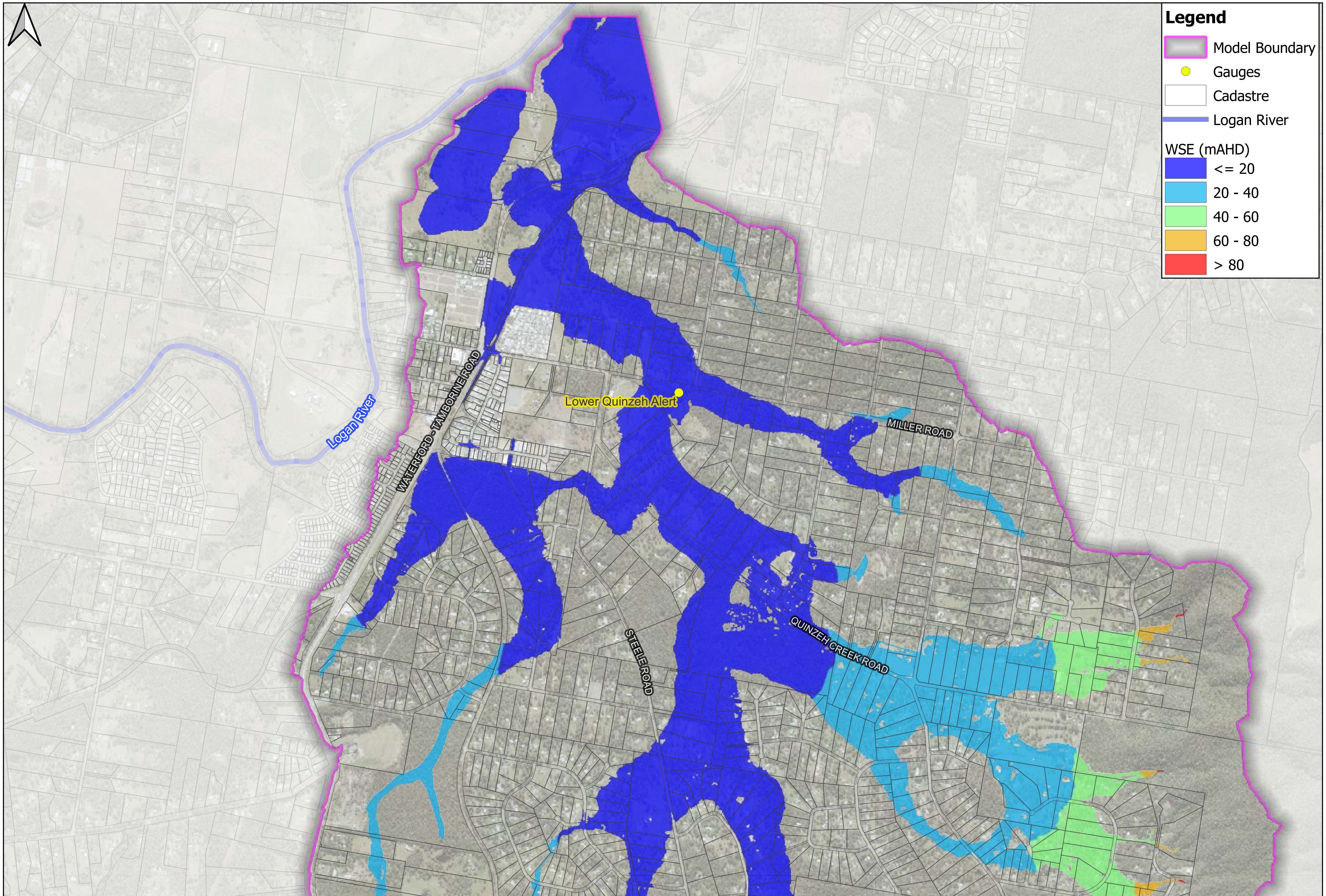
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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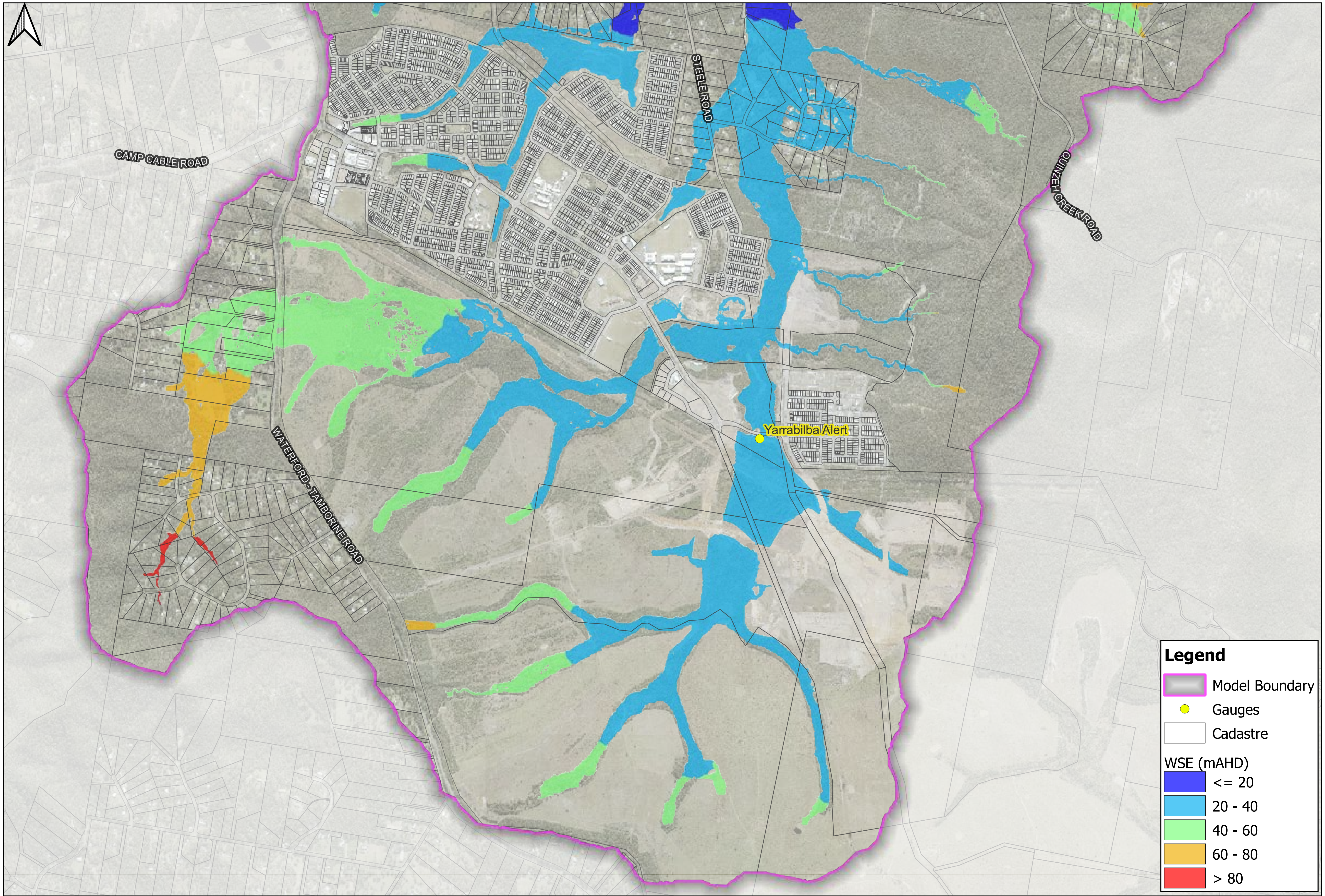
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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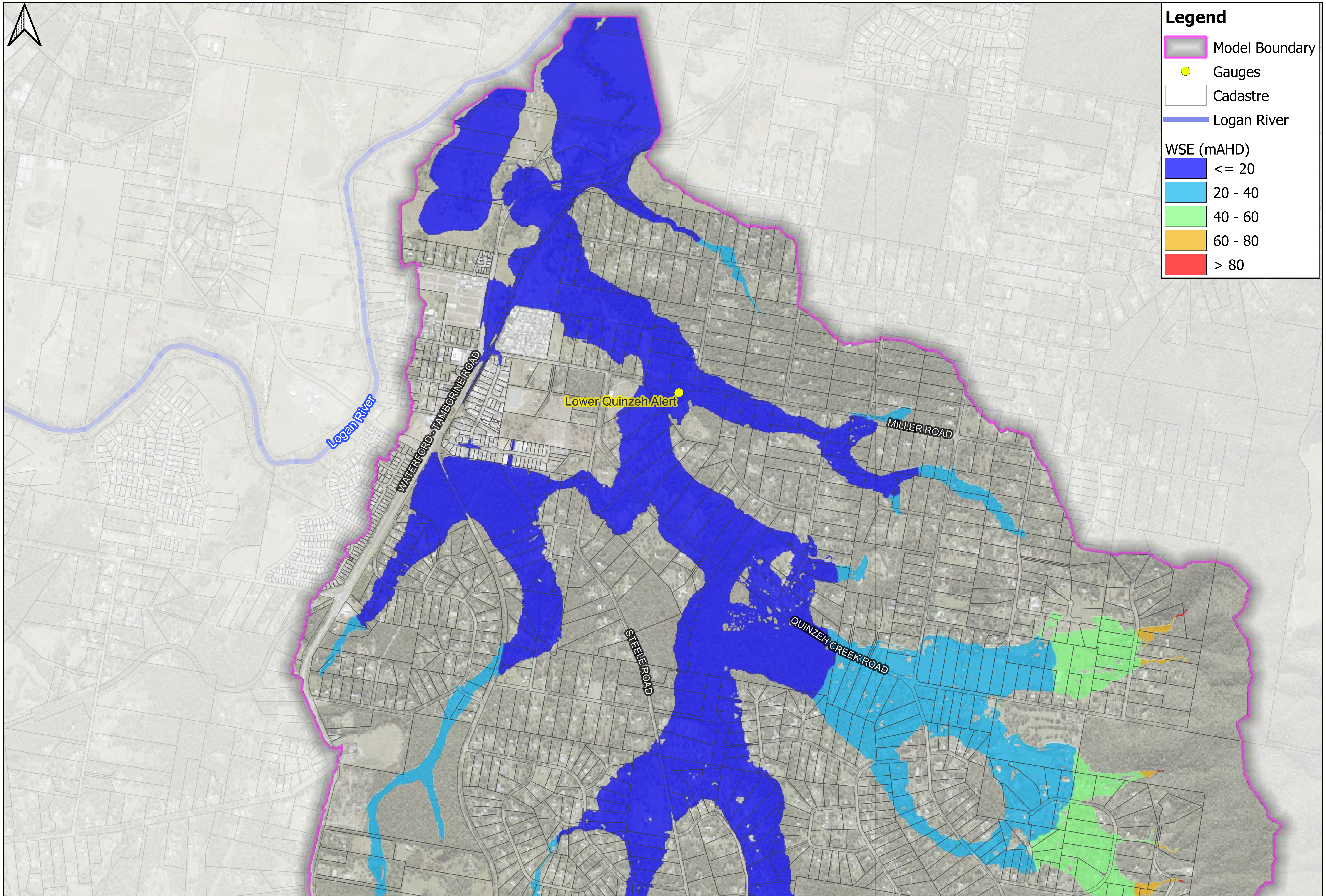
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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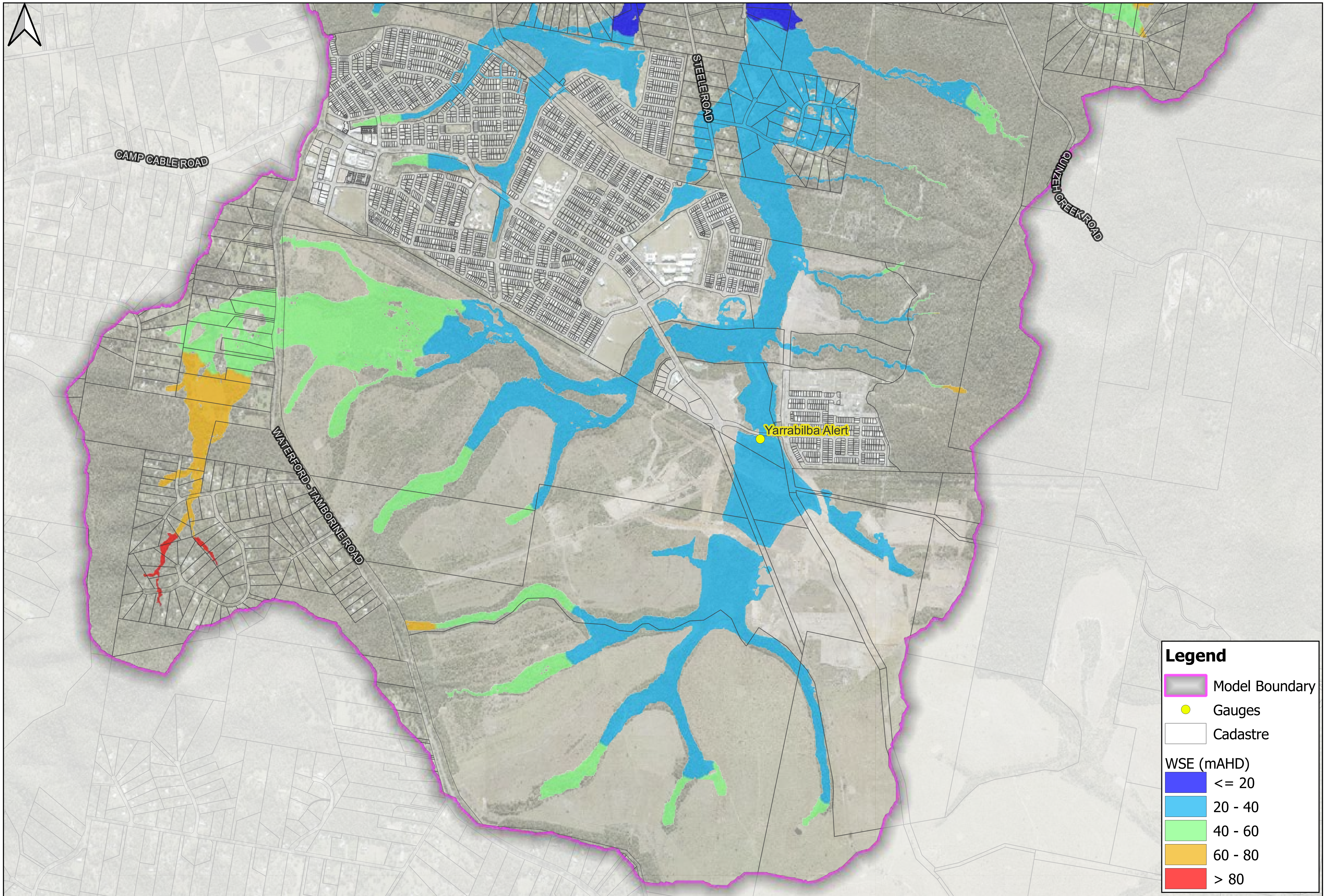
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.2% AEP Peak Water Surface Elevation - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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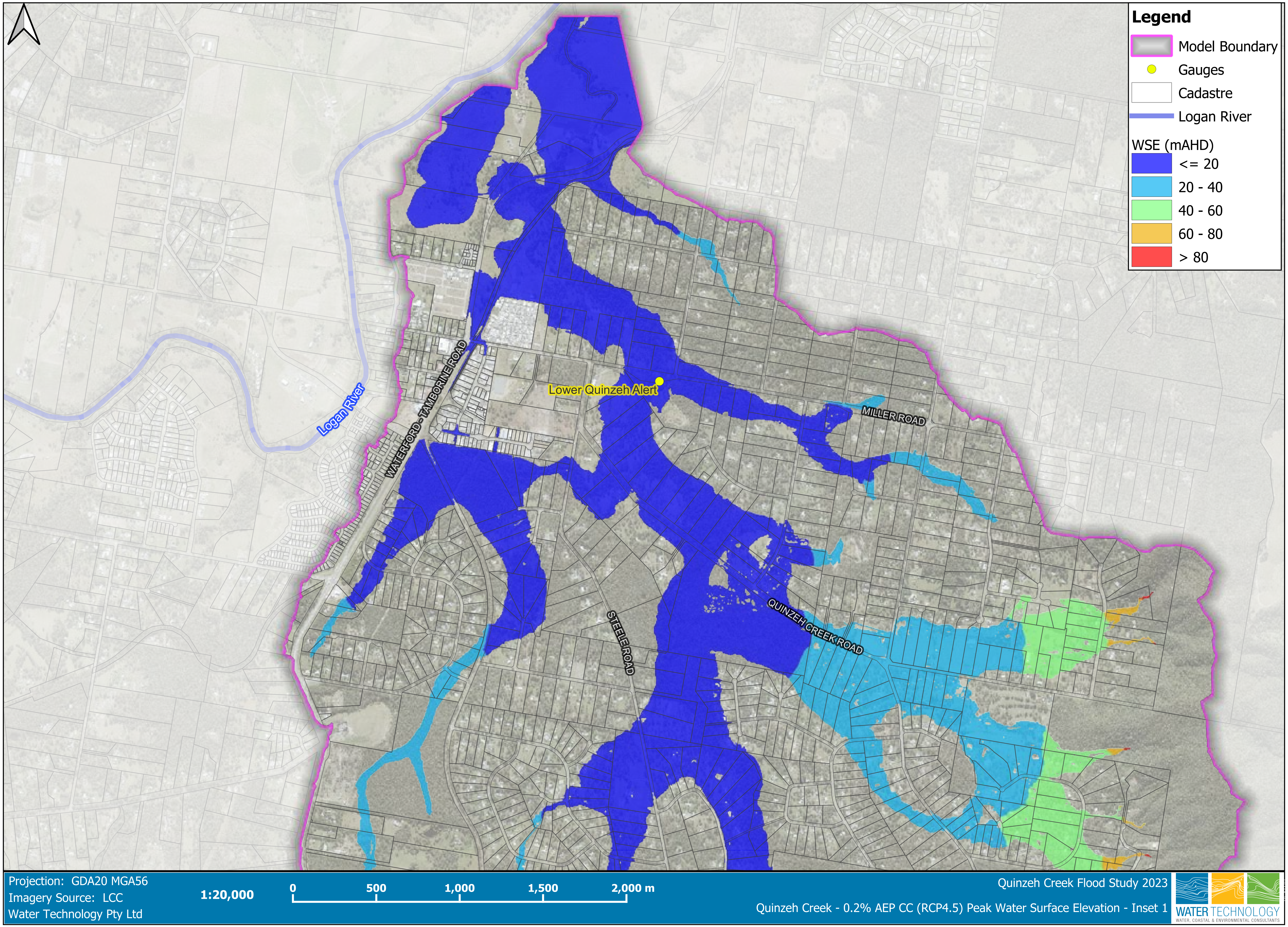
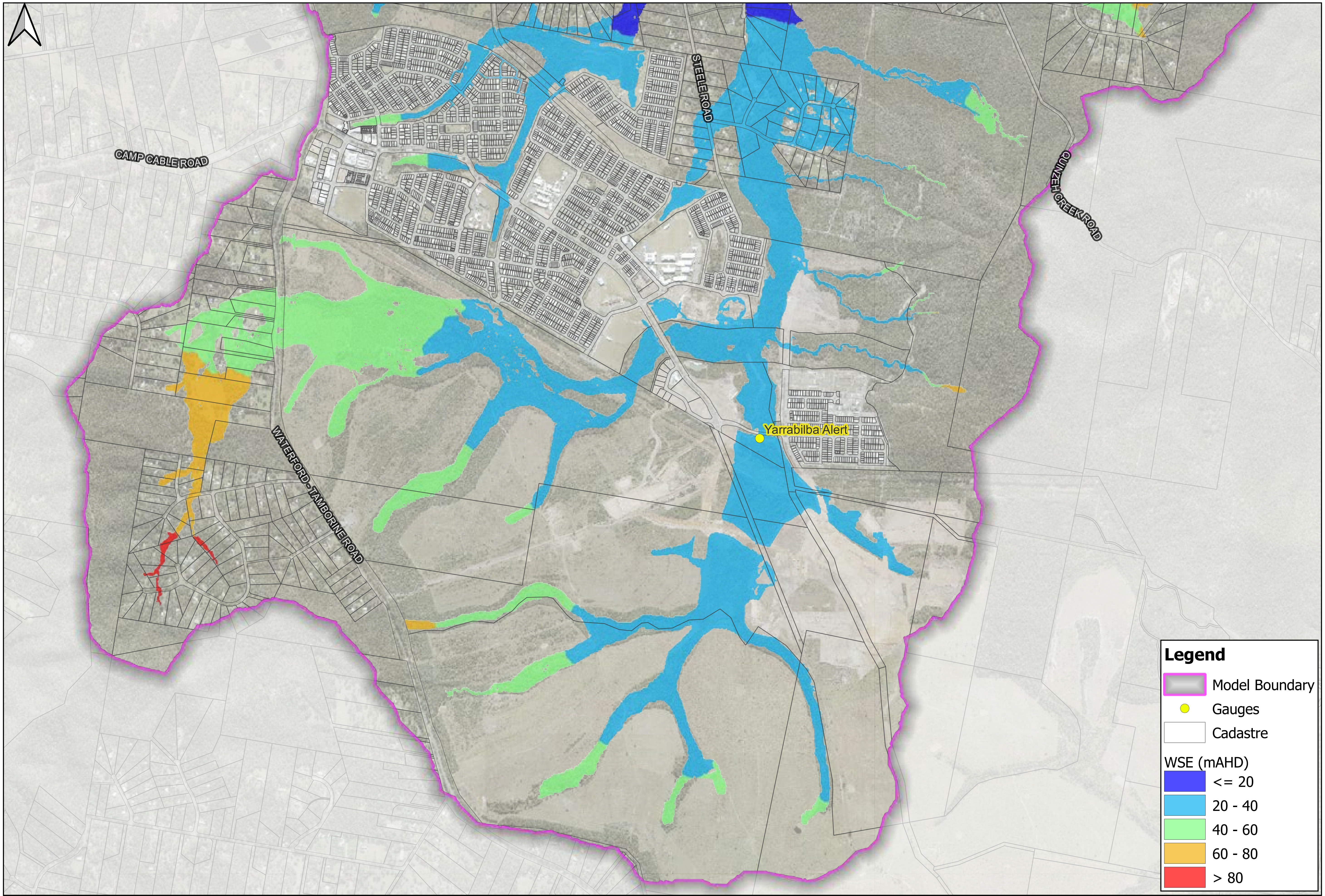
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY


Legend
Model Boundary
Gauges
Cadastre
Logan River
WSE (mAHD)
<= 20
20 - 40
40 - 60
60 - 80
> 80
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 1
WATER TECHNOLOGY



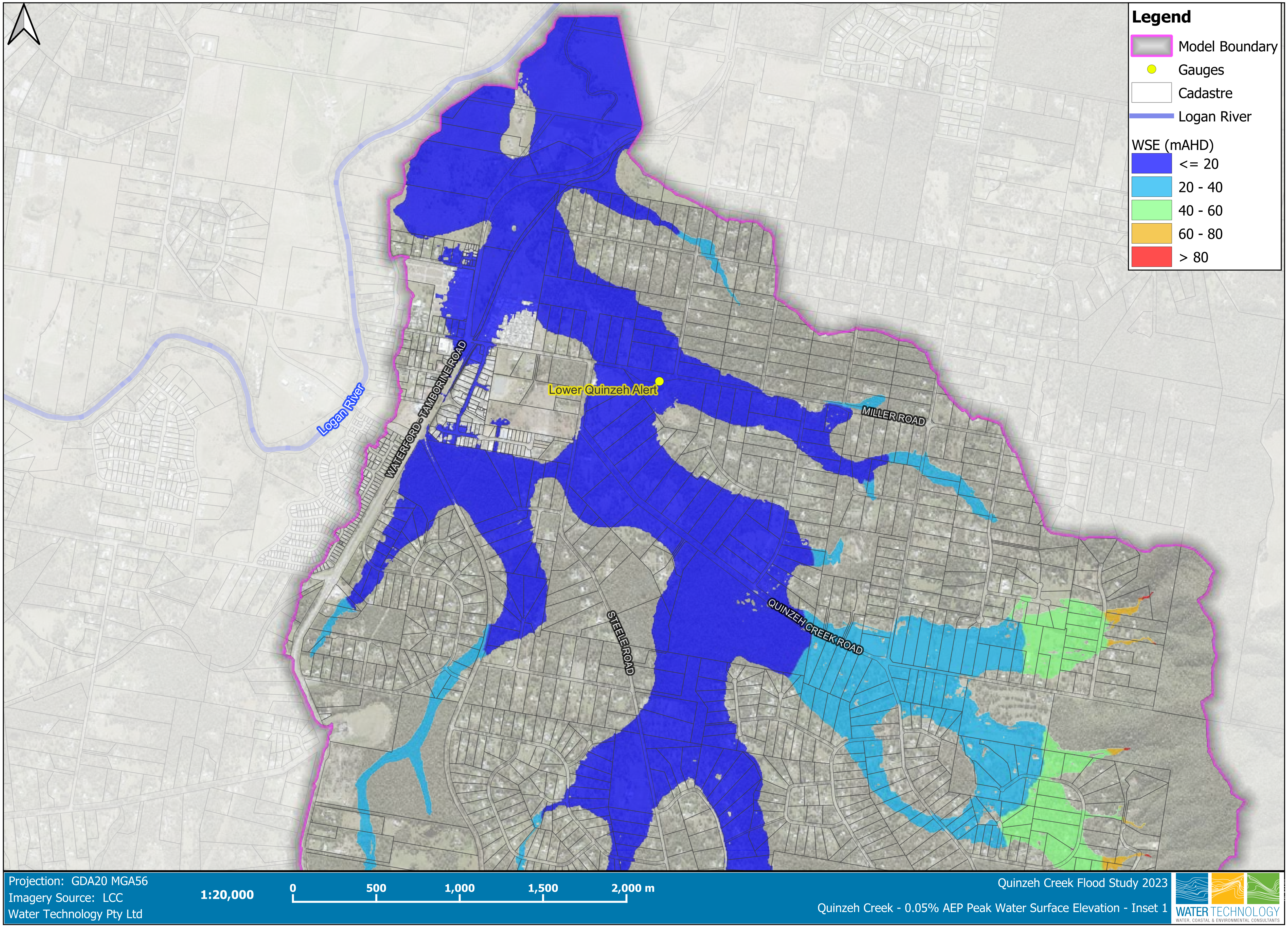
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

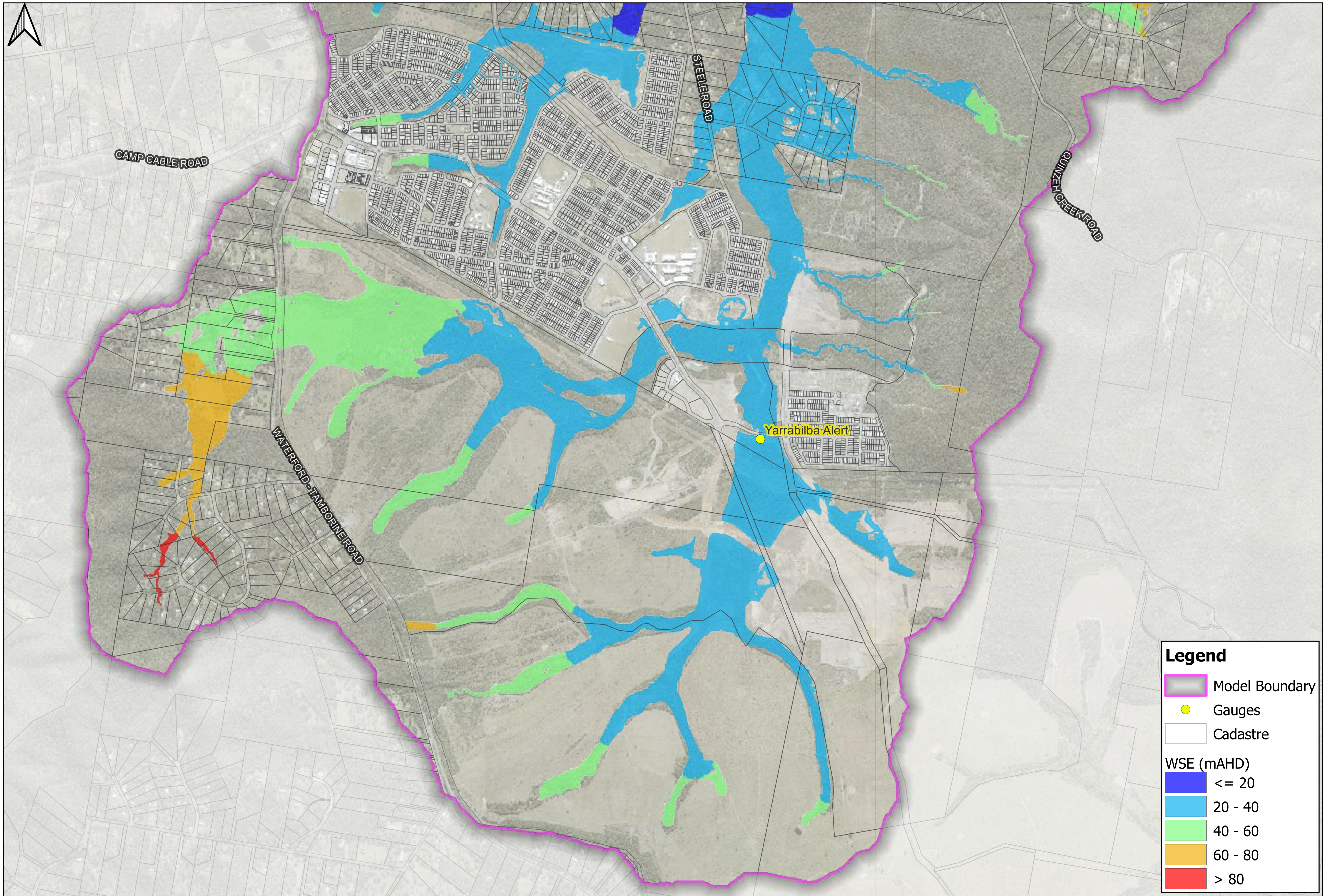
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Surface Elevation - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
WSE (mAHD)
<= 20
20 - 40
40 - 60
60 - 80
> 80
Logan River
Lower Quinzeh Alert
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.05% AEP Peak Water Surface Elevation - Inset 1
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

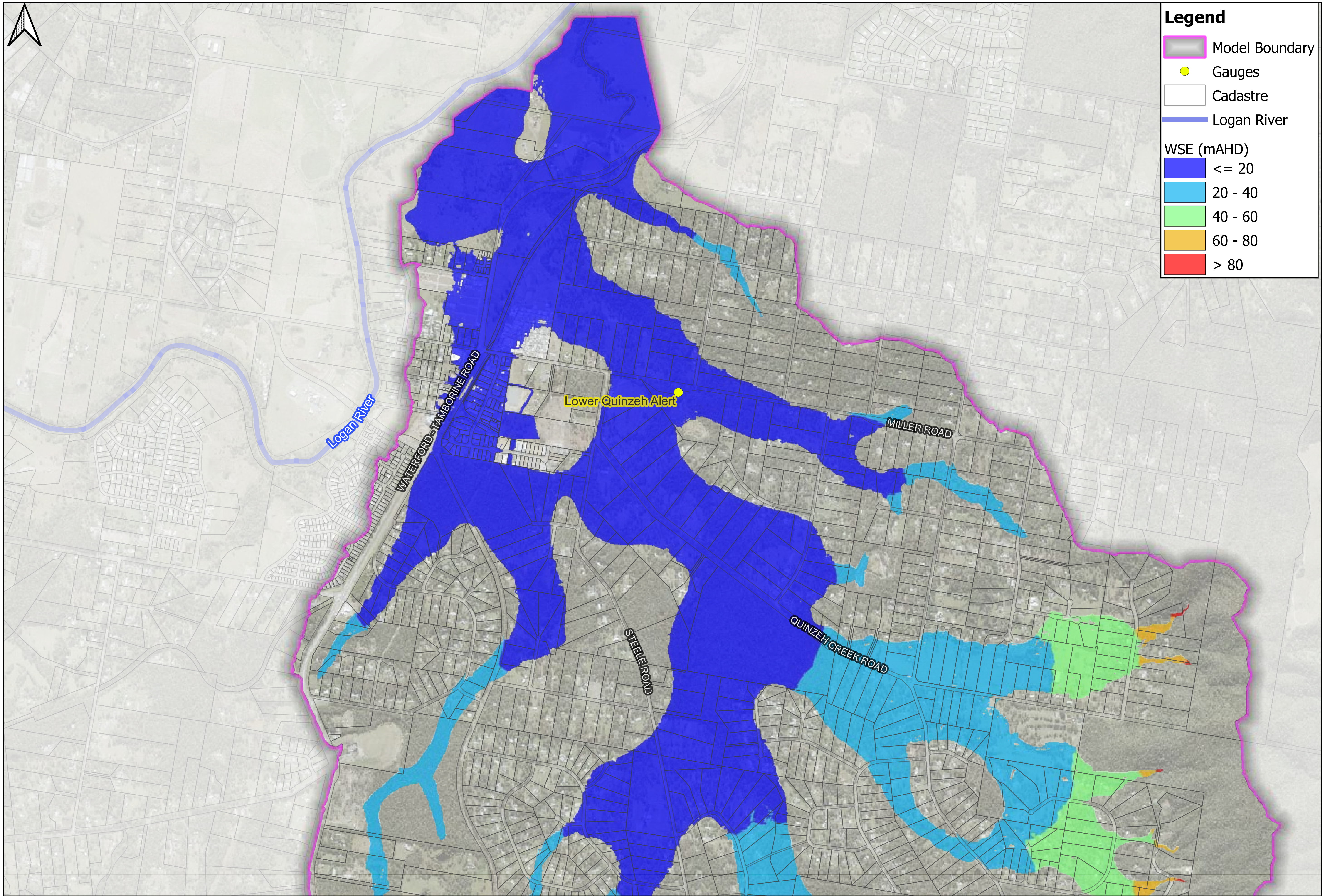
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.05% AEP Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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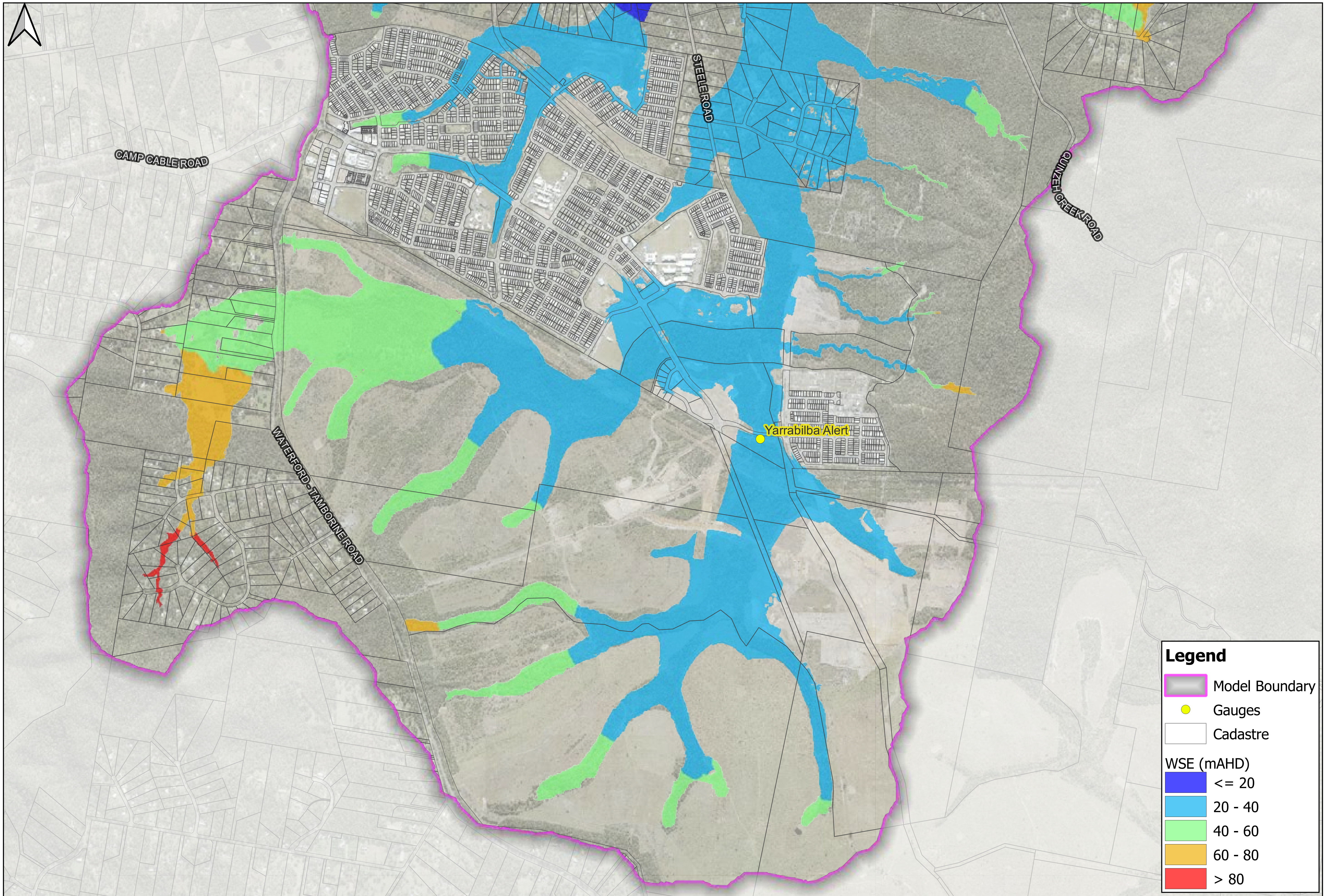
Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Surface Elevation - Inset 1



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Water Technology Pty Ltd

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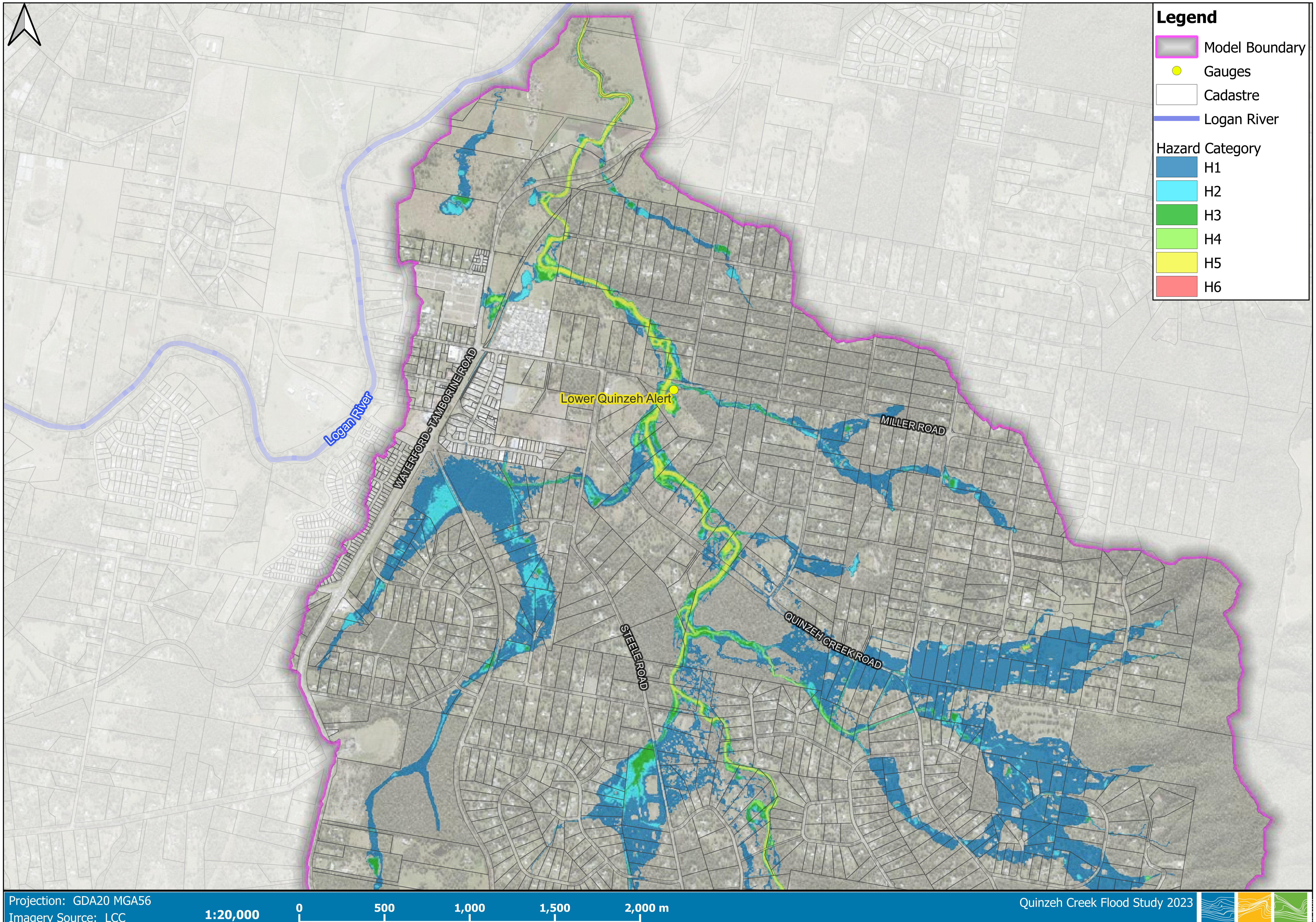
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Surface Elevation - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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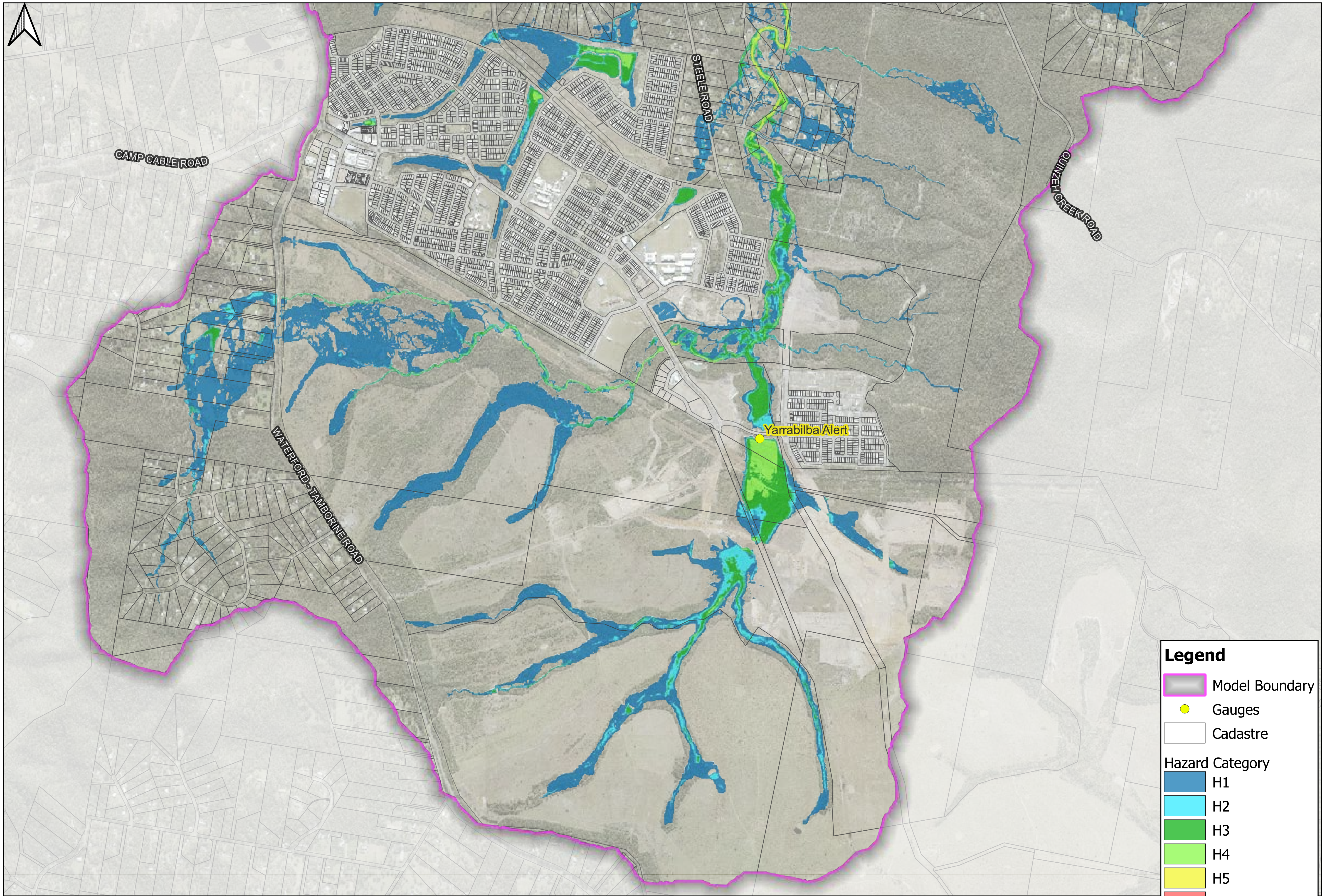
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 63.2% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

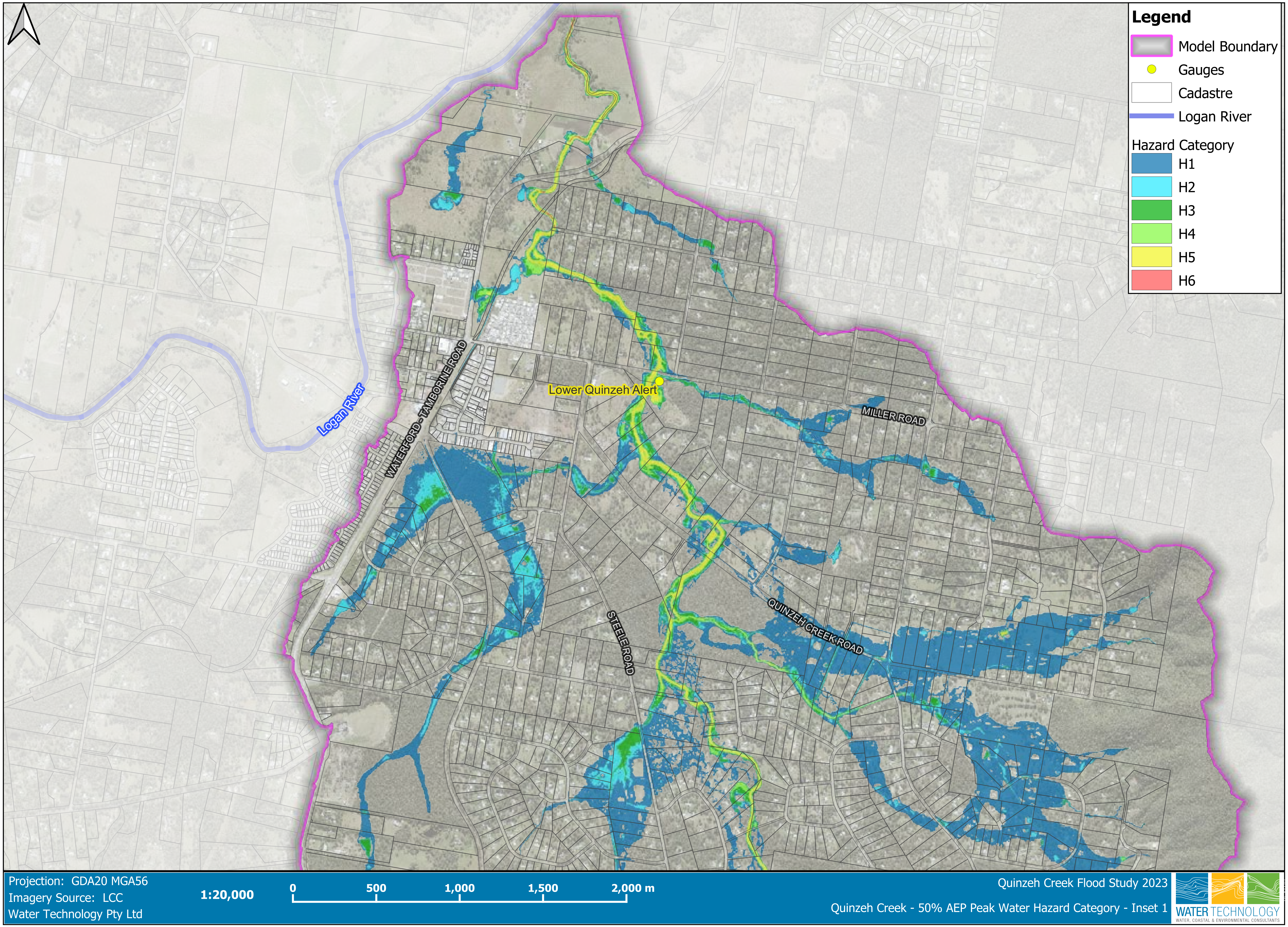
1:20,000

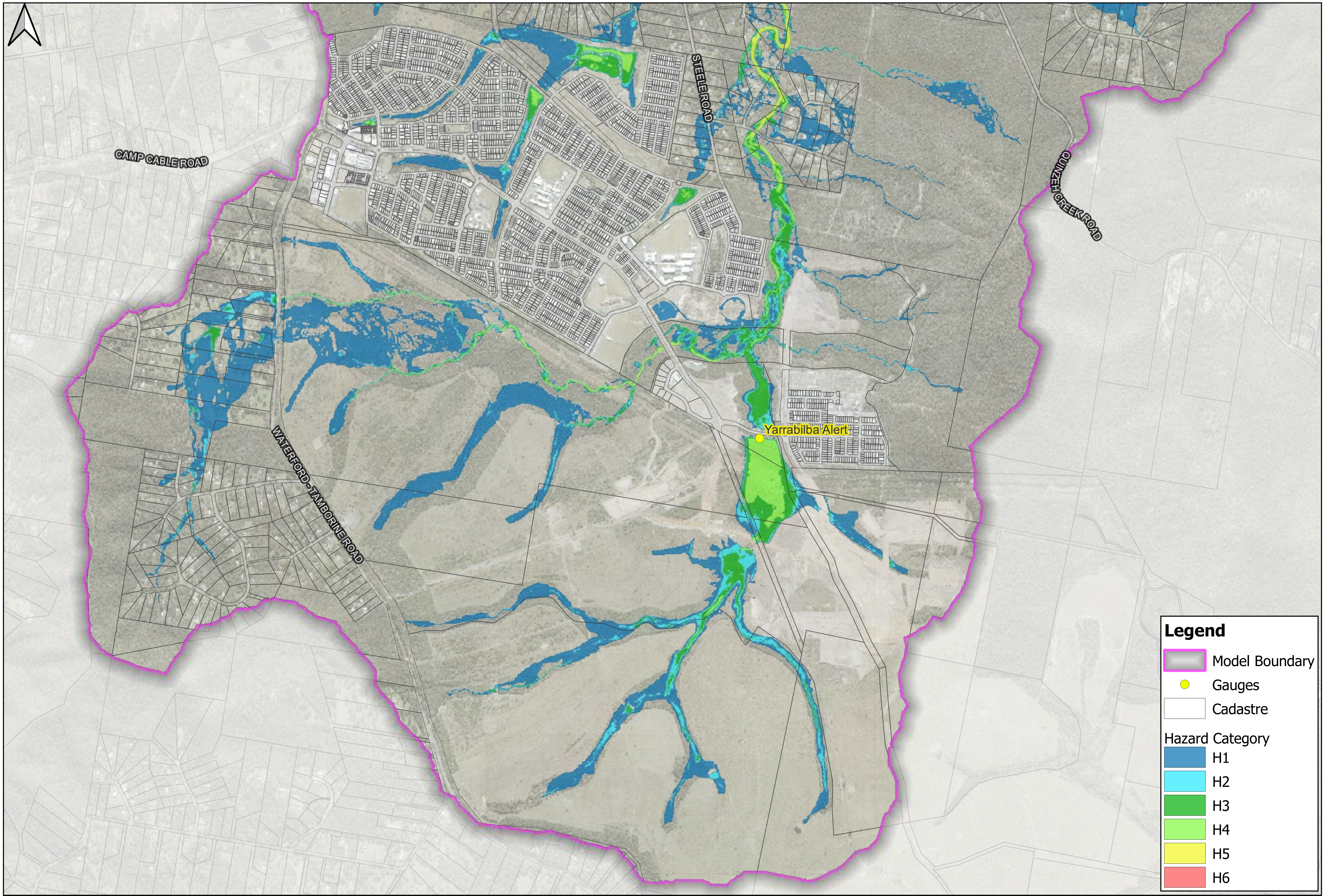
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Stu

Quinzeh Creek - 63.2% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


Legend
Model Boundary
Gauges
Cadastre
Logan River
Hazard Category
H1
H2
H3
H4
H5
H6
Lower Quinzeh Alert
Logan River
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 50% AEP Peak Water Hazard Category - Inset 1
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

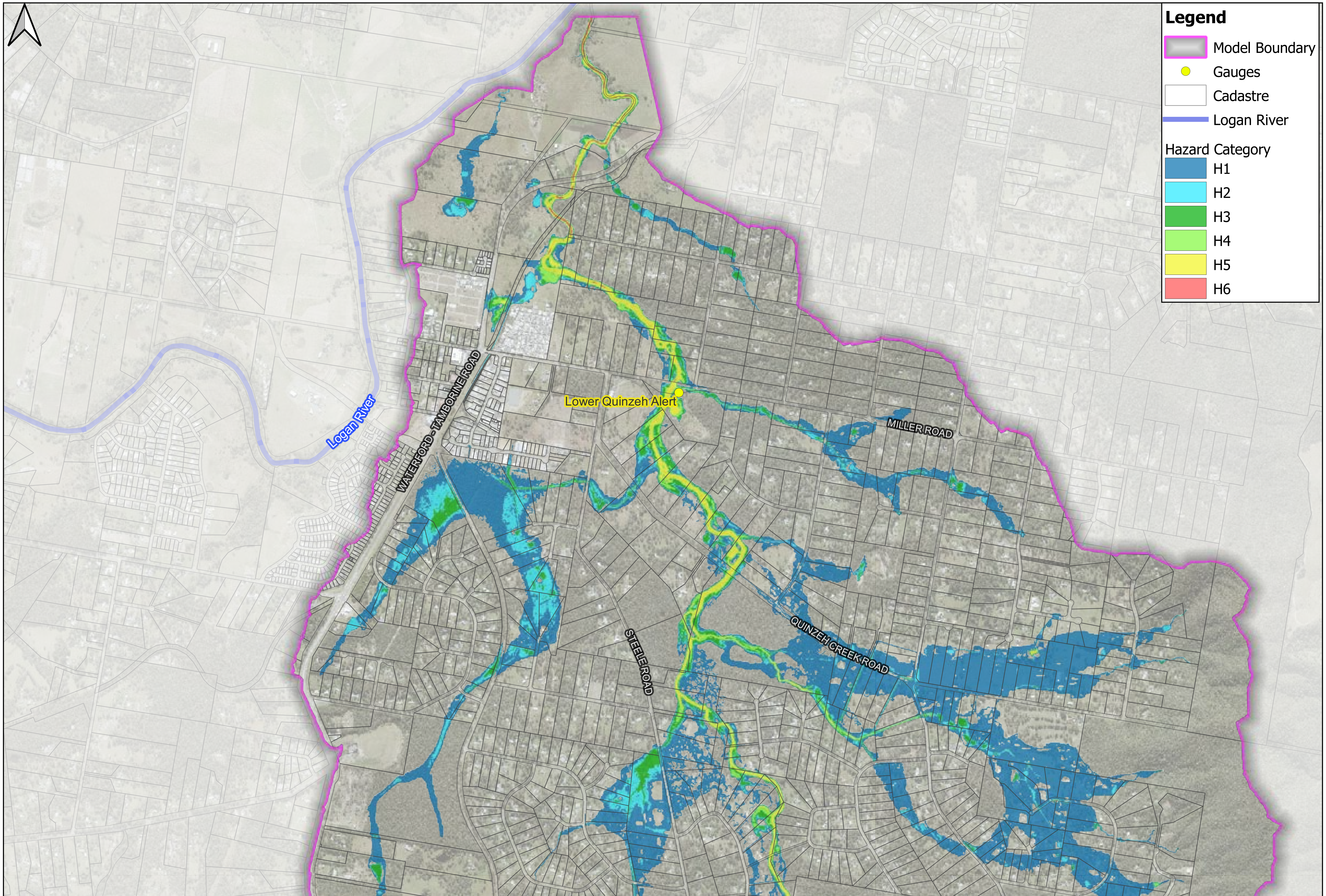
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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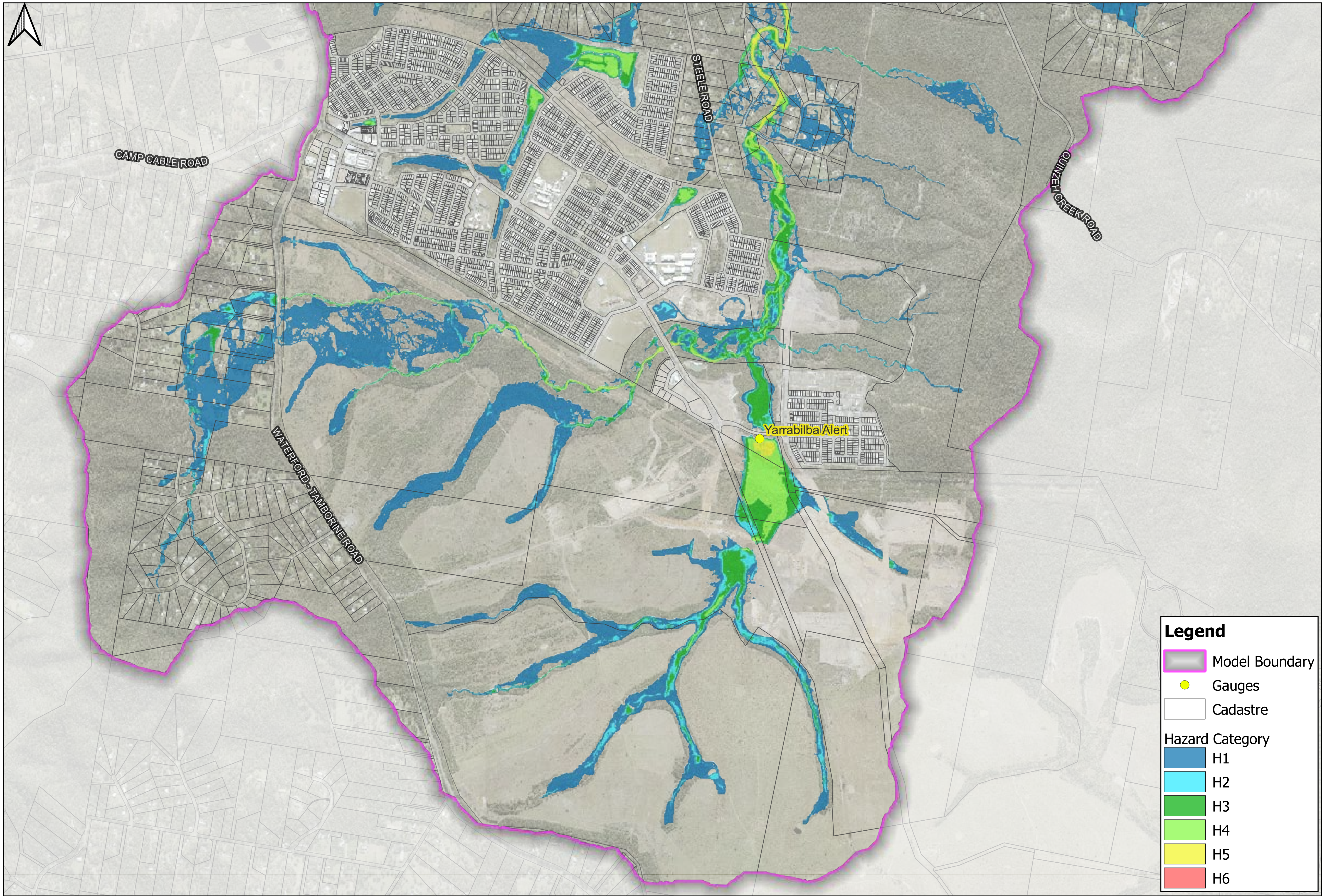
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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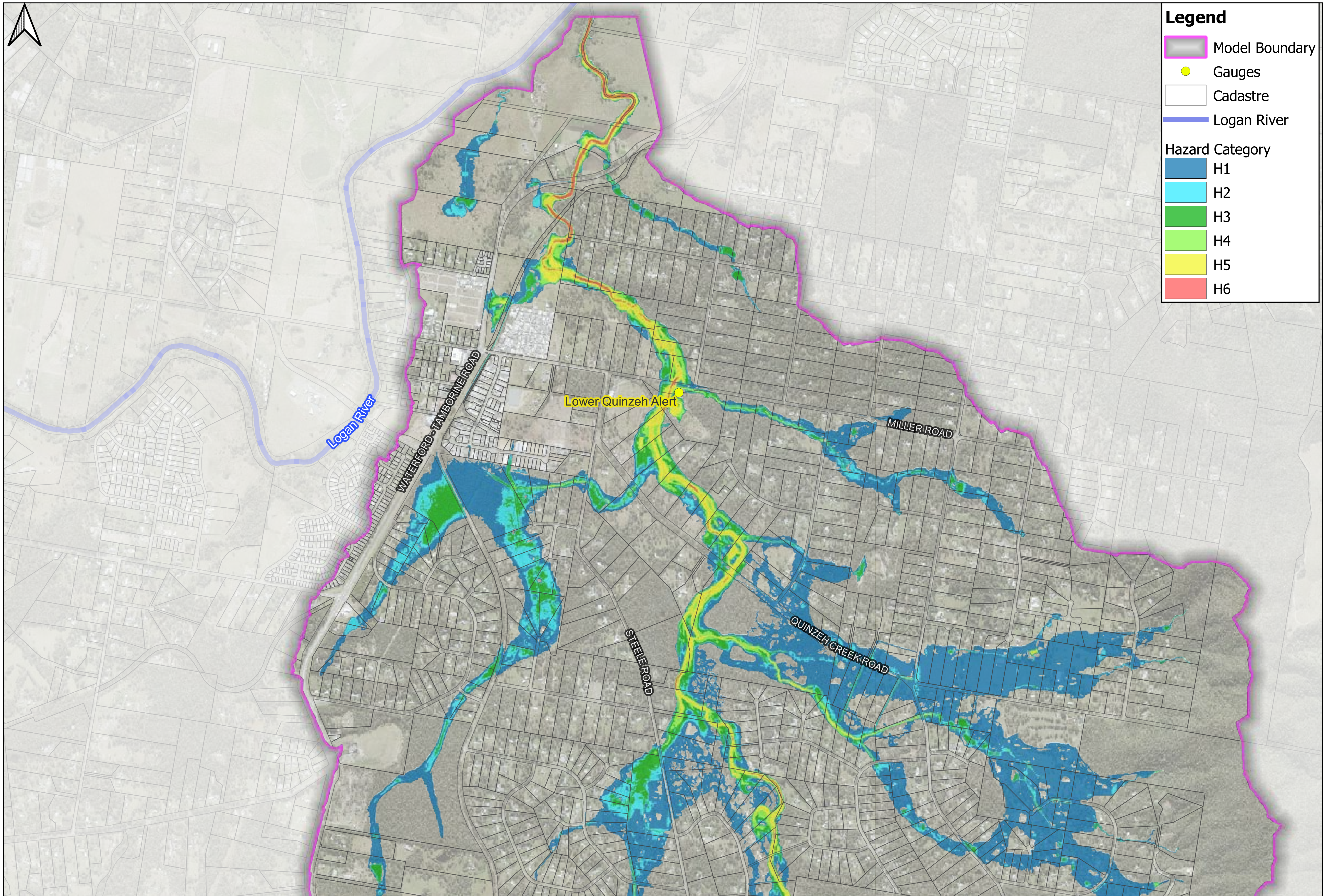
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2



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Water Technology Pty Ltd

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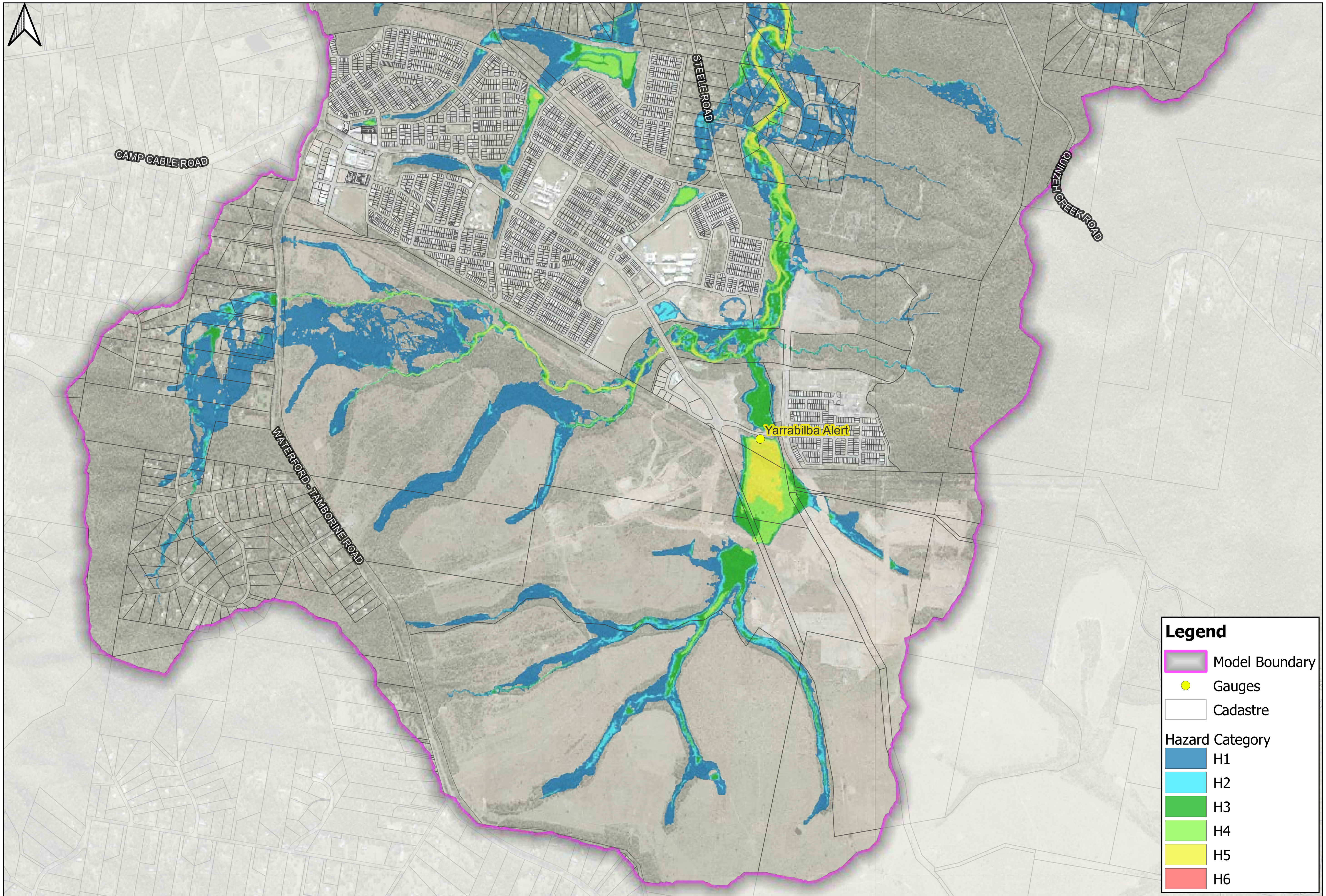
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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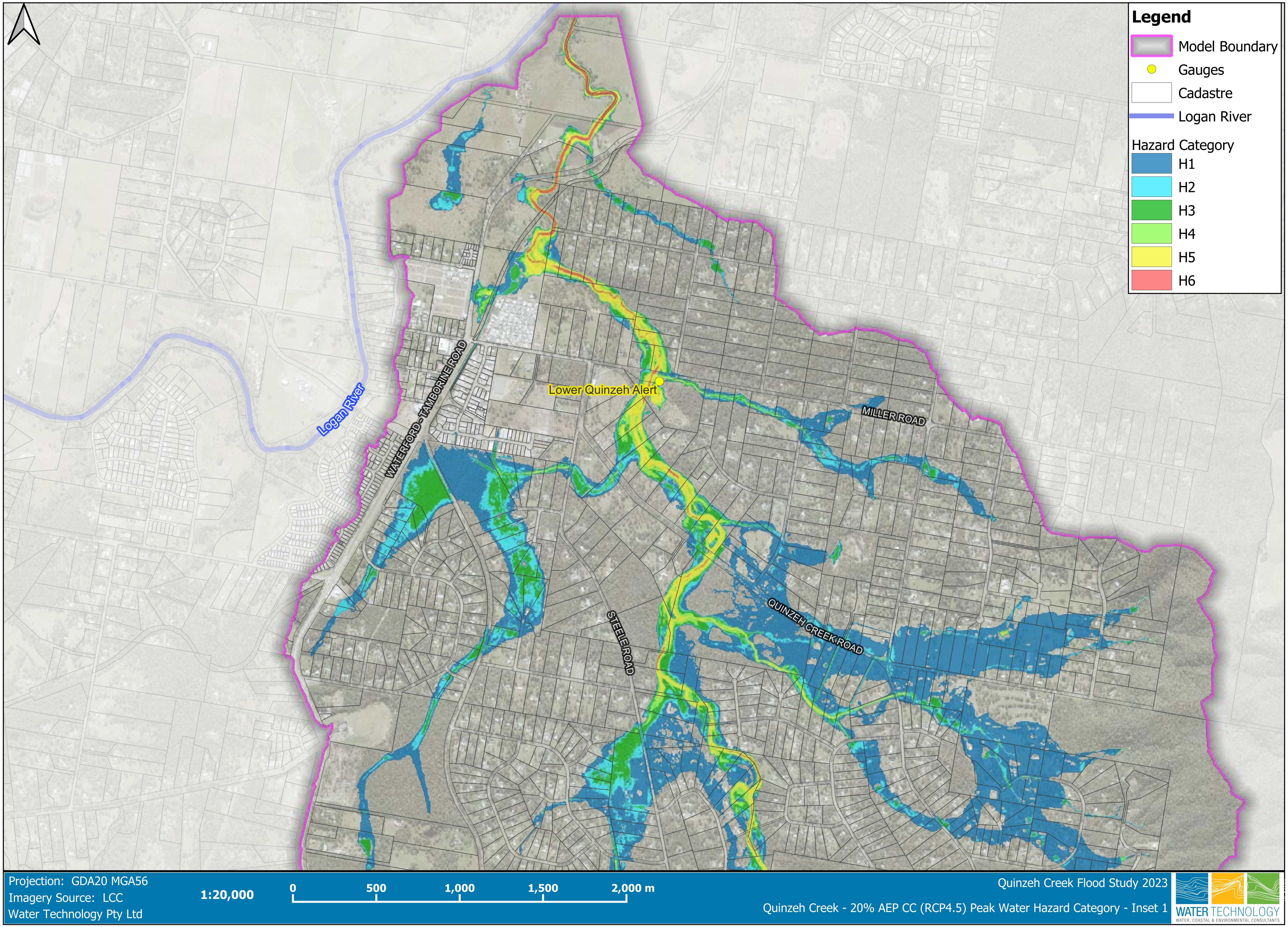
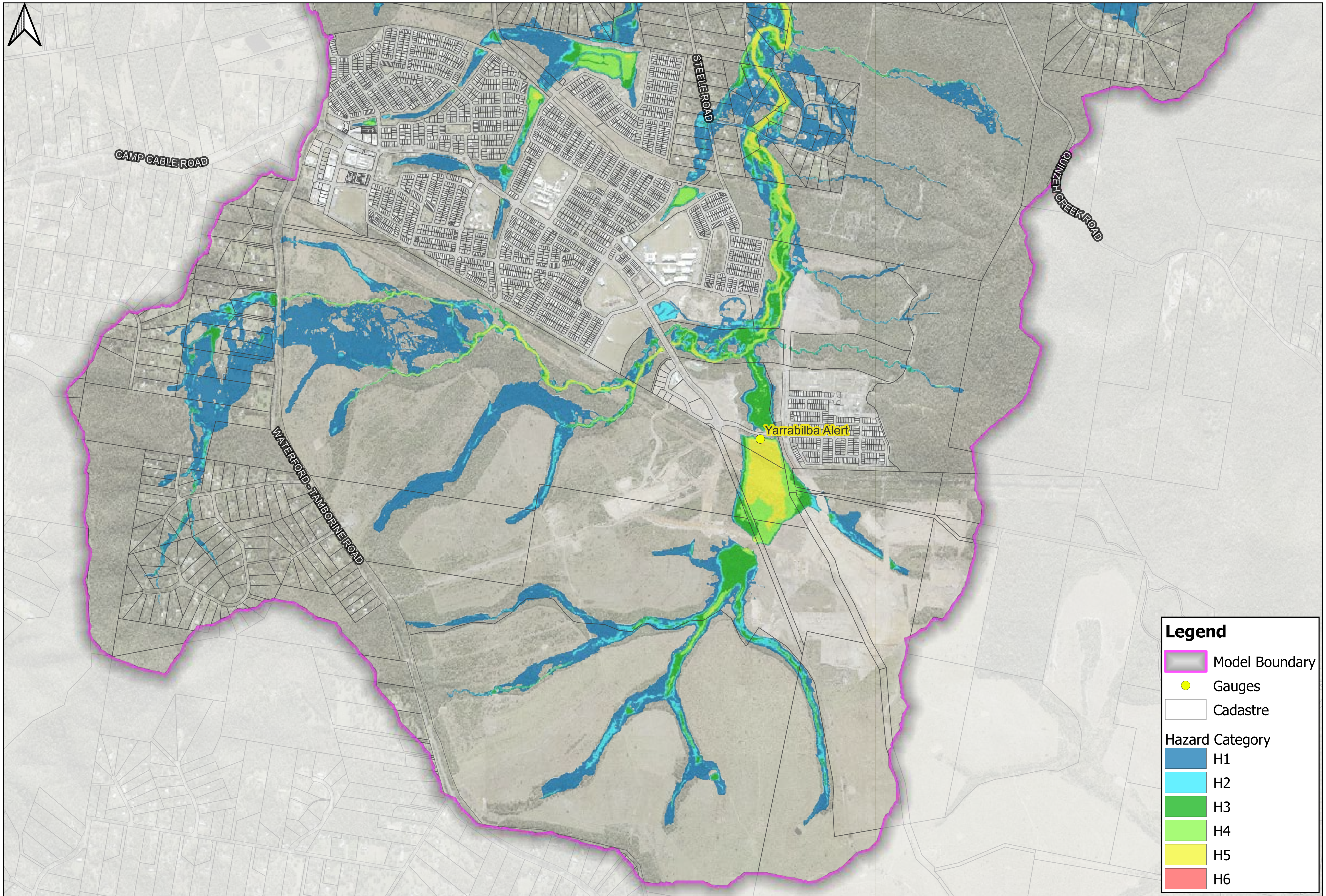
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY


Legend
Model Boundary
Gauges
Cadastre
Logan River
Hazard Category
H1
H2
H3
H4
H5
H6
Logan River
Lower Quinzeh Alert
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1



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Imagery Source: LCC
Water Technology Pty Ltd

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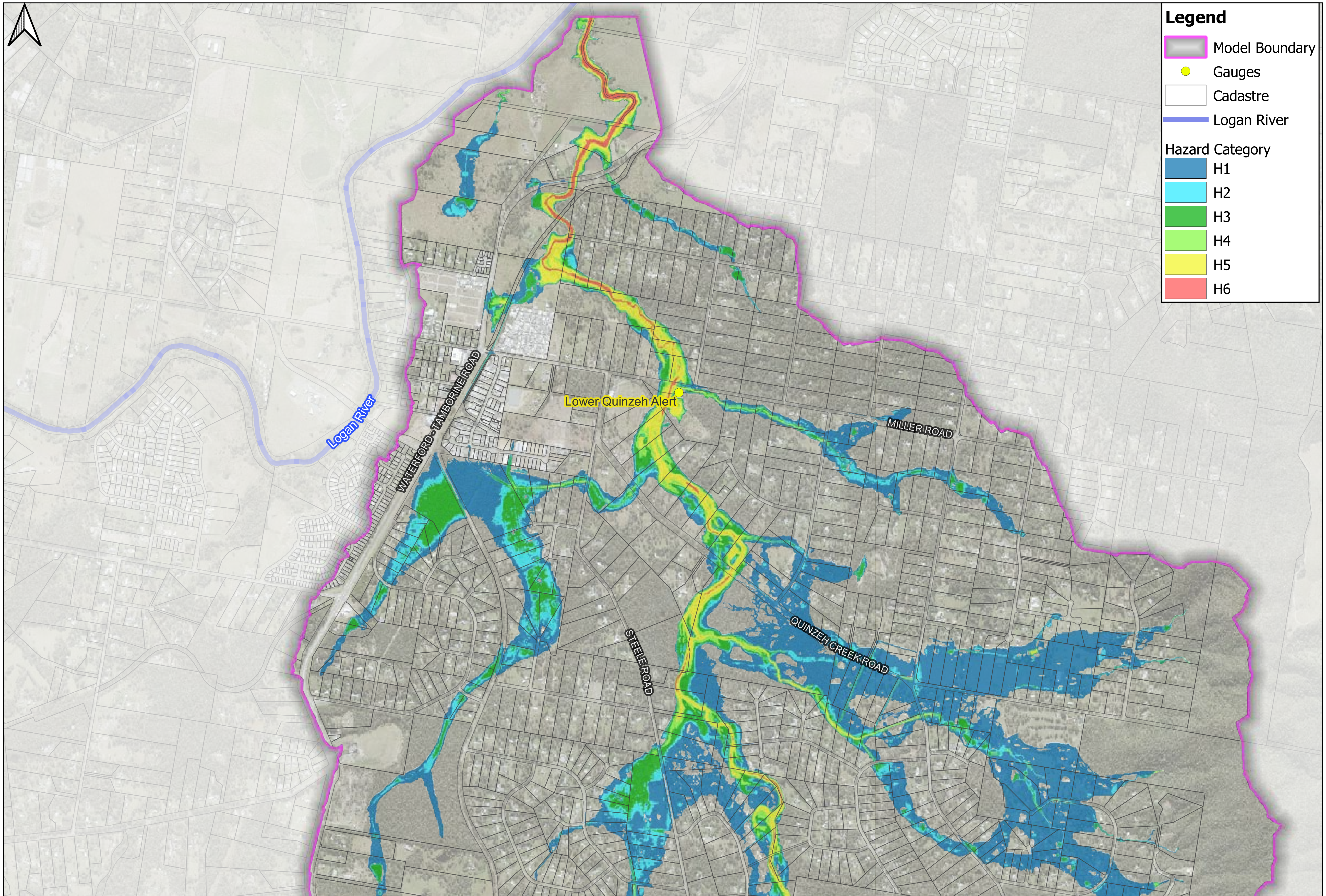
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 20% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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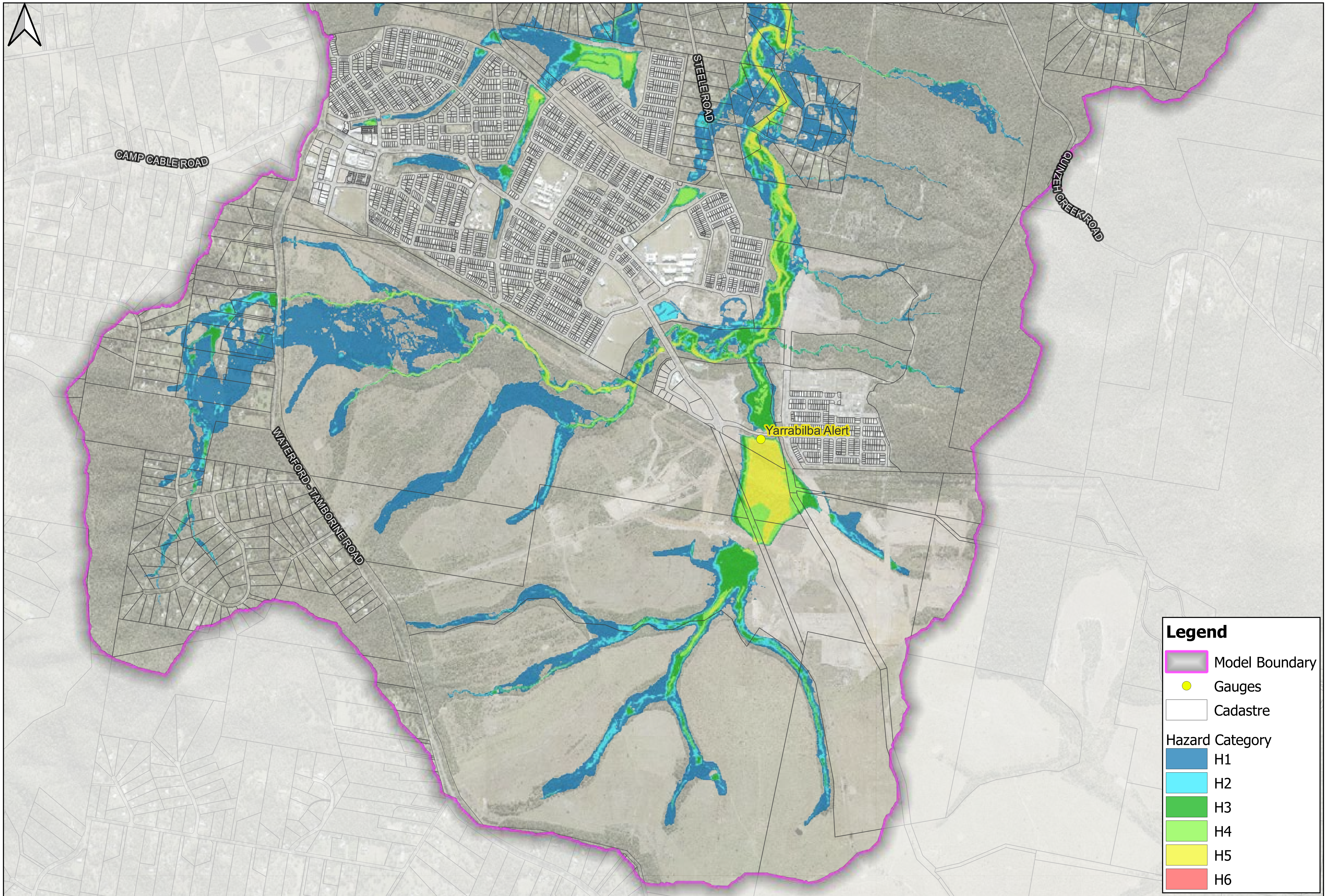
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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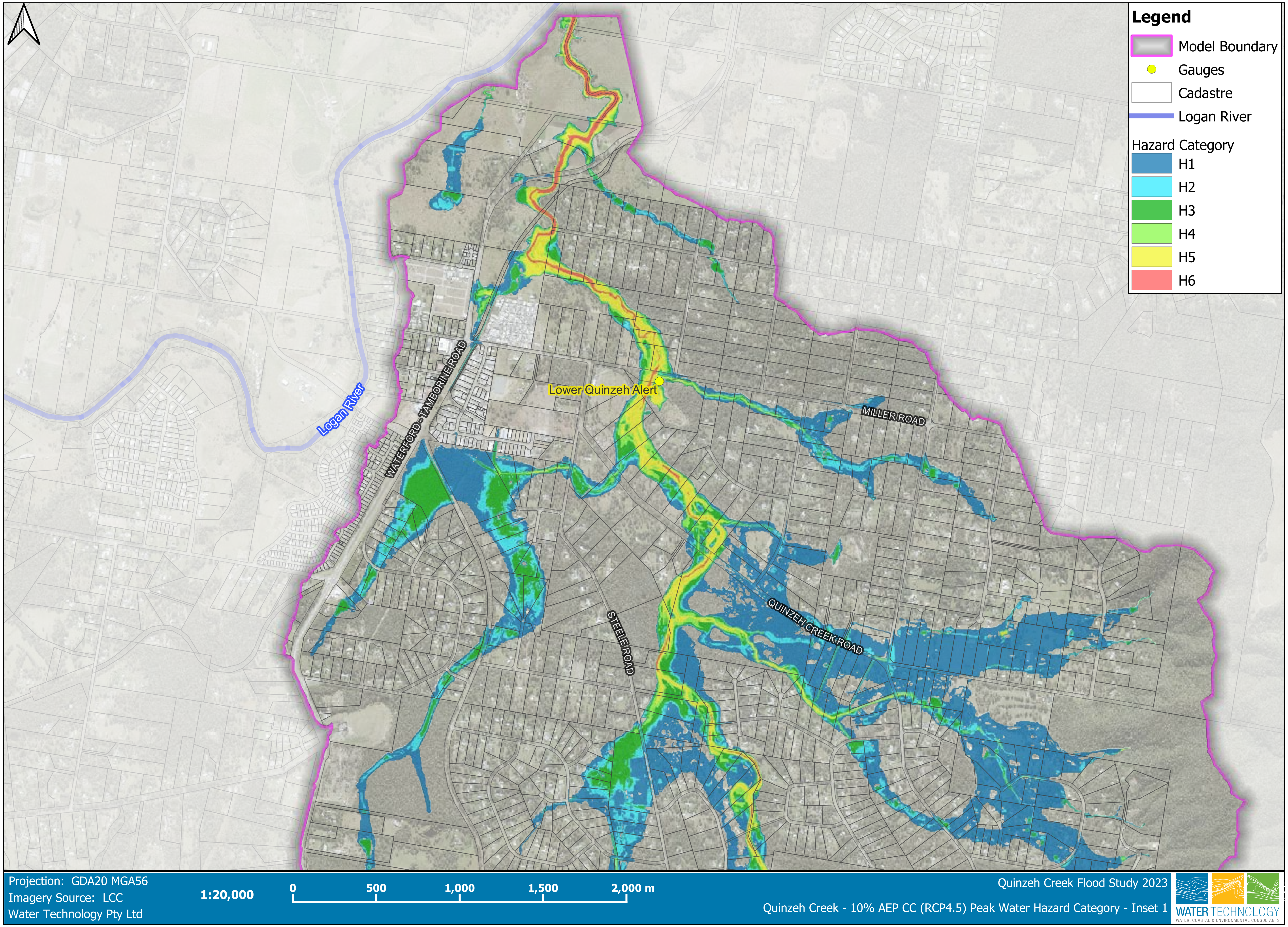
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Peak Water Hazard Category - Inset 2



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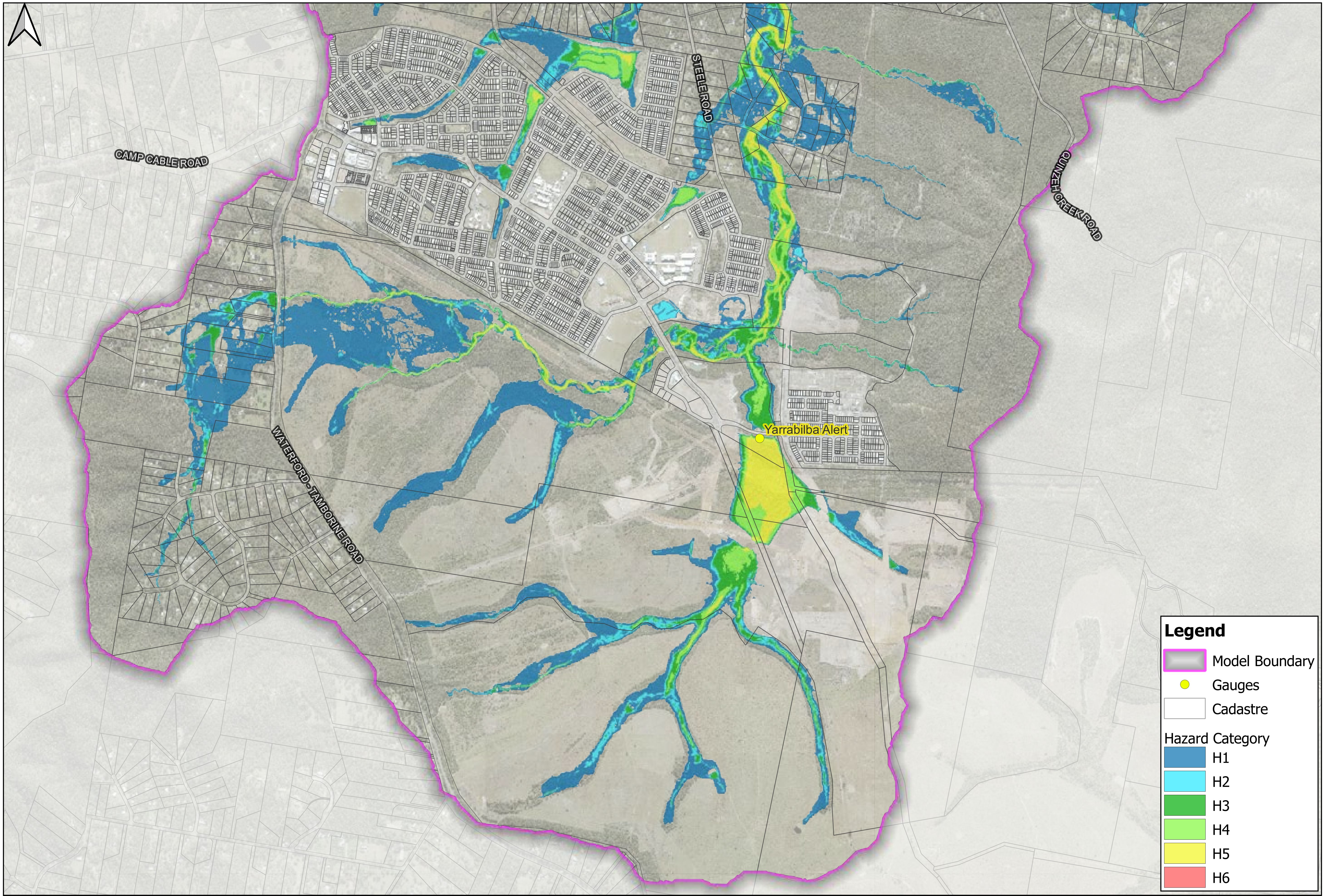
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1



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Imagery Source: LCC
Water Technology Pty Ltd

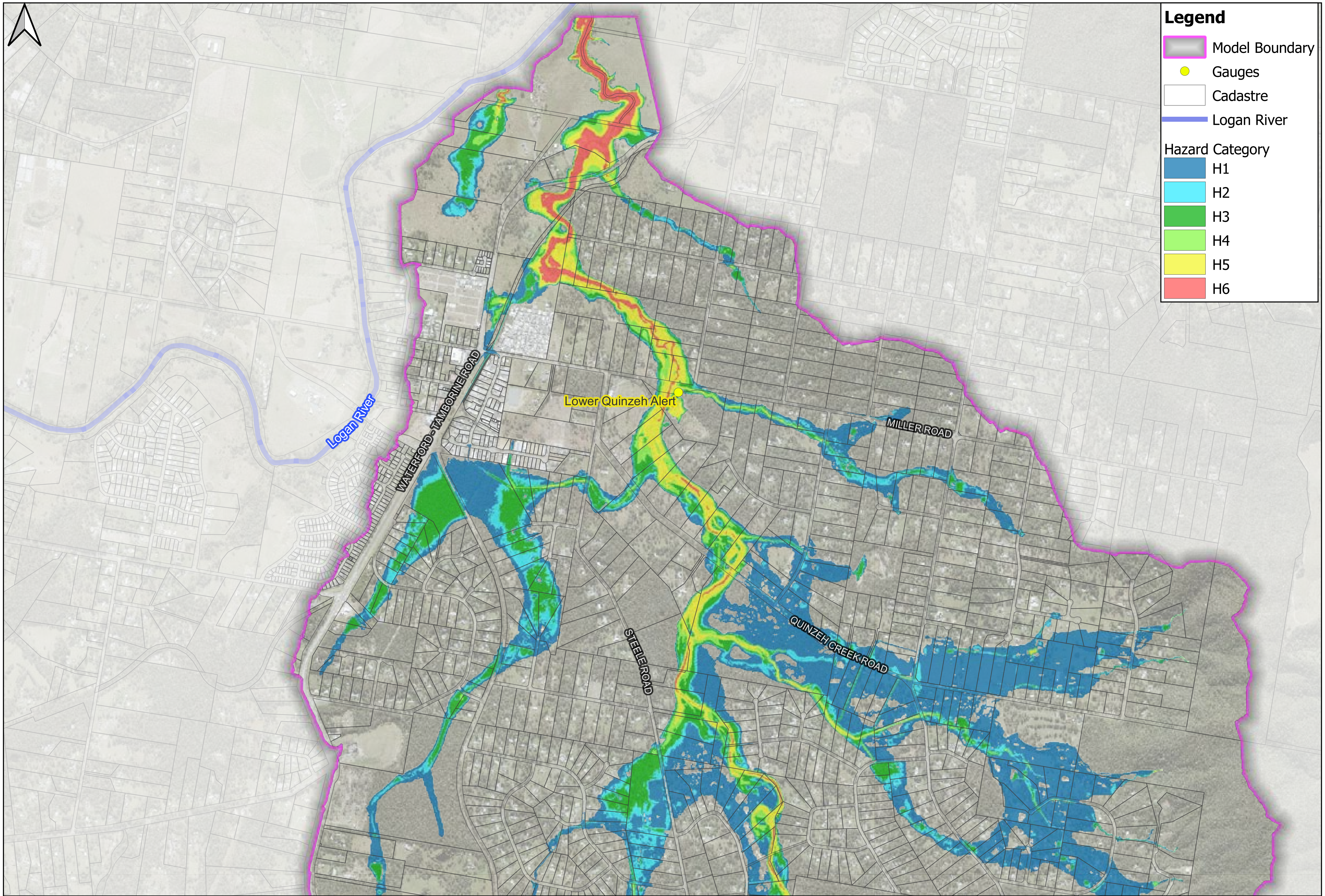
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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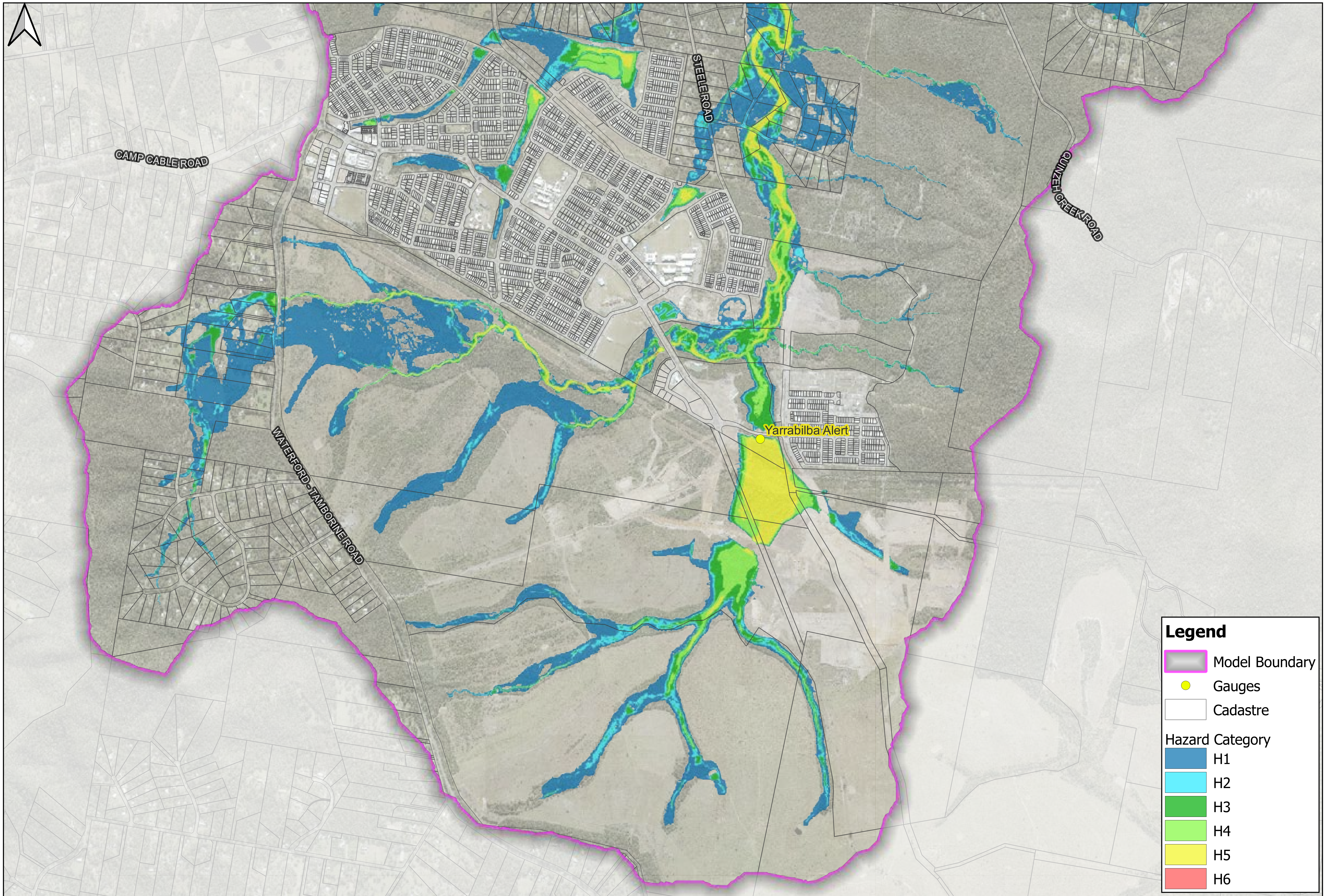
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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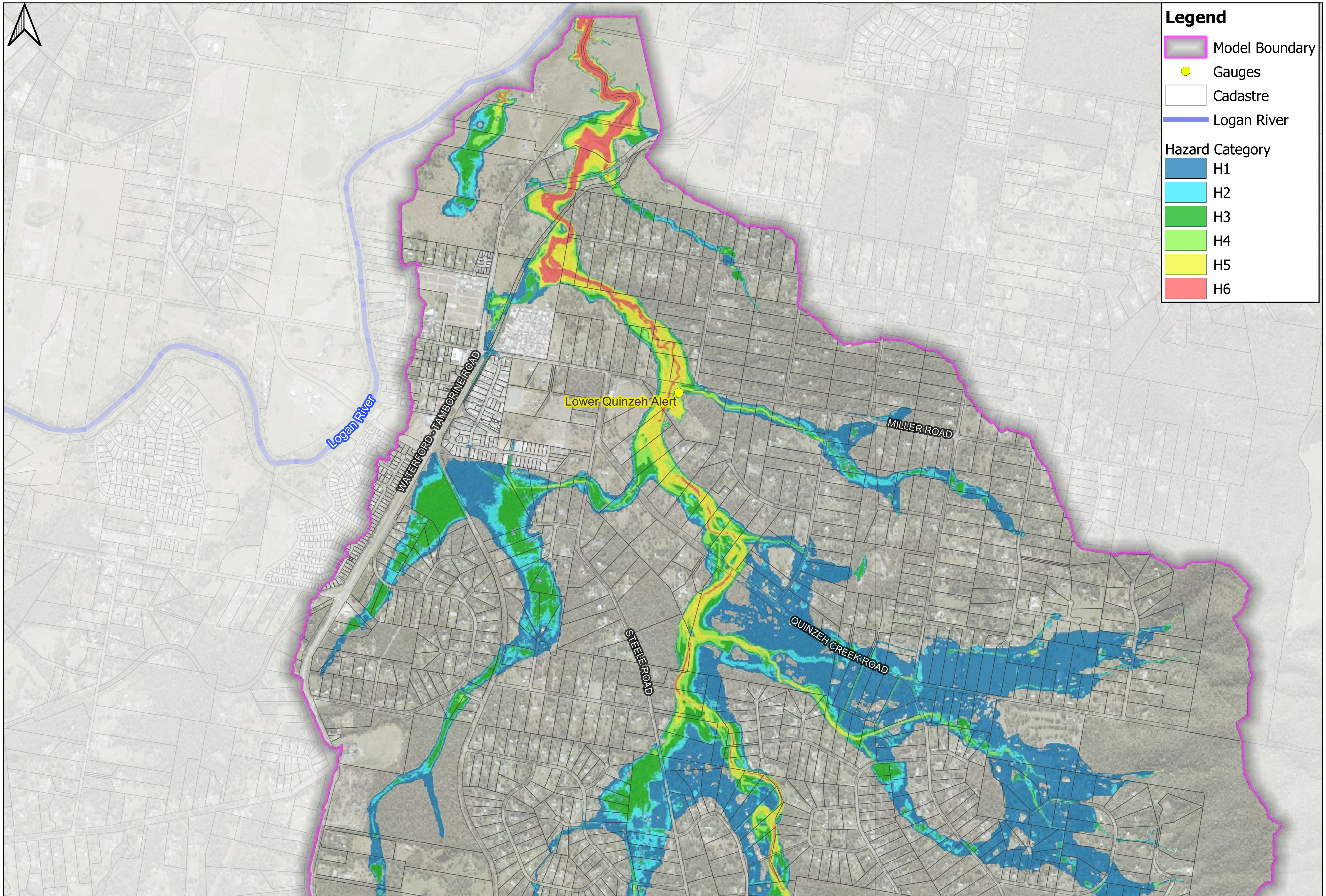
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP Peak Water Hazard Category - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

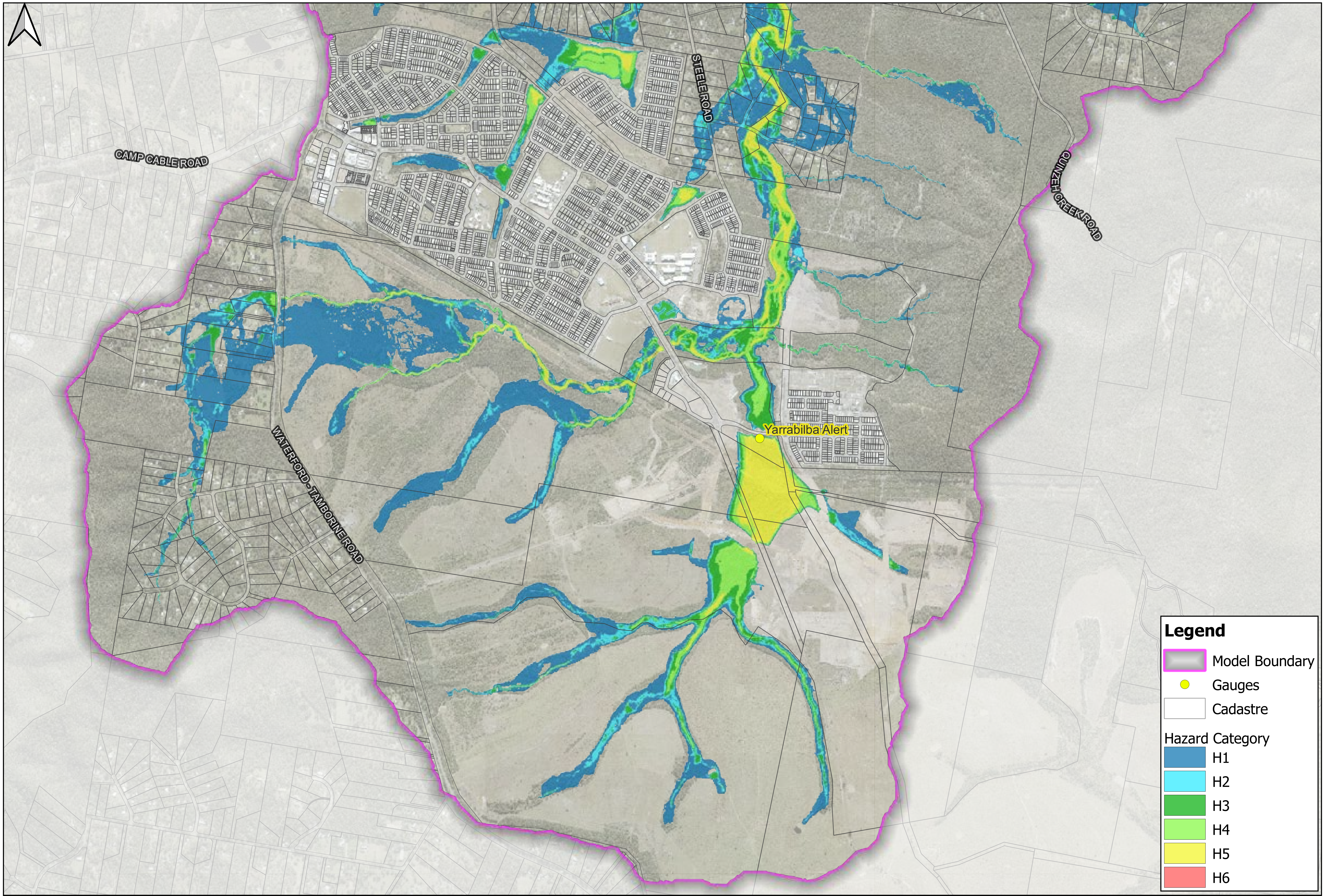
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

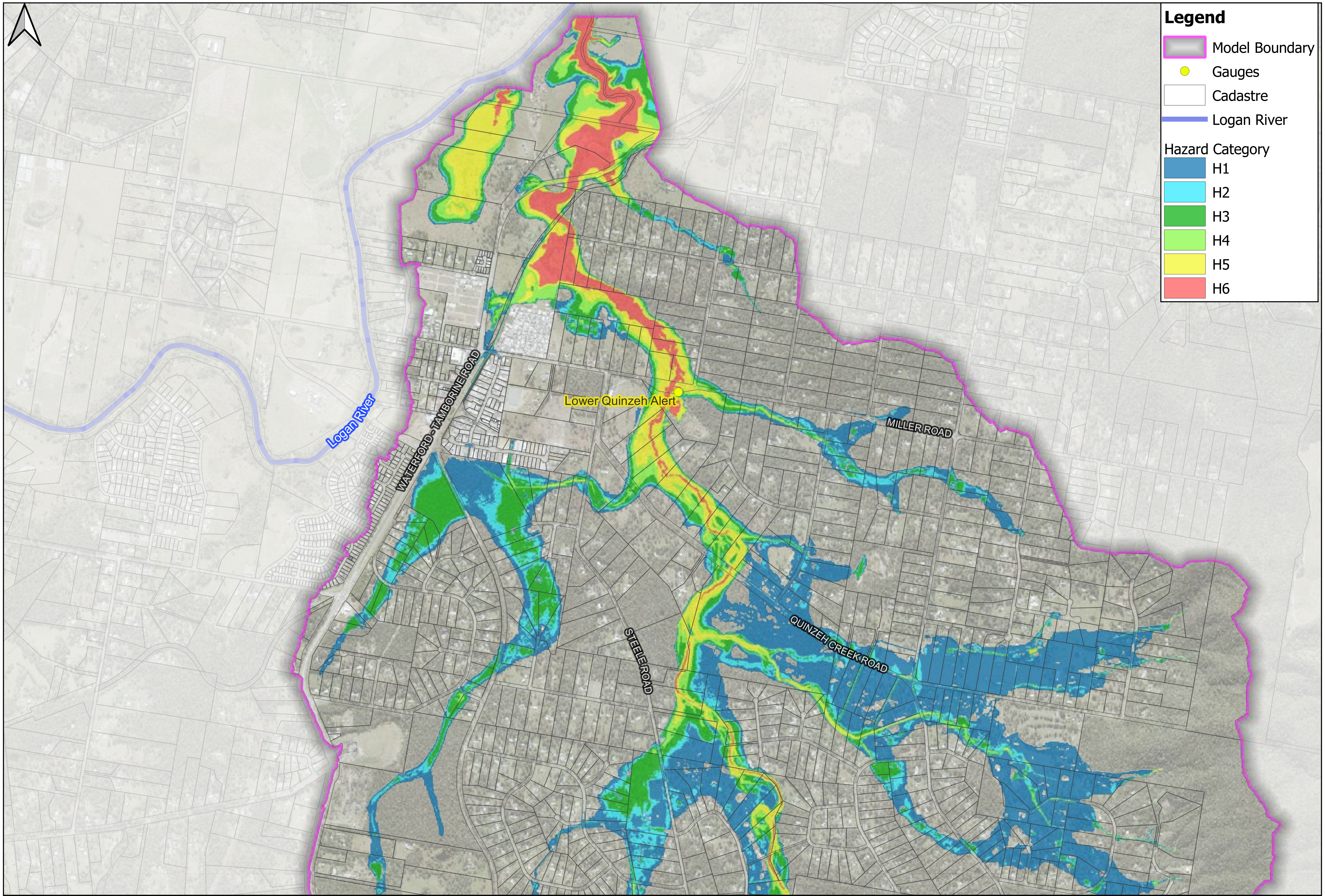
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 5% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

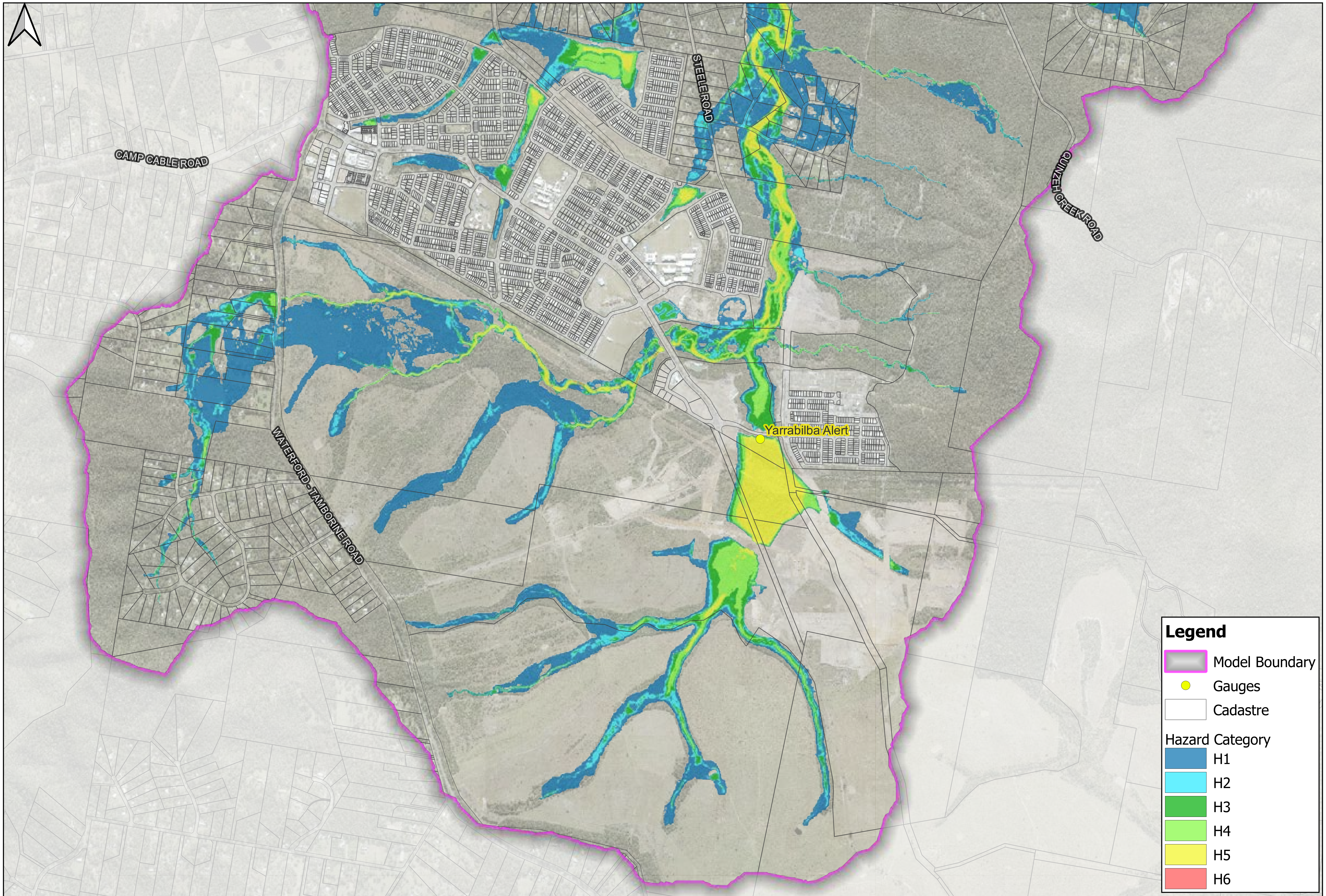
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

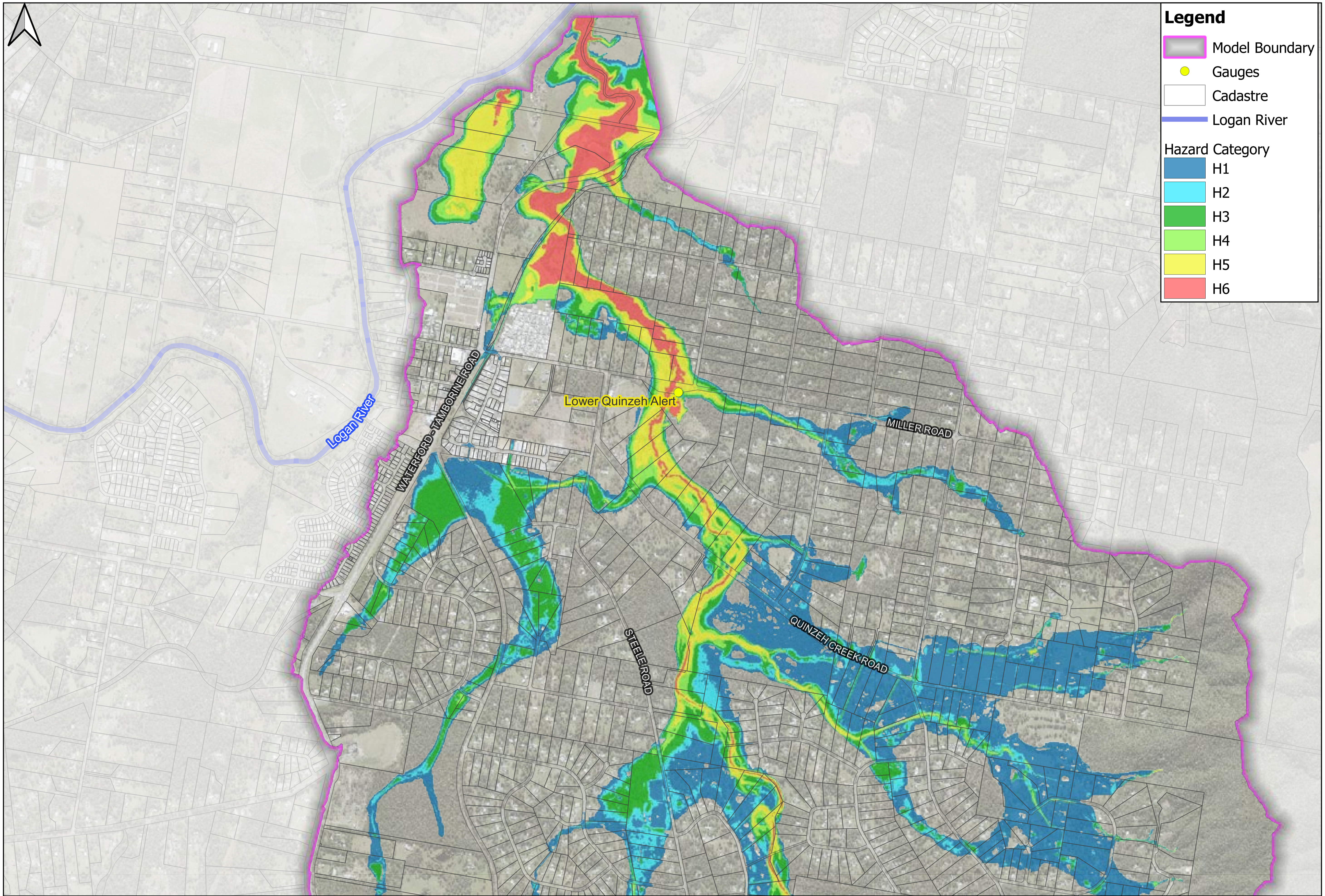
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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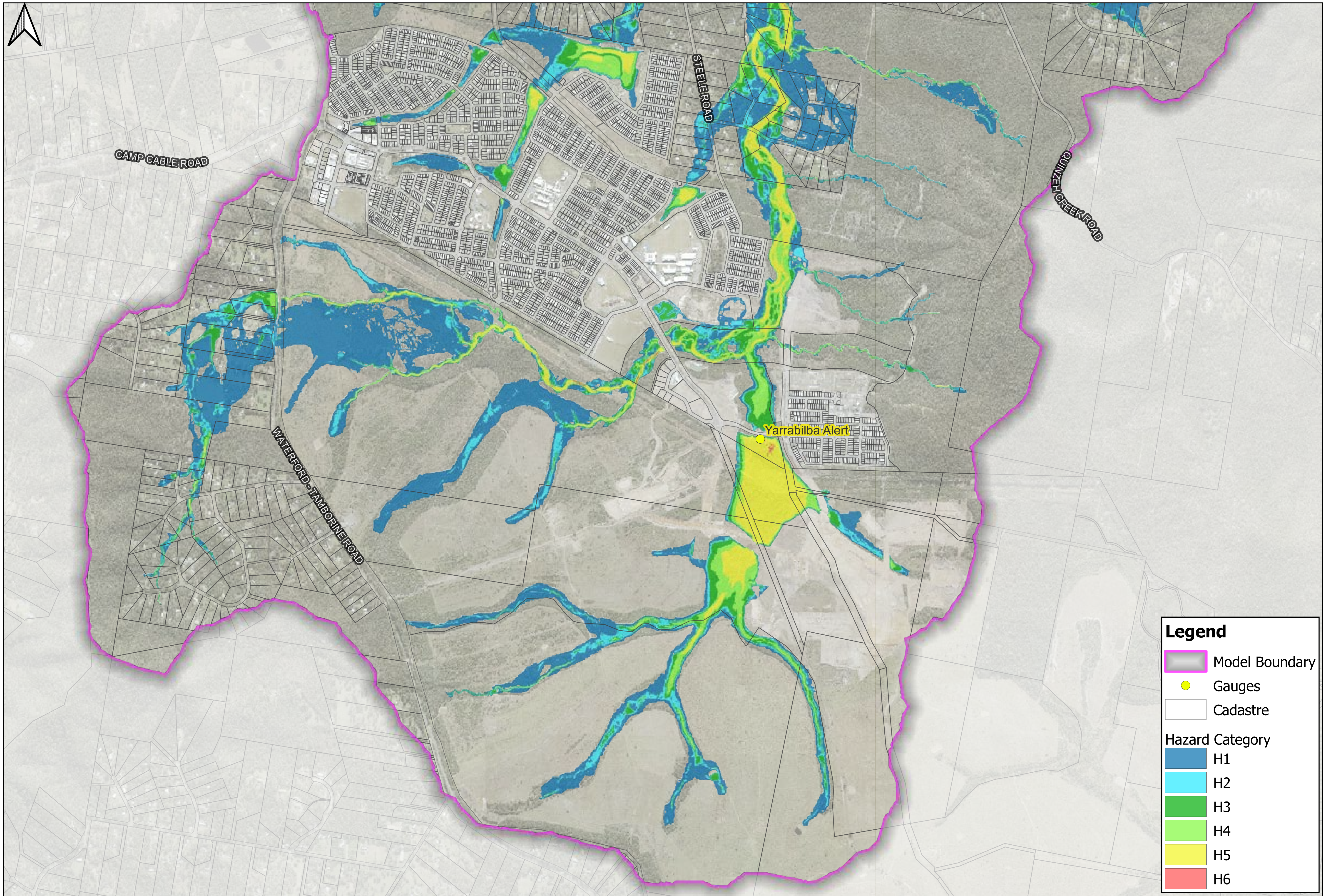
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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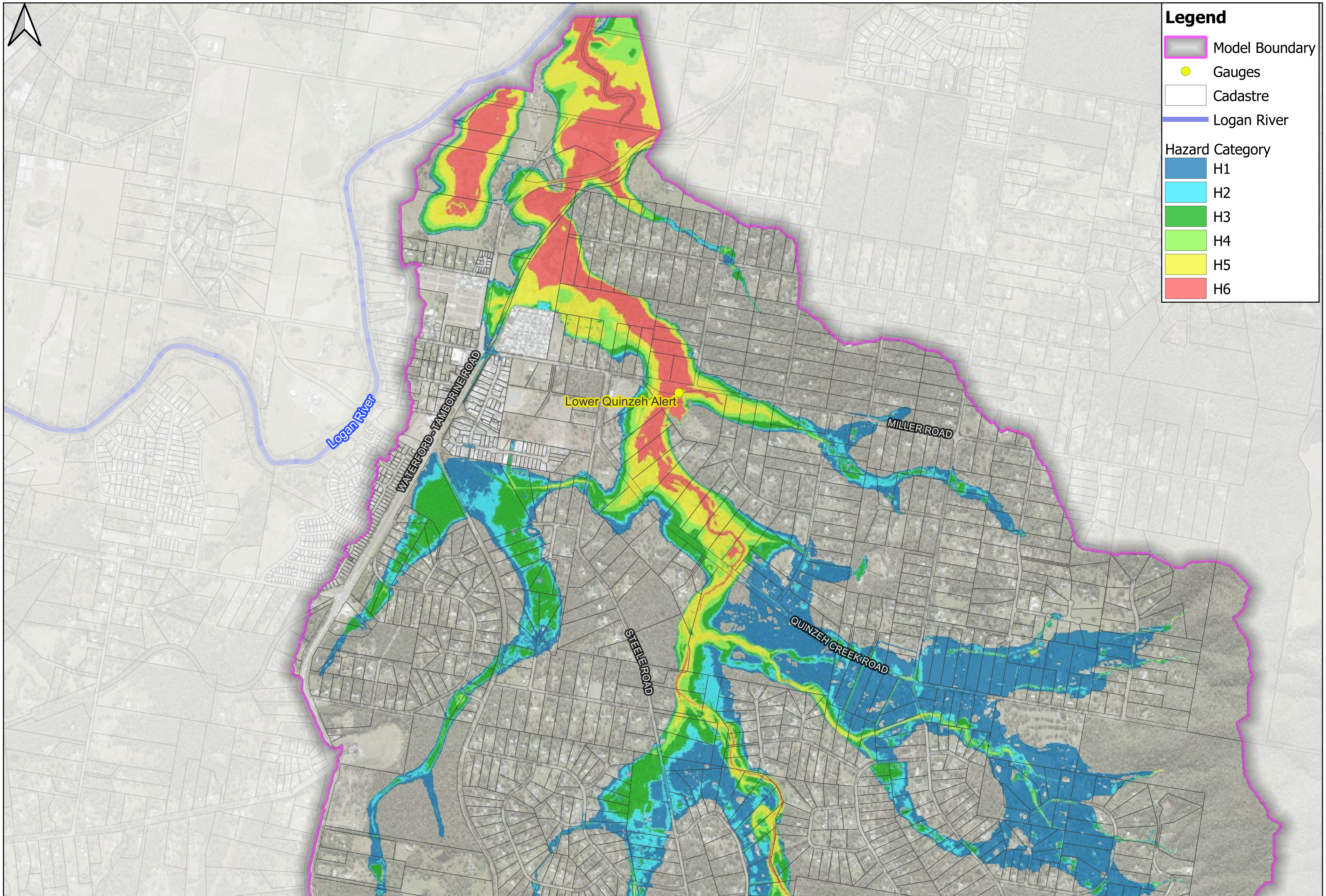
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 2% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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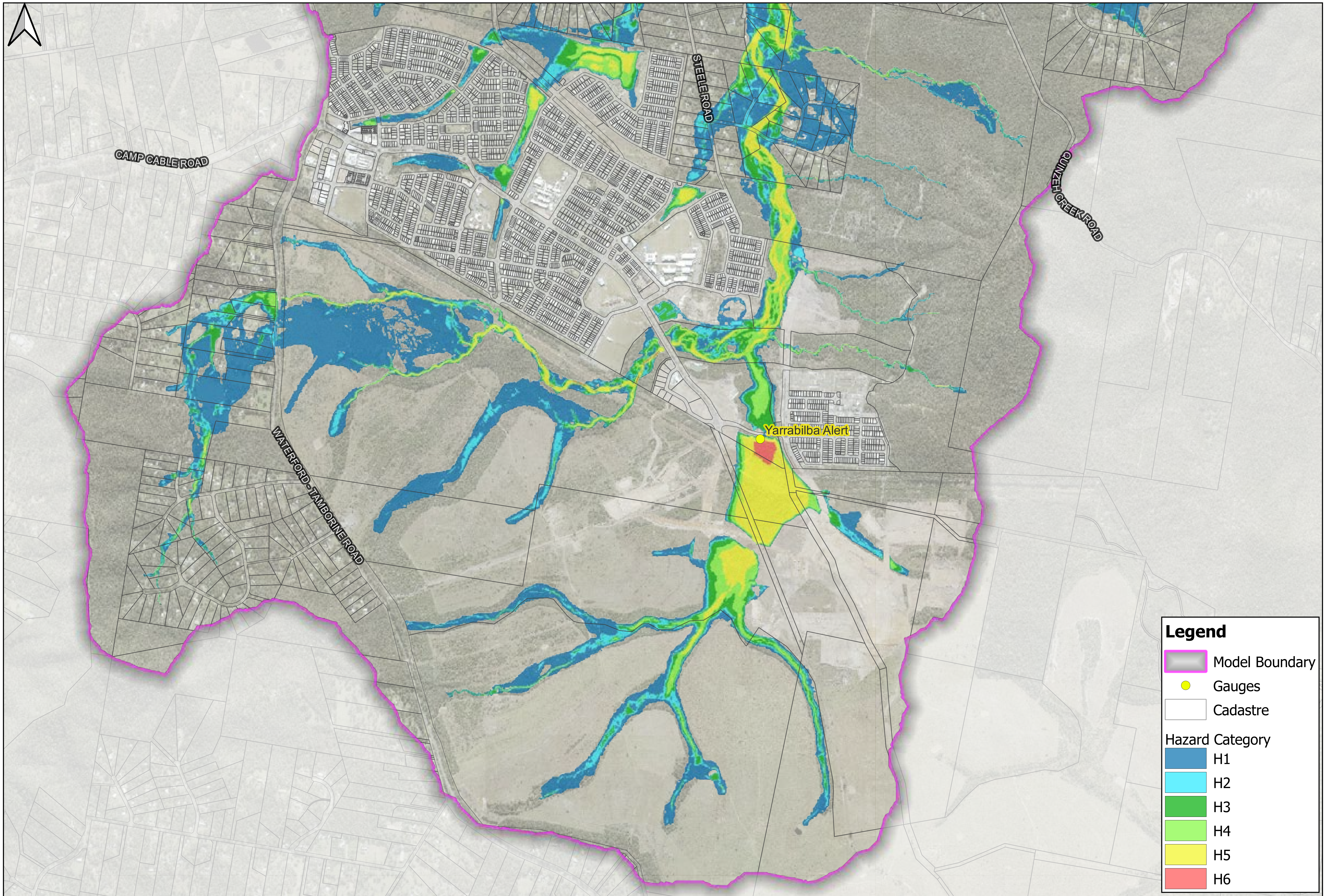
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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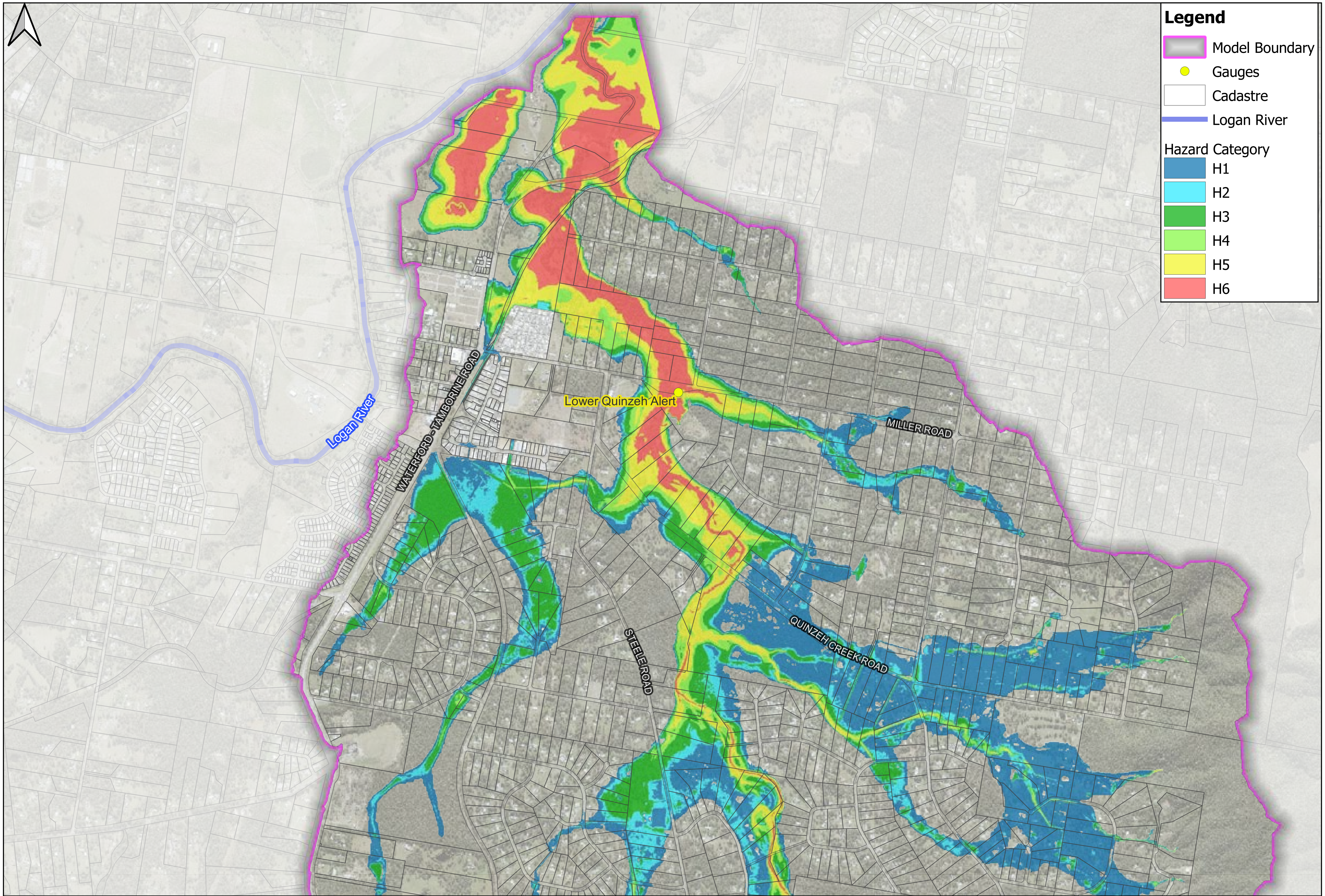
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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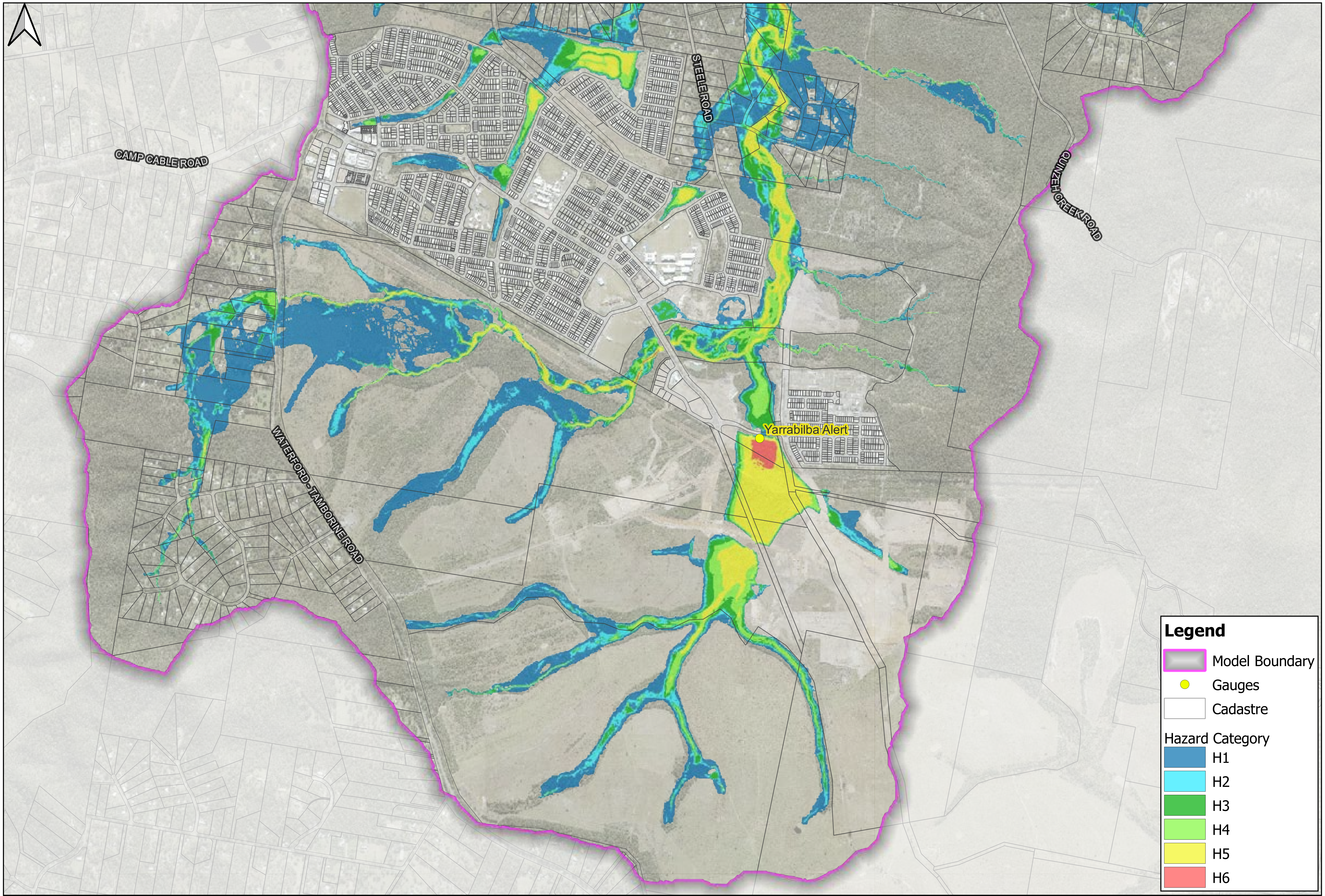
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1



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Water Technology Pty Ltd

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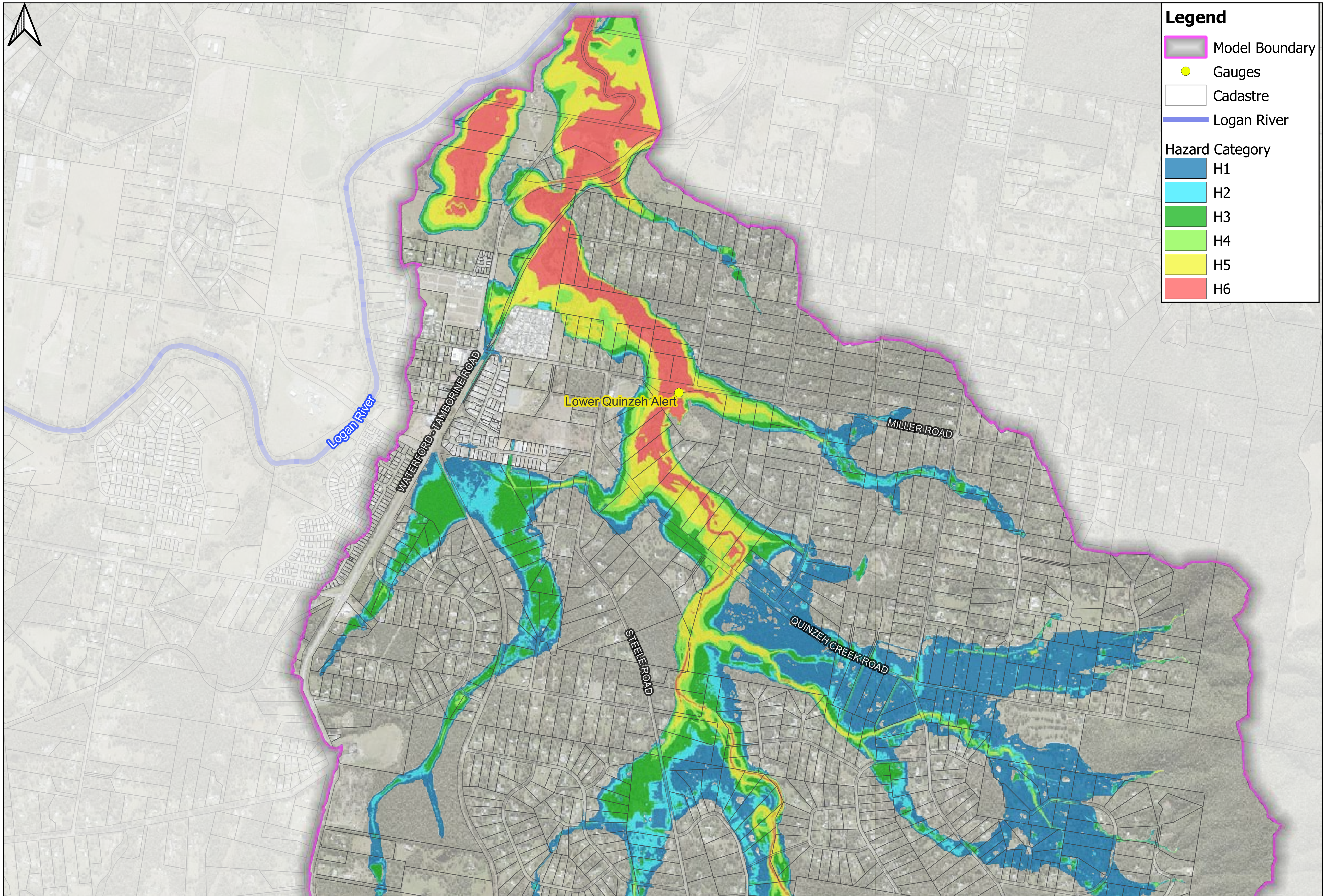
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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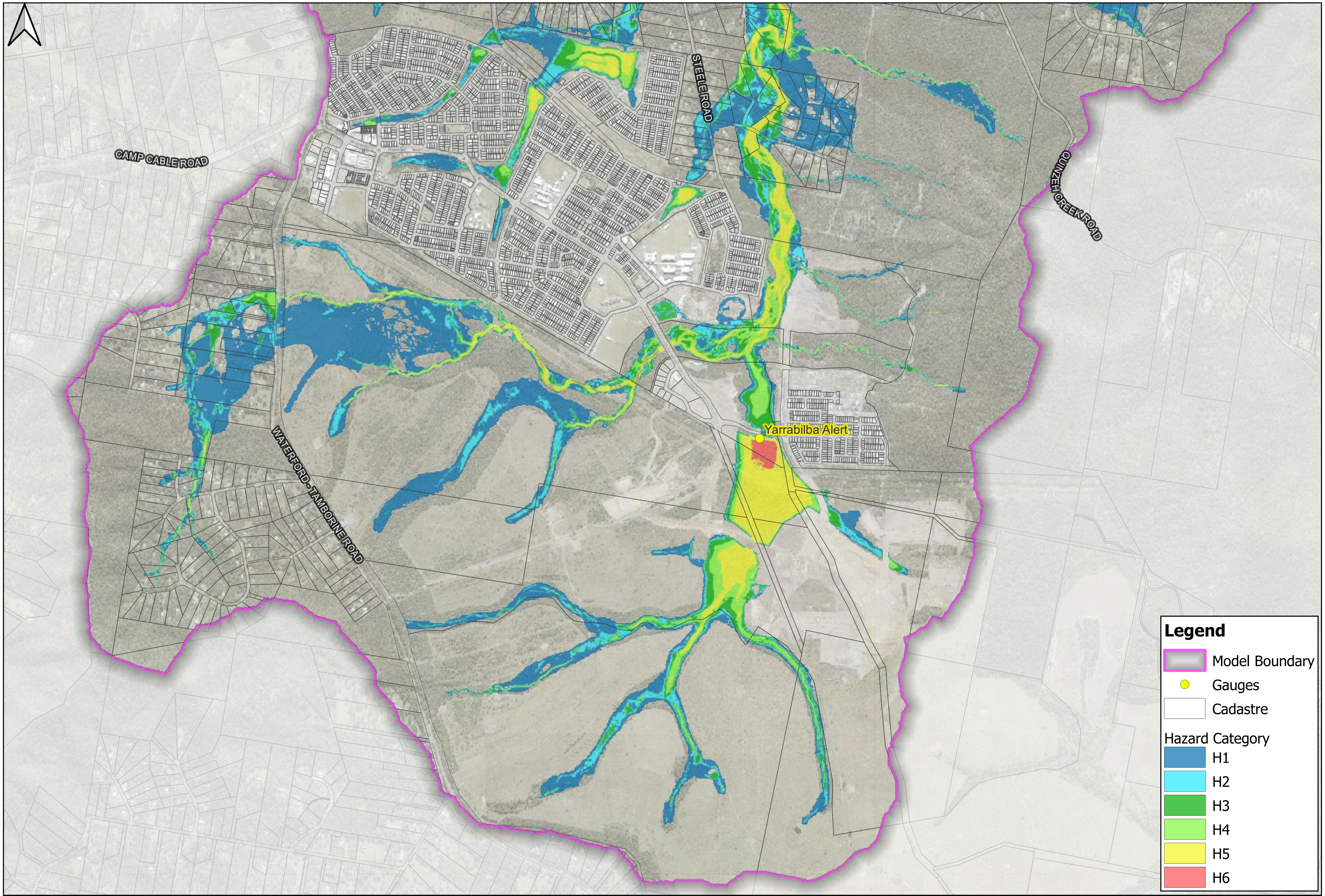
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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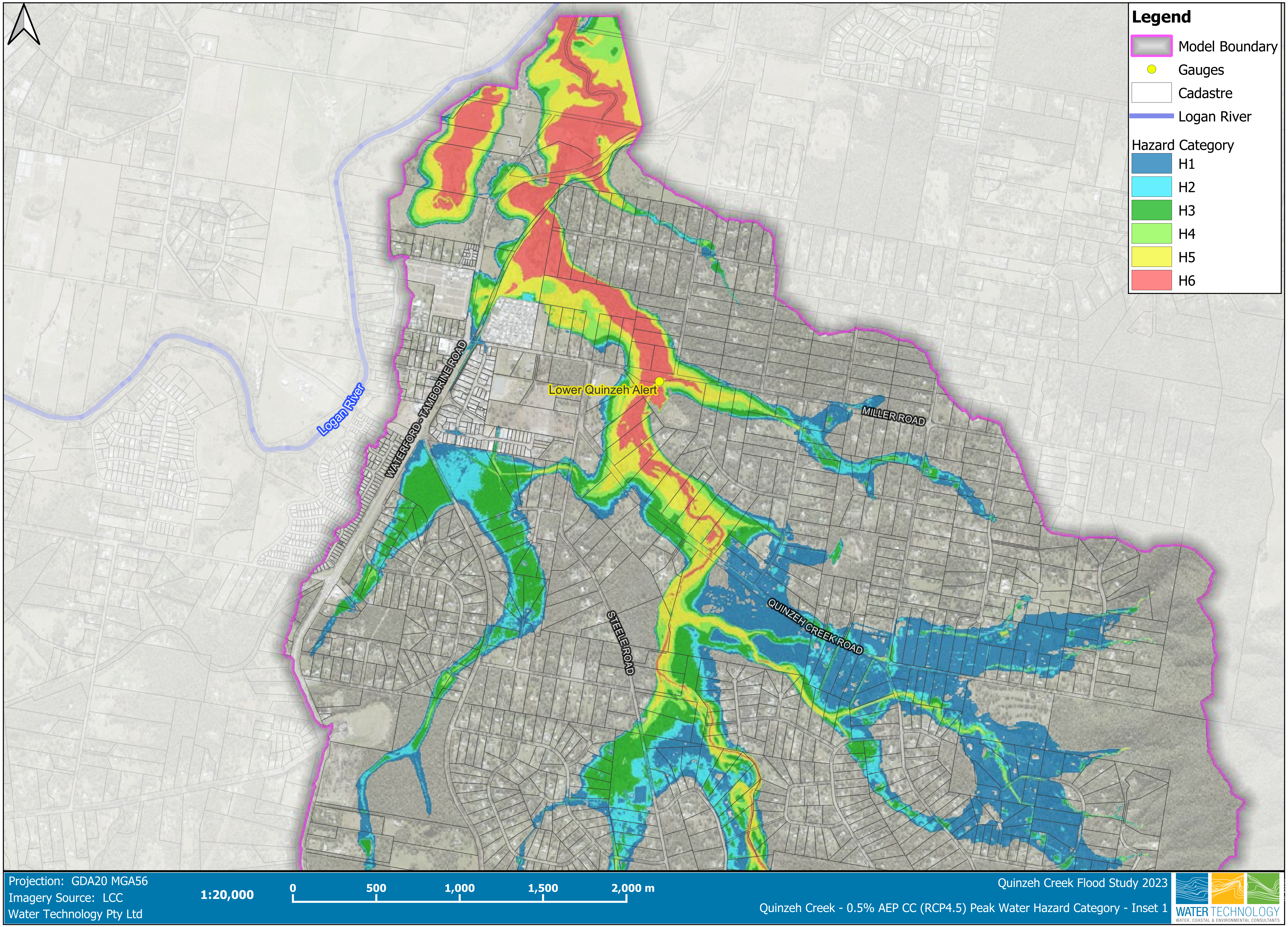
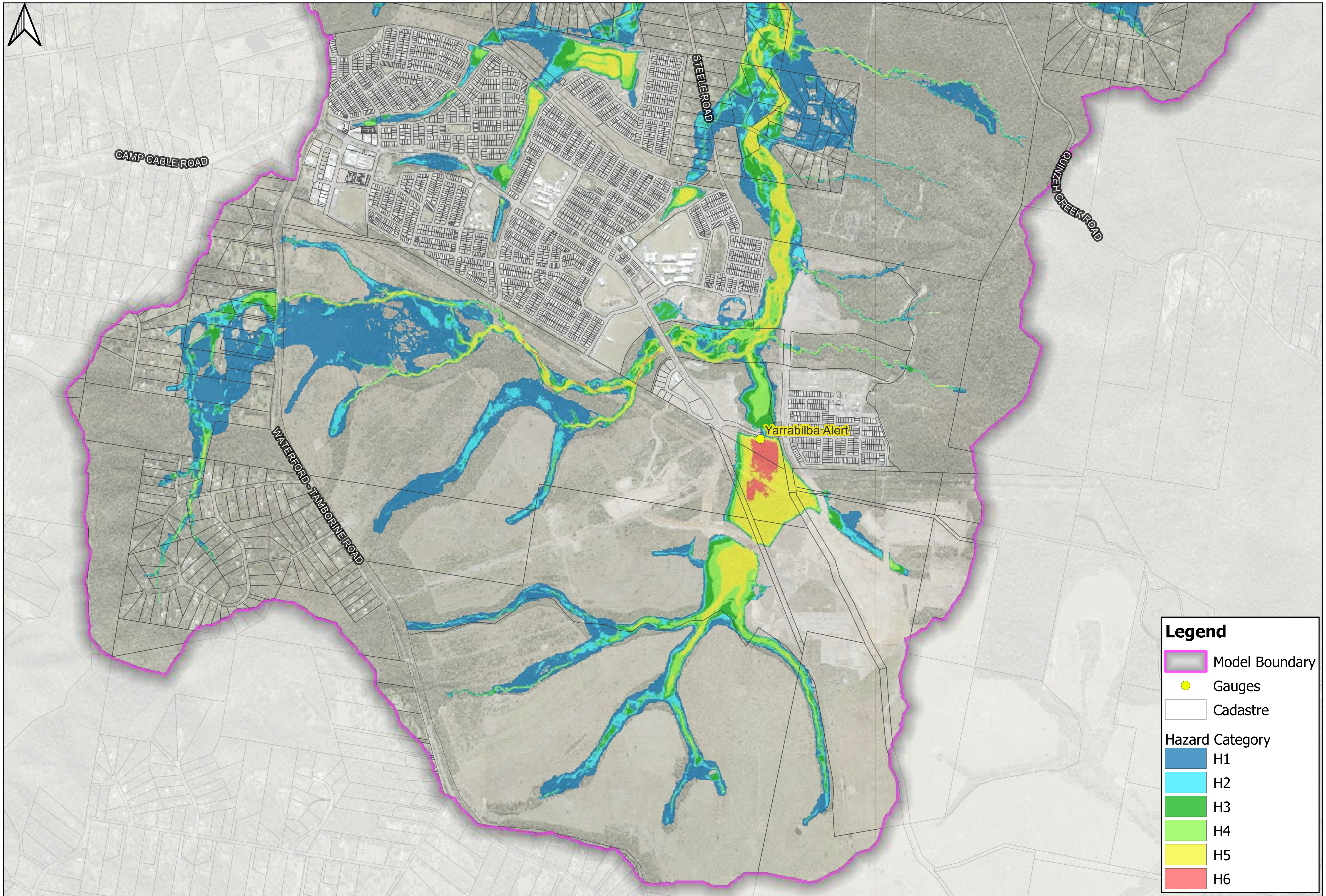
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP Peak Water Hazard Category - Inset 2



Legend
Model Boundary
Gauges
Cadastre
Logan River
Hazard Category
H1
H2
H3
H4
H5
H6
Logan River
Lower Quinzeh Alert
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1
WATER TECHNOLOGY



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Imagery Source: LCC
Water Technology Pty Ltd

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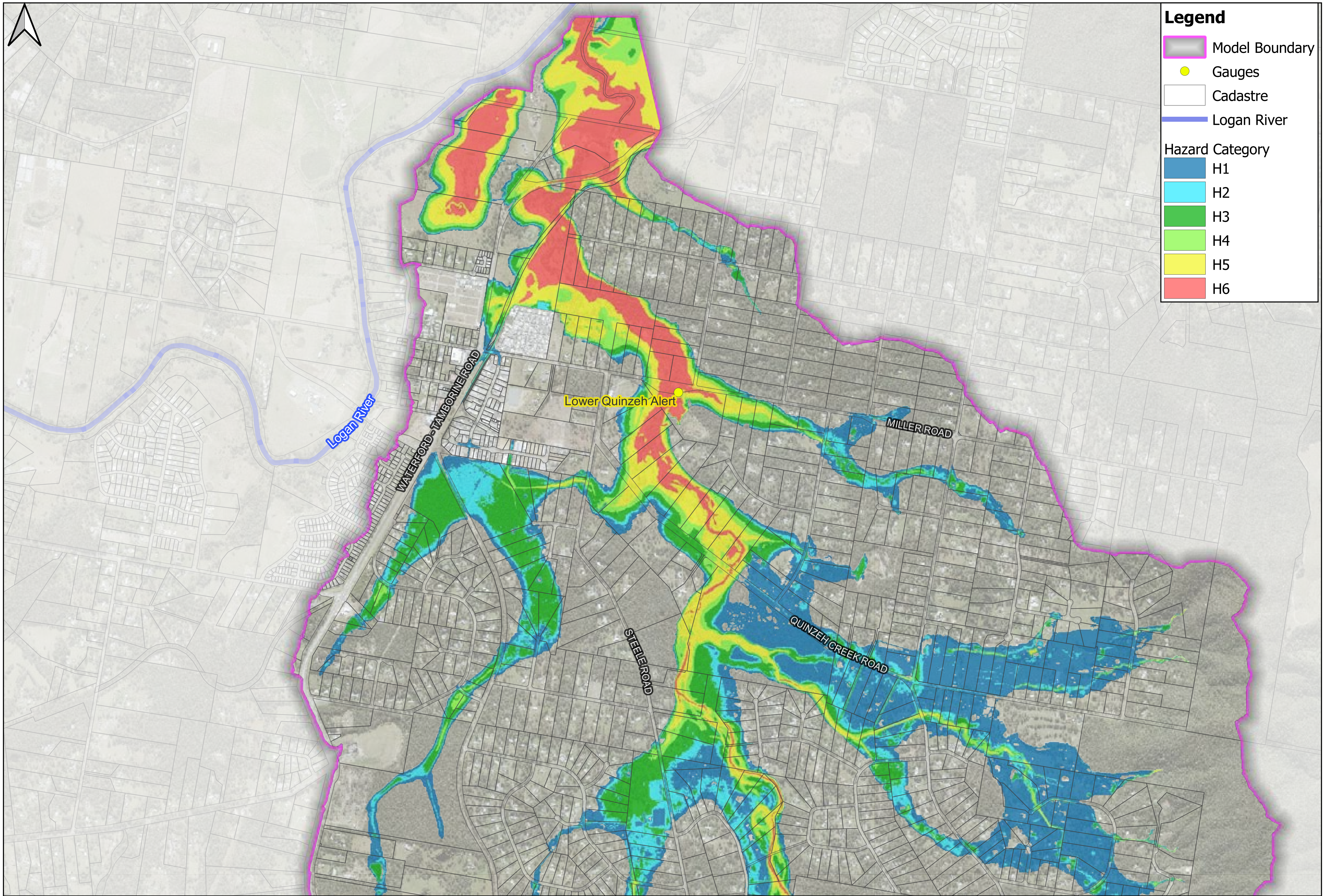
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.5% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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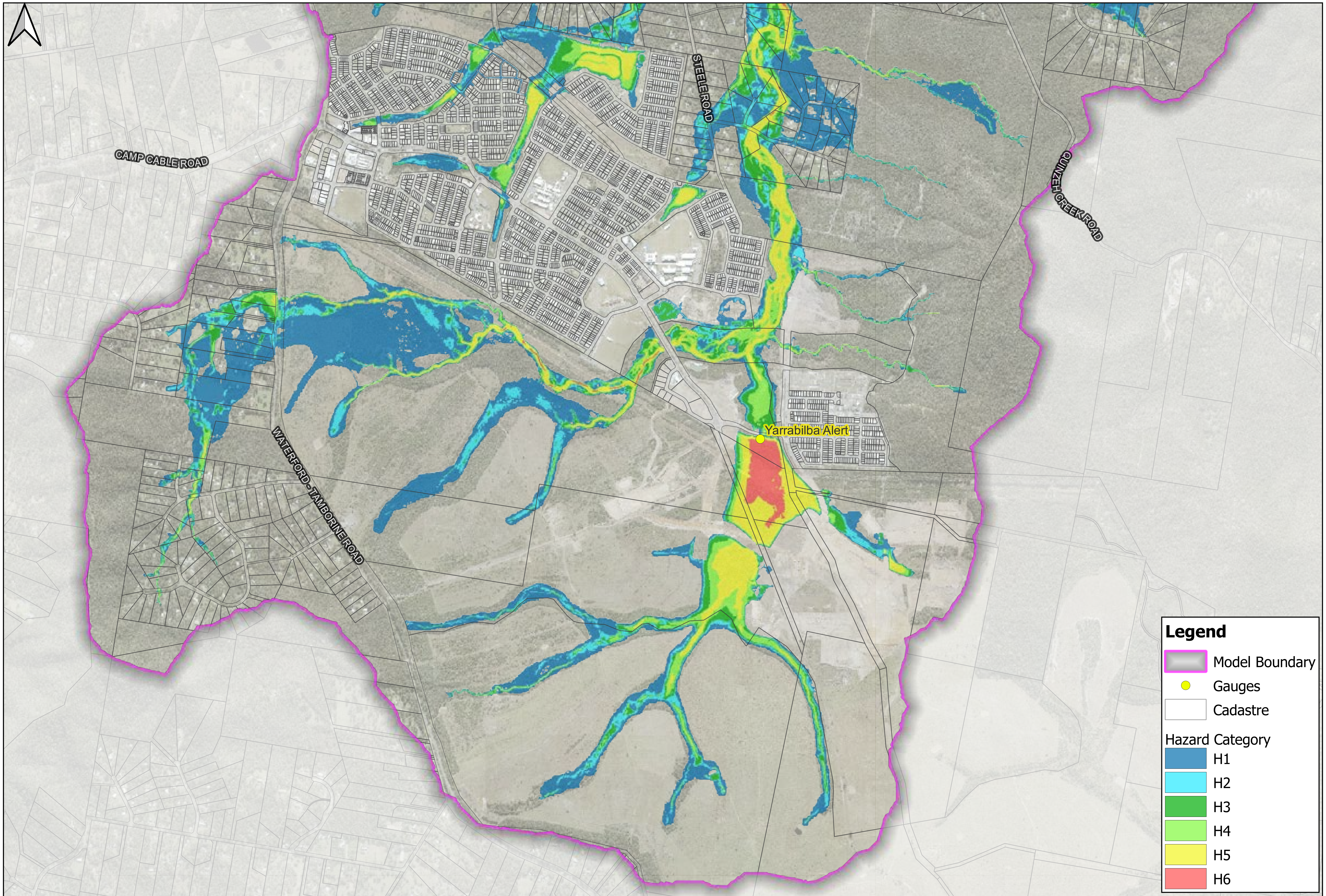
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Hazard Category - Inset 1



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Water Technology Pty Ltd

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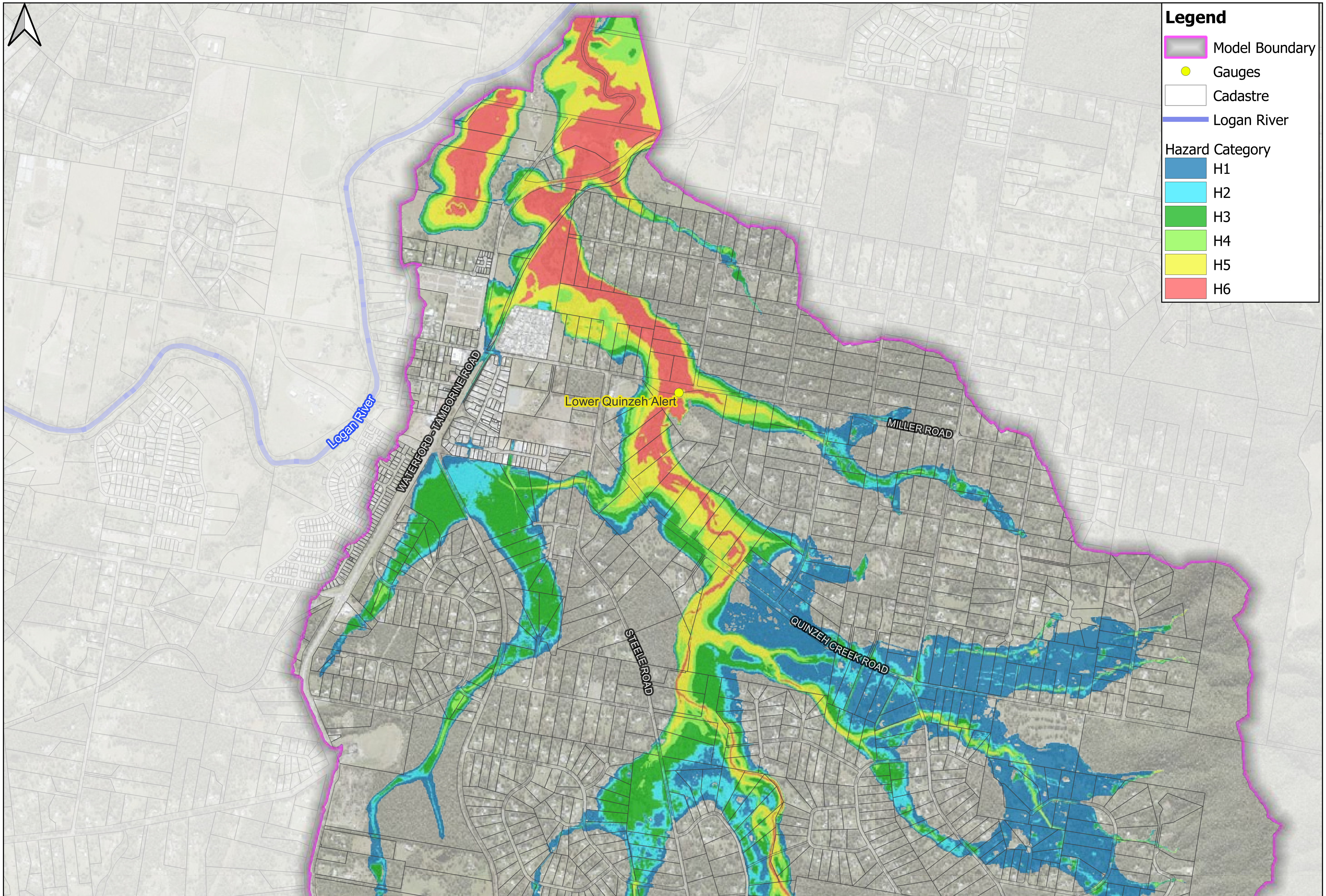
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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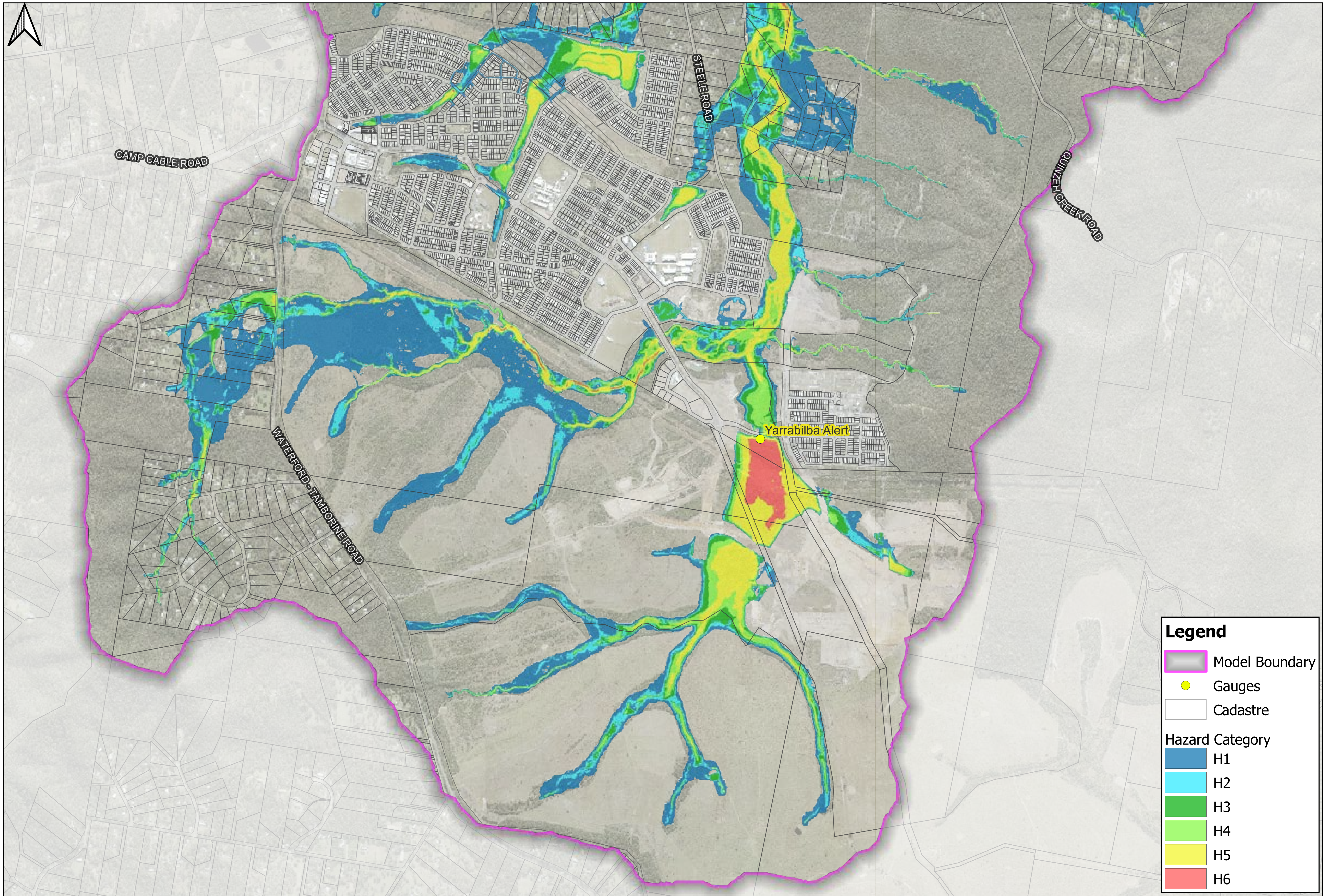
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 1



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Water Technology Pty Ltd

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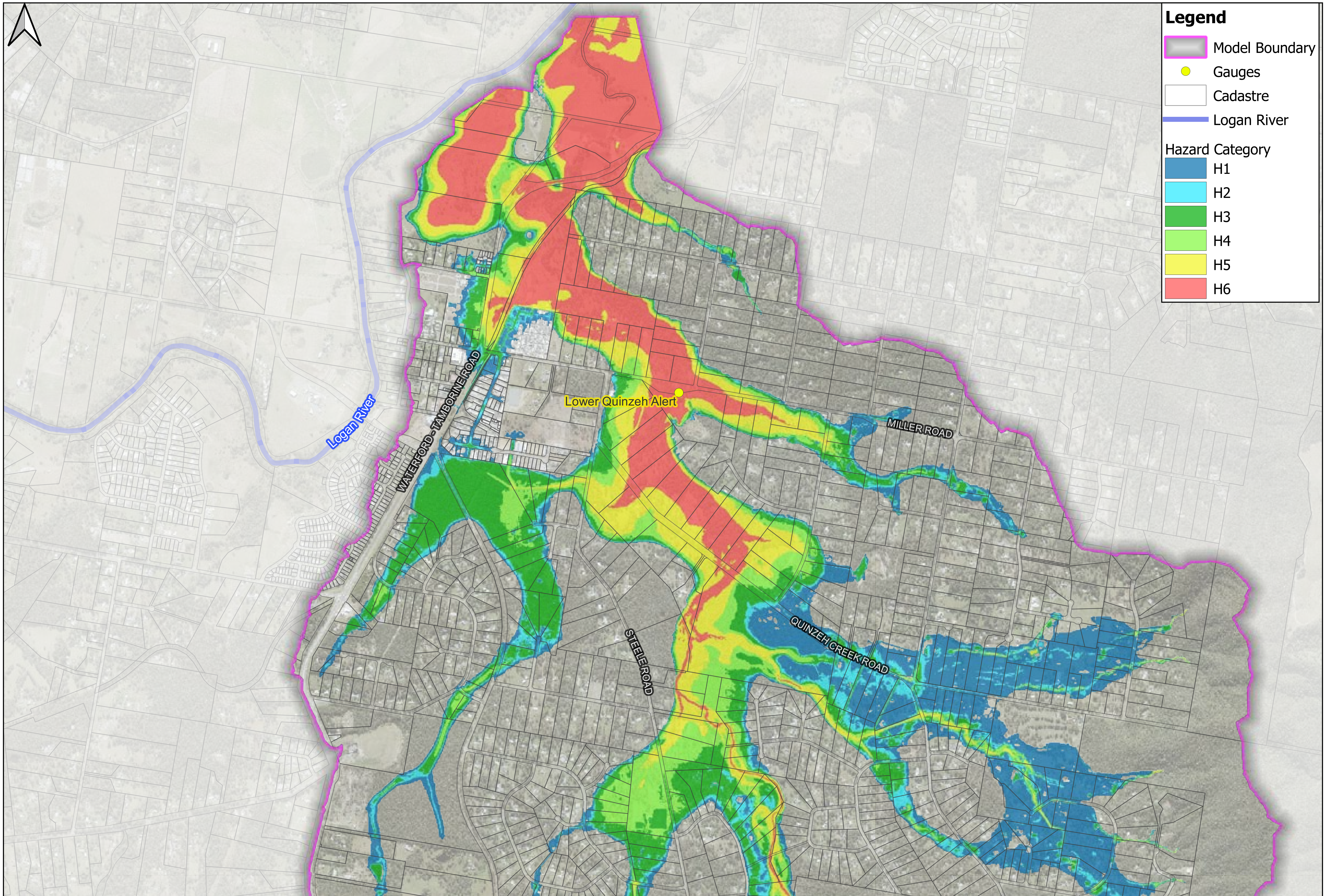
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.2% AEP CC (RCP4.5) Peak Water Hazard Category - Inset 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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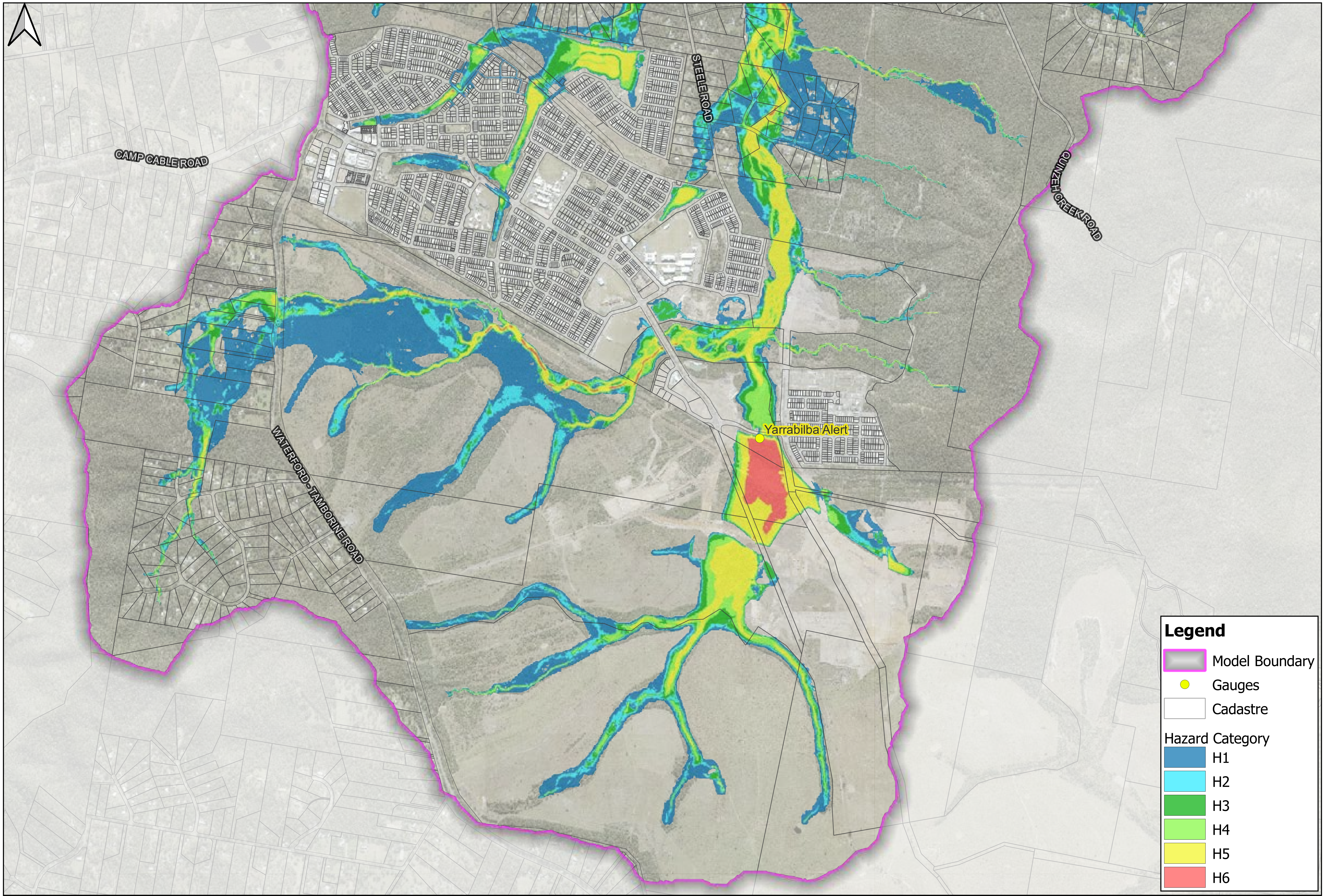
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 0.05% AEP Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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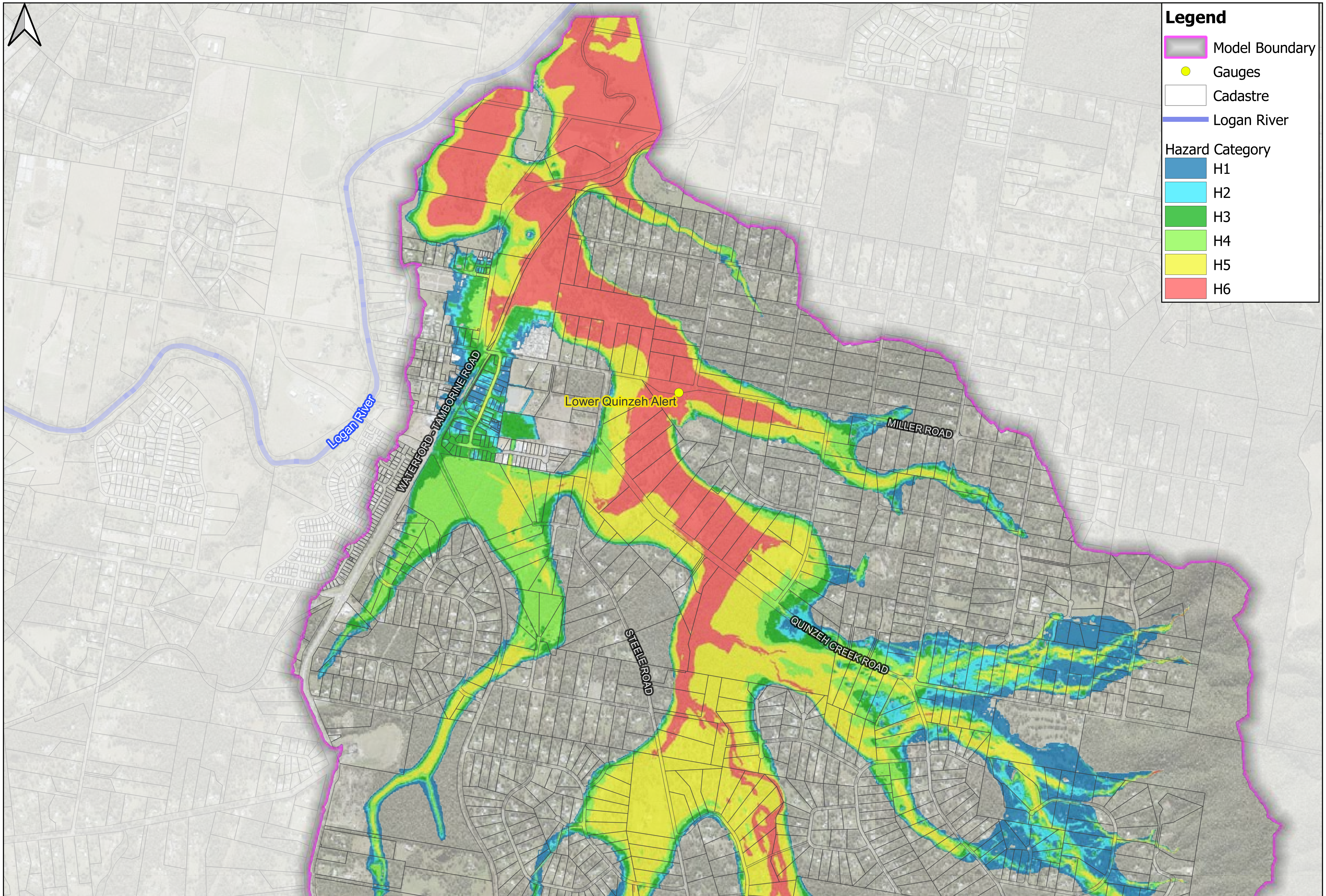
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 0.05% AEP Peak Water Hazard Category - Inset 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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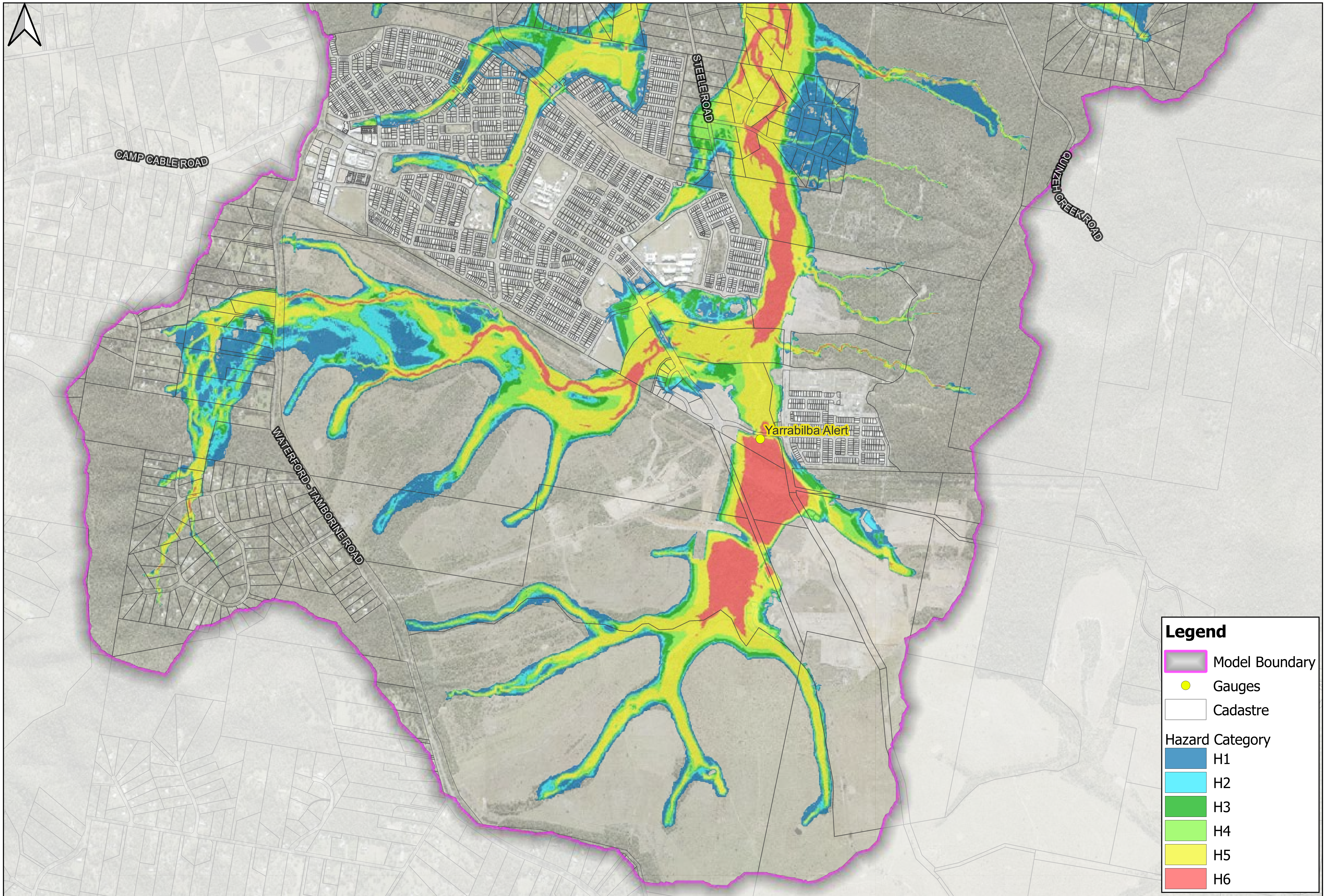
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Hazard Category - Inset 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

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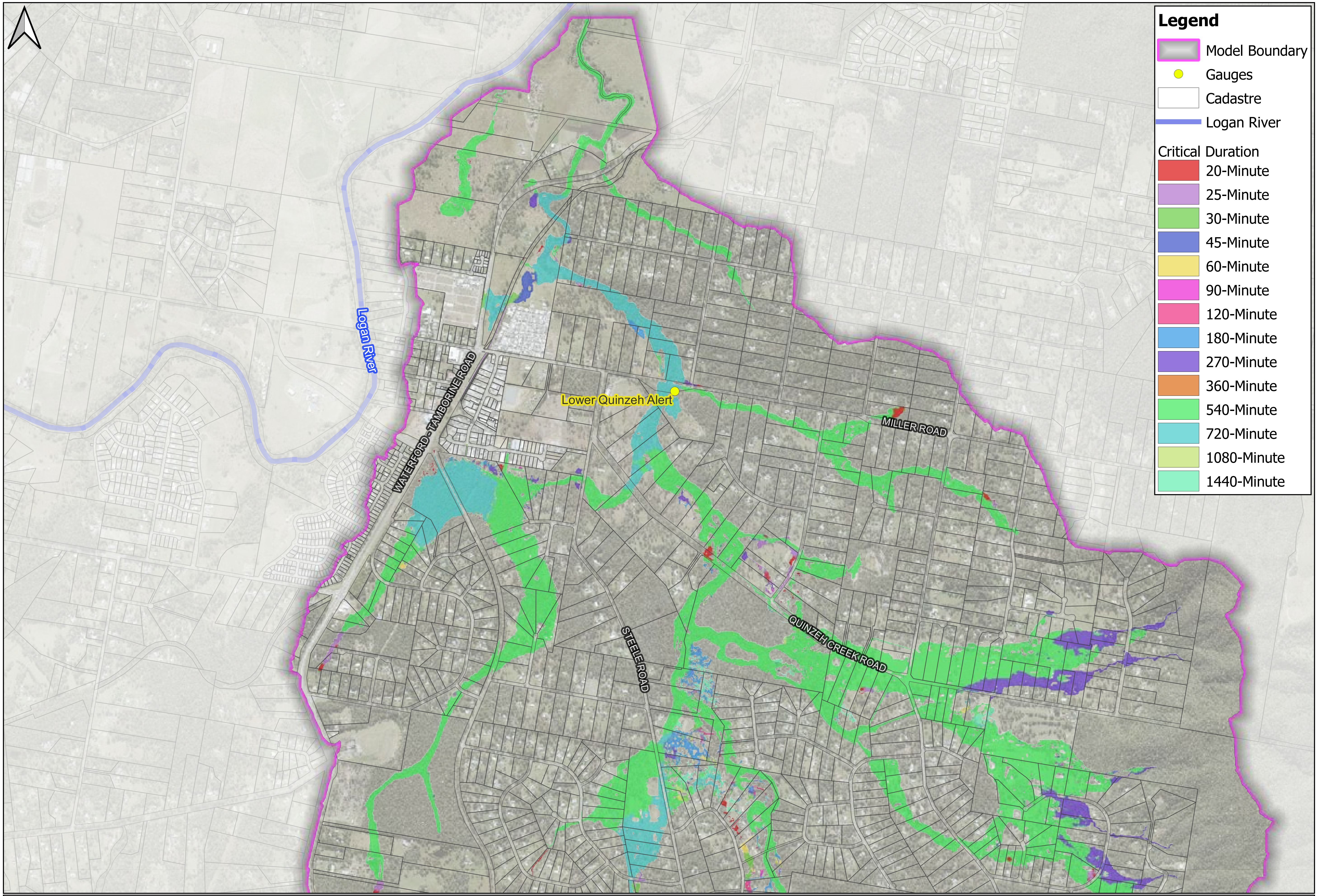
Quinzeh Creek Flood Study 2023

Quinzeh Creek - PMF Peak Water Hazard Category - Inset 2

APPENDIX F
CRITICAL DURATION AND TEMPORAL PATTERN GIS MAPS



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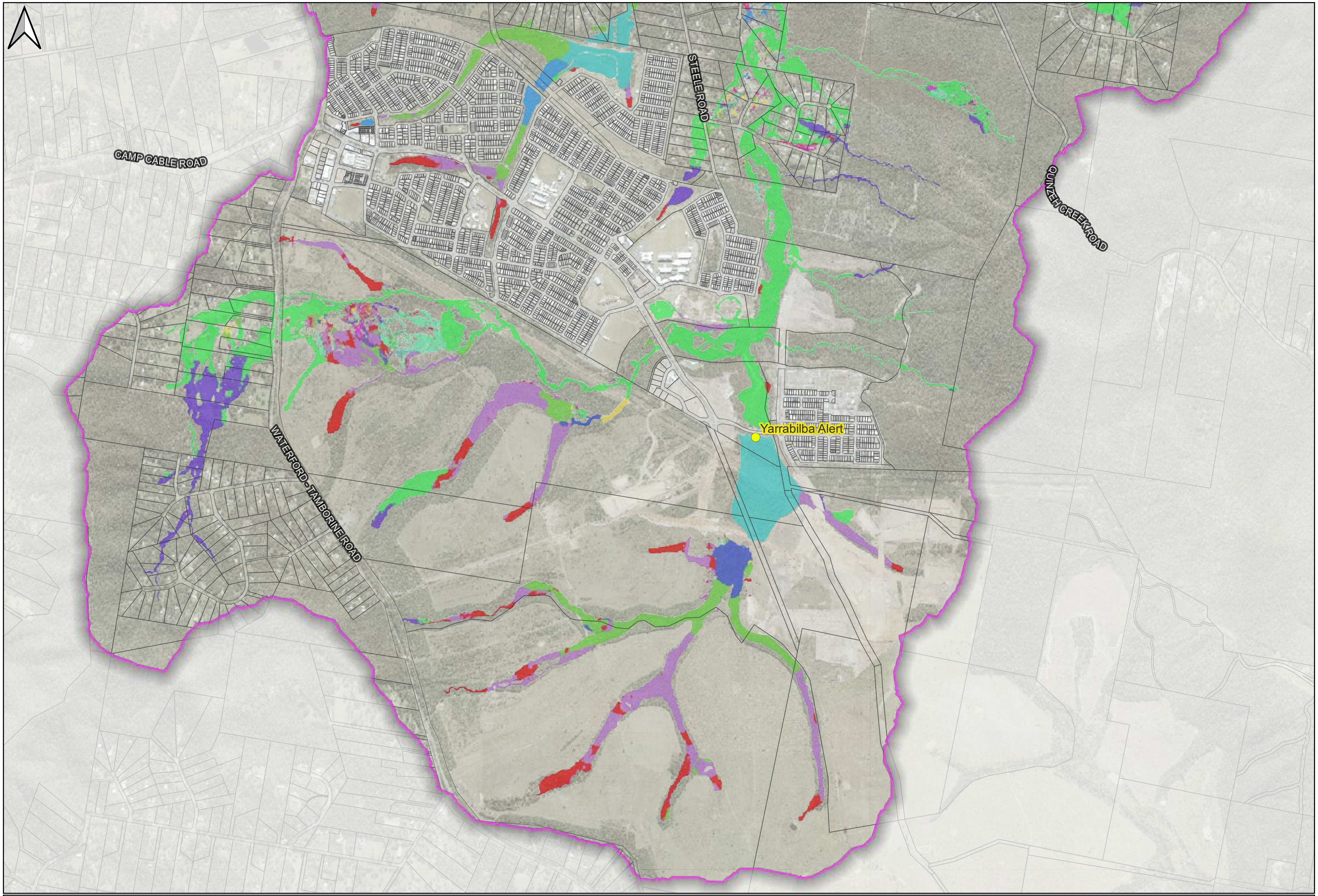
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 50% AEP Critical Duration - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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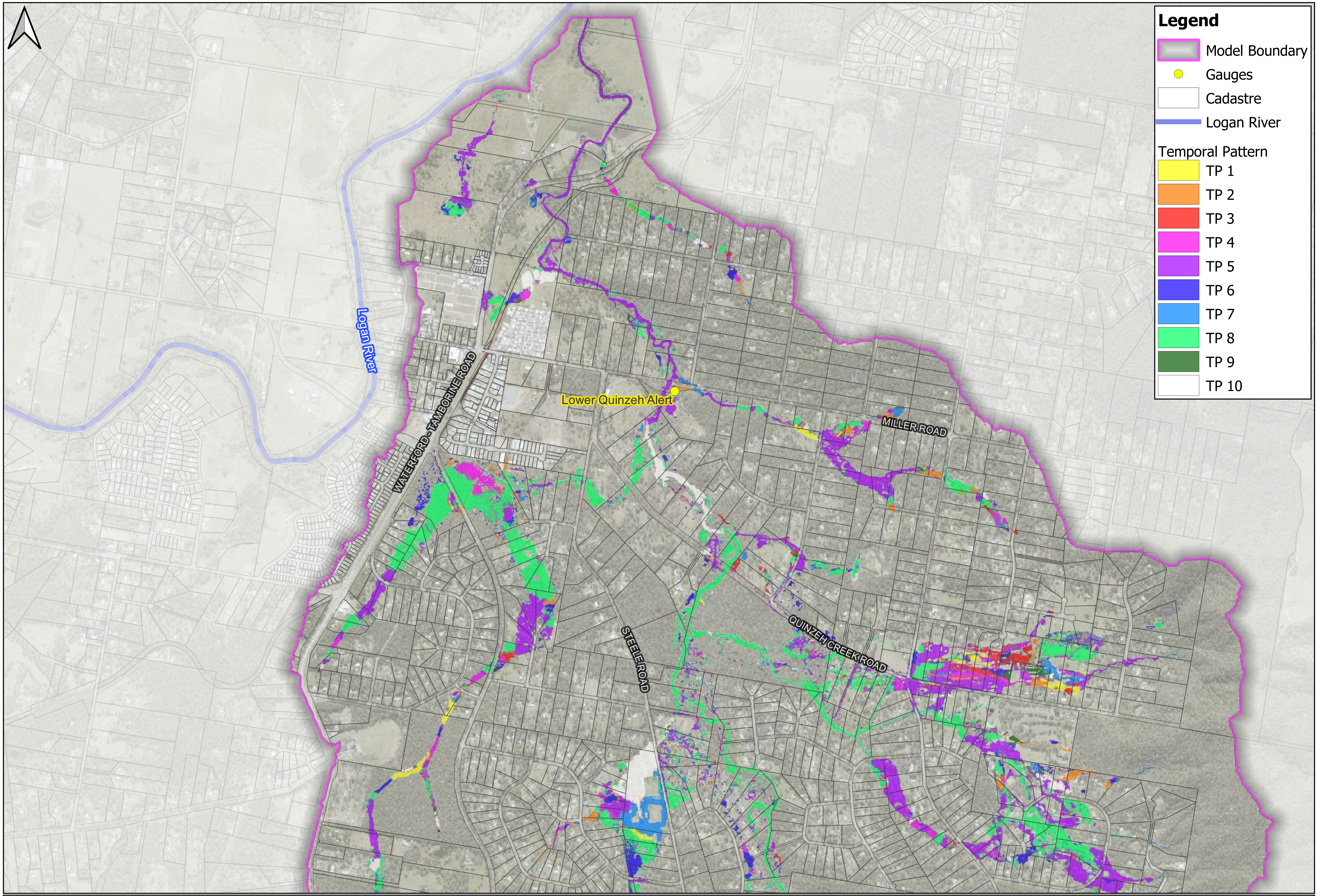
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP Critical Duration - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

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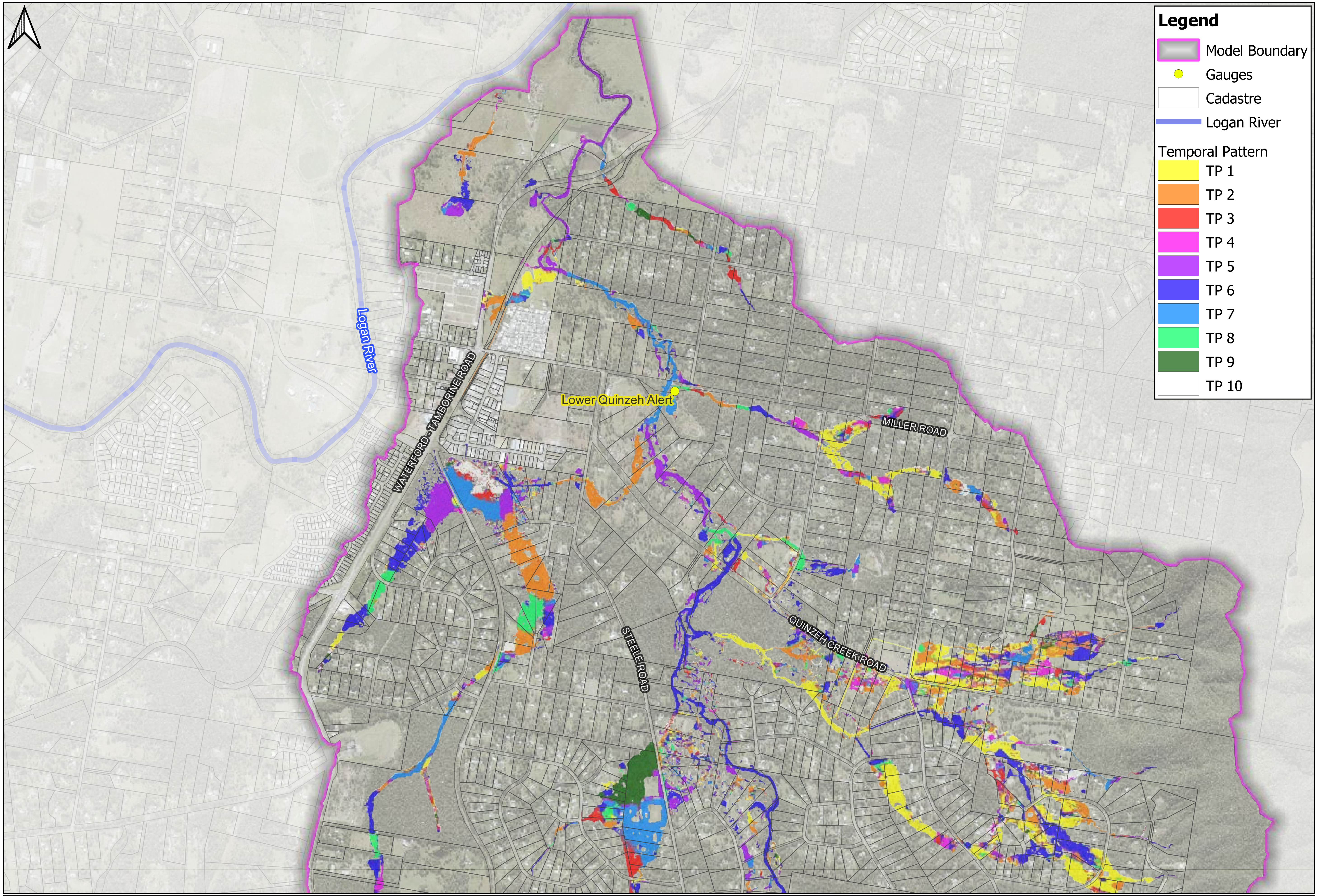
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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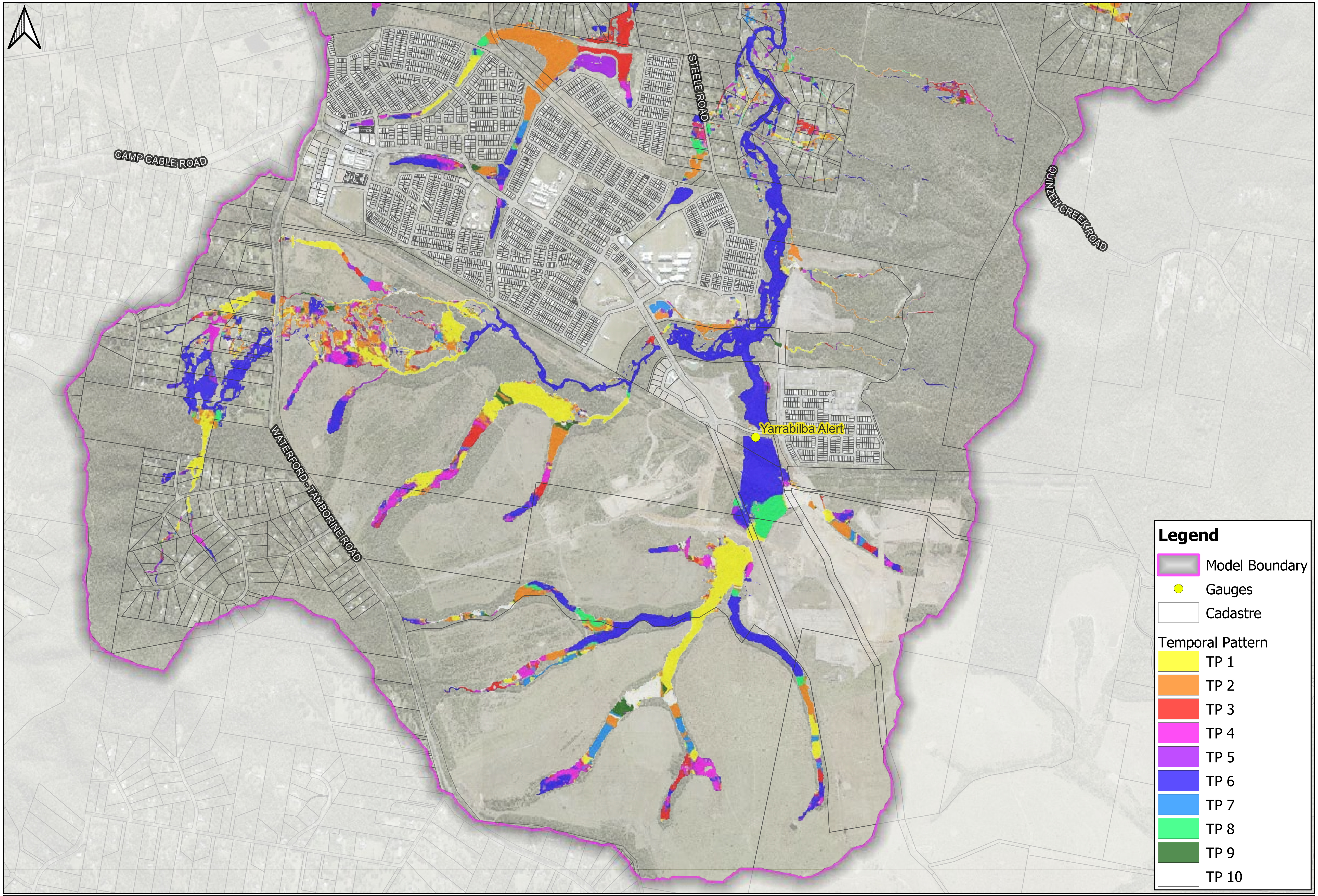
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Imagery Source: LCC
Water Technology Pty Ltd

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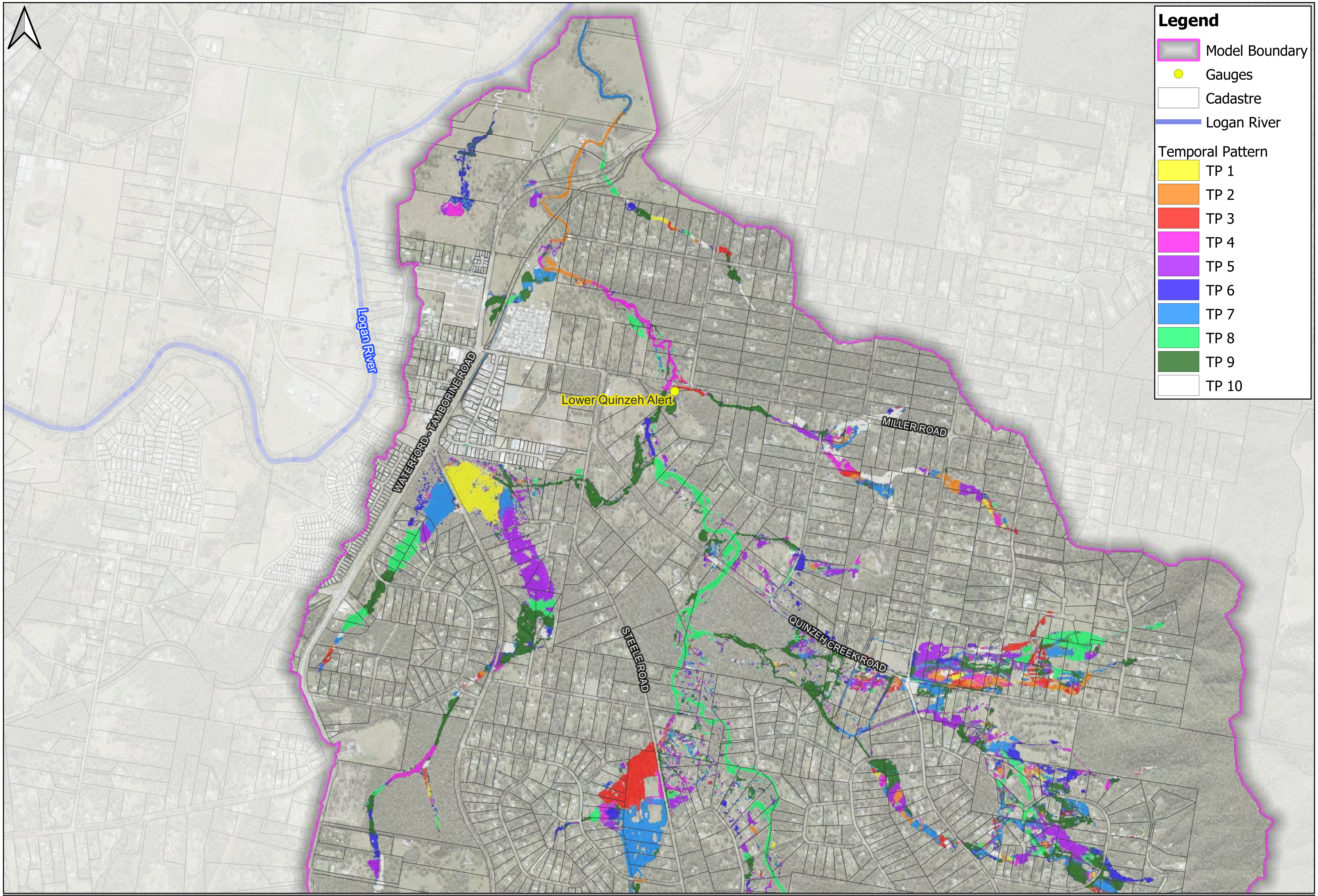
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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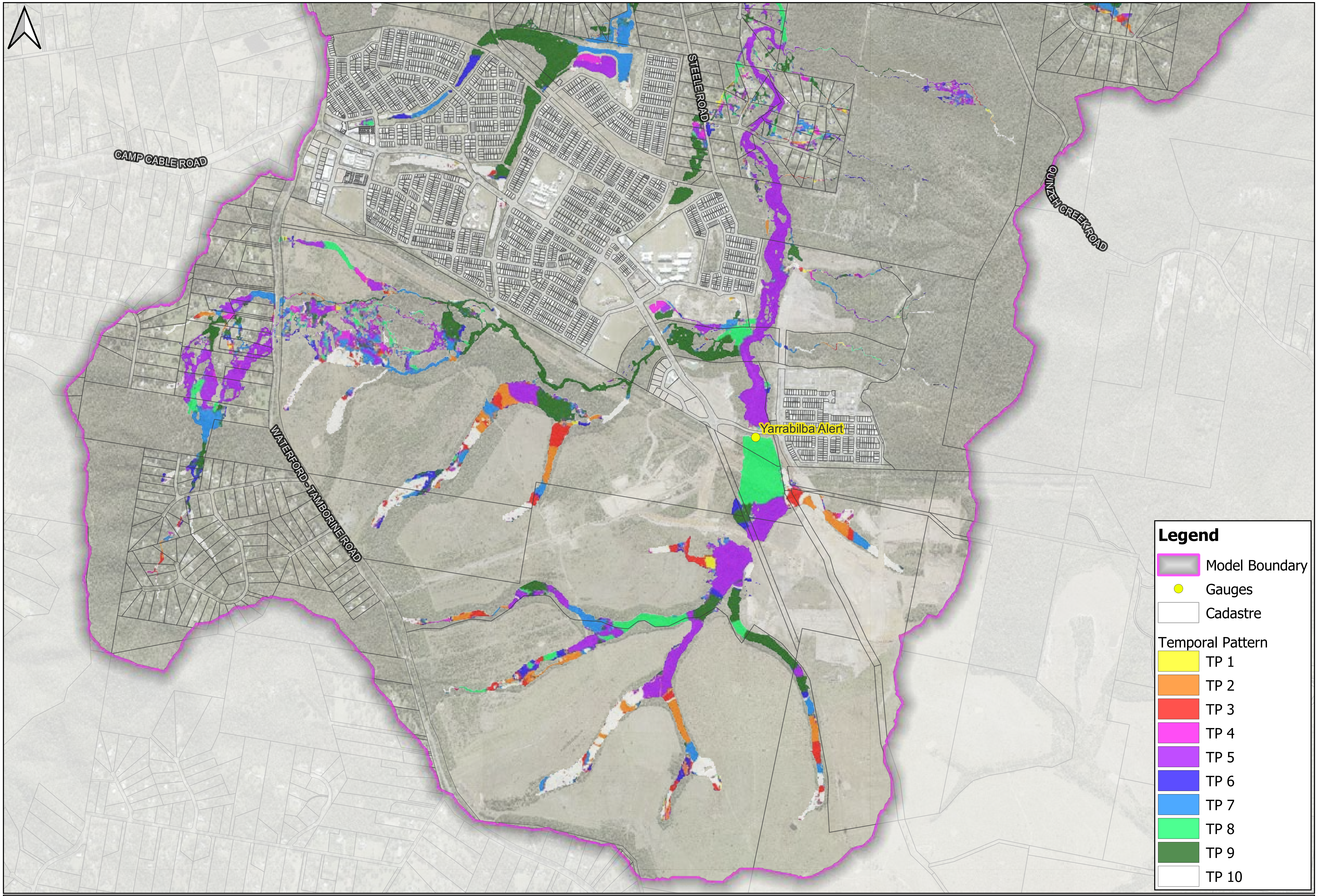
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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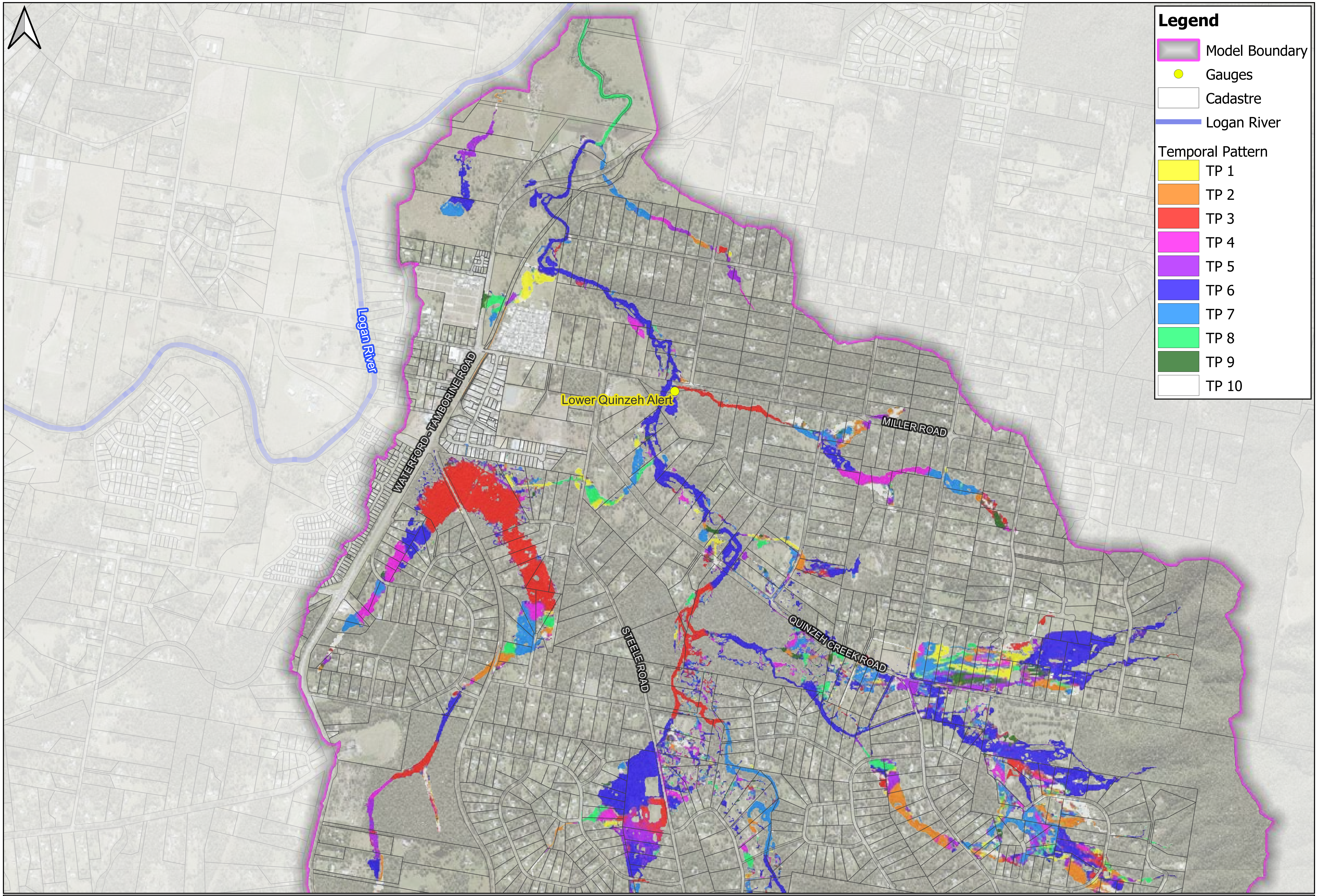
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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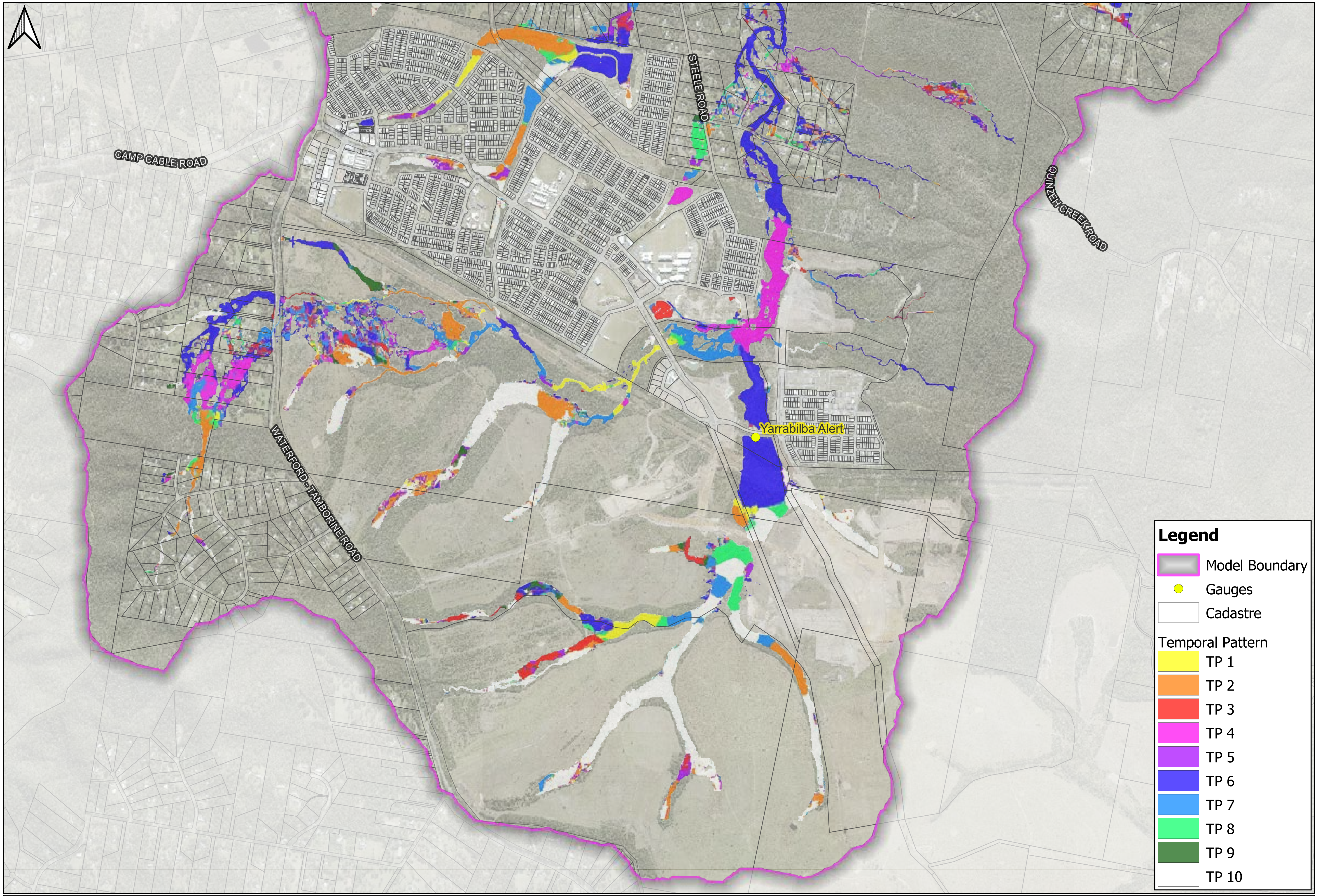
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

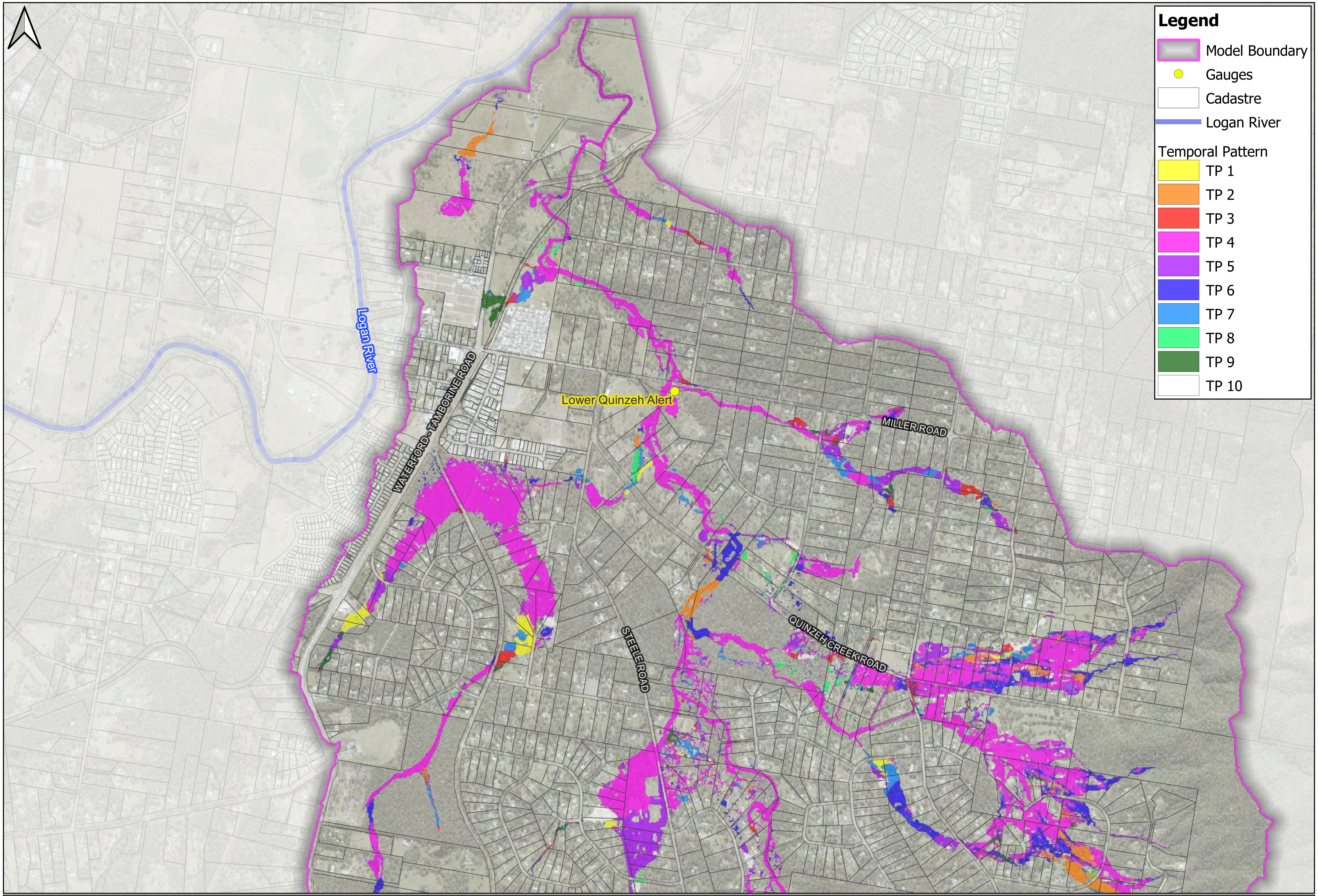
Quinzeh Creek - 50% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 50% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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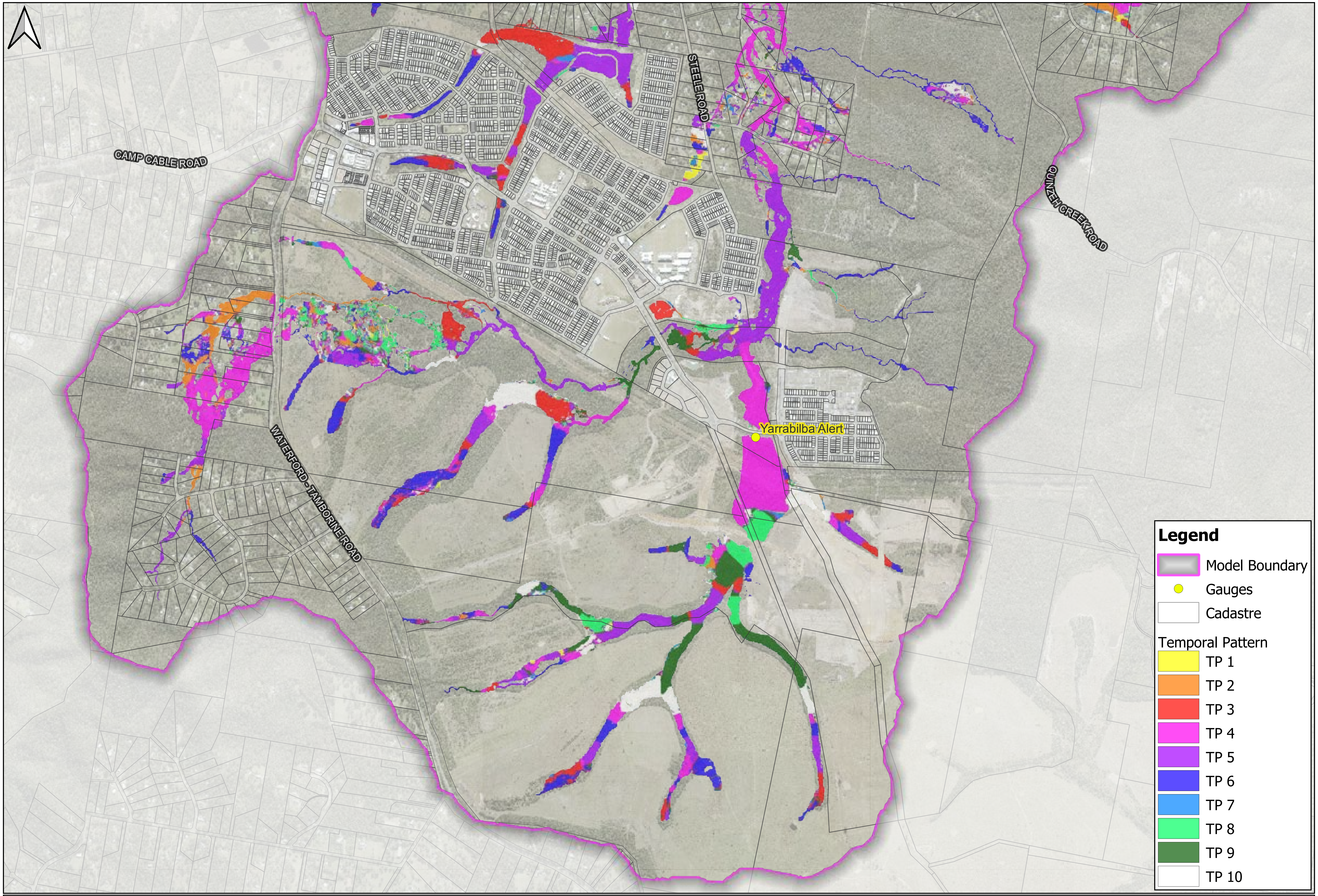
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



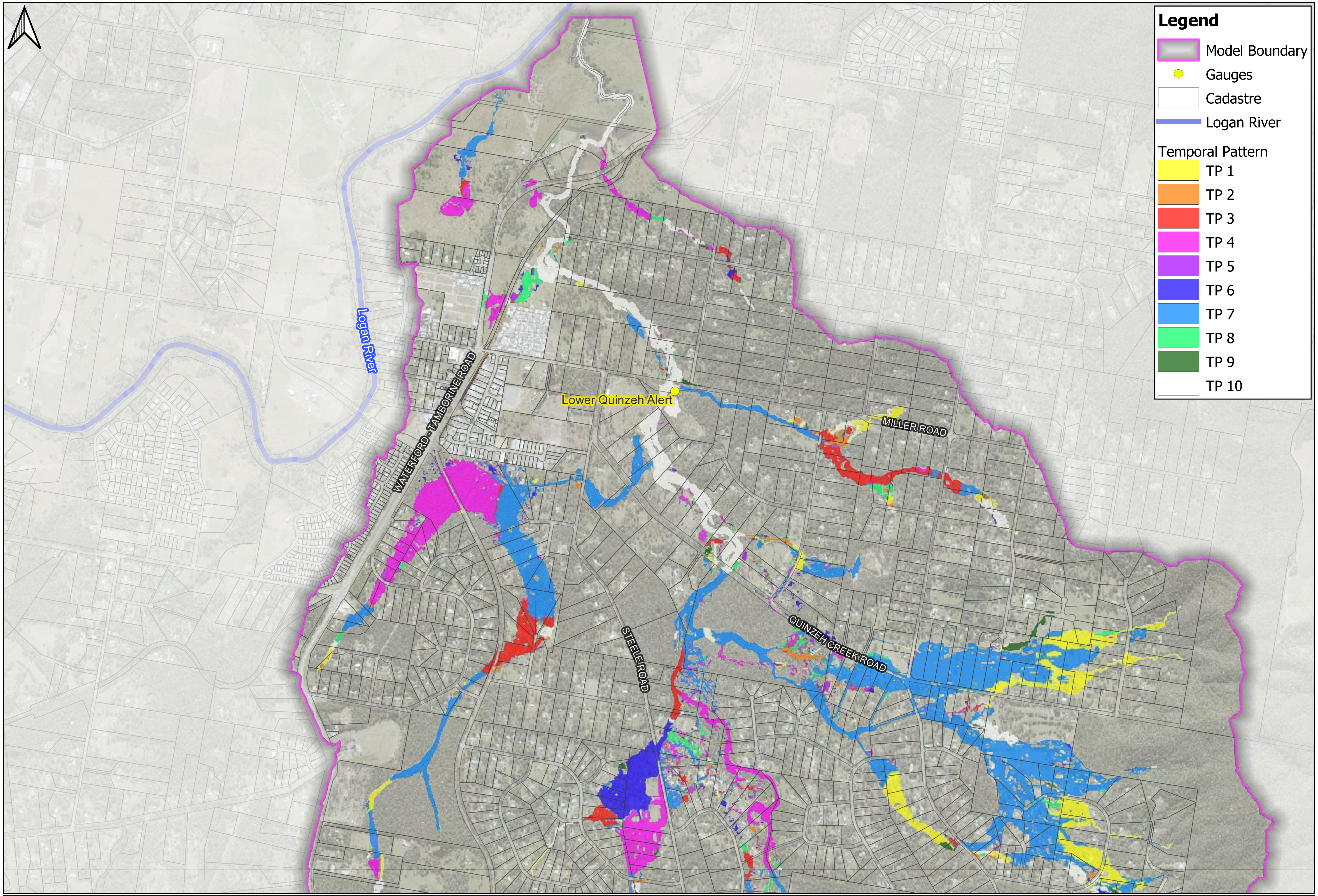
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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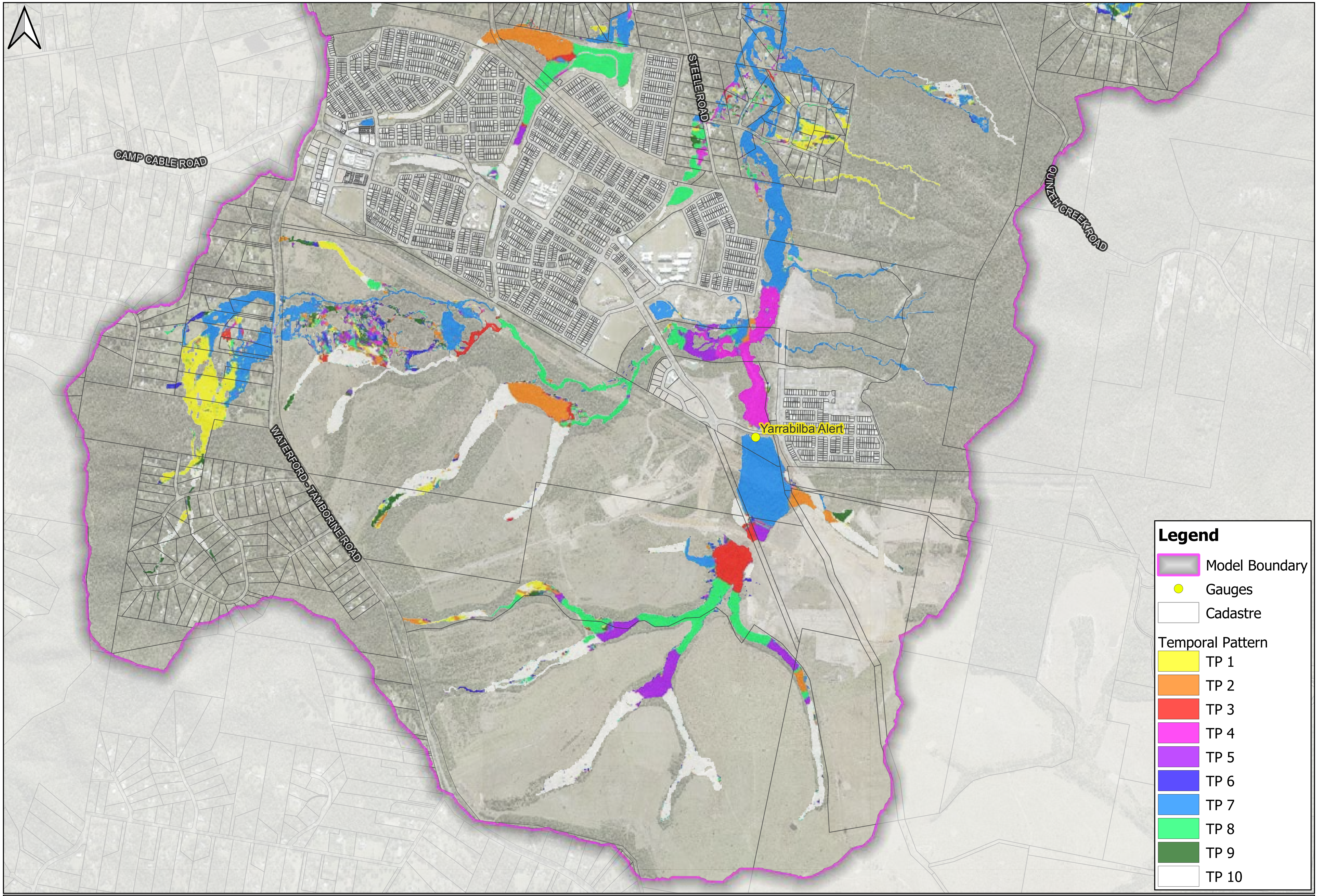
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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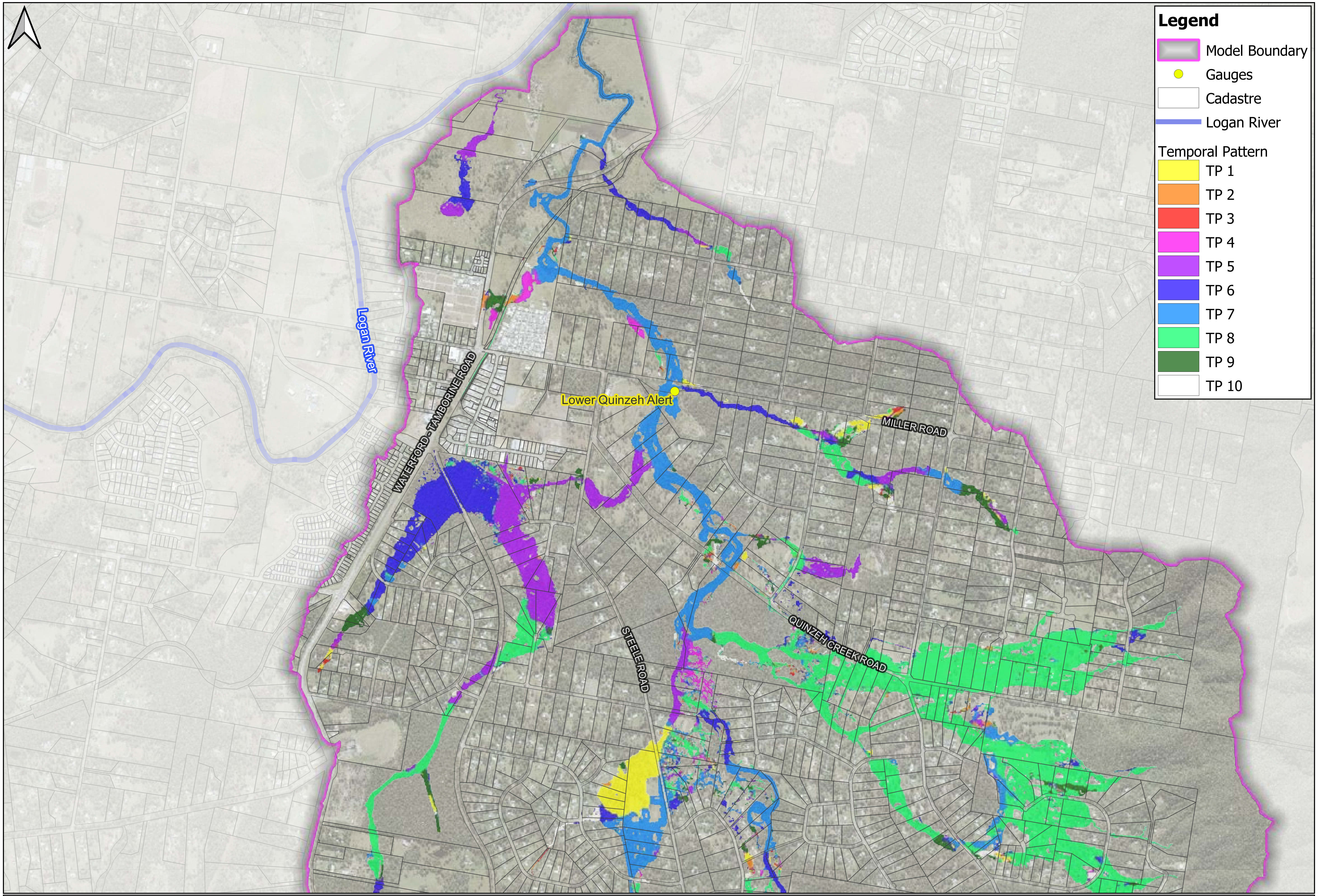
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

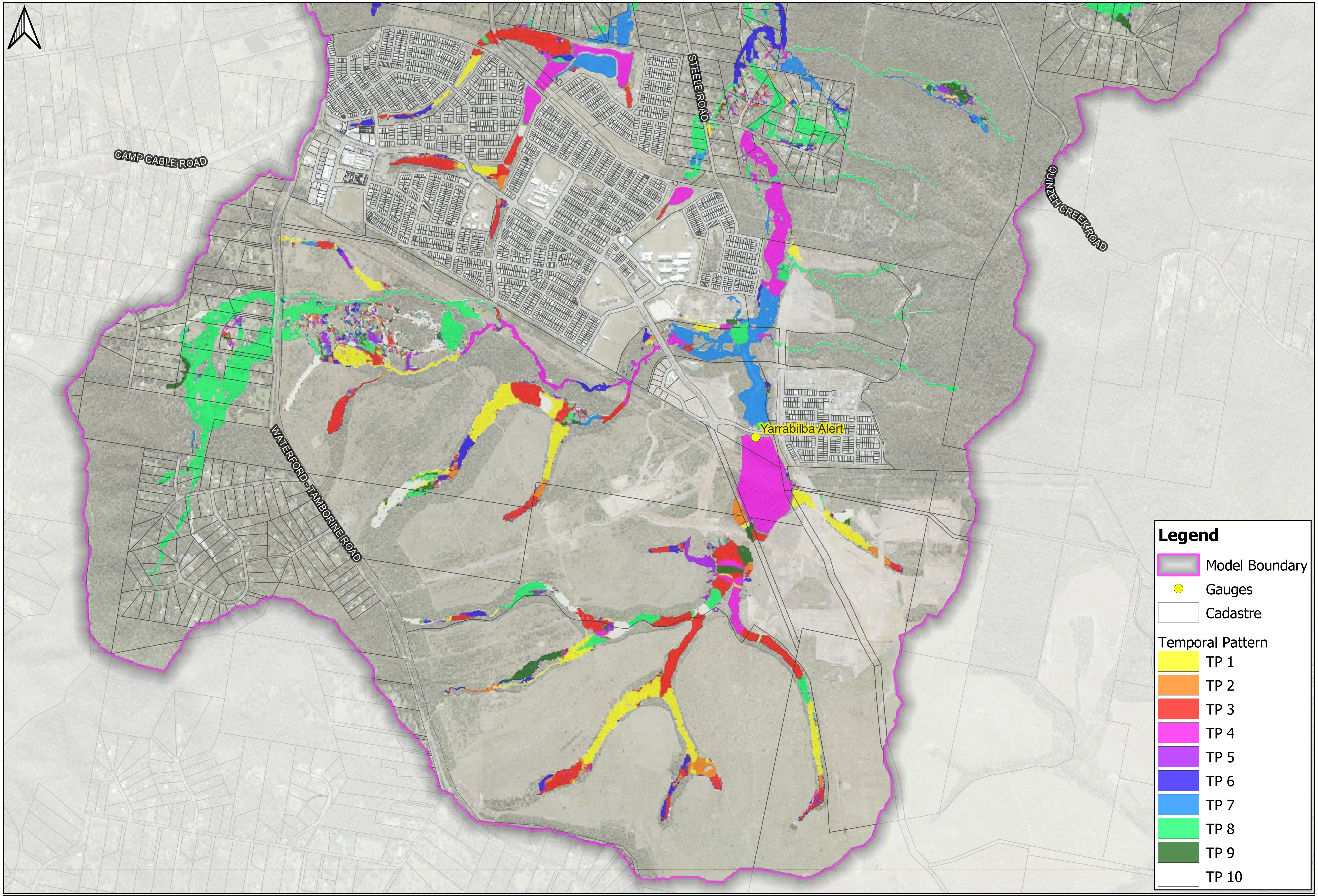
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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Water Technology Pty Ltd

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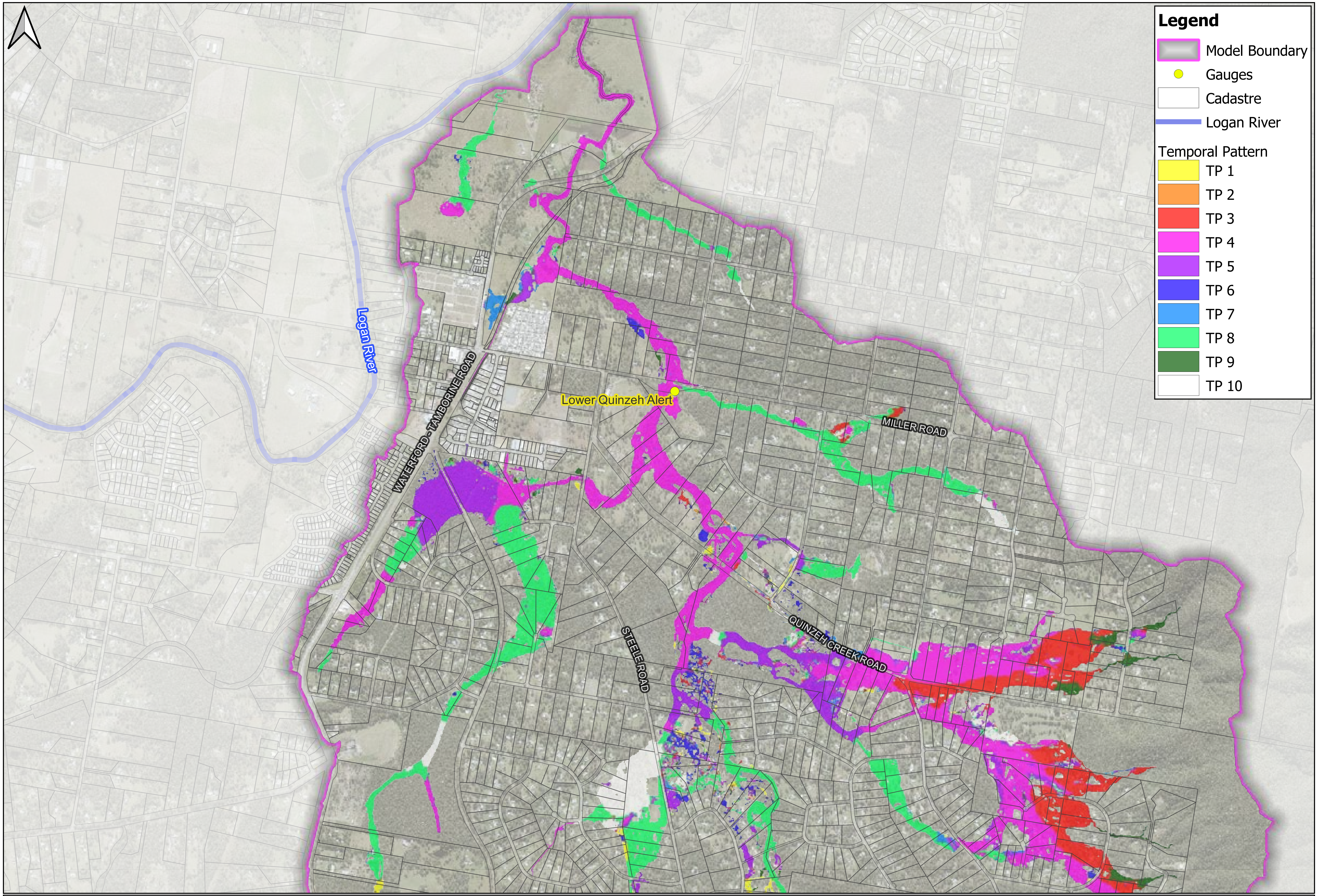
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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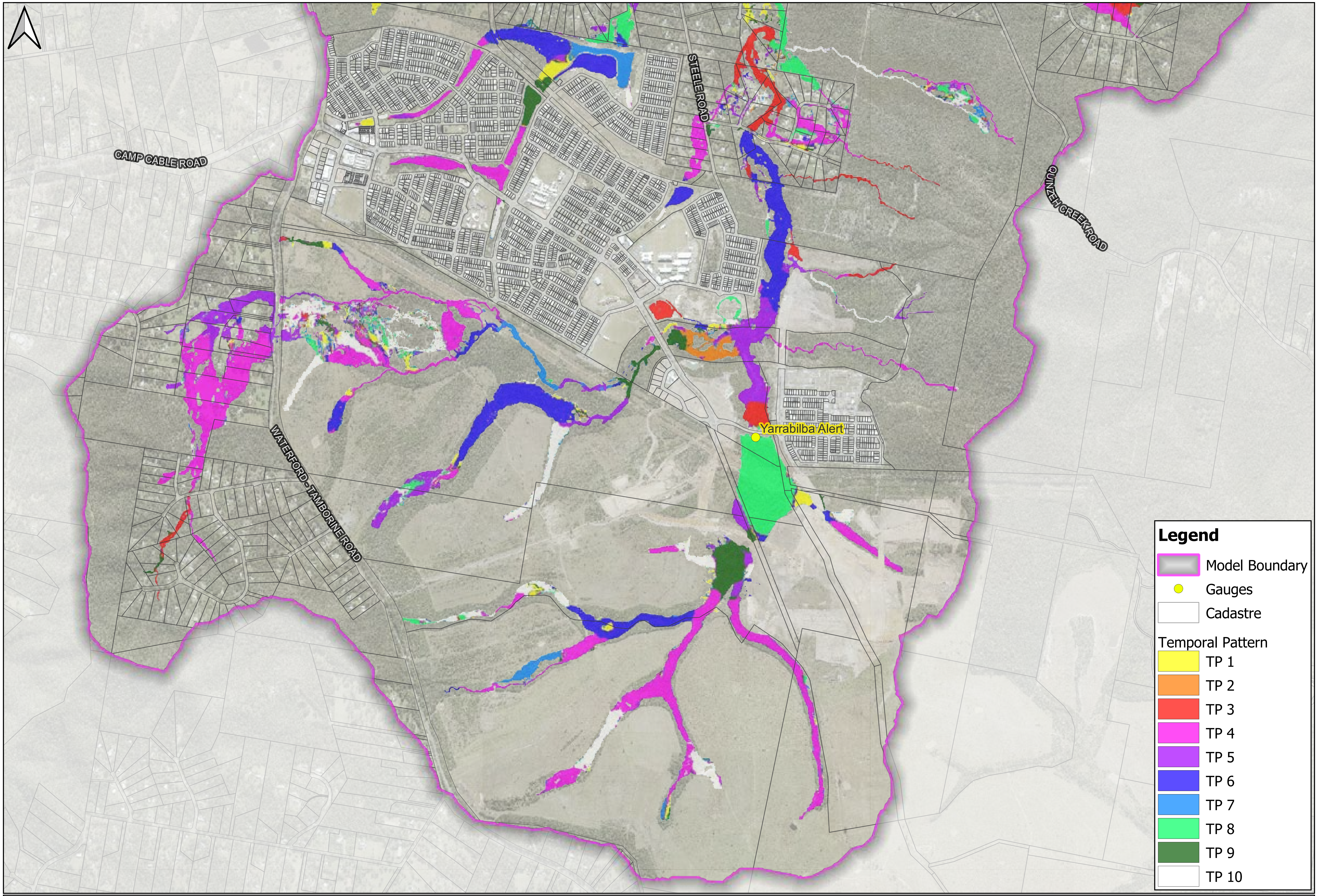
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



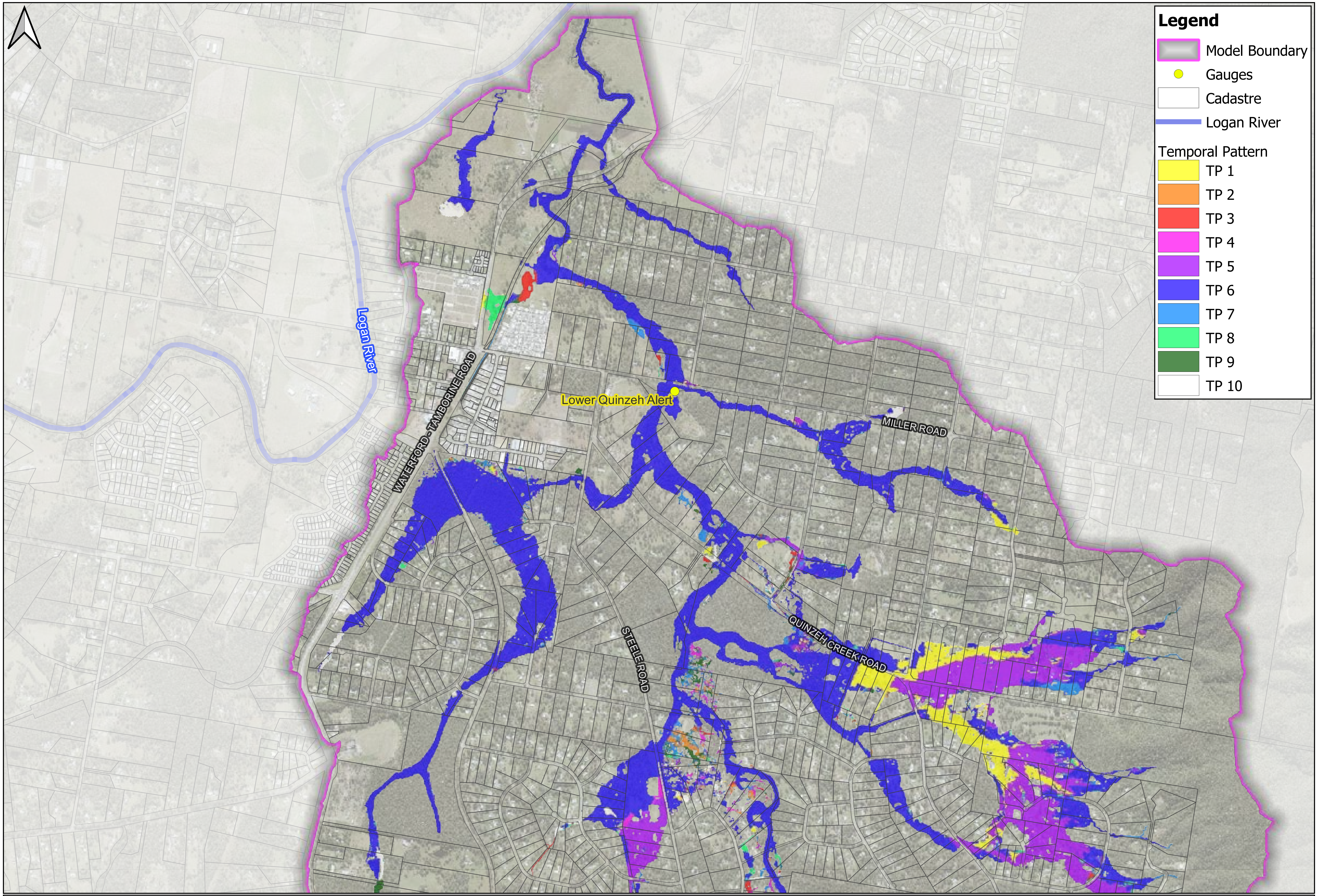
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

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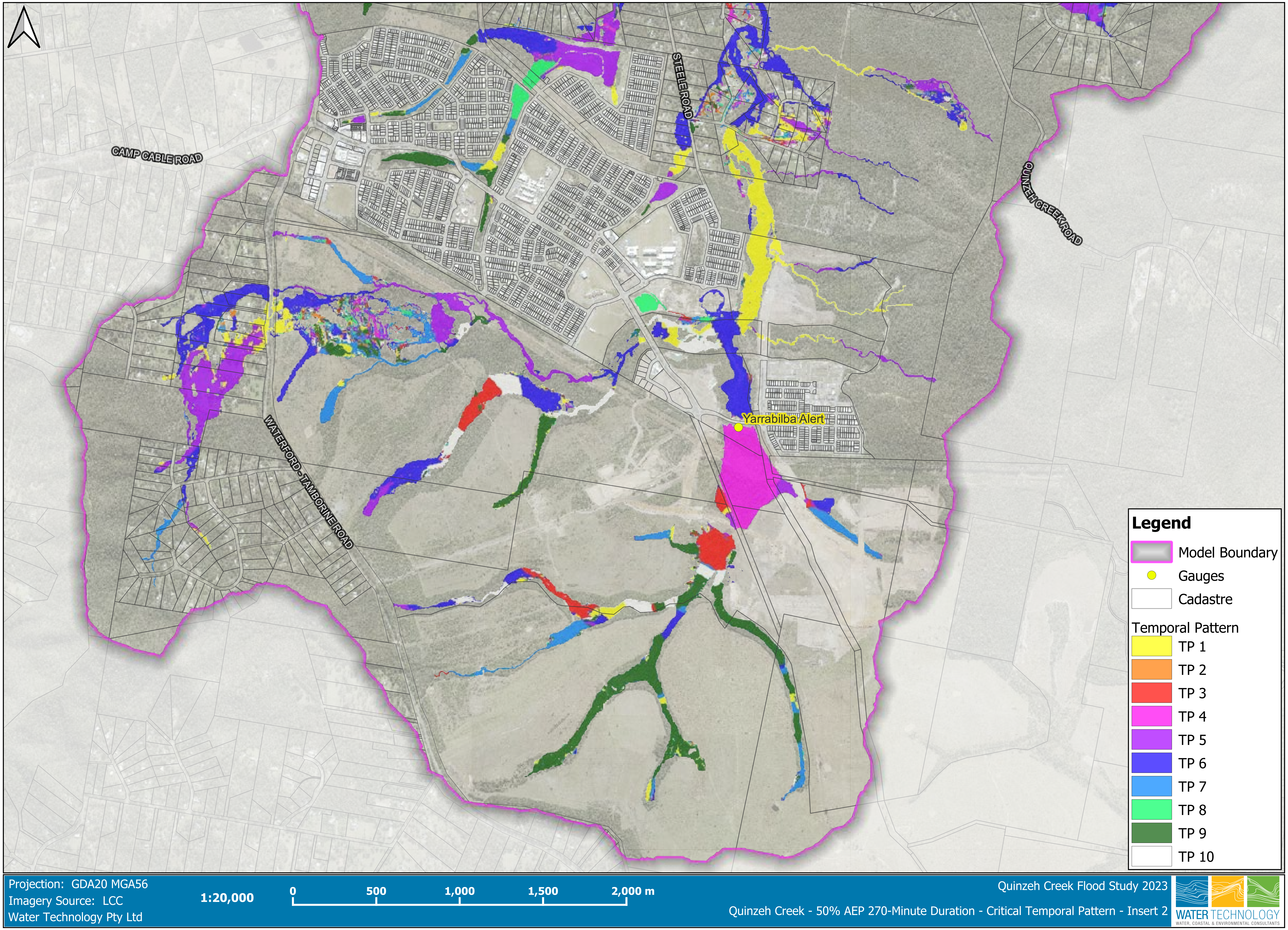
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

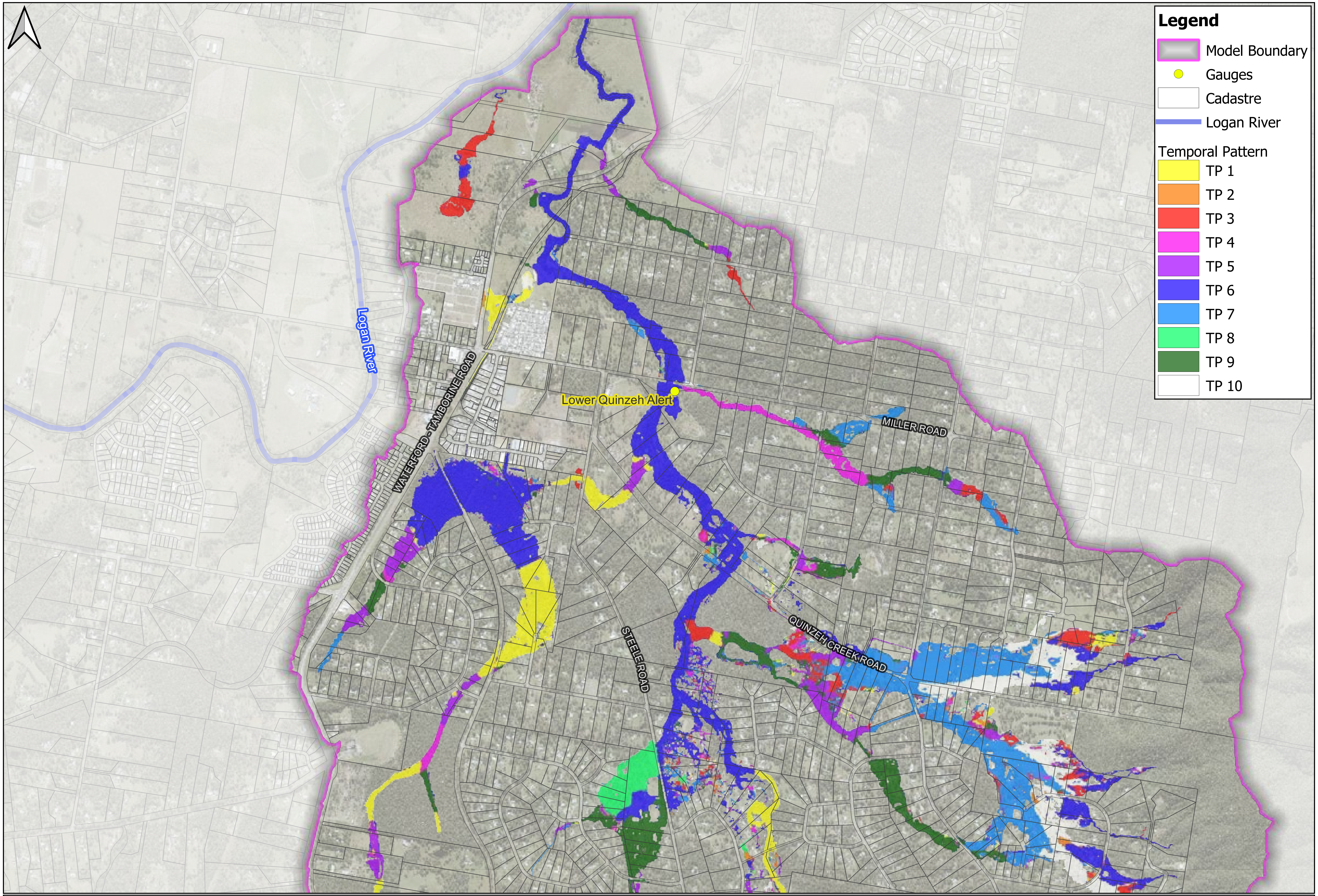


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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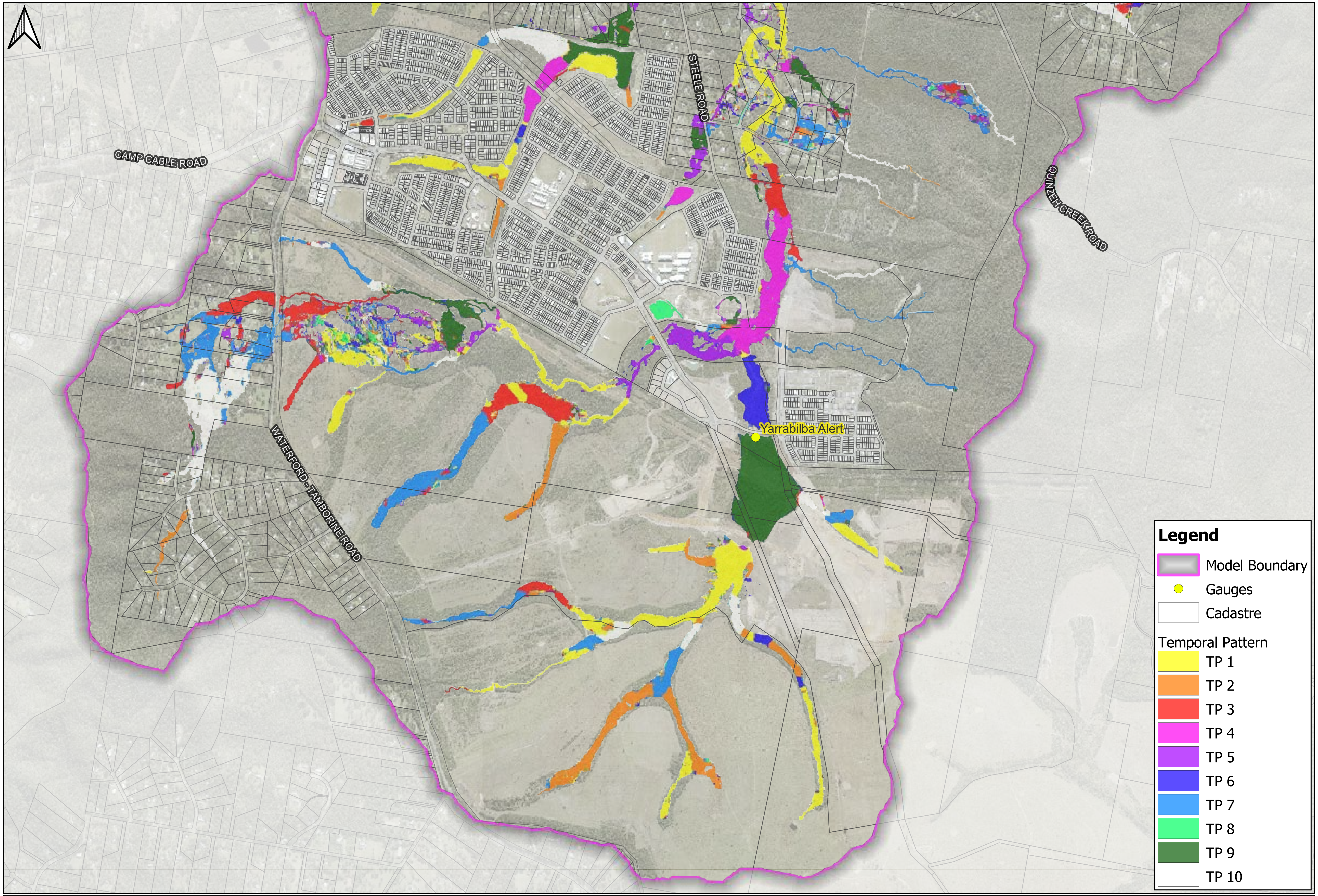
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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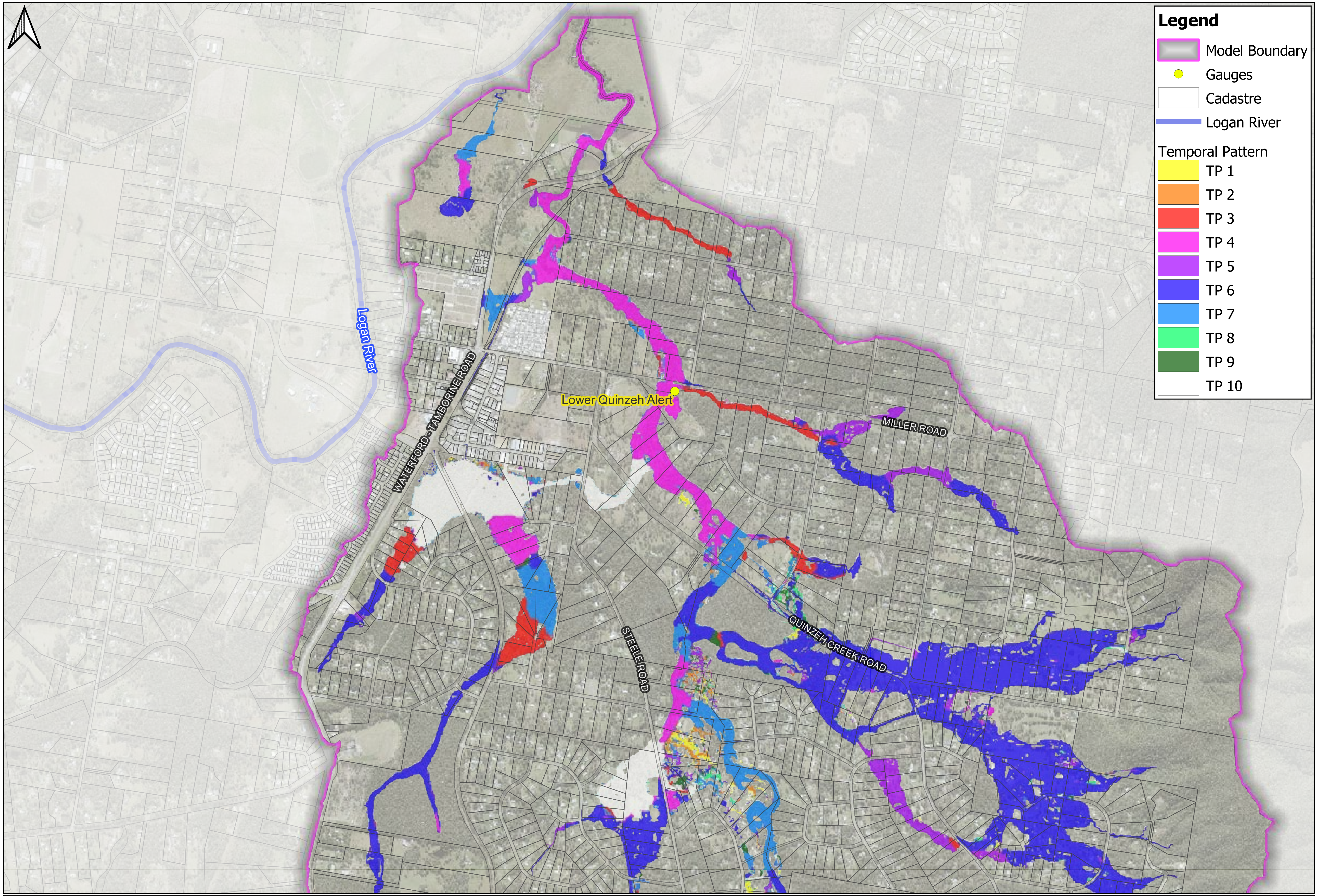
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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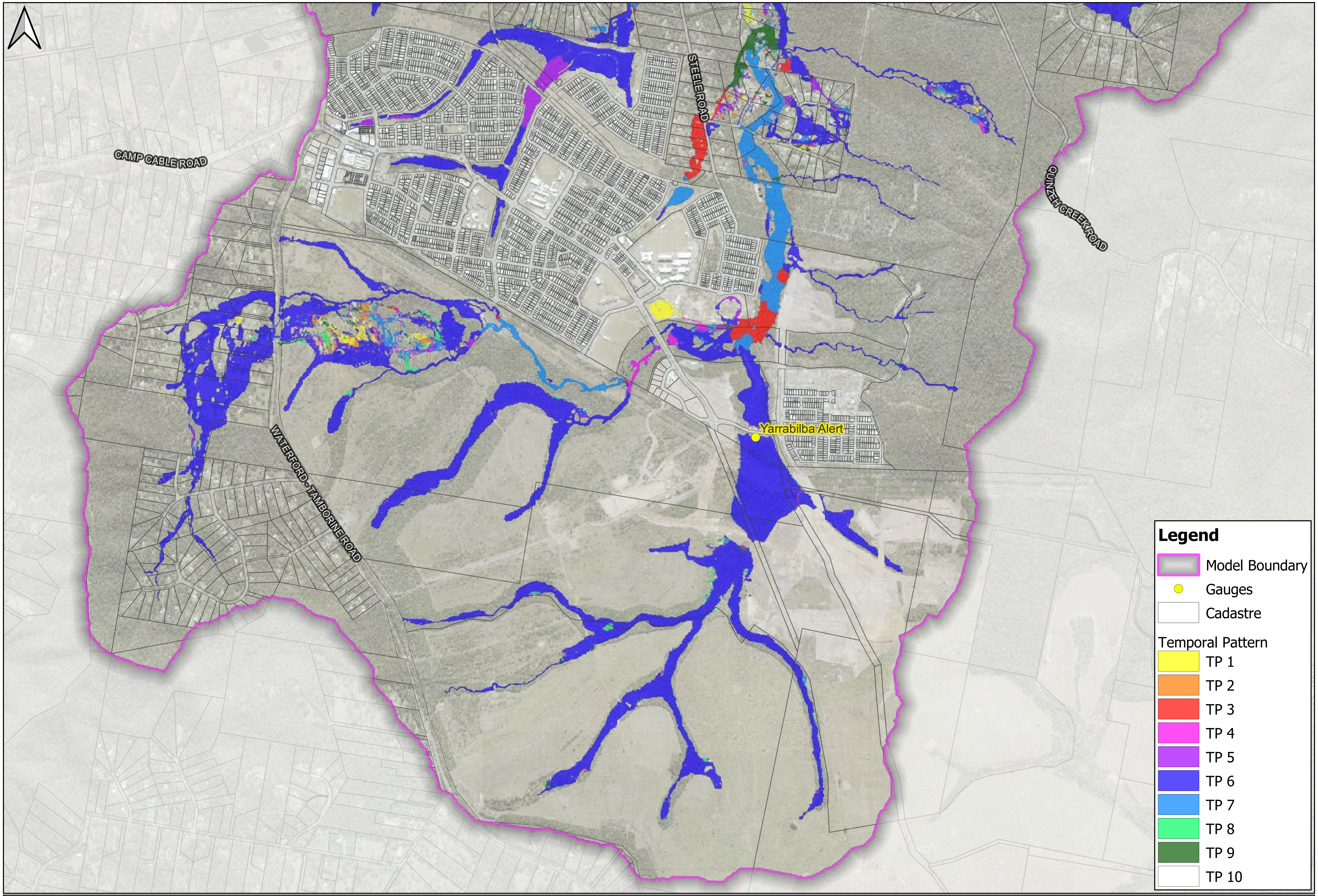
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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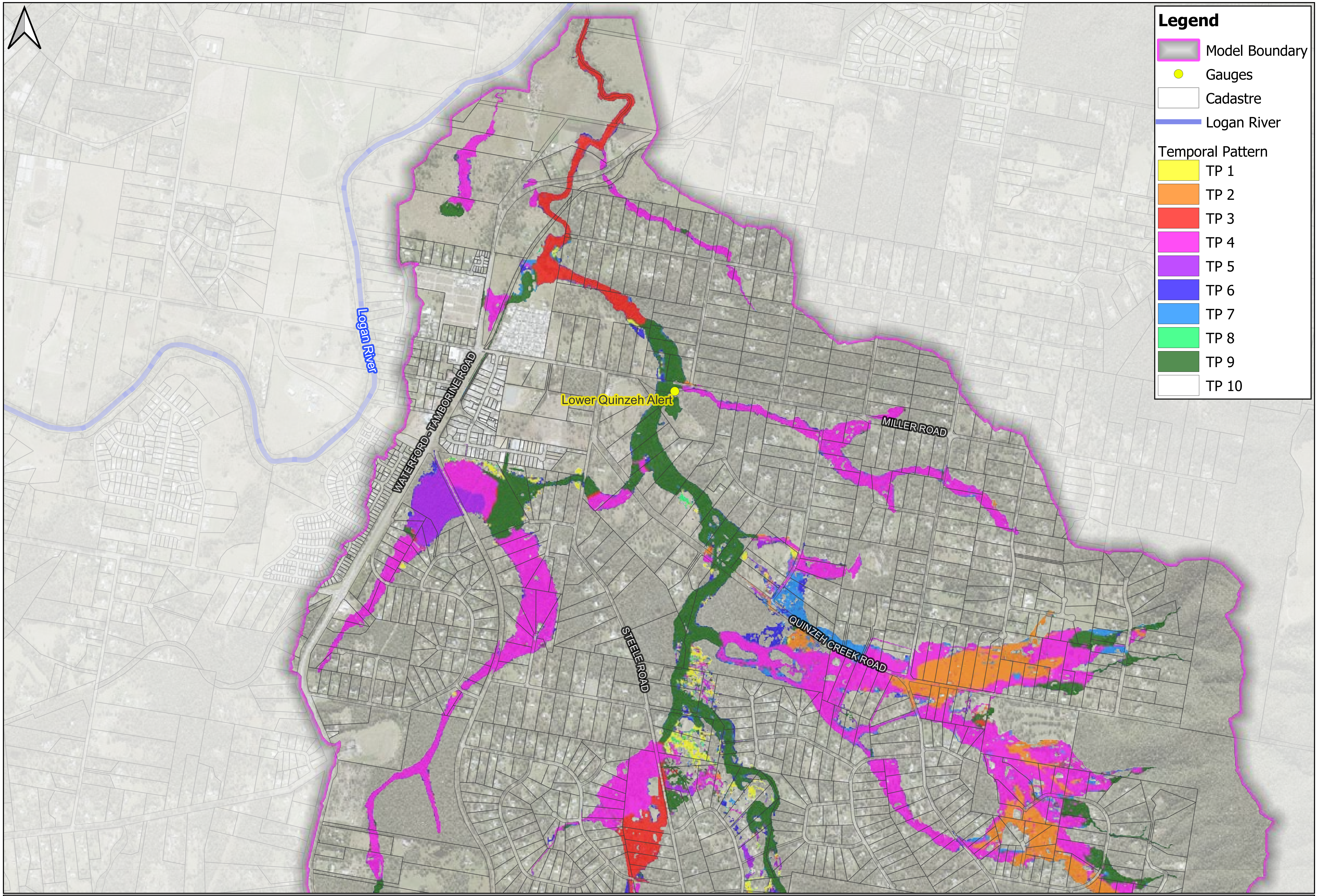
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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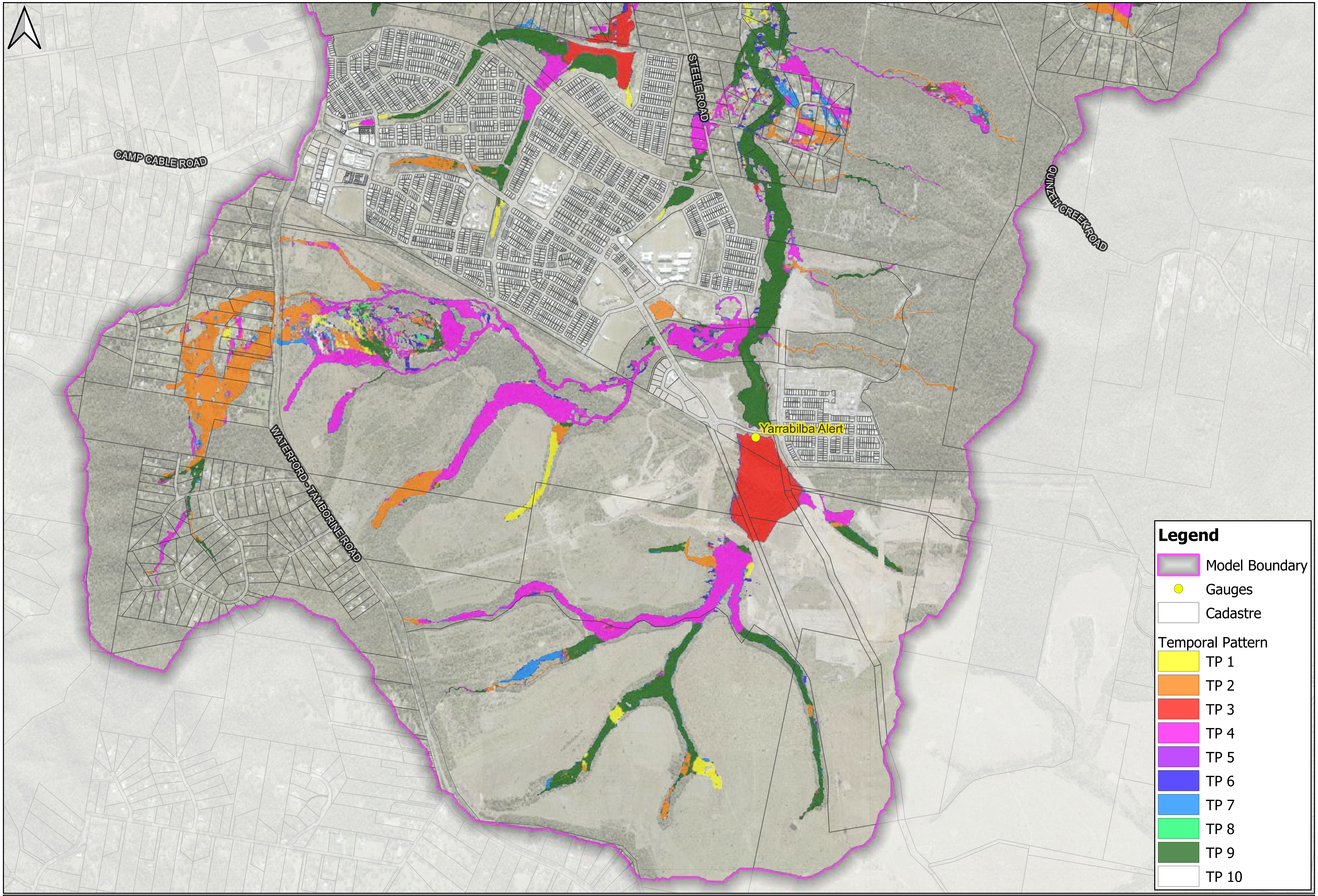
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 720-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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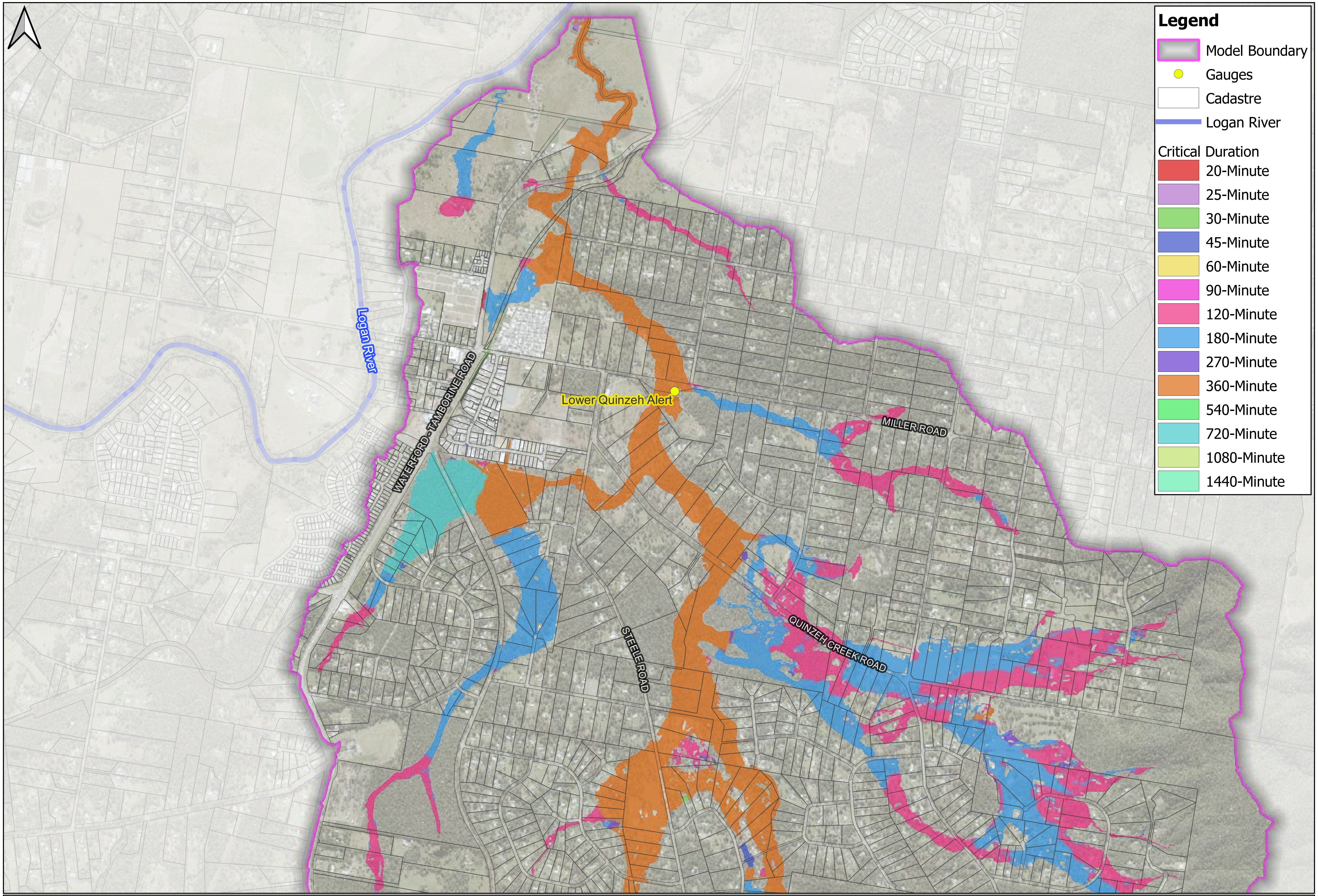
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 50% AEP 720-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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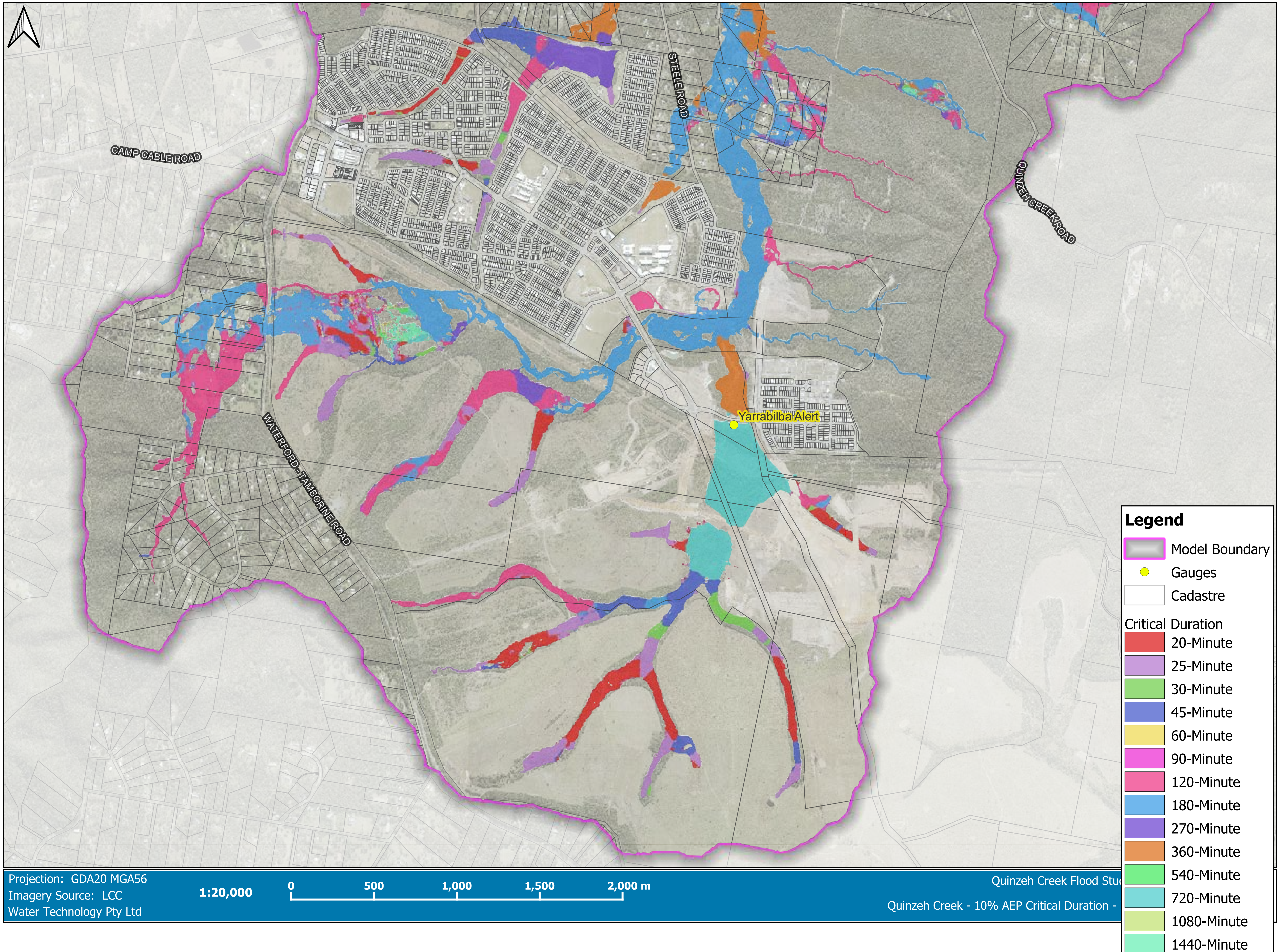
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP Critical Duration - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Critical Duration
20-Minute
25-Minute
30-Minute
45-Minute
60-Minute
90-Minute
120-Minute
180-Minute
270-Minute
360-Minute
540-Minute
720-Minute
1080-Minute
1440-Minute
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
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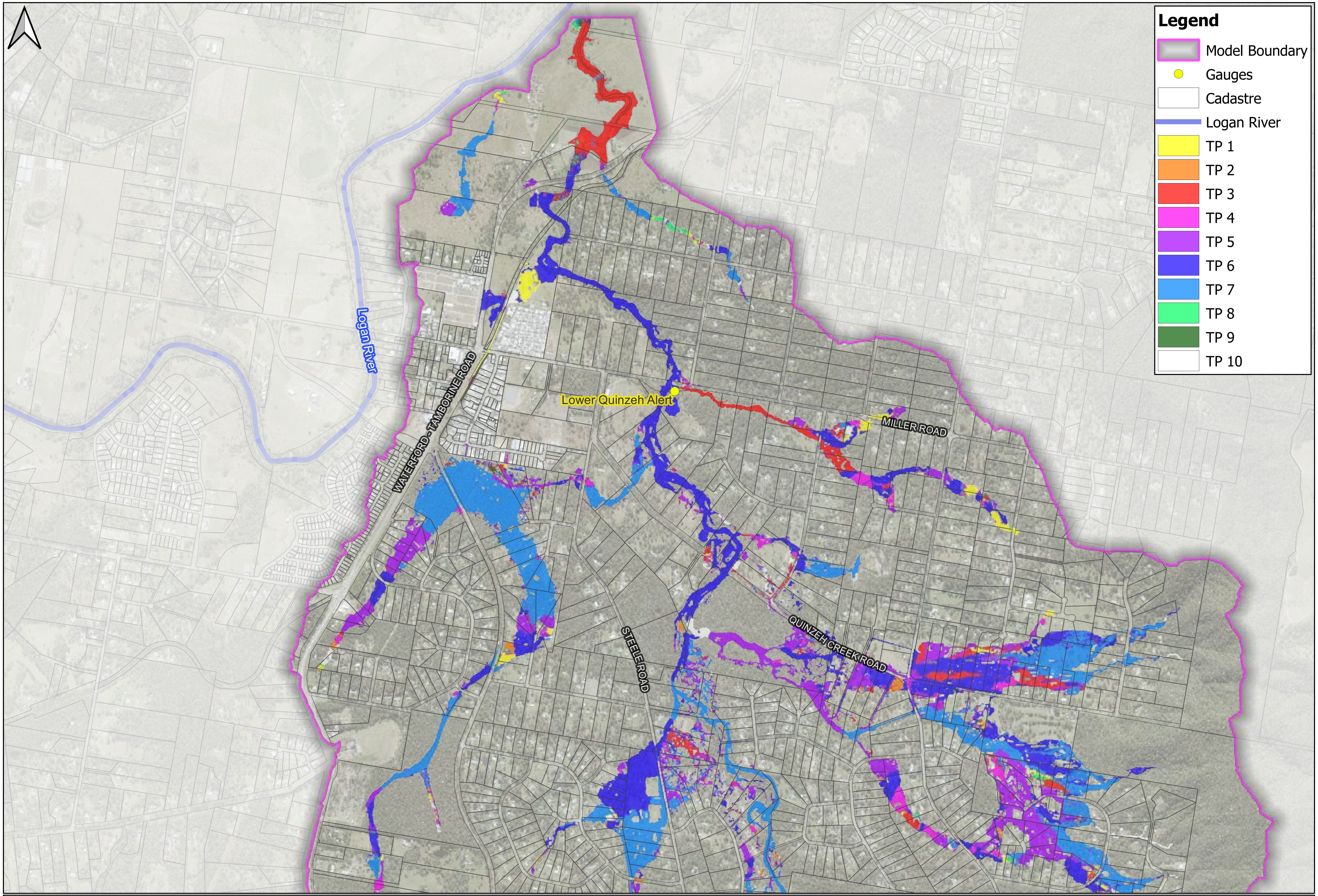
1,000
1,500
2,000 m
Quinzeh Creek Flood
Quinzeh Creek - 10% AEP Critical Duration -



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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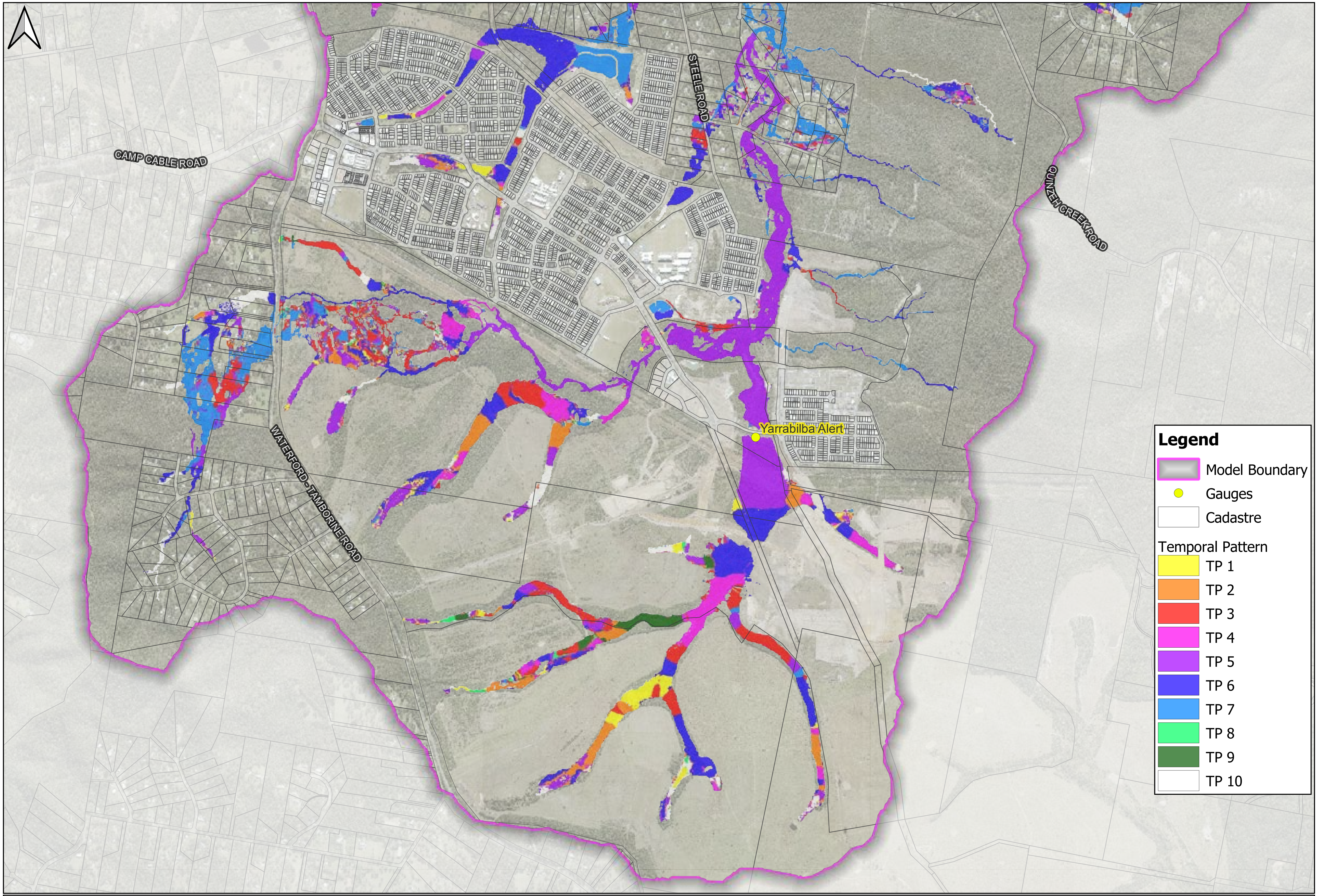
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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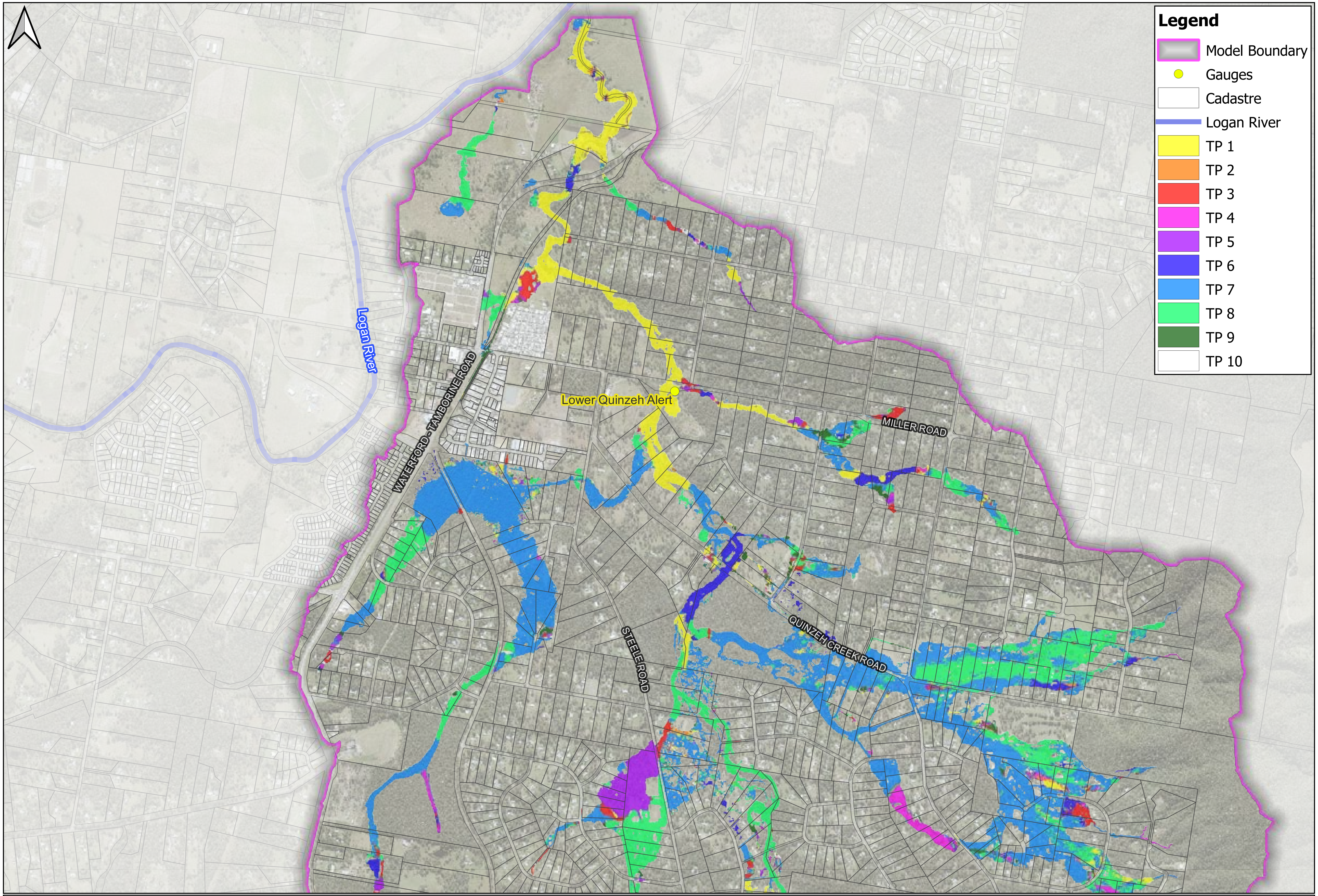
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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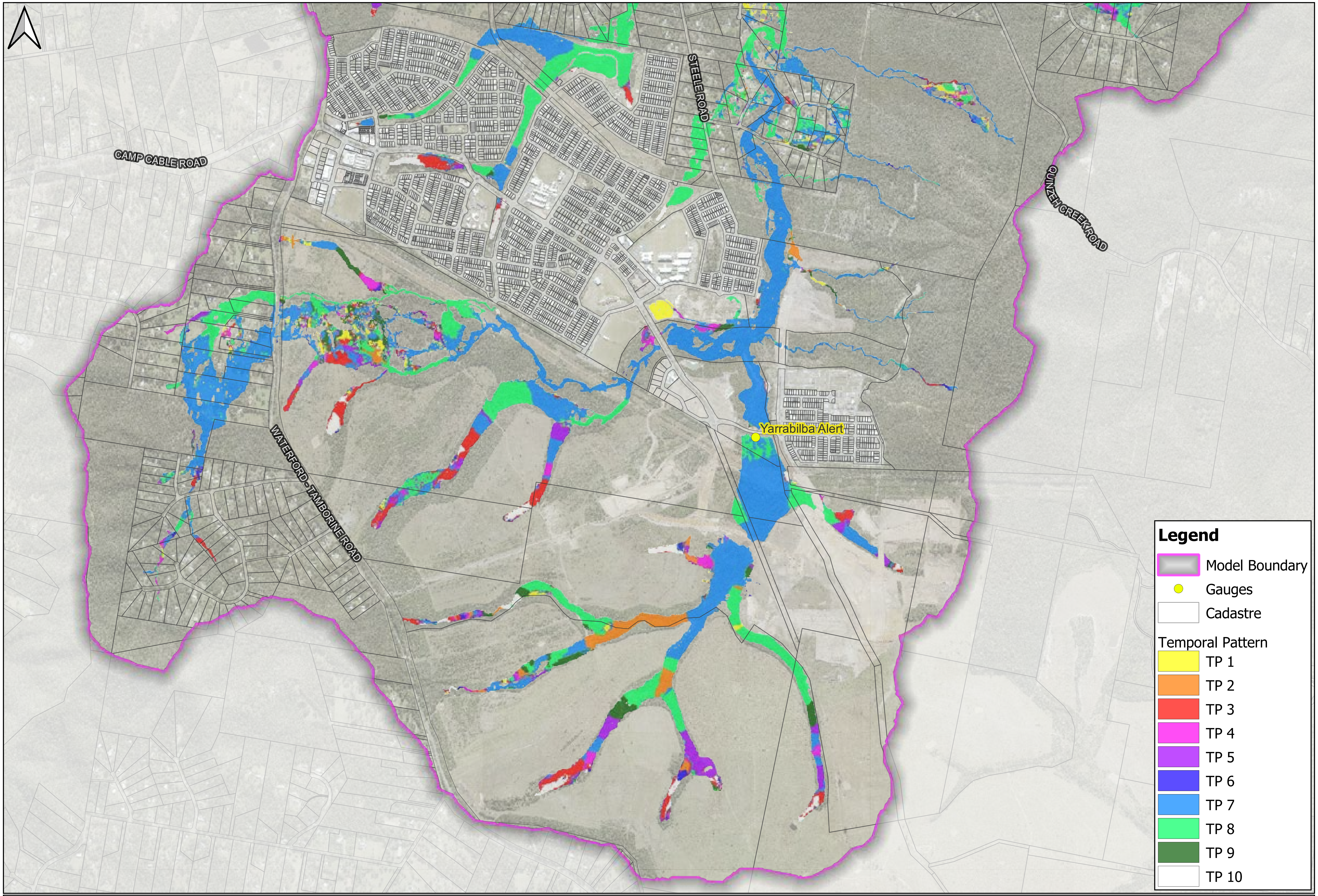
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

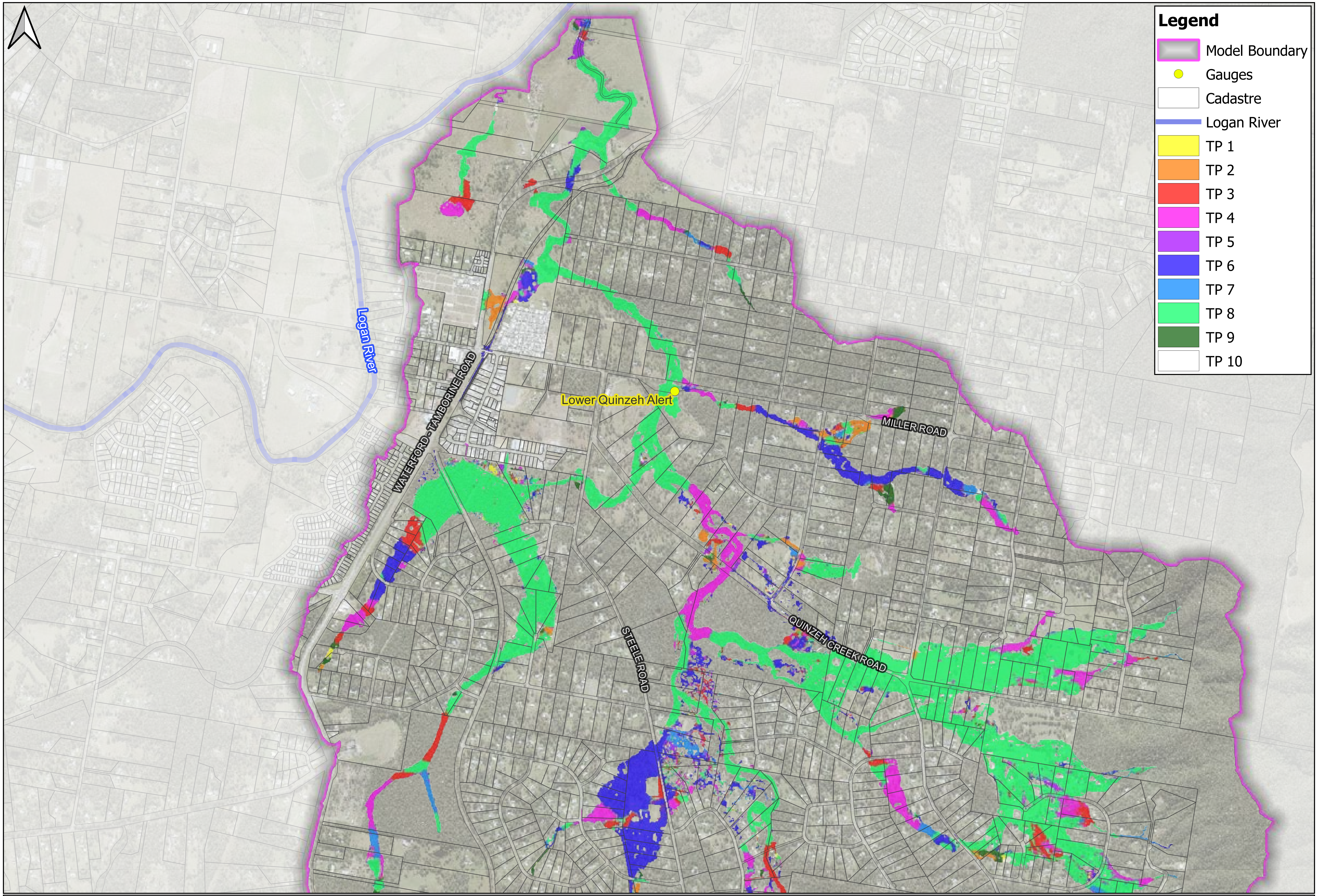


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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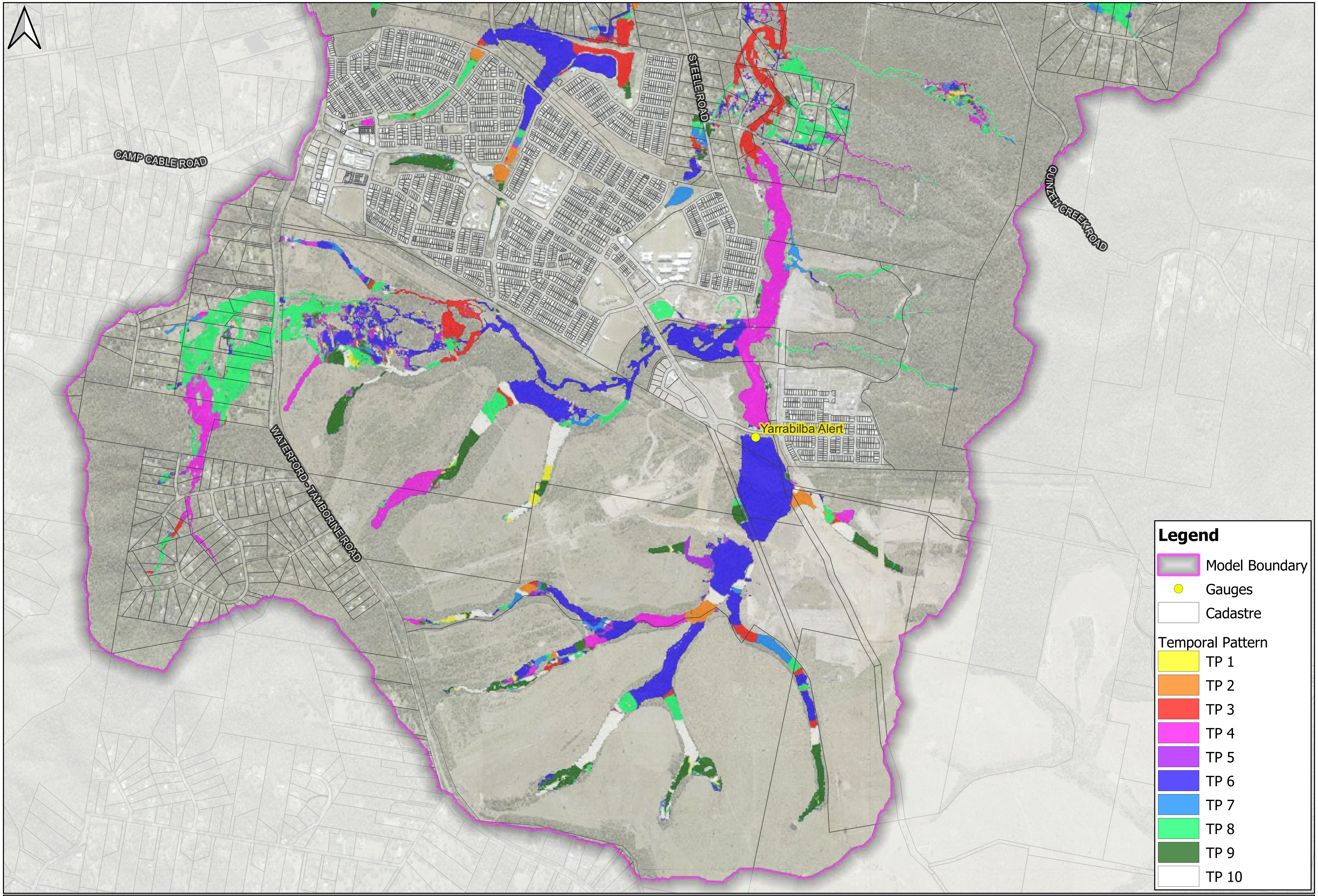
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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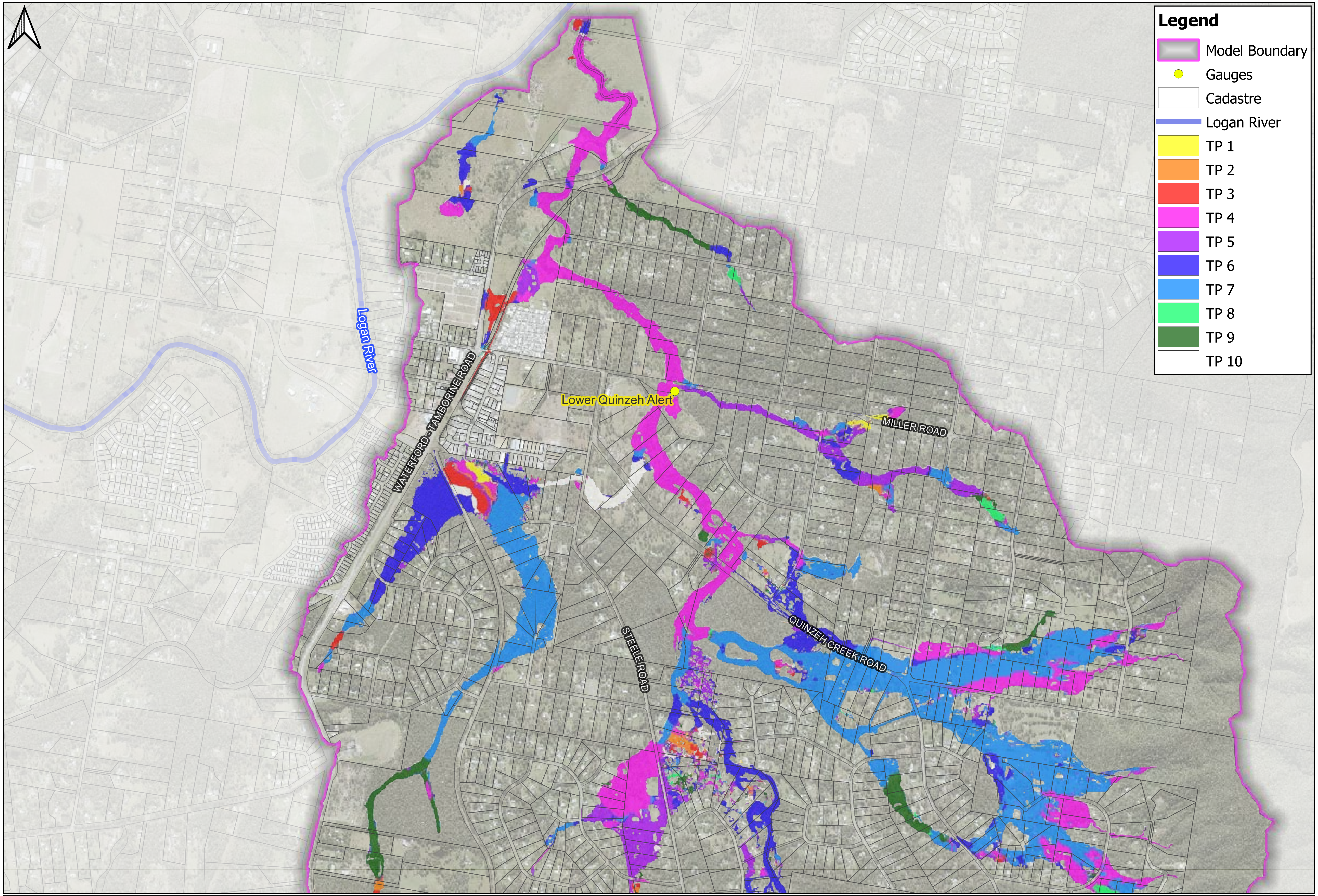
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 2

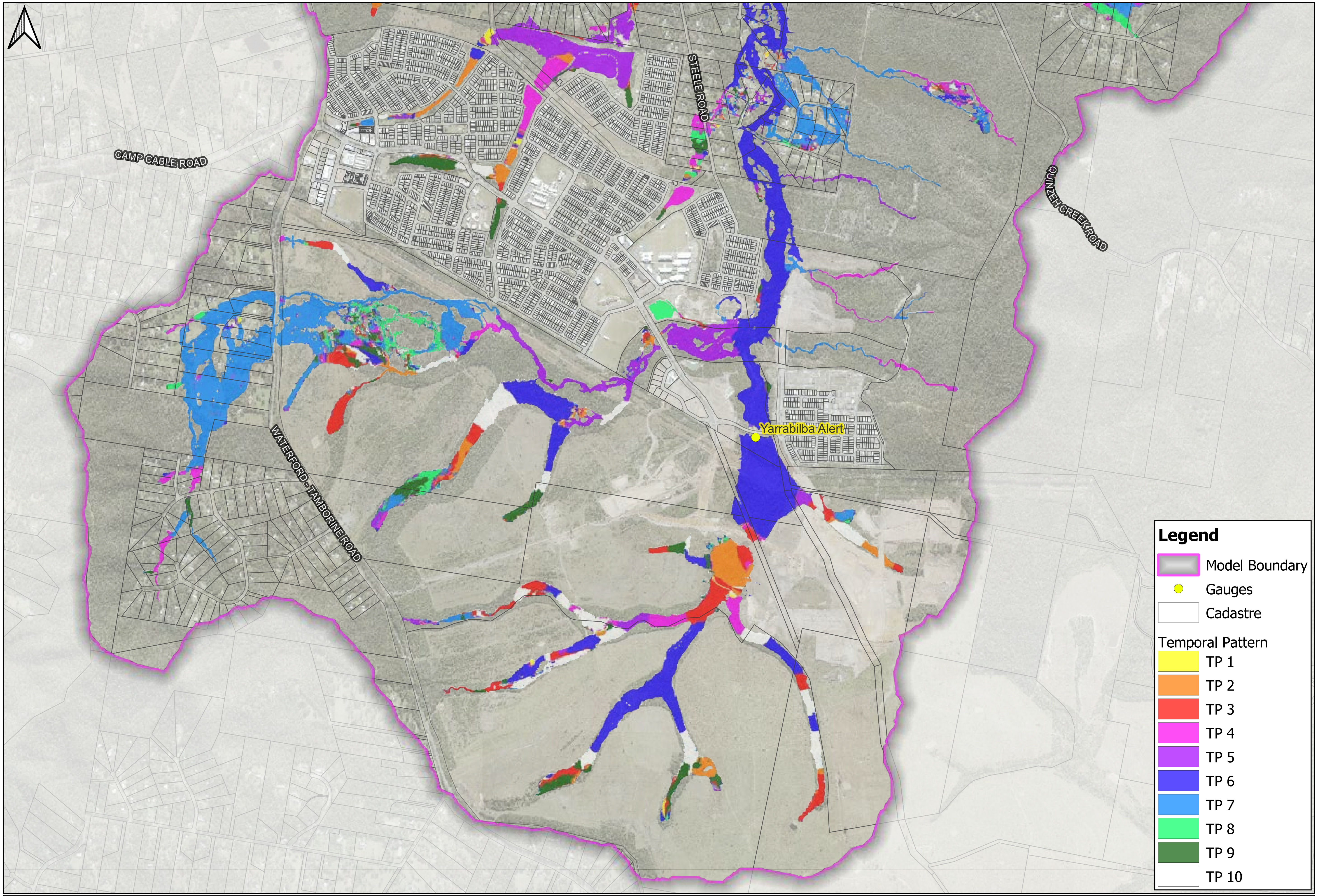


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023

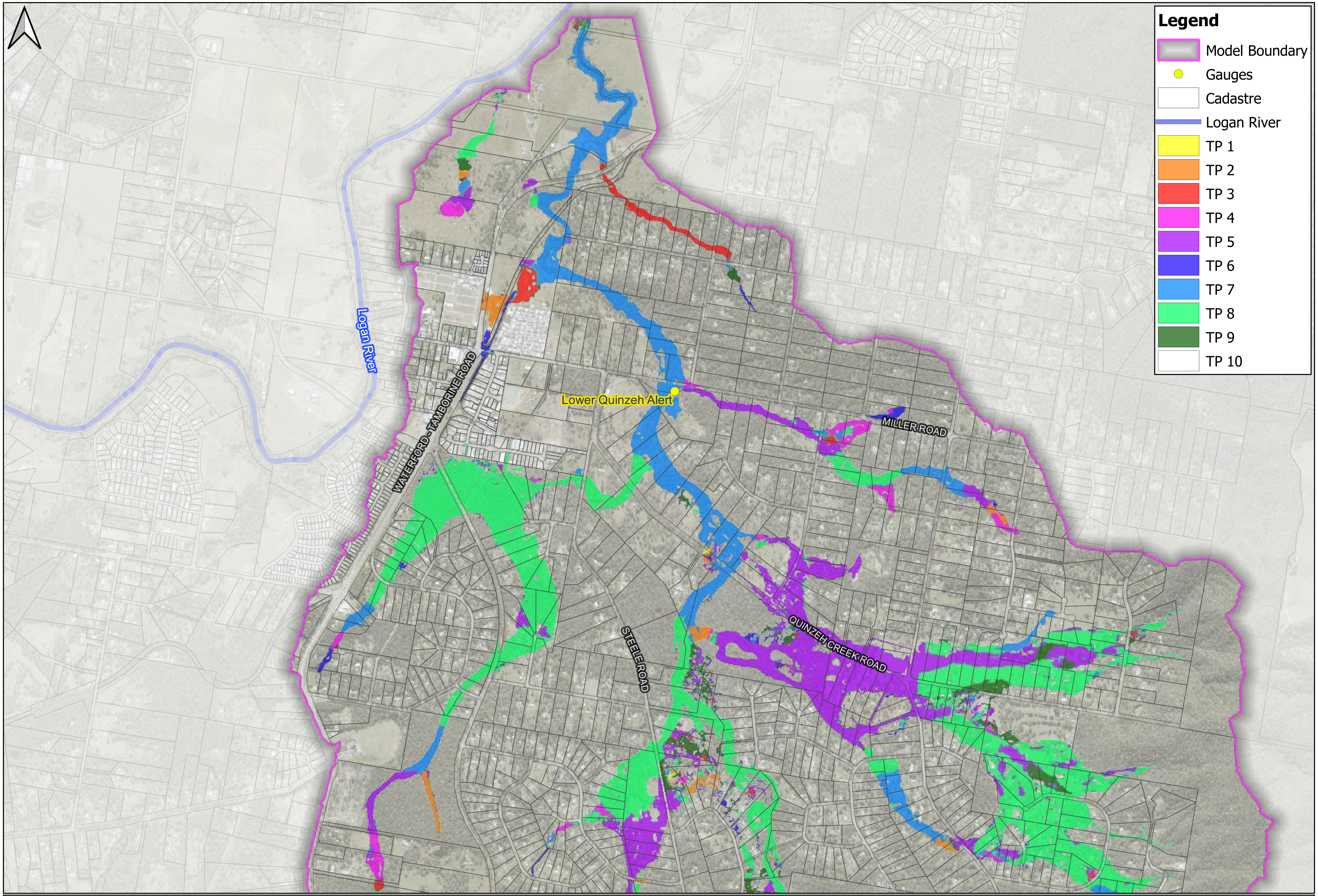
Quinzeh Creek - 10% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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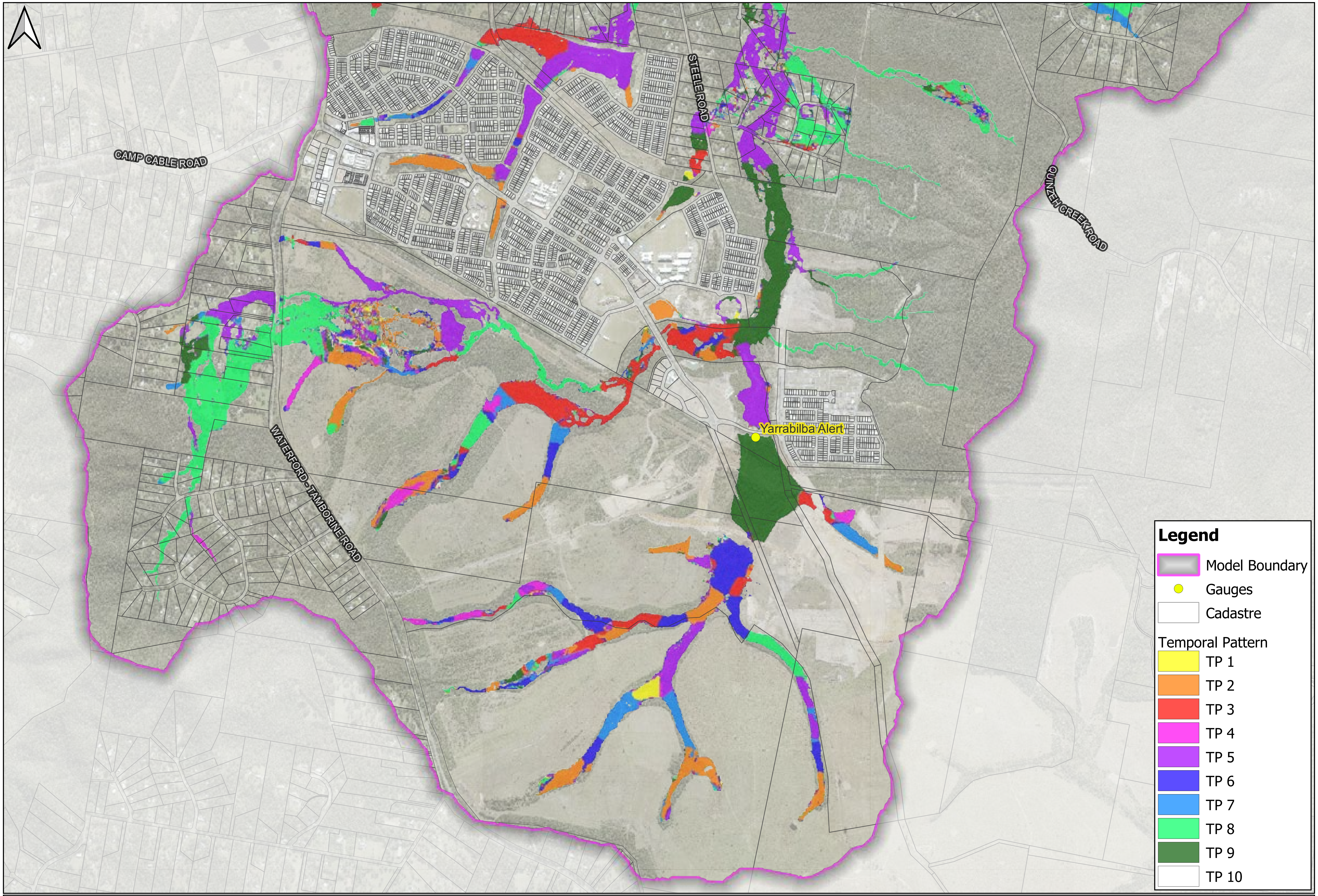
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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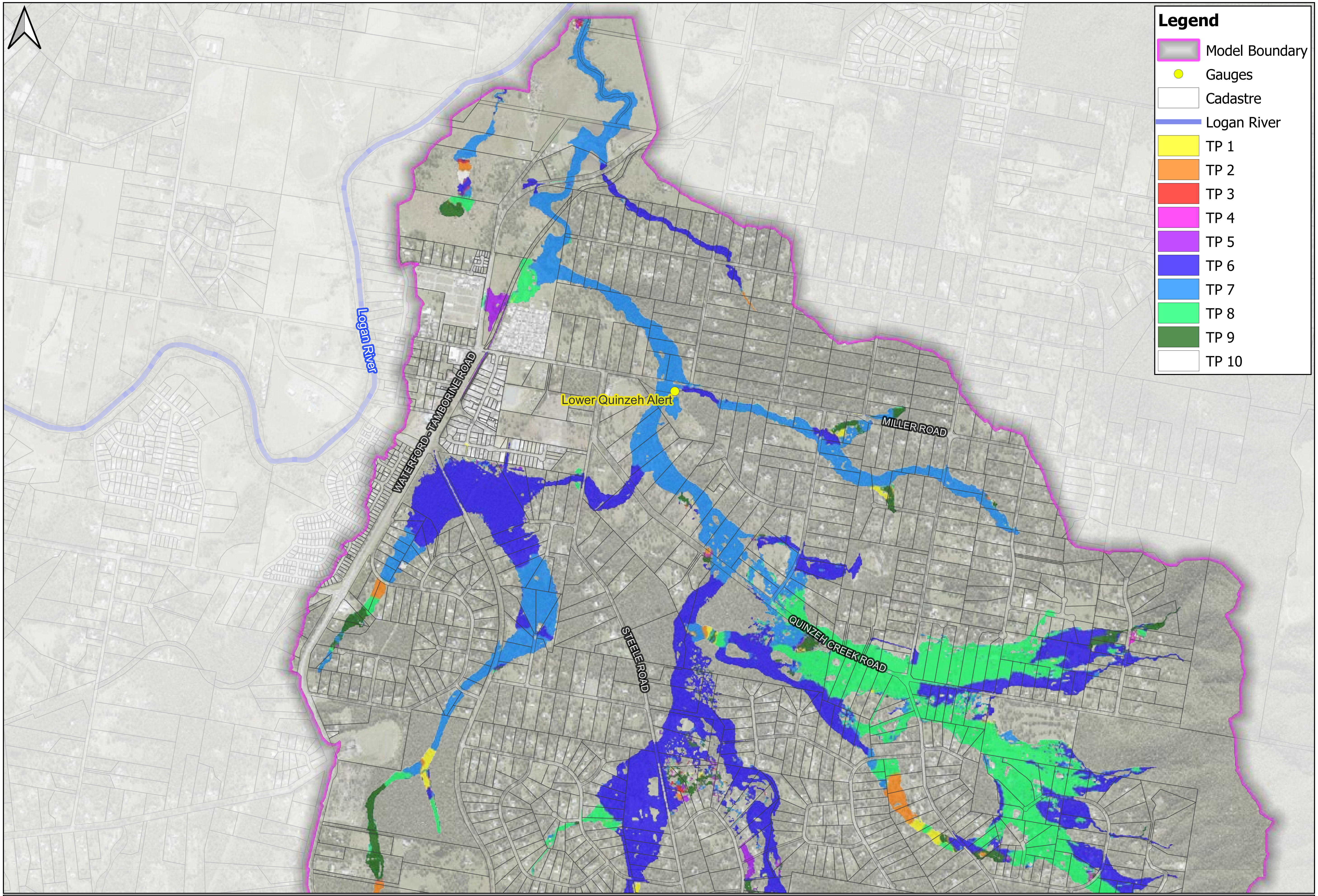
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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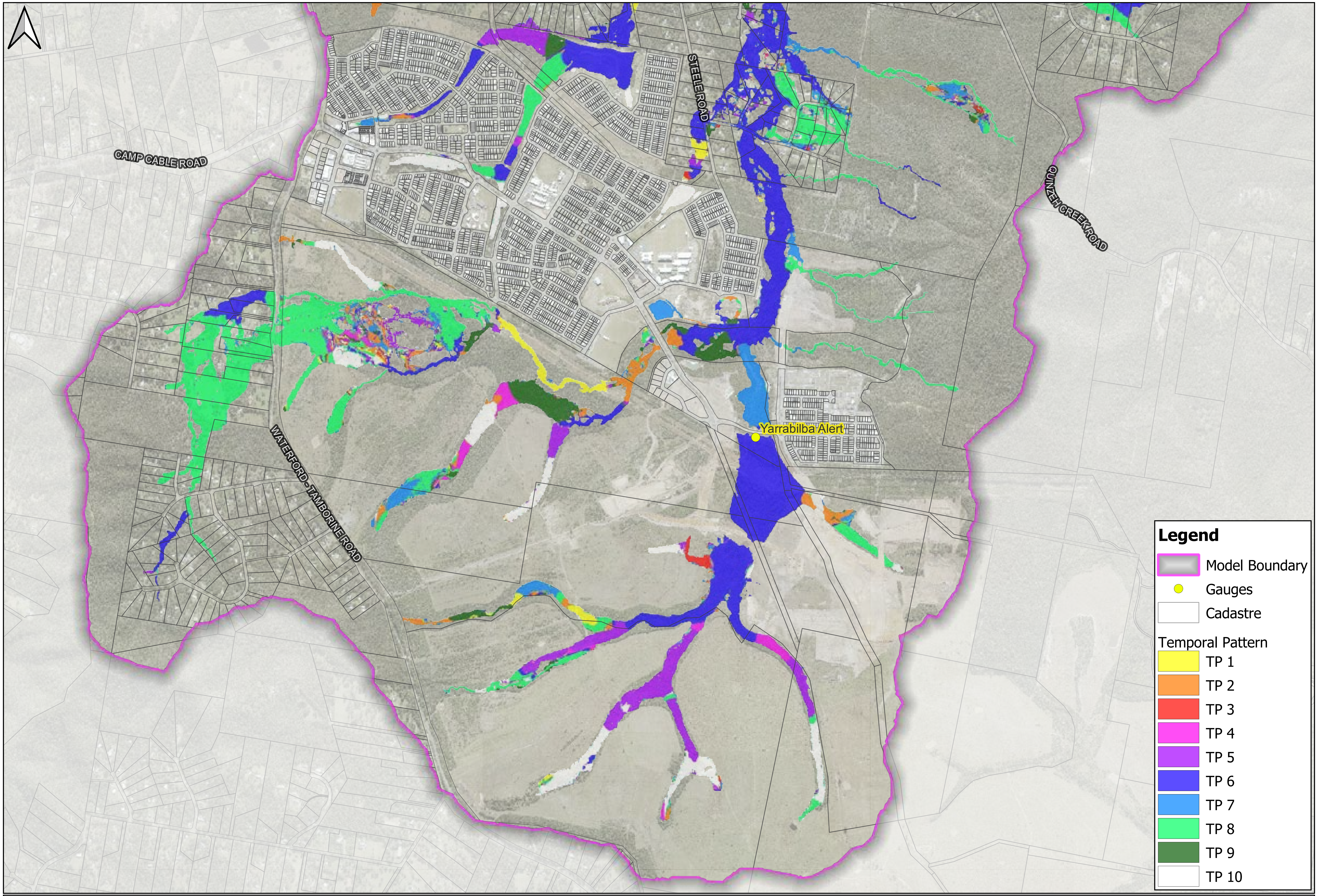
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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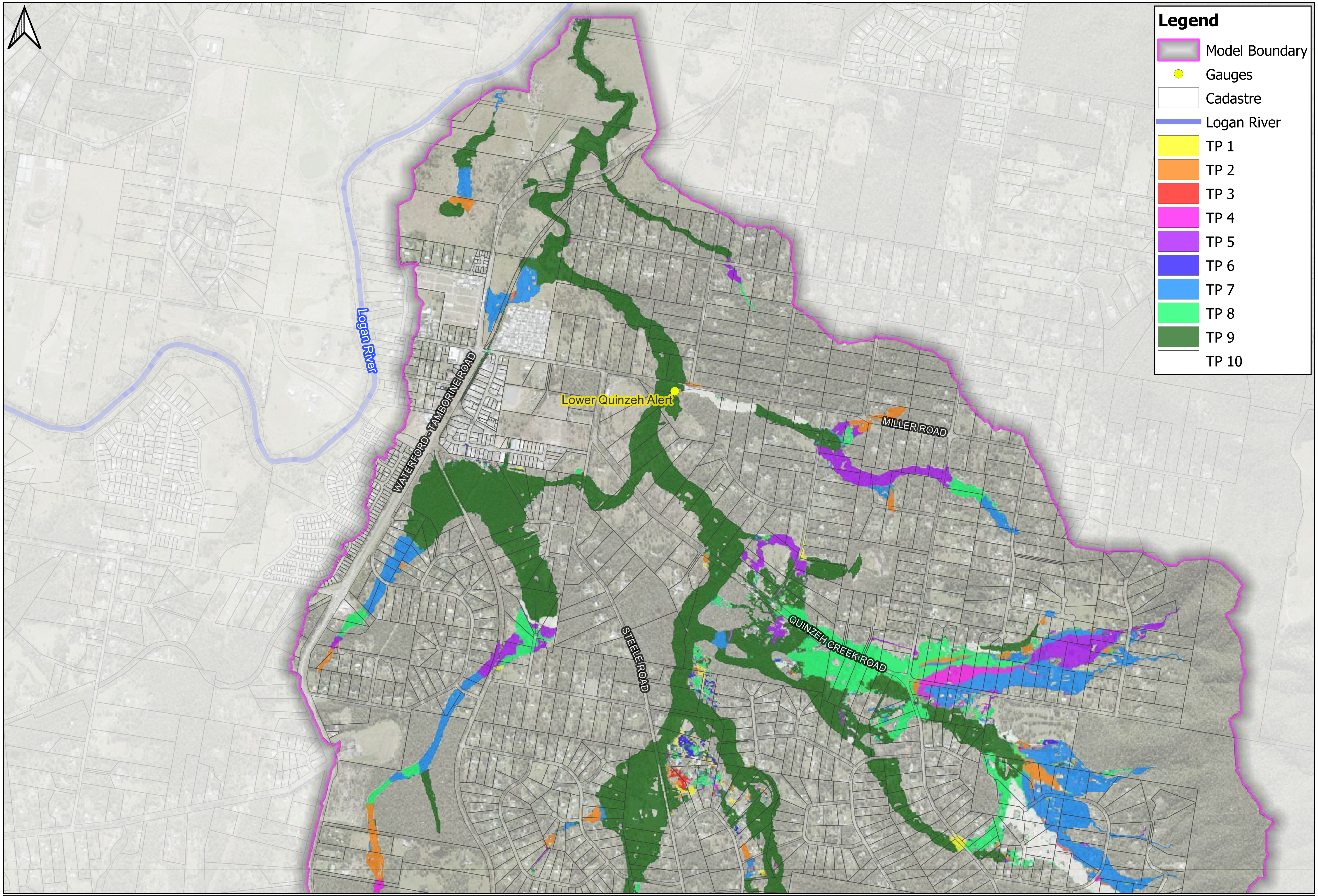
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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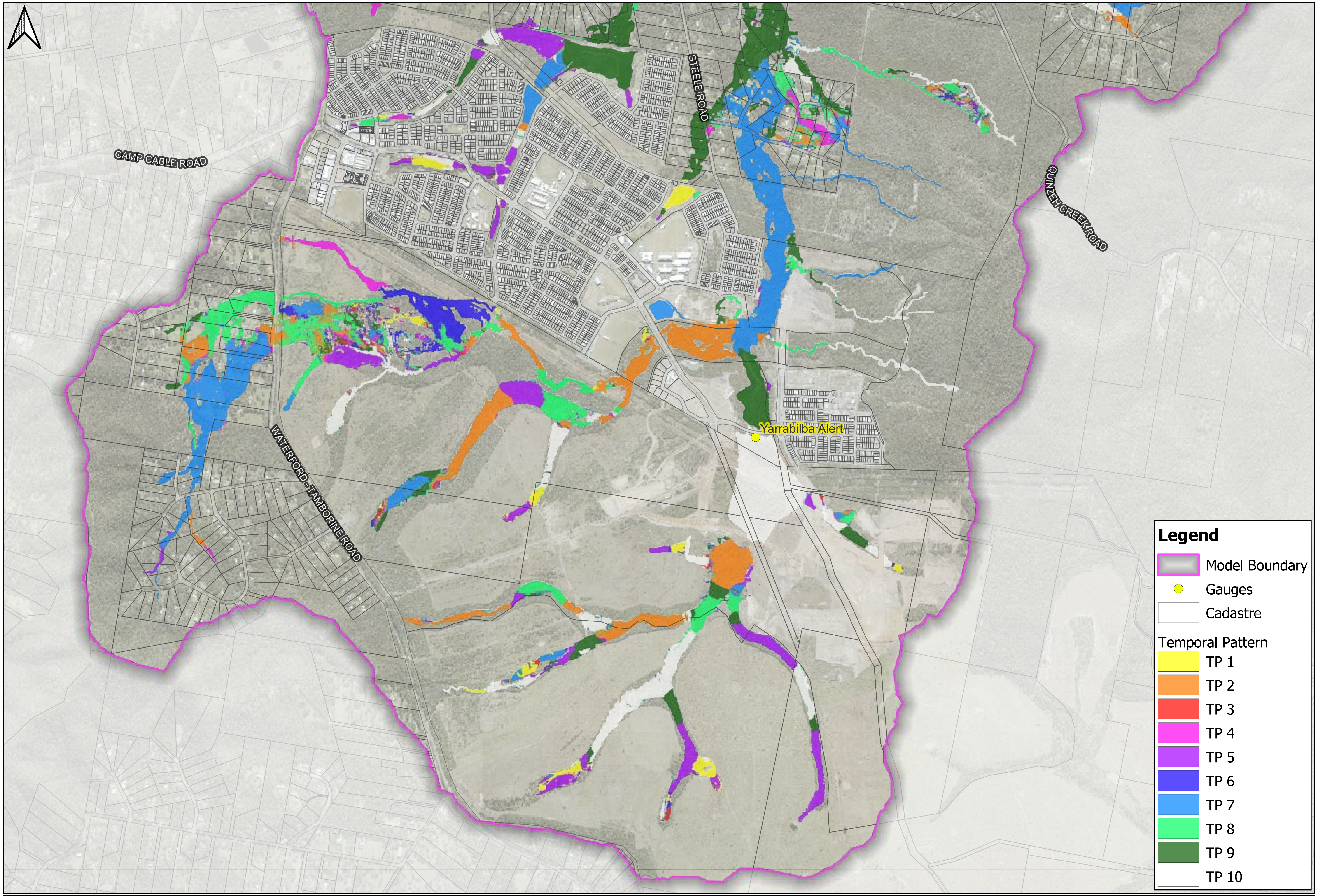
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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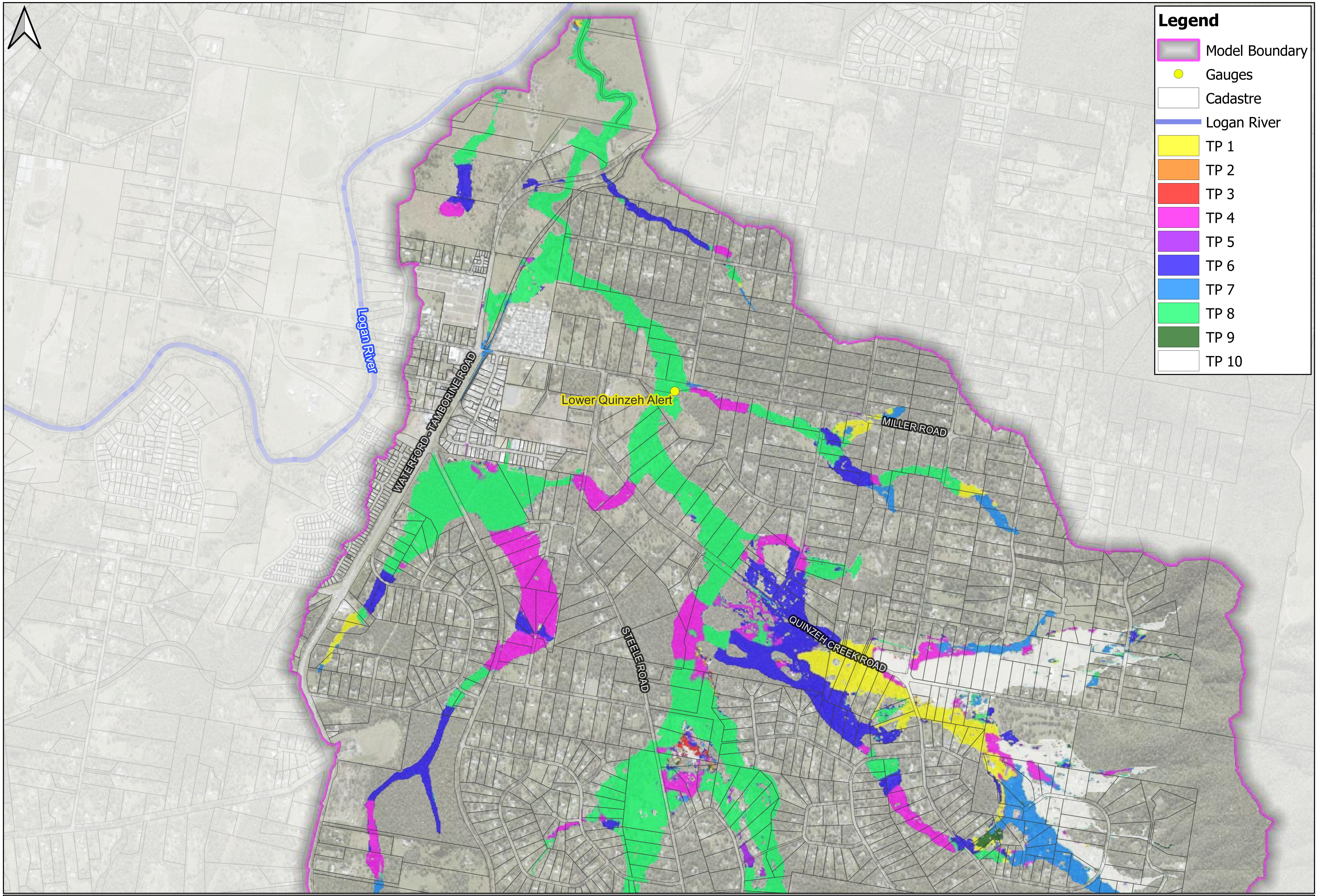
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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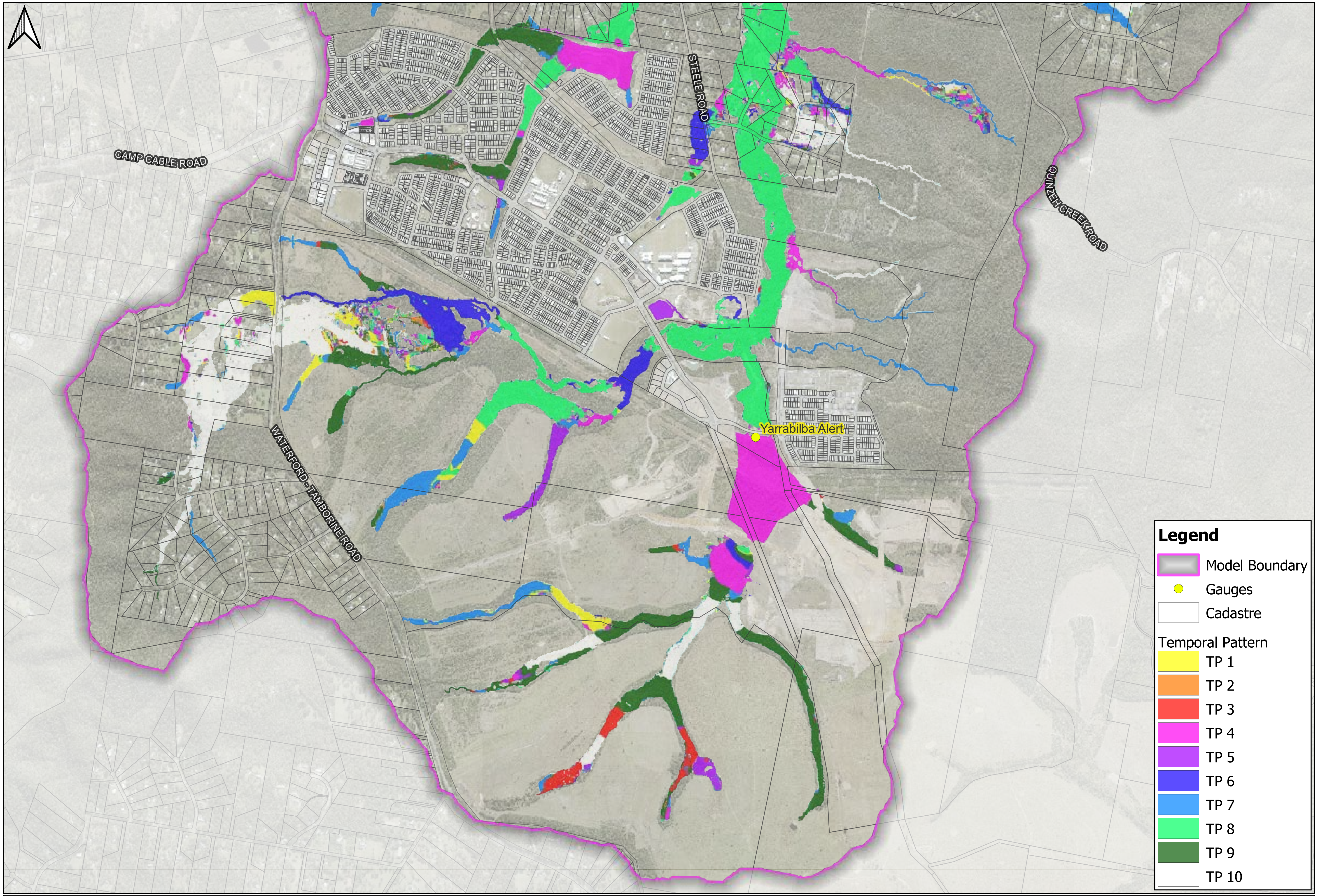
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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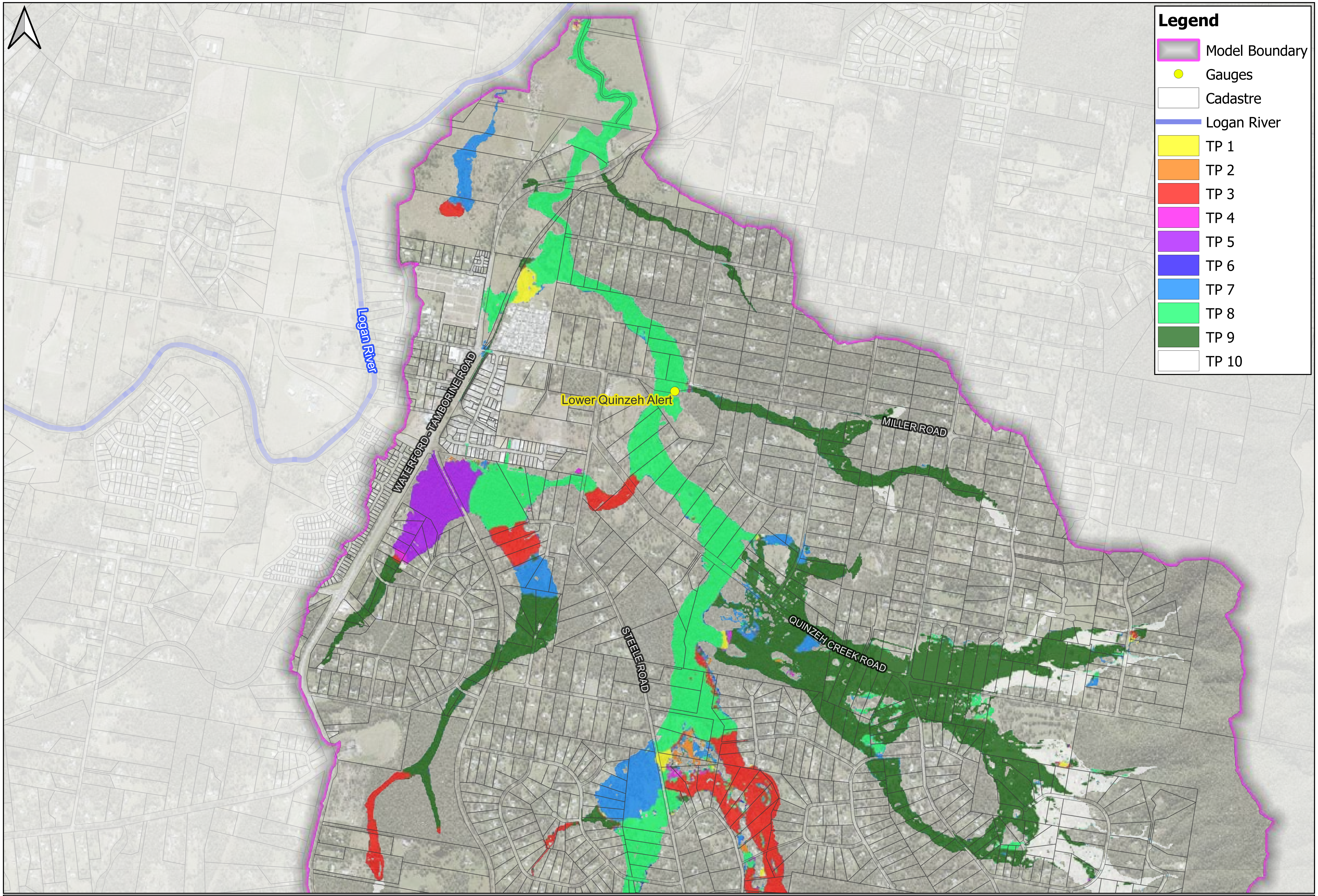
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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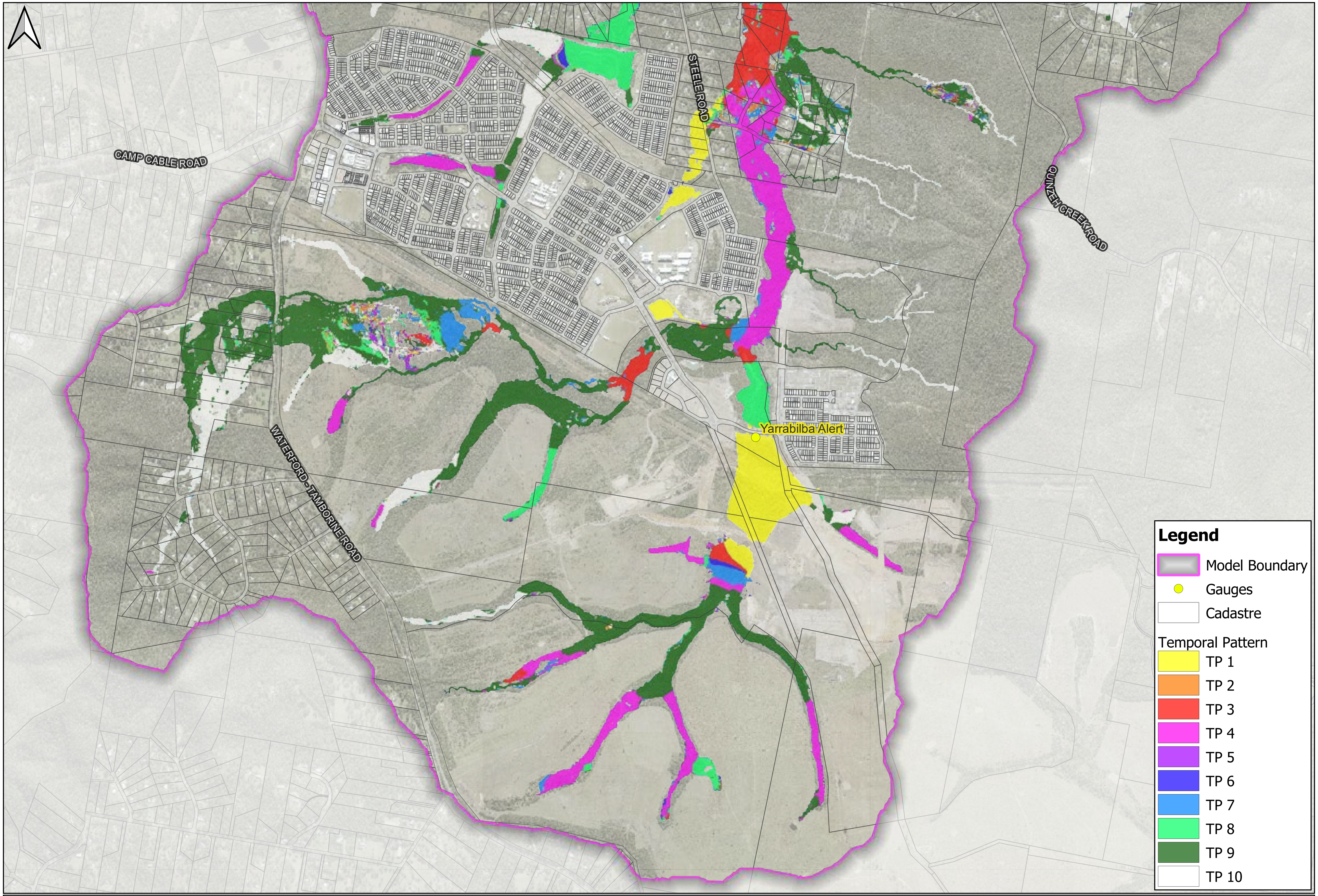
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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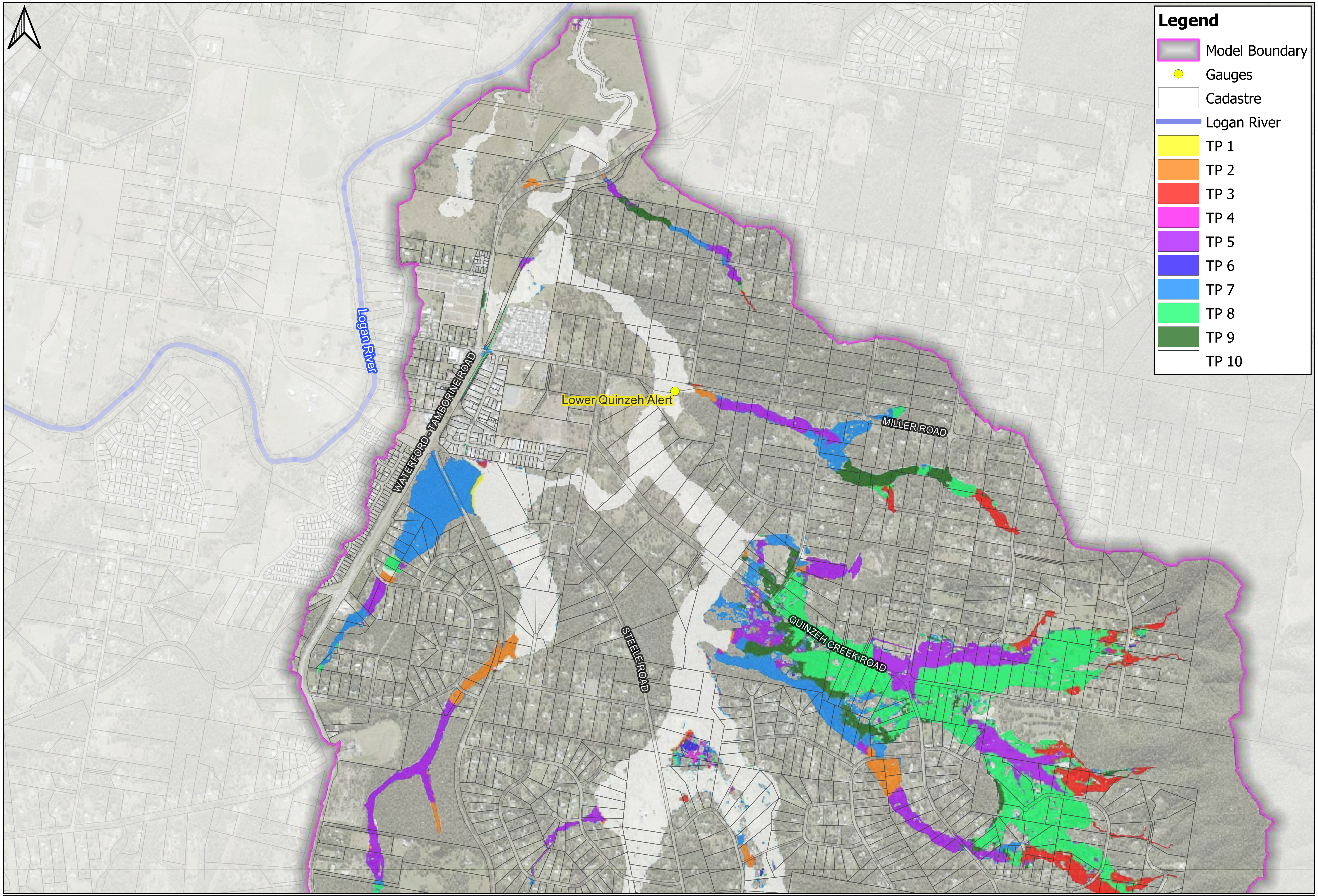
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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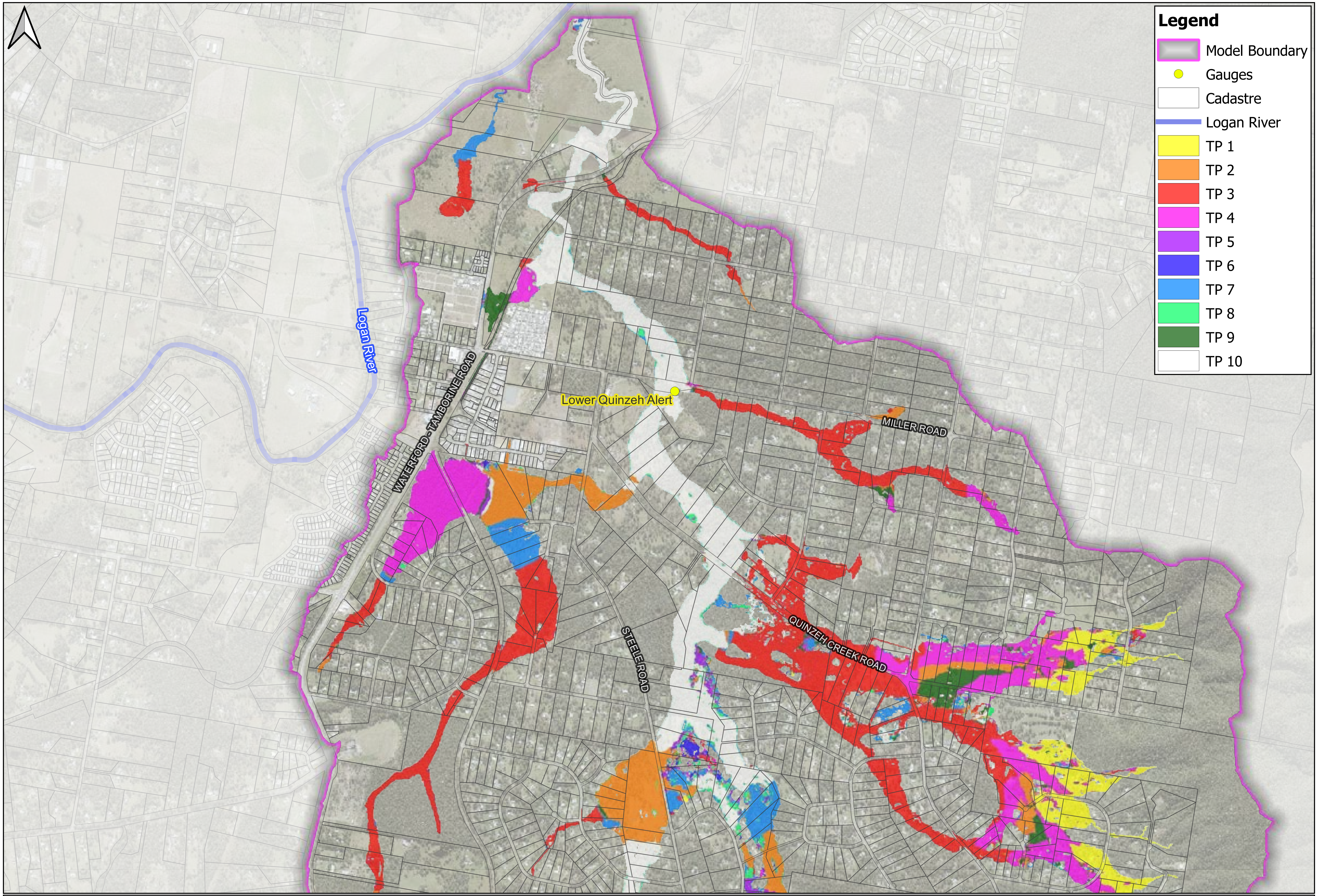
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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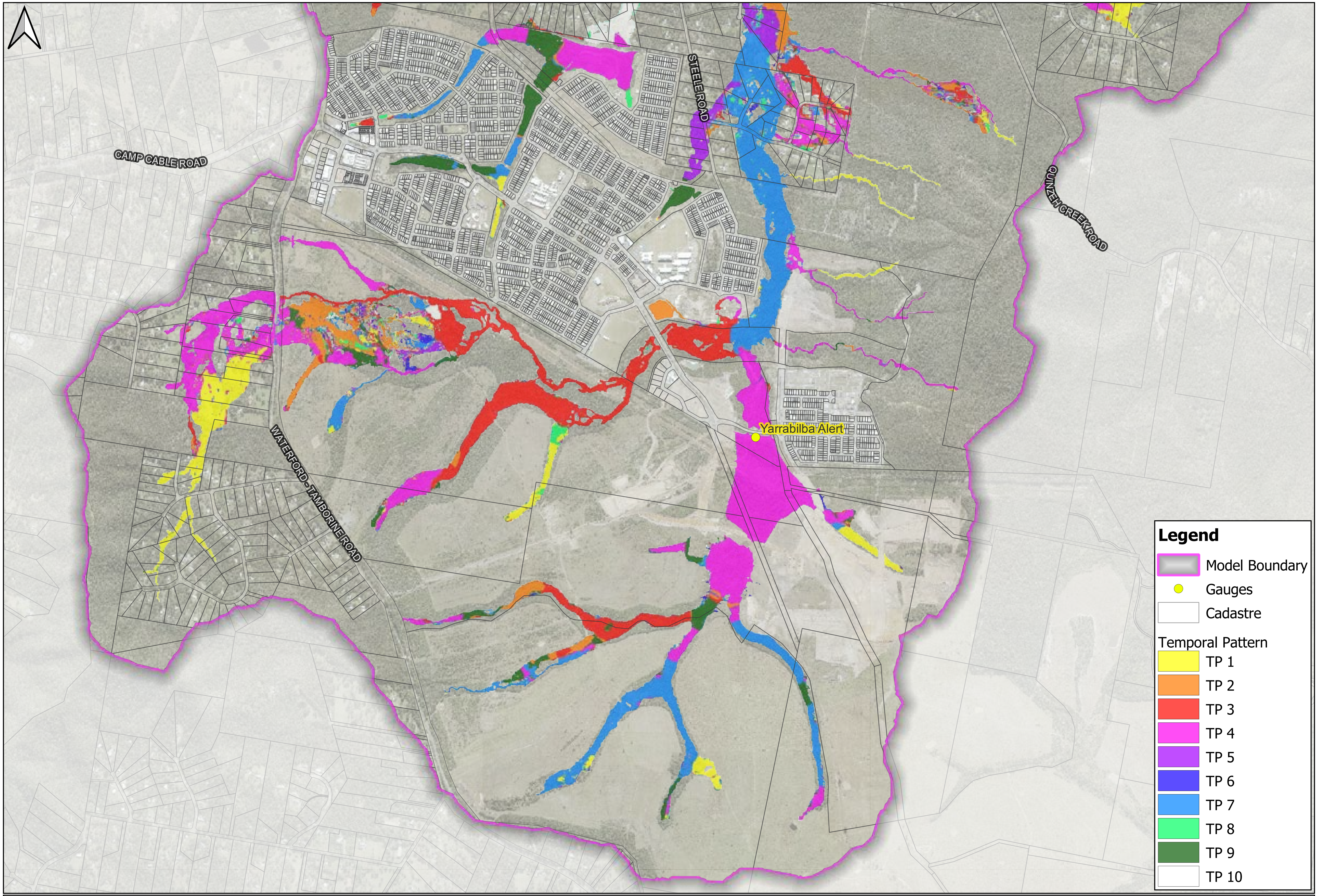
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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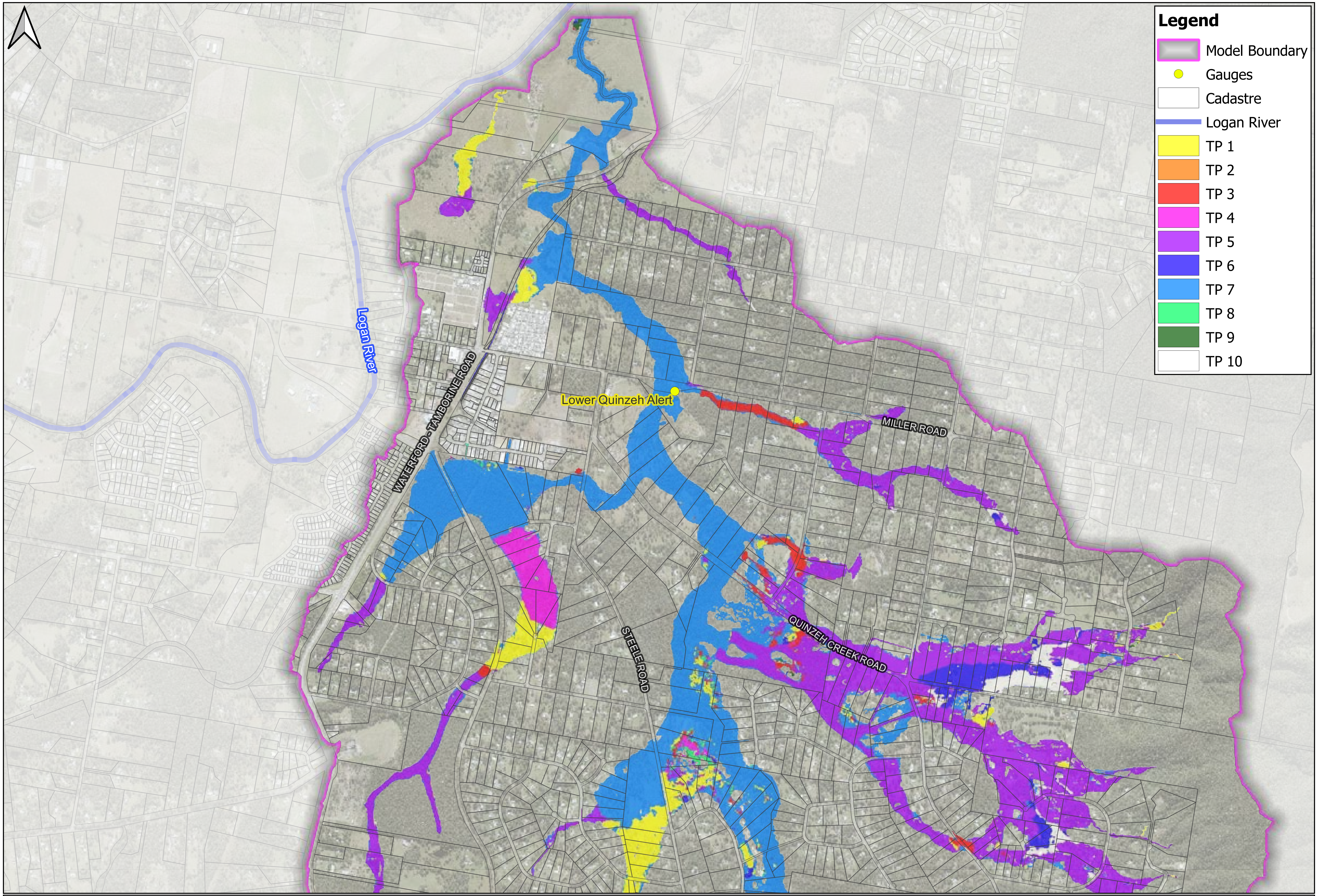
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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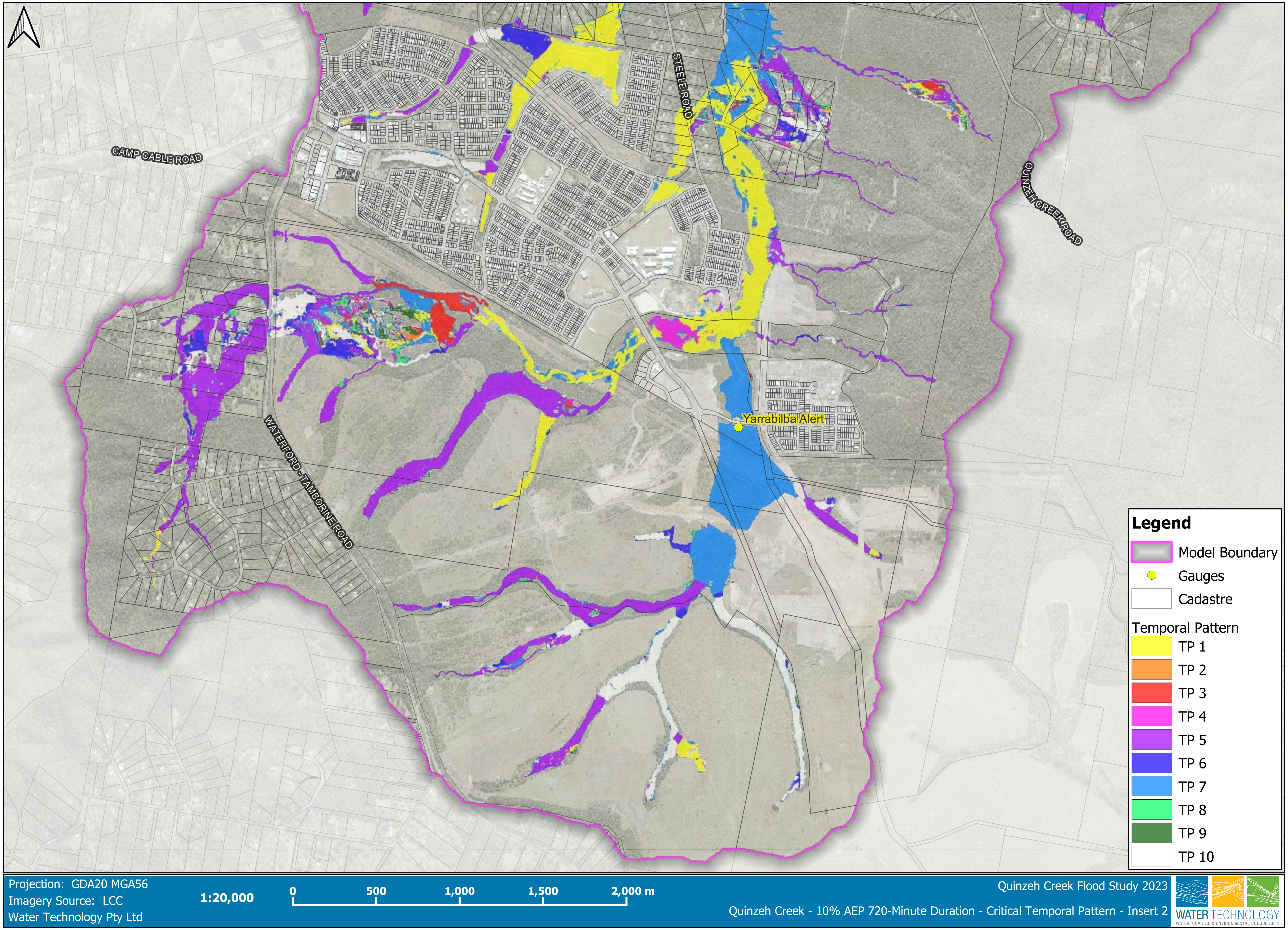
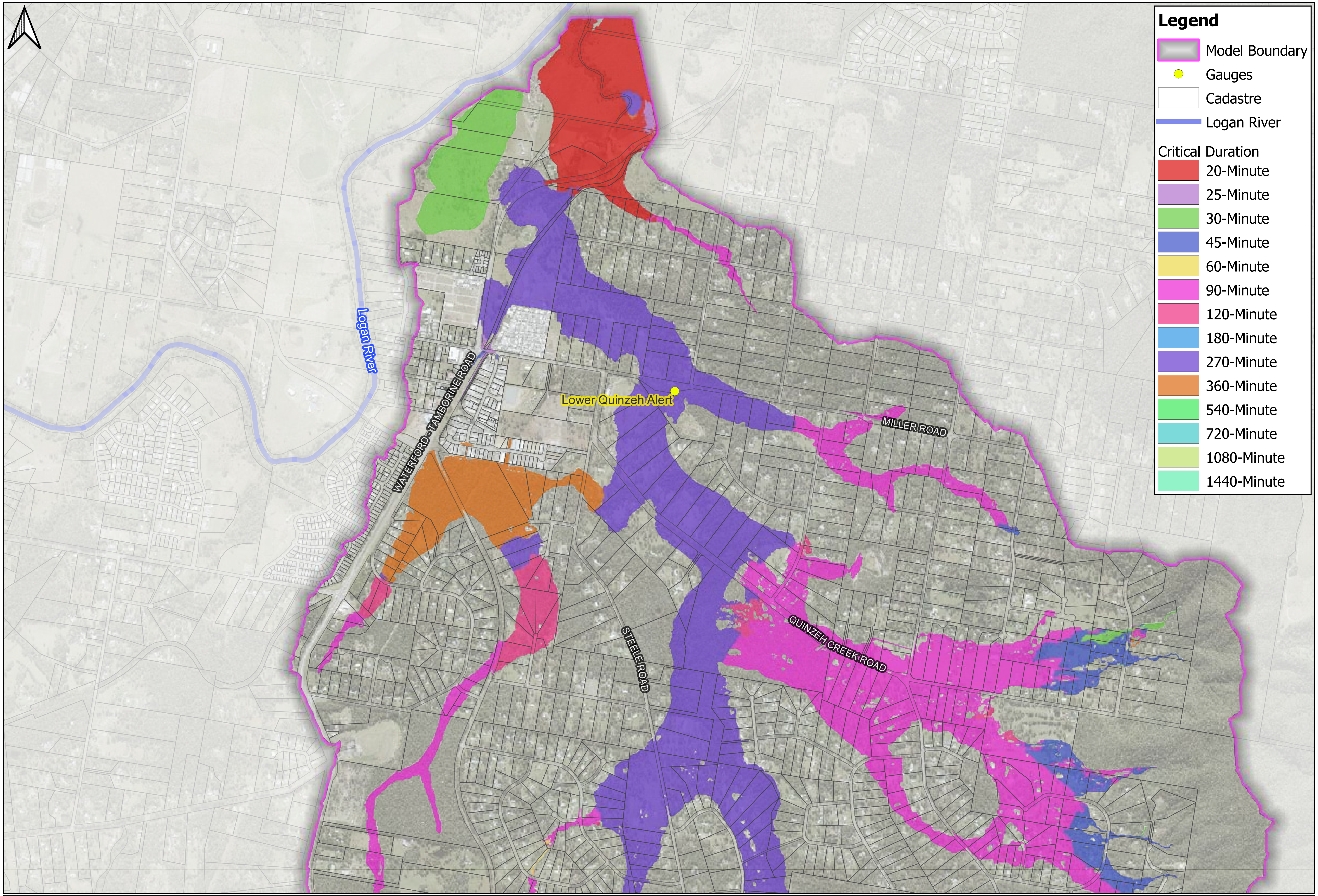
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 10% AEP 720-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 10% AEP 720-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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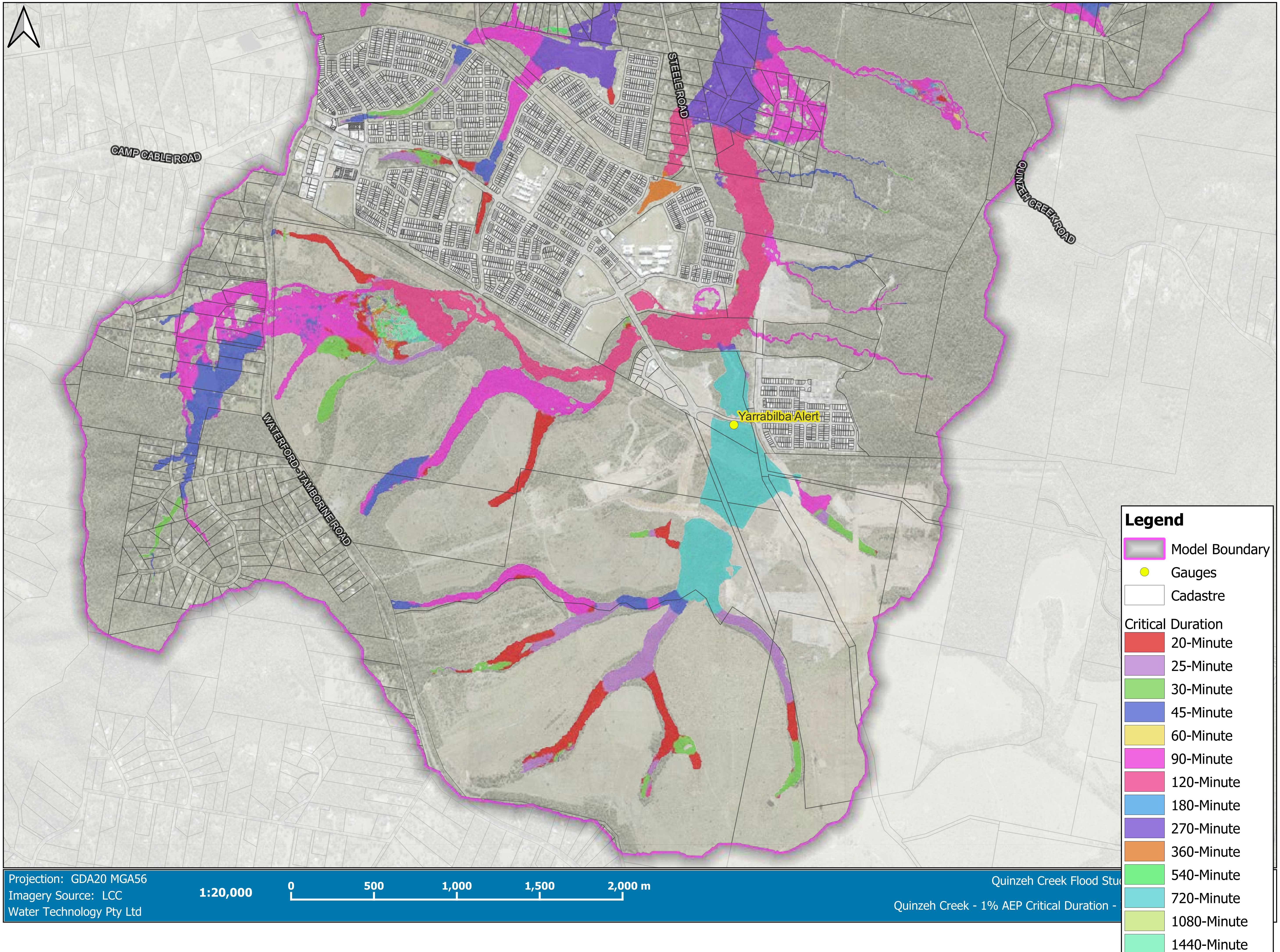
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP Critical Duration - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS


CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Critical Duration
20-Minute
25-Minute
30-Minute
45-Minute
60-Minute
90-Minute
120-Minute
180-Minute
270-Minute
360-Minute
540-Minute
720-Minute
1080-Minute
1440-Minute
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
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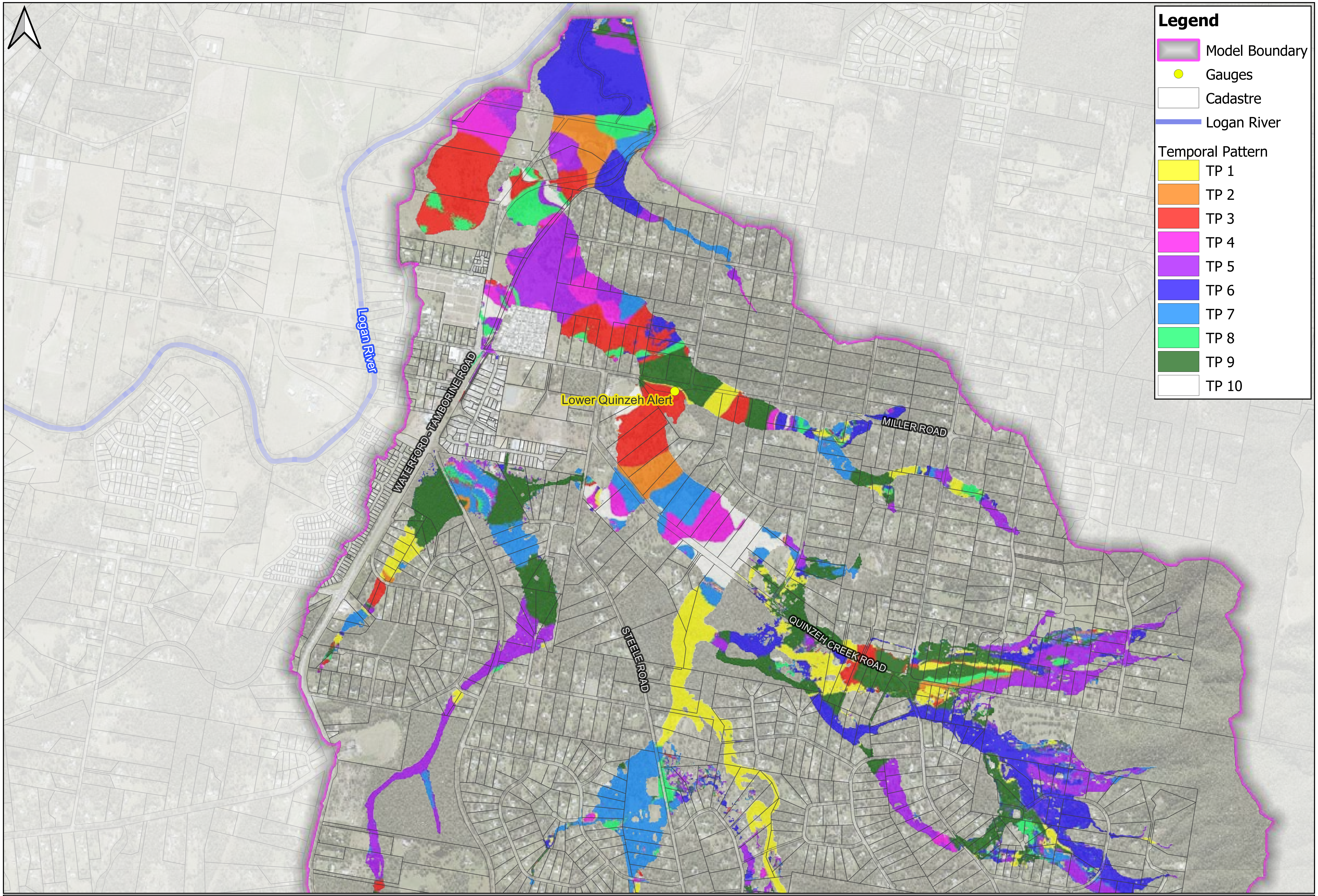
Quinzeh Creek Flood Stu
Quinzeh Creek - 1% AEP Critical Duration -



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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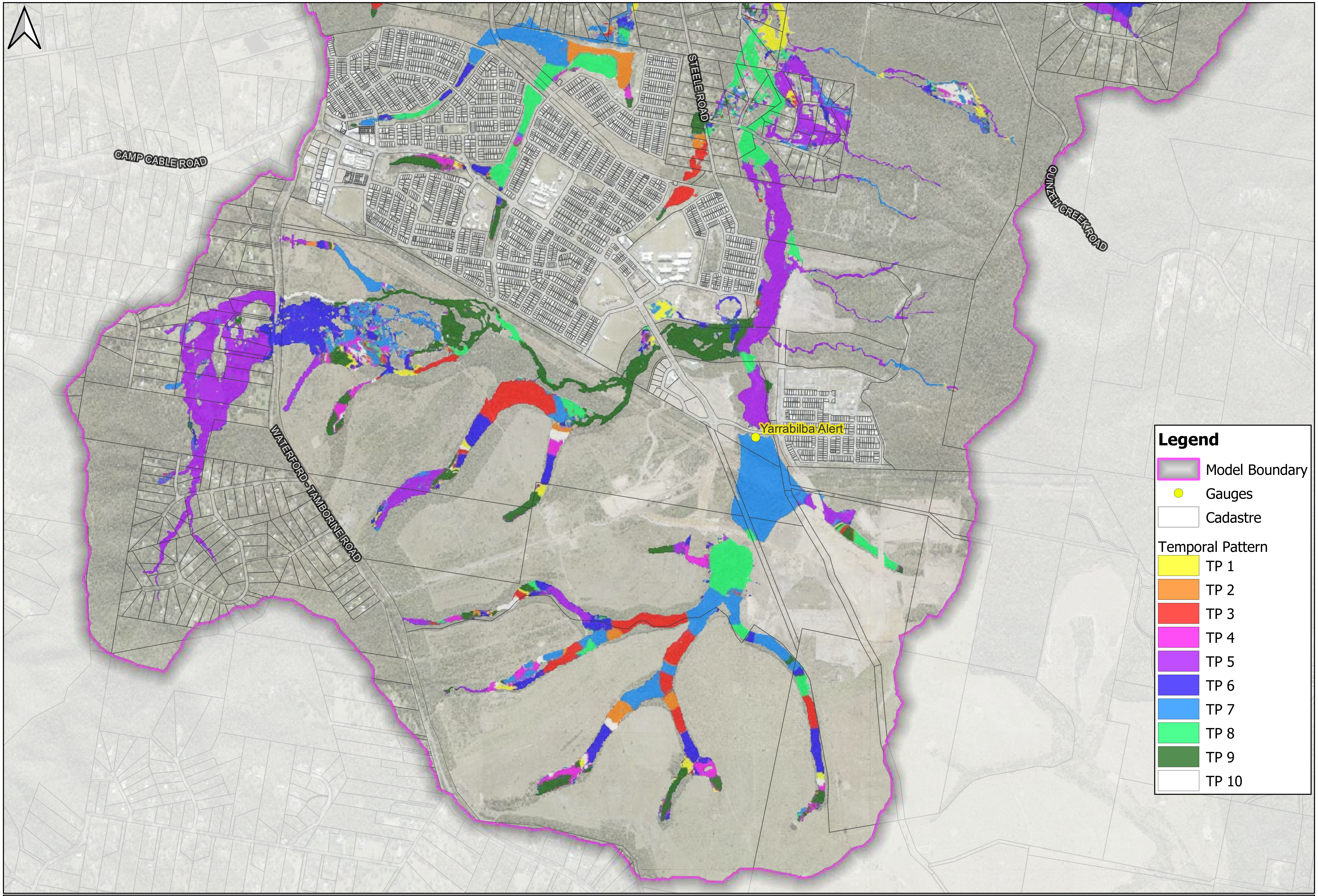
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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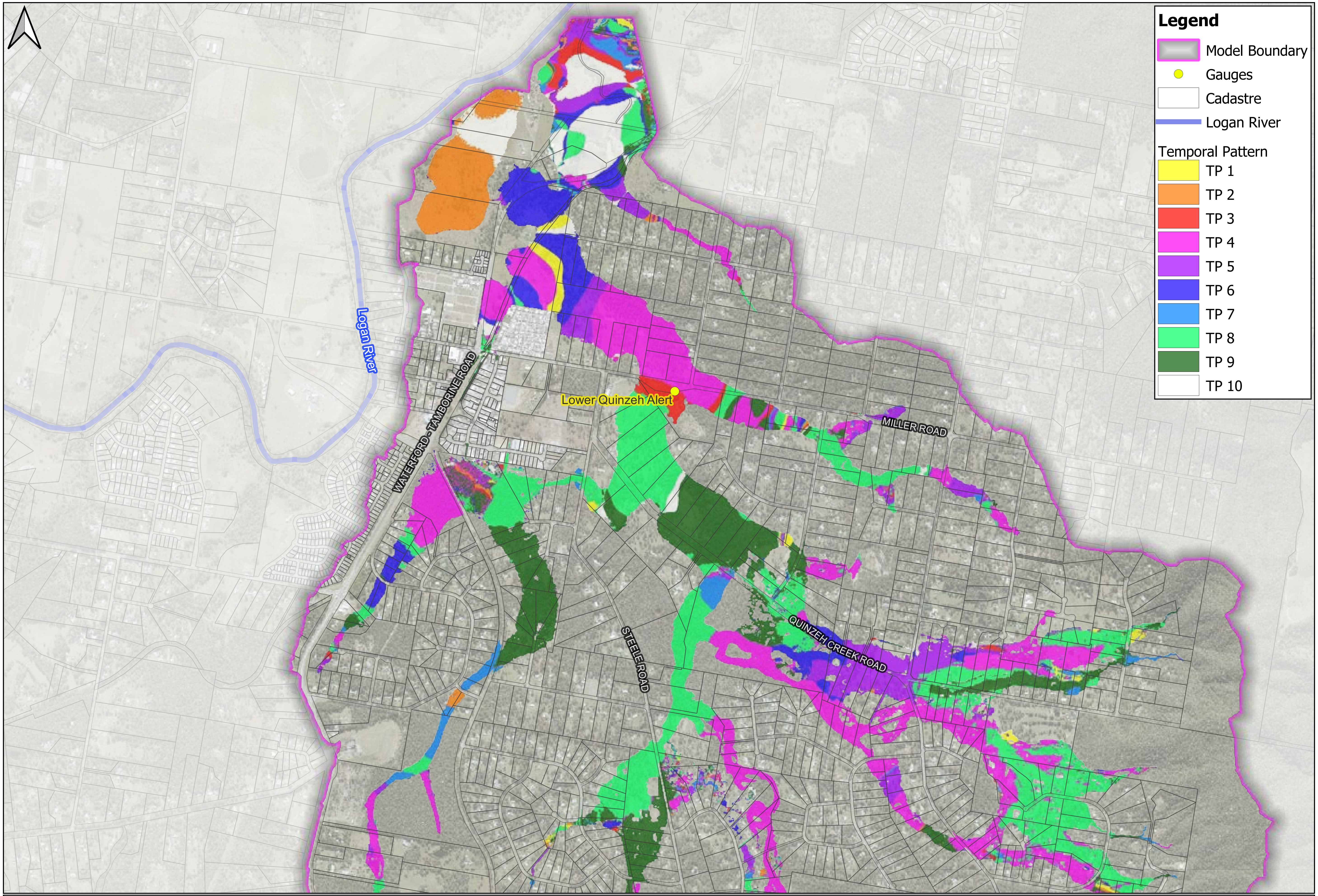
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 20-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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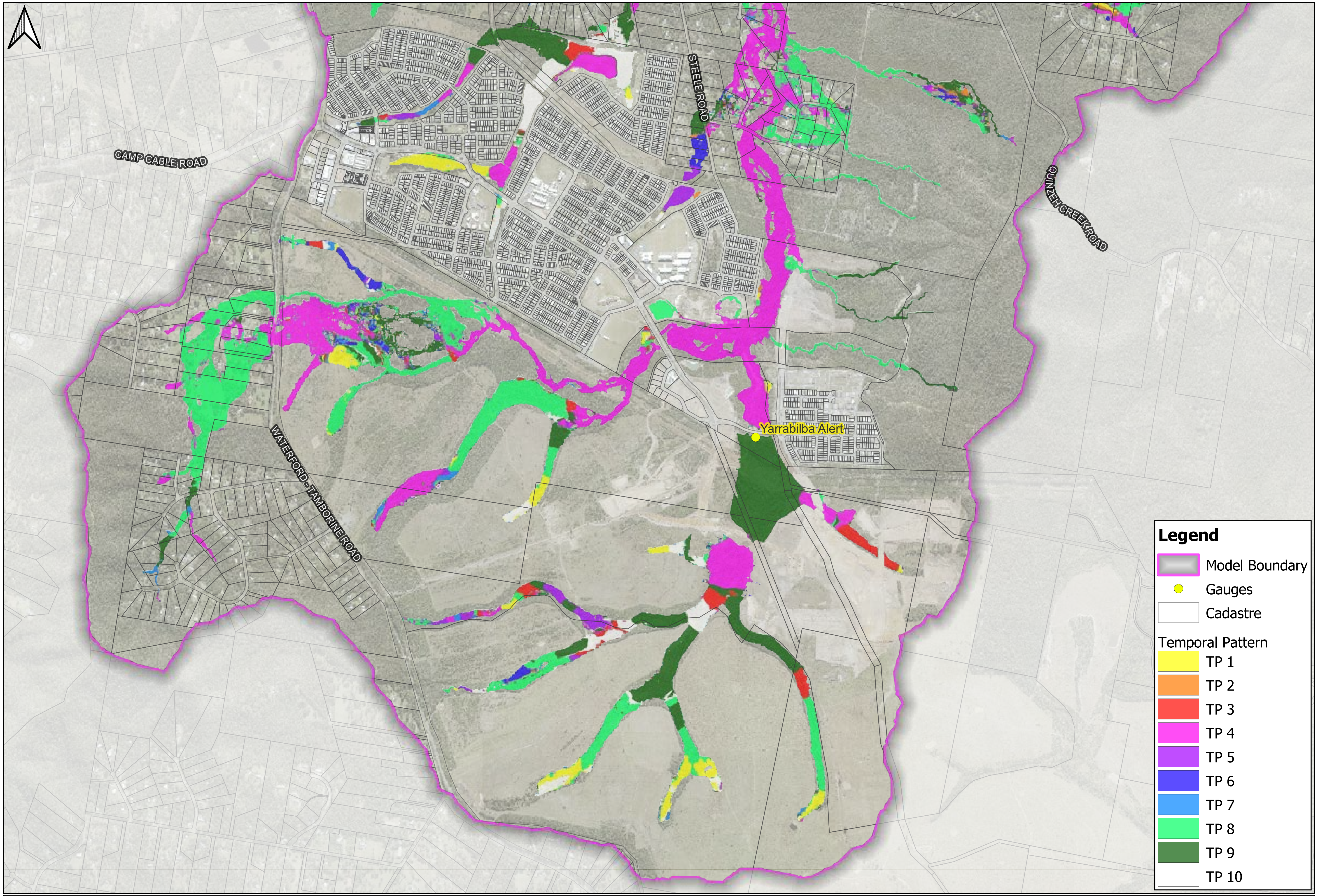
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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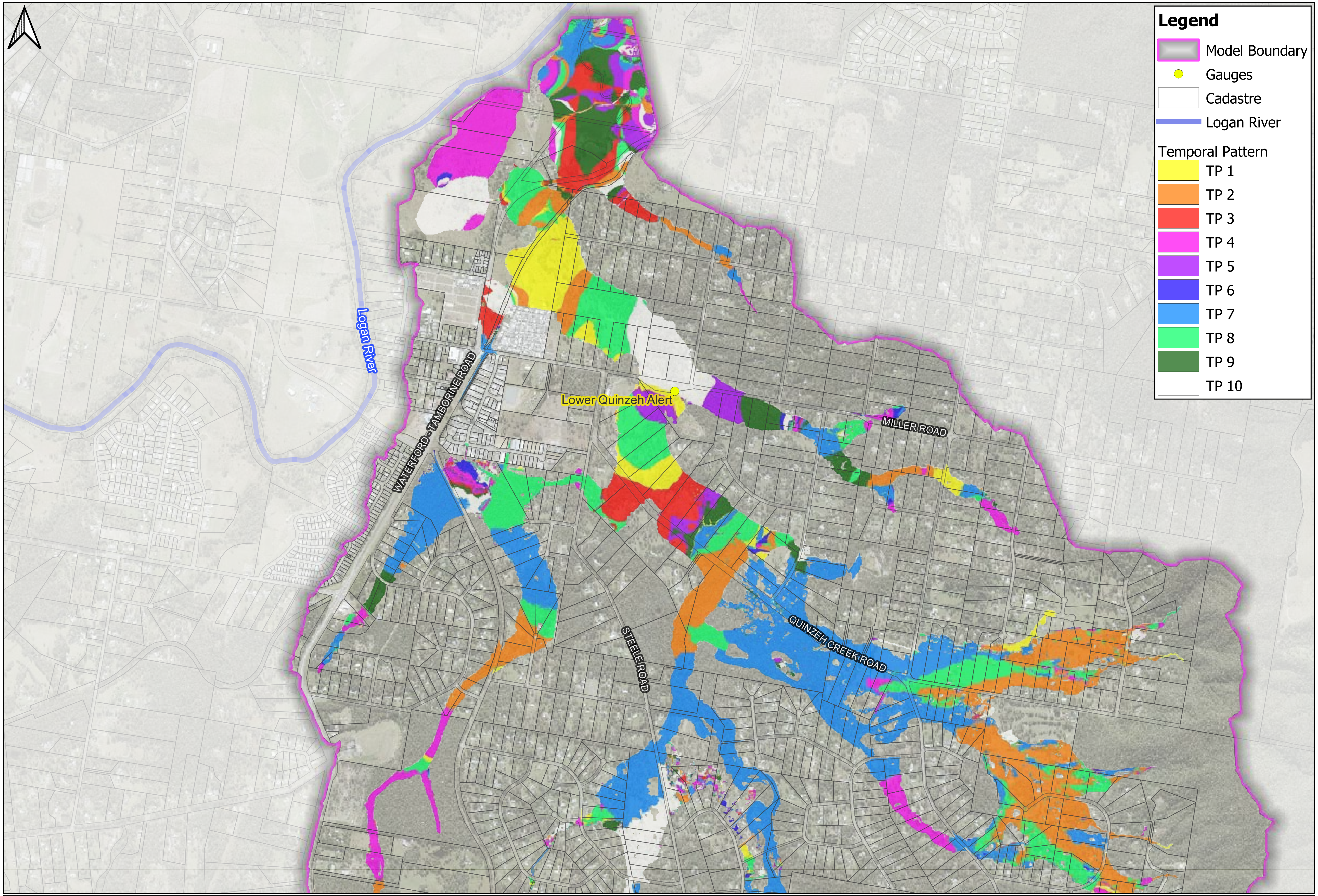
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 25-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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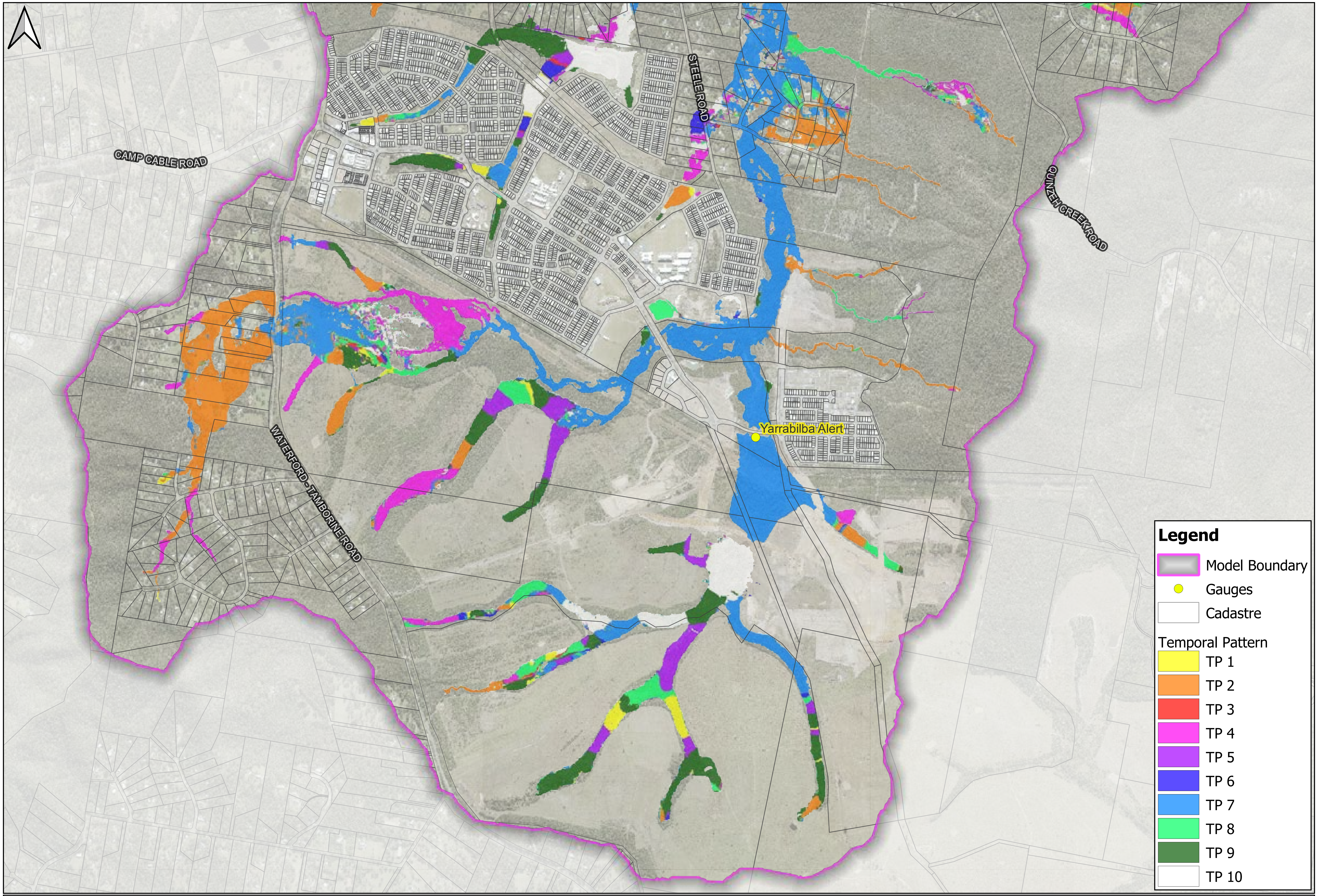
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

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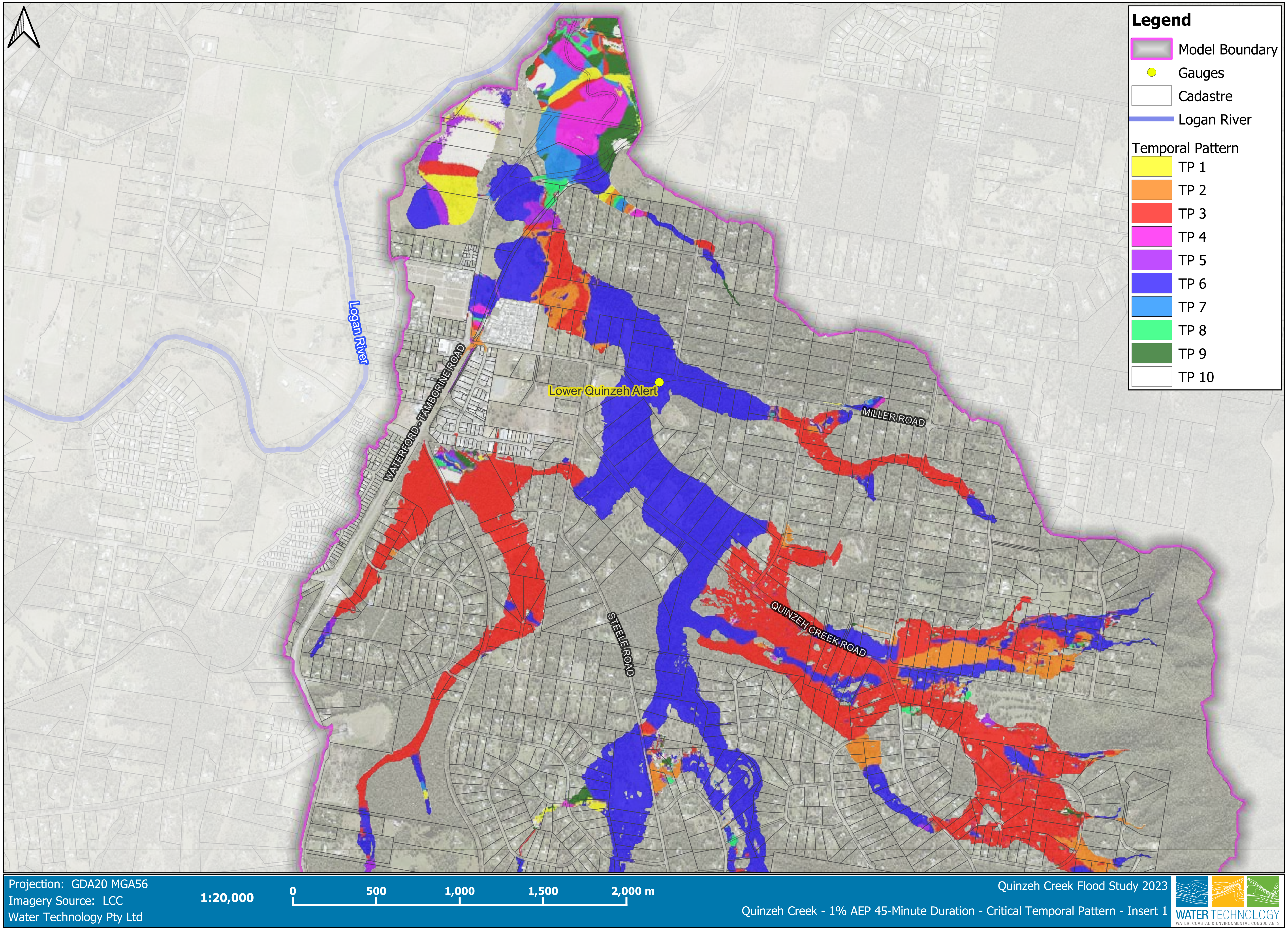
Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 30-Minute Duration - Critical Temporal Pattern - Insert 2


Legend
Model Boundary
Gauges
Cadastre
Logan River
Temporal Pattern
TP 1
TP 2
TP 3
TP 4
TP 5
TP 6
TP 7
TP 8
TP 9
TP 10
Logan River
Lower Quinzeh Alert
WATERFORD - TAMBORINE ROAD
MILLER ROAD
QUINZEH CREEK ROAD
STEELE ROAD
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
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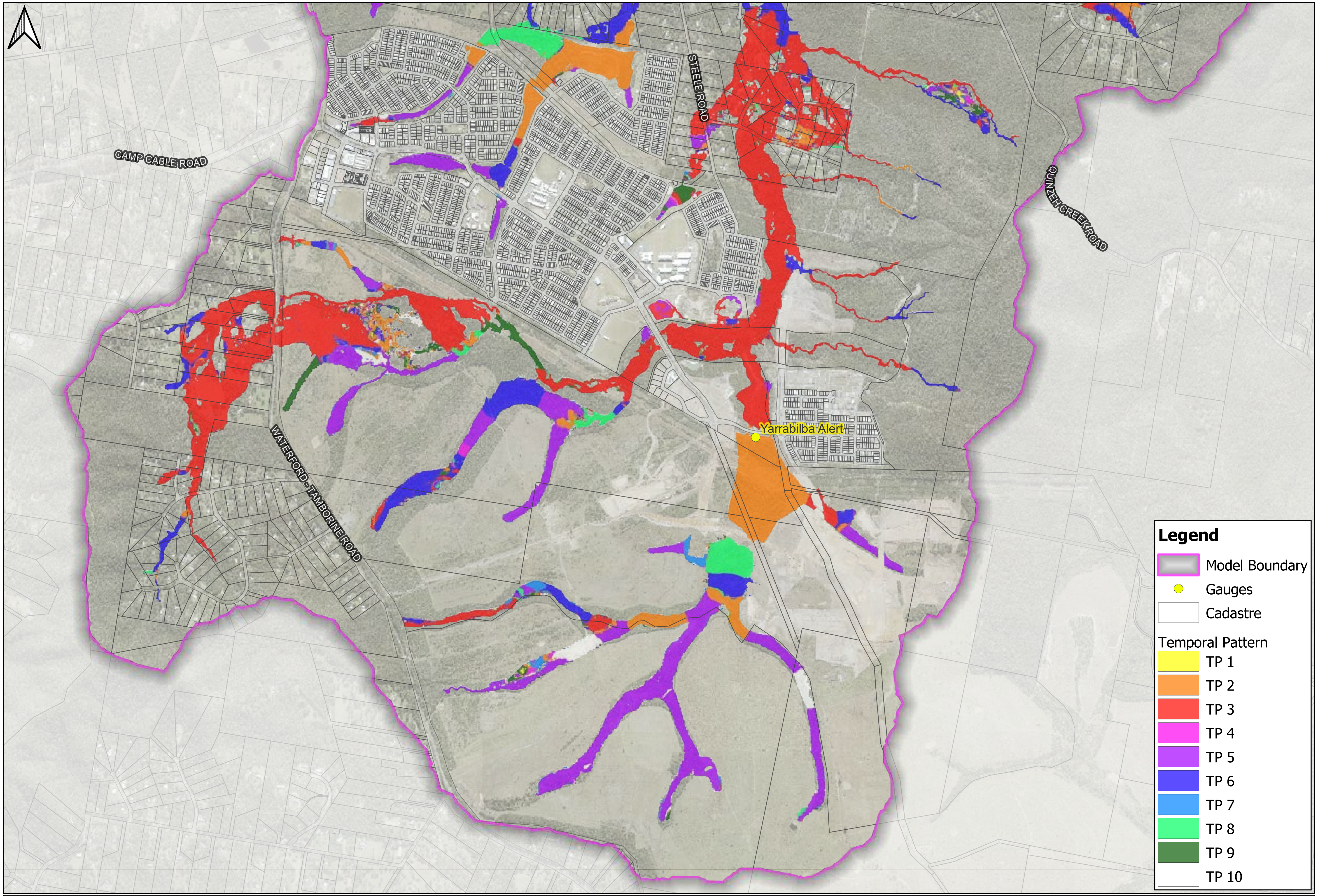
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 1
WATER TECHNOLOGY



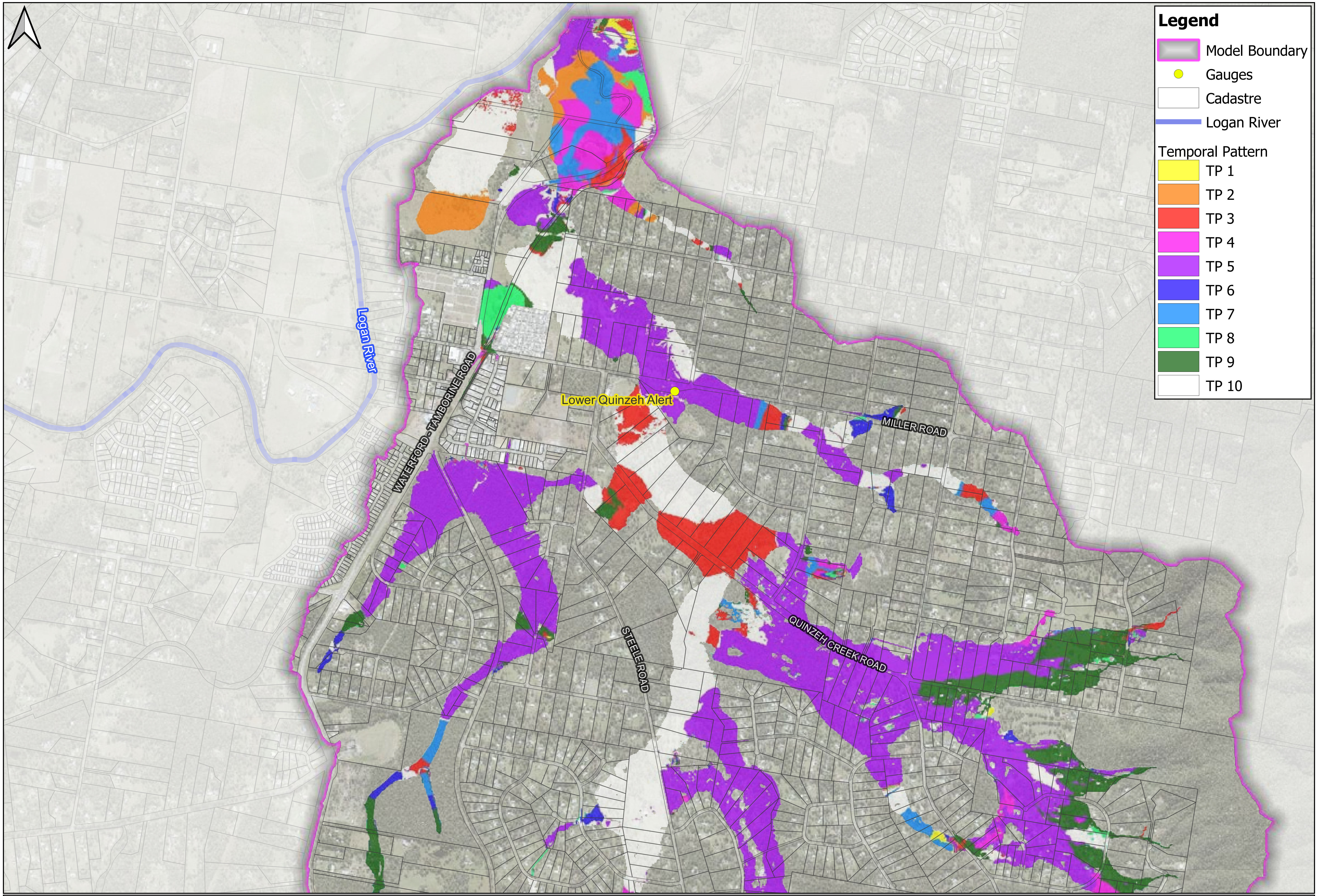
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 45-Minute Duration - Critical Temporal Pattern - Insert 2



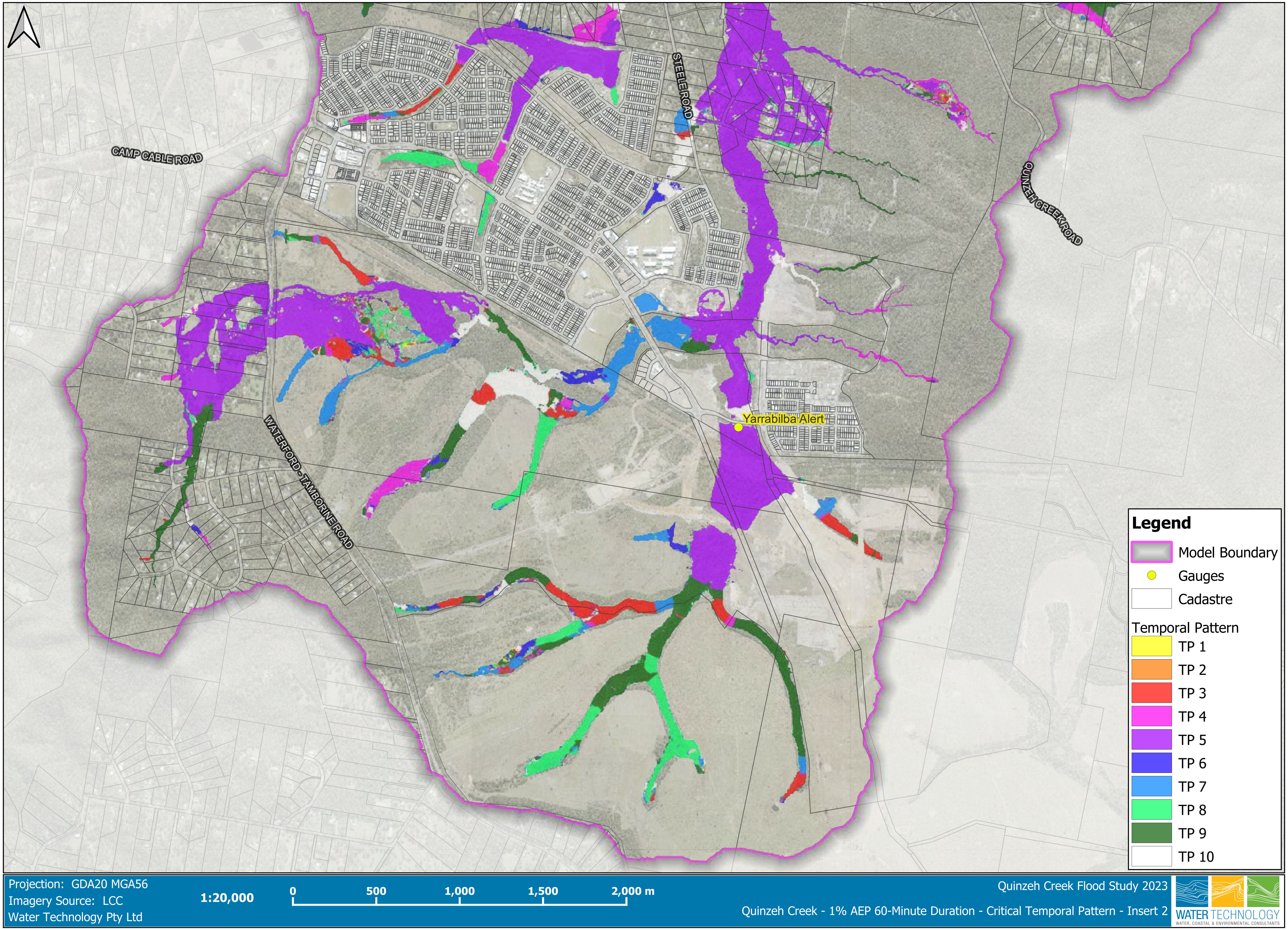
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

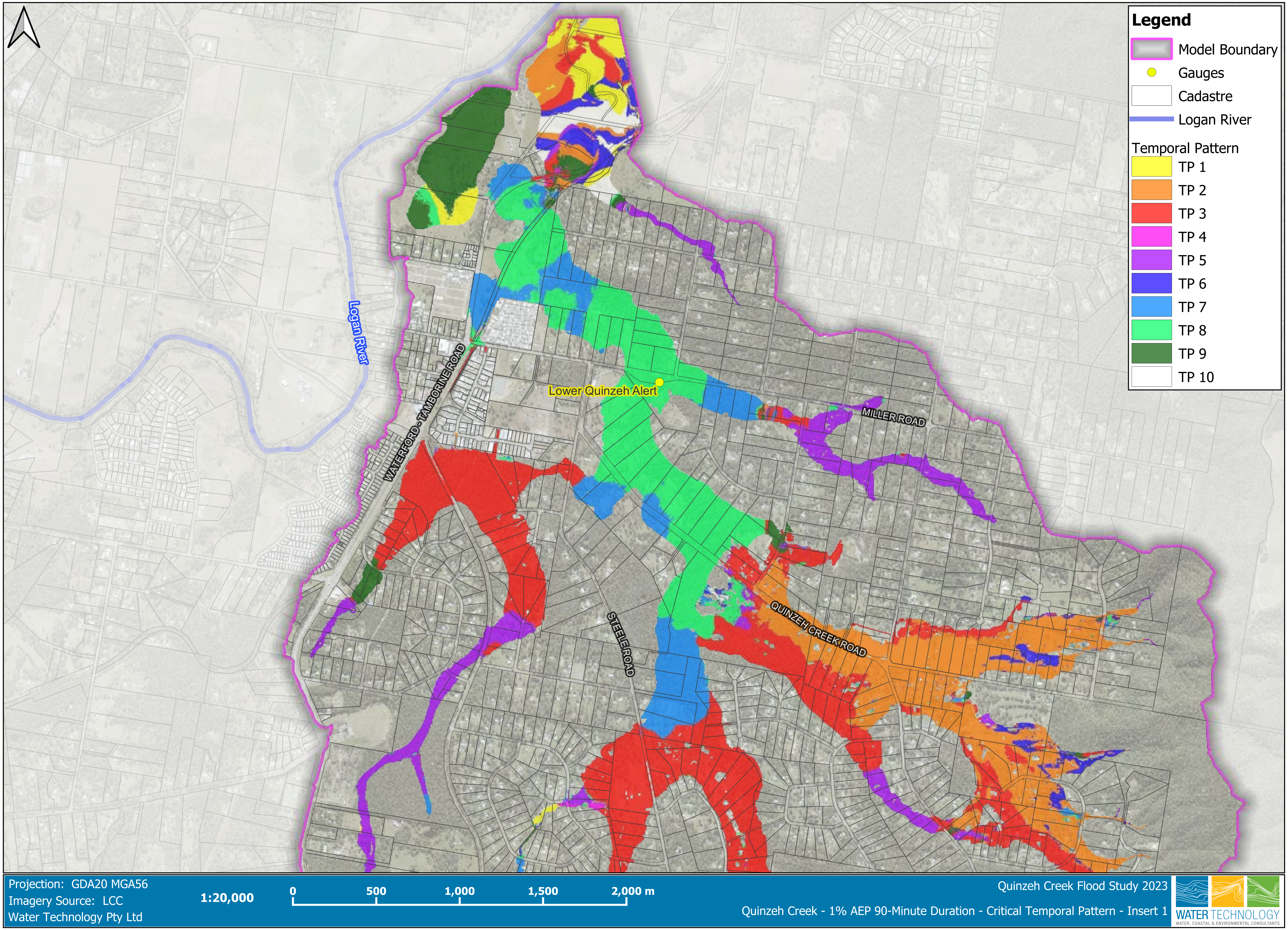
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 1



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Temporal Pattern
TP 1
TP 2
TP 3
TP 4
TP 5
TP 6
TP 7
TP 8
TP 9
TP 10
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP 60-Minute Duration - Critical Temporal Pattern - Insert 2
WATER TECHNOLOGY

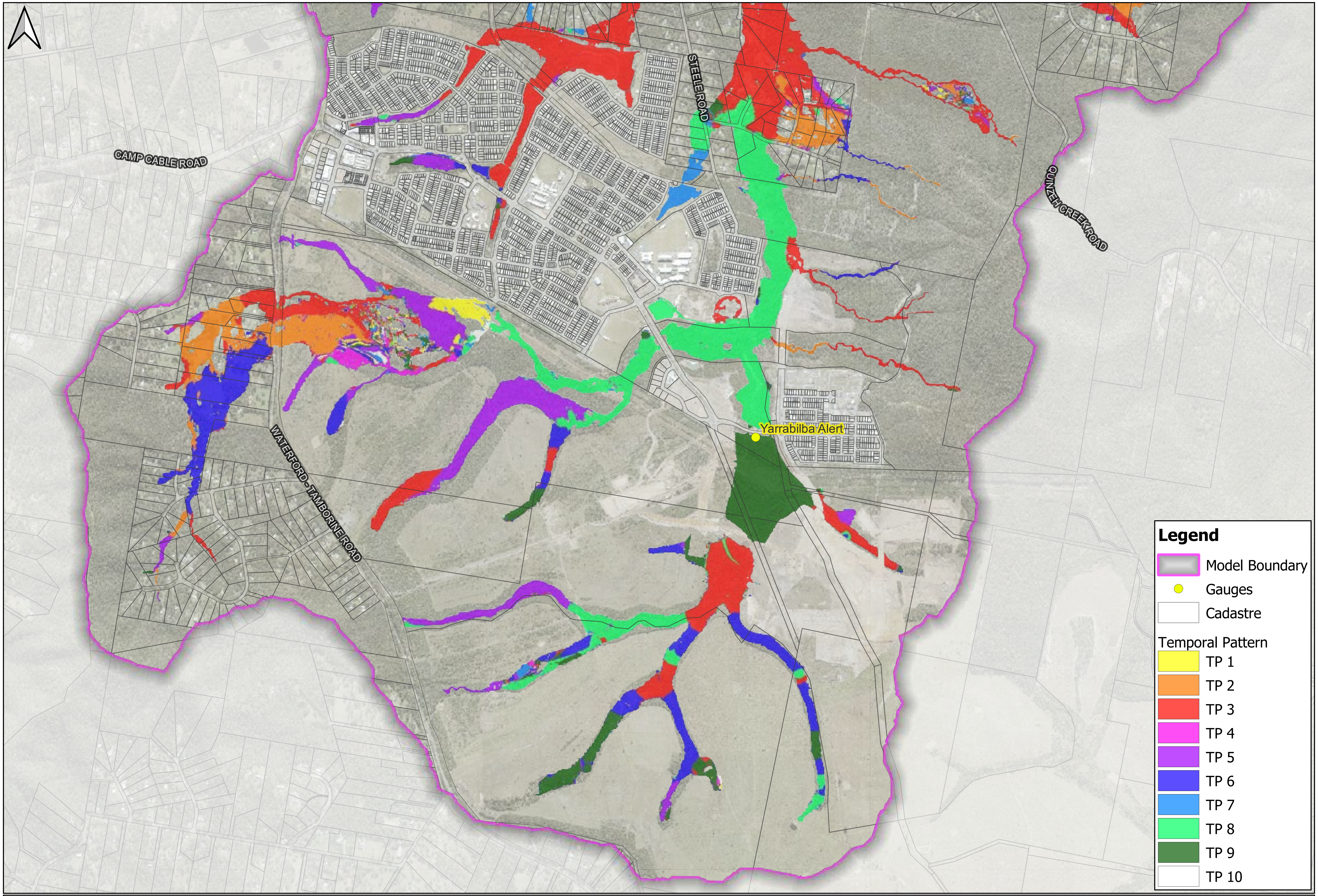


Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 1



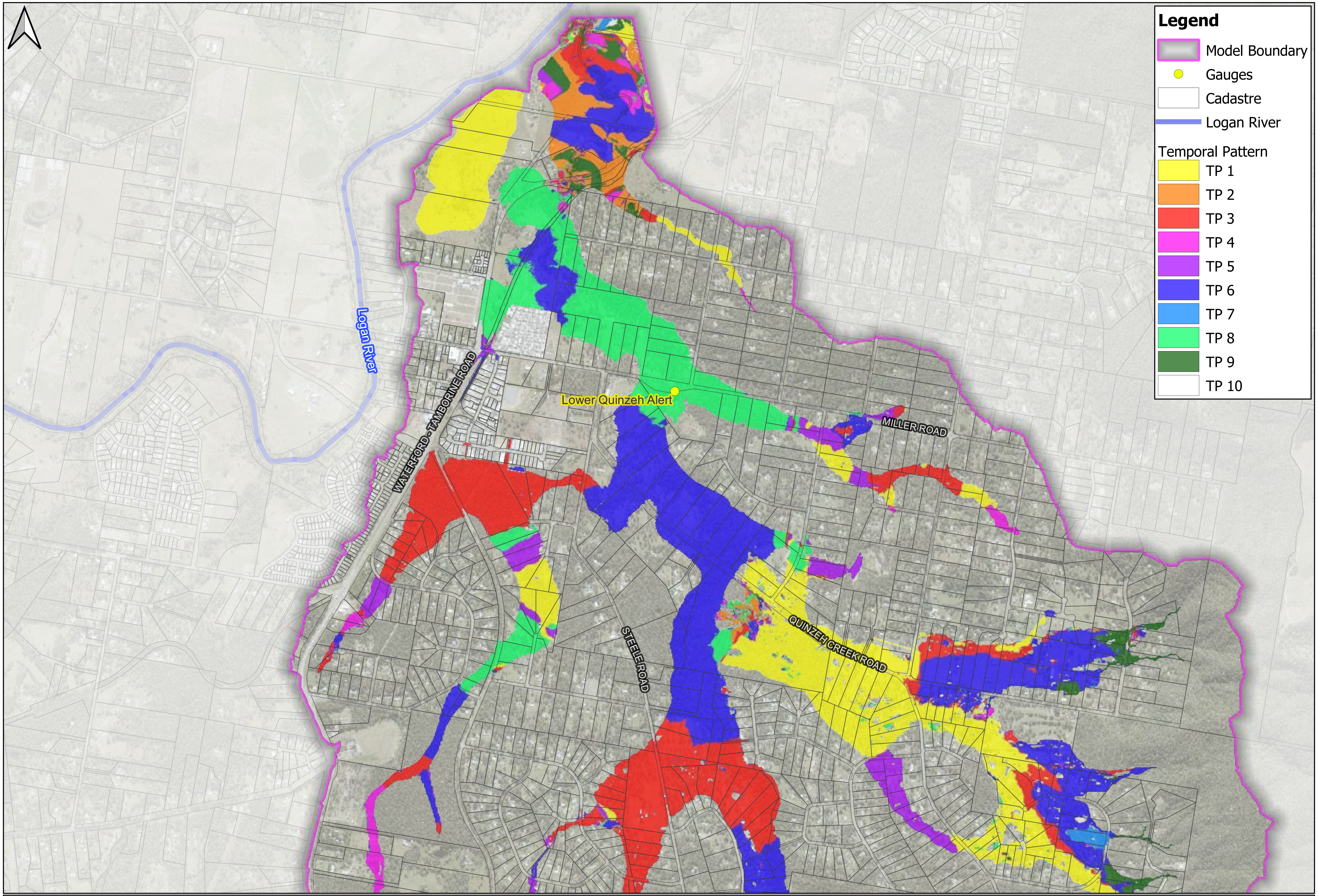
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 90-Minute Duration - Critical Temporal Pattern - Insert 2



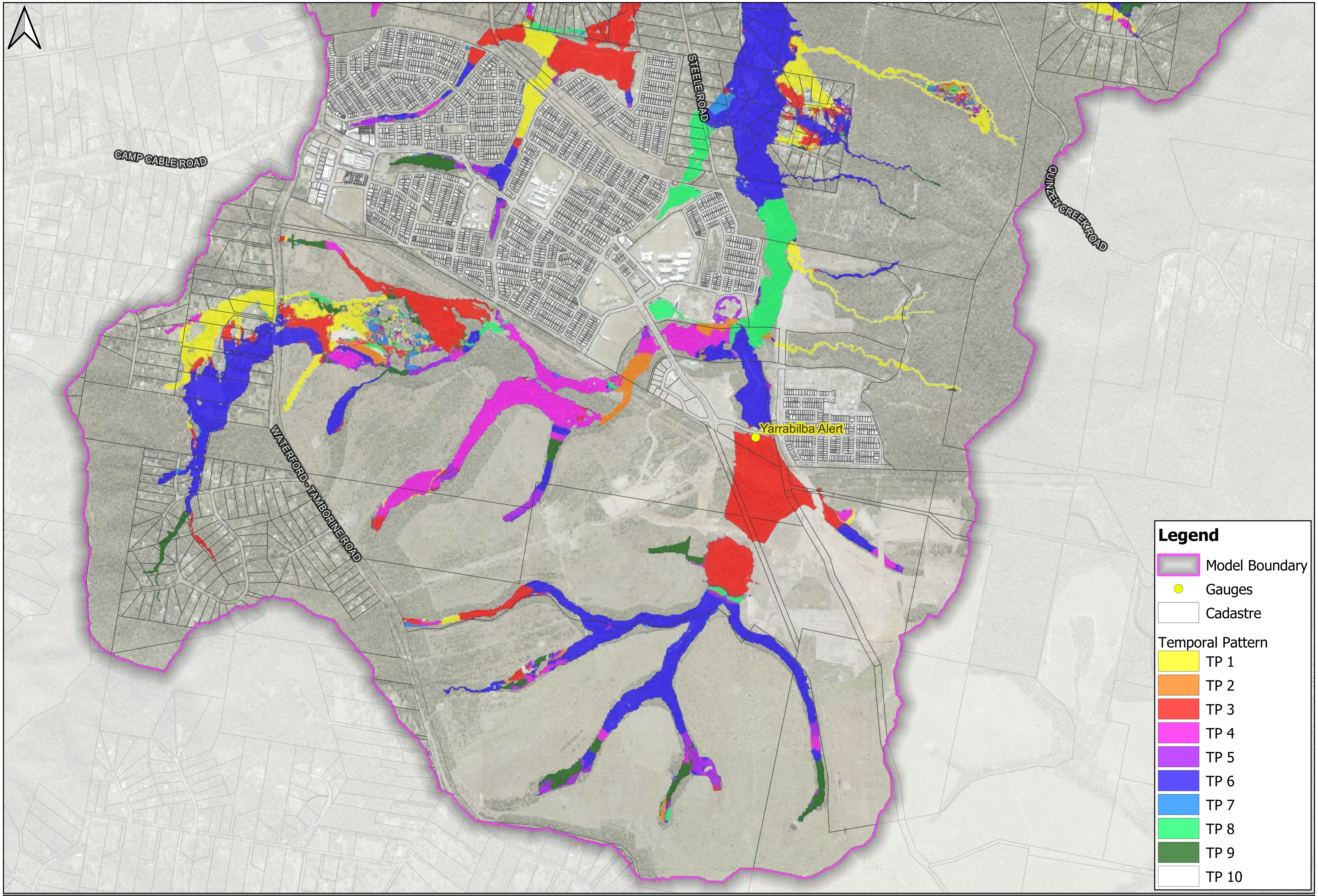
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 1



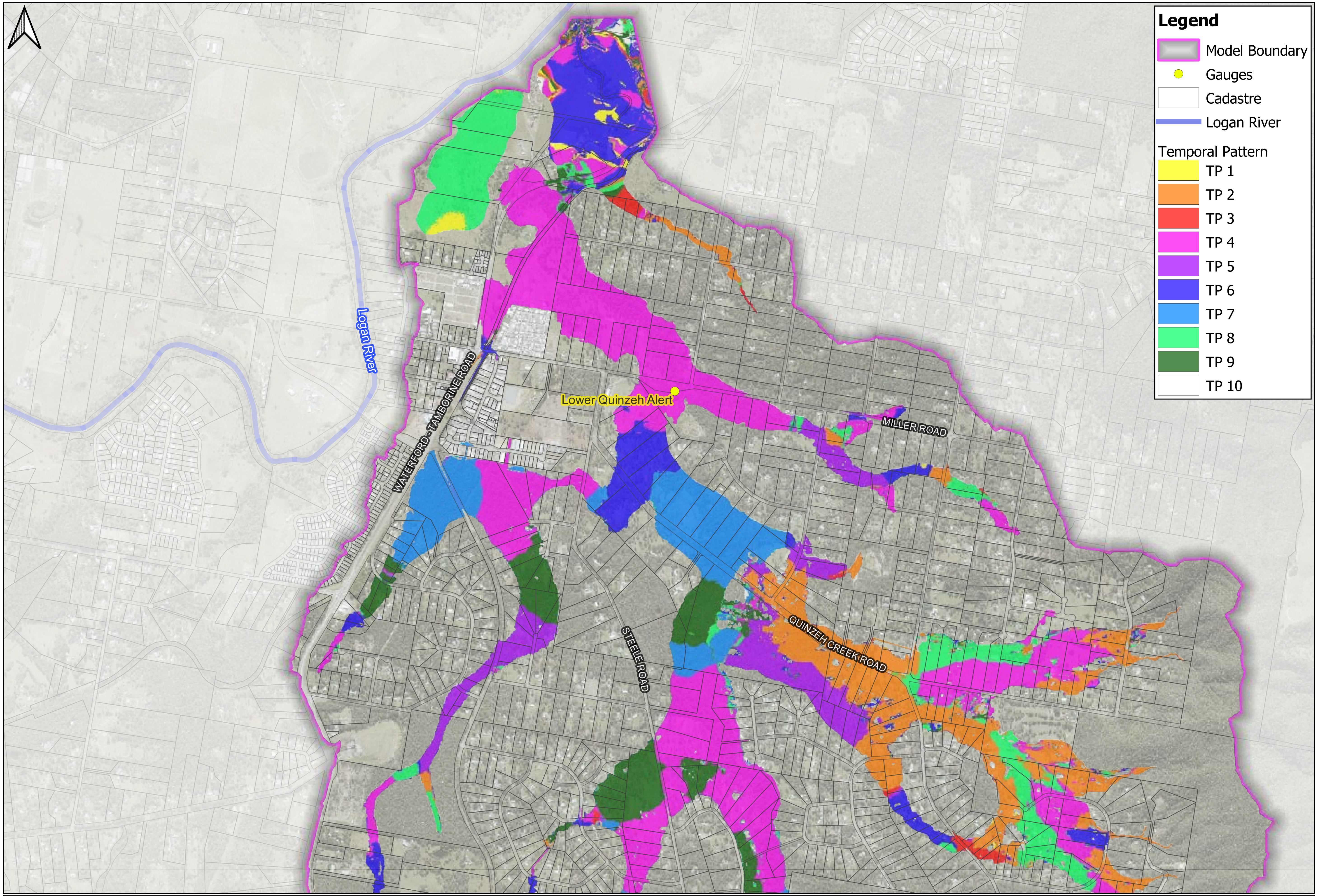
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 120-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



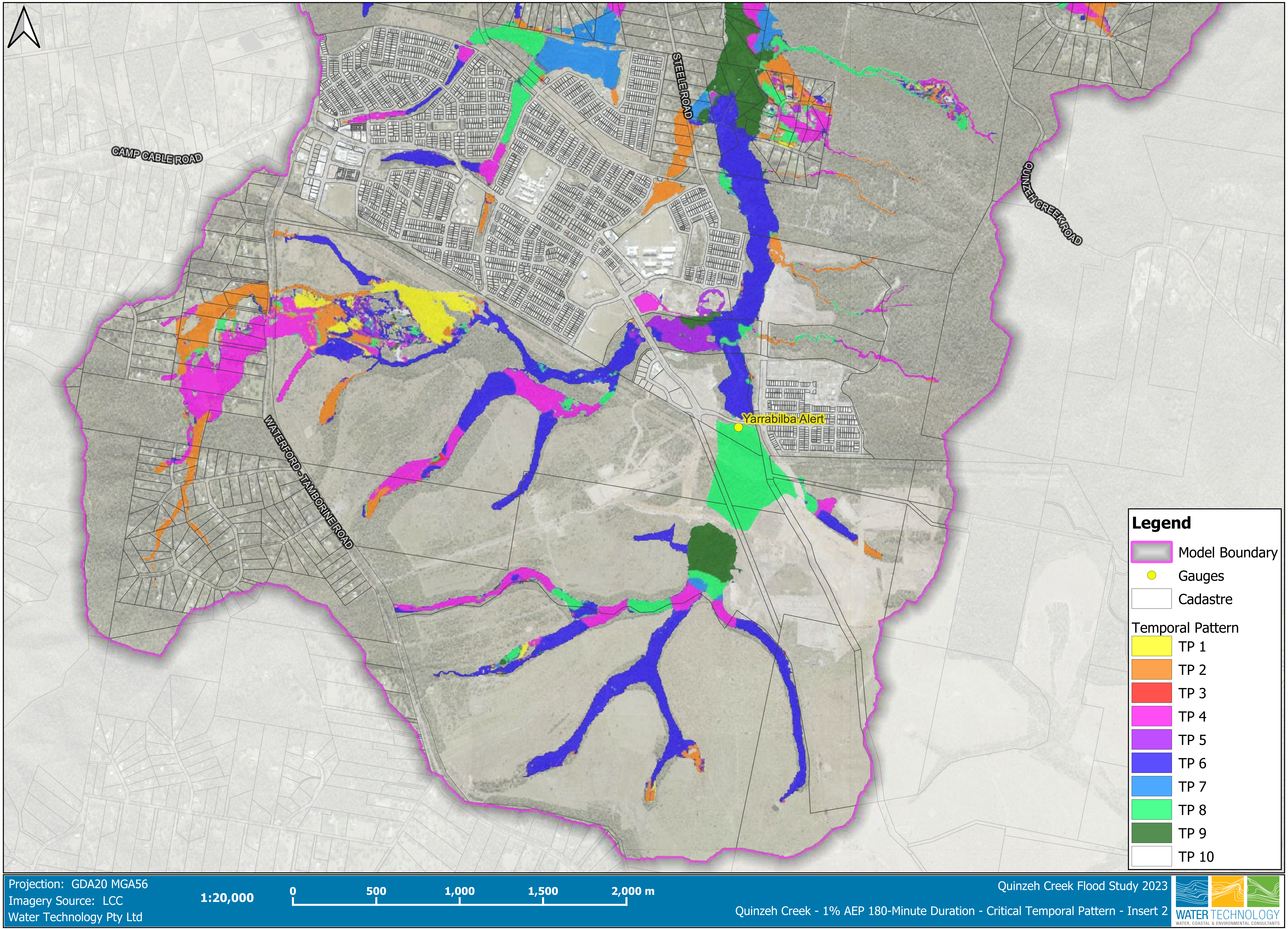
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

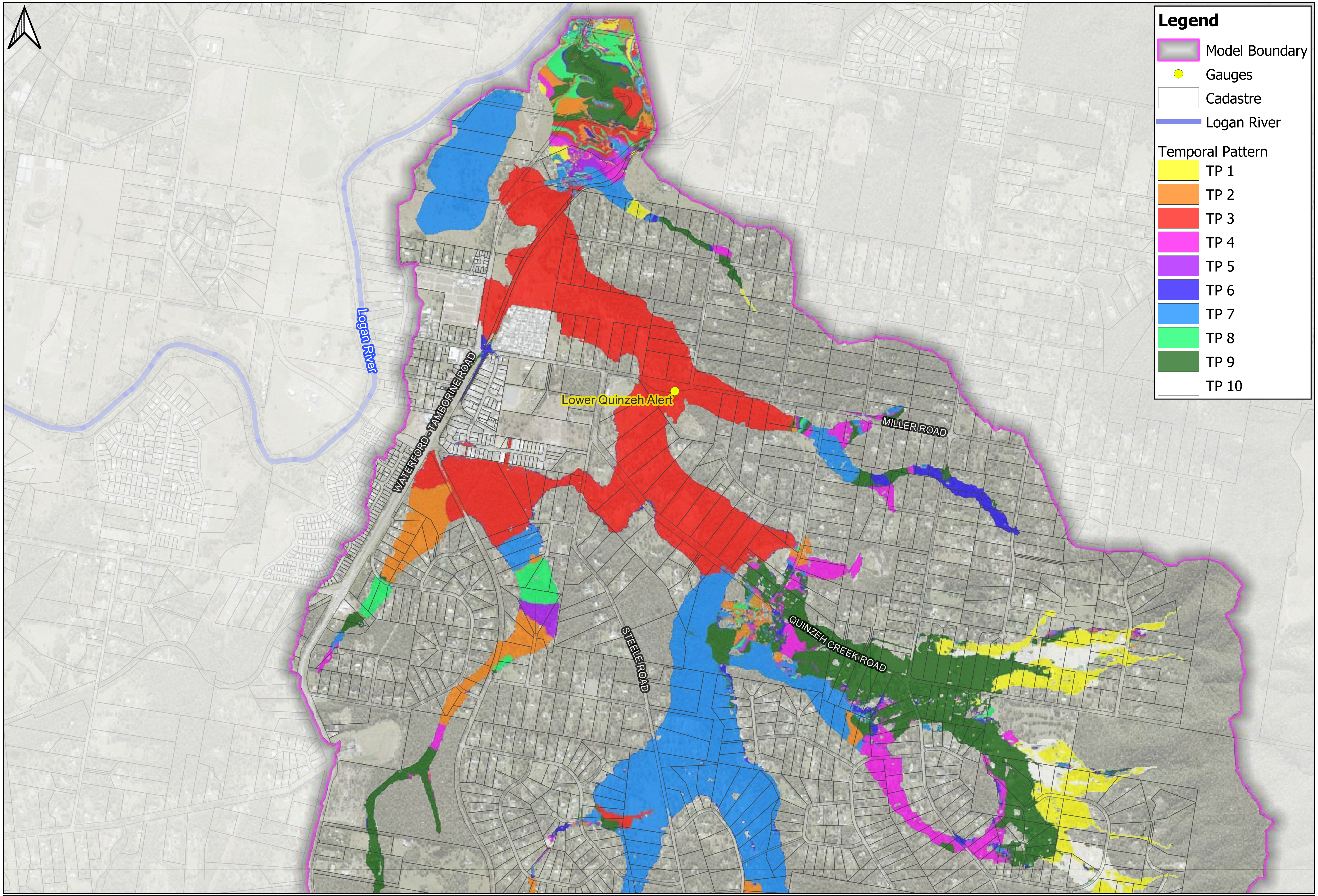
0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



CAMP CABLE ROAD
STEELE ROAD
QUINZEH CREEK ROAD
WATERFORD - TAMBORINE ROAD
Yarrabilba Alert
Legend
Model Boundary
Gauges
Cadastre
Temporal Pattern
TP 1
TP 2
TP 3
TP 4
TP 5
TP 6
TP 7
TP 8
TP 9
TP 10
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd
1:20,000
0
500
1,000
1,500
2,000 m
Quinzeh Creek Flood Study 2023
Quinzeh Creek - 1% AEP 180-Minute Duration - Critical Temporal Pattern - Insert 2
WATER TECHNOLOGY



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

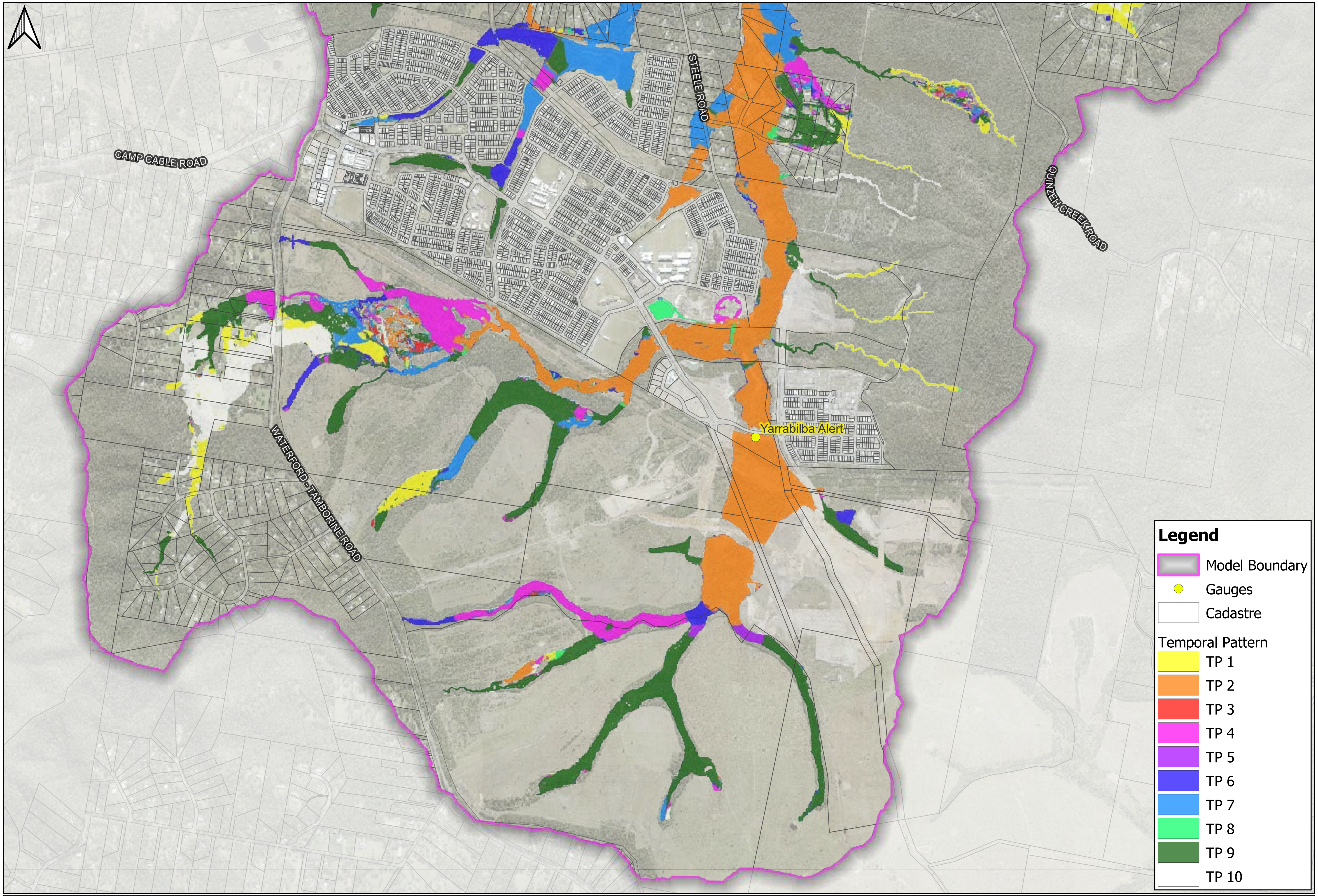
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



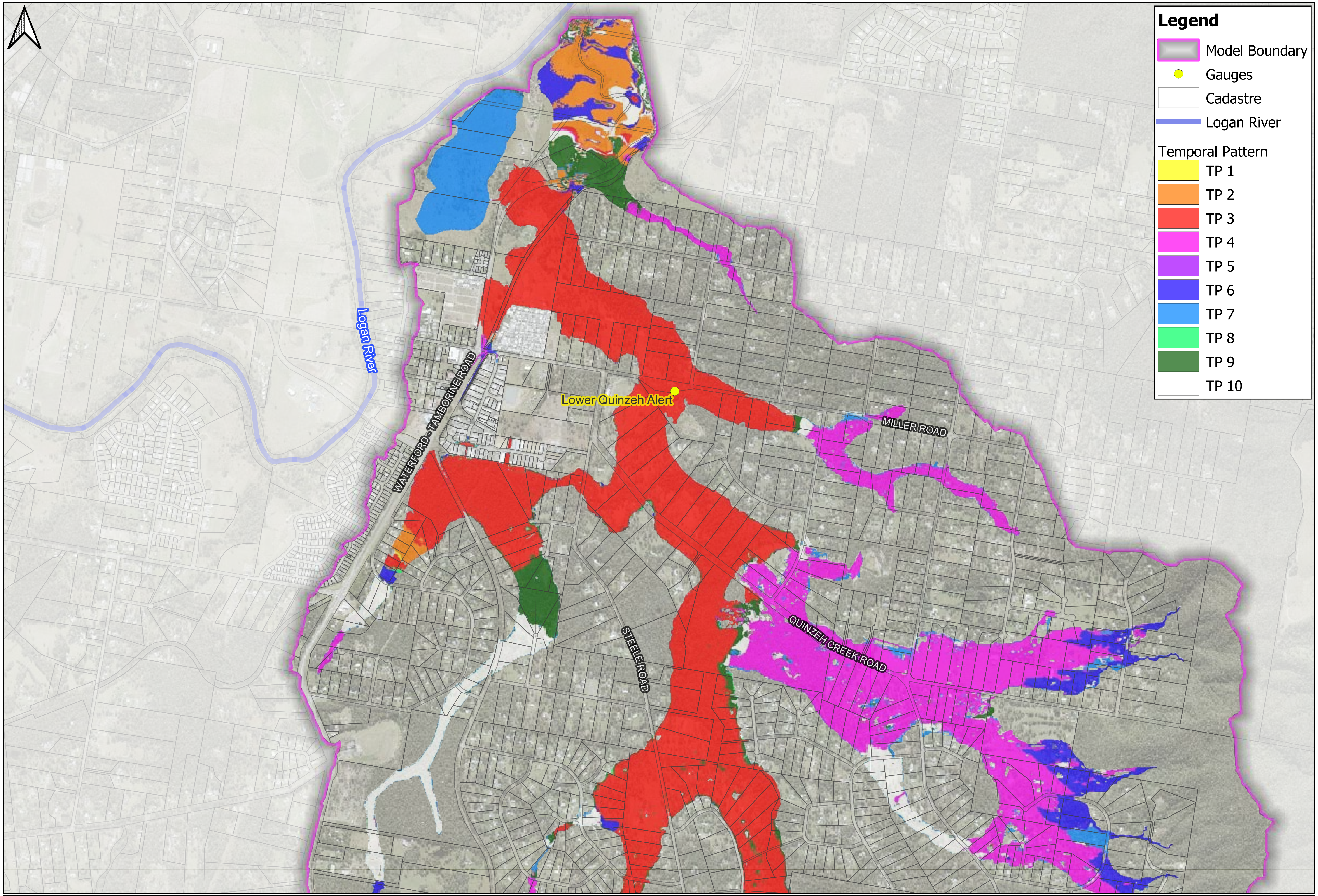
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 270-Minute Duration - Critical Temporal Pattern - Insert 2



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

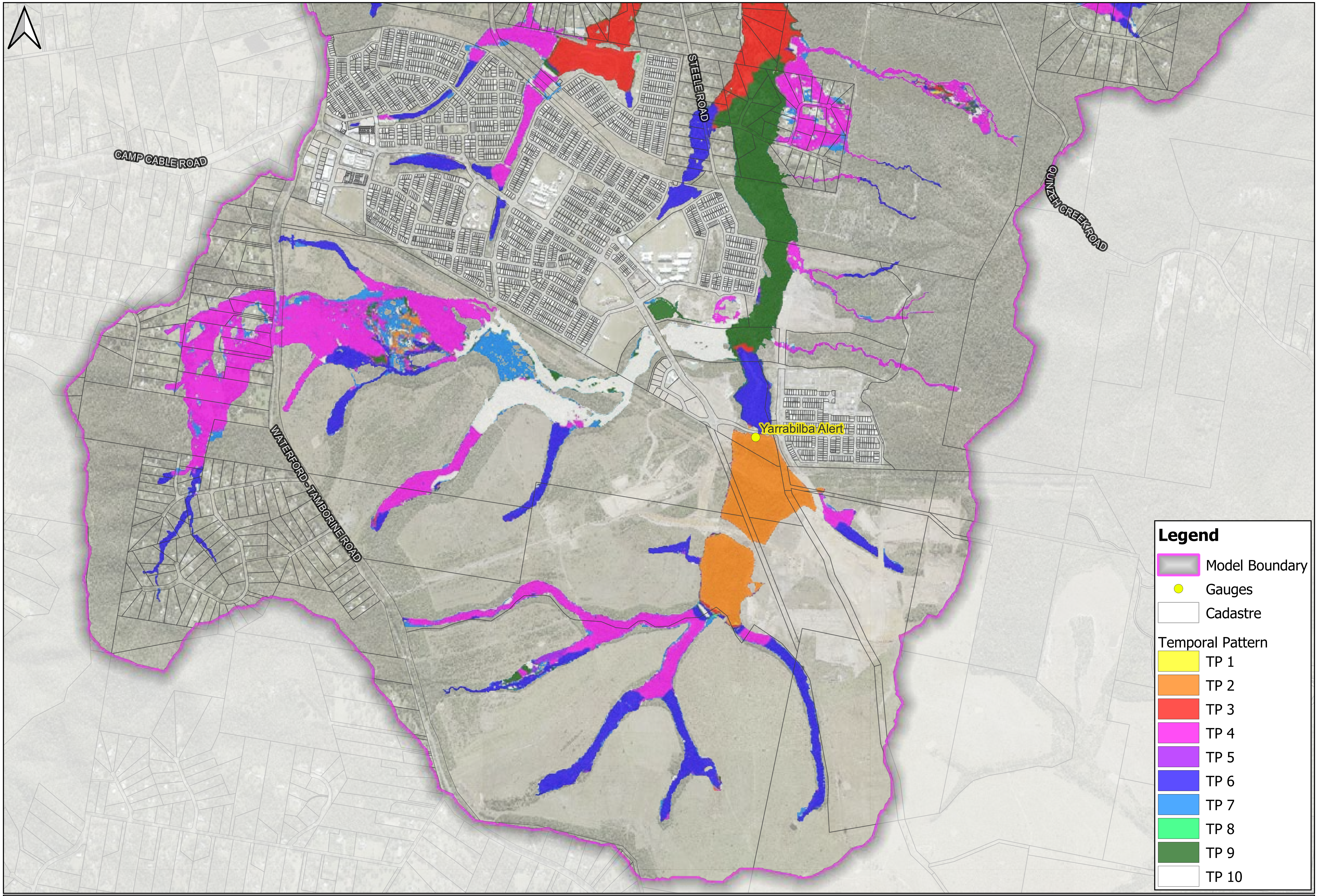
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 1

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

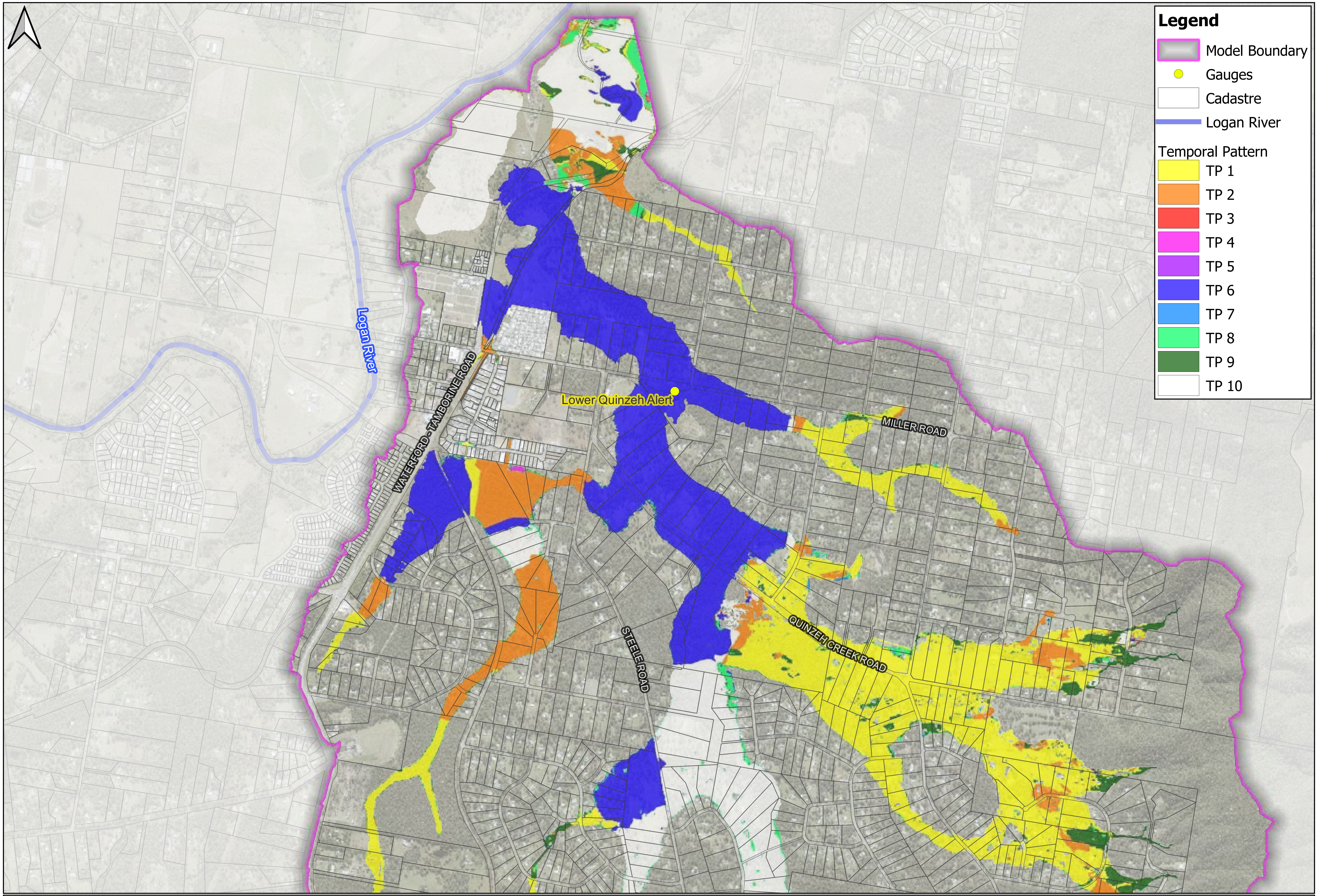
1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 360-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



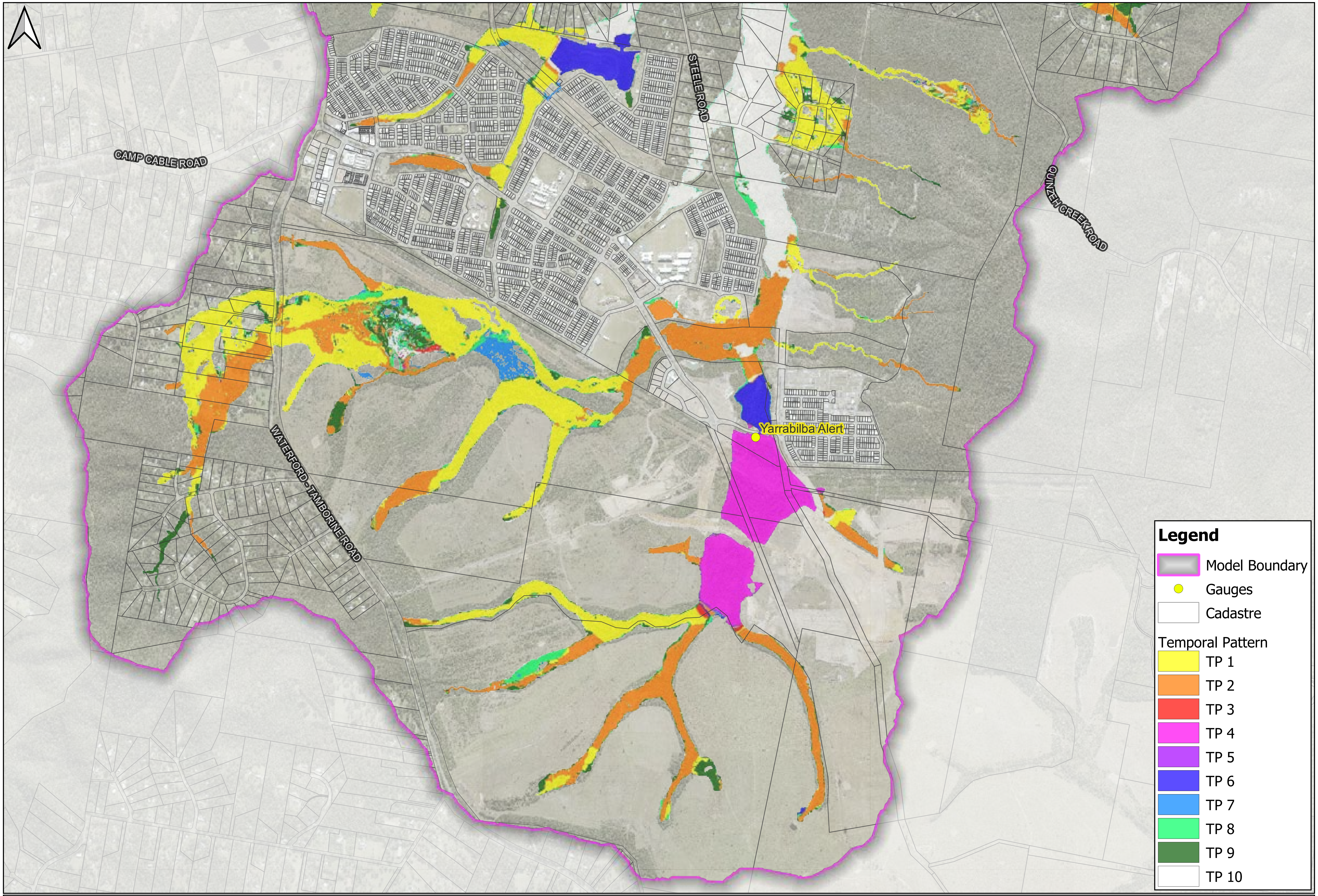
Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

0 500 1,000 1,500 2,000 m

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 1



Projection: GDA20 MGA56
Imagery Source: LCC
Water Technology Pty Ltd

1:20,000

Quinzeh Creek Flood Study 2023

Quinzeh Creek - 1% AEP 540-Minute Duration - Critical Temporal Pattern - Insert 2

WATER TECHNOLOGY
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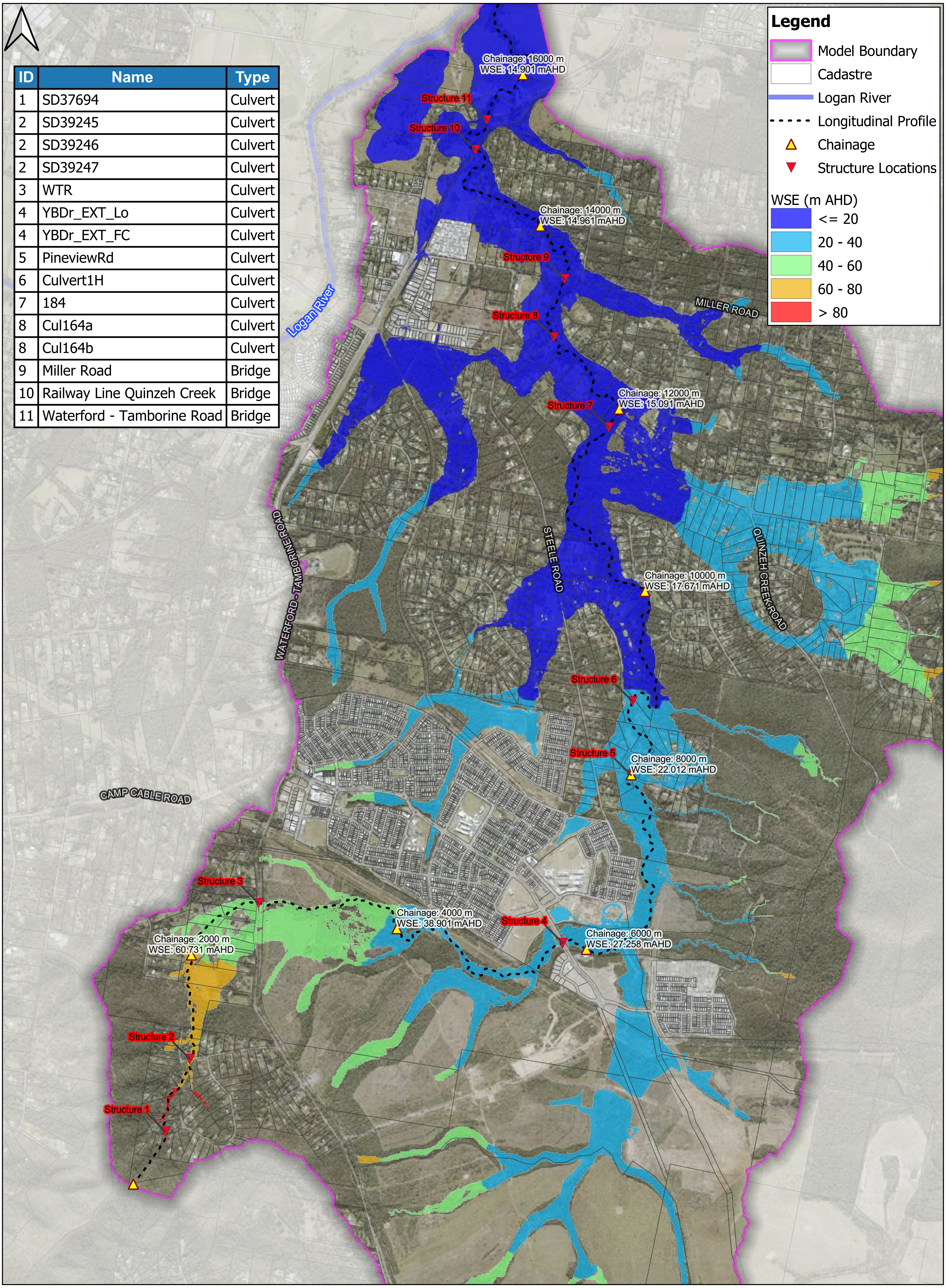
APPENDIX G
1% AEP LONGITUDINAL PROFILE OF PRIMARY QUINZEH CREEK FLOWPATH



ID	Name	Type
1	SD37694	Culvert
2	SD39245	Culvert
2	SD39246	Culvert
2	SD39247	Culvert
3	WTR	Culvert
4	YBDr_EXT_Lo	Culvert
4	YBDr_EXT_FC	Culvert
5	PineviewRd	Culvert
6	Culvert1H	Culvert
7	184	Culvert
8	Cul164a	Culvert
8	Cul164b	Culvert
9	Miller Road	Bridge
10	Railway Line Quinzeh Creek	Bridge
11	Waterford - Tamborine Road	Bridge

Projection: GDA20 MGA Zone 56
Imagery: LCC
Water Technology Pty Ltd

1:25,000 0 0.5 1 1.5 2 km

Quinzeh Creek Flood Study 2023

Quinzeh Creek 1% AEP Longitudinal Water Surface Elevation Profile

WATER TECHNOLOGY
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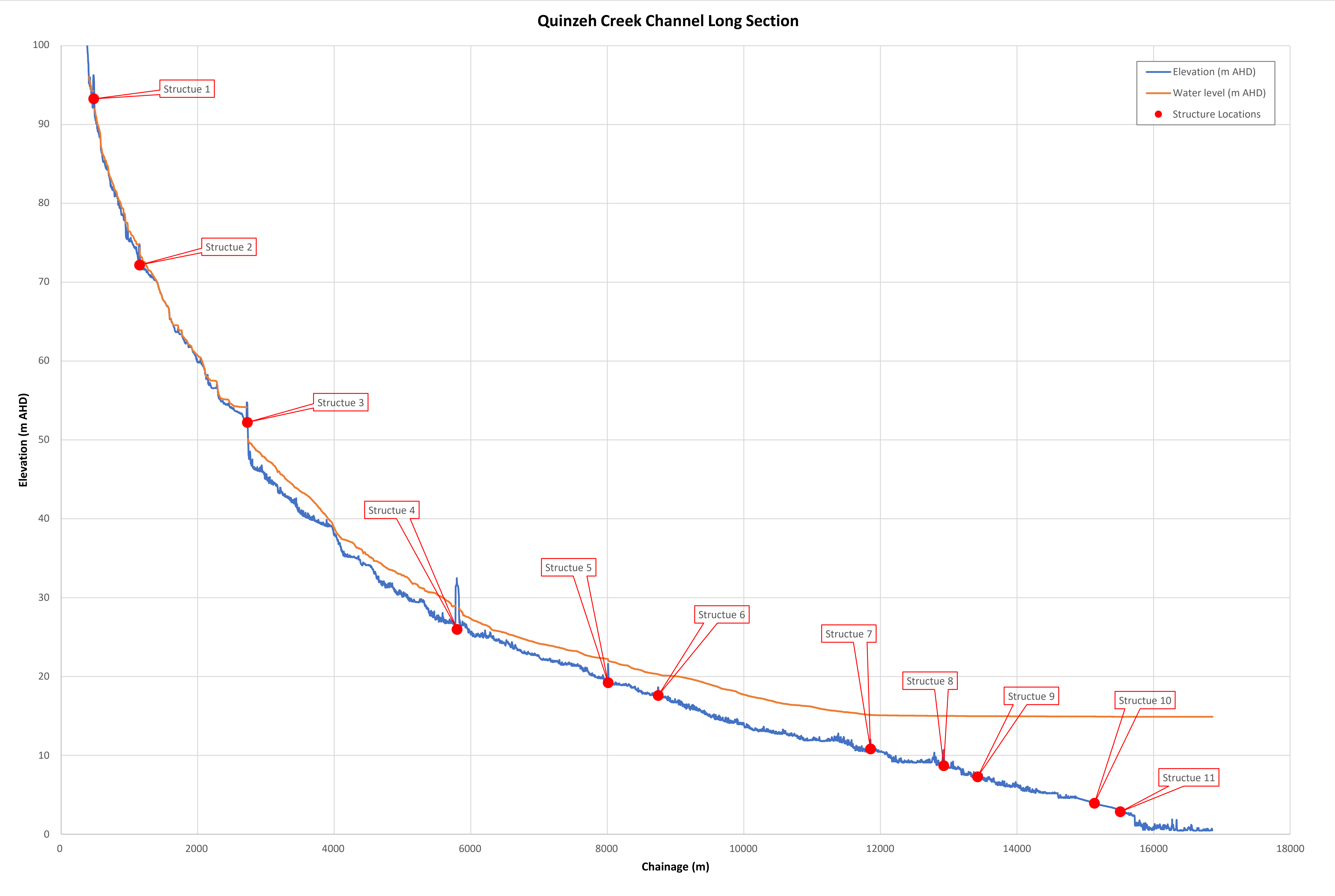

Quinzeh Creek Channel Long Section
Elevation (m AHD)
Chainage (m)
Elevation (m AHD)
Water level (m AHD)
Structure Locations
Structue 1
Structue 2
Structue 3
Structue 4
Structue 5
Structue 6
Structue 7
Structue 8
Structue 9
Structue 10
Structue 11
0
10
20
30
40
50
60
70
80
90
100
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

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Telephone (03) 5721 2650

Wimmera

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Stawell VIC 3380
Telephone 0438 510 240

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info@watertech.com.au