Kilcoy LFMP

Kilcoy Local Floodplain Management Plan

Somerset Regional Council

13 November 2020

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Synergy Solutions

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Draft	ABM	RWS	16 June 2020
03	Draft	AJT	RWS	30 September 2020
04	Final	CAB	RWS	13 November 2020

Project Details

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Document Number	19020078_R01_V04_Kilcoy_LFMP.docx

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1 INTRODUCTION

Flooding in Queensland in the summer of 2010/2011 affected more than 2.5 million people and approximately 29,000 homes and businesses. In 2012 the Queensland Flood Commission of Inquiry (QFCI) was established to recommend how state and local governments should manage flooding including future development, emergency response procedures, dam operations and structural mitigation.

Following the QFCI, Queensland Government and local governments have committed to long-term floodplain management practices to reduce the impact of current and future flood risks, including the Brisbane River Flood Studies and Brisbane River Strategic Floodplain Management (SFMP)[1], led by the Queensland Reconstruction Authority (QRA). The Flood Study was released in May 2017 and is the largest ever undertaken in Australia and informed the development of the SFMP to better understand current and future flood risks and identify regionally consistent approaches to strengthen flood resilience across the Brisbane River floodplain. The outcome of the SFMP includes a Technical Evidence Report (TER), recommendations for local floodplain management plans (LFMPs) and guidance material for amending planning schemes to align with State Planning Policy state interest for natural hazard risk and resilience. This LFMP establishes strategies to deliver sustainable management of flood risk in the long term for Kilcoy, a township in the wider local government area (LGA) of Somerset.

The primary causes of flooding in the Kilcoy region occurs from both Kilcoy Creek and Sheep Station Creek which border the Kilcoy Township on the eastern and western tributaries sides of the township, respectively. The Kilcoy catchment extends from the mountains of the Conondale Range in the north to close proximity to Lake Somerset in the south and is displayed in Figure 1-1. The township of Kilcoy is located in the southern portion of the catchment. Sheep Station Creek and Kilcoy Creek both flow in a north to south direction, with the creek confluence located approximately 600 m south of the Kilcoy Township.

The total catchment area to Kilcoy is approximately 315.6 km^2. Kilcoy Township itself occupies less than 1% of the total catchment area. In terms of lengths, the catchment is approximately 27 km measured from north to south and approximately 20 km east to west but is only approximately 5 km east to west in the lower areas to Kilcoy. The catchment is traversed by three (3) major roads as illustrated in Figure 2-2. The D'Aguilar Highway travers through the lower portion of the catchment. Mount Kilcoy Road traverses through the eastern part of the catchment and roughly follows Kilcoy Creek upstream to the mountains. Likewise, Kilcoy Murgon Road follows Sheep Station Creek and continues north through Jimna State Forest.

The majority of the existing development is located in the downstream portion of the catchment and just north of the D'Aguilar Highway. This includes existing commercial and low/medium residential areas. There are some isolated low-density areas along Kilcoy Creek, with the upstream catchment areas predominated by forest.

[1] BMT 2018, *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report.* Available: (Online) https://cloudstor.aarnet.edu.au/plus/s/o7L0vJD0Uo5UO4B.

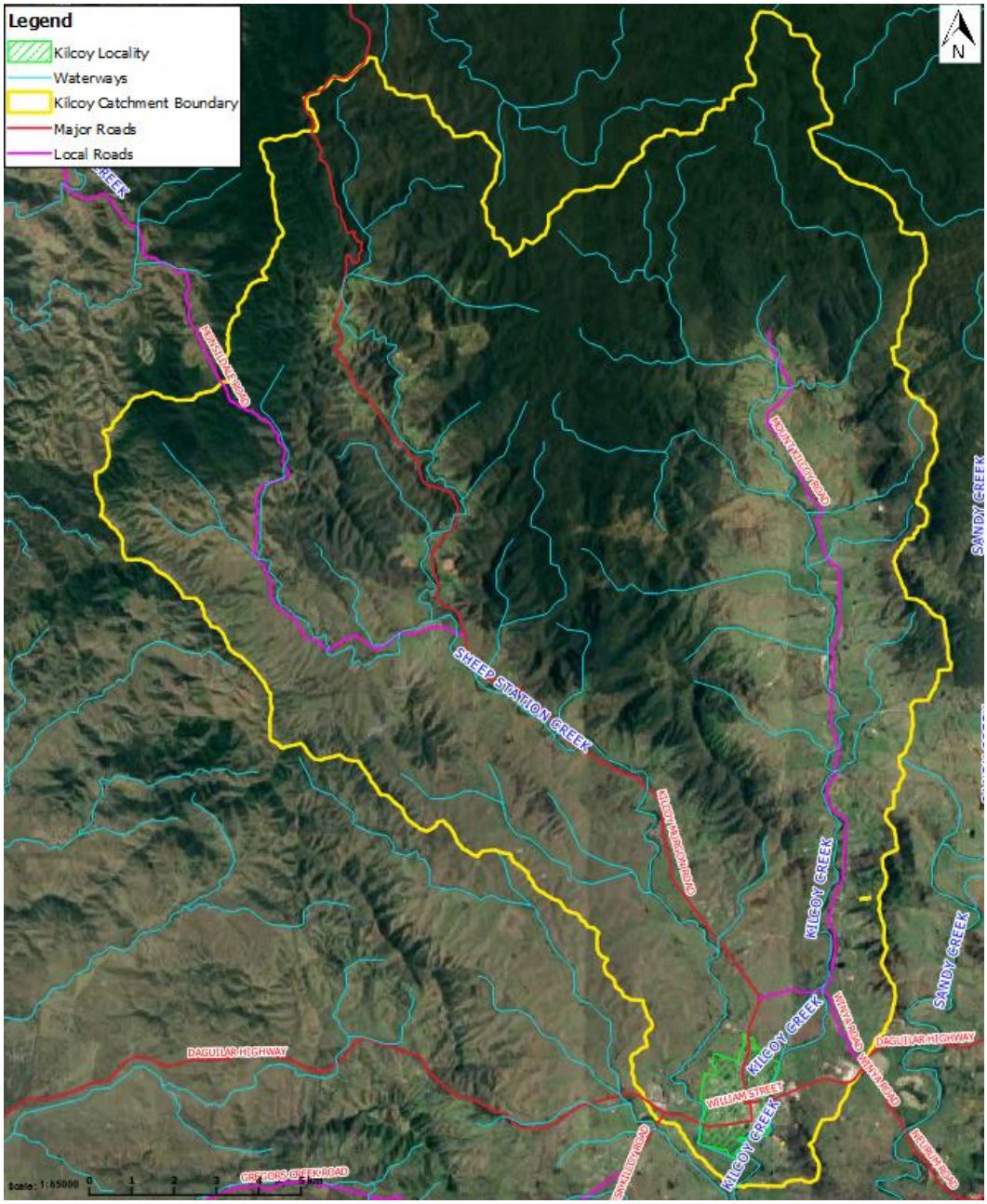

FIGURE 1-1 KILCOY CATCHMENT LOCALITY MAP

2 CURRENT FLOOD RISK

The following information provides an overview and understanding of the flood exposure and current flood risk within the Kilcoy catchment area. For further flood history of Kilcoy and its catchments, the Somerset Flood Studies Flood Study Technical Report should be consulted for a detailed breakdown of any historical flooding and catchment characteristics.

2.1 Flood Risk Assessment

2.1.1 Overview

The approach taken to identify, document and analyse flood risk in the Kilcoy Area for the Local Management Flood Plan (LFMP) follows the guidelines and strategic framework established in the Brisbane River Strategic Floodplain Management Plan (SFMP), which guides stakeholders to build flood resilience within the communities. The risk assessment methodology established in the SFMP is in accordance with ISO 31000:2009 which summarises the process into four steps:

1) Risk identification
2) Risk analysis
3) Risk evaluation
4) Risk treatment

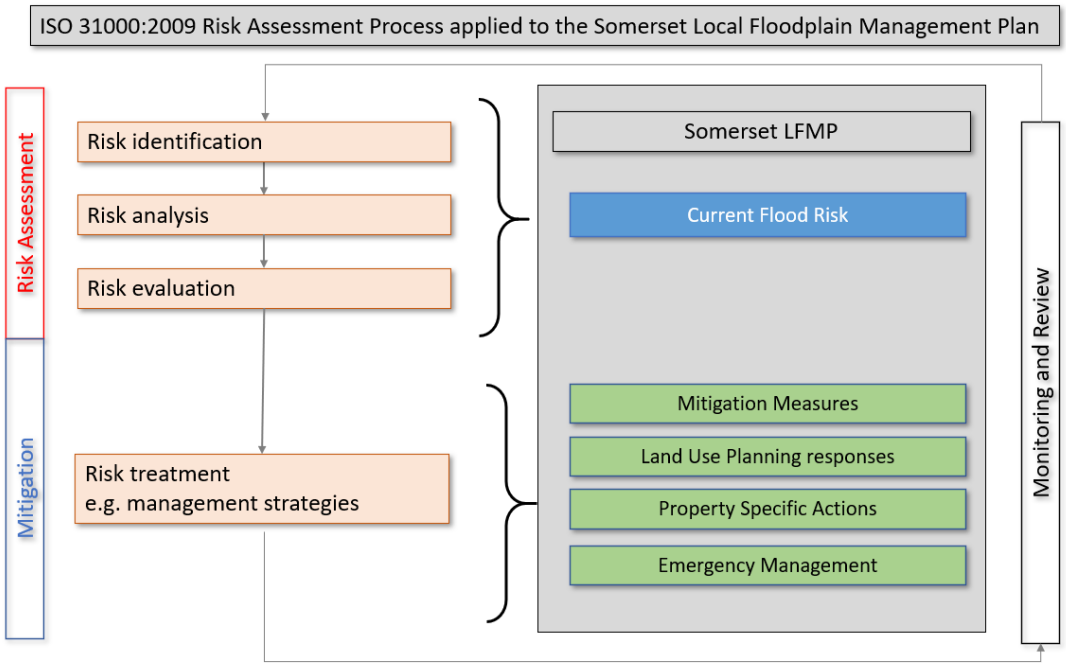

FIGURE 2-1 RISK ASSESSMENT PROCESS APPLIED TO THE LFMP

2.1.2 Risk Identification

Whilst the approach utilized for risk assessment within the Brisbane River Strategic Flood is suitable for regional flood applications, the risk assessment process was refined and further evolved to suit local and specific conditions.

Flood risk to the Somerset Local Government Area (LGA) has due consideration of the following:

- Potential hydraulic risk;
- Direct and indirect damages caused by flooding;
- Isolation caused by flood waters creating flood islands;
- Time to inundation of roads and buildings; and
- Duration of inundation of roads and buildings.

The SFMP provides the baseline methodology for calculating the risk identification. However, where the LFMP has refined the methodology, this will be clearly stated in this document.

2.2 Risk Analysis

Risk is defined as a combination of **likelihood** and **consequence**.

Likelihood of flood risk has been kept consistent across all flood studies in the Somerset Local Floodplain Management Plans (LFMP) and is expressed as the hazard's Annual Exceedance Probability (AEP), representing the probability of a flood event to reach or exceed a given intensity in any year.

The following AEP events were considered when assessing risk:

- 1 in 10 (10% AEP)
- 1 in 20 (5% AEP)
- 1 in 50 (2% AEP)
- 1 in 100 (1% AEP)
- 1 in 500 (0.2% AEP)
- 1 in 2000 (0.05% AEP)
- PMF (Probable Maximum Flood)

It should be noted that the PMF varies in flood likelihood across the Somerset LGA due to the local creek catchment variance. The Brisbane River Catchment adopts a consistent 1 in 100,000 likelihood for the PMF.

Consequence examines the impact to exposed elements resulted by a flood event. This is both the physical impact of the event on an asset, as well as the economic, social, and environmental impacts on the same asset.

Potential Hydraulic Risk has been used in the Brisbane River Flood Studies and SFMP to define a regionally consistent definition of consequence using Potential Hydraulic Risk derived from hazard characteristics identified in the Australian Institute of Disaster Resilience (AIDR) guideline. These six characteristics are defined in the graphic taken from AIDR in Figure 2-2 and represented in the map in Figure 2-3.

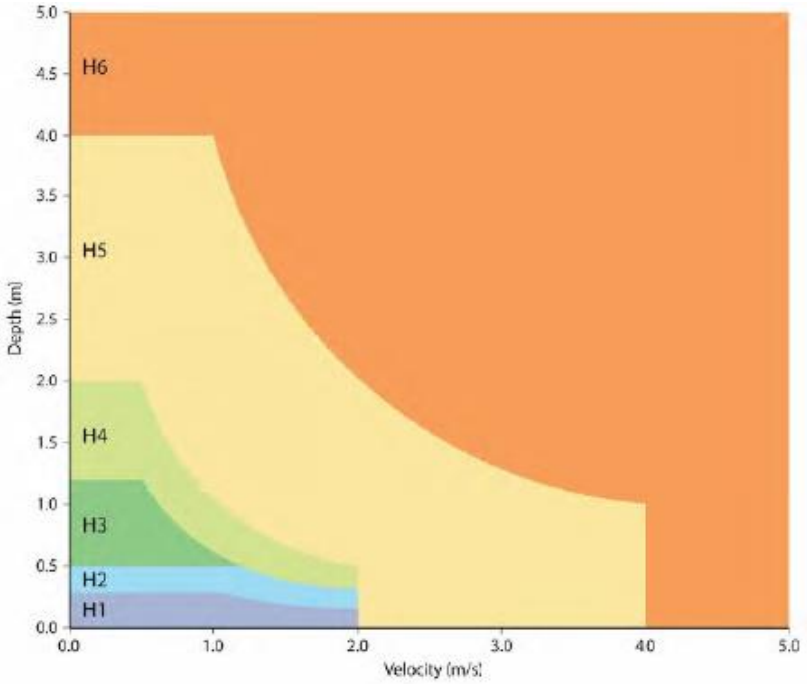

FIGURE 2-2 AIDR HAZARD CATEGORIES

These hazard categories are important component of defining flood risk and breaking down the hazard across the floodplain. Using different hazard categories across the catchment is helpful in designating appropriate flood risk management responses in areas exposed to hazard that is unsafe for children and the elderly; or on the other end of the scale, areas potentially exposed to hazard that threatens the structural integrity of buildings.

2.3 Hazard

Hazard is one of the most critical elements to defining overall flood risk. For the Kilcoy area it enables assessment of particular hazards to different circumstances (risk to life, property and vehicles). The entire hazard output from the flood model is shown below and a close-up version of the Kilcoy Township is shown for the 1 in 100 and 1 in 2000 AEP events.

The following is noted with regards to the township shown in Figure 2-4 and Figure 2-5:

- During the 1 in 100 AEP event, the majority of residential houses within the township are not exposed to this level of flooding. This is restricted to a handful of houses exposed to low hazard in Seib Street.
- During the 1 in 2000 AEP event, the consequences of flooding only increase marginally from the 1 in 100 AEP event. Properties along Seib Street increase in numbers and some properties have a higher hazard of H4 (risk to adult life).
- Outside of the township there are several houses impacted with high hazard and the GIS datasets should be used to integrate individual flood risk.

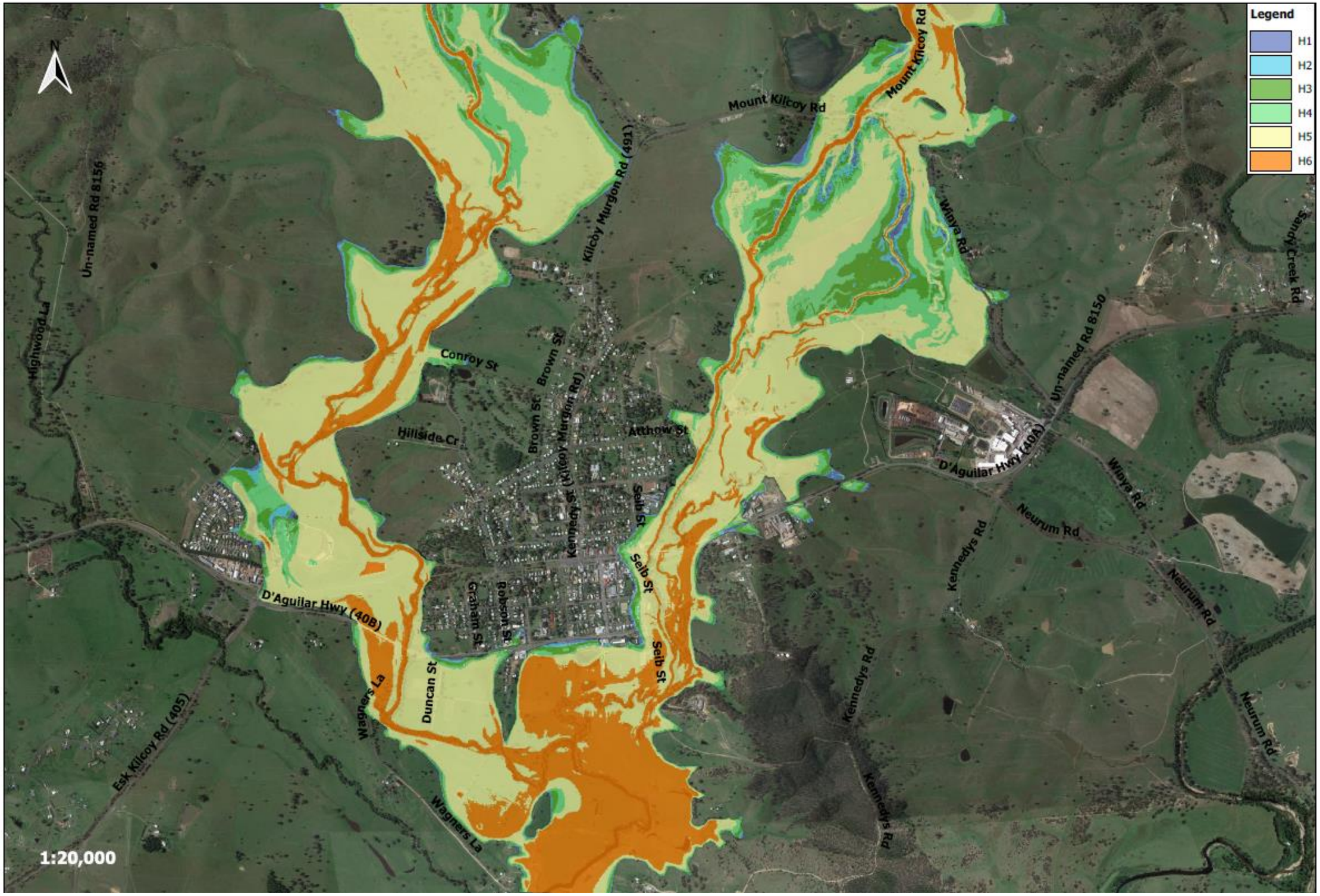

FIGURE 2-3 KILCOY 1 IN 2000 AEP HAZARD

FIGURE 2-4 KILCOY TOWNSHIP 1 IN 100 AEP HAZARD

FIGURE 2-5 KILCOY TOWNSHIP 1 IN 2000 AEP HAZARD

2.4 Potential Hydraulic Risk

Potential hydraulic risk (PHR) represents the hydraulic behaviour of floods and their likelihood to occur in a given floodplain. PHR is a useful tool to distinguish between degrees of risk (i.e. from low and high risks). For example, higher frequency higher hazard flooding requires special consideration due to the elevated risks of both characteristics.

The methodology in Section 4.2 of the Brisbane River Strategic Flood Management Plan Technical Evidence Report (BRSFMP TER) applies potential hydraulic risk across seven likelihood AEP events, providing a gradation of risk across five risk definitions. The mapping is sufficiently detailed to pick up different bands of risk areas across the floodplain regionally. The output is five bands of relative hydraulic risk, derived from a matrix combining seven flood events.

The SFMP HR matrix identifies five bands of risk (HR1-HR5), with HR1 being the highest hydraulic risk to HR5 being the lowest hydraulic risk.

This is intended to be used for regional riverine flooding, but it disproportionally overrepresents areas of higher hazard (HR1 and HR2) across local creek floodplains, due to the frequency of events mapped in these categories. Through project team workshops, it was determined that more refinement and detail was needed to distinguish between low likelihood and hazard. Examples of this include:

- Defining low likelihood flooding (1 in 10 AEP) that has low hazard (H2):
  - The SFMP method defines this as HR1 (the highest risk category being low likelihood).
  - While this is true, understanding why risk is so high is also important.
- Defining low likelihood flooding (1 in 10 AEP) with extreme hazard (H6):
  - The SFMP method defines this as HR1.

It is useful to distinguish between the two examples above, as the second situation has a much higher risk and should be mitigated in areas within this category. To differentiate between risk categories, a new matrix was adopted that provided a way to distinguish between floods driven by frequency and hazard.

Three broader subcategories are used, vertically splitting the matrix to align with the three consequence thresholds (AIDR hazard categories). This creates three sub-classifications within the HR1 to HR3 bands to reflect low hazard (H1), moderate hazard (H2-H4) and High hazard (H5-H6) within each HR band. The revised Hydraulic Risk matrix includes 10 discrete bands of risk.

The adopted Potential hydraulic risk matrix is shown below in Table 2-1.

TABLE 2-1 REVISED POTENTIAL HYDRAULIC RISK MATRIX

AEP	H1	H2	H3	H4	H5	H6
PMF	HR5	HR5	HR5	HR5	HR5	HR5
1 in 2000	HR5	HR5	HR4	HR4	HR4	HR4
1 in 500	HR5	HR4	HR4	HR3 (b)	HR3 (c)	HR3 (c)
1 in 100	HR4	HR4	HR3 (b)	HR2 (b)	HR2 (c)	HR2 (c)
1 in 50	HR4	HR3 (b)	HR2 (b)	HR2 (b)	HR1 (c)	HR1 (c)
1 in 20	HR3 (a)	HR2 (b)	HR2 (b)	HR1 (b)	HR1 (c)	HR1 (c)
1 in 10	HR2 (a)	HR1 (b)	HR1 (b)	HR1 (b)	HR1 (c)	HR1 (c)

The following can be derived from the new matrix:

- The (a) subcategories represent further distinction in catchments of a low hazard risk (i.e. of lesser consequence other than flood damage),
- The (b) subcategories represent the consequence range where there is risk to vehicles and life, and
- The (c) subcategories represent the consequence range where there is risk to structures.

It should be noted that hydraulic risk merely represents a portion of overall flood risk. Holistic flood risk includes a variety of other factors that are considered throughout the LFMP in conjunction with hydraulic risk.

The overview of the hydraulic risk output is shown in Figure 2-6 and Figure 2-7, and notes the following:

- Within the township there is a mix of hydraulic risk largely on the properties on Seib Street. These properties are exposed to HR4 hydraulic hazard
- The township is also widely exposed to HR5 flooding associated with the PMF event.

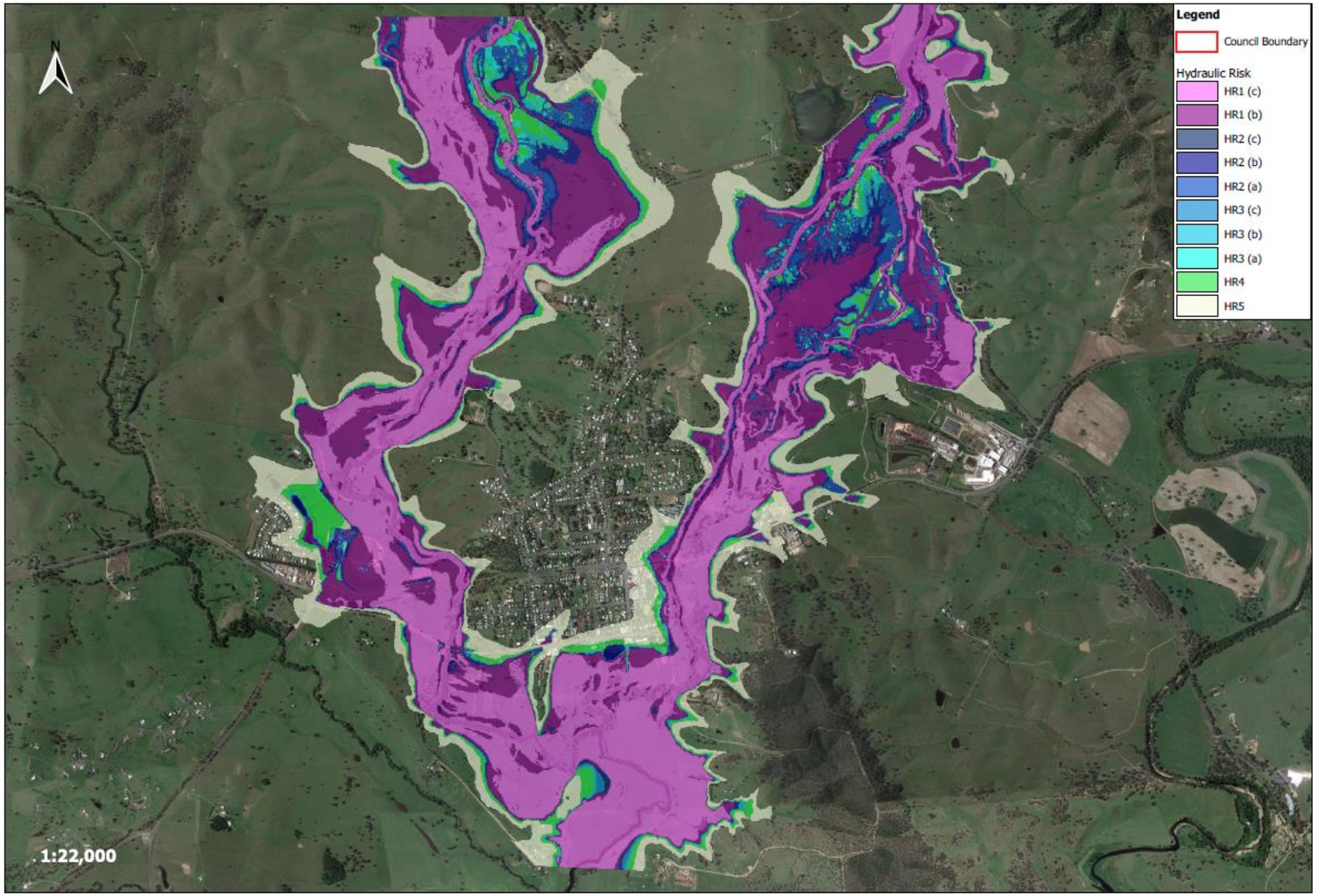

FIGURE 2-6 KILCOY HYDRAULIC RISK OUTPUT

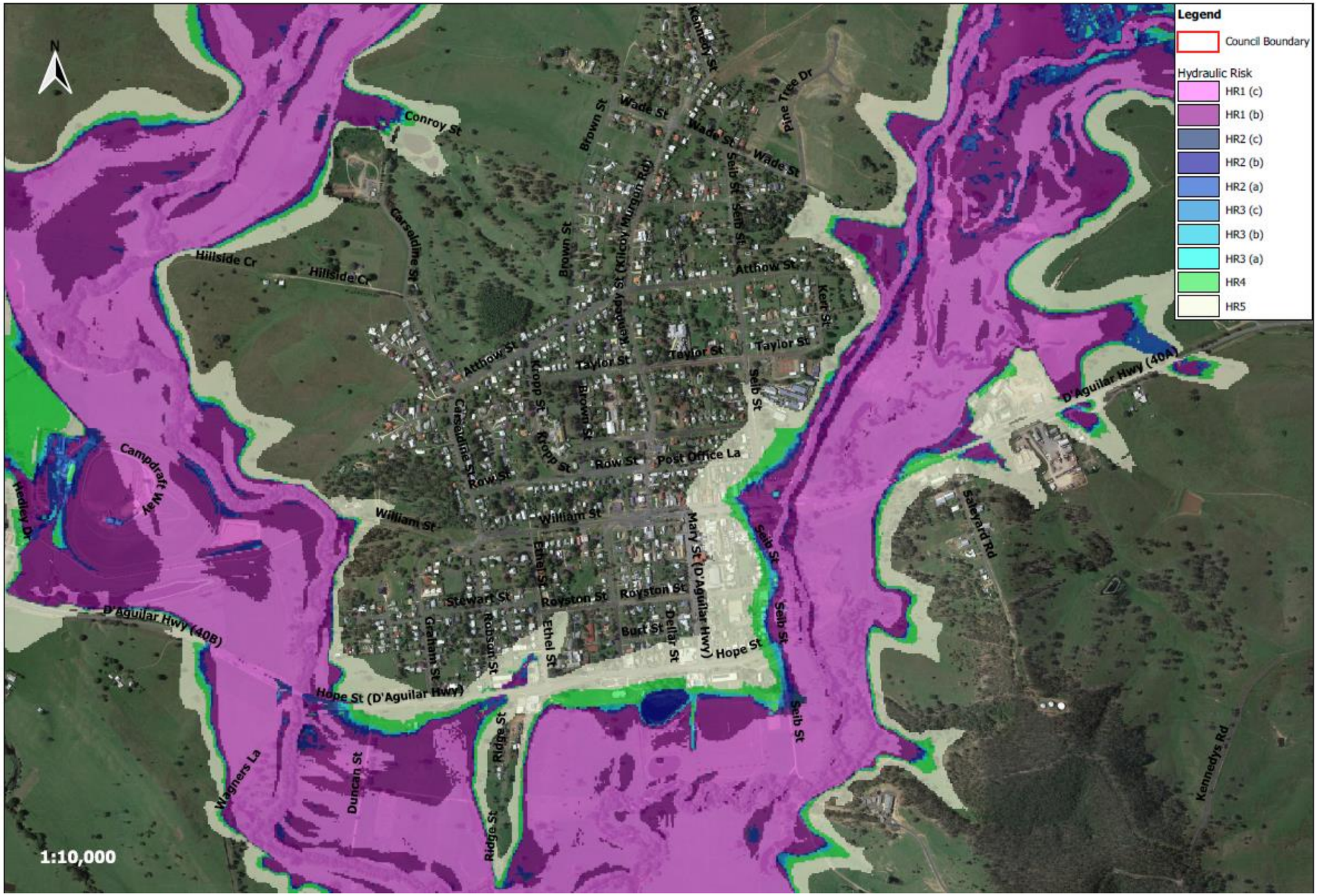

FIGURE 2-7 KILCOY HYDRAULIC RISK OUTPUT

2.5 Flooding and Climate Change in Kilcoy

The following provides a summary of the results of the Kilcoy hydraulic model that was used in the flood study:

- Inundation in the 1 in 100 AEP event affects residential dwellings in the east in the vicinity of Seib Street and in the south near Ridge Street.
- Several residences on Seib Street are inundated in the 1 in 20 AEP event.
- Recent development in Woolmar to the east of Kilcoy is located outside of the 1 in 100 AEP extent.
- The majority of the township is flood free in the PMF event.
- The model results suggest that the D'Aguilar Highway will regularly be flood affected in frequent events, however, ARR19 hydrology models tend to overestimate frequent flows therefore we consider that flooding of the highway will occur less frequently than the results suggest.
- The critical storm duration at Kilcoy was found to be the 360-min event.
- Maximum 1 in 100 AEP flood velocities across the model area tend to be less than 2.5 m/s.
- Hazard mapping for the town shows strong correlation to mapping developed by previous studies.

The climate change scenario considered as part of the Somerset Flood Study assessed an increase in rainfall intensity which was assessed based on the 1 in 100 AEP event. The climate change scenario was completed based on the guidance provided in Book 1, Chapter 6 of ARR2019. Specifically, this included a factored increase in rainfall intensity of 11.5% which is consistent with the 6.0 RCP to the year 2090.

The differences between the 1 in 100 AEP and 1 in 100 AEP plus climate change modelling results are displayed in Figure 2-8 for Kilcoy. The map is displayed in two halves to provide more of a zoomed in view of the extent affected in the township as well as the whole extent. The extent on the left shows a more zoomed out extent than the one on the right. Water levels increase up to approximately 210mm at the township, however the flooding extent is not markedly affected.

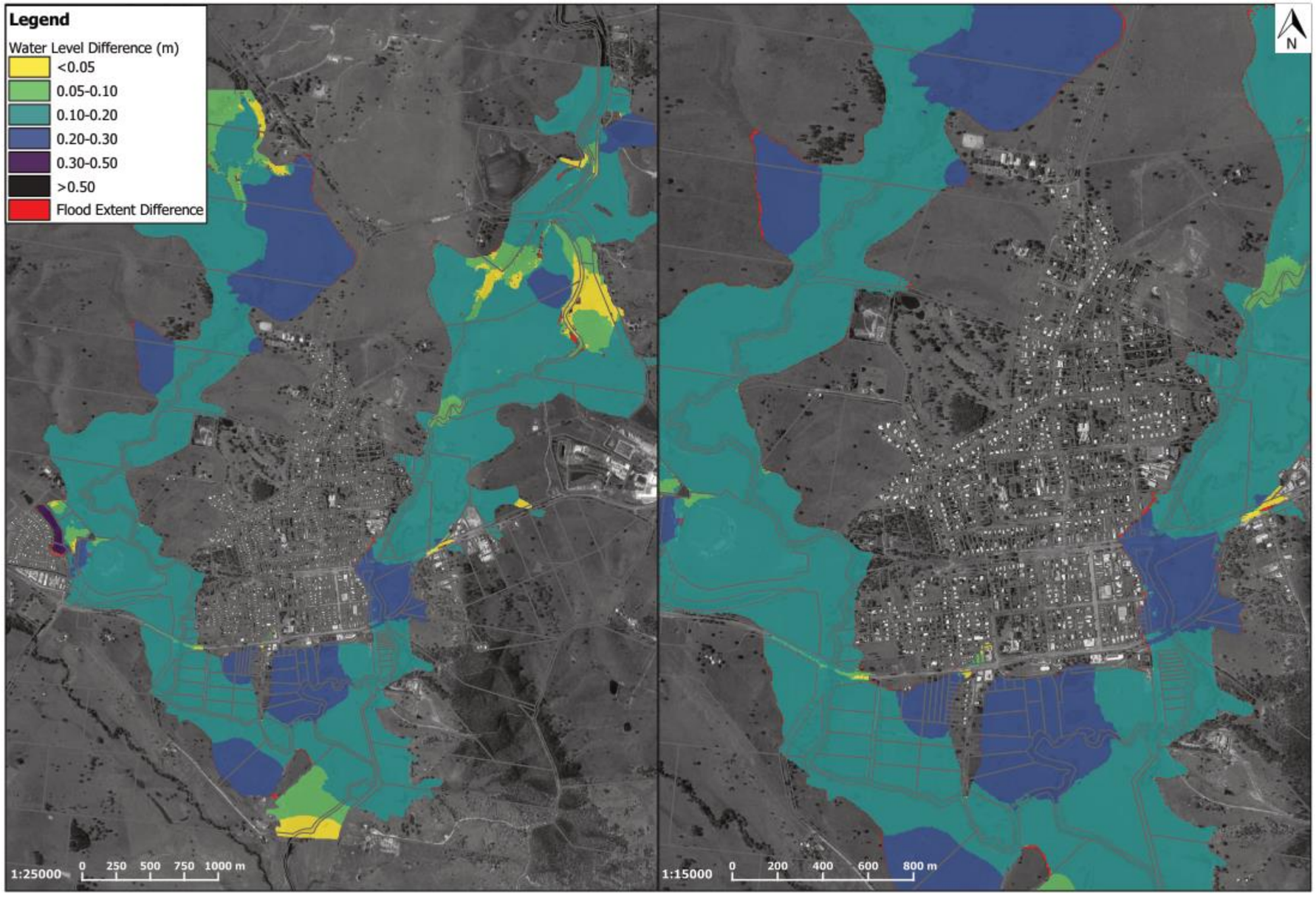

FIGURE 2-8 1 IN 100 AEP WATER LEVEL DIFFERENCE MAP FOR KILCOY

2.6 Current Flood Exposure

Understanding the multi-faceted nature of vulnerability and exposure is a prerequisite for determining how weather and climate events contribute to the occurrence of disasters, and for designing and implementing effective risk management strategies (Cardona et al. 2012). Therefore, it is important to not only map assets, buildings, and services, but also identify the community's vulnerability and exposure to flooding hazards.

This section explores the exposure of key built and community assets which are mapped within the floodplain, whereas later in the report, vulnerability of the community across the floodplain is summarised.

2.7 Building and Population Exposure

A spatial analysis of the land use zoning, buildings and flood information reveals the following exposure of existing land use across the Kilcoy area.

2.7.1 Building Use Type Exposure Summary

An analysis of land use exposure based upon planning scheme zonings has been undertaken across the Kilcoy Area and is shown in Table 2-2.

- The mapped extent of the floodplain reveals 85 detached residential buildings are exposed to flooding in the PMF event. There are only 9 properties within the 1 in 100 AEP extent.
- In the small event (1 in 10 AEP) there are very low numbers of houses inundated (3). These numbers only gradually rise to the 1 in 2000 AEP event.
- For the flooding exposure degree in relativity, there are somewhat larger numbers of community facilities flooded.

TABLE 2-2 OVERALL ZONE EXPOSURE GROUND LEVEL FLOODING

AEP	Residential (Detached)	Residential (Multi-Dwelling)	Rural Living / Primary Production	Commercial / Business	Industrial	Community / Public Facilities	Public Utility (Critical or Sensitive)	Mining	Other (Mixed Use)	Vacant^
1	-	-	-	-	-	1	-	-	-	-
2	-	-	-	-	-	3	-	-	-	-
5	-	-	1	-	1	13	-	-	-	-
10	3	-	1	2	2	14	-	-	-	-
20	7	-	1	3	2	14	-	-	-	-
50	8	-	1	3	4	14	-	-	-	-
100	9	-	2	4	5	15	-	-	-	-
200	11	-	2	6	5	15	-	-	-	-
500	14	-	5	6	6	17	-	-	-	-
1000	16	-	4	9	7	18	-	-	-	-
2000	20	-	12	9	10	21	-	-	-	-
PMF	85	-	47	39	20	24	-	-	-	-

** Does not include regional flooding stats*

^ Estimated by finding all lots zoned as Emerging Community, General Residential, Rural Residential or Township within the flood extent that do not have a house-sized building (>80sqm)

2.7.2 Residential Building Type

A building database for the entire Somerset LGA has been created for analysis for the Somerset LFMP. The database contains all building-scale information collated from Somerset Regional Council and the datasets from the Department of Natural Resources and Mines to calculate building floor level heights based on building classifications. The SFMP process for calculating floor level heights[2] has been applied to the buildings in the Somerset LGA. The building database documents building classification types, shown in Table 2-3.

TABLE 2-3 BUILDING CLASSIFICATION

Description	Category
Low set Single Story Slab on Ground	FDSS-SOG
Low set Single Story on stumps	FDSS - Stumps
Highset	FDHS
Low set Single Story (slab on ground)	FDDS
Single Storey	MUSS
Double or More Stories	MUDS

This database has been used in the Somerset LFMP for calculating existing and mitigated flood damages, screening properties potentially eligible for property specific actions and prioritising properties for evacuation. The database will be provided to Council for use after completion of the LFMP project.

Further analysis of the residential building types as identified in Table 2-4 reveals, minor differences in buildings affected in each flood event at ground level. For example:

- Between the lower magnitude events (1 in 1 to 1 in 10 AEP) there are only small numbers (up to 22) inundated in these more frequent events
- There is only a gradual increase in ground level inundation across most flood events
- There is a very large increase from the 1 in 2000 AEP to the PMF event

TABLE 2-4 RESIDENTIAL BUILDING TYPE EXPOSURE GROUND LEVEL

AEP (1 in X)	FDSS-SOG	FDSS-Stumps	FDHS	FDDS	MUSS	MUDS	Total
1	-	-	1	-	-	-	1
2	2	-	1	-	-	-	3
5	13	1	1	-	-	-	15
10	14	7	1	-	-	-	22
20	15	9	3	-	-	-	27

[2] As documented in the report Building Floor Level Heights – Brisbane Strategic Floodplain Management Plan – Brisbane LGA, Ipswich LGA, Somerset LGA and Lockyer Valley LGA dated 16/06/2017.

50	15	12	3	-	-	-	30
100	15	16	4	-	-	-	35
200	16	19	4	-	-	-	39
500	18	22	6	1	1	-	48
1000	21	27	6	1	1	-	56
2000	29	30	9	3	1	-	72
PMF	81	78	45	16	1	-	221

Note: Includes Rural Residential Buildings

Further analysis was undertaken to determine the number of and type of buildings with over-floor flooding:

- There are no properties exposed to over floor flooding in events all the way to the 1 in 100 AEP event. There are also very few numbers of flooded houses up to the 1 in 2000 AEP event (5).
- Over floor flooding increases substantially in the PMF event (20 times the number of houses than the 1 in 2000 AEP event).

TABLE 2-5 RESIDENTIAL BUILDING TYPE EXPOSURE OVERFLOOR FLOODING

AEP (1 in X)	FDSS-SOG	FDSS- Stumps	FDHS	FDDS	MUSS	MUDS	Total
1	-	-	-	-	-	-	0
2	-	-	-	-	-	-	0
5	-	-	-	-	-	-	0
10	-	-	-	-	-	-	0
20	-	-	-	-	-	-	0
50	-	-	-	-	-	-	0
100	-	-	-	-	-	-	0
200	1	-	-	-	-	-	1
500	2	3	-	-	-	-	5
1000	2	3	-	-	-	-	5
2000	2	3	-	-	-	-	5
PMF	49	36	18	4	-	-	107

2.7.3 Building Use Type Hazard Exposure

As presented in Section 2.7.3, there are no residential properties high risk flood categories. However, there are some commercial and community facilities in these categories.

- There are no residential properties exposed to the highest flood risk. There are however two community facilities exposed to the highest risk category.
- The total of 133 residential properties within the mapped extent of the floodplain.

Table 2-6 exposure information has been further refined to present the number of buildings within the floodplain and their relevant hydraulic risk.

Key inferences and considerations to be drawn from this information include:

- There are no residential properties high risk flood categories. However, there are some commercial and community facilities in these categories.
- There are no residential properties exposed to the highest flood risk. There are however two community facilities exposed to the highest risk category.

The total of 133 residential properties within the mapped extent of the floodplain.

TABLE 2-6 OVERALL BUILDING EXPOSURE

Building Type	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR 3(a)	HR4	HR5	TOTAL
Residential	-	-	-	2	1	-	2	2	8	71	86
Residential Multi-Dwelling	-	-	-	-	-	-	-	-	-	-	0
Commercial	-	-	-	2	-	-	-	1	3	33	39
Industrial	-	-	-	2	-	-	-		4	14	20

Building Type	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR 3(a)	HR4	HR5	TOTAL
Community and Public Facilities	2	3	-	3	6	-	-	-	4	6	24
Agriculture/Rural Living	-	-	-	-	1	-	-	-	4	42	47
Other	-	-	-	-	-	-	-	-	-	-	0
TOTAL	2	3	0	9	8	0	2	3	23	166	216

2.7.4 Suburb Building Exposure

Table 2-7 below shows the hydraulic risk exposure across all the suburbs in the Kilcoy flood model. As it can be seen, the suburb of Kilcoy has by far the greatest flood exposure primarily associated with the township population (other suburbs are rural in nature).

TABLE 2-7 SUBURB EXPOSURE

Suburb	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR3 (a)	HR4	HR5	Total
Kilcoy	1	-	-	4	1		2	3	17	113	141
Sheep Station Creek	-	-	-	-	-	-	-	-	-	1	1
Winya	-	-	-	2	1	-	-	-	4	13	20
Woolmar	1	3	-	3	6	-	-	-	2	45	60
Total	2	3	0	9	8	0	2	3	23	172	222

2.7.5 Population Exposure

Information about the population within the floodplain has been derived from the Australian Bureau of Statistics (ABS) 2016 census data. The equivalent census data to reflect building information (9 August 2017 Census) indicates a total population in Kilcoy of 1,898 people. For the exposure assessment, the existing residential building data is multiplied by the average equivalent residents per building for Kilcoy (2.6), as identified in Table 2-8.This shows the exposure of residential population per hydraulic risk category. The analysis shows:

- Almost 346 residents are mapped with the extent of the floodplain which indicates approximately 18% of the Kilcoy residents are exposed to flooding of some nature.
- There are only four residents in the highest five potential hydraulic risk categories of HR1(c) to HR2(a), and no residents in the highest risk categories.

Further analysis of the vulnerability of the exposed community is undertaken in the vulnerability section below.

TABLE 2-8 RESIDENTIAL POPULATION EXPOSURE

Building Type	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR3 (a)	HR4	HR5	TOTAL
Residential Buildings (combined)	0	0	0	2	2	0	2	2	12	113	133
Average Population	0	0	0	5	5	0	5	5	31	294	346

2.8 Critical and Sensitive Infrastructure

2.8.1 Critical Infrastructure Exposure

Critical infrastructure is an important component of flood exposure as this infrastructure performs an important life supporting role in flood events. It is critical to have infrastructure operational before, during and after flood events increases operational preparedness, response, and recovery significantly. The exposure analysis reveals there are three water infrastructure assets exposed to flooding within the datasets provided, shown in Table 2-9.

TABLE 2-9 CRITICAL INFRASTRUCTURE BUILDINGS EXPOSURE

Critical Infrastructure	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR3 (a)	HR4	HR5
Emergency management facilities	-	-	-	-	-	-	-	-	-	-
Water infrastructure	-	-	-	-	-	-	-	-	-	3
Total	0	0	0	0	0	0	0	0	0	3

2.8.2 Evacuation Centres

The following assessment of these buildings includes:

- The Kilcoy State School and Kilcoy Memorial Hall are not impacted by flooding (outside of PMF extent)

Further assessment of the evacuation centres and their overall flood risk is undertaken in the emergency management chapter of this report.

FIGURE 2-9 EVACUATION CENTRES

2.8.3 Sensitive Infrastructure

Uses that are 'sensitive' are considered as such due to the heightened risk associated with the inherent vulnerability of the occupants associated with that particular land use. For example, educational and childcare facilities are considered a sensitive use due to the vulnerability of children and elderly persons in flood events who may need assistance or emergency services to support evacuation.

As identified in Table 2-10, there are three educational facilities exposed to flooding within the supplied dataset. This flooding risk however is only within the HR5 category.

TABLE 2-10 SENSITIVE USE EXPOSURE

Sensitive Use	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR3 (a)	HR4	HR5
Childcare	-	-	-	-	-	-	-	-	-	-
Educational	-	-	-	-	-	-	-	-	-	3
Community Protection	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	3

3 FLOOD ISOLATION

Isolation caused by flood waters can be a major risk especially for long durations, or where critical services are cut-off or if persons isolated need emergency assistance and evacuation. Areas of isolation are an important element of overall flood risk that should have due consideration. The LFMP has undertaken an analysis of isolation to provide flood intelligence to plan for pre-emptive evacuations during flooding, resupply operations, strategic land use planning responses and for community education and awareness. Isolation can be used in combination with other flood risk factors to prioritise for flood risk management treatment and to ensure suitable future land uses are commensurate with the risk. This section describes the process of identifying flood islands, time to and duration of inundation.

3.1.1 Flooded Road Immunity

The analysis of flooded roads identifies the first event in which the road is inundated. An overview map of the flood immunity is presented in Figure 3-1. The flooded road immunity shows locations across the Kilcoy area which may be affected by poor road flood immunity.

FIGURE 3-1 FLOODED ROAD IMMUNITY

An example of a close-up view of an area with low road immunity is shown in Figure 3-2. This output can be extremely useful at a high level for identifying drainage infrastructure that is below immunity standard and for evacuation considerations (i.e. where key routes may require further investigation for upgrade). A key road shown with low road immunity (less than 1 in 1 AEP) is the D'Aguilar Highway crossing over Kilcoy Creek. This road may isolate the township during flooding.

FIGURE 3-2 KILCOY TOWNSHIP ROAD IMMUNITY

3.2 Time to Flood Inundation Information

The earliest time the road, building or asset is inundated with floodwaters is known as Time to Inundation. The data informs several outputs that contributes to the picture of flood risk across the Kilcoy area. The mapping produced uses time to inundation (TTI) information for a high-level understanding across each catchment, TTI for buildings flooded above floor level and TTI for roads flooded above low points.

Time to Inundation information is particularly useful to provide another factor in flood risk in areas such as evacuation, isolation and community awareness. TTI helps Council to understand exposed road assets and the need for earlier action on road closures. When coupled with other flood risk outputs is an incredibly important factor in determining flood risk. TTI information can and should also be used in future land use planning and strategic decisions regarding the appropriateness of settlement and designation of uses.

The emergency management chapter of the LFMP will explore the findings of this analysis. For example, flood intelligence could be used to develop and refine flood forecasting systems.

FIGURE 3-3 TIME TO INUNDATION (1 IN 2000 AEP) GROUND SURFACE

As it can be seen from Figure 3-3, TTI varies across the catchment dependent on:

- If the flood source is riverine, creek or overland flow/urban flooding,
- The location of the TTI (whether at the up or downstream sections of the catchment); and
- Interactions between multiple sources of flooding.

For the purpose of emergency management planning, a 1 in 2000 AEP can be considered the “worst case” TTI. The speed of inundation differs significantly to the 1 in 100 AEP and 1 in 2000 AEP primarily due to flood storages being depleted fast, less resistance because of lower roughness values on floodplains and an increase in velocity overall.

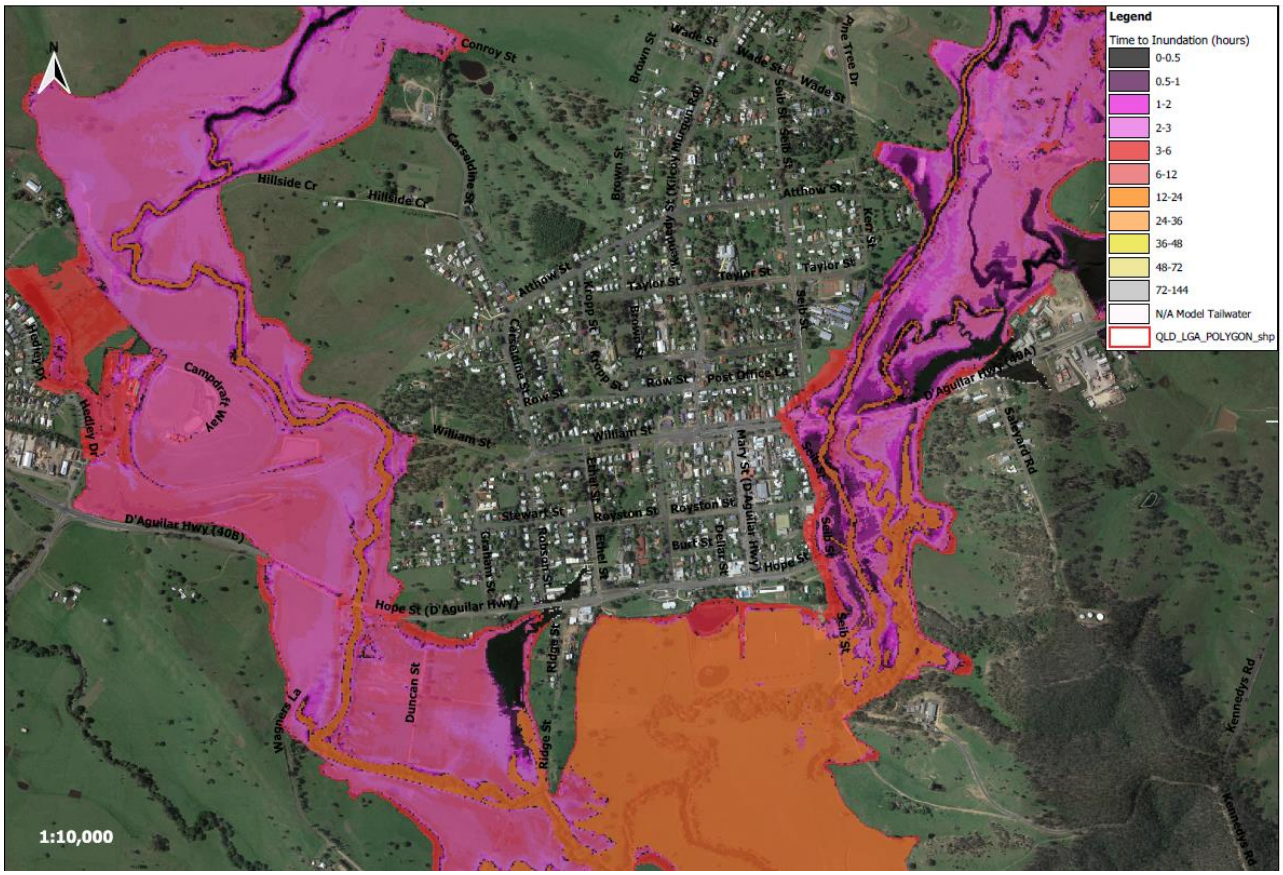

FIGURE 3-4 KILCOY TOWNSHIP CATCHMENT TIME TO INUNDATION (1 IN 100 AEP)

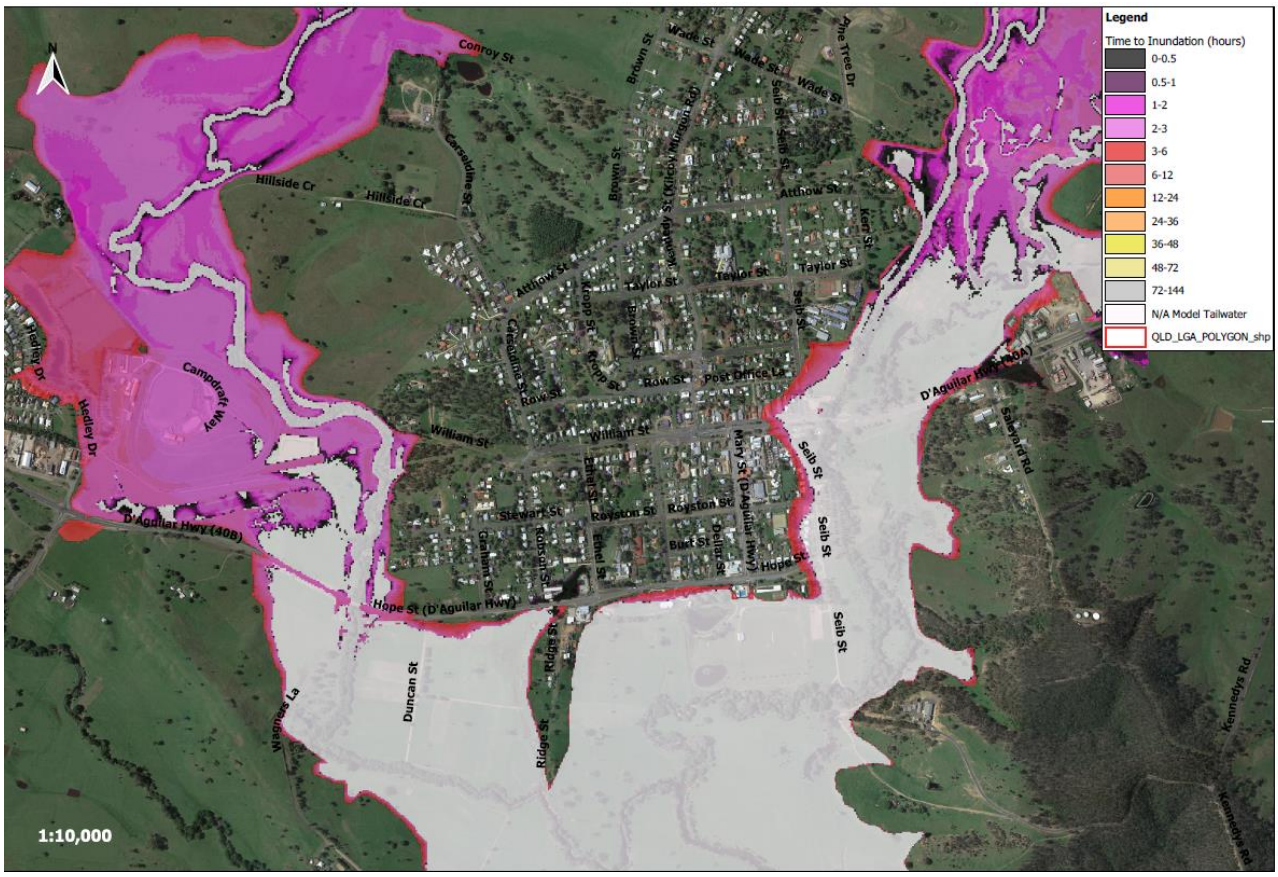

FIGURE 3-5 KILCOY TOWNSHIP CATCHMENT TIME TO INUNDATION (1 IN 2000 AEP)

Figure 3-4 and Figure 3-5 above in the Kilcoy township show the change in TTI between the 1 in 100 and 1 in 2000 AEP. As it can be seen, all areas of the floodplain decrease in TTI in the 1 in 2000 AEP. The differences between low and high magnitude flooding is an important concept to understand because as the TTI decreases, so does the overall flood risk due to less time for residents and emergency services to respond. In addition, high magnitude floods also have higher hazard further increasing and compounding flood risk.

The data shown in the mapping will provide Council further guidance on TTI in these areas, for example where TTI is as short as 1 hour for the 1 in 2000 AEP event. A short TTI is associated with short response times to react to impending floodwaters which may inhibit emergency response operations.

Across the Kilcoy area there are buildings and residents highly exposed to quite fast flood response times and short times of inundation above floor level. The raw GIS dataset provides TTI for all buildings and is a useful tool for Council to further investigate and understand these risks.

3.2.1 Time to Inundation Roads

TTI to roads within the Kilcoy township is shown in Figure 3-6. TTI is useful in determining which roads may flood first and is also useful in undertaking evacuation capability assessments. The emergency management chapter draws on this information to determine likelihood of evacuation capability by TTI of the road and the time taken to evacuate.

This information and the process used to determine the TTI would also be useful in future flood forecasting upgrades to provide real time and far more accurate assessments of road closures than simulated design flood events.

FIGURE 3-6 ROADS – TIME TO INUNDATION

As it can be seen from the figure above, many of the roads in Kilcoy are inundated very fast in a 1 in 2000 AEP event with most flooded within 2 hours.

3.2.2 Time to Inundation Property

The TTI for buildings is mapped in Figure 3-7. This dataset is useful in determining which properties may flood first, distinguishing different types of awareness and education required (flash flooding verse riverine). The emergency management chapter uses this information with other aspects (hazard and vulnerability etc) to help determine the priority overall of the most at-risk residents.

This information and the process used to determine the TTI would also be useful in future flood forecasting upgrades to provide real time and far more accurate assessments of road closures than simulated design flood events. The outputs produced whilst somewhat useful for background information, are static and do not align to real events. Combining this methodology with a forecast system would produce powerful intelligence that could help prioritise high risk properties during events.

FIGURE 3-7 BUILDINGS – TIME TO INUNDATION

Figure 3-7 shows a range of TTI values in the Kilcoy township, of note is the very fast inundation times associated with flooding that breakouts into the entire area. This emphasises that there is very little time to respond to flooding in this catchment for residents. Some of the houses along the Seib Street have inundation times of between 1 to 2 hours providing little time to respond during high magnitude flooding.

3.3 Duration of Flooding Inundation Information

Duration of flood inundation (DFI) has been identified by calculating the length of time water exceeds a certain level. This has been calculated using the same events as the TTI methodology, i.e. 1 in 10 AEP, 1 in 100 AEP and 1 in 2000 AEP.

As identified in Figure 3-8 and Figure 3-9, the following is noted:

- During the 1 in 100 AEP, flooding in the Kilcoy township has some duration of flooding up to 12 hours.
- During the higher magnitude floods (1 in 2000 AEP), flood duration increases up to 20 hours widespread but would not cause any resupply issues etc.

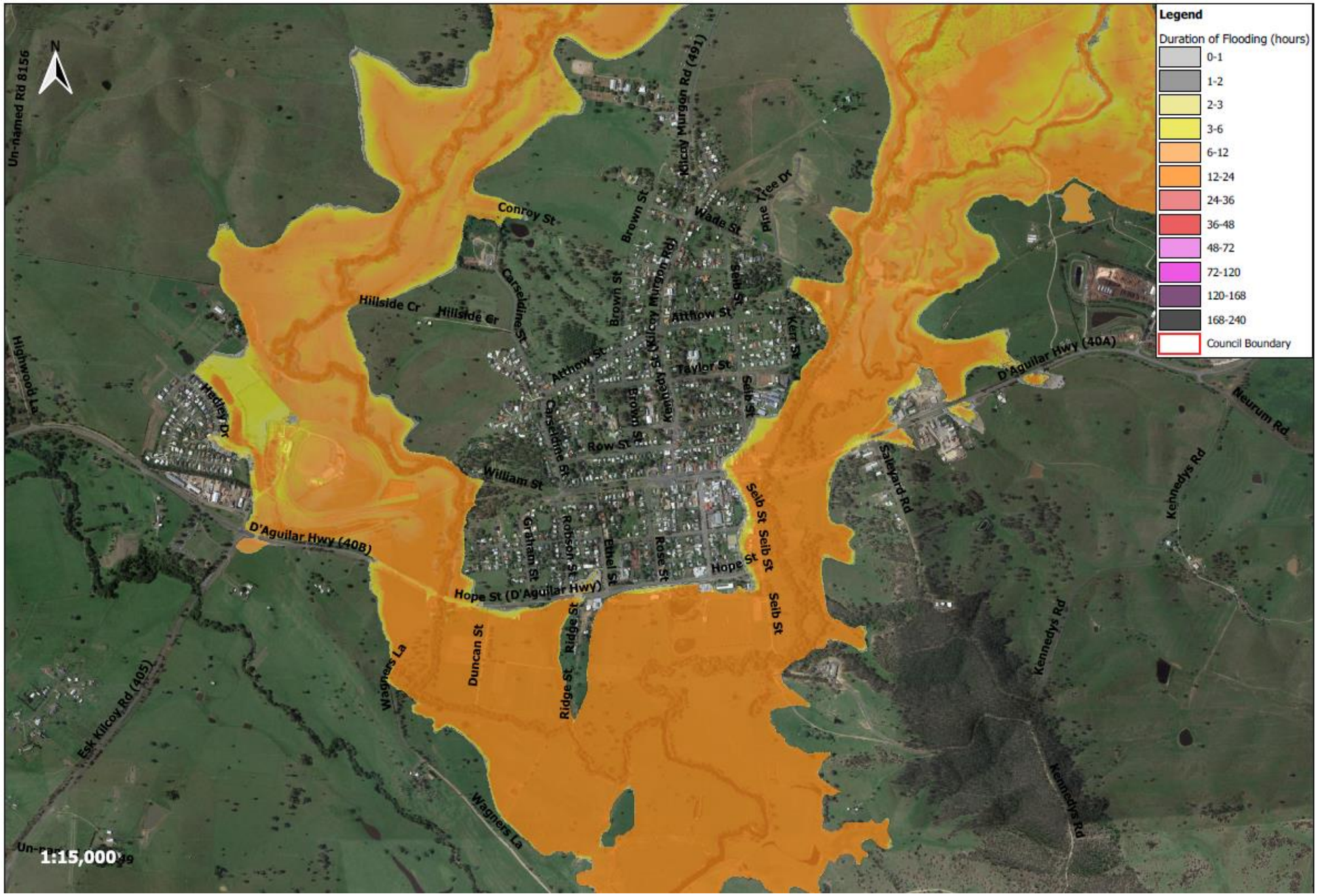

FIGURE 3-8 KILCOY DURATION OF INUNDATION 1 IN 2000 AEP

FIGURE 3-9 KILCOY TOWNSHIP DURATION OF INUNDATION 1 IN 100 AEP

3.3.1 Duration of Inundation Roads

Detailed duration of flood mapping can be found in the electronic data pack. Examples of duration of flood inundation time frames to roads is shown in Figure 3-10.

This dataset is useful in determining which roads will flood the longest and could be considered for approximate information of road closure times and preparation for opening.

This information and the process used to determine the duration of inundation would also be useful in future flood forecasting upgrades to provide real time and far more accurate assessments of road closures than pre-cooked “synthetic” flood events. The process would be useful in providing fairly accurate assessments within a forecast system of when roads are able to open again.

FIGURE 3-10 ROADS – DURATION OF INUNDATION ROADS

3.3.2 Duration of Inundation Property

Examples of duration of flooding to buildings is shown in Figure 3-11. The emergency management chapter uses this information with other aspects to help determine residents that are exposed to long timeframes of flooding (beyond 12 hours) and is used in combination with vulnerability to make further determination of residents that may require assistance because of these constraints.

In a similar fashion, this information could be used within a flood forecasting system to make fairly accurate assessments of residents that are exposed to long flooding duration above floor levels.

FIGURE 3-11 BUILDINGS – DURATION OF INUNDATION

The example above shows long times of inundation within the Kilcoy Township. There are some properties that are exposed to inundation timeframes of up to 20 hours which is worth noting with regards to the length of time residents may be exposed to dangerous flooding situations.

3.4 Flood Islands

Flood islands are a unique, complex, and relatively dangerous situation that can develop during flood events. Flood islands develop when servicing roads to areas are cut (often in multiple locations) and the area is then isolated with no means of vehicle transportation and restricted pedestrian mobility. An analysis of flood islands has been undertaken in the area of the Kilcoy township.

Two types of flood islands can develop during flood events: low and high flood islands as are shown below in Figure 3-12 and Figure 3-13.

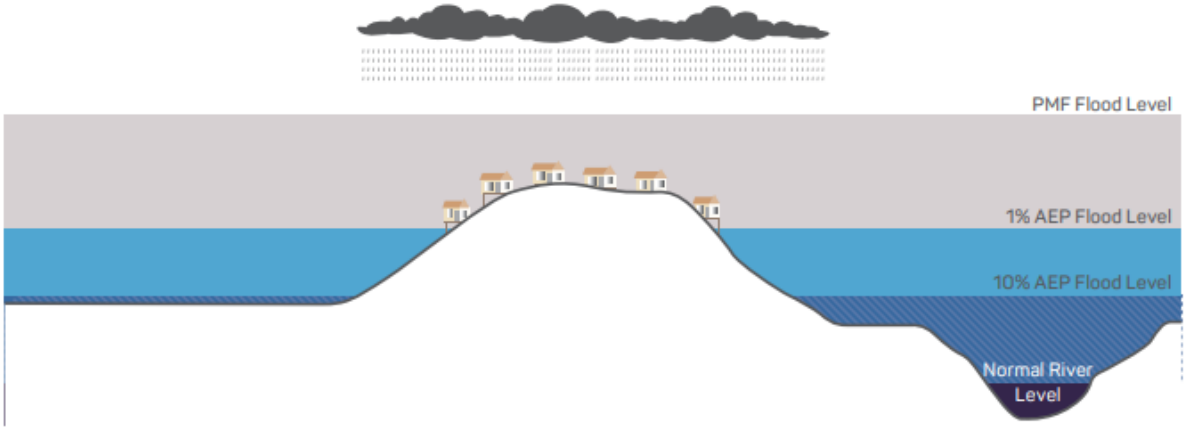

FIGURE 3-12 LOW FLOOD ISLAND (AIDR, 2017)

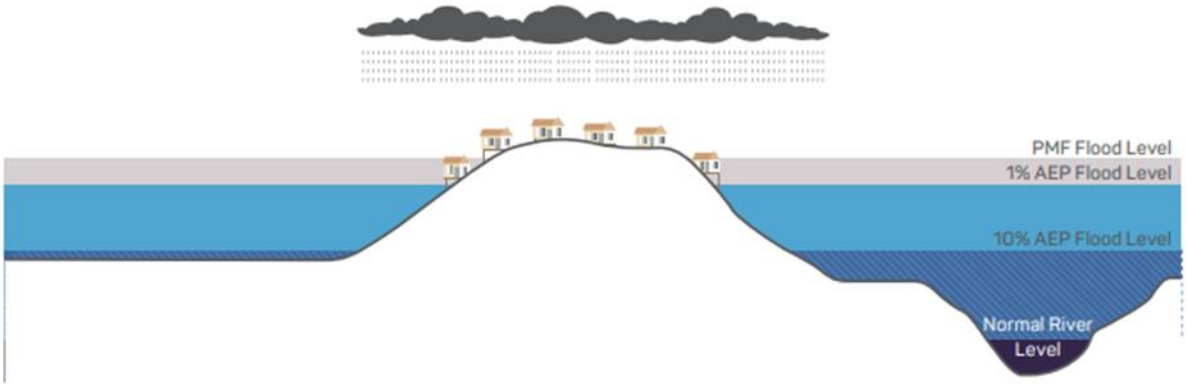

FIGURE 3-13 HIGH FLOOD ISLAND (AIDR, 2017)

3.4.1 Flood Island Distribution

Outputs of the flood island analysis areas are shown in Figure 3-14, these spatial data also contains further information on the respective AEP inundation events which can be useful in prioritising mitigation responses to flood islands combined with other outputs such as time to inundation, vulnerability and hazard.

Within Kilcoy there are 16 flood islands and one high flood islands. There are no buildings situated on low flood islands. The high island has some buildings located on it and is presented in Figure 3-14.

FIGURE 3-14 KILCOY FLOOD ISLANDS OVERVIEW

Figure 3-15 below shows an example of a high flood island at Russell Street. The island is very low risk high flood island characterised by:

- Ridge Street is only cut in the PMF event;
- The island does not submerge (a high island); and
- In high magnitude flood events, the island is trapped for up to 20 hours.

As the island is only trapped in the PMF event, this presents an extremely low risk and no further action is warranted.

FIGURE 3-15 EXAMPLE FLOOD ISLAND RIDGE STREET

4 VULNERABILITY

An assessment of social vulnerability is traditionally beyond a conventional risk assessment however is crucial for Councils to establish the characteristics of their population and their ability to respond to disaster such as a flood. Factors such as awareness, physical vulnerability, socio-economic vulnerability and mobility are social attributes that mostly strongly related to vulnerability during floods. There are many aspects of social vulnerability to flooding, but these four vulnerability indices have been considered (SFMP) in detail. This suite of vulnerability indices recognises demographic characteristics, socio-economic status, health and access to information.

4.1 Kilcoy Vulnerability

The vulnerability analysis highlights areas of the Kilcoy area that are highly vulnerable to flood events. This is an important concept to understand in a spatial context as it affects the community's capacity to respond to flooding and reduces the overall resilience. A proportion of the vulnerability indices across the Kilcoy township is shown in Table 4-1.

TABLE 4-1 PERCENTAGE OF KILCOY POPULATION THAT ARE VULNERABLE

Categories	Vulnerability Indices	% of Somerset LGA population	QLD Average
Physical vulnerability	Under 5 years	5.7%	6.3%
	Over 65 years	19%	15.1 in 50
	Lone person household	28.8%	23.5%
Social & Economic Vulnerability	Renting (house tenure)	36.7%	34.1 in 50
	Household income (<$650)	26.5%	19.5%
	Unemployed (seeking work)	5.7%	7.6%
Mobility Vulnerability	Without vehicle access	5.4%	6.0%
	One parent family	18.9%	16.5%
	Group households	4.6%	4.7%
Awareness Vulnerability	Speaks Language Other Than English (LOTE) at home	15.5	13.5%
	Without internet access	25.7	13.6%

Vulnerability indices have been calculated for the Kilcoy area, the relative values for each of the indices is mapped in in the figures below.

As identified in Table 4-2, highly vulnerable persons that represent the upper 20% of the relative vulnerability ranking for each indicator are exposed to hydraulic hazard. Population has been calculated by multiplying the number of buildings by 2.6 for the average population per household in Kilcoy. it is also assumed that all residents within each statistical area boundary (SA1) has the same degree of vulnerability. The distribution of exposure of vulnerable persons show:

- Overall, there are high vulnerability levels in Kilcoy, and there are large numbers of vulnerable people exposed to flooding.
- There are 12 people exposed to the highest flood risk category.

TABLE 4-2 HYDRAULIC RISK VULNERABLE PERSONS

Vulnerability Index	HR1 (c)	HR1 (b)	HR2 (c)	HR2 (b)	HR2 (a)	HR3 (c)	HR3 (b)	HR3 (a)	HR4	HR5	Total
Physical	3	0	0	5	0	0	5	5	29	143	190
Social and economic	0	0	0	0	0	0	0	0	0	0	0
Mobility	3	0	0	10	3	0	5	5	44	247	317
Awareness	3	0	0	5	0	0	5	5	29	143	190
Combined	3	0	0	5	0	0	5	3	36	140	192

4.1.1 Physical Vulnerability

There are 190 physically vulnerable people affected by flooding and 3 affected by the highest flood risk. Figure 4-1 shows the distribution of the most vulnerable people across the Kilcoy area affected by physical factors such as age and disability.

4.1.2 Social and Economic Vulnerability

There are 0 people that are classified as highly vulnerable due to socio-economic factors that are exposed to flooding. Figure 4-2 shows the distribution of the most vulnerable people across the Kilcoy area affected by social and economic factors such as household income and unemployment.

4.1.3 Mobility Vulnerability

There are 317 vulnerable people affected by flooding and 3 in the highest risk category. Figure 4-3 shows the distribution of the most vulnerable people across the Kilcoy area affected by mobility factors such as lack of vehicle access and group households with more than 5 residents.

4.1.4 Awareness Vulnerability

There are 190 vulnerable people affected by flooding. Figure 4-4 shows the distribution of the most vulnerable people across the Kilcoy area affected by awareness factors such as lack of access to the internet or language.

4.1.5 Combined Vulnerability

There are 192 people that are classified as highly vulnerable due to socio-economic factors that are exposed to flooding. Figure 4-5 shows the distribution of the most vulnerable people across the Kilcoy area affected by a combination of vulnerability indicators.

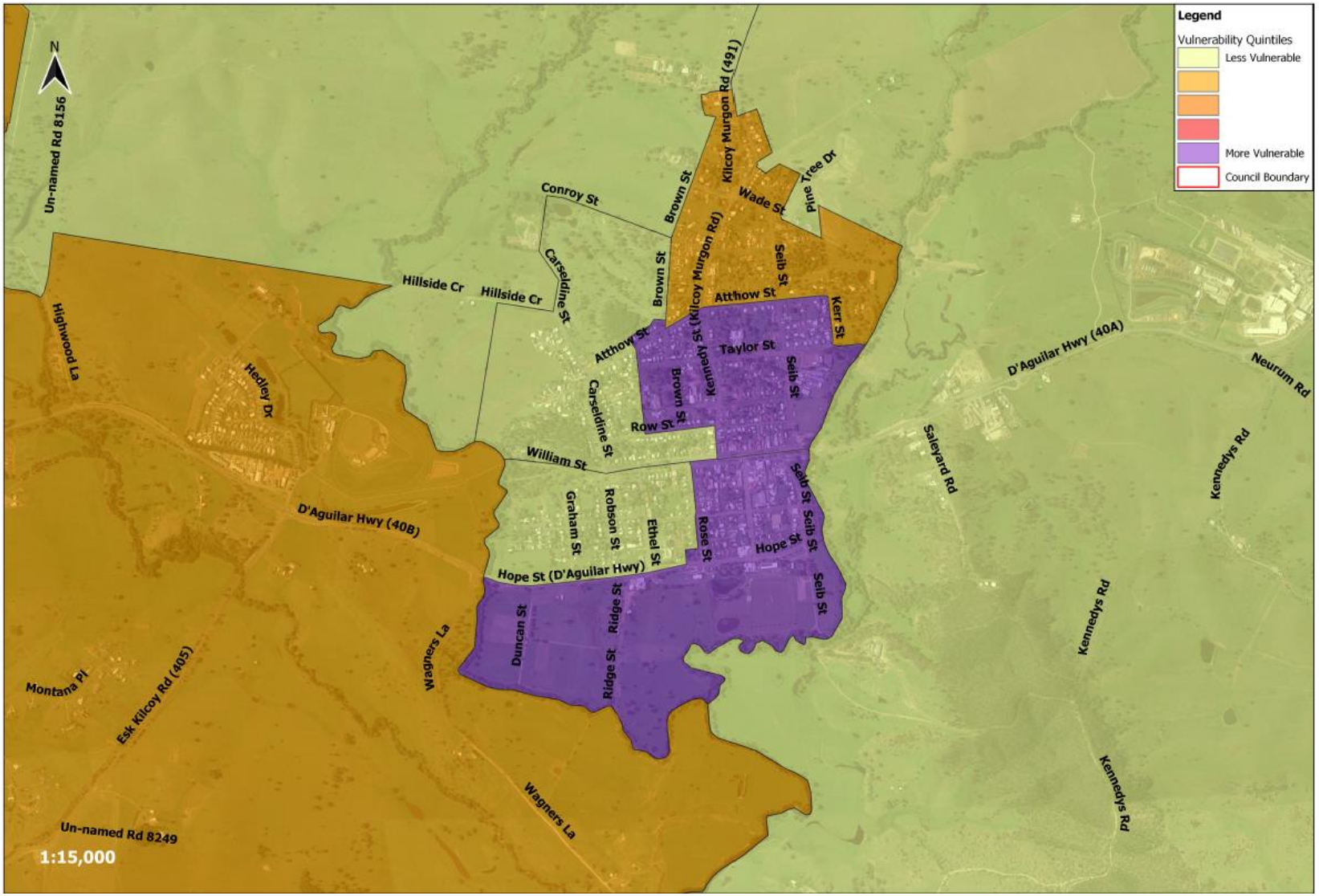

FIGURE 4-1 PHYSICAL VULNERABILITY DISTRIBUTION KILCOY TOWNSHIP

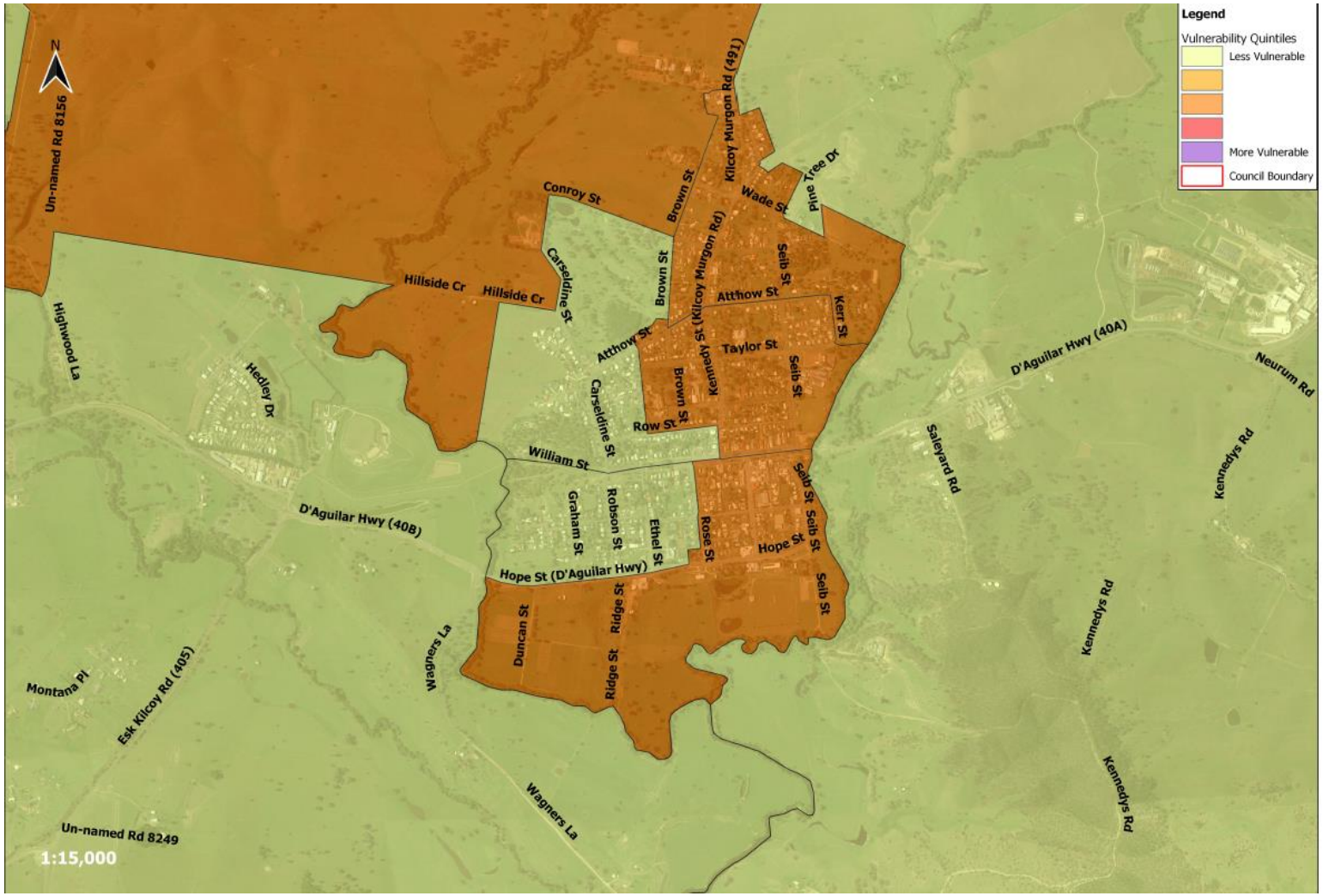

FIGURE 4-2 SOCIO-ECONOMIC VULNERABILITY DISTRIBUTION KILCOY TOWNSHIP

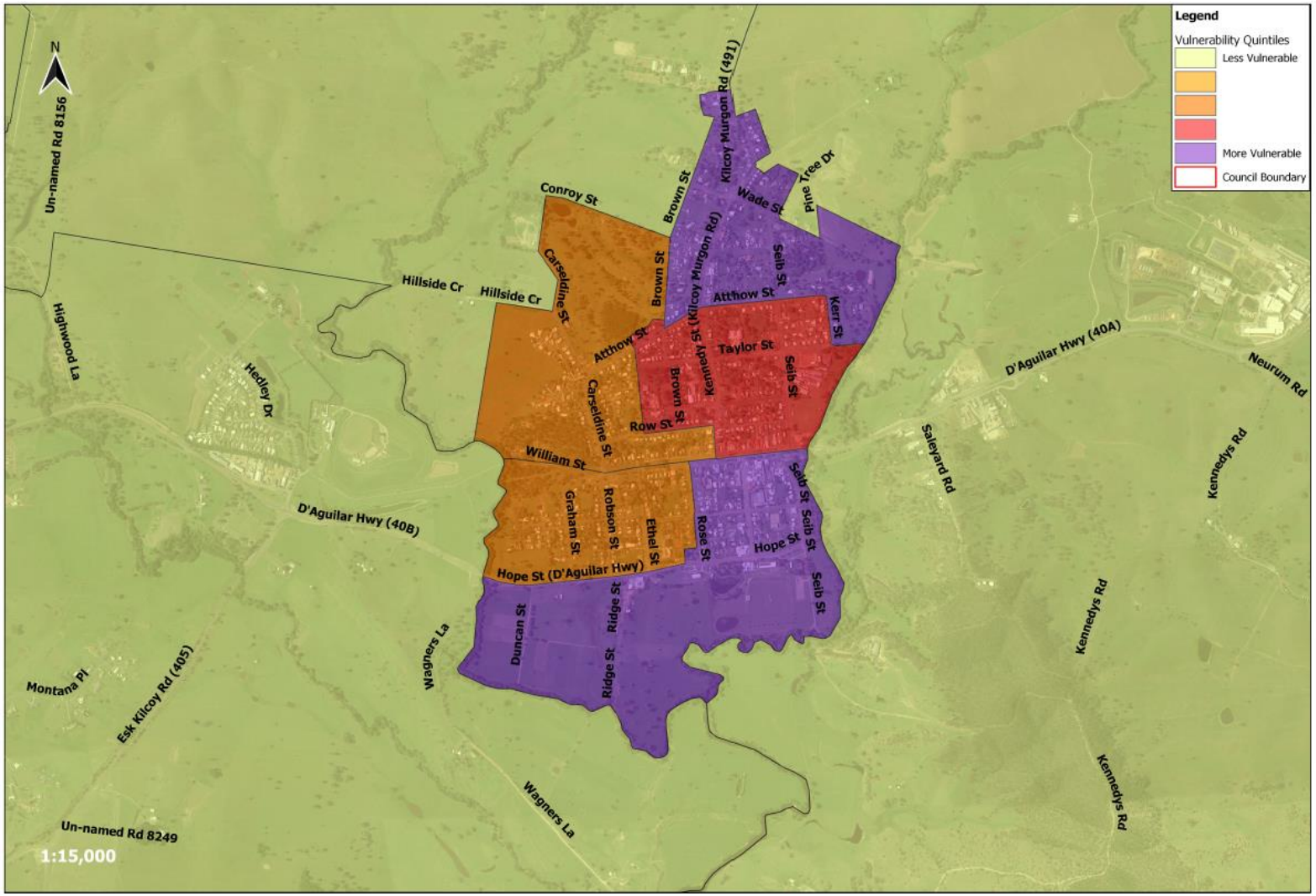

FIGURE 4-3 MOBILITY VULNERABILITY DISTRIBUTION KILCOY TOWNSHIP

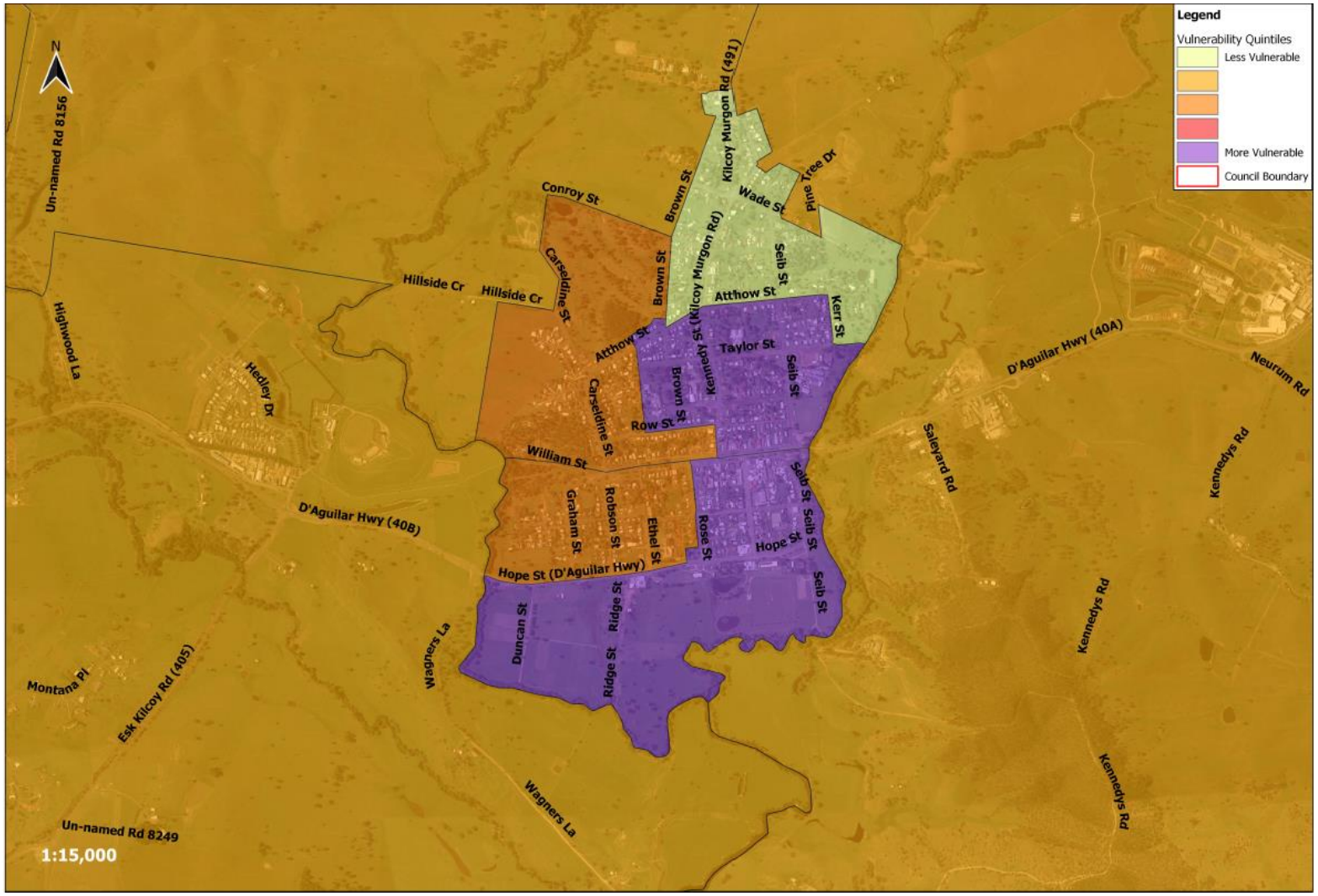

FIGURE 4-4 AWARENESS VULNERABILITY DISTRIBUTION KILCOY TOWNSHIP

FIGURE 4-5 COMBINED VULNERABILITY DISTRIBUTION

5 FLOOD DAMAGES

In order to maintain regional consistency and accord to the latest research and application within the flood damages space, the methodology used in the LFMP follows a similar process for categorising, analysing and displaying flood damages for the Somerset catchments to the SFMP[3]. For more details about how this method applies to the Somerset LGA, please refer to the *Somerset Regional Local Floodplain Management Plan Technical Evidence Report.* A summary of the method used, and the unmitigated flood damages results tables are provided in this section.

5.1 Existing Damage Overview

The following section presents the results of the damage assessment using the adopted SFMP methodology outlined in the TER report. Ultimately whilst total damages per magnitude of flood event is an important aspect to consider and understand, the Average Annual Damages (AAD) is the defining factor of how much flood damages are expected to cost the Kilcoy community each year on average.

Reducing these average annual damages is an important aspect of floodplain management to reduce the overall impact of flooding. This target is not an isolated goal; however, it is also is part of a multi-pronged approach to flood management across all work packages. Damages are used in the flood mitigation works and property specific actions prioritisation (where reducing damages is a primary aspect of these structural and non-structural measures) processes.

5.1.1 Residential Damages

The results of the total residential tangible damages and average annual damage calculations are shown below in Table 5-1 and Table 5-2. Of note in the residential damages is the following:

- There are no damages within the high frequency events (1 in 100 AEP and 1 in 20 AEP). Damages are very small in the 1 in 50 AEP but then climb considerably in the larger events.
- Damages increase threefold (3x) from the 1 in 50 AEP to 1 in 100 AEP event and then fourfold (4x) from the 1 in 200 AEP to 1 in 500 AEP.
- The average annual damages for direct and indirect damages for residential is $6,771 which overall is very small with regards to flood damages compared to other towns.

[3] For full refence to the research and application of the SFMP damages calculation method please refer to the *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report*

TABLE 5-1 TOTAL RESIDENTIAL DAMAGES

AEP (1 in X)	Direct Actual	Indirect	Total
1	$-	$-	$-
2	$-	$-	$-
5	$-	$-	$-
10	$-	$-	$-
20	$-	$-	$-
50	$6,800	$1,020	$7,820
100	$21,020	$3,153	$24,173
200	$62,388	$9,358	$71,746
500	$250,595	$37,589	$288,184
1000	$466,318	$69,948	$536,266
2000	$639,201	$95,880	$735,081
PMF	$17,051,154	$2,557,673	$19,608,827

TABLE 5-2 RESIDENTIAL AVERAGE ANNUAL DAMAGE

AEP (1 in X)"	Direct Actual	Indirect	Total
1	$-	$-	$-
2	$-	$-	$-
5	$-	$-	$-
10	$-	$-	$-
20	$-	$-	$-
50	$102	$15	$117
100	$139	$21	$160
200	$209	$31	$240
500	$469	$70	$540
1000	$358	$54	$412
2000	$276	$41	$318
PMF	$4,334	$650	$4,984
AAD	**$5,888**	**$883**	**$6,771**

5.1.2 Commercial and Industrial Damages

The results of the total commercial and industrial tangible damages and average annual damage calculations are shown below in Table 5-3. As it can be seen flood damages only begin to occur after the 1 in 100 AEP event. The PMF damages are extensive in comparison to the 1 in 2000 AEP event.

TABLE 5-3 TOTAL COMMERCIAL AND INDUSTRIAL DAMAGES

AEP (1 in X)"	Direct Actual	Indirect	Total
1	$-	$-	$-
2	$-	$-	$-
5	$-	$-	$-
10	$-	$-	$-
20	$-	$-	$-
50	$-	$-	$-
100	$-	$-	$-
200	$15,073	$8,290	$23,363
500	$67,222	$36,972	$104,195
1000	$133,288	$73,308	$206,596
2000	$187,068	$102,887	$289,955
PMF	$16,716,171	$9,193,894	$25,910,065

5.1.3 Other Building Damage

There are fairly significant numbers of other building damages as shown in Table 5-4.

TABLE 5-4 OTHER BUILDING TOTAL DAMAGES

AEP (1 in X)"	Direct Actual	Indirect	Total
1	$-	$-	$-
2	$-	$-	$-
5	$291,008	$160,054	$451,062
10	$940,810	$517,445	$1,458,255
20	$1,400,553	$770,304	$2,170,857
50	$1,703,228	$936,775	$2,640,003
100	$2,065,666	$1,136,117	$3,201,783
200	$2,380,738	$1,309,406	$3,690,143
500	$3,058,369	$1,682,103	$4,740,472
1000	$3,639,588	$2,001,773	$5,641,361
2000	$3,953,910	$2,174,650	$6,128,560

AEP (1 in X)"	Direct Actual	Indirect	Total
PMF	$11,271,498	$6,199,324	$17,470,823

5.1.4 Road Infrastructure Damages

The results of the road infrastructure damages are shown below in Table 5-5.

Of note, the road damages include:

- There are no classified major roads in the Kilcoy area which will reduce road damages significantly. The classification of major roads is defined by width parameters (usually split 2 lane etc). The D'Aguilar Highway whilst a major road, does not trigger the damage parameters for a major road.
- There are 85 kilometres of roads affected in total on the floodplain which in general is a considerable amount. There are damages in high frequency events (1 in 100 AEP and 1 in 50 AEP) indicating that some roads have very low flood immunity which is commonly associated with rural roads. In particular, the flooding in the 1 in 1 AEP and 1 in 2 AEP events adds significantly to the overall AAD of Kilcoy.

TABLE 5-5 ROAD DAMAGES

AEP (1 in X)"	Length of Minor Road (kms)	Total Damages	AAD
2	3.45	$260,719	$111,131
5	4.92	$371,988	$94,906
10	6.14	$463,822	$41,790
20	6.63	$500,725	$24,114
50	6.93	$523,965	$15,370
100	7.21	$544,936	$5,345
200	7.50	$567,088	$2,780
500	7.86	$594,149	$1,742
1000	8.13	$614,669	$604
2000	8.42	$636,145	$313
PMF	15.36	$1,161,241	$440
Total	85	$6,239,448	$298,536

5.1.5 Total Tangible Damages

Total Tangible damages have been calculated across the LFMP area and are shown below in the tables.

Of note, tangible damages include:

- Transport and other building damages make up the highest portion of flood damages and are substantially more than residential damages.
- Transport and other building damages make up significant proportions of damages in the frequent flood events

TABLE 5-6 TOTAL TANGIBLE DAMAGES

AEP (1 in X)"	Residential	Commercial-Industrial	Other Buildings	Transport	Utilities	Clean up	Total
1	$-	$-	$-	$183,805	$-	$13,785	$197,592
2	$-	$-	$-	$260,719	$-	$19,554	$280,275
5	$-	$-	$451,062	$371,988	$-	$61,729	$884,784
10	$-	$-	$1,458,255	$463,822	$-	$144,156	$2,066,242
20	$-	$-	$2,170,857	$500,725	$-	$200,369	$2,871,971
50	$7,820	$-	$2,640,003	$523,965	$587	$237,928	$3,410,353
100	$24,173	$-	$3,201,783	$544,936	$1,813	$282,953	$4,055,758
200	$71,746	$23,363	$3,690,143	$567,088	$5,381	$326,829	$4,684,750
500	$288,184	$104,195	$4,740,472	$594,149	$21,614	$431,146	$6,180,259
1000	$536,266	$289,955	$5,641,361	$614,669	$40,220	$534,185	$7,657,657
2000	$735,081	$289,955	$6,128,560	$636,145	$55,131	$588,365	$8,435,239
PMF	$19,608,827	$25,910,065	$17,470,823	$1,161,241	$1,470,662	$4,921,621	$70,643,240
AAD	**$6,771**	**$7,011**	**$399,016**	**$298,536**	**$508**	**$53,388**	**$765,263**

TABLE 5-7 TANGIBLE AAD

AEP (1 in X)"	Residential	Commercial-Industrial	Other Buildings	Transport	Utilities	Clean up	Total	%AAD
2	$-	$-	$-	$111,131	$-	$8,335	$119,467	15.61%
5	$-	$-	$67,659	$94,906	$-	$12,192	$174,759	22.84%
10	$-	$-	$95,466	$41,790	$-	$10,294	$147,551	19.28%
20	$-	$-	$90,728	$24,114	$-	$8,613	$123,455	16.13%
50	$117	$-	$72,163	$15,370	$9	$6,574	$94,235	12.31%
100	$160	$-	$29,209	$5,345	$12	$2,604	$37,331	4.88%
200	$240	$58	$17,230	$2,780	$18	$1,524	$21,851	2.86%
500	$540	$191	$12,646	$1,742	$40	$1,137	$16,298	2.13%
1000	$412	$197	$5,191	$604	$31	$483	$6,919	0.90%
2000	$318	$145	$2,942	$313	$24	$281	$4,023	0.53%
PMF	$4,984	$6,419	$5,782	$440	$374	$1,350	$19,374	2.53%
AAD	**$6,771**	**$7,011**	**$399,016**	**$298,536**	**$508**	**$53,388**	**$765,263**	

5.1.6 Total Intangible Damages

The total intangible damages were calculated in accordance with the SFMP method and are shown below for residential intangible damages below in Table 5-8.

TABLE 5-8 INTANGIBLE AAD

AEP (1 in X)"	Residential
1	$-
2	$-
5	$-
10	$-
20	$-
50	$5,474
100	$29,008
200	$121,969
500	$662,823
1000	$1,447,918
2000	$2,278,752
100000	$90,200,606
AAD	**$26,454**

5.1.7 Average Annual Damages

The final average annual damages have been calculated for the LFMP and are shown below in Table 5-9 and Table 5-10. Similar to past comments the following is noted:

- There are some damages in the very high frequency events associated with infrastructure damage. This information should be cross checked with the road immunity maps to pinpoint roads that do not have sufficient flood immunity to reduce flood damages. Other building damages also add significantly to the AAD values particularly after the 1 in 5 AEP event.
- The 1 in 5 AEP event has the highest AAD. This is associated with road damages and other building damage and may be a target for more attention if there are actual flood damages historically in this area to reduce the overall flood risk.
- Overall, the LFMP has shown a relatively high AAD of $791,716 for the size and extent of flooding in the area. Again however, the bulk of these damages are associated with road infrastructure and other buildings rather than residential damages (which are relatively low)

TABLE 5-9 TOTAL DAMAGES

AEP (1 in X)"	Tangible	Intangible	Total
1	$197,592	$-	$197,592
2	$280,275	$-	$280,275
5	$884,784	$-	$884,784
10	$2,066,242	$-	$2,066,242
20	$2,871,971	$-	$2,871,971
50	$3,410,353	$5,474	$3,415,827
100	$4,055,758	$29,008	$4,084,766
200	$4,684,750	$121,969	$4,806,719
500	$6,180,259	$662,823	$6,843,082
1000	$7,657,657	$1,447,918	$9,105,575
2000	$8,435,239	$2,278,752	$10,713,991
PMF	$70,643,240	$90,200,606	$160,843,846

TABLE 5-10 AVERAGE ANNUAL DAMAGES

AEP (1 in X)"	Tangible	Intangible	AAD Total
2	$119,467	$-	$119,467
5	$174,759	$-	$174,759
10	$147,551	$-	$147,551
20	$123,455	$-	$123,455
50	$94,235	$82	$94,317
100	$37,331	$172	$37,503
200	$21,851	$377	$22,229
500	$16,298	$1,177	$17,475
1000	$6,919	$1,055	$7,974
2000	$4,023	$932	$4,955
PMF	$19,374	$22,657	$42,032
AAD	$765,263	$26,454	$791,716

5.1.8 Individual Property Damages

Another powerful way to understand and leverage on the use of damages is to utilise the information available in the master database. This database has assigned AAD to each property and this can be used in a variety of ways to visually understand damage hotspots as shown below in Figure 5-1. This information is also being used in the property specific actions chapter to assist the prioritisation of flood resilient materials programs (as damage is the primary mechanism being targeted for mitigation). As it can be seen in Figure 4-1, the primary damages are within the Kilcoy township near Kilcoy Creek along Seib Street. These damages are relatively low for individual houses.

FIGURE 5-1 INDIVIDUAL RESIDENTIAL PROPERTY AVERAGE ANNUAL DAMAGE

6 KILCOY – OVERALL FLOOD RISK

Traditionally, flood risk has been defined by simplistic assessment based around frequency of flooding (level of immunity). Over time, flood risk assessments look at the consequence of these flood events such as an understanding of hazard across the floodplain.

Outputs of this project seek to extend the understanding and detail of flood risk factors which will further influence the responses to flood risk exposure of built assets and residents and ultimately inform a more refined and detailed understanding of overall flood risk.

By examining layers of flood risk information, appropriate mitigation response for any built asset or community can be identified. The master database built for the LFMP contains all the flood risk factors critical for this analysis.

This section provides a summary of the overall current flood risk by examining examples around Kilcoy. These examples consider critical infrastructure, sensitive institutions, and residential flood risks. The examples in this section show a combination of the following factors:

- Hydraulic Risk (combination of flood frequency and hazard);
- Vulnerability (special circumstances that introduce further risk through social and economic functions);
- Time to inundation (an understanding of how long it takes for an area, asset or residence to inundate);
- Duration of flooding (an understanding of how long an area, asset or residence may be flooded for); and
- Isolation (and understanding of whether residents are isolated on low or high flood islands).

This section also provides several limitations for due consideration when using the data presented in this report.

6.1 Seib Street Residential Area

An example of a residential use is shown in Figure 6-1. This shows the flood exposure of the Seib Street residential area. The area is exposed to medium risks overall however a handful of houses are exposed to a higher risk category of HR2 (b). It should be noted that during the 1 in 2000 AEP there are houses with very high flood depths of 1.8 metres of water in this flood event with a hazard rating of H4 (risk to life).

In addition, the following is noted about the area:

- The area is rapidly inundated during major events (6 hours in a 1 in 100 AEP and as short as 4 hours in a 1 in 2000 AEP event). This provides little warning or for emergency services to respond;
- The area is inundated during major events for extended periods (6 hours in a 1 in 100 AEP and 20 hours in a 1 in 2000 AEP event); and
- The area however has relatively low flood damages with the highest house having $1,300 annual average damage predictions.

Fortunately, the location is not on a flood island but has vulnerability issues with some residents with high combined vulnerability factors (primarily physical and awareness). The combination of short inundation times, relatively high hazard in some circumstances at some locations and in particular the high vulnerability makes this area high risk and special attention should be paid to this region as a priority.

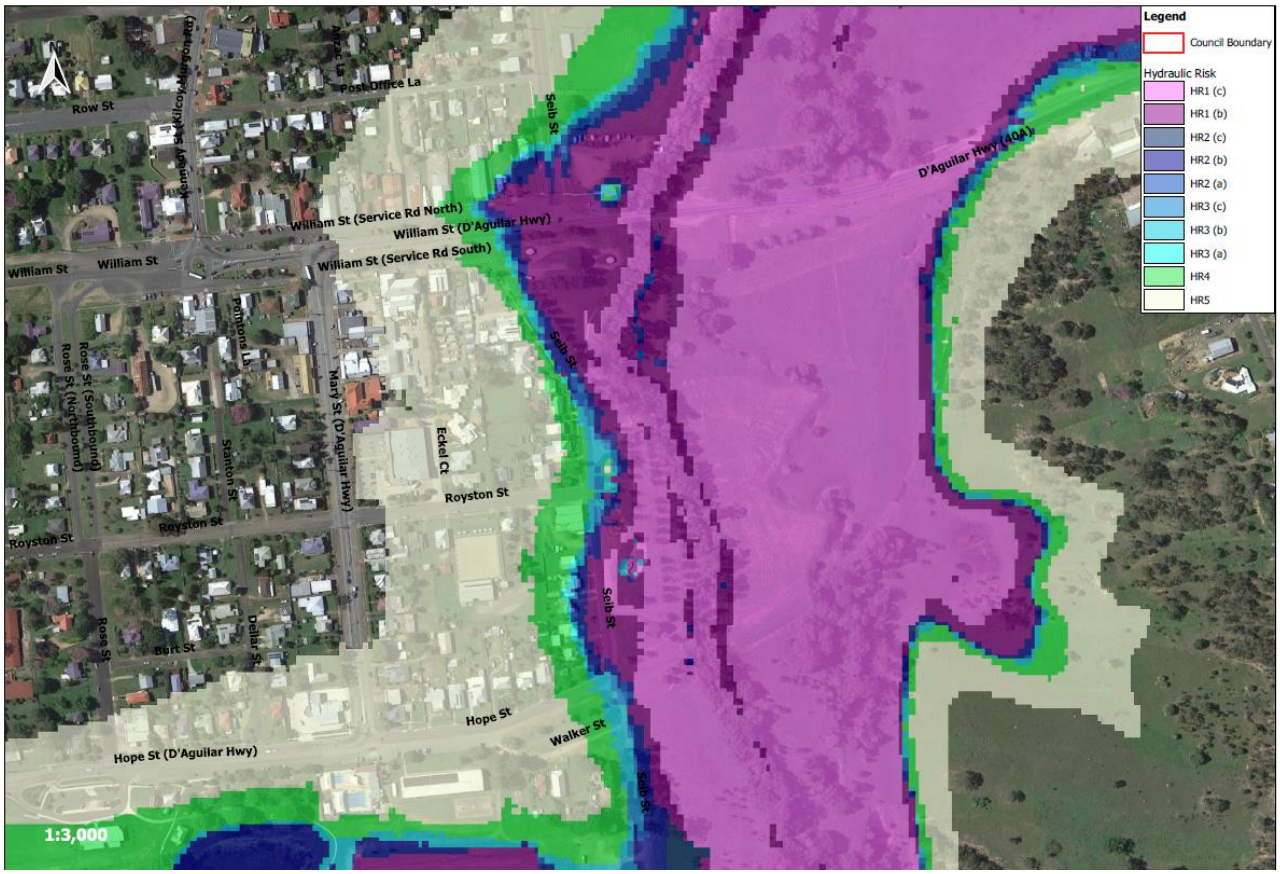

FIGURE 6-1 SEIB STREET AREA HYDRAULIC RISK

6.2 Kilcoy Showgrounds Area

An example of a commercial/sensitive use is shown in Figure 6-2 . This shows the flood exposure of the Kilcoy Showgrounds residential area. Whilst classified as unoccupied and non-residential, nonetheless special attention should be given to this high-risk area. The area is exposed to very high flood risks overall and the structures closest to the creek have the highest flood risk (HR1c) with the majority of the structures still in a high-risk category of (HR2a). It should be noted that during the 1 in 2000 AEP there are structures with very high flood depths of 2.3 metres of water in this flood event with high hazard of H5 (risk of structural failure).

In addition, the following is noted about the area:

- The area is rapidly inundated during major events (4 hours in a 1 in 100 AEP and as short as 3 hours in a 1 in 2000 AEP event). This provides little warning or for emergency services to respond.
- The area is inundated during major events for extended periods (11 hours in a 1 in 100 AEP and 13 hours in a 1 in 2000 AEP event).
- The area has high flood damages commercially in comparison to the rest of the Kilcoy area with some structures with a predicted AAD of $16,000 and more.

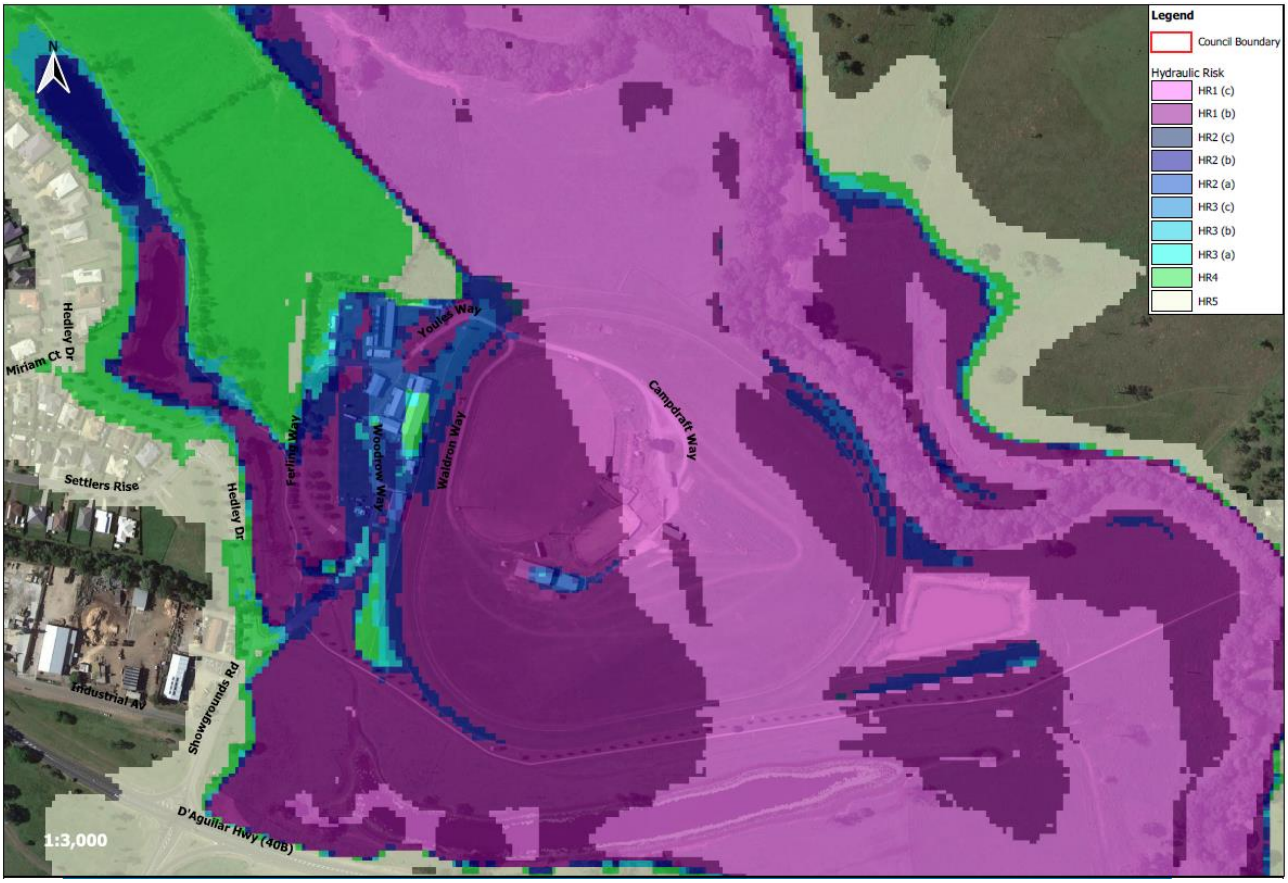

FIGURE 6-2 KILOCY SHOWGROUNDS AREA HYDRAULIC RISK

7 FLOOD MITIGATION MEASURES

This section presents the structural flood mitigation measures that were assessed through detailed flood modelling, damage assessment, costings, cost benefit assessment and multi criteria analysis. It should be noted that non-structural mitigation options are also presented in the property specific actions chapter and can be readily compared with the structural options.

7.1 Options Identified

The list of flood mitigation options identified for Kilcoy are shown below in Table 7-1. A description is also provided with a recommendation of whether further detailed assessment by Council should be undertaken. The mitigation options considered:

- Whether the option would be cost effective, i.e. the potential cost verse likely damages reduced. Large costs and small damage reduction would render the option not cost beneficial;
- The ability to significantly reduce flooding as these options are targeted for major regional flood events;
- Practicalities of design and construction and consideration of the likely impact to private property; and
- The residual risk from these potential assets and asset management burden to Council.

TABLE 7-1 OPTION ASSESSMENT

Option	Description	Comments	Detailed Assessment?
William Street Catchment	A known Council issue. Council has contemplated an easement with a low flow pipe.	This option was considered a localised drainage issue and not taken forward to assessment	No
Upstream Basin	Consideration of a large upstream basin to mitigate flow downstream in the township	The number of properties and size of the basin required would make this option not cost effective	No
Seib Street Flood Levee	This option involves construction of a small flood levee along Seib Street to protect several properties	This option was taken forward to detailed assessment.	Yes
Property Specific Actions	A program of works to be developed based on flood characteristic criteria and prioritising programs for flood resilient building materials and potential voluntary house purchase.	Further detail is provided in the Property Specific Actions chapter.	Yes

7.2 Options Analysis and Costings

A description and assessment of each of the Kilcoy Structural Flood Mitigation Options is shown below. For a full description of the process undertaken for this component please refer to the *Somerset Regional Local Floodplain Management Plan Technical Evidence Report*.

One option was assessed in detail for Kilcoy Township (Seib Street Flood Levee), which proceeded forward to a cost benefit assessment.

7.2.1 Seib Street Levee

An overview of the Kilcoy Township Levee at Seib Street is provided below and in Figure 7-1.

7.2.1.1 Description

This levee option is primarily aimed at restricting or removing the Kilcoy Creek breakout which floods some properties along Seib Street.

The components of mitigation option include:

1. An earthen levee along the western section of Kilcoy Creek to prevent flooding of urban properties

It is expected there may be some impact surrounding areas of the levee will be associated with a loss of floodplain storage.

FIGURE 7-1 LEVEE ARRANGEMENT

7.2.1.2 Flood Modelling Results

As it can be seen from the results presented in Figure 7-2, there is a large change to water levels and flood characteristics across the area and these include:

- Significant positive afflux (worsening) to the North east associated with the proposed levee. This afflux is a maximum of 50mm in the widespread areas. Locally around the levee there are increases of up to 200mm.
- There are two buildings that have an increase of approximately 40mm in the 1 in 100 AEP event.

- Six Properties along Seib Street having flooding totally removed in the 1 in 100 AEP event.

Overall whilst the number of properties provided flood mitigation is small, the cost of the levee will also be small and a cost benefit assessment is worthwhile. The impacts on private land in close proximity to this option will need to be considered further (including to residential buildings).

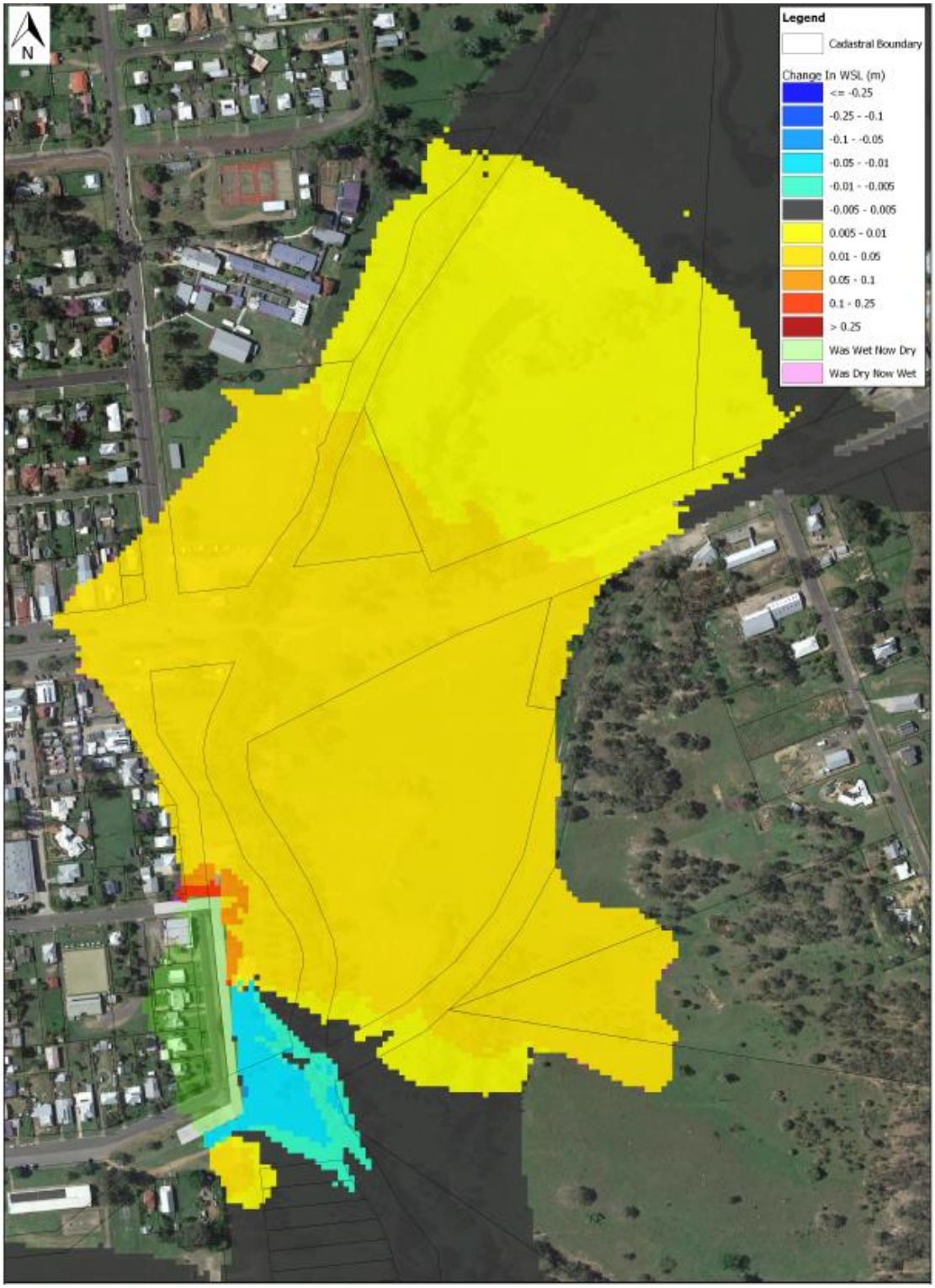

FIGURE 7-2 KILCOY OPTION 1 IN 100 AEP AFFLUX

7.2.1.3 Costings

The costs associated with the Kilcoy Township Option are shown in Table 7-2. The total cost for this project is estimated at $437,933.60.

TABLE 7-2 OPTION COSTINGS

Items	Unit	Quantity	Unit Rate ($)	Amount ($)
Clearing and Preparation	M2	2,000	8	16,000
Imported Earth Core	M3	3,380	40	135,200
Excavate and Replace Foundation	M3	200	80	16,000
Final profiling	M2	2,000	8	16,000
Spillway Rock	M3	50	250	12,500
Spillway Concrete	M3	20	300	6,000
Seeding and turf	M2	2,000	8	16,000
Retrofitting parks and property	item	1	30,000	30,000
Total Construction Cost				**$247,700**
Pre-Construction Items				
Mobilisation, Traffic Control, Erosion and Sediment Control, Environmental Plans and Setup	%	9		22,293
Design, Survey and Modelling	%	18		44,586
Project Management, Applications and other costs	%	9		22,293
Sub Total				**$89,172**
Total				**$336,872**
Contingency	%	30		$101,061
Grand Total				**$437,933**

7.2.1.4 Benefit Cost Assessment

The damages associated with a variety of flood events with the proposed mitigation in place has been simulated and the resultant reduction in AAD , shown in Table 7-3.

TABLE 7-3 OPTION BENEFIT RELATIVE TO CURRENT CONDITION

Option	Total AAD without option in place	Total AAD with option in place	Reduction in AAD	Option Benefit over 100-year lifespan (NPV)
Kilcoy Option 1	$791,716	$778,676	13,040	$186,154

When assessing the financial cost and benefit of the Kilcoy Levee Option, the benefit to cost ratio was found to be 0.07. As a result, the option does not return a large benefit from a flooding and economics point of view.

TABLE 7-4 BCR CALCULATION

Option Benefit over 100-year lifespan (NPV)	Total Capital Cost	Benefit / Cost Ratio (BCR)
$186,104	$437,933.60	**0.2**

Sensitivity of the parameters for this option included:

- The maintenance cost was reduced by half and this returned a BCA of 0.3
- Adjusting the discount rate to 4% returned a BCA of 0.42

A benefit cost assessment that show a BCR value of below 0.5 are not recommended to proceed as little economic benefit is provided. Based on the sensitivity testing also returning a value of below 0.5, the option is recommended not to proceed forward for further detailed assessment.

7.2.2 Multi Criteria Assessment

For flood mitigation options only costs and benefits are utilised to make determination of the overall scoring of mitigation options. The LFMP has followed the BRSFMP process to provide additional consideration of a wide range of tangible and intangible benefits and costs. The MCA is used to further assess and score the options to provide a further prioritised list for Council to consider.

TABLE 7-5 MCA ASSESSMENT

Criteria category	Criteria detail	Overall weighting	Kilcoy Levee Option
Safety of people	Reduce hydraulic risk rating (now and future)	18.8%	3
	Improve time for evacuation (now and future)	6.3%	2.5
Social	Targets vulnerable community members or areas	2.5%	3
	Social health benefits	1.5%	2.5
	Improves community flood resilience (now and future)	3.0%	3
	Recreation and amenity	1.5%	2.5
	Connection and collaboration	1.5%	2.5
	Community Attitude	2.0%	2.5
Economic	Reduce damages and costs to residential property (now and future)	9.0%	2.5
	Reduce damages and costs to business and industry (now and future)	5.0%	2.5
	Option likely to be cost beneficial (now and future)	6.0%	1.5

Criteria category	Criteria detail	Overall weighting	Kilcoy Levee Option
Feasibility	Physical / technical (now and future)	9.0%	2
	Legal / approval risk	5.0%	3.5
	Residual Risk/Asset Management	9.0%	2.5
Key infrastructure and transport	Improve availability and function (now and future)	5.0%	2.5
	Protection of regional water supply quality and security - catchment protection (quality and yield)	5.0%	2.5
Environment and natural resource management	Species impacts	2.0%	2.5
	Vegetation and habitat impacts	2.0%	2.5
	Ecosystem health and connectivity (fish passage/fauna movement)	2.0%	2.5
	Reduction in landscape salinity / improved moisture retention and groundwater recharge	2.0%	2.5
	Reduction in erosive capacity / soil movement - channel stability / geomorphology	2.0%	2.5

Overall, the option of the levee scores relatively low in all parameters due to the low damage's reduction. The following points are noted about this option:

- The option does protect against flooding for some residents.
- The option has scored low in the cost benefit analysis assessment, and damages score. These reflect the limited benefit of the option.
- The option scores lower in feasibility as it requires retrofitting of a park but higher in approvals due to limited issues in a levee of this size.
- The option does not provide any benefit to infrastructure and therefore scores neutral on this component.
- There is no impact to creeks and ecosystems, so a score of neutral was given to this aspect.
- Overall, the option results in no tangible benefit.

TABLE 7-6 MCA RESULT

Criteria category	No Change Value	Kilcoy Levee Option
Safety of people	0.63	0.72
Social	0.29	0.32
Economic	0.50	0.44
Feasibility	0.58	0.58
Key infrastructure	0.25	0.25

Criteria category	No Change Value	Kilcoy Levee Option
Environment & NRM	0.25	0.25
Total	2.49	2.55
Result		0.05

As it can be seen from Table 7-6, the Kilcoy option has a very low MCA score and combined with a very low BCA score clearly would not be recommended for further detailed investigation.

In addition to the overall scoring, Council would also be burdened with a potential referable levee, ongoing maintenance costs and residual risks associated with events above the 1 in 100 AEP and the impact of potential structural failure.

8 PROPERTY SPECIFIC ACTIONS

8.1 Introduction

While the onus to enact these measures will predominately reside with home owners within the region, Council can facilitate this process by considering the recommendations made at the end of this chapter; and will be effective when implementation is coordinated between the suite of flood mitigation options presented as a part of the floodplain management plan.

There are several actions house owners can take to increase flood resilience, including: residential property buy-back and voluntary purchase, house raising and flood-proofing (via retrofitting flood resilient building materials).

8.1.1 House Purchase

House purchase programs are costly to implement, and while applied to local government areas, reply on state and federal funding. These programs are used in areas that are susceptible to frequent and severe flooding, to mitigate the risk posed to life and property, referred to as property buy-back schemes, voluntary house purchase, or compulsory resumption programs.

8.1.2 Retrofitting Flood Resilient Materials

There are a range of building techniques and materials that can be retrofitted to homes in flood risk areas aimed at improving the resilience of buildings and their contents. Materials that are resistant to inundation damage such as double-brick, brick veneer, tiling or water-proof flooring and lining, water-resistant timber framing, closed-cell insulation, and eliminating cavities behind stairs and wall spaces. Also included is the movement of internal services such as electricity power points, air conditioning units and/or hot-water units above a certain flood level.

8.2 Methodology

Properties will be screened for their exposure to hazard, i.e. those properties that are subject to a higher hazard H5 and H6 in a 1 in 100 AEP event are exposed to potential structural failure and therefore will be put forward as suitable for voluntary house purchase.

The next group of properties which are exposed to habitable floor flooding in a 1 in 20 AEP will be screened for hazard. Those exposed to H1 to H4 hazard category in a 1 in 100 AEP will be suitable for potential retrofitting of resilient building materials.

The properties listed as suitable for either potential voluntary house purchase or retrofitting building materials will undergo a damages assessment to compare expected reductions in damages resulting from flooding after property specific actions have been implemented. The cost-benefit analysis uses flood damage assessment to determine the economic viability of an option.

8.2.1 Cost Benefit Ratio

Cost assumption

The median house price presented in Table 8-1 will be used to price a potential voluntary house purchase program and used to assess the cost benefit to Council.

TABLE 8-1 MEDIAN HOUSE PRICE BY SUBURB IN SOMERSET LGA

Locality	Median house price[4]
Kilcoy	$272,500

The expected cost of retrofitting materials to create resilient buildings has been established by NCEconomics as part of the Brisbane River SFMP program. The following information presented in Table 8-2 shows the average cost per m^2 to establish a resilient building. The cost of 'like for like' rebuilding and incremental cost of resilient build from the study by NCEconomics is shown below:

TABLE 8-2 THE COST OF LIKE FOR LIKE REBUILDING AND THE INCREMENTAL COST OF RESILIENT BUILD

Building type	Average Cost[5] per m2
Fully detached single story on stumps (FDSS – stumps)	$239
FDSS – stumps (raise)	$401
Fully detached single story – slab on ground (FDSS – SOG),	$171
Fully detached double story – slab on ground for the bottom floor only (FDDS – SOG)	$171

These costs will be used to assess whether retrofitting building materials is an economically viable option for Council.

Benefits

An estimate of the reduction in average annual damage (AAD) will be calculated for the whole catchment over the lifetime of a property. The assumptions for AAD reduction are based upon the NCEconomics study as part of the Brisbane River SFMP program. 70% reduction of internal damages will be applied to each residential building and aggregated across the study area. Table 8-3 shows the classification of flood damage which would be reduced by retrofitting building materials.

TABLE 8-3 CLASSIFICATIONS OF FLOOD DAMAGE REDUCED BY RETROFITTING BUILDING MATERIALS

Building Type	Internal[6]	External	Structural	Indirect	Intangible
FDSS – Stumps	70%	No	No	Partial	Partial
FDSS - SOG	70%	No	No	Partial	Partial

8.3 Results

No properties in Kilcoy passed the eligibility criteria for both the voluntary house purchase program and the building resilient materials program and therefore have no economic viability.

8.3.1 Voluntary House Purchase (VHP)

Potential voluntary house purchase (VHP) of residential buildings has been considered across the Kilcoy township. The implementation of a VHP program could be considered across the Somerset LGA as a whole, the methods and results presented in this report are for consideration only.

[4] Source: Realestate.com.au date: 25th June 2020
[5] Cost per m2 assumption from NCEconomics study for the Brisbane River SFMP (2016)
[6] Reduction to AAD assumption from NCEconomics study for the Brisbane River SFMP (2016)

In the Kilcoy township there are 0 residential buildings that are exposed to both frequent flooding (i.e. 1 in 10 AEP) and high hazard categories in a 1 in 100 AEP (H5 or H6).

At the time of writing, VHP would not be an effective measure of removing people and property from the risks of flooding including reduction in damages including partial and intangible damages in Kilcoy. The lots do not have the potential to be turned into open space and an enjoyable recreational area for residents. The assessment of this could however change in the future and the social impact of removing homes would need to be considered by Council on a case by case basis. A benefit cost analysis was therefore not carried out, and more information on the methodology can be found in the *Somerset Regional Local Floodplain Management Plan Technical Evidence Report* document.

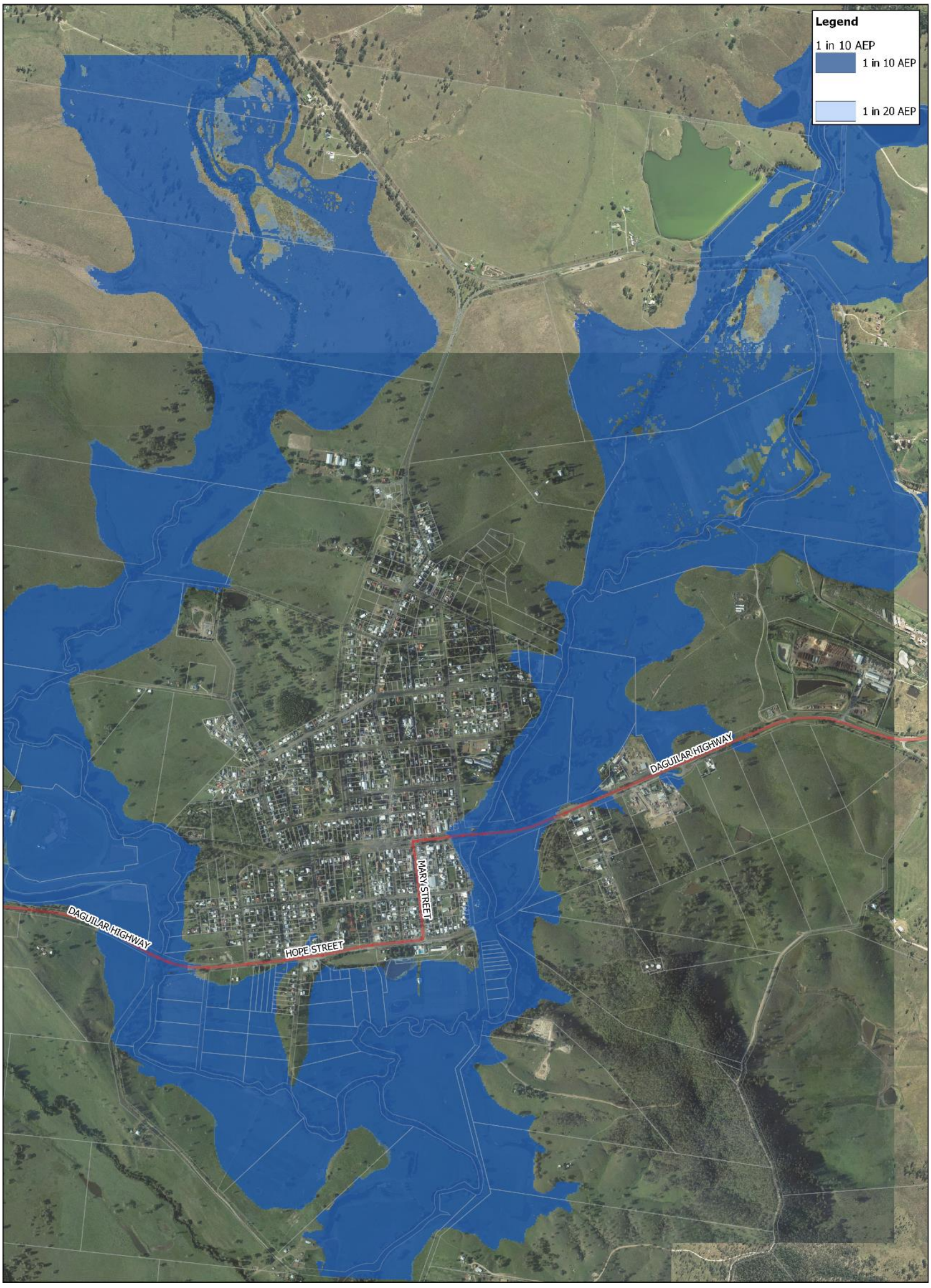

FIGURE 8-1 MAP SHOWING NO PROPERTIES POTENTIALLY ELIGIBLE FOR PROPERTY SPECIFIC ACTION IN KILCOY

8.3.2 Retrofitting building materials

Retrofitting building materials to residential buildings exposed to flooding risks has been considered in Kilcoy. The implementation of a Resilient Building Materials program must be considered across the Somerset LGA as a whole. In the township of Kilcoy there are 0 residential building that are exposed to both frequent flooding (i.e. 1 in 20 AEP) and lower hazard categories in a 1 in 100 AEP (i.e. H1 to H4), therefore a benefit cost analysis could not be calculated. Please refer to the *Somerset Regional Local Floodplain Management Plan Technical Evidence Report* for more information on the methodology.

8.4 Summary of Property Specific Actions in Kilcoy

A detailed economic assessment of property specific actions, considering the reduction annual average damages (AAD) was not undertaken in Kilcoy as there were no potentially eligible properties.

The following recommendations are put to Council for consideration as part of a wider floodplain management strategy for Kilcoy and the Somerset LGA:

- Continue to monitor flood risk information in Kilcoy and carry out another screening of properties potentially eligible for property specific actions.

9 EMERGENCY MANAGEMENT

Effective floodplain management planning requires a vast array of consideration and implementation of different techniques and tools to reduce flood risk to a tolerable or acceptable level. Measures such as flood mitigation aim to remove the risk altogether whereas emergency management measures are aimed at providing management techniques to better prepare and respond to flooding.

Emergency management overall is a complex arrangement through local government, state and federal government and is centred around PPRR: prevention, preparedness, response and recovery. Whilst the scope of this project is limited, the datasets used, have the opportunity to help increase the preparedness, planning and response to flood events.

9.1 Introduction

The scope of the LFMP has been limited in the emergency management and community awareness components. Further detailed investigation would be required to provide useful outputs in the flood forecasting and intelligence space, evacuation planning and in particularly the community awareness component.

It is recommended that Council use the outputs of this project to further inform scope in these areas particularly in specific high flood risk areas to target.

9.2 Flood Forecasting and Intelligence

The process to determine a suitable flood forecasting and intelligence system is based on the level of risk in each township. Ultimately, a flood forecasting system in each LFMP area would be ideal, and this should be the end goal for Council where resources and funding become available. Further information is available in the *Somerset Regional Local Floodplain Management Plan Technical Evidence Report.*

9.2.1 Flood Forecast System Assessment

The township of Kilcoy has the following characteristics when assessing its suitability towards the required flash flooding system:

- The Kilcoy township is not inundated to a major degree below the 1 in 100 AEP which reduces the risk with the frequency of flooding.
- There are several properties inundated in the 1 in 100 AEP but isolated to the area along Seib Street primarily.
- During the 1 in 2000 AEP flooding within the Kilcoy township increases but is not widespread.
- There is a rapid time to inundation for all properties in the floodplain making warning and evacuation difficult.

Because of the level of hazard and number of properties, an advanced warning system is likely not required and a low or medium risk system sufficient for this catchment. Caution should be applied outside of the township however for isolated properties impacted during flood events.

9.2.1.1 Low Risk Flash Flood Warning System

As above, a low risk flood warning systems can be implemented as part of the deliverables in the LFMP using the developed rainfall and road trigger mapping as shown in Figure 9-1. This simplified method utilises the road deck heights as a reference point.

A full suite of rainfall and water level trigger maps for the Kilcoy Creek bridge have been provided in the electronic data pack for immediate use during flood events.

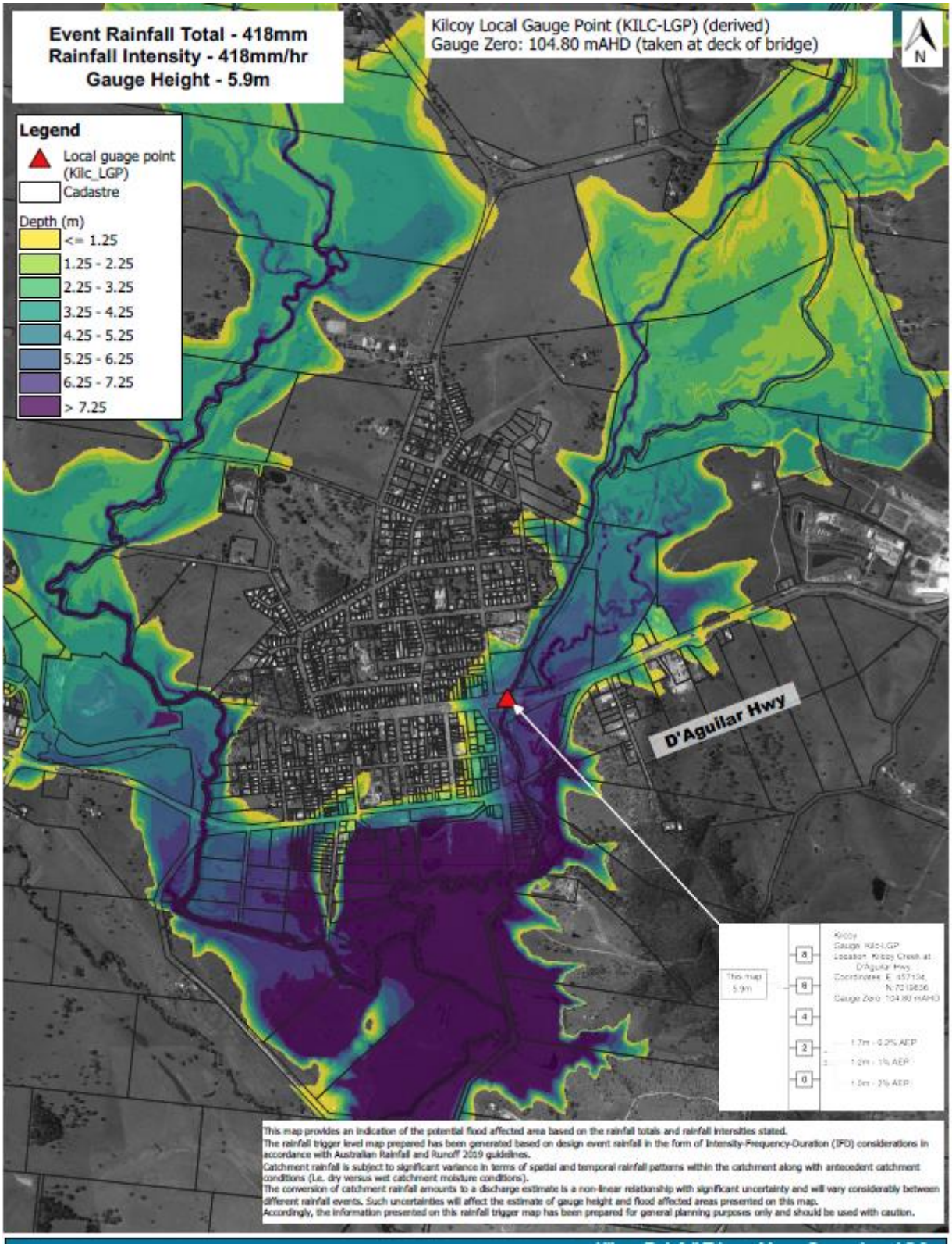

FIGURE 9-1 RAINFALL AND WATER LEVEL TRIGGER MAP KILCOY TOWNSHIP

9.2.1.2 Future Medium Risk Flash Flood Warning System

In order to increase the reliability, sophistication and responsiveness of the low risk system, the following measures could be implemented:

- Construction of a rain and river gauge on Kilcoy Creek at the D'Aguilar Highway. This gauge will then be able to reference the rainfall intensity and predicted flood levels for each type of event. Alternatively, another rain gauge could also be provided higher in the catchment to determine spatial variation of rainfall. Similarly, a water level gauge could be installed in other parts of the catchment, however the level trigger maps would also need to be changed.
- Utilising the rainfall and water level trigger maps developed for this project and linking these to the gauge data in the future. In the interim, the maps have been developed to use the bridge deck as a reference.
- Using the flood intelligence developed as part of this project to indicate high risk properties and associate these with the rainfall and water level trigger maps.

In the context of relative flood risk (compared to other catchments), the low risk system may be sufficient to respond to the threat of flooding in this area. The upgraded medium risk system is however recommended to provide further flood intelligence.

9.3 Evacuation Prioritisation

The major component of scope for emergency management was the identification and development of an evacuation screening and prioritisation approach. It is important to understand the limitations and risks during evacuation and consider:

- Evacuation is limited by resources and needs to be targeted to the highest risk properties and prioritised.
- Flood events are response based due to the complexities of events and how they pan out during the event.
- Evacuation is often far more dangerous than sheltering in place due to being swept away in floodwaters etc and the hazards and complexity associated with human behaviour during events.
- Sheltering in place (if safe to do so) is often the recommended measure during flood events because of the complexities and risks associated with evacuation. It is also preferable for many reasons that people stay at home, with friends and not in formal evacuation centres.

In the first instance effective flood warning and intelligence must be provided to the community to enable members to voluntarily evacuate. It is always preferable that residents stay with family and friends outside of flood areas well before flood events happen. This requires effective warning, forecasting and flood intelligence measures as well as community awareness and education programs which is outside of the scope to develop these aspects for the project.

Whereby residents have not evacuated, the complexities of evacuating entire suburbs are made clear by the sheer numbers and resources required. Whilst this is the overall preference where significant risk is involved, this project has documented a prioritisation method to attempt to locate properties at great flood risk due to a number of factors (flood hazard, vulnerability and warning time).

9.3.1 Evacuation Screening Process

The screening process developed and explained within the LFMP TER has prioritised the following property triage locations. The distribution of properties is shown below in Figure 9-2.

It was noted that there were five properties that had a very high risk with regards to fast inundation and very high hazards.

TABLE 9-1 PRIORITISATION RESULTS

Screen	Detail	Number of Properties	Priority
1	1 in 2000 AEP H5|H6	0	High
1a	1 in 2000 AEP H5|H6 and TTI <6 hours	0	Higher
1b	1 in 2000 AEP H5|H6 and Vulnerable	0	Higher
1c	1 in 2000 AEP H5|H6and TTI <6 hours and Vulnerable	0	Highest
2	1 in 2000 AEP H3|H4	5	Medium
2a	1 in 2000 AEP H3|H4 and TTI <6 hours	5	High
2b	1 in 2000 AEP H3|H4 and Vulnerable	0	High
2c	1 in 2000 AEP H3|H4 and TTI <6 hours and Vulnerable	0	Higher
3	1 in 2000 AEP H1|H2	0	Low
3a	1 in 2000 AEP H1|H2, low set property, longer than 6 hours flooding	0	Medium
3b	1 in 2000 AEP H1|H2, high set property, longer than 12 hours flooding	0	Medium
3c	1 in 2000 AEP H1|H2 and vulnerable	0	High

FIGURE 9-2 EVACUATION PRIORITISATION LOCATIONS

9.4 Evacuation Centre Assessment

Evacuation centres are a critical element of preparing, responding and recovery from flood events. Whilst it is preferential for residents to take up shelter with family and friends, this is not always possible and high flood risks in areas may also prevent residents from navigating to relatives' homes. Thus, establishment of secure and safe evacuation centres becomes critical as a last resort to protect and houses residents during floods.

9.4.1 Evacuation Centres in Kilcoy

Council have established two evacuation centres in the Kilcoy township at the following locations:

- Kilcoy State School 47 Royston Street Kilcoy; and
- Kilcoy Memorial Hall corner Kennedy and McCauley Streets Kilcoy.

These evacuation centres are shown below in Figure 2-9. The centres are congregated on the western side of Kilcoy Creek.

FIGURE 9-3 EVACUATION CENTRE LOCATIONS

9.4.2 Flood Risk Assessment

The location of evacuation centres is often selected with only minimal, historical flooding or no consideration for flood risk. The LFMP now presents a wealth of information that locates high risk residents requiring priority evacuation and the flood risks associated with particularly parcels of land and indeed established centres.

The following provides an assessment of each of the centre locations, their suitability considering flood risk, locations of high-risk residents requiring priority evacuation and the suitability of site selection to service these residents.

9.4.2.1 Kilcoy State School

This evacuation centre location appears to have been placed to service the main Kilcoy Township west of the Kilcoy Creek bridge, shown in Figure 9-4. The current location is well located and is not flooded in the PMF Event.

FIGURE 9-4 KILCOY EVACUATION CENTRES PMF FLOOD DEPTH

9.4.2.2 Kilcoy Memorial Hall

This evacuation centre location appears to have been placed to service the main Kilcoy Township west of the Kilcoy Creek bridge. The current location is well located and is not flooded in the PMF Event.

9.4.3 Evacuation Centre Recommendations

Based on the flood risk assessment of evacuation centres in the Kilcoy area, the following is recommended:

1. Both the Kilcoy Memorial Hall and Kilcoy State School Evacuation Centres are well located to service the Kilcoy Township with properties on the western side of Kilcoy Creek.

2. Properties located on the eastern side of Kilcoy Creek may have trouble evacuating to the other side of the creek to the evacuation centres in the township. William Street in particular has very low flood immunity (Q1) and would be cut early preventing access.

3. Properties situated to the west of the township across Sheep Station Creek would also have difficulty accessing the evacuation centres as the road has low immunity.

The assessment above has provided an assessment of the suitability of the current evacuation centre locations.

9.5 Evacuation Route Planning

With the prioritised results, these areas were grouped into clusters and evacuation paths mapped out for each of the clusters as shown in Figure 9-5.

It should also be noted that there are other high risk properties not accounted for in the evacuation planning below and the electronic datasets should be consulted to provide more awareness of all properties (outside of the main Kilcoy township). A description of each of these routes is described below:

9.5.1 Cluster 1 | Seib Street Properties

This area has a handful of residents likely requiring priority evacuation. The residents along Seib Street can evacuate safely to the centres with good levels of road immunity.

All of these properties have a very short time to inundation in major floods and would require a higher priority of evacuation for these reasons.

9.5.2 Cluster 2 | 12 Atthow Street

This one resident at 12 Atthow Street is prioritised with high hazard and short inundation times. This resident can evacuate safely to the centres with good levels of road immunity.

FIGURE 9-5 EVACUATION ROUTES KILCOY TOWNSHIP

10 SUMMARY AND RECOMMENDATIONS

10.1 Flood Risk Overview

The LFMP for Kilcoy has been used to understand the extent and scale of flooding and to set policies for managing risks associated with flooding within the catchment. The plan can be used to guide capital investment, land use planning activities, disaster management planning and raise community awareness and understanding of flood risk and how it will be managed. The LFMP used the outputs from the Brisbane River Flood Studies, SFMP and Somerset Flood Studies which provides the data to help understand the flood behaviour of the catchments, to assess and characterise the nature of flood risk across the floodplain and how to best manage the risk.

During the 1 in 100 AEP event, the majority of residential houses within the township are not exposed to this level of flooding. This is restricted to a handful of houses exposed to low hazard in Seib Street. During the 1 in 2000 AEP event, the consequences of flooding only increase marginally from the 1 in 100 AEP event. Properties along Seib Street increase in numbers and some properties have a higher hazard of H4 (risk to adult life). The township is also widely exposed to HR5 flooding associated with the PMF event.

The mapped extent of the floodplain reveals that 85 detached residential buildings are exposed to flooding in the PMF event. There are only 9 properties within the 1 in 100 AEP extent. For the flooding exposure degree in relativity, there are somewhat larger numbers of community facilities flooded. There are no properties exposed to over floor flooding in events all the way to the 1 in 100 AEP event. There are also very few numbers of flooded houses up to the 1 in 2000 AEP event (5). Within Kilcoy there are 16 flood islands and 1 high flood islands. There are no buildings situated on low flood islands.

Various levels of vulnerability are faced by the township of Kilcoy, there are 12 people exposed to the highest flood risk category. In Kilcoy there are 12 people exposed to the highest flood risk category. In total however, there are 192 people being at risk from one or more of the four types of vulnerability: physical, social and economic, mobility and awareness. The average annual damages for direct and indirect damages for residential is $6,771 which overall is very small with regards to flood damages compared to other townships across Somerset. There are 85 kilometres of roads affected in total on the floodplain. There are damages in high frequency events (Q1 and Q2) indicating that some roads have very low flood immunity which is commonly associated with rural roads. In particular, the flooding in the 1 in 1 AEP and 1 in 2 AEP events adds significantly to the overall AAD of Kilcoy. The total tangible damages for Kilcoy is $765,263, with the total intangible damages is $26,454.

10.2 Flood Mitigation Responses

To address the flood risk faced by Kilcoy and the community, several mitigation options have been explored. Detailed assessments of options considered practical, including cost benefit analysis and multicriteria assessment have been undertaken for Council's consideration.

In Kilcoy there was one option that was assessed in detail

- Seib Street Flood Levee, to protect several properties
  - This option involves construction of a small flood levee along Seib Street to protect several properties and would remove Kilcoy Creek breakout which floods some properties along Seib Street.
  - Cost benefit ratio 0.2
- Property specific actions were considered which including:
  - Residential properties eligible for a potential Voluntary House Purchase Scheme
    - Cost benefit ratio of 0; and

- Residential properties eligible for Retrofitting Building Materials to create flood resilient properties
  - Cost benefit ratio of 0.

The flood modelling results for the Seib Street levee illustrated that whilst the number of properties provided flood mitigation is small, the cost of the levee will also be small. The impacts hover to private land surrounding this option will need to be considered further (including to residential buildings). The other mitigation options considered that did not go through to detail assessment were an easement in the William Street Catchment, and an upstream basin to mitigate flow downstream in the township. In addition to mitigation measures, property specific actions were considered which included the assessment of buildings and residents eligible for the House Purchase Scheme and those eligible for retrofitting flood resilient materials of properties. Council should not consider implementation of a Voluntary House Purchase program or retrofitting building materials, as there are no eligible properties under each of the criteria.

10.3 Emergency Management Responses

Effective floodplain management planning requires a vast array of consideration and implementation of different techniques and tools to reduce flood risk to a tolerable or acceptable level. Assessment of the flood risk at the two evacuation centres (Kilcoy State School and Kilcoy Memorial Hall), has shown that both are well located. However, it should be noted that properties situated to the west of the township across Sheep Station Creek would also have difficulty accessing the evacuation centres as the road has low immunity.

10.4 Recommendations

A summary of the recommendations outlined in the township of Kilcoy are outlined below, with a more detail displayed in Table 10-1.

- Updating Flood Levels with more accurate methods such as survey.
- Providing values classes for commercial damages.
- No structural flood mitigation options have been recommended as part of this project and thus other management measures are critical to reduce flood risk in the area.
- Utilise the risk-based examples in the TER and other outputs of the LFMP to update land use planning outcomes in Kilcoy.
- Utilise the details from the flood mitigation options to inform any zoning changes with No Feasible Alternatives Assessment Reports.
- The recommendations within the flood forecasting section of the report should be considered for further investigation.
- The developed evacuation prioritisation lists should be reviewed and utilised to provide a better understanding of high-risk residents.
- The evacuation centres at Kilcoy State School and the Kilcoy Memorial Hall are well located to service most of the township.

TABLE 10-1 SUMMARY OF LFMP RECOMMENDATIONS – KILCOY TOWNSHIP

Category	**Recommendation**	Description
Existing Risk	Updating Flood Levels with more accurate methods such as survey	Floor levels have a substantial impact on overall flood damages and can skew results significantly. As the LFMP relies on estimated floor levels and overall damages are very high in the ICP overall, it is recommended that high risk areas are investigated in more detail. This should also extend to where detailed implementation of mitigation options is being undertaken to ensure accurate cost benefit assessments are realised.
Existing Risk	Providing values classes for commercial damages	The SFMP uses value classes to define different commercial damages based on how valuable the building contents may be. Unfortunately, this information was not made available and an average value class was used. Council may consider updating the commercial value damages after the ICP is complete.
Flood Mitigation	No structural flood mitigation options have been recommended as part of this project and thus other management measures are critical to reduce flood risk in the area	All of the investigated structural flood mitigation measures are not cost beneficial for Kilcoy. As residual risk of flooding remains, it is recommended that emergency management recommendations are implemented and in particular a community education and awareness program is developed and undertaken for Kilcoy.
Land Use Planning	Utilise the risk-based examples in the TER and other outputs of the LFMP to update land use planning outcomes in Kilcoy	The SPP requires all Councils to update planning schemes and transition to a risk-based approach to flooding. This project has provided example approaches to risk based planning and also other outputs such as flood islands, vulnerability assessment, time to and duration of flooding and emergency management aspects that will be useful to transition to a full risk based approach to flooding.

Category	Recommendation	Description
Land Use Planning	Utilise the details from the flood mitigation options to inform any zoning changes with No Feasible Alternatives Assessment Reports	When any zoning changes are considered to land, a No FAAR report must be undertaken to assess all of the alternatives to these zoning changes. A key component of this is investigating structural flood mitigation options which has been undertaken in this project. As there are no feasible alternatives, this will assist in the development of No FAAR reports.
Emergency Management	The recommendations within the flood forecasting section of the report should be considered for further investigation.	The trigger-based maps provided with this project may be utilised as a method for flood warning in the township. A combined water level and rainfall gauge is also recommended to be installed on Kilcoy Creek at the D'Aguilar Highway to provide a higher level of flood warning and flood intelligence should resources permit. The rainfall and water level trigger maps would need to be updated with any new gauge install.
Emergency Management	The developed evacuation prioritisation lists should be reviewed and utilised to provide a better understanding of high-risk residents	The developed prioritisation lists provide a "triage" style of priority evacuations where sheltering in place is not safe to do so. In addition, the process developed could also be replicated to be utilised in flood forecasting systems to provide real time information and flood intelligence.
Emergency Management	The evacuation centres at Kilcoy State School and the Kilcoy Memorial Hall are well located to service most of the township	The assessment revealed that both of these evacuation centres are able to service the township. Houses requiring evacuation on the eastern side of Kilcoy Creek and western side of Sheepstation Creek will have increased difficulty in reaching these centres.

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