

Glennelg Shire

FLOOD EMERGENCY PLAN

A Sub-Plan of the Municipal Emergency Management Plan

For Glennelg Shire Council
and
VICSES Unit(s) Dartmoor, Heywood and Portland

Version 5.3, February 2019



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Distribution of MFEP

Once endorsed and signed the, MFEP should be distributed to all MFEP committee members, MEMPC Chair, council, MERO, Deputy MERO, Representatives from; BoM, CMA, DELWP, Parks Victoria, Ambulance Victoria, VicRoads, DHHS, relevant utilities, MFB, MERC, RERC, Police station, VICSES Units, VICSES Regional office, CFA Brigades, CFA Regional office.

Document Transmittal Form / Amendment Certificate

This Municipal Flood Emergency Plan (MFEP) will be amended, maintained and distributed as required or every 3 years facilitated by VICSES in consultation with the Municipal Emergency Management Planning Committee (MEMPC)

Suggestions for amendments to this Plan should be forwarded to VICSES Regional Office via SouthWest@ses.vic.gov.au.

Amendments listed below have been included in this Plan and updated as a new version.

Amendment Number	Date of Amendment	Amendment Entered By	Summary of Amendment
1.0	May 2015	Ian Carlton	Draft Version
2.0	Feb 2018	GHCMA	Available flood intelligence for Portland, Casterton, Narrawong and Heywood added.
2.1	April 2018	Ken Smith	Updated with Flood Action Cards, Reduced inundation mapping. Included appendix C Sandford and included Estuary and Storm Surge.
2.1	July 2018	Ken Smith	Update after Municipal Flood Planning Committee Meeting.
2.1	August 2018	Ken Smith	Update with CMA minor amendments.
2.1	November 2018	Clare Mintern	Update with MEMPC feedback, changed maps, changed all tables.
5.2	November 2018	Clare Mintern	Update into new MFEP template with minor changes to maps, tables and section of the document.
5.2	February 2019	Clare Mintern	Incorporated additional flood maps, flood photos, key flood impact maps.

This Plan will be maintained on the VICSES website at www.ses.vic.gov.au/get-ready/your-local-flood-information and Glenelg Shire website <https://www.glenelg.vic.gov.au/page/HomePage.aspx>

List of Abbreviations & Acronyms

The following abbreviations and acronyms are used in the Plan

AAR	After Action Review	IIA	Initial Impact Assessment
AEP	Annual Exceedance Probability	IEMT	Incident Emergency Management Team
AHD	Australian Height Datum (the height of a location above mean sea level in metres)	JSOP	Joint Standard Operations Procedure
AIDR	Australian Institute of Disaster Resilience	IMS	Incident Management System
AIIMS	Australasian Inter-service Incident Management System	LSIO	Land Subject to Inundation Overlay
AoCC	Area of Operations Control Centre / Command Centre	MEMO	Municipal Emergency Management Officer
ARI	Average Recurrence Interval	MEMP	Municipal Emergency Management Plan
ARMCANZ	Agricultural & Resource Management Council of Australia & New Zealand	MEMPC	Municipal Emergency Management Planning Committee
AV	Ambulance Victoria	MERC	Municipal Emergency Response Coordinator
BoM	Bureau of Meteorology	MERO	Municipal Emergency Resource Officer
CEO	Chief Executive Officer	MFB	Metropolitan Fire Brigade
CERA	Community Emergency Risk Assessment	MFEP	Municipal Flood Emergency Plan
CFA	Country Fire Authority	MFEPCC	Municipal Flood Emergency Planning Committee
CMA	Catchment Management Authority	MRM	Municipal Recovery Manager
RERC	Regional Emergency Response Coordinator	PMF	Probable Maximum Flood
RERCC	Regional Emergency Response Coordination Centre	RAC	Regional Agency Commander
DHHS	Department of Health and Human Services	RCC	Regional Control Centre
DEDJTR	Department of Economic Development, Jobs, Transport, Resources	RDO	Regional Duty Officer
DELWP	Department of Environment, Land, Water and Planning	SAC	State Agency Commander
EMLO	Emergency Management Liaison Officer	SBO	Special Building Overlay
EMMV	Emergency Management Manual Victoria	SCC	State Control Centre
EMT	Emergency Management Team	SDO	State Duty Officer
ERC	Emergency Relief Centre	SERP	State Emergency Response Plan
EO	Executive Officer	SEWS	Standard Emergency Warning Signal
FO	Floodway Overlay		

Part 1. Introduction

1.1 Approval and Endorsement

This Municipal Flood Emergency Plan (MFEP) has been prepared by VICSES, Glenelg Hopkins CMA and Glenelg Shire staff and with the authority of the Glenelg Municipal Emergency Management Planning Committee (Glenelg MEMPC) pursuant to Section 20 of the Emergency Management Act 1986 (as amended).

VICSES staff has undertaken consultation with the Glenelg Shire staff, Glenelg Hopkins CMA staff, Portland, Dartmoor and Heywood VICSES Unit members regarding the arrangements contained within this plan.

This MFEP is a sub plan to the Glenelg Shire Emergency Management Plan (MEMP), is consistent with the Emergency Management Manual Victoria (EMMV) and the Victorian Floodplain Management Strategy (2016), and takes into account the outcomes of the Community Emergency Risk Assessment (CERA) process undertaken by the Municipal Emergency Management Planning Committee (MEMPC).

The MFEP is consistent with the South West Regional Flood Emergency Plan (RFEP) and the State Emergency Response Plan (SERP) – Flood sub-plan.

This MFEP is a result of the cooperative efforts of the MFPC and its member agencies.

This Plan is approved by the VICSES Regional Manager.

This Plan is endorsed by the Glenelg Shire MEMPC as a sub-plan to the MEMP.

Approval



Michael Harper

Date 27 November 2018

Barwon South West Region VICSES Regional Manager

Endorsement



Cr. Karen Stephens

Date 27 November 2018

Chair – Municipal Emergency Management Planning Committee

1.2 Purpose and Scope of this Flood Emergency Plan

The purpose of this MFEP is to detail arrangements agreed for managing a flood emergency before, during and after it occurs or potentially occurs within Glenelg Shire.

As such, the scope of the Plan is to:

- Identify the local flood risk;
- Support the implementation of mitigation and planning measures to minimise the causes and impacts of flooding;
- Detail emergency management arrangements;
- Identify linkages with Local, Regional and State emergency and wider planning arrangements with a specific emphasis on those relevant to flood.

1.3 Responsibility for Planning, Review & Maintenance of this Plan

This MFEP must be maintained in order to remain effective.

VICSES through the MFPC has responsibility for facilitating the preparation, review, maintenance and distribution of this plan.

The MFPC will meet at least once per year. The plan should be reviewed following:

A new flood study;

A significant change in flood mitigation measures;

After the occurrence of a significant flood event within the Municipality;

Or if none of the above occur, every 3 years.

Part 2. BEFORE: Prevention / preparedness arrangements

2.1 Community Engagement and Awareness

Details of this MFEP will be released to the community through; local media, any FloodSafe engagement initiatives and websites (VICSES and the Municipality) upon formal adoption by VICSES and the Municipality. VICSES with the support of Glenelg Shire and Glenelg Hopkins CMA will coordinate targeted community flood engagement programs within the council area.

Refer to appendix H (LFG and FloodSafe Information. Attach any broader FloodSafe details).

2.2 Structural Flood Mitigation Measures

While there are no formal structural flood mitigation measures within the Council area, when storage levels are low in Rocklands Reservoir it provides excellent flood mitigation, significantly reducing the flood magnitude in downstream towns of Harrow and Casterton. However when Rocklands Reservoir spills, this can increase the severity of flooding in Harrow and Casterton. Refer to Appendix A section 5.8 for more detailed information.

2.3 Non-structural Flood Mitigation Measures

2.3.1 Exercising the Plan

Arrangements for exercising this Plan will be at the discretion of the MEMPC. It is recommended that the MFEP is exercised on annual basis and reviewed in line with Section 1.4.

2.3.2 Flood Warning

Arrangements for Bureau issued Flood Watch and Flood Warning products are contained within the SERP Sub Plan – Flood (www.ses.vic.gov.au/em-sector/vicses-emergency-plans) and on the Bureau of Meteorology (BoM) website www.bom.gov.au.

Details on Warnings issued by VICSES through VicEmergency and VICSES channels are outlined in **Appendix E**.

2.3.3 Local Knowledge

Community Observers provide local knowledge to VICSES and the Incident Control Centre regarding local insights and the potential impacts and consequences of an incident and may assist with the dissemination of information to community members.

Specific details of arrangements to capture local knowledge are provided in **Appendix G**.

Part 3. DURING: Response arrangements

3.1 Introduction

3.1.1 Activation of Response

Flood response arrangements may be activated by the Regional Duty Officer (RDO) VICSES Barwon South West Region or Regional Agency Commander (RAC).

The VICSES Incident Controller (IC)/RDO will activate agencies as required as documented in the State Emergency Response Plan - Flood.

3.1.2 Responsibilities

There are a number of agencies with specific roles that will act in support of VICSES and provide support to the community in the event of a serious flood within the Glenelg Shire. These agencies will be engaged through the IEMT (Incident Emergency Management Team) when enacted or via the RAC when the IEMT is not enacted.

The general roles and responsibilities of supporting agencies are as agreed within the: MEMP, EMMV (Part 7 'Emergency Management Agency Roles') and SERP Sub Plan - Flood and Regional Flood Emergency Plan.

3.1.3 Emergency Coordination Centre or equivalent

If established, liaison with the emergency coordination centre will be through the established Division/Sector Command and through Municipal involvement in the IEMT, in particular the Municipal Emergency Response Coordinator (MERC). The VICSES RDO / ICC will liaise with the centre directly if no Division/Sector Command is established.

The function, location, establishment and operation of an emergency coordination centre if relevant will be as detailed in the MEMP.

3.1.4 Escalation

Many flood incidents are of local concern and an appropriate response can usually be coordinated using local resources. However, when these resources are exhausted, the State's arrangements provide for further resources to be made available, firstly from neighbouring Municipalities (on a regional basis) and then on a State-wide basis.

Resourcing and event escalation arrangements are described in Part 3 of the EMMV.

3.2 The six C's

Arrangements in this MFEP must be consistent with the 6 C's detailed in State and Regional Flood Emergency Plans and the MEMP. For further information, refer to Part 3 of the EMMV.

Command: Overall direction of response activity in an emergency.

Control: Internal direction of personnel and resources within an agency.

Coordination: Bringing together agencies and resources to ensure effective preparation for response and recovery.

Consequence: Management of the effect of emergencies on individuals, communities, infrastructure and the environment.

Communication: Engagement and provision of information across agencies and proactively with the community around preparation, response and recovery in emergencies.

Community Connection: Understanding and connecting with trusted networks, leaders and communities around resilience and decision making.

Specific details of arrangements for this plan are to be provided in **Appendix C**.

3.2.1 Control

Functions 5(a) and 5(c) at Part 2 of *the Victoria State Emergency Service Act 1986 (as amended)* detail the authority for VICSES to plan for and respond to flood.

Part 7 of the EMMV prepared under the *Emergency Management Act 1986 (as amended)*, identifies VICSES as the Control Agency for flood. It identifies DELWP as the Control Agency responsible for "dam safety, water and sewerage asset related incidents" and other emergencies. A more detailed explanation of roles and responsibilities is provided in later sections of Part 7 of the EMMV.

All flood response activities within the Glenelg Shire including those arising from a dam failure or retarding basin / levee bank failure incident will therefore be under the control of the appointed IC, or delegated representative.

3.2.2 Incident Controller (IC)

An Incident Controller (IC) will be appointed by the VICSES (as the Control Agency) to command and control available resources in response to a flood event on the advice of the Bureau of Meteorology (or other reliable source) that a flood event will occur or is occurring. The IC responsibilities are as defined in Part 3 of the EMMV.

3.2.3 Incident Control Centre (ICC)

As required, the IC will establish an Incident Control Centre (ICC) from which to initiate incident response command and control functions. The decision as to if and when the ICC should be activated, rests with the Control Agency (i.e. VICSES).

Pre-determined ICC locations are available in the MEMP.

3.2.4 Divisions and Sectors

To ensure that effective Command and Control arrangements are in place, the IC may establish Divisions and sectors depending upon the complexity of the event and resource capacities.

The following Divisions and Sectors may be established to where applicable to assist with the management of flooding within the Municipality:

Division	Sector
Hamilton	Heywood
	Dartmoor
	Portland

3.2.5 Incident Management Team (IMT)

The IC will form an Incident Management Team (IMT).

Refer to Part 3 of the EMMV for guidance on IMTs and Incident Management Systems (IMs).

3.2.6 Incident Emergency Management Team (IEMT)

The IC will establish a multi-agency Incident Emergency Management Team (IEMT) to assist the flood response. The IEMT consists of key personnel (with appropriate authority) from stakeholder agencies and relevant organisations who need to be informed of strategic issues related to incident control. They are able to provide high level strategic guidance and policy advice to the IC for consideration in developing incident management strategies.

Organisations, including Glenelg Shire, required within the IEMT will provide an Emergency Management Liaison Officer (EMLO) to the ICC if and as required as well as other staff and / or resources identified as being necessary, within the capacity of the organisation.

Refer to 3 of the EMMV for guidance on IEMTs.

3.2.7 On Receipt of a Flood Watch / Severe Weather Warning

SOP008 and SOP009 outline in detail the actions to be undertaken upon receipt of a Flood Watch/Flood Warning or Severe Weather Warning. VICSES RDO (until an incident controller is appointed) or IC will undertake actions as defined within the flood intelligence cards (**Appendix C**). General considerations by the IC/VICSES RDO will be as follows:

- Review flood intelligence to assess likely flood consequences
- Monitor weather and flood information – www.bom.gov.au
- Assess Command and Control requirements.
- Review local resources and consider needs for further resources regarding personnel, property protection, flood rescue and air support
- Notify and brief appropriate officers. This includes Regional Control Centre (RCC) (if established), State Control Centre (SCC) (if established), Council, other emergency services through the EMT.
- Assess ICC readiness (including staffing of IMT and IEMT) and open if required
- Ensure flood warnings and community information is prepared and issued to the community where required
 - Flood (Riverine and flash) Warnings are managed by the RDO/RAC
 - Severe Weather/ Thunderstorm warnings are managed by SDO/SAC
- Develop media and public information management strategy
- Monitor watercourses and undertake reconnaissance of low-lying areas
- Ensure flood mitigation works are being checked by owners
- Develop and issue incident action plan, if required
- Develop and issue situation report, if required

3.2.8 On Receipt of the First and Subsequent Flood Warnings

VICSES RDO (until an incident controller is appointed) or IC will undertake actions as defined within the flood intelligence cards (**Appendix C**). General considerations by the IC/VICSES RDO will be as follows:

- Develop an appreciation of current flood levels and predicted levels. Are floodwaters, rising, peaking or falling?
- Review flood intelligence to assess likely flood consequences.
- Consider:
 - What areas may be at risk of inundation?
 - What areas may be at risk of isolation?
 - What areas may be at risk of indirect affects as a consequence of power, gas, water, telephone, sewerage, health, transport or emergency service infrastructure interruption?
 - The characteristics of the populations at risk
- Determine what the at-risk community need to know and do as the flood develops.
- Warn the at-risk community including ensuring that an appropriate warning and community information strategy is implemented including details of:
 - The current flood situation
 - Flood predictions
 - What the consequences of predicted levels may be
 - Public safety advice
 - Who to contact for further information
 - Who to contact for emergency assistance
- Liaise with relevant asset owners as appropriate (i.e. water and power utilities)
- Implement response strategies as required based upon flood consequence assessment.
- Continue to monitor the flood situation – www.bom.gov.au/vic/flood/
- Continue to conduct reconnaissance of low-lying areas

3.3 Initial Impact assessment

Initial impact assessments will be conducted in accordance with Part 3 section 5.2.5 of the EMMV to assess and record the extent and nature of damage caused by flooding. This information may then be used to provide the basis for further needs assessment and recovery planning by DHHS and recovery agencies.

3.4 Preliminary Deployments

When flooding is expected to be severe enough to cut access to towns, suburbs and/or communities the IC will consult with relevant agencies to ensure that resources are in place if required to provide emergency response. These resources might include emergency service personnel, food items and non-food items such as medical supplies, shelter, assembly areas, relief centres etc.

3.5 Response to Flash Flooding

Emergency management response to flash flooding should be consistent with the guideline for the emergency management of flash flooding contained within the State Emergency Response Plan - Flood.

When conducting pre-event planning for flash floods the following steps should be followed, and in the order as given:

1. Determine if there are barriers to evacuation by considering warning time, safe routes, resources available and etc;
2. If evacuation is possible, then evacuation should be the adopted strategy and it must be supported by a public information capability and a rescue contingency plan;
3. Where it is likely people will become trapped by floodwaters due to limited evacuation options safety advice needs to be provided to people at risk. Advice should be given to not attempt to flee by entering floodwater if they become trapped, it may be safer to seek the highest point within the building and to telephone 000 if they require rescue.
4. For buildings known to be structurally un-suitable an earlier evacuation trigger will need to be established (return to step 1 of this cycle).
5. If an earlier evacuation is not possible then specific preparations must be made to rescue occupants trapped in structurally unsuitable buildings either pre-emptively or as those people call for help.
6. Contact the Glenelg Shire MERC and MERO at the earliest opportunity to allow for relief preparation to commence.

Due to the rapid development of flash flooding it will often be difficult, to establish relief centres ahead of actually triggering the evacuation. This is normal practice but this is insufficient justification for not adopting evacuation.

Refer to **Appendix C** for response arrangements for flash flood events.

3.6 Evacuation

The IC decides whether to warn people to evacuate or if it is recommended to evacuate immediately.

Once the decision is made VicPol are responsible for the management of the evacuation process where possible. VICSES and other agencies will assist where practical. VICSES is responsible for the development and communication of evacuation warnings.

VicPol and/or Australian Red Cross may take on the responsibility of registering people affected by a flood emergency including those who have been evacuated.

Refer to EMMV Part 8, Appendix 9 and the Evacuation Guidelines for guidance of evacuations for flood emergencies.

Refer to **Appendix C** of this Plan and the MEMP for additional local evacuation considerations for the municipality.

3.7 Flood Rescue

VICSES may conduct flood rescues. Appropriately trained and equipped VICSES units or other agencies that have appropriate training, equipment and support may carry out rescues.

Rescue operations may be undertaken where voluntary evacuation is not possible, has failed or is considered too dangerous for an at-risk person or community. An assessment of available flood rescue resources (if not already done prior to the event) should be undertaken prior to the commencement of Rescue operations.

Rescue is considered a high-risk strategy to both rescuers and persons requiring rescue and should not be regarded as a preferred emergency management strategy. Rescuers should always undertake a dynamic risk assessment before attempting to undertake a flood rescue.

Victoria Police Rescue Coordination Centre should be notified of any rescues that occur: (03) 9399 7500

The following resources are available within Glenelg Shire to assist with rescue operations:

- Flood Rescue boats are located at Dartmoor and Hamilton
- Warrnambool has a land based Swift Rescue Team.
- HEMS 4 Rescue helicopter is located at Warrnambool Aerodrome.

3.8 Aircraft Management

Aircraft can be used for a variety of purposes during flood operations including evacuation, resupply, reconnaissance, intelligence gathering and emergency travel.

Air support operations will be conducted under the control of the IC

The IC may request aircraft support through the State Air Desk located at the SCC will establish priorities.

Suitable airbase facilities are located at:

- Heywood
- Portland
- Casterton
- Hamilton (Southern Grampians Shire)
- Warrnambool (Warrnambool City Council)

3.9 Resupply

Communities, neighbourhoods or households can become isolated during floods as a consequence of road closures or damage to roads, bridges and causeways. Under such circumstances, the need may arise to resupply isolated communities/properties with essential items.

When predictions/intelligence indicates that communities, neighbourhoods and/or households may become isolated, VICSES will advise businesses and/or households that they should stock up on essential items.

After the impact, VICSES can support isolated communities through assisting with the transport of essential items to isolated communities and assisting with logistics functions.

Resupply operations are to be included as part of the emergency relief arrangements with VICSES working with the relief agencies to service communities that are isolated.

3.10 Essential Community Infrastructure and Property Protection

Essential Community Infrastructure and Property (e.g. residences, businesses, roads, power supply etc.) may be affected in the event of a flood.

A small stock of sandbags are located in Portland, Heywood and Casterton and back-up supplies are available through the VICSES Hamilton Regional Headquarters. The IC will determine the priorities related the use of sandbags, which will be consistent with the strategic priorities.

If VICSES sandbags are becoming limited in supply, then priority will be given to protection of Essential Community Infrastructure. Other high priorities may include for example the protection of historical buildings.

Property may be protected by:

- Sandbagging to minimise entry of water into buildings
- Encouraging businesses and households to lift or move contents
- Construction of temporary levees in consultation with the CMA, LGA and VICPOL and within appropriate approval frameworks.

The IC will ensure that owners of Essential Community Infrastructure are kept advised of the flood situation. Essential Community Infrastructure providers must keep the IC informed of their status and ongoing ability to provide services.

Contact your local VICSES representative for the most current Sandbag Guidelines or download it from IMT Toolbox in EMCOP- Operations.

Refer to **Appendix C** for further specific details of essential infrastructure requiring protection and location of sandbag collection points.

3.11 Disruption to Services

Disruption to services other than essential community infrastructure and property can occur in flood events. Refer to **Appendix C** for specific details of likely disruption to services and proposed arrangements to respond to service disruptions in Glenelg Shire.

3.12 Road Closures

Glenelg Shire and Regional Roads will carry out their formal functions of road closures including observation and placement of warning signs, road blocks etc. to its designated local and regional roads, bridges, walking and bike trails. Glenelg Shire staff should also liaise with and advise Regional Roads as to the need or advisability of erecting warning signs and / or of closing roads and bridges under its jurisdiction. Regional Roads are responsible for designated main roads and highways and councils are responsible for the designated local and regional road network.

Regional Roads and the Glenelg Shire will communicate community information regarding road closures. Information will be updated on the VIC Traffic website: <https://traffic.vicroads.vic.gov.au/>

Refer to **Appendix C** for specific details of potential road closures.

3.13 Dam Spilling/ Failure

DELWP is the Control Agency for dam safety incidents (e.g. breach, failure or potential breach / failure of a dam), however VICSES is the Control Agency for any flooding that may result.

DELWP have developed Dam Safety Emergency Plans for municipalities where it is applicable.

Major dams with potential to cause structural and community damage within the Municipality are contained in **Appendix A**.

3.14 Waste Water related Public Health Issues and Critical Sewerage Assets

Inundation of critical sewerage assets including septic tanks and sewerage pump stations may result in water quality problems within the Municipality. Where this is likely to occur or has occurred the responsibility agency for the critical sewerage asset should undertake the following:

Advise VICSES of the security of critical sewerage assets to assist preparedness and response activities in the event of flood;

Maintain or improve the security of critical sewerage assets;

Check and correct where possible the operation of critical sewerage assets in times of flood;

Advise the ICC in the event of inundation of critical sewerage assets.

It is the responsibility of the Glenelg Shire Environmental Health Officer to inspect and report to the MERO and the ICC on any water quality issues relating to flooding.

3.15 Access to Technical Specialists

VICSES Manages contracts with private technical specialists who can provide technical assistance in the event of flood operations or geotechnical expertise. Refer to VICSES SOP061 for the procedure to engage these specialists.

3.16 After Action Review

VICSES will coordinate the after action review arrangements of flood operations as soon as practical following an event.

All agencies involved in the flood incident should be represented at the after action review.

Part 4. AFTER: Emergency relief and recovery arrangements

4.1 General

Arrangements for recovery from a flood incident within the Glenelg Shire is detailed in the Glenelg Shire MEMP.

4.2 Emergency Relief

The decision to recommend the opening of an emergency relief centre sits with the IC. The IC is responsible for ensuring that relief arrangements have been considered and implemented where required under the State Emergency Relief and Recovery Plan (Part 4 of the EMMV).

The range and type of emergency relief services to be provided in response to a flood event will be dependent upon the size, impact, and scale of the flood. Refer to Part 4 of the EMMV for details of the range of emergency relief services that may be provided.

Suitable relief facilities identified for use during floods are detailed in **Appendix D** and the MEMP.

Details of the relief arrangements are available in the MEMP.

4.3 Animal Welfare

Matters relating to the welfare of livestock and companion animals (including feeding and rescue) are to be referred to DEDJTR.

Requests for emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue are passed to DEDJTR.

Matters relating to the welfare of wildlife are to be referred to DELWP.

Refer to **Appendix D** for animal shelter compound locations.

4.4 Transition from Response to Recovery

VICSES as the Control Agency is responsible for ensuring effective transition from response to recovery. This transition will be conducted in accordance with existing arrangements as detailed in Part 3 of the EMMV or location of the transition arrangements are available in the MEMP

Appendix A: Flood threats for the Glenelg Shire

This Appendix is to provide a broad overview of flood risk within the Municipality. Detailed Flood Risk Information for Individual Communities should be detailed in **Appendix C**.

5.1 General

Flood events within the Glenelg Shire have been infrequent during the last decade. The most recent flood event was recorded in Casterton during 2016.

5.2 Storm Surge Flooding

Coastal areas where storm surge flooding is known to occur includes;

- Dutton Way, north of Portland.
- Nelson
- Bridgewater Bay Café and Surf Life Saving Club at Cape Bridgewater

Low atmospheric depressions including cyclones at sea can cause flooding due to storm surge, resulting in abnormally high sea levels along the coastline. While there are limited records of historic storm surge events, a significant storm surge event occurred on the 24th of June 2014. During this event a number of buildings were impacted by flooding along Dutton Way, at Nelson and the Bridgewater Bay Café and Surf Life Saving Clubrooms at Cape Bridgewater.

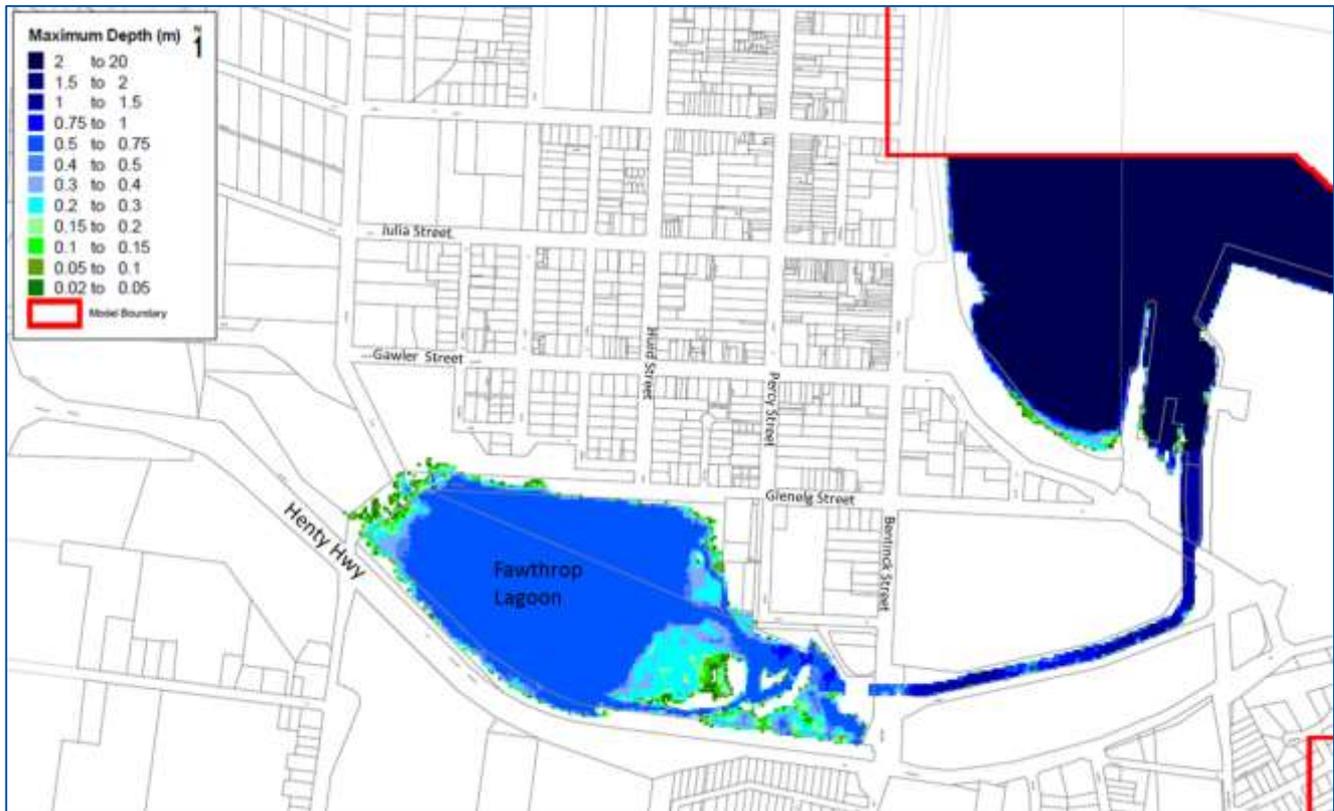
Portland tidal Information is a good source of local information when Storm Surge is potential as advised by the Bureau of Meteorology.

For BOM Marine Warnings web page: <http://www.bom.gov.au/marine/>

For further general information regarding storm surge, refer to the BOM web page: <http://www.bom.gov.au/cyclone/about/stormsurge.shtml>

5.3 King Tide Flooding

The Glenelg Shire have highlighted that Portland is impacted by nuisance flooding surrounding Fawthrop Lagoon during king tide events. Inflows from the king tide events fills Fawthrop Lagoon, causing nuisance flooding, refer to map below for approximate area impacted. Access to walking tracks and adjacent roads surrounding Fawthrop Lagoon have been impacted in the past as shown in the map below.



Map showing the approximate area impacted by king tide flooding of Fawthrop Lagoon. (source Cardno 2011).

5.4 Estuaries

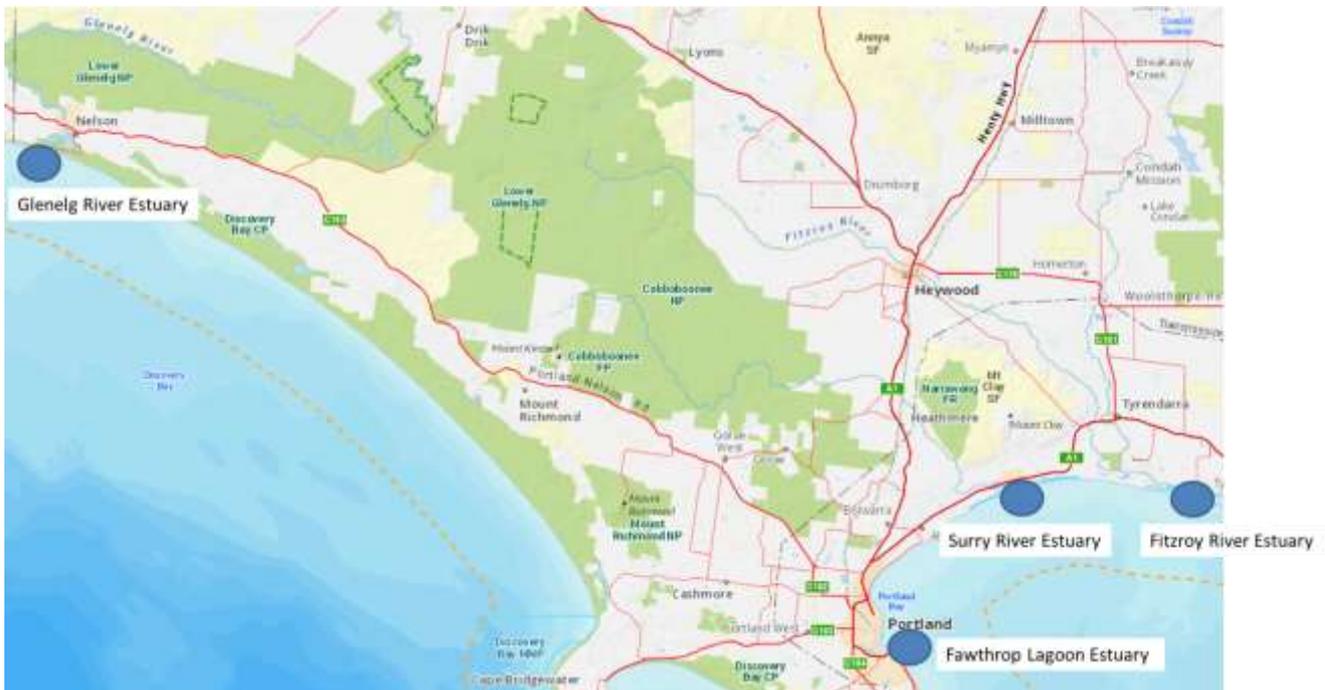
Many south west Victorian estuaries close intermittently following the formation of a sand bar at the estuary mouth. Estuaries that intermittently close typically reopen following high rainfall events when there is enough water flowing down the river to flush built-up sand from the estuary mouth. Estuaries that are closed during riverine flood events can significantly increase flood levels on adjacent property.

Most Estuaries in the Glenelg Hopkins CMA region are naturally intermittently closed estuaries – the exceptions are the Moyne estuary and Fawthrop Lagoon, which are artificially kept open. The Estuary Entrance Management Support System (EEMSS) database was developed in 2006 by Glenelg Hopkins CMA in partnership with other agencies. The EEMSS considers the social, economic and environmental values of each estuary and the likely impact of opening and not opening at different times of the year and at different water levels. The EEMSS was recently modified to be web-based and is now available to all coastal CMAs.

<https://www.ghcma.vic.gov.au/our-region/waterways/estuaries/>

Estuaries within the Glenelg Shire include;

- Glenelg River Estuary (Nelson)
- Fawthrop Lagoon Estuary (Portland)
- Surry River Estuary (Narrawong)
- Fitzroy River Estuary (Tyrendarra)



Estuaries within the Glenelg Shire.

5.5 Riverine Flooding

The Glenelg Shire has a long history of riverine flood events. Towns impacted by riverine flooding include; Casterton, Portland, Heywood and Narrawong. Refer to the map below.



5.6 Major Waterways

The major waterways within the Glenelg Shire are listed in the table below.

Waterway	Description
Crawford River	<p>The Crawford River in southwest Victoria starts at an elevation of 127m and ends at an elevation of 16.1m merging with the Glenelg River. The Crawford River drops around 111m over its 75.3km length.</p> <p>The following creeks and rivers flow into the Crawford River: Deep Creek, Kangaroo Creek and Portland Creek.</p>
Fitzroy River	<p>The Fitzroy River catchment has an area of 1,460 km² extending 57 km north westerly from Portland Bay to a maximum elevation of 170 m AHD in the Cobbobonee State Forrest. Heywood is located in the middle reaches of this river, with a total catchment area at Heywood of 234 km². The majority of the Heywood township sits adjacent to the Fitzroy River, with a number of stream crossings through town, including the low-level Bond St crossing, Henty Hwy bridge crossing and Railway crossing. Downstream of Heywood, the Fitzroy River meets its major tributary Darlot Creek before discharging into Portland Bay.</p> <p>The Fitzroy River drops around 138 m over its 58.3 km length.</p>
Glenelg River	<p>The Glenelg River flows through Victoria and South Australia and starts below The Chimney Pots at an elevation of 759 m and flows into the Southern Ocean.</p> <p>The Glenelg River drops around 760 m over its 467 km length.</p> <p>The Glenelg River flows through Rocklands Reservoir (194 m).</p> <p>32 creeks and rivers flow into the Glenelg River. The five longest tributaries are: Wannon River, Crawford River, Stokes River, Chetwynd River and Pigeon Ponds Creek.</p>
Stokes River	<p>The following 6 creeks and rivers flow into the Stokes River (ordered by descending elevation): Buckle Creek (105 m), Humpy Creek (84 m), Bobby Creek (80 m), McKenzie Creek (73 m), Teakettle Creek (64 m) and Morgan Creek (45 m).</p>
Surrey River	<p>The Surrey River in southwest Victoria starts below Mount Kincaid at an elevation of 146 m and flows into the Southern Ocean.</p> <p>The Surrey River drops around 144 m over its 46.4 km length.</p> <p>The Mount Kincaid Creek flows into the Surrey River.</p>
Wando River	<p>The Wando River in southwest Victoria starts at an elevation of 250 m and ends at an elevation of 59.4 m flowing into the Macpherson Creek.</p> <p>The Wando River drops around 190 m over its 33.8 km length.</p>

5.7 Building Damages

Refer to table below for property and building damages for riverine flood events for towns within the Glenelg Shire.

Average Recurrence Interval (ARI)	Total number of properties flooded (buildings flooded above floor)				Total damages for the Glenelg Shire region.
	Casterton (BMT 2014)	Heywood (Water Tech 2017)	Portland (Cardno 2011)	Narrawong (Water Tech 2008)	
Probable Maximum Flood	269 (226)				269 (226)
200		89 (49)			89 (49)
100	166 (80)	63 (18)	98 (12) *	26 (8)*	353 (118)
50	162 (70)	21 (6)	88 (1) *	23 (4)*	294 (81)
20	156 (31)	6 (0)	56 (1) *	23 (4)*	241 (36)
10	149 (16)	2 (0)	44*	23 (4)*	218 (20)
5	96 (1)	0		8 (2)*	104 (3)

* Damages are based on council recorded information or community anecdotal information and may be of low accuracy (no floor level survey undertaken), useful as a guide.

5.8 Dam Spill / Failure

Flooding resulting from spilling or failure of the following dam is likely to cause significant structural and community damage to Harrow and Casterton.

Location	Owner	Full Supply level/volume	Maximum Operating level/volume	Comments
Rocklands Reservoir	GWMWater	194.67 m AHD 296,000 ML	195.47 m AHD 348,300 ML	Refer to web link for the latest storage levels: http://www.storage manager.com.au/index.php?option=com_bwm&view=reservoirvolumechart&chart=reservoir_volume&id=9&primary=0&Itemid=532

5.9 Rocklands Reservoir

Rocklands Reservoir is located west of the Grampians National Park in the upper catchment of the Glenelg River. It is the largest dam in the GMMWater supply system, with a capability of 348,300 ML. The Rocklands Reservoir has the potential to significantly impact flooding in the upper Glenelg River. High water levels in Rocklands reduce the available storage and increases the magnitude of flood events downstream when spills occur. However when the initial water level is low, this provides significant flood mitigation downstream by attenuating flows upstream of Rocklands reservoir, significantly reducing the flood magnitude for downstream towns of Harrow and Casterton.



Location of Rocklands Reservoir (source Glenelg Hopkins CMA)



Rocklands Reservoir spillway.

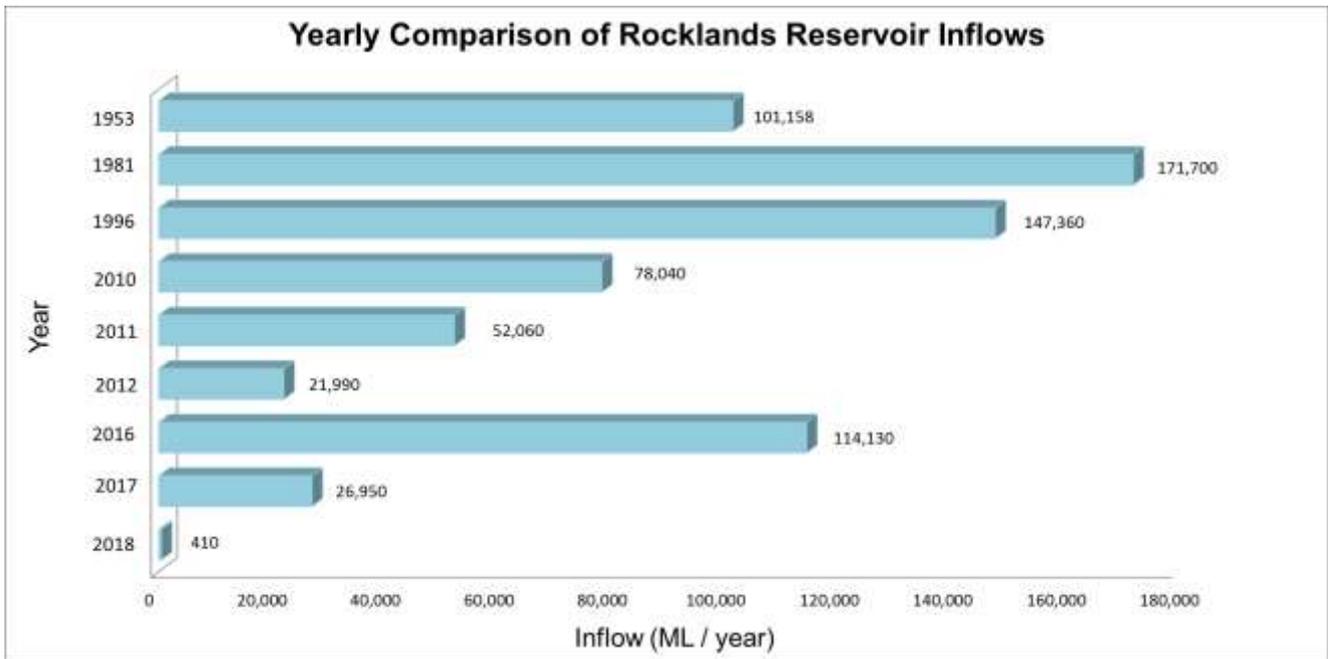
Rocklands Reservoir is the largest reservoir within Grampians Wimmera Mallee Water's (GMMWater) supply system and is located on the Glenelg River upstream of the Balmoral Township. All entitlement holders, including the environment, are able to be supplied with water from the reservoir.

Rocklands Reservoir Summary:

Full Supply Level	195.47 m AHD
Full Supply Volume	348,300 ML
Maximum Operating Level (MOL)	194.67 m AHD
Maximum Operating Volume	296,000 ML
Spillway Length	154.53 m
Spillway Capacity	66,000 ML/day
Outlet Capacity	600 ML/day
Catchment Area	1,355 km ²
Surface Area When Full	67.5 km ²
Average Annual Inflow	83,000 ML/year
Maximum Depth	17 m
Year Constructed	1953

GMMWater maintains a Dam Safety Plan. When Rocklands Storage is full there is a high risk that the storage could spill and exacerbate flood impacts downstream.

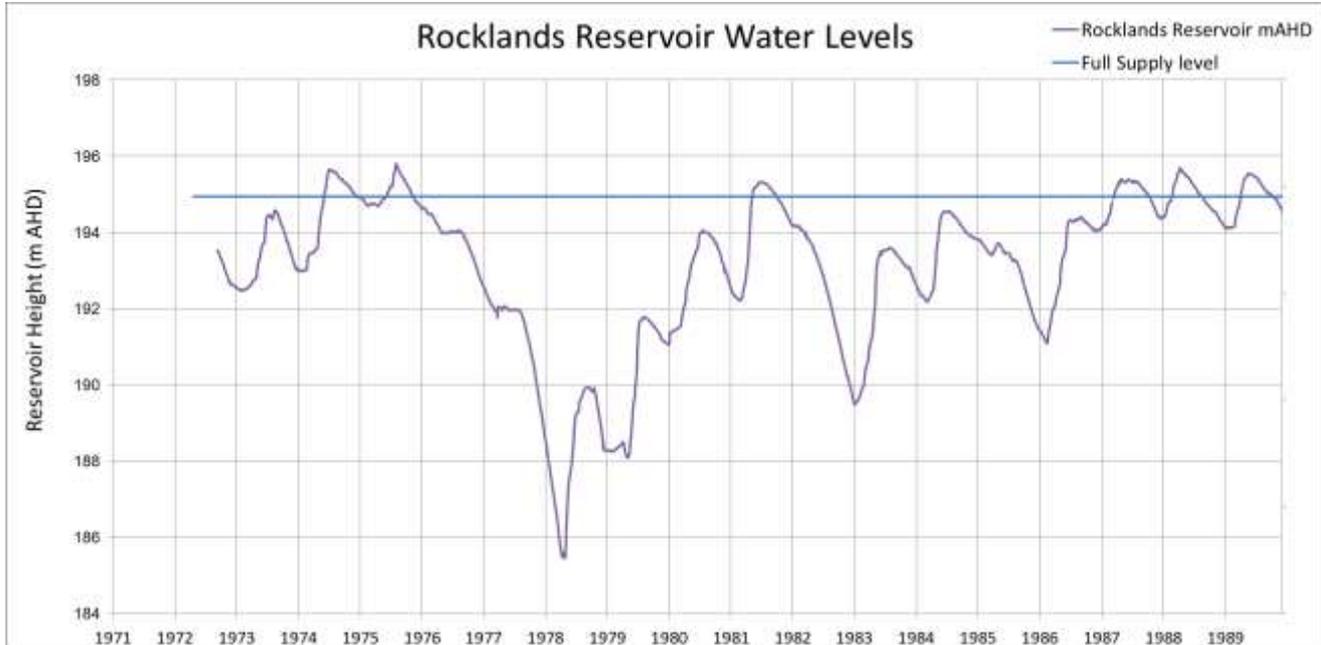
While the annual average inflows into Rocklands Reservoir is 83,000 ML/y, since 1996 very rarely has the annual inflows come close to this volume, refer to the graph below. In 2018 inflows were less than 500 ML. Since 1996, less frequent rainfall and runoff has significantly reduced inflows into Rocklands Reservoir. The inflow graph below shows that in most years after 1996 the annual inflow volumes were significantly below average.



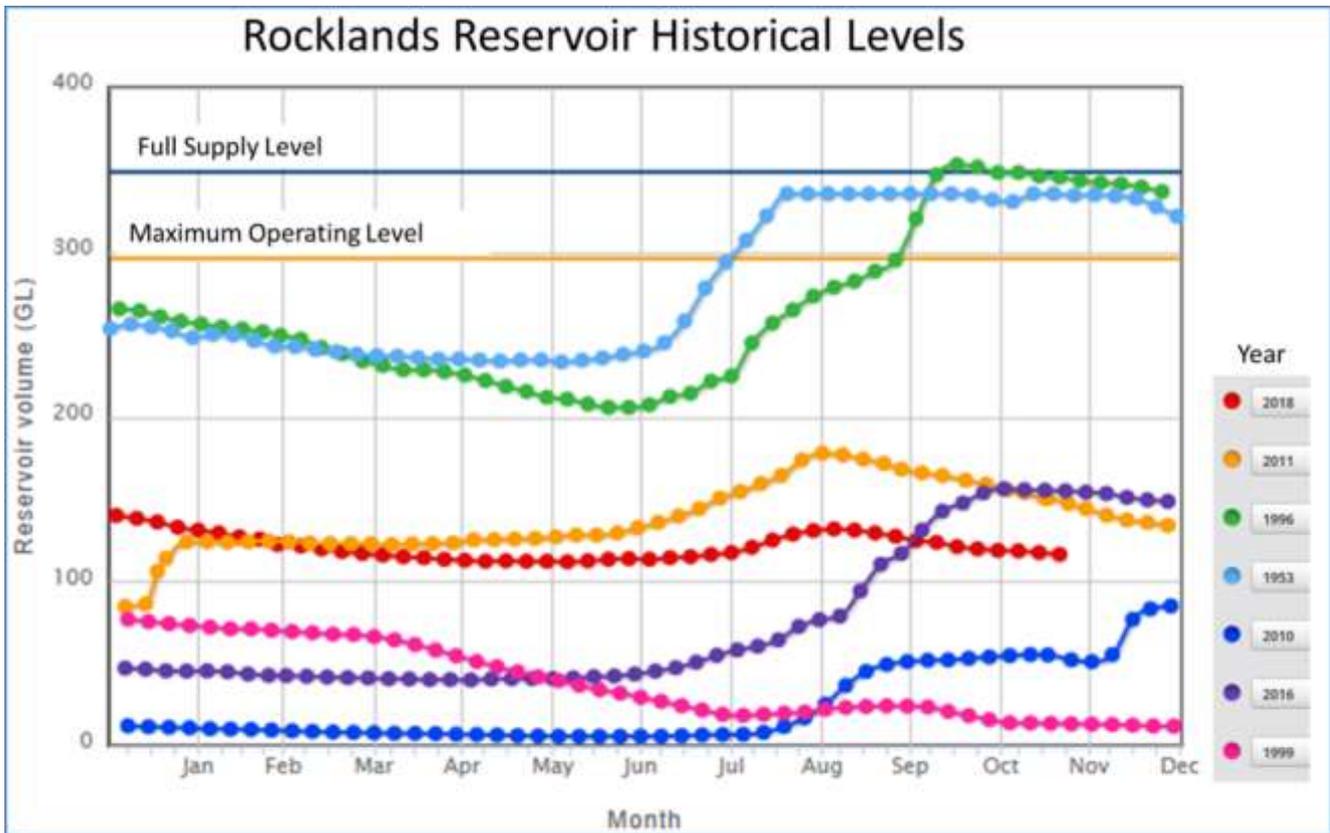
Source: data taken from GWMWater website November 2018.

The graphs below of Rocklands Reservoir historical levels shows that the storage was regularly full before 1996. However post 1996 due to the reduction of storage inflows it was often less than 50% capacity.

While spills have occurred historically and potentially can occur again, they are unlikely to occur given the low inflows and high annual losses (from evaporation, water diversions to other storages and environmental flow releases).



Historic water levels at Rocklands Reservoir (GWMWater)



Source: data taken from GWMWater website November 2018.

The current storage capacity of Rocklands Reservoir is 39% (November 2018). If a flood occurred in the Glenelg River tomorrow the low storage levels in Rocklands Reservoir will provide flood mitigation by attenuating flows upstream of Rocklands Reservoir, significantly reducing the flood magnitude for downstream towns, Harrow and Casterton.

Appendix B: Typical flood peak travel times

Source (Glenelg Hopkins Catchment Flood Intelligence Summary)

Location From	Location To	Typical Travel Time	Comments	Duration
Portland				
Start of rainfall (upper catchment)	Portland	6 - 12 hours	Begin to rise from normal levels	20 hours
Start of rainfall (upper catchment)	Portland	12 - 24 hours	To peak	
Heywood (Fitzroy River)				
Start of rainfall (upper catchment)	Heywood	3.5 - 6 hours	Begin to rise from normal levels	2.5 days
Start of rainfall (upper catchment)	Heywood	7 - 12 hours	Minor flooding	
Start of rainfall (upper catchment)	Heywood	10 - 18 hours	Moderate flooding	
Start of rainfall (upper catchment)	Heywood	12 - 20 hours	Major flooding	
Narrawong (Surry River)				
Start of rainfall (upper catchment)	Narrawong	12 - 24 hours	Begin to rise from normal levels	2.5 days
Heathmere gauge (Surry River)	Narrawong Caravan Park	< 2 hours	To peak	
Casterton (Glenelg River)				
Start of rainfall (upper catchment)	Casterton	24 - 36 hours	Begin to rise from normal levels	2 days
Wando Vale (Wando River)	Casterton	3 - 14 hours	To peak, average 8 hours	
Dergholm (Glenelg River)	Casterton	11 - 30 hours	To peak	

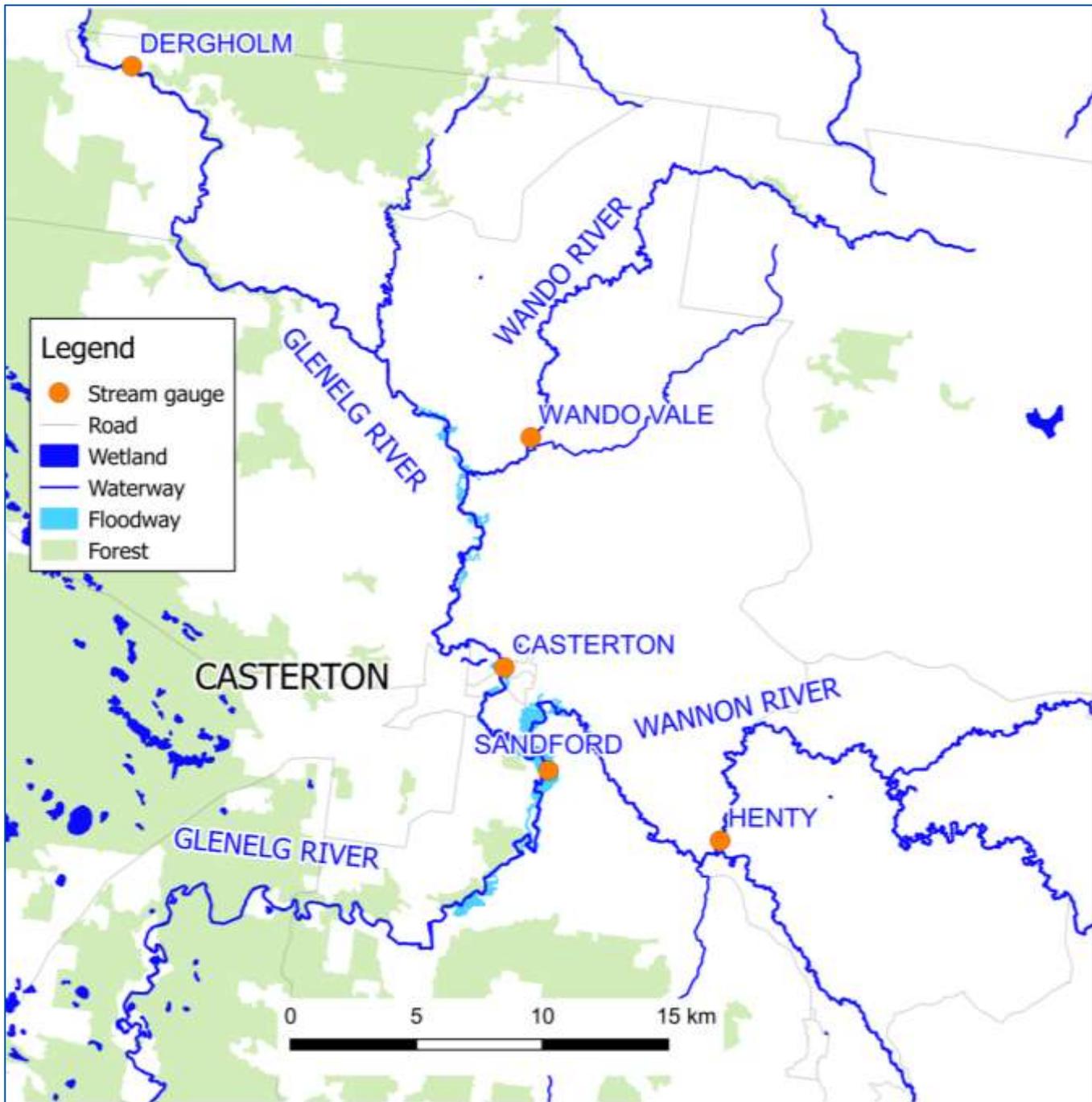
<i>Date of Peak at Wando</i>	<i>Wando Height (m)</i>	<i>Date of Peak at Casterton</i>	<i>Casterton Height (m)</i>	<i>Difference in hours</i>
25/10/1975 17:00	1.90	26/10/1975 07:00	4.75	14
09/10/1975 17:00	1.73	10/10/1975 00:00	3.38	7
16/10/1976 11:00	2.66	16/10/1976 21:00	4.66	10
18/09/1978 13:00	3.10	18/09/1978 22:00	5.82	9
10/10/1979 07:00	1.94	10/10/1979 15:00	4.52	8
08/09/1983 11:00	2.68	09/09/1983 01:00	5.78	14
26/08/1984 20:00	1.95	27/08/1984 02:00	4.71	6
17/09/1986 11:00	1.71	17/09/1986 22:00	4.00	11
19/07/1987 00:00	1.44	19/07/1987 03:00	3.97	3
25/07/1988 16:00	1.63	25/07/1988 21:00	4.03	5

Peak height data for the Wando River at the Wando Vale gauge compared to the Glenelg River at the Casterton gauge.

Appendix C1: Casterton Flood Emergency Plan

Casterton is located on the banks of the Glenelg River and lies within the Glenelg River catchment. The Glenelg River has a catchment area of approximately 12,000 km², with its point of discharge to Bass Strait at Nelson.

The catchment headwaters start in the Grampians which drain towards the west to Rockland Reservoir. From Rocklands the Glenelg River generally drains to the west until its confluence with the Chetwynd River upstream of Dergholm. The river then gradually turns to the south east and flows towards Casterton, with the Wando River contributing flows to the Glenelg River 8 km upstream of Casterton. The Wannon River contributes flows to the Glenelg River 4 km downstream of Casterton, refer to map below.



Influence of the Wando River

During the September 2016 flood the initial flood peak recorded in Casterton was from inflows from the Wando River (peak height 2.18m flow 3,940 ML recorded at the Wando Vale gauge 238223). Refer to the Casterton Flood Intelligence Card below for other flood events where the Wando River contributed to flooding in Casterton.

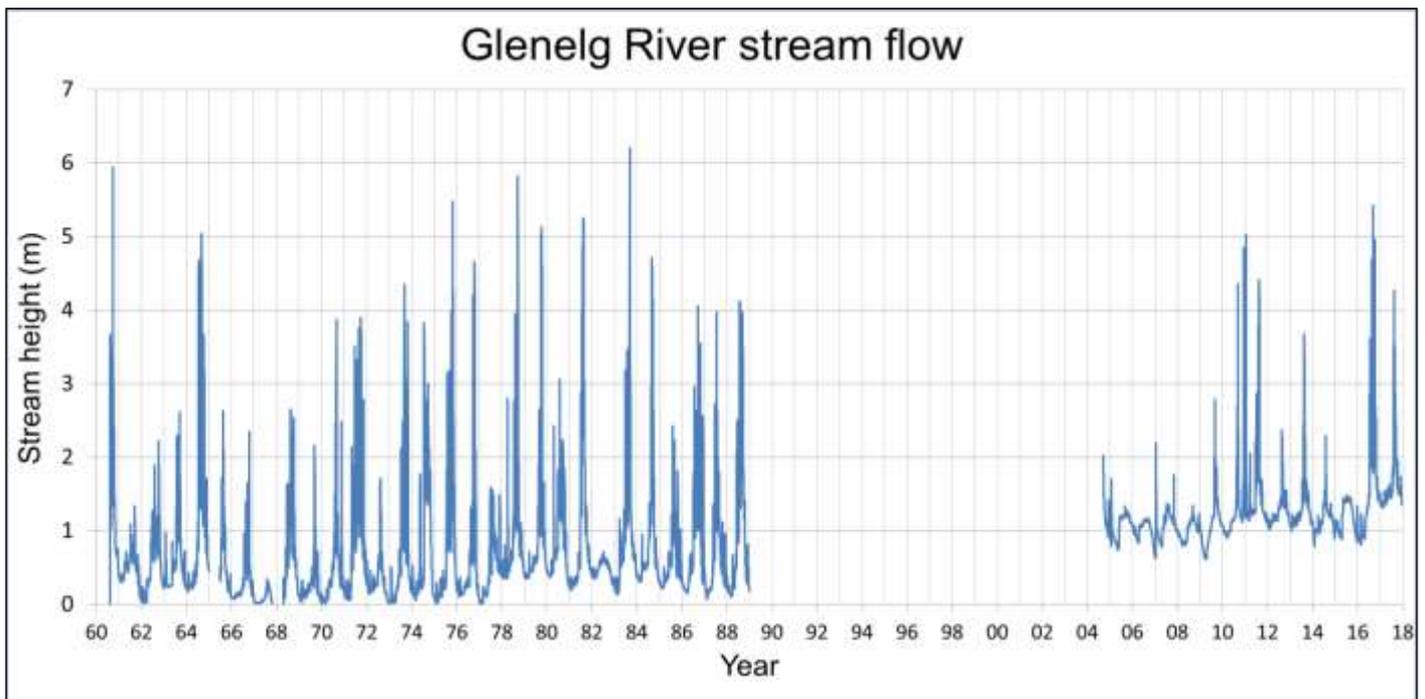
Influence of the Wannon River

The Wannon River contributes significant inflows to the Glenelg River 4 km downstream of Casterton. The peak 100 year ARI flow for the Wannon River is 69,120 ML/d compared to the Glenelg River 35,856 ML/d. If inflows from the Wannon River enter the Glenelg River when the Glenelg River is in flood, this will reduce the discharge capacity of the Glenelg River, causing floodwater to flow back upstream of the confluence (river junction). This is described as a backwater effect. An analysis undertaken as part of the Casterton Flood Study (BMT 2014 page 44) showed that flows from the Wannon River does not influence flood levels at Casterton for events up to and including the 100 year ARI event (this analysis assumed both waterways peaks coincided). To monitor the Wannon River flows during flood events, check Henty gauge 238228.

The Casterton Central Business District is located on the right hand bank of the Glenelg River, an incised valley that rises steeply to the east and west of the town. **During major flood events water breaks out of the Glenelg River and inundates the town centre from the north.** During minor flood events water inundates the low-lying land near the river. In addition to the major flood events experienced in Casterton the town has been subject to numerous smaller flood events. Floods typically occur in later winter and early spring. The table below provides a summary of notable Casterton flood events. Although there are significant gaps in the Glenelg River stream flow record, the graph below show how frequent flooding has occurred in the Glenelg River.

A summary of significant Casterton flood events.

Year	Outcome
1893/94	Highest flood recorded since the founding of the township in 1846
1906	Significant stock losses and damage to properties in the low part of town near the Glenelg River
1946	221mm of rain fell in four days. Glenelg River rose at a rate of 30cm per hour. The Major Mitchell monument on the Sandford Road was almost covered. Six Casterton men were awarded Silver bravery medals.
1956	Evacuation of a number of residents
1983	Evacuation of a number of residents
1991	Major flooding and evacuation of a number of residents
2010/2011	Minor flooding on the Glenelg River with public meetings held at Casterton (Casterton bridge water level 4.8m).
2016	Moderate flooding on the Glenelg River with public meetings held at Casterton (Casterton bridge water level 5.8 m).



Glenelg River stream flow records show how frequently of flood events in Casterton (Casterton gauge 1960 – 1990, Dergholm gauge 2004 – 2016).

Warning time

Typically there is a steep rise in flood levels 24 to 36 hours from rainfall. Peak river flows occur within 11 to 30 hours from rainfall. The Wando River flood peak travel time from the Wando Vale gauge to Casterton can take between 3 to 14 hours (with an average of 8 hours).

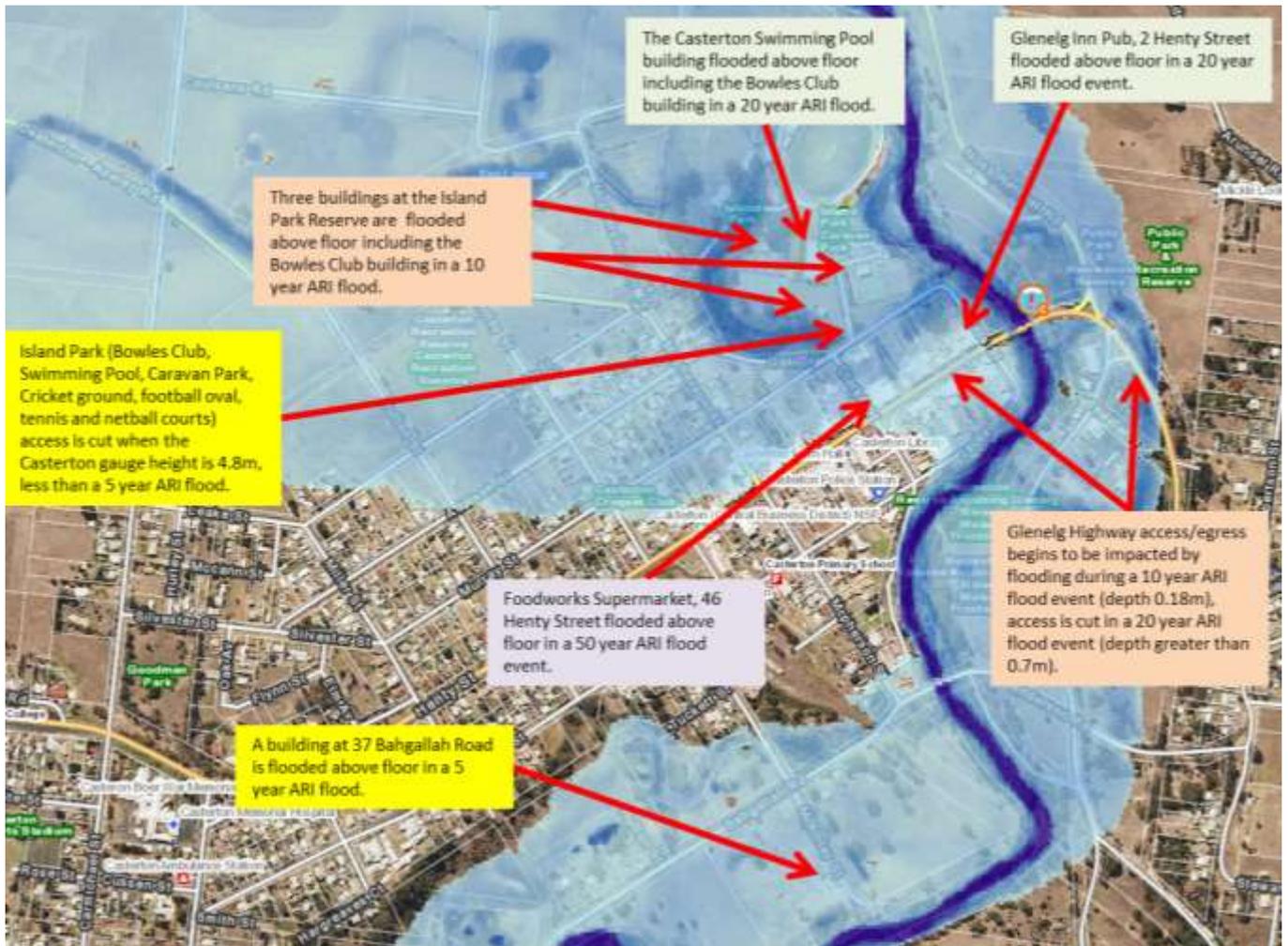
Bus Routes

The map below shows regional bus routes (red) over the 100 year flood extent (shaded blue). The map below indicates that access will be cut to a number of bus routes during a range of flood magnitudes.

Flood Impacts and Required Actions

Key assets at risk of flooding are listed in the table below.

Asset register				
Asset Name and location	Casterton gauge height (ARI)	Consequence / Impact	Mitigation/ Action	Lead Agency
Island Park (Bowles Club, Swimming Pool, Caravan Park, Cricket ground, football oval, tennis and netball courts)	4.8m (< 5 year flood)	Access/egress is cut.	Evacuate before flood level reaches 4.8 m	Victoria Police
Building at 37 Bahgallah Road	5.82 m (5 year flood)	A building is flooded above floor	Council relief Centre on stand-by	Glenelg Shire
Glenelg Highway	6.1 m (10 year flood)	Glenelg Highway access/egress begins to be impacted by flooding	Undertake traffic management as needed.	Regional Roads Victoria
Island Park Caravan Park, Carmichaels Drive	6.1 m (10 year flood)	Grounds significantly impacted		
Casterton Bowles Club, Carmichaels Drive	6.1 m (10 year flood)	Building flooded above floor	Sandbag buildings as needed.	VICSES
Glenelg Highway	6.38 m (20 year flood)	Glenelg Highway access/egress is cut by flooding, depth of water greater than 0.7m.	Undertake traffic management as needed.	Regional Roads Victoria
Casterton Swimming Pool Buildings, Carmichaels Drive	6.38 m (20 year flood)	Access/egress is cut to Glenelg Highway	Deploy road closure signs and undertake traffic management	Regional Roads Victoria
Glenelg Inn Pub, 2 Henty Street	6.38 m (20 year flood)	Flooded above floor	Sandbag buildings as needed.	VICSES
Foodworks Supermarket, 46 Henty Street.	6.64 m (50 year flood)	Flooded above floor	Sandbag buildings as needed.	VICSES



Casterton 100 year ARI flood extent with a summary of key flood impacts.

For more detailed information regarding buildings and roads impacted refer to the Casterton Flood Intelligence Card and flood damages map below. Also refer to the Casterton flood depth maps in **Appendix E**.

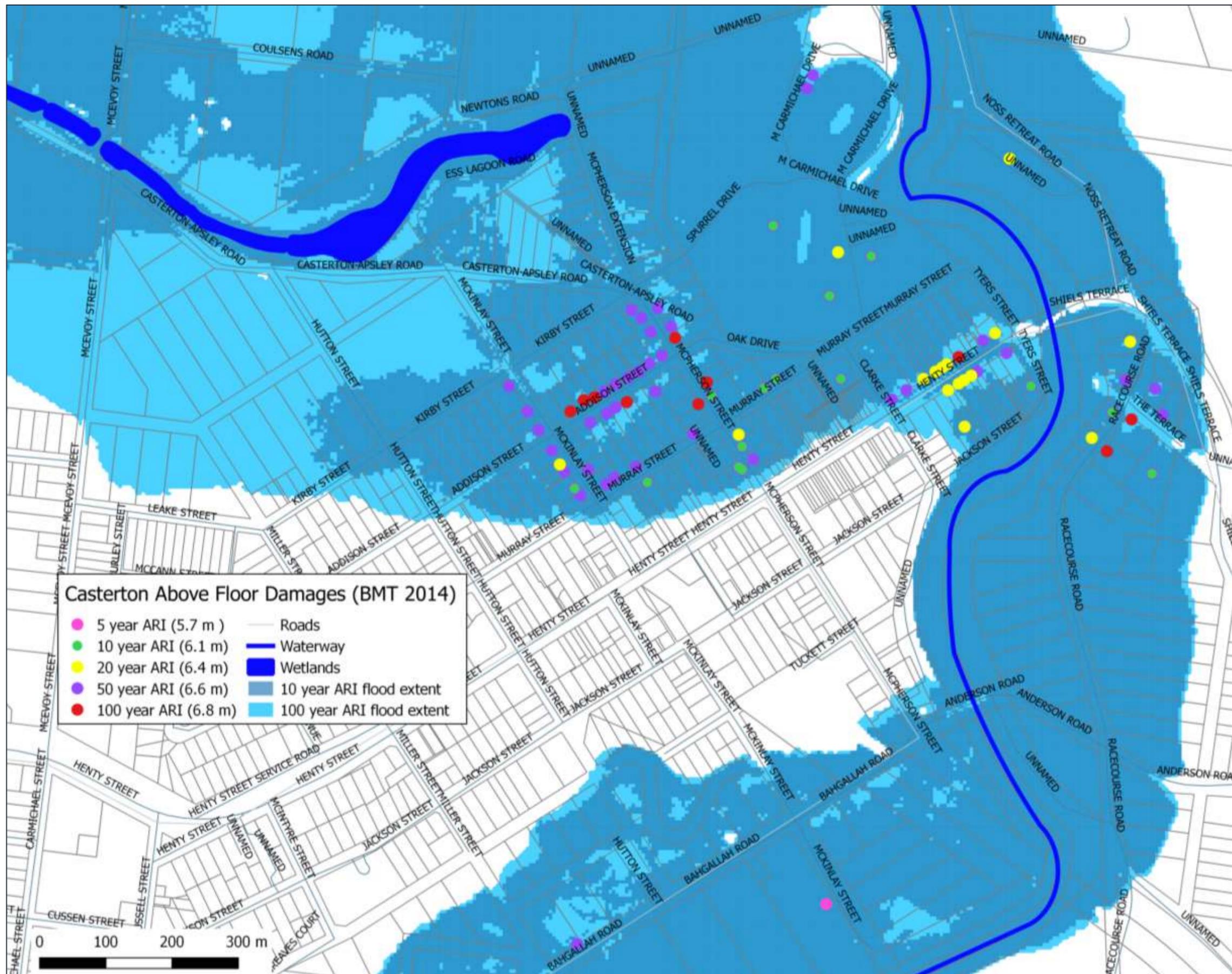
Casterton Flood Intelligence Card

Glenelg River at Casterton gauge 238212

Flood travel time						Time from start of rain to steep rise in floodwater at Casterton 24 - 36 hours			
						Time between Wando Vale gauge (Wando River) and Casterton peak 3 -14 hours, average 8 hours			
						Time between Dergholm and Casterton peak 11 - 30 hours			
						Riverine flooding duration: 2 days			
Wando River at Wando Vale gauge height 238223 (m)	Glenelg River at Dergholm gauge height 238211 (m)	Glenelg River at Casterton gauge height 238212 (m)	Average Recurrence Interval (ARI) (BMT WBM, 2014)	Glenelg River at Casterton Design Flows (ML/d) BMT 2014	Casterton damages total number buildings flooded (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Roads Impacted	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
1.25 (885 ML/d)	4	3.8	Minor Flood Level July 1995						VICSES to monitor (Local Police, CFA or DELWP may support) Casterton – Naracoorte Rd may start to be impacted north of Casterton. Glenelg Shire advise occupiers of Casterton Recreation reserve of potential flooding. VICSES advise farmers lift machinery and pumps to higher ground
		4.2				Where the Glenelg River exceeds 4.2m without a prediction (may be due to inflows from the Wando River. This happened during the 2016 flood event)			Glenelg Shire activate Island Park Flood Response Guidelines where water level exceeds 4.2m.
		4.8				Access to Island Park Cut Off		Murray Street, Clarke Street, Tyers Street, Henty Street.	Glenelg Shire close Island Park and deploy road closure signs as needed. Glenelg Shire deploy road closure signs as needed at Murray Street between Clarke Street and Tyers Street. Council – road closure at Tyers Street between Henty Street and Clarke Street.
		4.9			20 (0)				
		5.0				Predictions for the Glenelg River @ Casterton 5m or above.			Glenelg Shire to activate Flood Response Guidelines - Island Park where prediction is 5m or above (appendix C1 (b)). VICSES – establish a community sandbag location.
	5.03		January 2011						
	4.8	5.2	Moderate Flood Level approx. 2010		36 (0)	Floodwater starts to impact areas between the river and Racecourse Road. Water starts to impact area near corner of Murray Street and Tyers Street. Access to Casterton Recreation reserve cut off			Incident Control Centre established DCP at DELWP / CFA Office Casterton
		5.82	5	14,170	96 (1)		A building 37 Bahgallah Road flooded above floor (evacuation is possible via McKinlay Street). Early on houses along Racecourse Road and The Terrace become isolated (evacuation is possible via Shiels Terrace, Glenelg Highway). Best option to evacuate these buildings before access/egress is likely to be cut when water level exceeds 5.9m at the Casterton gauge.	Racecourse Road depth 0.2m, Bahgallah Road depth 0.6m, Murray Street depth 0.5m, McPherson Street depth 0.4m Tyers Street depth 2.1m	Glenelg Shire deploy road closure signs as needed at Murray Street between Henty Street and McKinlay Street, Clarke Street, Spurrel Drive, Oak Street, Racecourse Road, Bahgallah Road, Anderson Road Glenelg Shire ensure relief Centre is on Stand-by. Relief Centre located at Casterton Town Hall Henty St. The town hall has facilities to accommodate up to 300 people.
		5.9			113 (7)				
	5.1	6.0	Major Flood Level		142 (12)	Glenelg Highway access/egress will begin to be impacted by flooding. Casterton-Naracoorte Road and the Glenelg Highway/Henty Street is likely to be closed. Consider evacuation of areas around Racecourse Road, Murray Street, McPherson Street, Addison Street, and Mckinlay Street.			VICSES sandbag Vinnies flooding over floor 0.01 at 10 year flood event.
1.61			October					Casterton – Dartmoor Road at Stokes Bridge,	

(1,823 ML/d)			1996					Casterton – Naracoorte Road (Ken Black's and Roseneath, Dunan Road and Boiling Downs, Lower Coleraine Road, Ridge Road, Sandford – Bahgallah Road, Penola Road, Retreat Estate Road, Murray Street, McPherson Street, Addison Street, Tyre Street, Clarke Street, Anderson Road, Racecourse Road, Bahgallah Road (near Stock Bridge and Wombwell's), Myaring – Pieracle Road, Dartmoor – Hamilton Road.	
2.18 (3,940 ML/d)	5.3	6.1	September 2016	19,008	149 (16)			Anderson Road, Addison Street, Bahgallah Road (from McPherson Street to Old Mt Gambier Road), Ferry Hills Road, Murray Street (from McPherson Street which now includes Clarke Street), Murray Street and Tyers Street (near the bottom pub), Noss Retreat Road (from Section Bridge), Noss Retreat Road (from Glenelg Highway to Arundel Road) Racecourse Road, Retreat Hummocks Road, Section Road (from Casterton Apsley Road to Noss Retreat Road), Portland Casterton Road (at the intersection of the Glenelg Highway, Casterton Apsley Road (between Dergholm and Casterton)	
1.25 (885 ML/d)		6.14	10 year flood 1975	19,008	149 (16)		15 additional buildings flooded above floor: x9 Murray Street (2, 8, 12, 14, 15, 16, 31), 6 The Terrace, x6 Henty Street (1-5, 126), 17 McKinlay Street, 14-24 Clarke Street, 10 Racecourse Road, 35 McPherson Street. This includes 3 buildings at 2 Murray street, the Casterton Bowls Club.	Racecourse Road depth 0.7m, Bahgallah Road depth 1.1m, Murray Street depth 1m, McPherson Street depth 0.8m Tyers Street depth 2.5m Casterton-Naracoorte Road depth 0.3m	Regional Roads Victoria deploy road closure signs as needed at Casterton Naracoorte Rd Closed. Glenelg Shire deploy road closure signs as needed at McKinlay north of Henty Street, Hutton Street north of Addison Street, Addison Street east of Hutton Street, Kirby Street east of Miller St and McEvoy Street north of Mitchell Street
1.98 (3,457 ML/d)		6.3	15 year event August 1983	21,600					
		6.38	20	23,933	156 (31)	Deep flooding along the Glenelg Highway has caused access/egress to be cut, causing Casterton to be isolated.	Additional 15 buildings flooded above floor: Henty Street (2-10, 13-28, 30-32, 34, 38), Noss Retreat Road (19), McPherson Street (38), Racecourse Road (2), McKinlay Street (23), Murray Street (2).	Racecourse Road depth 0.9m, Bahgallah Road depth 1.3m, Murray Street depth 1.3m, McPherson Street depth 1m Tyers Street depth 2.8m Casterton-Naracoorte Road depth 0.6m Glenelg Highway depth 0.3m	Regional Roads Victoria deploy road closure signs as needed at the Glenelg Highway. The town is split into two with no access to Casterton from the east side of the Glenelg River. VICSES sandbag Foodworks Supermarket flooding over floor 0.15m at 50 year ARI.
		6.45	March 1946			Over 200 people were evacuated from 70 flooded houses. All bridges were washed away causing the town to become isolated.			
		6.64	50	30,672	162 (70)		Additional 40 buildings flooded above floor: 5 The Terrace, Henty Street (1-11, 46-52) including Foodworks Supermarket, McPherson Street (34, 41, 52-55, 57), Racecourse Road (2, 3,16), McKinlay Street (15, 20, 21, 25, 27, 31, 33), Addison Street (6- 8, 10, 12-17), Murray Street (2, 30, 34, 36) 58 Bahgallah Road	Racecourse Road depth 1.1m, Bahgallah Road depth 1.4m, Murray Street depth 1.6m, McPherson Street depth 1.3m Tyers Street depth 3.1m Casterton-Naracoorte Road depth 0.7m Glenelg Highway depth 0.6m	
		6.80	100	35,856	166 (80)		Additional 10 buildings flooded above floor: Henty Street (16-22), 4 The Terrace , McPherson Street (42, 45),	Racecourse Road depth 1.2m, Bahgallah Road depth 1.5m, Murray Street depth 1.8m, McPherson Street depth 1.5m	

							Racecourse Road (17), Addison Street (4,11, 18, 20, 22),	Tyers Street depth 3.2m Casterton-Naracoorte Road depth 0.8m Glenelg Highway depth 0.7m	
		10.90	Probable Maximum Flood (PMF)		269 (226)				
		After Peak	After Peak			Flooding down stream of Casterton generally affects rural areas, and camping areas along the Glenelg River in the Lower Glenelg National Park. Donovan's (SA) and Nelson boat moorings.			VICSES – Community Information re flooding downstream of Casterton. VICSES – to advise SASES re Donovan's



Casterton Property Inundation Table (BMT 2014)

Colours used in the property table below are the same used in the Casterton above floor damages map above. Pink, buildings flooded above floor in a 5 year ARI flood event. Green, buildings flooded above floor in a 10 year ARI flood event, etc.

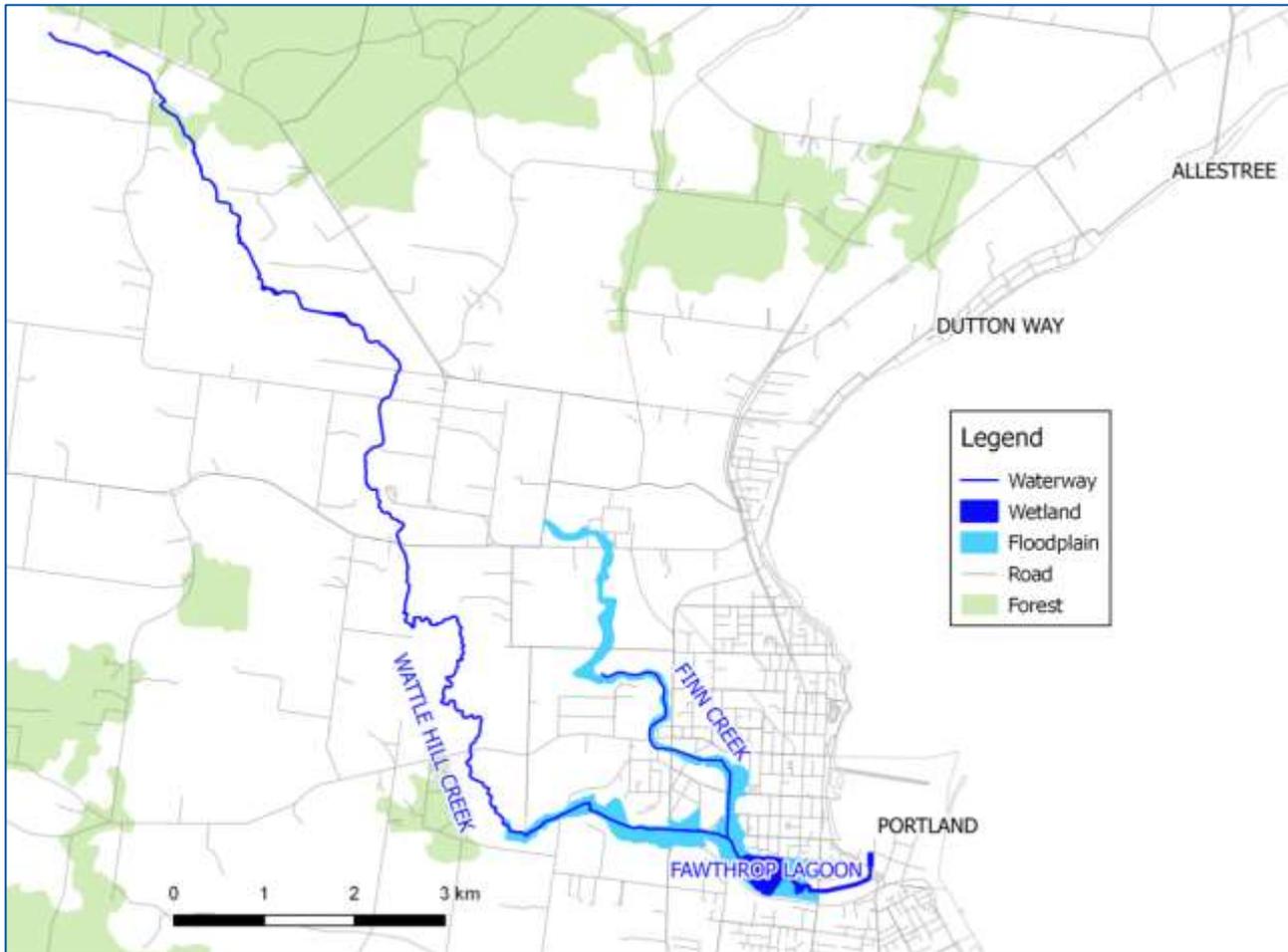
ADDRESS	Floor Level (m AHD)	Maximum Depth of Flooding on Property for each ARI event (m)					Depth of known over-floor flooding at property for each ARI event (m)					Type of Building and comments
		5	10	20	50	100	5	10	20	50	100	
37 BAHGALLAH ROAD	42.92	4.94	5.31	5.45	5.60	5.71	0.06	0.61	0.79	0.98	1.1	
2 MURRAY STREET	44.35	3.24	3.68	3.94	4.21	4.38		0.44	0.71	0.98	1.14	
12 MURRAY STREET	44.39	0.14	0.69	0.97	1.24	1.41		0.41	0.68	0.96	1.13	Shed
8 MURRAY STREET	44.39	0.88	1.42	1.69	1.96	2.13		0.41	0.68	0.96	1.12	Jeffrey's Bros
31 MURRAY STREET	44.43	0.29	0.95	1.23	1.52	1.69		0.37	0.65	0.94	1.11	Industrial building
2 MURRAY STREET	44.48	3.24	3.68	3.94	4.21	4.38		0.35	0.61	0.88	1.05	
36 MCPHERSON STREET	44.55	0.28	0.83	1.11	1.39	1.55		0.25	0.53	0.81	0.98	Old cordial factory
2 MURRAY STREET	44.52	3.24	3.68	3.94	4.21	4.38		0.22	0.49	0.77	0.93	Casterton Bowls Club
6 THE TERRACE	43.99	1.78	2.20	2.41	2.64	2.79		0.21	0.42	0.66	0.83	
126 HENTY STREET	44.61		0.37	0.65	0.93	1.10		0.19	0.47	0.75	0.92	Shed
17 MCKINLAY STREET	44.62		0.55	0.84	1.14	1.32		0.18	0.47	0.77	0.95	House
1-5 HENTY STREET	44.23	1.23	1.58	1.78	2.00	2.15		0.16	0.36	0.59	0.75	Industrial complex
14-24 CLARKE STREET	44.68	0.93	1.47	1.74	2.01	2.17		0.12	0.38	0.65	0.81	House
14-16 MURRAY STREET	44.7	0.37	0.92	1.19	1.47	1.64		0.1	0.38	0.66	0.83	Dunlop
10 RACECOURSE ROAD	44.36	0.13	0.50	0.70	0.94	1.10		0.02	0.18	0.45	0.64	Industrial Shed
35 MCPHERSON STREET	44.79		0.55	0.83	1.11	1.27		0.01	0.29	0.57	0.74	Vinnies
23 MCKINLAY STREET	44.83		0.32	0.61	0.92	1.10			0.26	0.57	0.74	House
2 MURRAY STREET	44.78	3.24	3.68	3.94	4.21	4.38			0.26	0.53	0.69	Memorial Swimming Pool
2 RACECOURSE ROAD	44.47	1.26	1.64	1.86	2.09	2.26			0.22	0.48	0.65	Dowfarm Machinery
17-19 HENTY STREET	44.7	0.68	1.03	1.23	1.44	1.59			0.19	0.45	0.6	Shop
17-19 HENTY STREET	44.75	0.68	1.03	1.23	1.44	1.59			0.13	0.4	0.55	Industrial Building
25 HENTY STREET	44.42	0.74	1.09	1.29	1.50	1.64			0.13	0.37	0.55	Shed
19 NOSS RETREAT ROAD	44.84	5.25	5.68	5.95	6.23	6.39			0.12	0.4	0.56	Unknown building
21-23 HENTY STREET	44.82	0.67	1.03	1.22	1.43	1.58			0.1	0.36	0.51	Industrial Building
34 HENTY STREET	44.88	1.10	1.60	1.87	2.13	2.29			0.06	0.33	0.48	Secondhand dealer
38 HENTY STREET	44.9	1.28	1.79	2.06	2.32	2.49			0.05	0.33	0.48	
13-15 HENTY STREET	44.84	0.61	0.96	1.15	1.38	1.53			0.05	0.31	0.46	Almar Zaadstra
24-28 HENTY STREET	44.89	1.13	1.60	1.87	2.15	2.31			0.04	0.3	0.46	Shop
38 MCPHERSON STREET	45.05	0.40	0.95	1.22	1.50	1.67			0.03	0.31	0.48	House
30-32 HENTY STREET	44.91	0.96	1.45	1.72	1.99	2.15			0.03	0.29	0.44	Shop
2-10 HENTY STREET	44.9	2.51	2.96	3.23	3.50	3.67			0.01	0.27	0.42	Glenelg Hotel
16 RACECOURSE ROAD	44.5	0.49	0.81	1.00	1.22	1.37				0.25	0.43	House
21 MCKINLAY STREET	45.1		0.36	0.65	0.96	1.14				0.3	0.47	House
5 THE TERRACE	44.6	1.74	2.17	2.42	2.79	2.98				0.29	0.47	House
53 MCPHERSON STREET	45.1		0.19	0.46	0.75	0.91				0.28	0.45	House
41 MCPHERSON STREET	45.09	0.38	0.93	1.21	1.49	1.66				0.27	0.44	Industrial building
16 ADDISON STREET	45.12		0.30	0.57	0.88	1.05				0.27	0.44	House
17 ADDISON STREET	45.14		0.59	0.87	1.16	1.33				0.26	0.43	House

ADDRESS	Floor Level (m AHD)	Maximum Depth of Flooding on Property for each ARI event (m)					Depth of known over-floor flooding at property for each ARI event (m)					Type of Building and comments
		5	10	20	50	100	5	10	20	50	100	
6 ADDISON STREET	45.12		0.12	0.40	0.68	0.85				0.25	0.42	House
12 ADDISON STREET	45.14		0.28	0.55	0.85	1.02				0.25	0.41	House
11 HENTY STREET	44.89	0.76	1.11	1.30	1.52	1.67				0.25	0.4	Laundry
27 MCKINLAY STREET	45.17		0.29	0.62	0.95	1.13				0.24	0.42	House
15 ADDISON STREET	45.15		0.14	0.43	0.73	0.90				0.24	0.41	House
1-5 HENTY STREET	44.89	1.23	1.58	1.78	2.00	2.15				0.24	0.39	Hardware
13 ADDISON STREET	45.17	0.16	0.71	0.99	1.28	1.45				0.22	0.39	House
14 ADDISON STREET	45.17		0.41	0.68	0.98	1.15				0.22	0.39	House
2 MURRAY STREET	45.15	3.24	3.68	3.94	4.21	4.38				0.22	0.38	
54 MCPHERSON STREET	45.17	0.99	1.55	1.82	2.09	2.26				0.21	0.38	House
34 MCPHERSON STREET	45.16	0.06	0.60	0.87	1.15	1.32				0.2	0.37	House
33 MCKINLAY STREET	45.24		0.70	1.04	1.36	1.54				0.18	0.36	House
2 RACECOURSE ROAD	44.76	1.26	1.64	1.86	2.09	2.26				0.17	0.34	Shed
30 MURRAY STREET	45.22	0.08	0.62	0.90	1.19	1.36				0.15	0.32	House
8 ADDISON STREET	45.23		0.25	0.52	0.81	0.98				0.15	0.32	House
46-52 HENTY STREET	45.09	0.65	1.18	1.44	1.71	1.87				0.15	0.31	Foodworks
10 ADDISON STREET	45.24		0.38	0.65	0.95	1.11				0.14	0.31	House
15 MCKINLAY STREET	45.26		0.50	0.78	1.08	1.26				0.13	0.3	House
36 MURRAY STREET	45.26		0.64	0.92	1.22	1.39				0.12	0.29	House
2 MURRAY STREET	45.25	3.24	3.68	3.94	4.21	4.38				0.12	0.28	
52 MCPHERSON STREET	45.26	1.19	1.75	2.02	2.30	2.46				0.11	0.28	House
2-10 HENTY STREET	45.07	2.51	2.96	3.23	3.50	3.67				0.1	0.25	Hotel Rooks
58 BAGGALLAH ROAD	43.46		1.02	1.23	1.44	1.56				0.09	0.2	House
3 RACECOURSE ROAD	44.86	0.31	0.74	1.00	1.39	1.60				0.07	0.24	Visitor center?
25 MCKINLAY STREET	45.35		0.30	0.60	0.92	1.10				0.05	0.23	House
7 ADDISON STREET	45.32	0.39	0.94	1.22	1.50	1.67				0.05	0.22	House
34 MURRAY STREET	45.33		0.61	0.89	1.18	1.36				0.05	0.22	House
57 MCPHERSON STREET	45.34		0.37	0.64	0.94	1.11				0.05	0.22	House
55 MCPHERSON STREET	45.33		0.30	0.58	0.86	1.03				0.05	0.22	House
31 MCKINLAY STREET	45.37		0.69	1.02	1.35	1.53				0.04	0.22	House
20 MCKINLAY STREET	45.36		0.42	0.70	1.00	1.17				0.03	0.2	House
46-52 HENTY STREET	45.25	0.65	1.18	1.44	1.71	1.87				0.02	0.18	Foodworks
22 ADDISON STREET	45.4		0.24	0.53	0.84	1.02					0.17	House
4 THE TERRACE	44.88	0.56	0.90	1.12	1.38	1.59					0.15	Industrial building
18 ADDISON STREET	45.44		0.42	0.71	1.01	1.18					0.13	House
17 RACECOURSE ROAD	44.78	0.62	0.96	1.17	1.41	1.58					0.11	House
42 MCPHERSON STREET	45.44		0.49	0.76	1.04	1.20					0.09	House
11 ADDISON STREET	45.48	0.35	0.89	1.17	1.46	1.63					0.07	House
20 ADDISON STREET	45.52		0.30	0.59	0.89	1.07					0.05	House
16-22 HENTY STREET	45.31	1.58	2.04	2.31	2.58	2.74					0.02	Shop
4 ADDISON STREET	45.52	1.19	1.75	2.01	2.29	2.45					0.02	House

ADDRESS	Floor Level (m AHD)	Maximum Depth of Flooding on Property for each ARI event (m)					Depth of known over-floor flooding at property for each ARI event (m)					Type of Building and comments
		5	10	20	50	100	5	10	20	50	100	
45 MCPHERSON STREET	45.51	0.19	0.74	1.02	1.30	1.47					0.02	House

Appendix C2: Portland Flood Emergency Plan

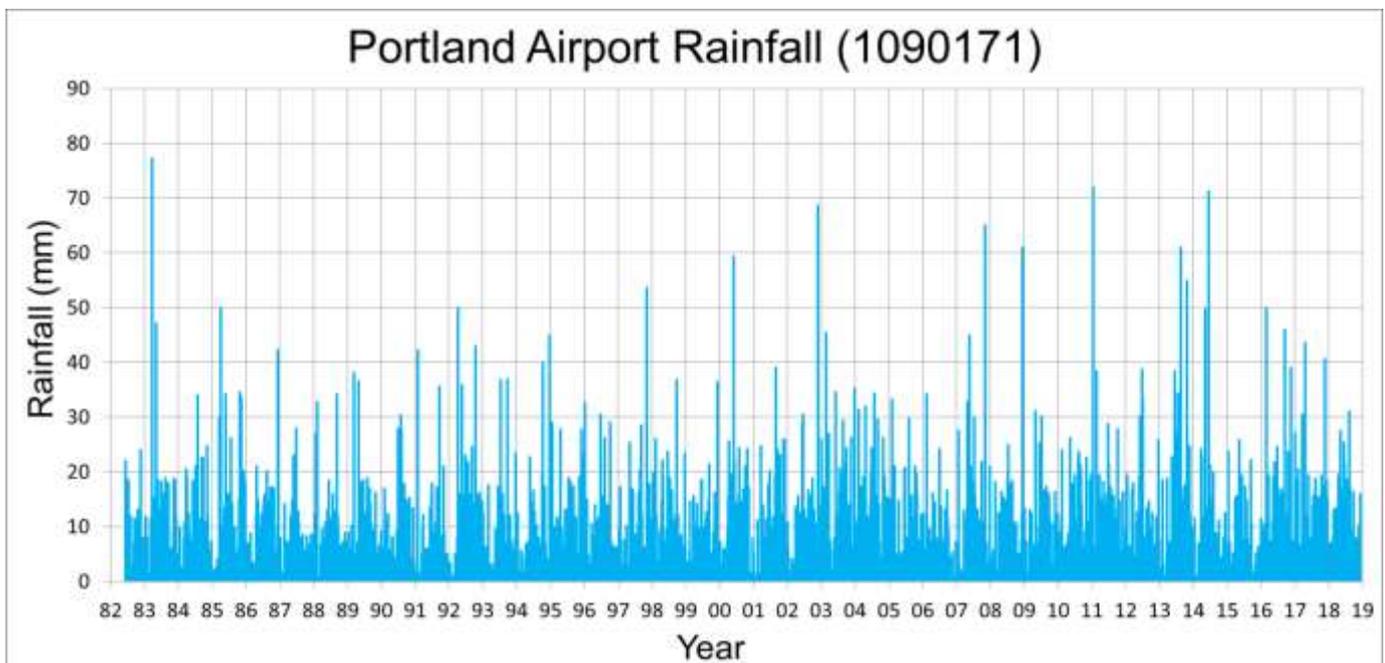
Portland is impacted by flooding from Wattle Hill Creek and Finn Creek, refer to map below. Unfortunately there is no stream or rainfall gauge monitoring to provide flood warning for the community. Emergency management agencies rely on local flood observers to provide early warning regarding flood impacts, refer to observers listed in Appendix F.



Historic Flood Events

The Glenelg Shire have reported recent flood events have occurred in Portland during 2012, 2013, 2014 and 2016, the 2013 flood being the largest recent event. Refer to the table and graph below for a summary of recent significant rainfall events. Rainfall data was taken from the Portland Airport rain gauge (BOM Automatic Weather Station 1090171).

Date	Highest daily rainfall	Monthly Rainfall	Comments
22 nd June 2012	38 mm	172 mm	
14 th August 2013	61 mm	255 mm	very wet leading up to the flood event, 332 mm over June and July
14 th June 2014	71 mm	199 mm	
9 th September 2016	46 mm	161 mm	very wet leading up



Portland rainfall records (source BOM Automatic Weather Station 1090171).



Flooding at Kerrs Road on the 15th of August 2013(Source: Glenelg Shire).



Flooding at Kerrs Road on the 15th of August 2013(Source: Glenelg Shire).



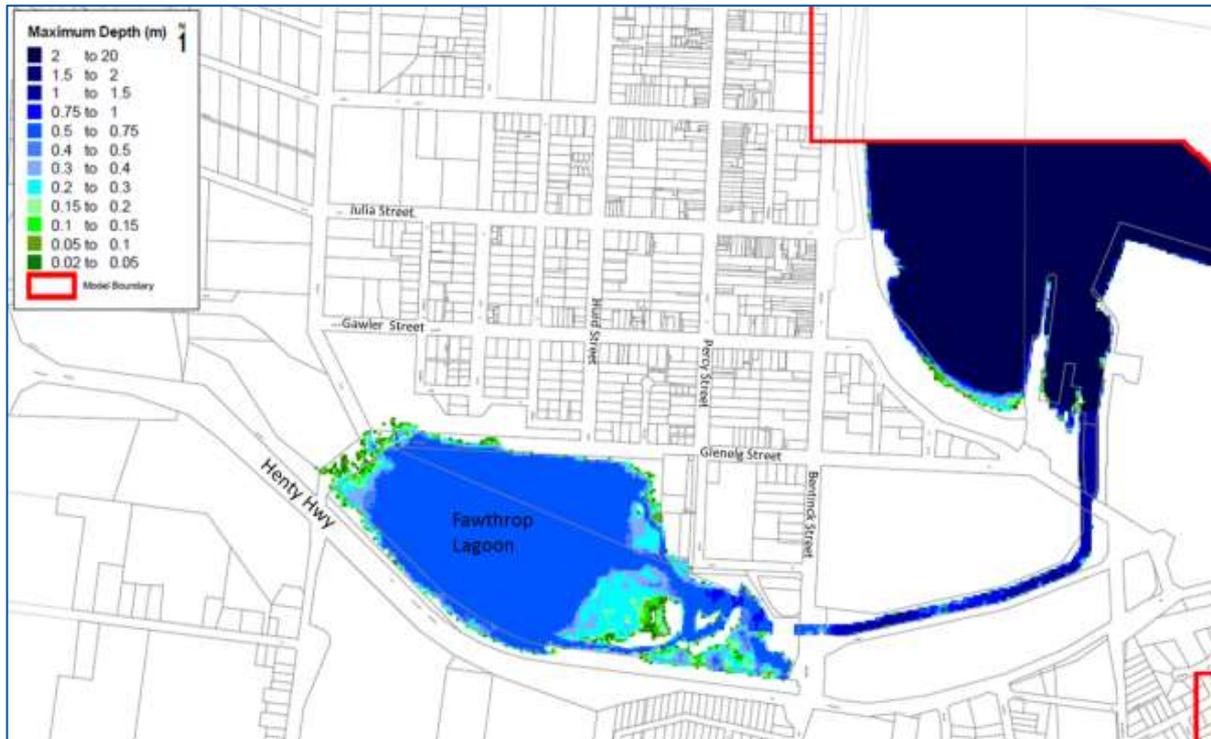
Flooding at Clarkes Street on the 14th of August 2013(Source: Glenelg Shire).

Flood Mitigation

In Portland there is a small levee immediately upstream of Fawthrop Lagoon that is overtopped during a 10 year flood event.

Storm surge flooding

During a 100 year ARI storm surge event (with no riverine flooding), seawater fills Fawthrop Lagoon with only minor localised flood impacts, refer to map below. This event is unlikely to cause increases in flooding upstream of Fawthrop Lagoon.



Portland 10 year ARI storm surge flood event (approximately the same impact for a king tide flood event) (source Cardno 2011).

The Bureau of Meteorology provided a severe weather warning for the storm surge event on the 24th of June 2014. Refer to the picture below of rough seas at Portland that was taken during this storm surge event.



Rough seas at the Portland Peir during the June 2014 storm surge event.

Influence of storm surge and king tides

The Glenelg Shire have highlighted that Portland has been impacted by several king tide flood events, causing similar flood impacts to storm surge events, refer to map above. Inflows from the king tide events also fills Fawthrop Lagoon, causing nuisance flooding, impacting access to walking tracks and adjacent roads surrounding Fawthrop Lagoon.

The Portland flood study (Cardno 2011) provides evidence that riverine flooding and extreme sea levels are unlikely to occur simultaneously. During the 1946 flood event (500 year streamflow ARI) Portland tide records show that the peak sea level during the flood was 0.5m (0.22 year ARI tide event).

An analysis was undertaken to determine the appropriate downstream tide boundary condition to use for the Portland design flood events. An assessment of the Portland tidal data and streamflow from Surry and Merri Rivers indicated that there is no discernible correlation between riverine flood events and extreme tidal levels. It was concluded that these two variables are independent of each other. It was determined that the probability of a 100 year flood event occurring in conjunction to a 100 year ARI tidal event would be approximately 1 in 10,000, too conservative to use for flood planning and mitigation.

Warning time

There is steep rise in flood levels 6 to 12 hours from rainfall, peak river flows occur within 12 to 24 hours from rainfall. Given there is no stream monitoring data available, there is uncertainty in these estimates, they should be used only as a guide.

Bus Routes

The map below shows regional bus routes (red) over the 100 year flood extent (shaded blue). The map below indicates that access will be cut to a number of bus routes during a range of flood magnitudes.



Portland bus routes (red) over the 100 year flood extent.

Flood Impacts and Required Actions

It is important to note that due to the lack of recorded stream and rainfall data for Portland there is considerable uncertainty with the design flood extent mapping and above floor building damage estimates. Buildings subject to above floor flooding were defined using estimates from the Portland Flood Study (Cardno 2011), combined with anecdotal information from the Glenelg Shire, Portland VICSES Unit members and members of the Portland community. Given that no floor level survey was undertaken as part of the flood study, these figures are based on the assumption that all building floor levels are 300mm above ground. These building damage estimates should be used as a guide only. Key assets estimated to be at risk of flooding are listed in the table below.

Asset register				
Asset Name and location	Portland design ARI event	Consequence / Impact	Mitigation/ Action	Lead Agency
Walking and riding tracks adjacent to Fawthrop Lagoon	< 5 year flood	Access/egress is cut	Deploy road closure signs as needed.	Glenelg Shire
Kerrs Road	5 year flood	Access/egress may be impacted by flooding	Deploy road closure signs as needed	Glenelg Shire
Kerrs Road	10 year flood	Access/egress is likely to be cut.	Deploy road closure signs and undertake traffic management	Glenelg Shire
Units at 10 Smith Street.	10 year flood	Access/egress to units in Smith Street is likely to be cut.	Evacuate the units before access is cut.	Victoria Police
Portland Railway Operations Centre (Henty Court)	10 year flood	Access/egress is likely to be cut and buildings may start to be impacted by flooding	Evacuate the buildings and car park before access is cut.	Victoria Police
Portland Railway line, adjacent to Anderson Street	10 year flood	Begins to be impacted by flooding.		
Graham Husson Fauna Park (Otway Street)	10 year flood	Site begins to be impacted by flooding.	Relocate animals as needed.	Glenelg Shire to notify landholder
Houses may be flooded above floor; 76 Henty Street 4 Clarke Street and 5 Portland Court	20 year flood	Buildings may be flooded above floor.	Sandbag buildings as needed.	VICSES
Council Toilet blocks in Hood Street	20 year flood	Site begins to be impacted by flooding.	Deploy signs as needed.	Glenelg Shire
Wannon Water Pump Station (Percy Street)	20 year flood	Begins to be impacted by flooding.	Sandbag as needed.	VICSES
Portland Powerhouse Motor and Car Museum (Glenelg Street)	20 year flood	Begins to be impacted by flooding.	Sandbag as needed.	VICSES
Houses may be flooded above floor; 166 Wyatt Street, x4 Bentinck Street (7, 9, 11, 13) x2 Henty Street (72, 74) x7 Clarke Street (6, 7, 8, 9, 10, 11, 13) x2 Portland Court (4, 6) x12 Blair Street (67, 69, 71, 73, 75, 79, 81 (x5 units).	50 year flood	Buildings may be flooded above floor.	Sandbag buildings as needed.	VICSES
Portland Special Development School 75 – 77 Henty Street	50 year flood	The school grounds of the Portland Special Development School is impacted by flooding, access/egress is cut to the west.	Evacuate the buildings of the school before access is cut. Floodwater is a hazard to students attending the school.	Victoria Police
Units at 10 Smith Street (starting at Unit 1)	50 year flood	Buildings may be flooded above floor.	Sandbag as needed.	VICSES
Fawthrop Community Centre (Hood Street)	50 year flood	Access/egress is cut (building could be impacted above floor in a 100 year flood)	Evacuate the building before access is cut.	Victoria Police
Henty Highway at two locations, where Wattle Hill Creek (adjacent to Alexandra Park) and Finn Creek (adjacent to Finn Street) intersect the	50 year flood	Access/egress is cut to the Henty Highway	Deploy road closure signs and undertake traffic management	Regional Roads Victoria

Henty Highway				
Henty Highway south of Fawthrop Lagoon (different location from what's listed above)	100 year flood	Henty Highway access/egress may be impacted by flooding	Undertake traffic management as needed.	Regional Roads Victoria

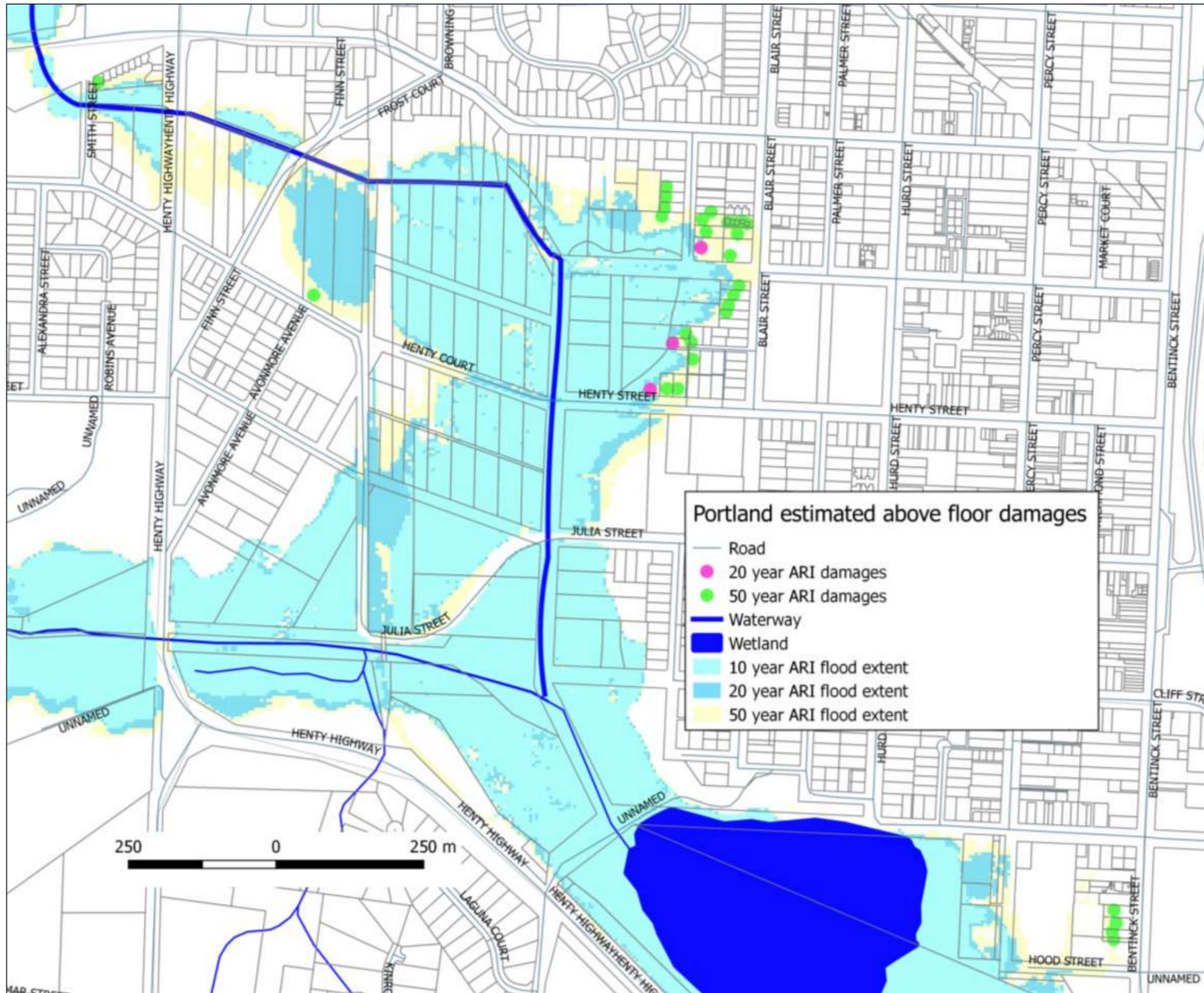
For more detailed information regarding buildings and roads impacted refer to the Portland Flood Intelligence Card, flood damages map and key flood impacts map below. Also refer to the Portland flood depth maps in Appendix E.

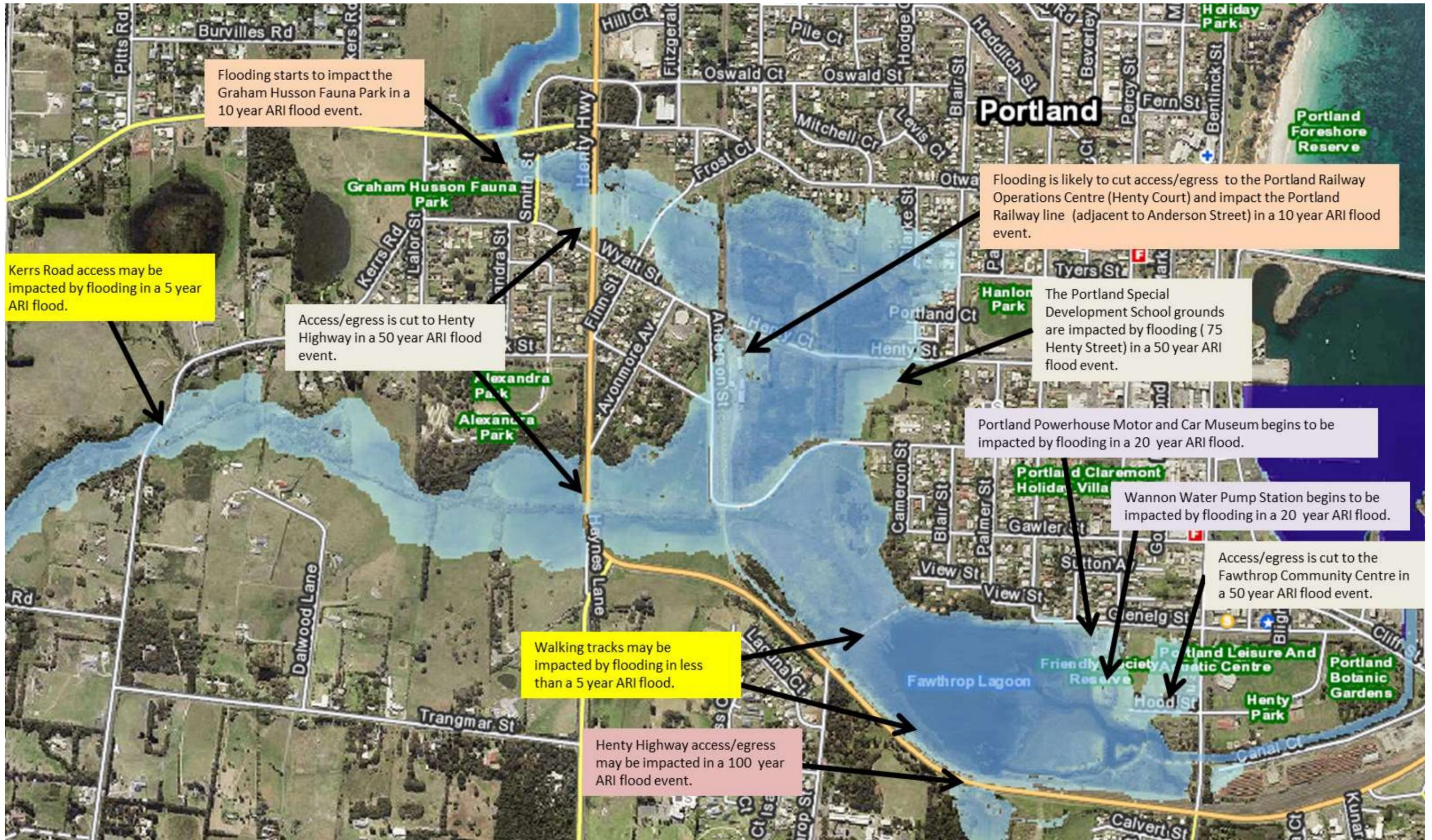
Portland Flood intelligence Card

Due to the lack of recorded stream and rainfall data for Portland there is considerable uncertainty with the design flood extent mapping and above floor building damage estimates (defined using anecdotal information).

Flood travel time					Time from start of rain to steep rise in floodwater 6 - 12 hours		
					Time from start rainfall to flood peak at Narrawong 12-24 hours		
					Riverine flooding duration: 20 hours		
Design Rainfall	Wattle Hill Creek Design Flow (ML/d) (Cardno 2011)	Average Recurrence Interval (ARI) (Cardno 2011)	Portland damages total number buildings flooded (above floor)	Consequence / Impact	Houses / buildings flooded / isolated *estimated: no floor level survey	Roads Impacted	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
46 mm in one day, 161 mm monthly rainfall		September 2016		Minor flooding of roads and walking tracks caused nuisance flooding surrounding Fawthrop Lagoon. Access/egress to roads was cut for a short time, no recorded buildings impacted by flooding above floor.		Spinks Road, Kerrs Road, Edwards Road.	Glenelg Shire deploy road closure signs as needed.
~54 mm in 24 hours to ~77 mm in 72 hours	1,708	5		Flooding generally within Wattle Hill Creek. Minor overtopping of Kerrs Road. Along Finn Creek minor flooding along Smith Street. Henty Street also becomes overtopped		Kerrs Road, Smith Street, Glenelg Street, Otway Street, Clarke Street, Wyatt Street, and Henty Street.	Local SES Unit to monitor and gather Flood Intelligence. Advise RDO of any issues or ongoing rainfall occurring. Evacuate Portland Railway Station car park. Access to Kerrs Road may be impacted by flooding
71 mm in one day, 199 mm monthly rainfall		2014		8 houses were recorded to be at risk of above floor flooding.			
61 mm in one day, 255 mm monthly rainfall Very wet leading up to the flood event, 332 mm over June and July		2013		More than 8 houses were recorded to be at risk of above floor flooding.			
~68 mm in 24 hours to ~97 mm in 72 hours	3,170	10	44	Flooding generally within Wattle Hill Creek. Access/egress to Kerrs Road may be cut. Along Finn Creek minor flooding along Smith Street. Henty Street also becomes overtopped. Levee upstream of Fawthrop Lagoon significantly overtopped. Access/egress is likely to be cut and buildings may start to be impacted by flooding at the Portland Railway Operations Centre (Henty Court). Portland Railway line, adjacent to Anderson Street starts to be impacted by flooding. Graham Husson Fauna Park (Otway Street) starts to be impacted by flooding.	May impact buildings at the Portland Railway Station (Henty Court). Access/egress to units at 10 Clarke Street may be cut.	In addition to roads listed above: Henty Court.	Local SES Unit to monitor and gather Flood Intelligence. Situation reports to RDO. SES RDO / RAC Local Flood Advice – Public Information. Local SES to advise Council MERO access to Kerrs Road and Henty Street likely to be cut. SES RDO / RAC consider IMT requirements. Victoria Police evacuate the Portland Railway line buildings and car park before access is cut. Glenelg Shire to notify landholder to relocate animals at Graham Husson Fauna Park as needed.
		1992					
~84 mm in 24 hours to ~120 mm in 72 hours	4,847	20	56 (1)*	Finn Creek flooding breaks out of the channel prior to the railway. One industrial building flooded above floor the Powerhouse Museum (Corner of Percy and Glenelg Street). Wannan Water Pump Station (Percy Street) may be impacted by flooding.	Buildings that may be flooded above floor: 76 Henty Street 4 Clarke Street and 5 Portland Court, Portland Powerhouse Motor and Car Museum (Glenelg Street) begins to be impacted.	In addition to roads listed above: Percy Street.	Local SES Unit to monitor and gather Flood Intelligence. Situation reports to RDO. VICSES sandbag buildings as needed. Glenelg Shire put relief Centre to be on stand-by. VICSES sandbag the Wannan Water Pump Station (Percy Street) as needed.
~108 mm in 24 hours to ~153 mm in 72 hours	6,972	50	88 (1)*	Flooding overtops Anderson Road and the railway. Significant flooding north of Julia Street. More properties and roads near Clarke and Otway Street are impacted. Large area of flooding north of Fawthrop Lagoon with properties along Glenelg Street now affected. Access/egress is cut to the Fawthrop Community Centre (Hood Street) (building could be impacted above floor in a 100 year flood). Flooding impacts the school grounds of the Portland Special Development School, 75 Henty Street.	Flooding impacts the school grounds of the Portland Special Development School, 75 Henty Street. Buildings that may be flooded above floor: 166 Wyatt Street, x4 Bentinck Street (7, 9, 11, 13), x2 Henty Street (72, 74) x7 Clarke Street (6, 7, 8, 9, 10, 11, 13), x2 Portland Court (4, 6), x12 Blair Street (67, 69, 71, 73, 75, 79, 81 (x 5 units). Units at 10 Smith Street (starting at Unit 1)	In addition to roads listed above: Anderson Road, Julia Street and Portland Court. Access/egress is cut to the Henty Highway at two locations, where Wattle Hill Creek (adjacent to Alexandra Park) and Finn Creek (adjacent to Finn Street) intersect the Henty Highway	IEMT engaged. VICSES sandbag buildings as needed. Council to close Anderson Road as needed. RAIL authority to be notified. Local SES Unit to monitor and gather flood intelligence. Situation reports to ICC. CFA Crews on stand-by to support sand bagging and flood intelligence. Victoria Police evacuate the Fawthrop Community Centre (Hood Street) before access is cut. Regional Roads Victoria deploy road closure signs and undertake traffic management at two impacted location along the Henty Highway.
~128 mm in 24 hours to ~183 mm in 72 hours	8,933	100	98 (12)*	Properties along Clarke Street, Otway Street and Glenelg Street are impacted above floor. The flood extent in the 100 year isn't significantly larger than the 50 year, due to the steep topography of the area.	11 additional buildings are flooded above floor.	In addition to roads listed above: Frost Court. Henty Highway access/egress may be impacted by flooding south of Fawthrop	Victoria Police consider evacuations for Clarke, Otway and Glenelg Streets. Relief Centre to be opened. Glenelg Shire I to close Anderson Road Local SES Unit to monitor and gather flood intelligence. Situation reports to ICC. CFA and DELWP Crews on stand-by to support sand bagging and flood intelligence.

						Lagoon.	Regional Roads Victoria deploy road closure signs and undertake traffic management at Henty Highway.
~152 mm in 24 hours to ~219 mm in 72 hours	11,206	200					
Almost 200 mm over 3 days	14,575	March 1946 500 year event					





Summary of Portland key flood impacts for a range of flood magnitudes.

Portland Property Inundation Table

No buildings were surveyed as part of the Portland Flood Study. The table below only indicates depth of flooding on properties in meters, not buildings flooded above floor. The table below shows the depth of flooding at a property increases with the flood magnitude (increase in Average Recurrence Interval). For example at the address 1 William Street Portland the depth of flooding for a 10 year ARI is 1.56m, for a 100 year ARI depth of flooding is 1.86m.

LEGEND : Where properties are shaded floodwaters may impact a building above floor in a 100 year ARI flood event.					Building type and comments
ADDRESS	Average Recurrence Interval (ARI)				
	10	20	50	100	
72 DALWOOD LANE PORTLAND WEST	1.56	1.71	1.86	1.88	House
75-77 HENTY STREET PORTLAND					Special Development School
1 WILLIAM STREET PORTLAND	1.43	1.67	1.79	1.86	House
31 GLENELG STREET PORTLAND	1.31	1.58	1.81	1.94	Fawthrop Lagoon - Some public infrastructure impacted 20yr onwards
63 KERRS ROAD PORTLAND	1.29	1.42	1.57	1.59	House
23 GLENELG STREET PORTLAND	1.20	1.48	1.71	1.84	Powerhouse Motor Car Museum
69 TYERS STREET PORTLAND	1.12	1.39	1.85	2.03	Some rural infrastructure possibly affected
3 WATTLE HILL ROAD PORTLAND	1.03	1.20	1.38	1.41	House
LALOR STREET PORTLAND	1.01	1.17	1.32	1.34	House
9 OAKPARK ROAD PORTLAND WEST	1.00	1.11	1.22	1.23	House
89 OTWAY STREET PORTLAND	1.00	1.28	1.73	1.91	House.Rear Shed impacted
87 OTWAY STREET PORTLAND	0.98	1.26	1.71	1.89	House
188B-190 WYATT STREET PORTLAND	0.93	1.15	2.15	2.08	House
97 OTWAY STREET PORTLAND	0.93	1.20	1.65	1.84	House
85 OTWAY STREET PORTLAND	0.90	1.18	1.63	1.81	House
15 HAYNES LANE PORTLAND WEST	0.90	1.20	1.52	1.56	House
95 OTWAY STREET PORTLAND	0.89	1.17	1.62	1.81	House
13 PARK STREET PORTLAND	0.87	0.97	1.12	1.16	Alexander Park
7 CLARKE STREET PORTLAND	0.87	1.14	1.60	1.78	House
41 KERRS ROAD PORTLAND	0.87	0.99	1.10	1.12	House. Unknown structure impacted
15 BRIDGEWATER ROAD PORTLAND	0.84	0.86	1.01	0.96	Graham Husson Fauna Park
66 DALWOOD LANE PORTLAND WEST	0.82	0.95	1.07	1.09	House
66 WATTLE HILL ROAD PORTLAND WEST	0.82	1.02	1.23	1.25	House
69 OTWAY STREET PORTLAND	0.81	1.08	1.53	1.72	House
28 MCINTYRE ROAD PORTLAND WEST	0.81	0.97	1.14	1.17	House
76-78 HENTY STREET PORTLAND	0.77	1.05	1.50	1.69	House
56 DALWOOD LANE PORTLAND WEST	0.76	0.89	1.02	1.04	House
38 DALWOOD LANE PORTLAND WEST	0.74	0.85	0.97	0.99	House
73 KERRS ROAD PORTLAND	0.71	0.81	0.92	0.94	House
40 MCINTYRE ROAD PORTLAND WEST	0.65	0.82	1.00	1.02	House
184 WYATT STREET PORTLAND	0.58	0.69	1.20	1.29	House. Outbuildings affected
81 OTWAY STREET PORTLAND	0.55	0.82	1.27	1.46	House
79 OTWAY STREET PORTLAND	0.51	0.78	1.23	1.42	House
31 KERRS ROAD PORTLAND	0.49	0.60	0.73	0.75	House
145 OTWAY STREET PORTLAND	0.47	0.56	1.06	1.15	Rural Shed
15 HENTY COURT PORTLAND	0.45	0.73	1.18	1.37	Industrial area
401 HENTY HIGHWAY PORTLAND	0.43	0.54	1.18	1.14	Rural Shedding possible house
30 DALWOOD LANE PORTLAND WEST	0.39	0.50	0.61	0.63	Rural Shed
83 OTWAY STREET PORTLAND	0.39	0.67	1.12	1.30	House
25 GLENELG STREET PORTLAND	0.39	0.66	0.89	1.02	Industrial Site.
5 PORTLAND COURT PORTLAND	0.37	0.64	1.09	1.28	House
67 KERRS ROAD PORTLAND	0.36	0.47	0.58	0.59	House
70 MCINTYRE ROAD PORTLAND WEST	0.29	0.46	0.65	0.67	House
10 OAKPARK ROAD PORTLAND WEST	0.27	0.41	0.57	0.59	House
10 MADEIRA PACKET ROAD PORTLAND WEST	0.22	0.51	0.83	0.87	House
166 WYATT STREET PORTLAND		0.62	1.41	1.59	House
170 WYATT STREET PORTLAND		0.56	1.35	1.52	House. Shedding impacted
18 BRIDGEWATER ROAD PORTLAND		0.33	1.02	0.98	house
50 FINN STREET PORTLAND		0.21	0.66	0.84	House. Sheds Impacted
74 HENTY STREET PORTLAND		0.21	0.66	0.84	House
2-4 CLARKE STREET PORTLAND		0.19	0.72	0.91	House
71 BLAIR STREET PORTLAND		0.18	0.64	0.82	House
94 JULIA STREET PORTLAND		0.18	0.63	0.81	Portland children's and family complex
67 OTWAY STREET PORTLAND		0.16	0.61	0.80	House. Outbuildings affected
73 BLAIR STREET PORTLAND		0.14	0.59	0.78	House
13 GLENELG STREET PORTLAND		0.12	0.35	0.63	Friendlies Reserve Buildings affected
6 CLARKE STREET PORTLAND		0.02	0.71	0.89	House
79 BLAIR STREET PORTLAND			0.67	0.85	House
75 BLAIR STREET PORTLAND			0.63	0.82	House
8 CLARKE STREET PORTLAND			0.49	0.67	House
1/81 BLAIR STREET PORTLAND			0.49	0.67	Unit
153 OTWAY STREET PORTLAND			0.40	0.47	House
4/81 BLAIR STREET PORTLAND			0.39	0.58	Unit
72 HENTY STREET PORTLAND			0.39	0.57	House
186 WYATT STREET PORTLAND			0.39	0.44	House

4 PORTLAND COURT PORTLAND			0.38	0.56	House
188 WYATT STREET PORTLAND			0.37	0.38	House
69 BLAIR STREET PORTLAND			0.35	0.53	House.Rear Shed impacted
3/81 BLAIR STREET PORTLAND			0.31	0.50	Unit
13 CLARKE STREET PORTLAND			0.23	0.42	House
12/1 HOOD STREET PORTLAND			0.22	0.38	Units
70 HENTY STREET PORTLAND			0.20	0.39	House
5/81 BLAIR STREET PORTLAND			0.20	0.61	Unit
1/81 BLAIR STREET PORTLAND			0.20	0.38	Unit
7 BENTINCK STREET PORTLAND			0.17	0.52	House
11 CLARKE STREET PORTLAND			0.15	0.34	House
67 BLAIR STREET PORTLAND			0.15	0.33	House. Possibly 2 properties . Rear buildings impacted
11 BENTINCK STREET PORTLAND			0.11	0.46	House
10 CLARKE STREET PORTLAND			0.10	0.29	House.
3/9 BENTINCK STREET PORTLAND			0.10	0.46	House. Possibly 3 houses on site
9 CLARKE STREET PORTLAND			0.09	0.27	House
431 HENTY HIGHWAY PORTLAND			0.09	0.43	Warehouse
23-25 CAMERON STREET PORTLAND			0.08	0.19	House
19 BENTINCK STREET PORTLAND			0.07	0.82	House
6 PORTLAND COURT PORTLAND			0.06	0.25	House
61 OTWAY STREET PORTLAND			0.06	0.25	House
15 BENTINCK STREET PORTLAND			0.06	0.63	House
2/81 BLAIR STREET PORTLAND			0.05	0.23	
13 BENTINCK STREET PORTLAND			0.04	0.53	House
3/17 BENTINCK STREET PORTLAND				0.68	Unit
4/17 BENTINCK STREET PORTLAND				0.66	Unit
5 GLENELG STREET PORTLAND				0.44	House
3 GLENELG STREET PORTLAND				0.43	House
21 BENTINCK STREET PORTLAND				0.22	House. Garage affected.
15 CLARKE STREET PORTLAND				0.18	House
7 PORTLAND COURT PORTLAND				0.16	House. Rear shedding impacted
17 CLARKE STREET PORTLAND				0.08	House
65 OTWAY STREET PORTLAND				0.08	House. Garage impacted
83 BLAIR STREET PORTLAND				0.07	Unit impacted. Numbers 2/83 and 1/83 close to being impacted

Appendix C3: Heywood Flood Emergency Plan

Heywood is impacted by flooding from the Fitzroy River. Fitzroy River rises in the Cobboboonee National Park before flowing through Heywood, refer to the map below for the location of the Heywood stream gauge on the Fitzroy River. The Fitzroy River stream records shows that Heywood has experienced frequent flood events since the early 1970's, with the largest recent flood event occurring in 2016. Refer to the table and graph below.

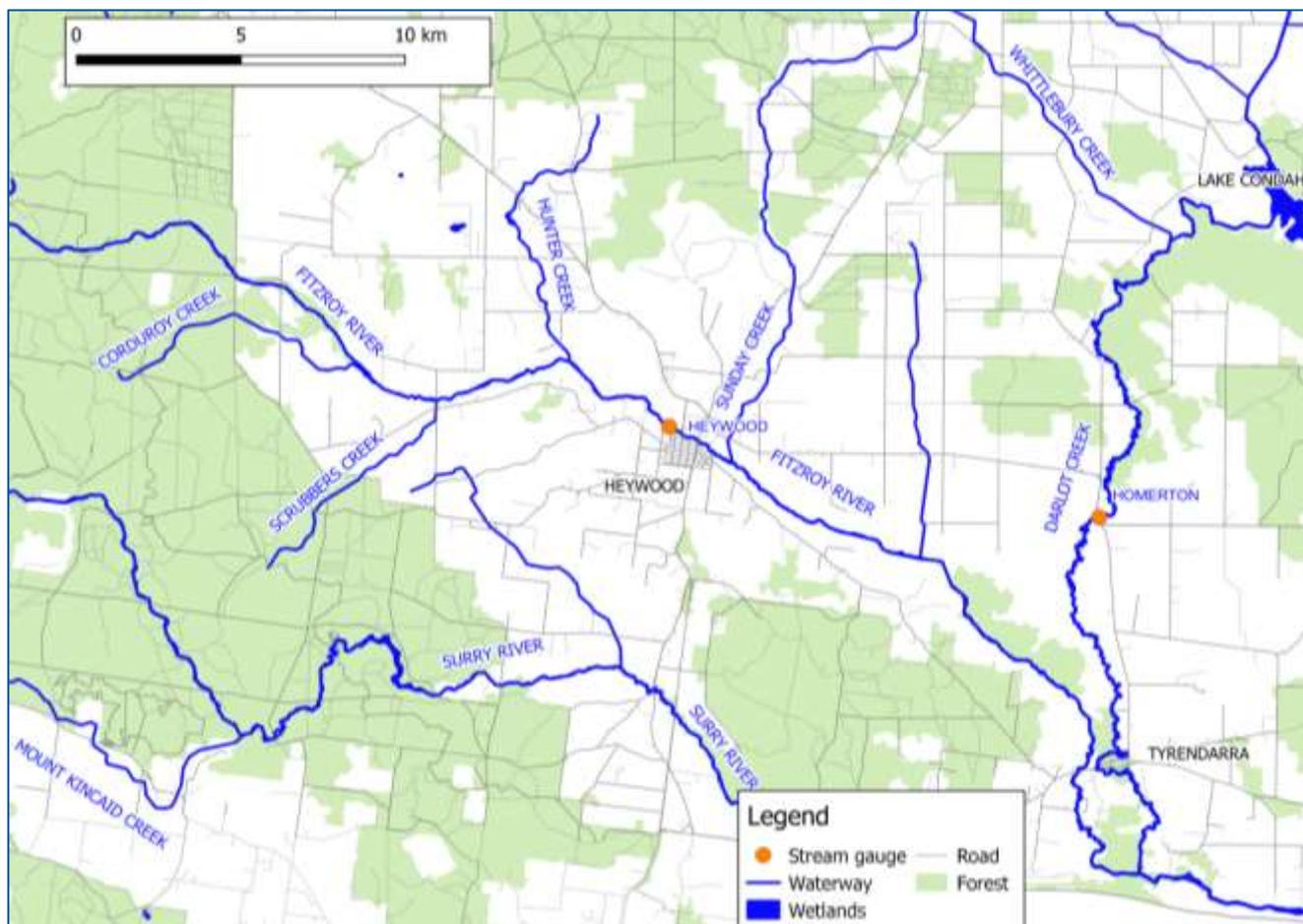
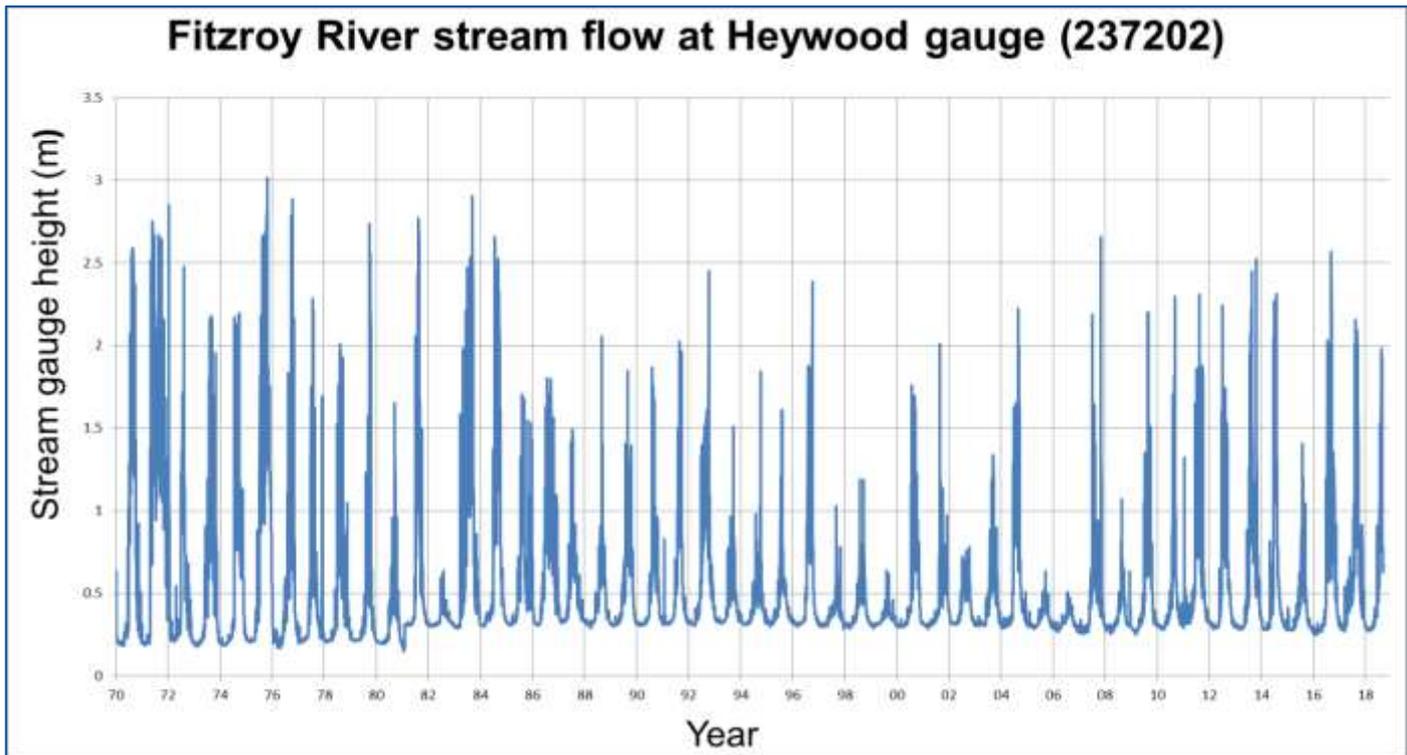


Table of historic flood events in Heywood.

Year	Description
November 1906	Largest flood experienced at the time. Three inches of rain fell over 40 minutes. Water from the river reached the floor of some houses.
August 1939	Largest flood in 8-10 years, 83 mm of rain fell in two days. The Fitzroy River surged over its banks and was up to 300m wide in some places.
March 1946	The south west of Victoria, including Heywood, receives its worst flood in living memory. Many rivers are in flood, including the Fitzroy River and Darlot Creek. Estimated as a 200 year ARI flood event.
August 1951	Flooding of some streets, the worst seen since 1946.
October 1975	Largest recorded flood at Heywood.
October 1976	Third largest recorded flood at Heywood.
September 1983	Second largest recorded flood at Heywood.
November 2007	Most significant event in recent past. Estimated to be between a 50 year and a 100 year ARI flood event.



Fitzroy River stream flow records show the frequency flood events in Heywood.

Photos of the August 2007 flood event (refer to photos below), show minor flooding in Heywood along the Fitzroy River. These photos show minor flooding breaking out of the main channel in low lying parkland areas in Heywood, adjacent to Hunter Street and the Heywood Recreation Reserve.



Flooding in Heywood along the Fitzroy River during the August 2017 flood event (source Glenelg Shire Council).



Flooding in Heywood along the Fitzroy River during the August 2017 flood event (source Glenelg Shire Council).



Flooding in Heywood along the Fitzroy River during the August 2017 flood event (source Glenelg Shire Council).

Fitzroy River Flood Behaviour

The Fitzroy River at Heywood gauge is also situated adjacent to the key township of Heywood, a critical location with respect to flood mapping. It was found that high flow gauges at Fitzroy River at Heywood gauge was unreliable due to flow bypassing the gauge, refer to the flood impact map below.

Influence of the Fitzroy Estuary

Where the Fitzroy River meets the ocean a sandbar seasonally closes the river mouth. The actual location of the entrance channel is variable over time as it can break out across the sand dune barrier (Water Technology 2017). The effect of closure of the entrance is an increase in the extent of inundation across the estuary. Artificial openings of the estuary entrance do occur and are managed by the Glenelg Hopkins CMA. The Fitzroy River Estuary is only likely to influence flooding locally.

Influence of the Railway Bridge

The railway bridge structure and embankments in Heywood present a major flow constriction. Given that the rail bridge over the Fitzroy River (east of Hunter Street East) is undersized floodwater starts to back up on the western side of the railway during a 10 year flood event. Refer to the flood impact map below for the location of the railway bridge. The impact of the rail bridge increases with flood magnitude.

Flood levels in Heywood are sensitive to the rail bridge opening, and potential increases in the bridge culvert capacity should be considered when assessing future flood mitigation options (Water Technology 2017).

Warning time

Typically there is steep rise in flood levels 3.5 to 6 hours from rainfall, peak river flows occur within 7 to 20 hours from rainfall.

Bus Routes

The map below shows regional bus routes (red) with the 100 year flood extent (shaded blue). The map below indicates that access will be cut to a number of bus routes during a range of flood magnitudes.

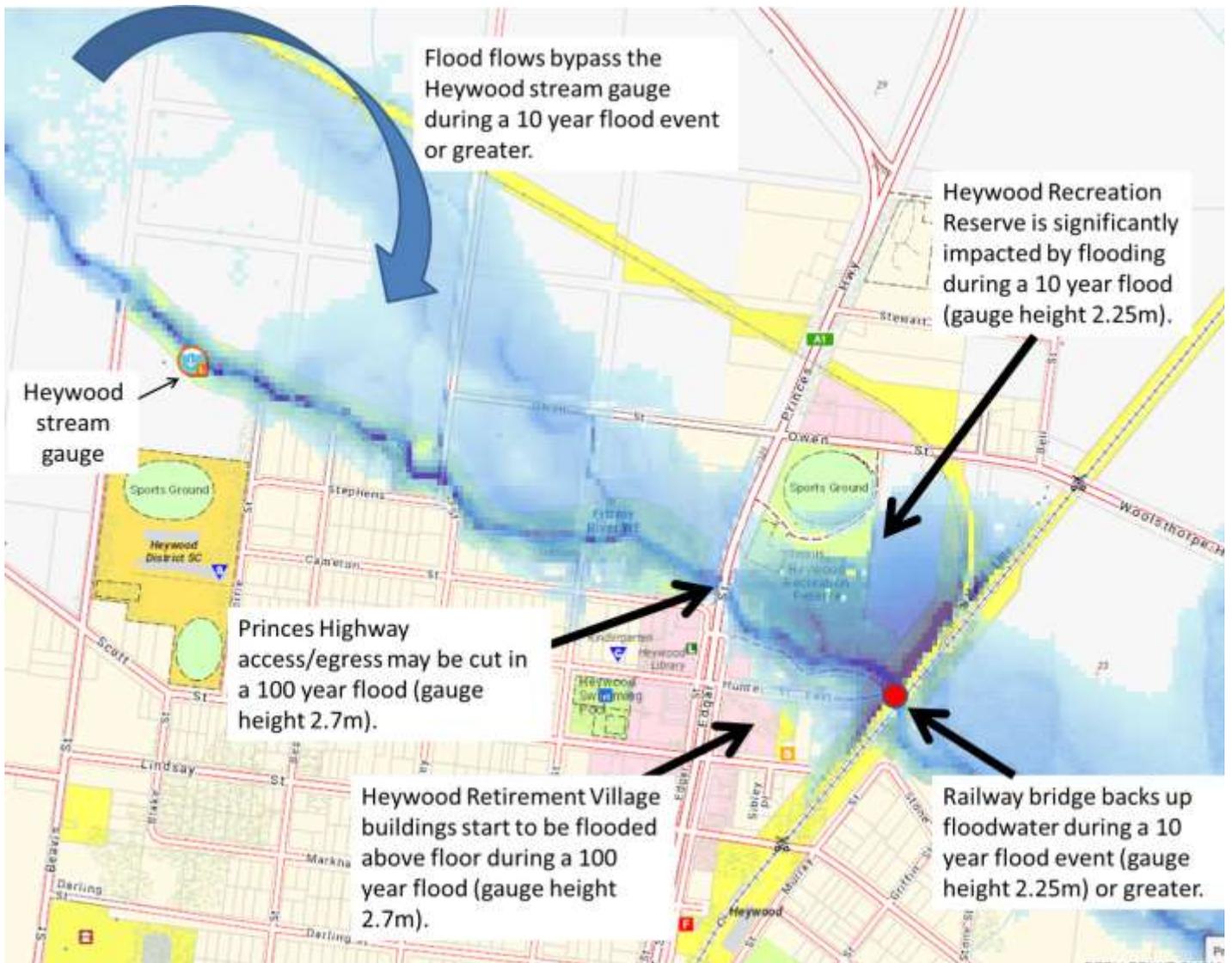


Heywood bus routes (red) with the 100 year flood extent.

Flood Impacts and Required Actions

Buildings in Heywood are inundated above floor level in the 50 year ARI and larger flood events. There are also a number of key roadways that are inundated in 100 year ARI events and larger. Key assets at risk of flooding are listed in the table and map below.

Asset register				
Asset Name and location	Heywood gauge height (ARI)	Consequence / Impact	Mitigation/ Action	Lead Agency
Heywood Recreation Reserve (cricket ground, football oval, tennis and netball courts)	1.95m (5 year flood)	Grounds begin to be impacted by flooding.	Evacuate before flood level reaches 1.95m	Victoria Police
Heywood Recreation Reserve (cricket ground, football oval, tennis and netball courts)	2.25m (10 year flood)	Grounds significantly impacted	Evacuate before flood level reaches 1.95m	Victoria Police
6 buildings are flooded above floor including the Heywood Pioneer Wagon Shed and Museum.	2.61 m (50 year flood)	6 buildings are flooded above floor.	Sandbag buildings as needed.	VICSES
Princes Highway (in Heywood at the Fitzroy River crossing)	2.61 m (50 year flood)	Princes Highway access/egress may be impacted by flooding	Undertake traffic management as needed.	Regional Roads Victoria
Princes Highway (in Heywood at the Fitzroy River crossing)	2.7 m (100 year flood)	Access/egress is cut to Princes Highway	Deploy road closure signs and undertake traffic management	Regional Roads Victoria
Heywood Retirement Village Main Building (9 Hunter Street)	2.7 m (100 year flood)	Flooded above floor.	Sandbag building as needed.	VICSES
Daly's Supermarket (64 Edgar Street)	2.7 m (100 year flood)	Flooded above floor.	Sandbag building as needed.	VICSES
Wannon Water Heywood Sewer Pump Station no1 (Hunter Street)	2.7 m (100 year flood)	Impacted by flooding.	Sandbag as needed.	VICSES
9 units at the Heywood Retirement Village (9 Hunter Street)	2.78 m (200 year flood)	Flooded above floor.	Sandbag buildings as needed.	VICSES



Heywood 100 year ARI flood extent with a summary of key flood impacts.

For more detailed information regarding buildings and roads impacted refer to the Heywood Flood Intelligence Card below. Also refer to the Heywood flood depth maps in Appendix E.

Heywood Flood Intelligence Card

Fitzroy River at Heywood gauge 237202

Flood travel time							
					Time from start of rain to steep rise in floodwater 3.5 - 6 hours		
					Time from start rainfall to minor flood peak at Heywood 7 - 12 hours		
					Time from start rainfall to moderate flood peak at Heywood 10 - 18 hours		
					Time from start rainfall to major flood peak at Heywood 12 - 20 hours		
					Riverine flooding duration: 2.5 days		
Design Rainfall	Fitzroy River at Heywood Design Flows (ML/d) (Water Tech 2017)	Fitzroy River at Heywood gauge height 237202 (m)	Average Recurrence Interval (ARI)	Heywood damages total number properties flooded (buildings above floor)	Consequence/ Impact	Roads Impacted	Action <small>Actions may include: Evacuation, closure of road, sandbagging, issue warning and who is responsible etc.</small>
		1.88	Proposed minor flood level		Flooding starts to inundate the Heywood parkland areas. Heywood is not impacted by the estuary sandbar height on the lower Fitzroy River.		
37.2 mm in 12 hours, 50.4 mm in 24 hours	604	1.95	5	0 (0)	Flooding inundates parkland.	Bond Street.	Glenelg Shire deploy water over road signs as needed.
		2.18	Proposed moderate flood level		Flooding in Heywood begins to inundate properties in Heywood and impact roadways.		
42 mm in 12 hours, 55.2 mm in 24 hours	1,036	2.25	10	2 (0)	Within Heywood flooding inundates parkland. The Heywood gauge is currently significantly bypassed during flows greater than 10 year flood event, via a flowpath to the north of the main river and gauge. This severely impacts the quality of the output data from the site. Re-location of the site is recommended, with the railway crossing at Heywood appearing to be an appropriate site. Approximately 1.5km upstream of Heywood, there is a channel break out to the north of the river, abutting the Mount Gambier railway line. This breakout reconnects with the main Fitzroy River upstream of the Princes Highway bridge, after passing over Bond Street and Owen Street on the northern side of the river in Heywood.	In addition to roads listed above: Owen Street, Tyrendarra School Road, Thompsons Road and Mount Gambier railway line.	Glenelg Shire deploy water over road signs as needed.
48 mm in 12 hours, 64.8 mm in 24 hours	1,728	2.44	20	6 (0)	Within Heywood flooding inundates parkland. Properties on the south side of the Fitzroy River at Heywood between Bond St and the Railway line become threatened by floodwater.	No additional roads.	
		2.48	Proposed major flood level		Flooding causes extensive inundation of roadways and properties in the Catchment.		
		2.57	September 2016			A section of road at the corner of Cave Hill Road and the Princes Highway was impacted by flooding during this event.	
56.4 mm in 12 hours, 76.8 mm in 24 hours	2,592	2.61	50	21 (6)	Some low-lying properties on the southern side of town are inundated above floor level: the Heywood Bolts and Bits (66 Edgar Street), Heywood Pioneer Wagon Shed and Museum in Hunter Street, 4 Hunter Street (2x sheds), 12 Cameron Street (x1 shed), 14 Cameron Street (x1 shed), Cameron Street and Edgar Street has some shallow floodwater, as does Hunter Street East.	In addition to roads listed above: Cameron Street, Edgar Street, and Hunter Street.	Glenelg Shire deploy water over road signs as needed. VICSES sandbag Heywood Bolts and Bits at 66 Edgar Street and the Heywood Pioneer Wagon Shed and Museum in Hunter Street
		2.65	November 2007				Regional Roads Victoria closely monitor flooding along the Princes Highway (at Edgar Street), deploy water over road signs and traffic management as needed.
63.6 mm in 12 hours, 86.4 mm in 24 hours	3,196	2.70	100	63 (18)	A large number of properties on the southern side of the river are threatened, with floodwaters expected to be above floor for 12 additional buildings; Retirement Village Main Building (9 Hunter Street), Football/Cricket Building (2042 Princes Highway), Tennis/Netball Building (2042 Princes Highway), Heywood Horse and Country building (69-71 Edgar Street), Daly's IGA Supermarket and Loading Zone (64 Edgar Street), Wannon Water Heywood Sewer Pump Station No1 (Hunter Street), x4 sheds at Cameron Street (1, 7, 9, 11). Shallow floodwater has propagated down Fitzroy St and Edgar Street, reaching as far as Hunter Street. The football	In addition to roads listed above: Woolsthorpe-Heywood Road at Sunday Creek, Princes Highway / Edgar Street at Heywood, Tyrendarra-Ettrick Road at Darlot Creek, Princes Highway at downstream end of Fitzroy River.	Victoria Police evacuate residents at the Retirement Village Main Building (9 Hunter Street). VICSES sandbag the Wannon Water Heywood Sewer Pump Station No1 in Hunter Street. VICSES sandbag Heywood Horse and Country building (69-71 Edgar Street) and Daly's IGA Supermarket (64 Edgar Street).

					ground is significantly inundated. North of town, Sunday Creek has overtopped Woolsthorpe-Heywood Road.		When access to the Princes Highway is cut (at Edgar Street), Regional Roads Victoria deploy road closed signs and traffic management as needed.
70.8 mm in 12 hours, 96 mm in 24 hours	3,888	2.78	200	89 (49)	An additional 31 buildings are flooded above floor; Retirement Village Units (1, 2, 3, 4, 5, 6, 7, 8 at 7 Hunter Street), Barclays Tyre & Battery Centre (23 – 25 Hunter Street), St Andrew's Church (3 Hunter Street), Caremore Pharmacy (65-67 Edgar Street), Holly Rock Milkbar (73 Edgar Street), Bendigo Bank (61 Edgar Street), Heywood Butchers (57 Edgar Street), SES Shed (6 Scott Street), Immunisation Building (22 Hunter Street), Heywood Newsagency (59 Edgar Street), x3 houses at Cameron Street (1,12, 13), 1 Cameron Street Significant flooding on the Princes Highway either side of the Fitzroy River. Floodwaters have reached Silby Place and Scott Street.		VICSES sandbag buildings at risk of flooding.
80.4 mm in 12 hours, 110.4 mm in 24 hours	5,097	2.90	500	134 (80)	An additional 31 buildings are flooded above floor; Heywood Bakery , Council Library, Gunditj Mirring Traditional Owners Aboriginal Corporation, Scout Hall Ricco's Pizza Bar (50 Edgar Street), Old Heywood School (58 Edgar Street), Heywood Patchwork & Craft (51 Edgar Street), Australian Post Office (52 Edgar Street), St Gregory's Catholic Church (2049 Princes Highway), Angling Club (27 Hunter Street), Heywood Plumbing Services (32-40 Edgar Street). This includes a number of houses flooded above floor: x5 at Cameron Street (7, 11, 16-18), 15 Stone Street, 28 Hunter Street. Flooding has proceeded on the southern side of the Fitzroy River as far as Stephens Street, Mount Clay Road, Scott Street and Stone Street.	In addition to roads listed above: Owen Street and Stone Street.	Glenelg Shire deploy water over road signs as needed.
		3.01	1975				
530.4 mm in 24 hours, 638.4 mm in 28 hours		5.41	Probable Maximum Flood (PMF)		Most of the town is heavily inundated on the southern side of Fitzroy River, with only the most southerly blocks free of floodwater. The north side of the town is also heavily inundated, with at least 1km of the Princes Hwy inundated. The railway line through town is also inundated.		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Institute of Disaster Resilience (AIDR) Handbook series on managing the Floodplain.

Heywood Property Inundation Table

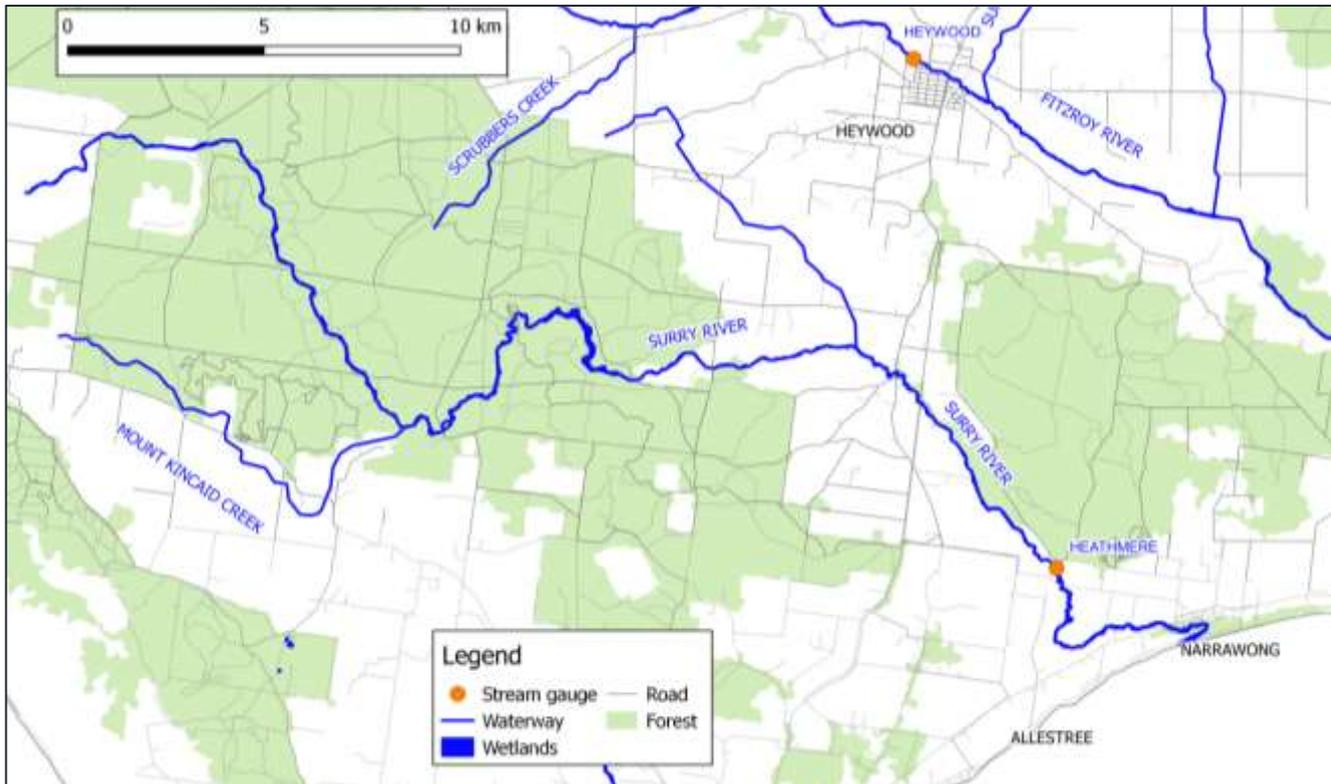
Note: Table ordered by first flooded over floor

ADDRESS	Maximum Depth of Flooding on Property for each ARI event (m)							Depth of known over-floor flooding at property for each ARI event (m)							Type of Building and comments
	5	10	20	50	100	200	500	5	10	20	50	100	200	500	
12 CAMERON STREET		0.359	0.578	0.895	1.124	1.326	1.570				0.237	0.467	0.669	0.912	Rear Shed
14 CAMERON STREET	0.092	0.340	0.561	0.864	1.089	1.290	1.533				0.220	0.447	0.648	0.891	Rear Shed
HUNTER STREET	0.94	1.25	1.61	1.94	2.17	2.42	2.77				0.19	0.42	0.66	1.01	Heywood Pioneer Wagon Shed & Museum
4 HUNTER STREET			0.275	0.602	0.831	1.071	1.413				0.144	0.374	0.615	0.957	Front Shed
66 EDGAR STREET		0.171	0.499	0.827	1.056	1.295	1.635				0.136	0.351	0.583	0.914	Heywood Bolts & Bits
4 HUNTER STREET			0.156	0.485	0.714	0.953	1.293				0.126	0.355	0.593	0.932	Rear Shed
1 HUNTER STREET		0.217	0.586	0.930	1.176	1.430	1.785					0.189	0.443	0.800	Garage
9 HUNTER STREET				0.17	0.42	0.66	1.01					0.16	0.39	0.74	Retirement Village Main Building
9 CAMERON STREET				0.14	0.37	0.58	0.82					0.14	0.35	0.59	Rear Shed
2042 PRINCES HIGHWAY	0.992	1.330	1.668	2.000	2.233	2.477	2.825					0.130	0.372	0.742	Football/Cricket Building
2042 PRINCES HIGHWAY	0.992	1.330	1.668	2.000	2.233	2.477	2.825					0.110	0.354	0.715	Tennis/Netball Building
69-71 EDGAR STREET					0.228	0.368	0.622					0.084	0.236	0.490	Heywood Horse & Country
HUNTER STREET	0.94	1.25	1.61	1.94	2.17	2.42	2.77					0.08	0.32	0.67	Wannon Water Heywood Sewer Pump Station No.1
64 EDGAR STREET		0.171	0.499	0.827	1.056	1.295	1.635					0.077	0.311	0.643	Daly's IGA Supermarket Loading Zone
64 EDGAR STREET				0.269	0.500	0.743	1.086					0.064	0.299	0.632	Daly's IGA Supermarket
7 CAMERON STREET				0.13	0.36	0.56	0.81					0.02	0.22	0.46	Rear Shed
1 CAMERON STREET					0.219	0.417	0.655					0.004	0.207	0.447	Rear Shed
11 CAMERON STREET				0.151	0.388	0.593	0.837					0.002	0.206	0.448	Garage
2A SCOTT STREET				0.197	0.449	0.708	1.071						0.258	0.620	Rear Shed
1 HUNTER STREET		0.217	0.586	0.930	1.176	1.430	1.785						0.222	0.579	House
4 HUNTER STREET			0.281	0.608	0.837	1.077	1.418						0.215	0.556	House
75 EDGAR STREET					0.15	0.29	0.54						0.21	0.46	Vacant Shop
3/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.203	0.548	Retirement Village Unit 3
4/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.195	0.540	Retirement Village Unit 4
81 EDGAR STREET					0.26	0.47	0.72						0.20	0.45	Shed (Fronting Cameron St)
58 EDGAR STREET				0.166	0.420	0.662	1.006						0.190	0.533	Rotunda
2/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.188	0.534	Retirement Village Unit 2
1/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.185	0.533	Retirement Village Unit 1
23-25 HUNTER STREET					0.100	0.319	0.572						0.184	0.437	Barclays Tyre & Battery Centre
5 CAMERON STREET				0.127	0.356	0.561	0.807						0.169	0.410	Rear Shed
16-18 CAMERON STREET	0.084	0.296	0.552	0.855	1.081	1.281	1.525						0.148	0.391	Rear Shed
3 HUNTER STREET				0.283	0.537	0.790	1.144						0.128	0.486	St. Andrew's Presbyterian Church
12 CAMERON STREET		0.359	0.578	0.895	1.124	1.326	1.570						0.122	0.364	House
30 HUNTER STREET					0.152	0.351	0.586						0.121	0.355	Rear Shed
13 CAMERON STREET				0.222	0.471	0.675	0.918						0.104	0.343	House
65-67 EDGAR STREET					0.164	0.345	0.596						0.089	0.333	Caremore Pharmacy
73 EDGAR STREET					0.23	0.37	0.62						0.09	0.38	Holly Rock Milkbar
3 CAMERON STREET				0.012	0.246	0.456	0.708						0.076	0.313	Shed
61 EDGAR STREET					0.164	0.345	0.596						0.071	0.313	Bendigo Bank
5/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.054	0.398	Retirement Village Unit 5
57 EDGAR STREET						0.162	0.393						0.044	0.276	Heywood Butchers

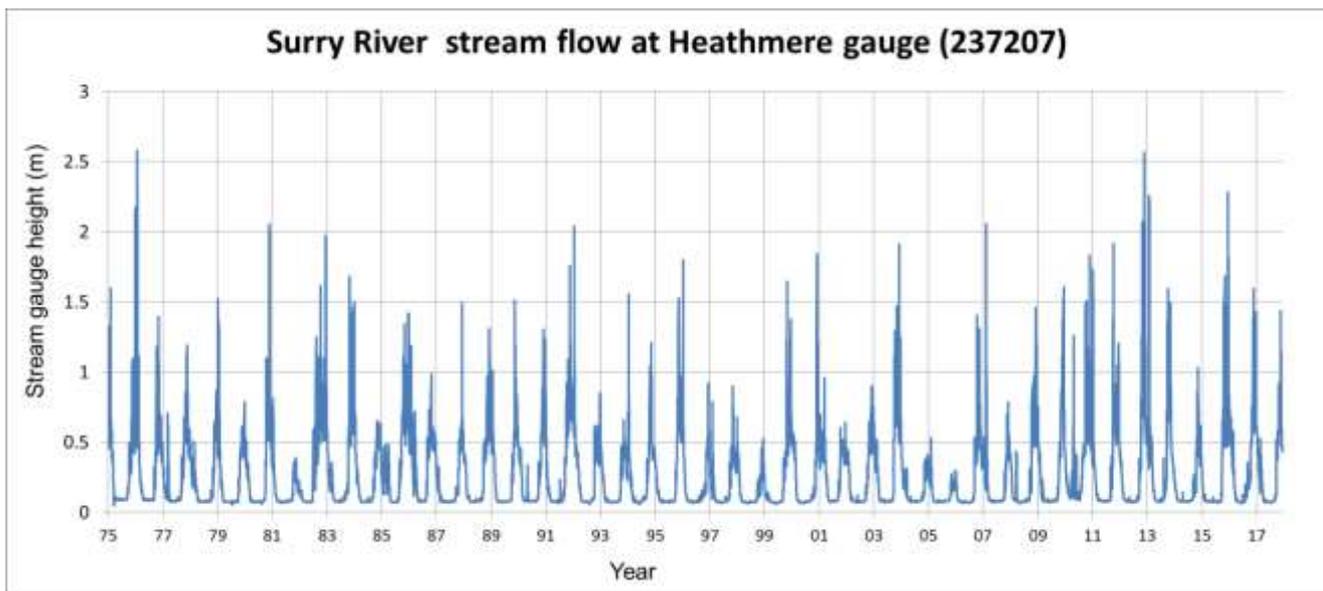
ADDRESS	Maximum Depth of Flooding on Property for each ARI event (m)							Depth of known over-floor flooding at property for each ARI event (m)							Type of Building and comments
	5	10	20	50	100	200	500	5	10	20	50	100	200	500	
6/7 HUNTER STREET				0.219	0.457	0.697	1.042						0.041	0.386	Retirement Village Unit 6
22 HUNTER STREET					0.294	0.497	0.735						0.039	0.281	Immunisation Building
59 EDGAR STREET					0.059	0.205	0.437						0.037	0.278	Heywood Newsagency
8 SCOTT STREET					0.10	0.32	0.67						0.04	0.39	Shed
8/7 HUNTER STREET				0.28	0.54	0.79	1.14						0.03	0.38	Retirement Village Unit 8
6 SCOTT STREET					0.098	0.316	0.665						0.027	0.379	SES Shed
1 CAMERON STREET					0.274	0.484	0.736						0.014	0.263	House
7/7 HUNTER STREET				0.22	0.46	0.70	1.04						0.00	0.35	Retirement Village Unit 7
2042 PRINCES HIGHWAY	0.992	1.330	1.668	2.000	2.233	2.477	2.825							0.356	Football/Cricket Building
46 EDGAR STREET						0.140	0.522							0.249	Elders
1 SCOTT STREET						0.209	0.587							0.247	Rear Shed
14 CAMERON STREET	0.092	0.340	0.561	0.864	1.089	1.290	1.533							0.226	House
81 EDGAR STREET					0.26	0.47	0.72							0.20	House
9 CAMERON STREET				0.14	0.37	0.58	0.82							0.19	House
3 HUNTER STREET				0.283	0.537	0.790	1.144							0.190	St. Andrew's Presbyterian Church
52 EDGAR STREET						0.147	0.496							0.174	Shipping Container (Photo Needs Cross)
55 EDGAR STREET						0.162	0.393							0.170	Heywood Bakery
1 STONE STREET	1.192	1.418	1.599	1.770	1.887	2.004	2.161							0.146	House
77 EDGAR STREET					0.22	0.42	0.65							0.14	Council building and library
12 OWEN STREET							0.592							0.141	Shed
1/50 EDGAR STREET						0.091	0.440							0.137	Gunditj Mirring Traditional Owners Aboriginal Corporation
9 SCOTT STREET						0.26	0.64							0.13	Scout Hall
1/50 EDGAR STREET						0.091	0.440							0.125	Ricco's Pizza Bar
1/50 EDGAR STREET						0.091	0.440							0.121	Ricco's Pizza Bar
58 EDGAR STREET				0.166	0.420	0.662	1.006							0.113	Old Heywood School No. 297
7 CAMERON STREET				0.13	0.36	0.56	0.81							0.11	House
51 EDGAR STREET						0.130	0.361							0.107	Heywood Patchwork & Craft
20 HUNTER STREET					0.329	0.521	0.757							0.105	Building
52 EDGAR STREET						0.147	0.496							0.090	Australia Post Office
11 CAMERON STREET				0.137	0.372	0.577	0.821							0.087	House
2049 PRINCES HIGHWAY		0.153	0.293	0.630	0.868	1.073	1.318							0.079	St. Gregory's Catholic Church
10 STEPHENS STREET					0.125	0.194	0.301							0.070	Rear Shed
24-26 CAMERON STREET				0.082	0.275	0.469	0.710							0.067	Front Shed
16-18 CAMERON STREET	0.092	0.340	0.561	0.864	1.089	1.290	1.533							0.066	House
27 HUNTER STREET					0.100	0.319	0.572							0.053	Angling Club
28 HUNTER STREET					0.172	0.362	0.594							0.039	House
2-6 STEPHENS STREET		0.280	0.475	0.612	0.686	0.770	0.910							0.034	Rear Shed

Appendix C4: Narrawong Flood Emergency Plan

Narrawong is impacted by flooding from the Surry River. The Heathmere stream gauge on the Surry River (refer to map below), is located 3 km upstream of Narrawong. Surry River stream records show that Narrawong has experienced frequent flood events since the early 1970's, refer to graph below. The largest recent flood event occurred in 2013.



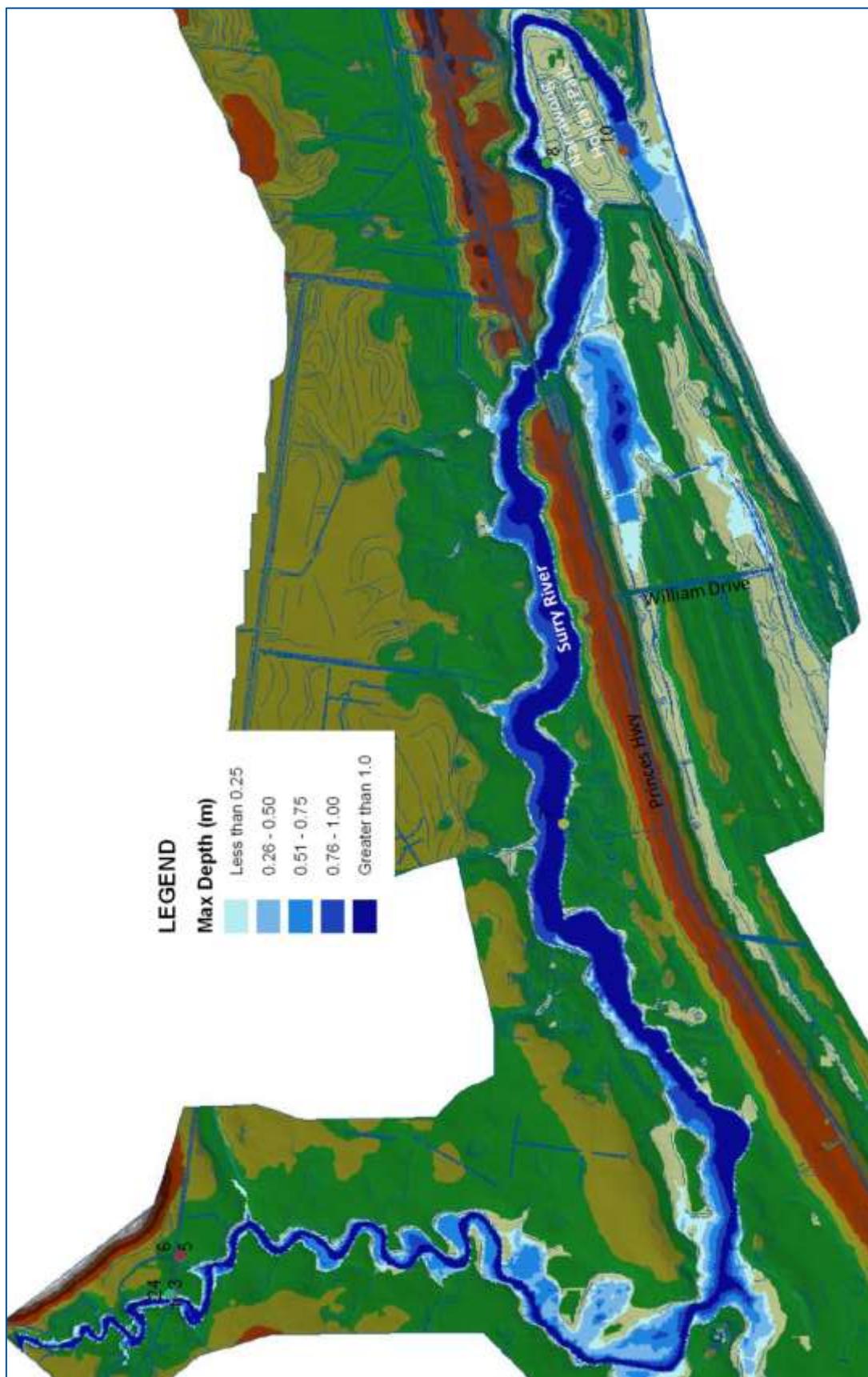
Narrawong stream gauge location.



Graph showing frequency of flood events in Narrawong.

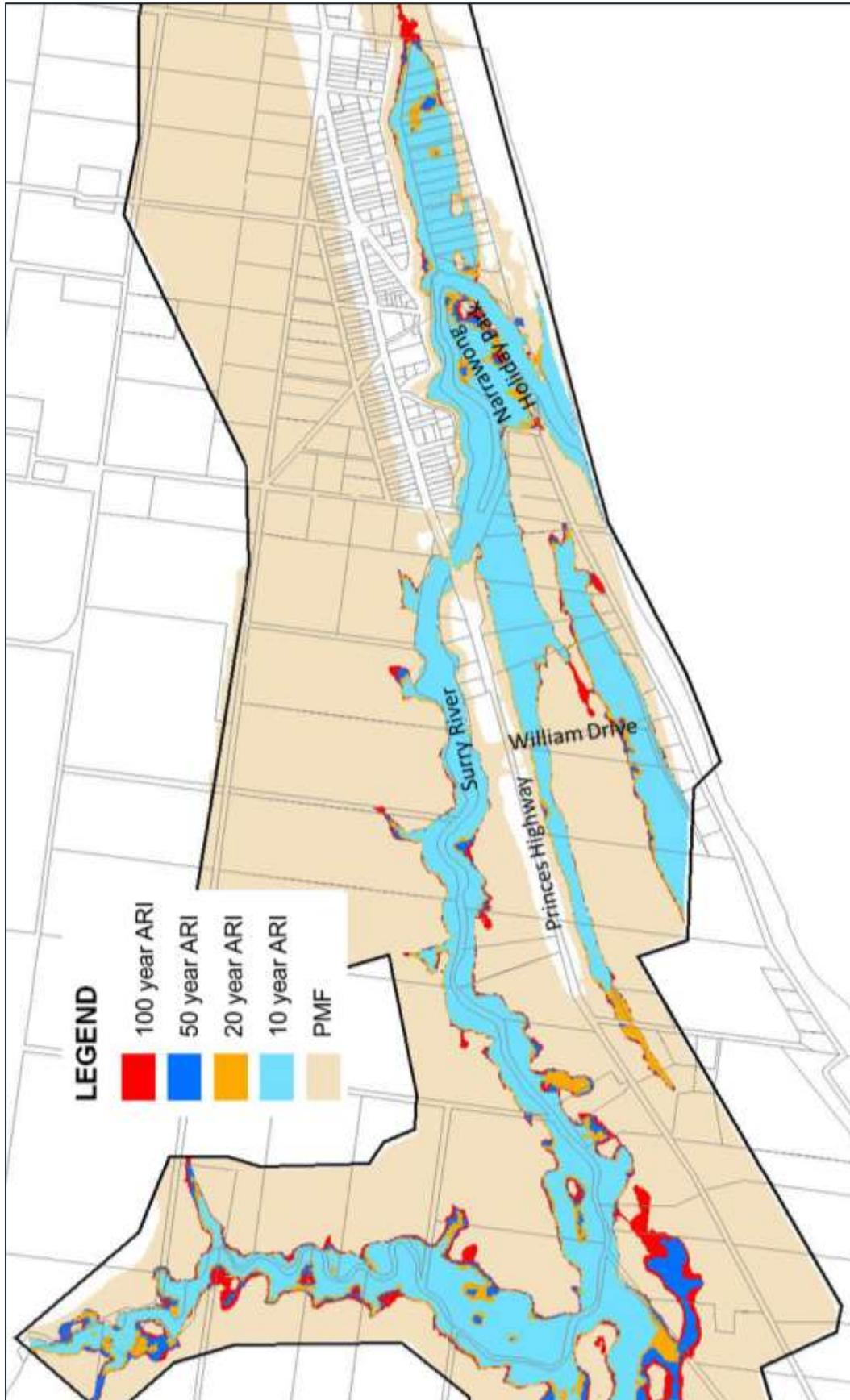
Although there is limited information documenting flood impacts experienced in Narrawong, recent flooding in September 2016 impacted several Narrawong Holiday Park buildings above floor. The Surry River Estuary

Flood Study undertaken by Water Technology in 2008 also mapped the November 2007 flood extent (refer to map below) as well as a range of design flood extents (refer to flood extent maps in Appendix E).



Narrowawong flood depth map of the November 2007 flood event (source: Water Technology 2008).

Design flood extent maps show only very minor difference between 10 year and 100 year flood extents despite the significant differences in flow magnitude and volume. This is largely due to the confining nature of the floodplain geometry in the study area.



Narrawong flood design extent maps (source: Water Technology 2008).

When the estuary sandbar is closed, this has a relatively localised effect on flood levels back through the estuary with negligible difference observed upstream of the highway bridge. Caution should be used when using the Heathmere gauge to infer flood magnitude. If the sandbar is closed, this can cause localised increases in flood levels.

The Narrawong Holiday Caravan Park has a Caravan Park Emergency Plan as part of its requirements for Registration.

Overview of Flooding Consequences/Assets

Refer to the Narrawong Flood Intelligence Card below for details regarding flooding consequences, assets, warning time, damages.

There are no documented mitigation works.

Narrawong Flood Intelligence Card

Surry River at Narrawong, Heathmere gauge 237207

Flood travel time				Time from start of rain to steep rise in floodwater 12 - 24 hours		
				Time from Heathmere gauge flood peak to Narrawong Caravan Park < 2 hours		
				Riverine flooding duration: 2.5 days		
Surry River, Heathmere gauge height 237207 (m)	Average Recurrence Interval (ARI)	Surry River at Heathmere Design Flows (ML/d) Cardno 2011	Consequence/ Impact	Narrawong damages total number buildings flooded (above floor) *estimated: no floor level survey	Roads Impacted/ Buildings Isolated	Action Actions may include: Evacuation, closure of road, sandbagging, issue warning and who is responsible etc.
All design flood maps assume an estuary sand bar height of 0.3 m AHD and an ocean water level of 0.93 m AHD.						
1.56	August 2017	1,214	Narrawong Holiday Park is not flooded.		Minor flooding of Caravan Park Road, south of the Princes Highway from the Surry River	Notify the Glenelg MERO and the Narrawong Holiday Park that minor flooding is likely and if stream levels at the Heathmere gauge continue to raise access/egress could be cut to the Caravan Park Road.
1.93	5	2,678	Flooding of two buildings above floor at the Narrawong Holiday Park.	8 (2)*	Access/egress may be cut to the Caravan Park Road, south of the Princes Highway from the Surry River, isolating the Narrawong Holiday Park and x2 houses. Access/egress may be cut to the William Drive,	Victoria Police consider evacuation of the Narrawong Holiday Park due to access/egress of Caravan Park Road may be cut.
2.02	November 2007	2,938				
2.12	10	3,370	Two additional buildings at the Narrawong Caravan Park are flooded above floor.	23 (4)*		
2.26	September 2016					
2.30	20	4,406		> 23 (4)*		
2.49	50	5,875		> 23 (4)*		
2.54	August 2013					
2.63	100	7,171	Four additional buildings at the Narrawong Caravan Park are flooded above floor.	26 (8)*		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Institute of Disaster Resilience (AIDR) Handbook series on managing the Floodplain

Narrawong Property Inundation Table (Water Technology 2008)

Given no floor level survey was undertaken as part of the Narrawong Flood Study (Water Technology 2008), only property flood depth data is available, refer to property inundation table below.

ADDRESS	10 ARI	100 ARI	Building type and comment
234 WILSONS ROAD HEATHMERE 3305	4.883	5.7012	Farm. Possible quarry impacted
107 WADES ROAD NARRAWONG 3285	4.7308	5.4872	Rural shed. Farmland impacted
THE ESPLANADE NARRAWONG 3285	4.4567	4.9316	Public buildings impacted
8116 PRINCES HIGHWAY NARRAWONG 3285	4.1165	4.8555	House, back paddocks impacted
8352 PRINCES HIGHWAY ALLESTREE 3305	3.9931	4.8199	House, back paddocks impacted
8316 PRINCES HIGHWAY ALLESTREE 3305	3.9139	4.7403	House, flooding in back paddocks
8302 PRINCES HIGHWAY ALLESTREE 3305	3.8102	4.6337	House, flooding in paddocks
288 WILSONS ROAD HEATHMERE 3305	3.485	4.4267	Shed flooding in paddocks
8248 PRINCES HIGHWAY ALLESTREE 3305	3.541	4.3608	House, flooding in back paddocks
PRINCES HIGHWAY ALLESTREE 3305	3.5641	4.3431	Shed, flooding in back paddocks
241 WADES ROAD NARRAWONG 3285	3.5519	4.3158	House, flooding in paddocks
286 WILSONS ROAD HEATHMERE 3305	2.9005	3.8062	House, flooding comes close
8228 PRINCES HIGHWAY ALLESTREE 3305	2.7192	3.5102	House, flooding in paddocks
8200 PRINCES HIGHWAY ALLESTREE 3305	2.7004	3.4682	House, flooding in paddocks
90 CARAVAN PARK ROAD NARRAWONG 3285	2.7939	3.3578	Flooding over the entire caravan park
8086 PRINCES HIGHWAY NARRAWONG 3285	1.6519	2.3215	House, Jetty impacted
30 CARAVAN PARK ROAD NARRAWONG 3285	1.5839	2.314	House, flooding over the access
8090 PRINCES HIGHWAY NARRAWONG 3285	1.5707	2.2795	House, flooding at boundary
8258 PRINCES HIGHWAY ALLESTREE 3305	0.9367	2.2418	House, flooding at rear
OCEAN VIEW DRIVE E NARRAWONG 3285	1.3359	2.1312	House, flooding in paddocks
8133 PRINCES HIGHWAY NARRAWONG 3285	0.9141	2.1312	House flooding at rear
21 WILLIAM DRIVE NARRAWONG 3285	1.3359	2.0762	House, floodwaters just abut building
PRINCES HIGHWAY NARRAWONG 3285	1.1992	1.9117	Sheds/house, flooding at rear
SNAPPER POINT ROAD ALLESTREE 3305	0	1.0242	Some impact in the front of paddock
8283 PRINCES HIGHWAY ALLESTREE 3305	0	0.5827	House
8368 PRINCES HIGHWAY ALLESTREE 3305	0	0.3991	House, flooding at rear of the property

Appendix C5: Regional Road Flood Emergency Plan

Glenelg Shire Council provided details of regional roads impacted during the September 2016 flood event, refer to the table below.

Location	Road Name
Henty	Dunan Road, Henty
Hotspur	Morven Road, Hotspur
Hotspur	Condah Hotspur Upper Road
Merino	Henty Paschendale Road, Merino
Merino	Talisker School Road, Merino
Sandford	Lower Coleraine Road , near the intersection with Ridge Road North. Ridge Road north closed to Nolans Road.
Sandford	Lower Coleraine Road, closed at Staffa Road.
Sandford	Sandford Rec Reserve Road, Sandford
Sandford	Sandford-Bahgallah Road, where the Wannan and Glenelg Rivers meet.
Wando Vale	Warrock Road, Wando Vale, from the Casterton Edenhope Road.

Appendix D - Flood evacuation arrangements

Phase 1 - Decision to Evacuate

The decision to evacuate is to be made in consultation with the MERO, MERC, DHHS, Health Commander and other key agencies and expert advice (CMA's and Flood Intelligence specialists).

The Incident Controller may make the decision to evacuate an at-risk community under the following circumstances:

- Properties are likely to become inundated;
- Properties are likely to become isolated and occupants are not suitable for isolated conditions;
- Public health is at threat as a consequence of flooding and evacuation is considered the most effective risk treatment. This is the role of the Health Commander of the incident to assess and manage. Refer to the State Health Emergency Response Plan (SHERP) for details);
- Essential services have been damaged and are not available to a community and evacuation is considered the most effective risk treatment.

The following should be considered when planning for evacuation:

- Anticipated flood consequences and their timing and reliability of predictions;

- Size and location of the community to be evacuated;
- Likely duration of evacuation;
- Forecast weather;
- Flood Models;
- Predicted timing of flood consequences;
- Time required and available to conduct the evacuation;
- Evacuation priorities and evacuation planning arrangements;
- Access and egress routes available and their potential flood liability;
- Current and likely future status of essential infrastructure;
- Is cross border assistance required or evacuation to another municipality relief centre?;
- Resources required and available to conduct the evacuation;
- Shelter including Emergency Relief Centres, Assembly Areas etc.;
- Vulnerable people and facilities;
- Transportation;
- Registration
- People of CALD background and transient populations;
- Safety of emergency service personnel;
- Different stages of an evacuation process.

Phase 2 – Warning

Warnings may include a warning to ‘prepare to evacuate’ and a warning to ‘evacuate now’. Once the decision to evacuate has been made, the at-risk community will be warned to evacuate. Evacuation warnings should be disseminated via methods listed in section 3.3 of this plan.

Phase 3 – Withdrawal

VICPOL is the responsible agency for evacuation. VICSES will provide advice regarding most appropriate evacuation routes and locations for at-risk communities to evacuate to.

VICSES, CFA, AV and Local Government will provide resources where available to support VICPOL/ REGIONAL ROADS with route control and may assist VICPOL in arranging evacuation transportation.

VICPOL will control security of evacuated areas.

Evacuees will be encouraged to move using their own transport where possible. Transport for those without vehicles or other means will be arranged.

Landing zones for helicopters are located at:

- Casterton Airport
- Portland Airport

Special needs groups will be/are identified in Council’s ‘vulnerable persons register’. This can be done through community network organisations.

Phase 4 – Shelter

Relief Centres and/or assembly areas which cater for people’s basic needs for floods may be established to meet the immediate needs of people affected by flooding

VICPOL in consultation with VICSES will liaise with Local Government and DHHS (where regional coordination is required) via the relevant control centre to plan for the opening and operation of relief centres. This can best be achieved through the Emergency Management Team (EMT).

Animal Shelter

Animal shelter compounds will be established for domestic pets and companion animals of evacuees.

Phase 5 – Return

The Incident Controller in consultation with VICPOL will determine when it is safe for evacuees to return to their properties and will arrange for the notification of the community.

VicPol will manage the return of evacuated people with the assistance of other agencies as required.

Considerations for deciding whether to evacuate include:

- Current flood situation;
- Status of flood mitigation systems;
- Size and location of the community;
- Access and egress routes available and their status;
- Resources required to coordinate the return;
- Special needs groups;
- Forecast weather;
- Transportation particularly for people without access to transport

Disruption to Services

Disruption to a range of services can occur in the event of a flood. This may include road closures affecting school bus routes, truck routes, water treatment plant affecting potable water supplies etc.

Public Information and Warnings

VICSES uses EM-COP Public Publishing to distribute riverine and flash flood warnings in Victoria. The platform enables automatic publishing to the VicEmergency app, website and hotline (1800 226 226). Communities can also access this information through VICSES social media channels (Victoria State Emergency Service on Facebook and VICSES News on Twitter) and emergency broadcasters, such as Sky News TV and various radio stations (current list available via the [EMV website](#)).

VICSES Regions (or ICCs where established) lead the issuing of warnings for riverine flood events when pre-determined triggers are met (issuing of a BOM Flood Watch or Warning), and share locally tailored information via the standard VICSES communication channels (social media, traditional media, web and face to face). These activities are coordinated by the VICSES RDO and approved by the VICSES RAC, or the PIO and IC respectively (when an ICC is active).

If verified reports are received of flash flooding posing, or resulting in, a significant threat to life or property, VICSES Regions (or ICCs) will issue a flash flood warning product via EM-COP.

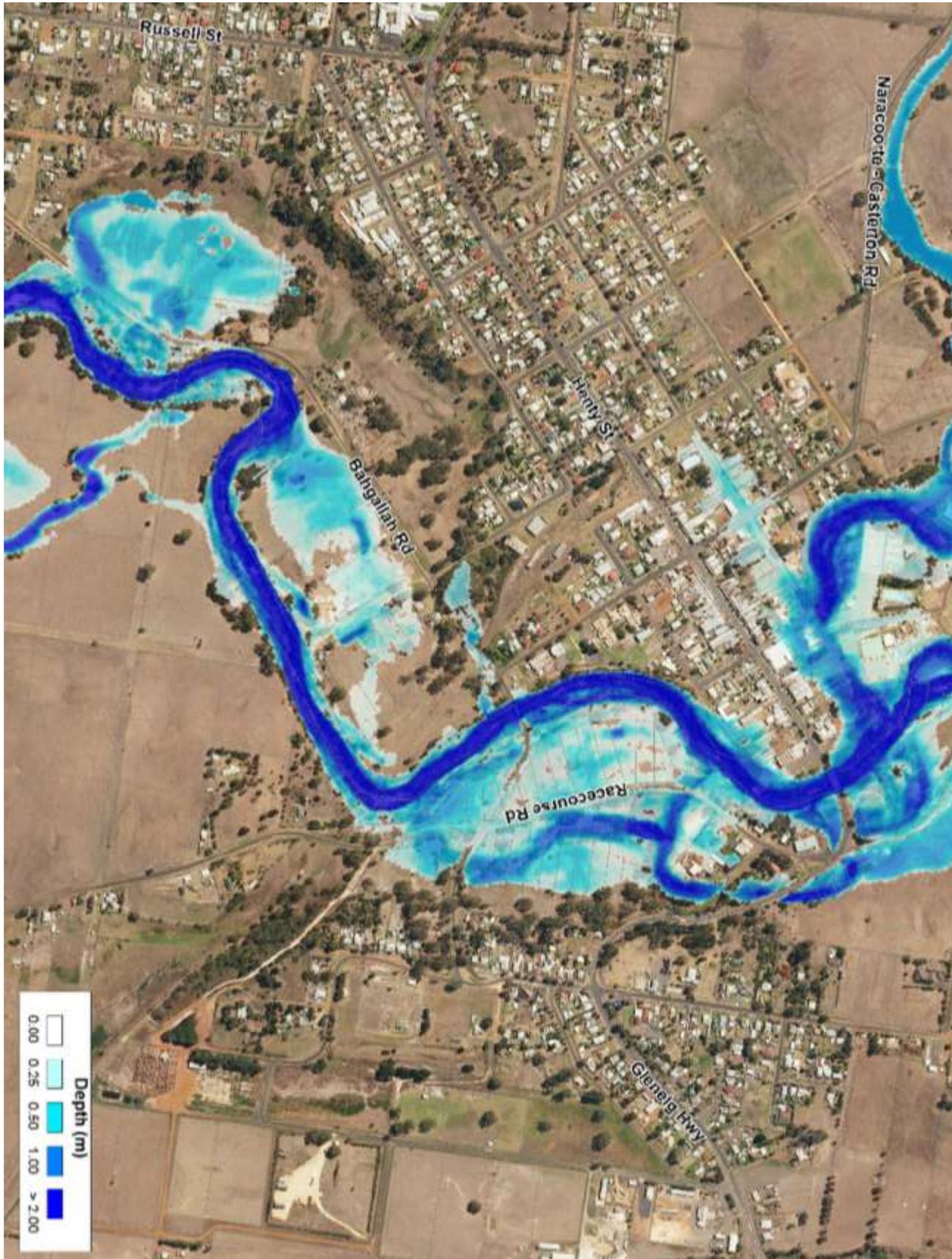
VICSES at the state tier (or SCC Public Information Section) plays an important role in sharing riverine and flash flood information via state-based standard communication channels.

During some emergencies, VICSES may alert communities by sounding a local siren, or by using the Emergency Alert (EA) platform to send an SMS to mobile phones or a voice message to landlines. The use of sirens for higher-end warnings has been pre-determined, and mapped to relevant warning templates in EM-COP.

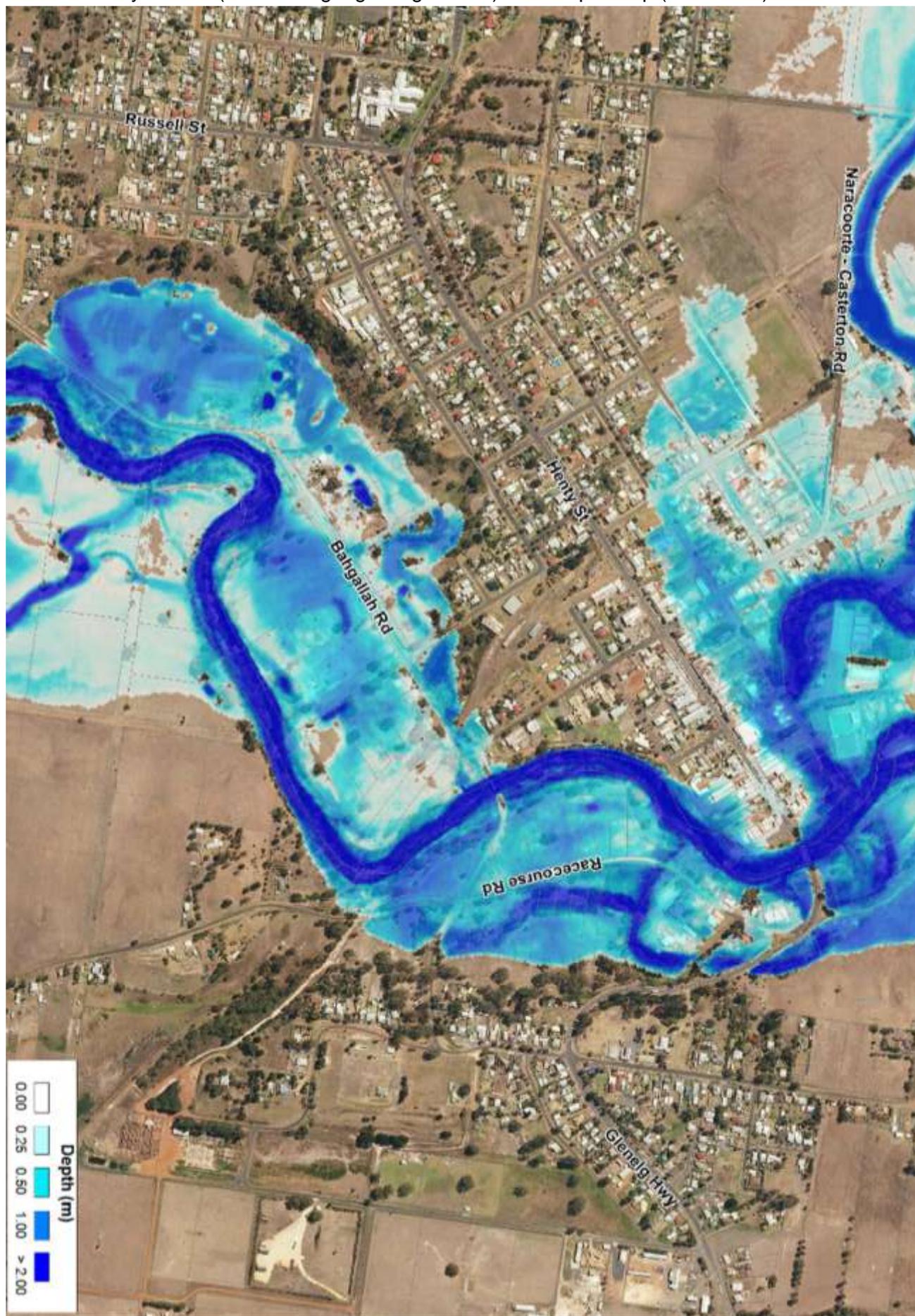
EM-COP Public Publishing Business Rules for Riverine and Flash Flood are available in the **Public Information tab of the IMT Toolbox**, providing further guidance on specific triggers, roles and responsibilities. VICSES SOP057 and JSOP 04.01 provide further guidance.

Appendix E: Maps and Schematics

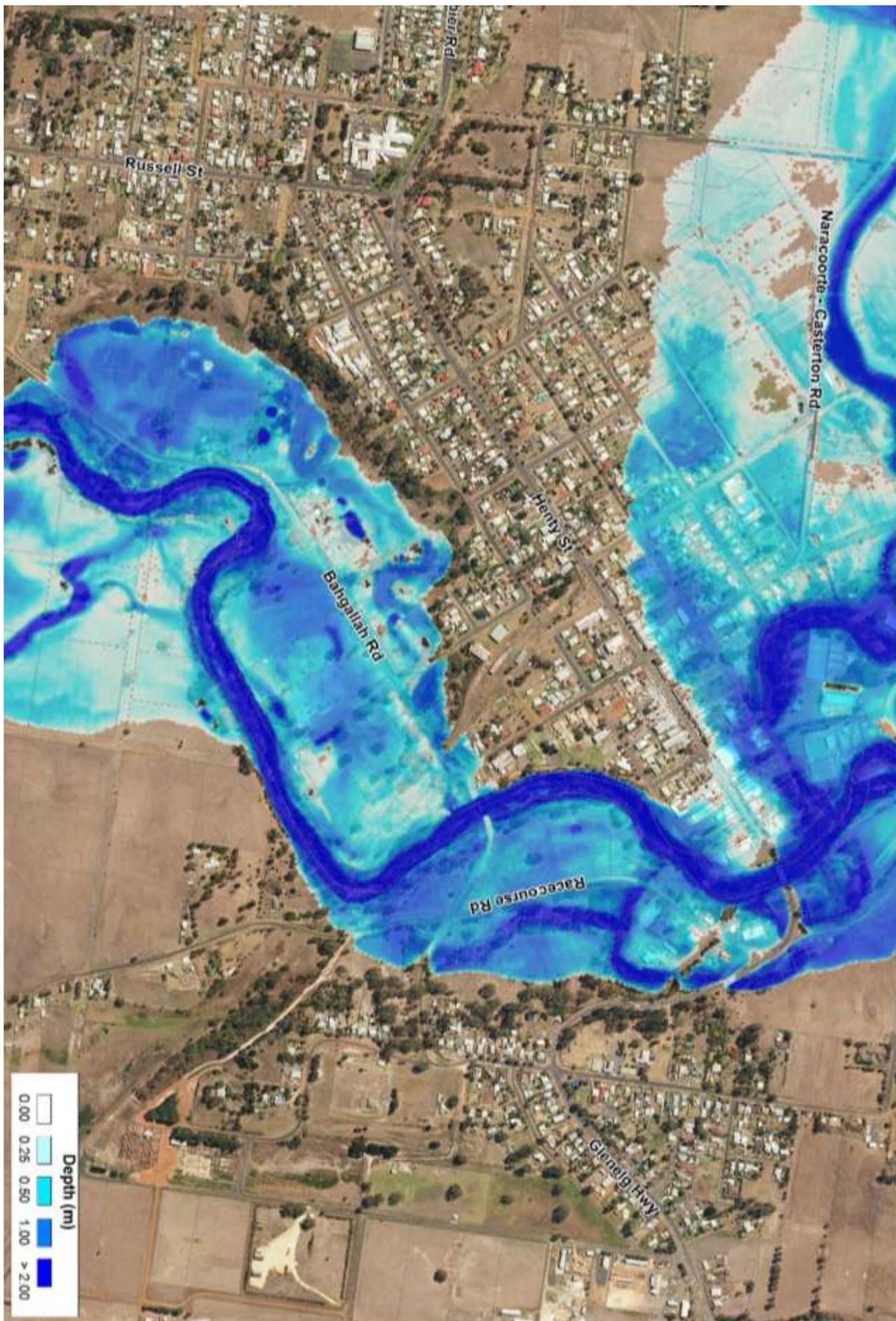
1.1. **Casterton Flood Depth Maps.** Casterton 5 year ARI (Casterton gauge height 5.7m) flood depth map (BMT 2014).



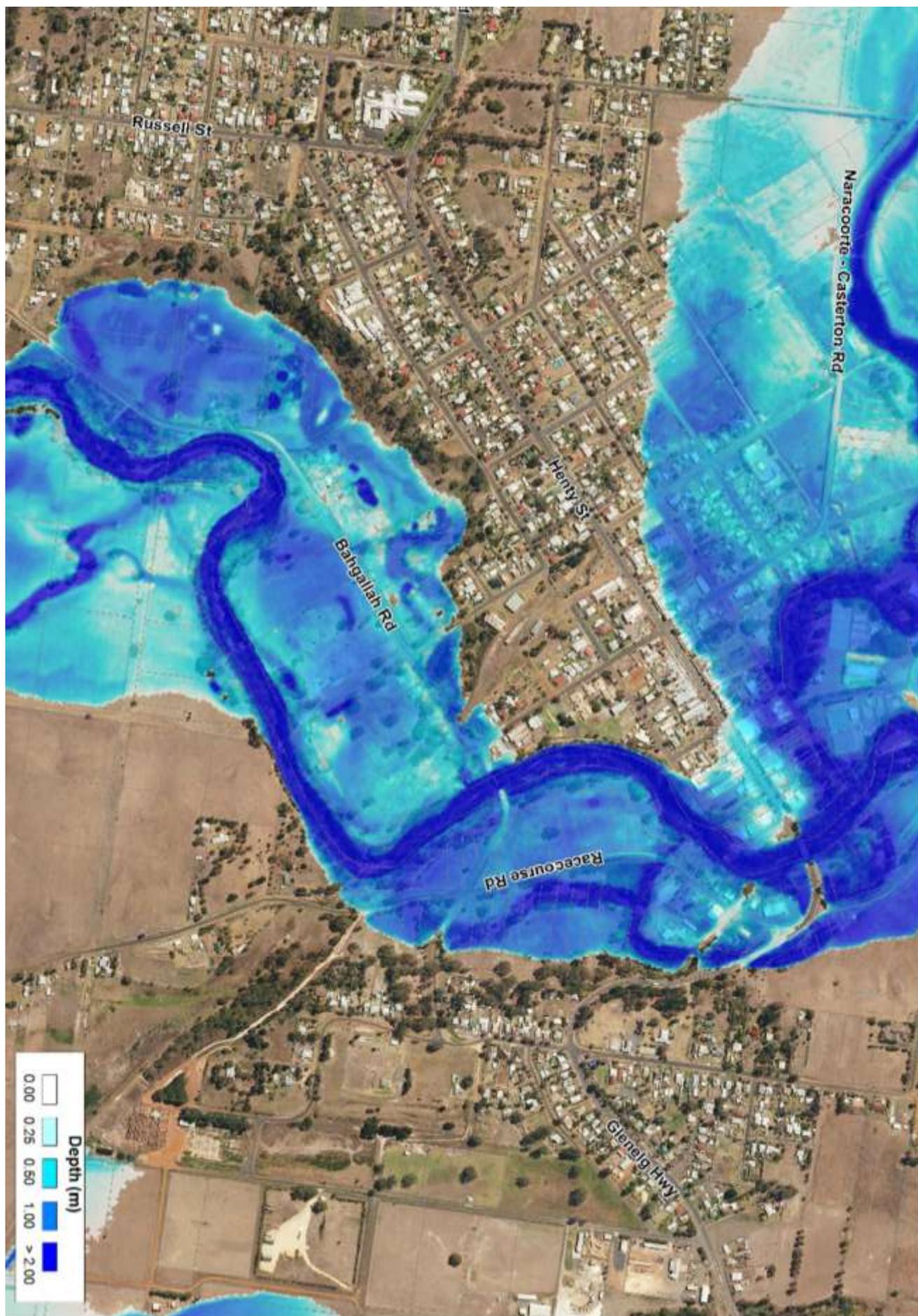
Casterton 10 year ARI (Casterton gauge height 6.1m) flood depth map (BMT 2014).



Casterton 20 year ARI (Casterton gauge height 6.4m) flood depth map (BMT 2014).



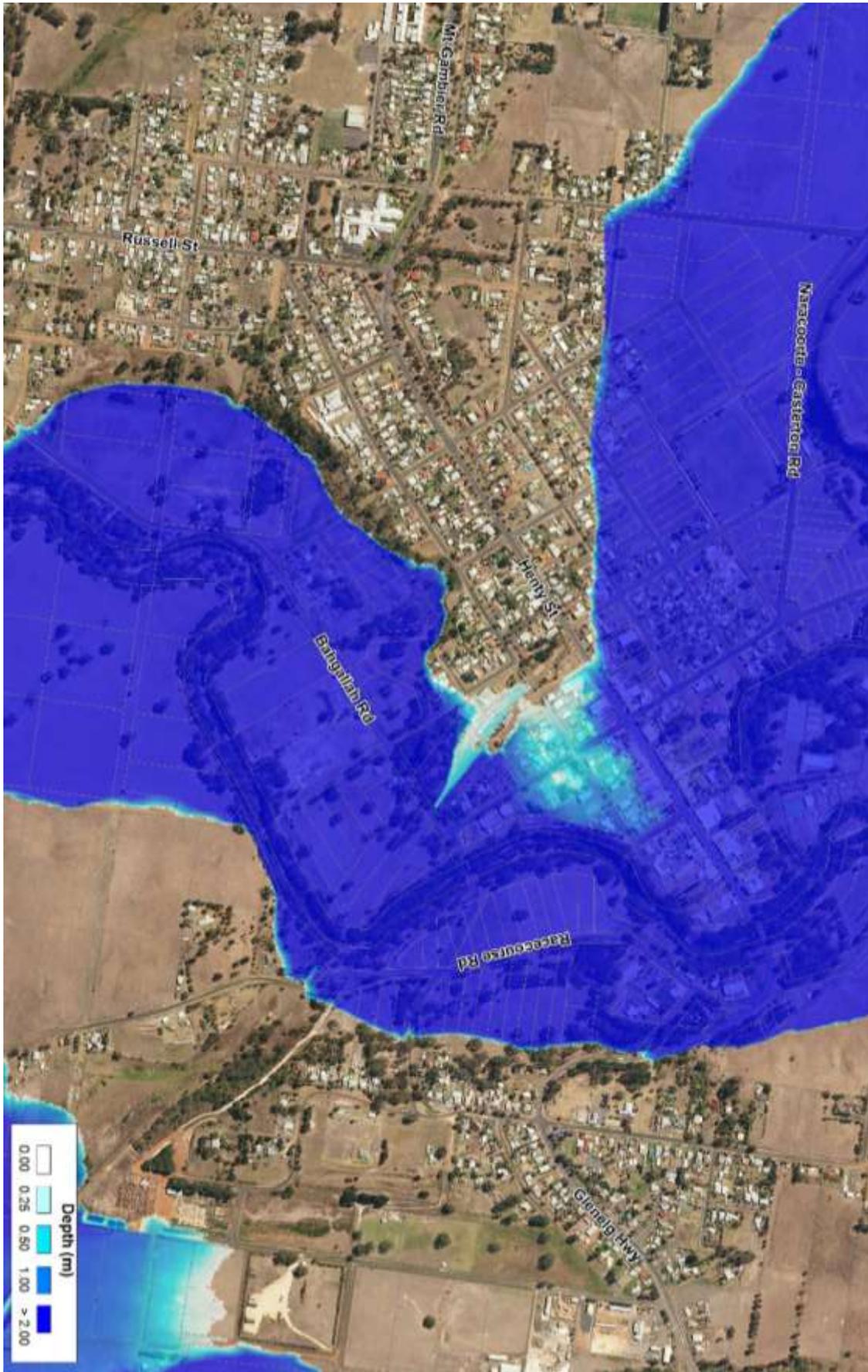
Casterton 50 year ARI (Casterton gauge height 6.6m) flood depth map (BMT 2014).



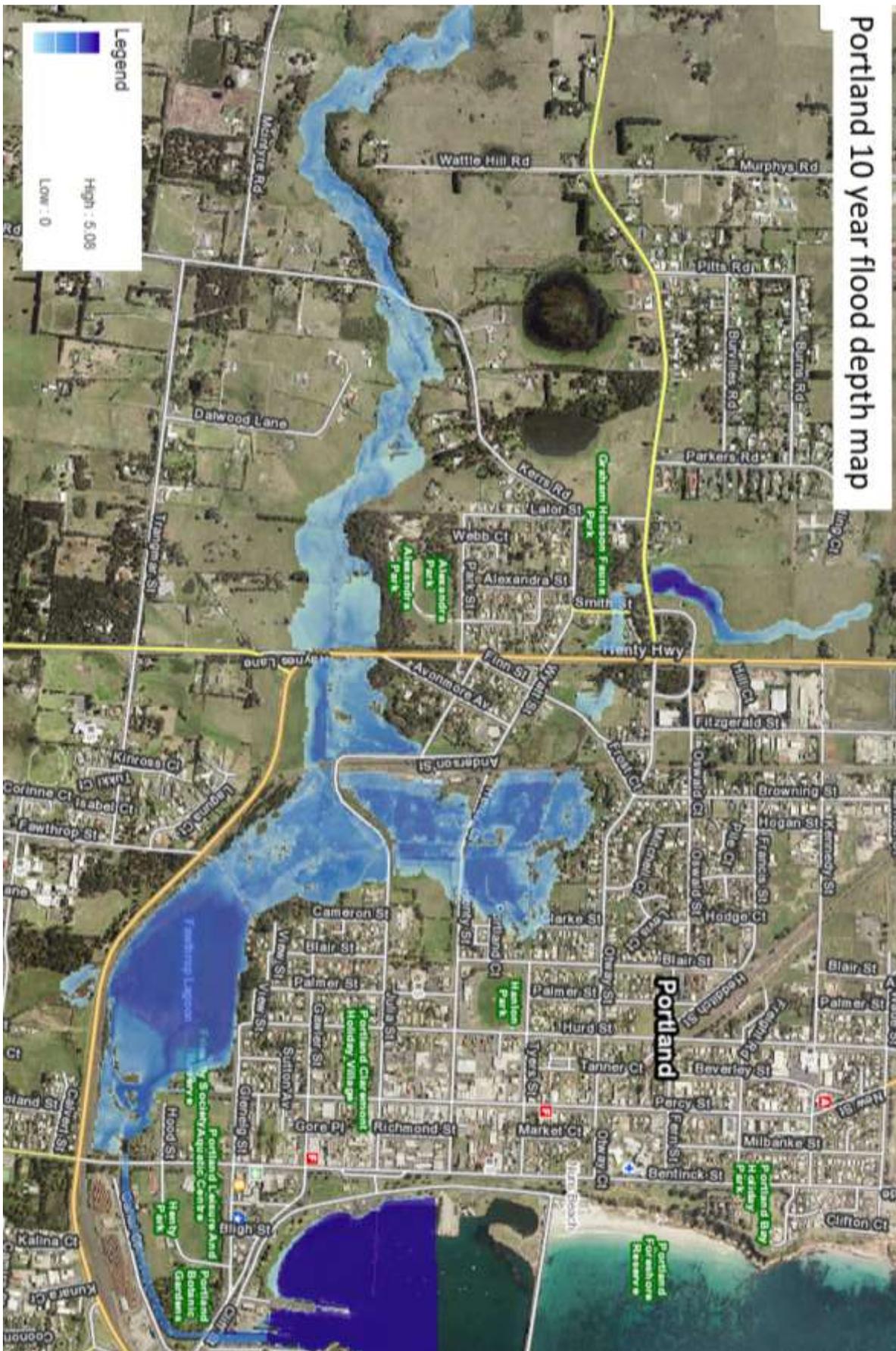
Casterton 100 year ARI (Casterton gauge height 6.8 m) flood depth map (BMT 2014).



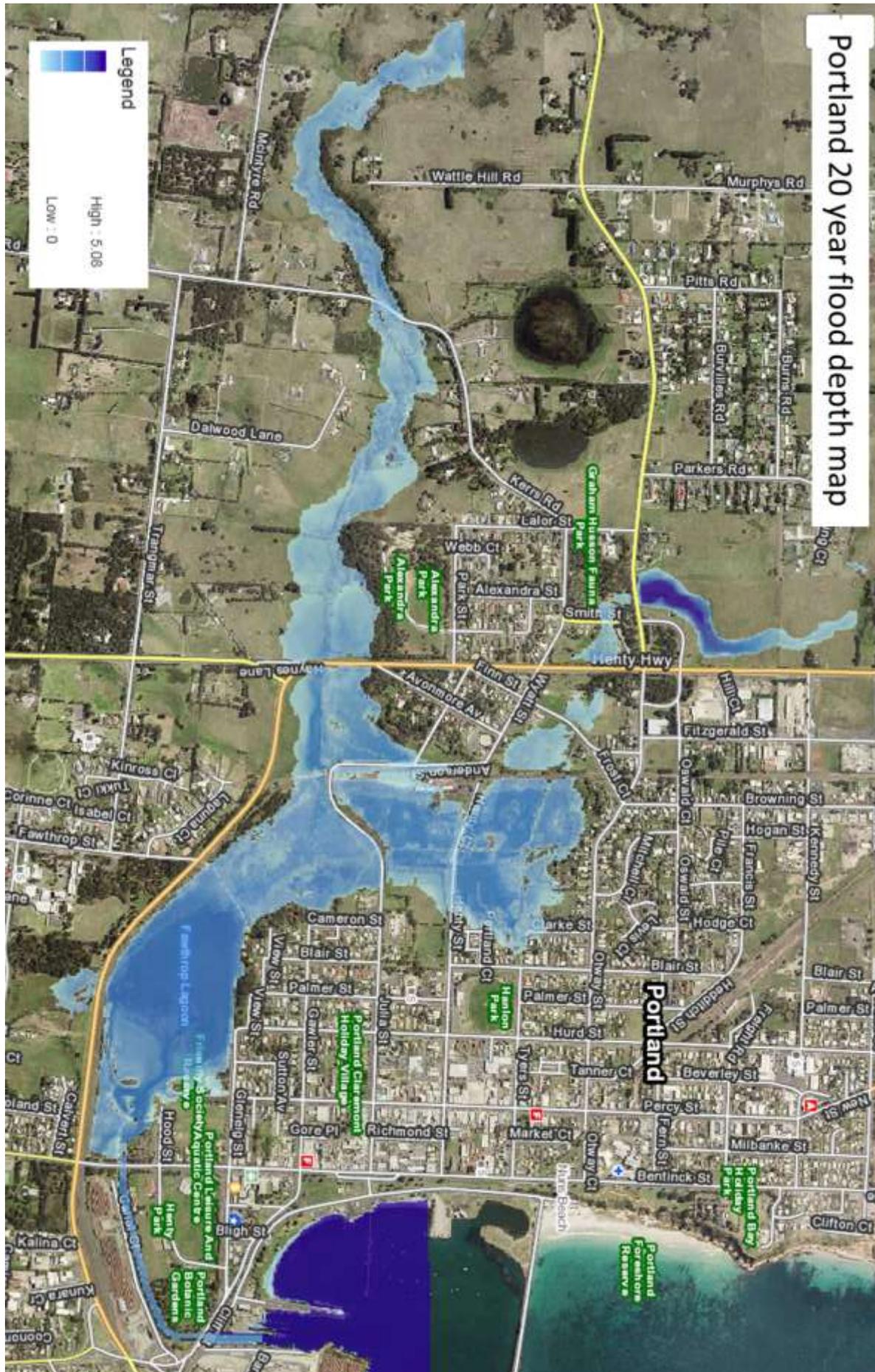
Casterton Probable Maximum Flood (PMF), (Casterton gauge height 10.9 m) flood depth map (BMT 2014).



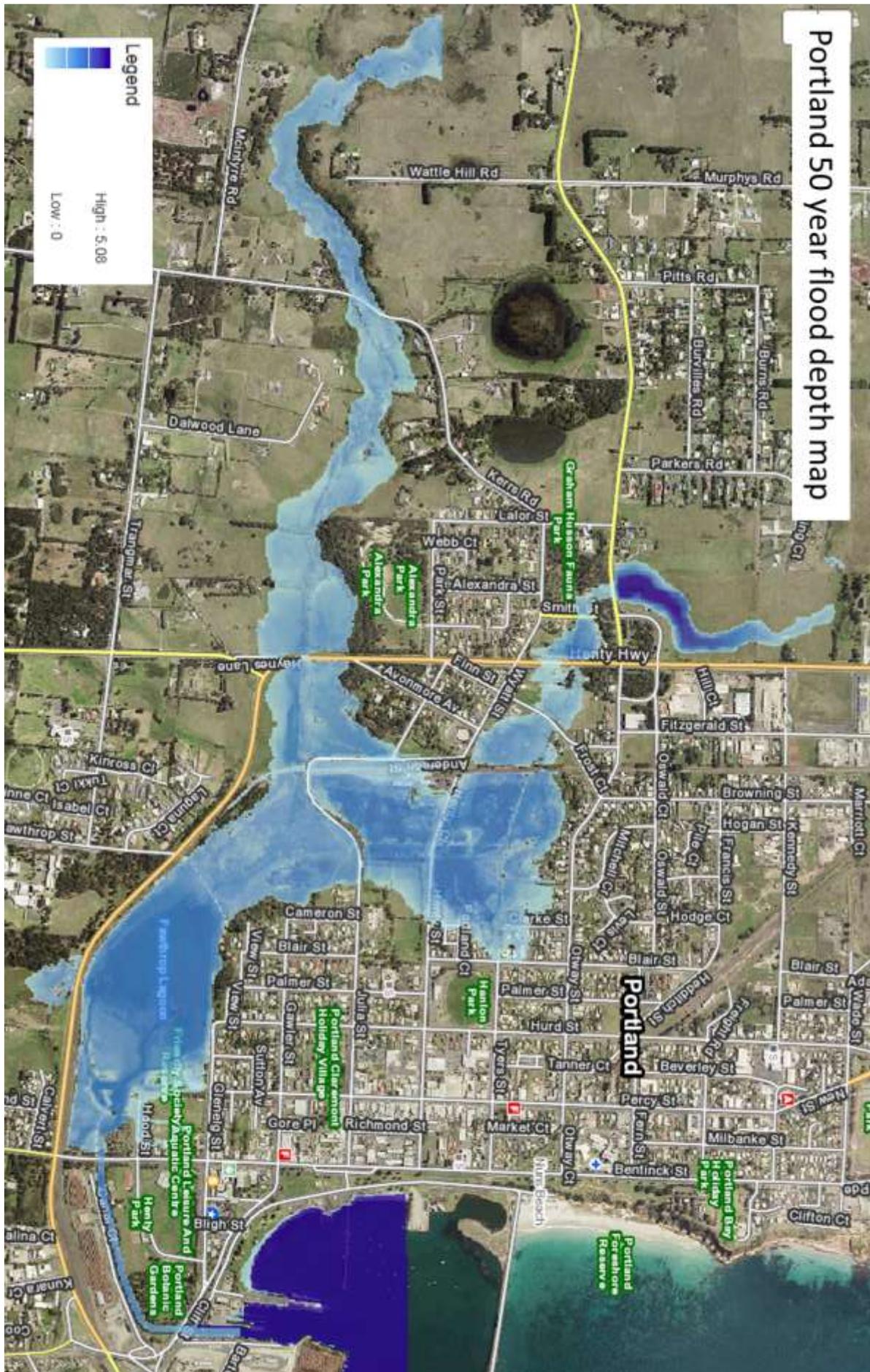
1.2. **Portland Flood Depth Maps.** Portland 10 year ARI flood depth map (Cardno 2011).



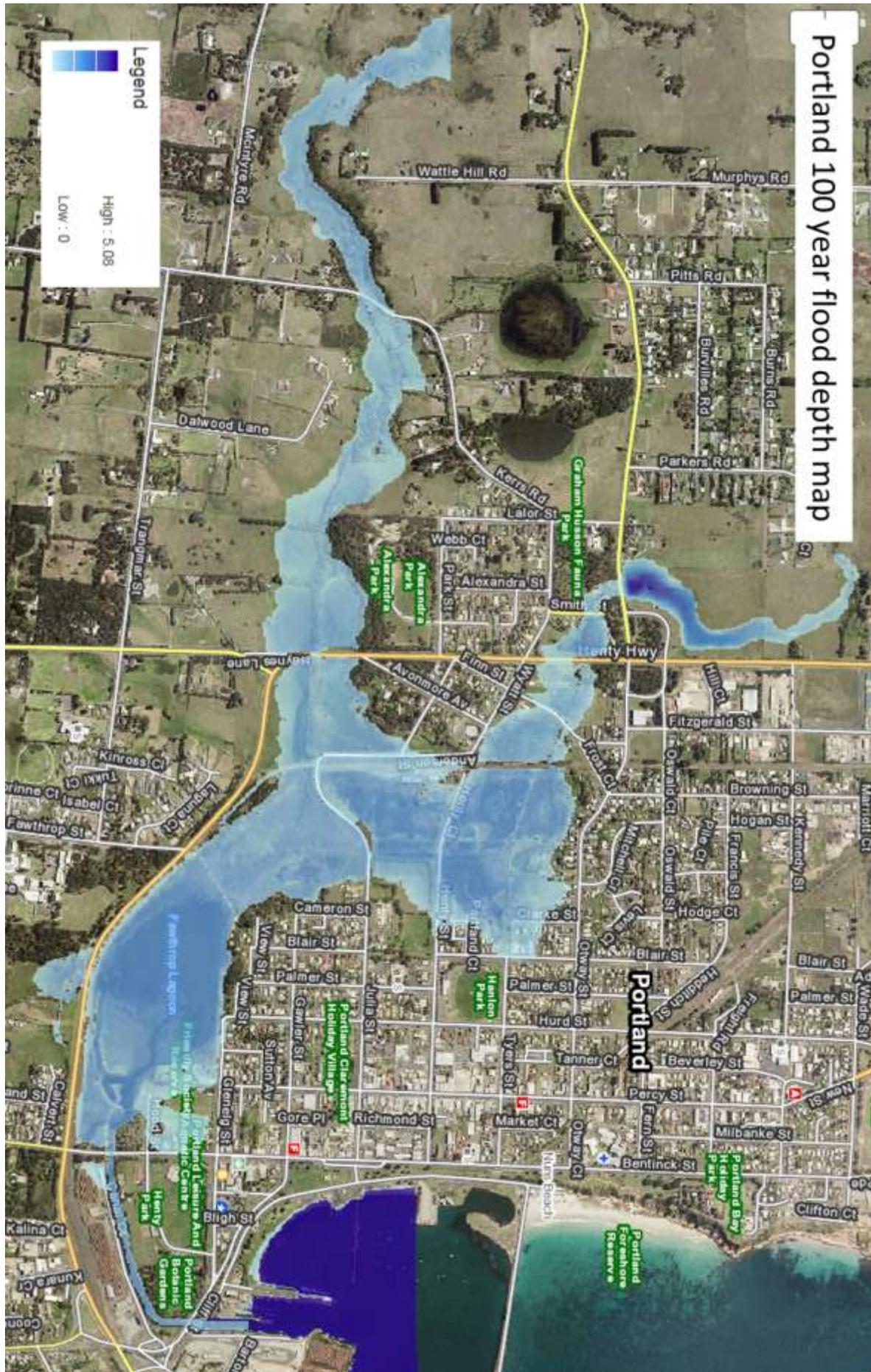
Portland 20 year ARI flood depth map (Cardno 2011).



Portland 50 year ARI flood depth map (Cardno 2011).



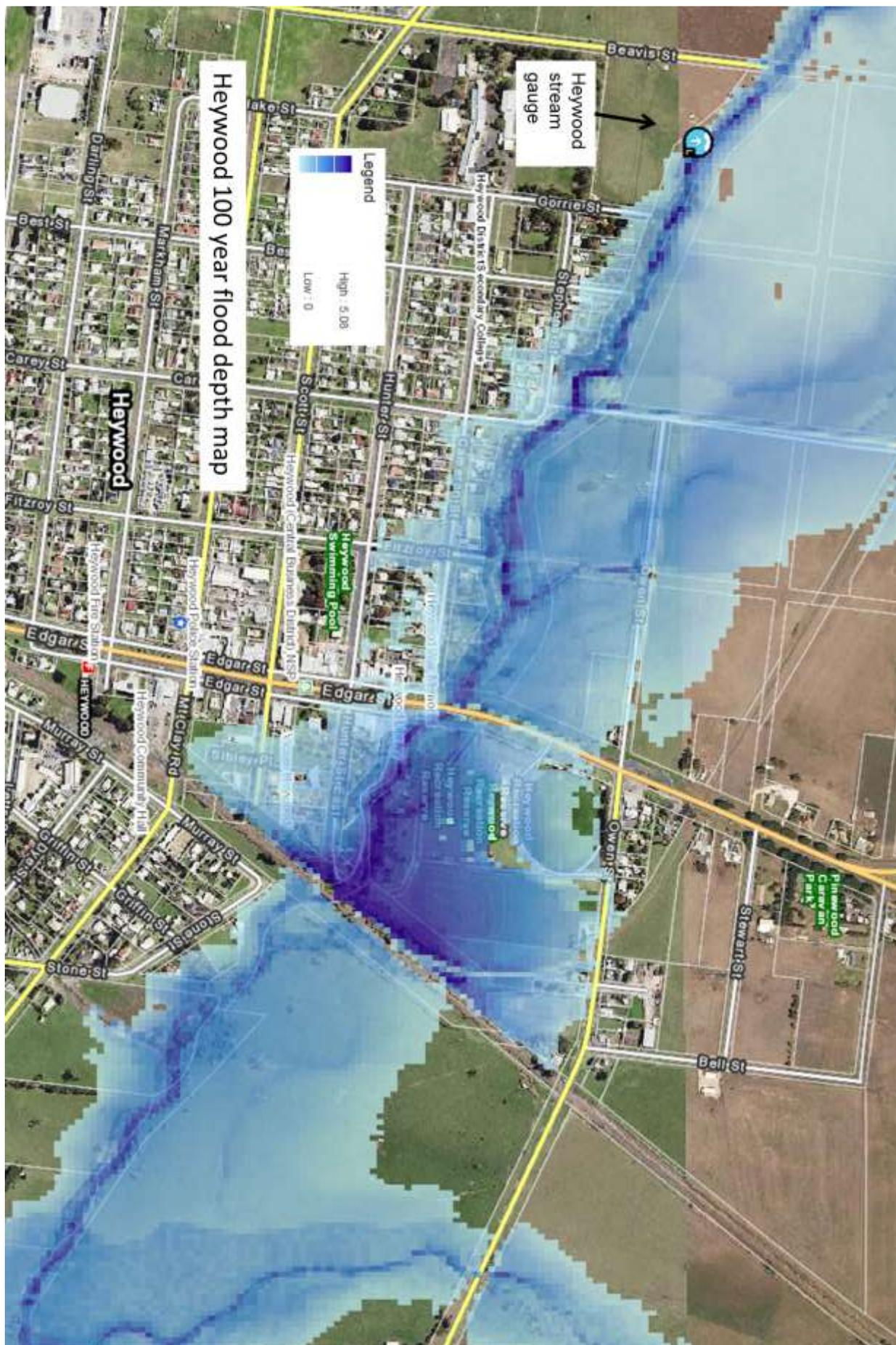
Portland 100 year ARI flood depth map (Cardno 2011).



1.3. **Heywood Flood Depth Maps.** Heywood 10 year ARI (Fitzroy River at Heywood gauge height 2.25m) flood depth map (Water Tech 2017).



Heywood 100 year ARI (Fitzroy River at Heywood gauge height 2.7m) flood depth map (Water Tech 2017).



1.4. **Narrawong Flood Depth Maps.** Narrawong 10 year ARI (Surry River at Heathmere gauge height 2.12m) flood depth map (Water Tech 2008).



Narrawong 100 year ARI (Heathmere gauge height 2.63m) flood depth map (Water Tech 2008).



Appendix F: Local knowledge arrangements

As control agency for flood in Victoria, VICSES is committed to ensuring the incorporation of local knowledge in decision making before, during and after incidents.

Information from community sources including but not limited to observations, historical information and information about current and possible consequences of an incident may be utilised to help inform the process of incorporating local knowledge into decision making during an incident. Community observers and agency staff will help support this process.

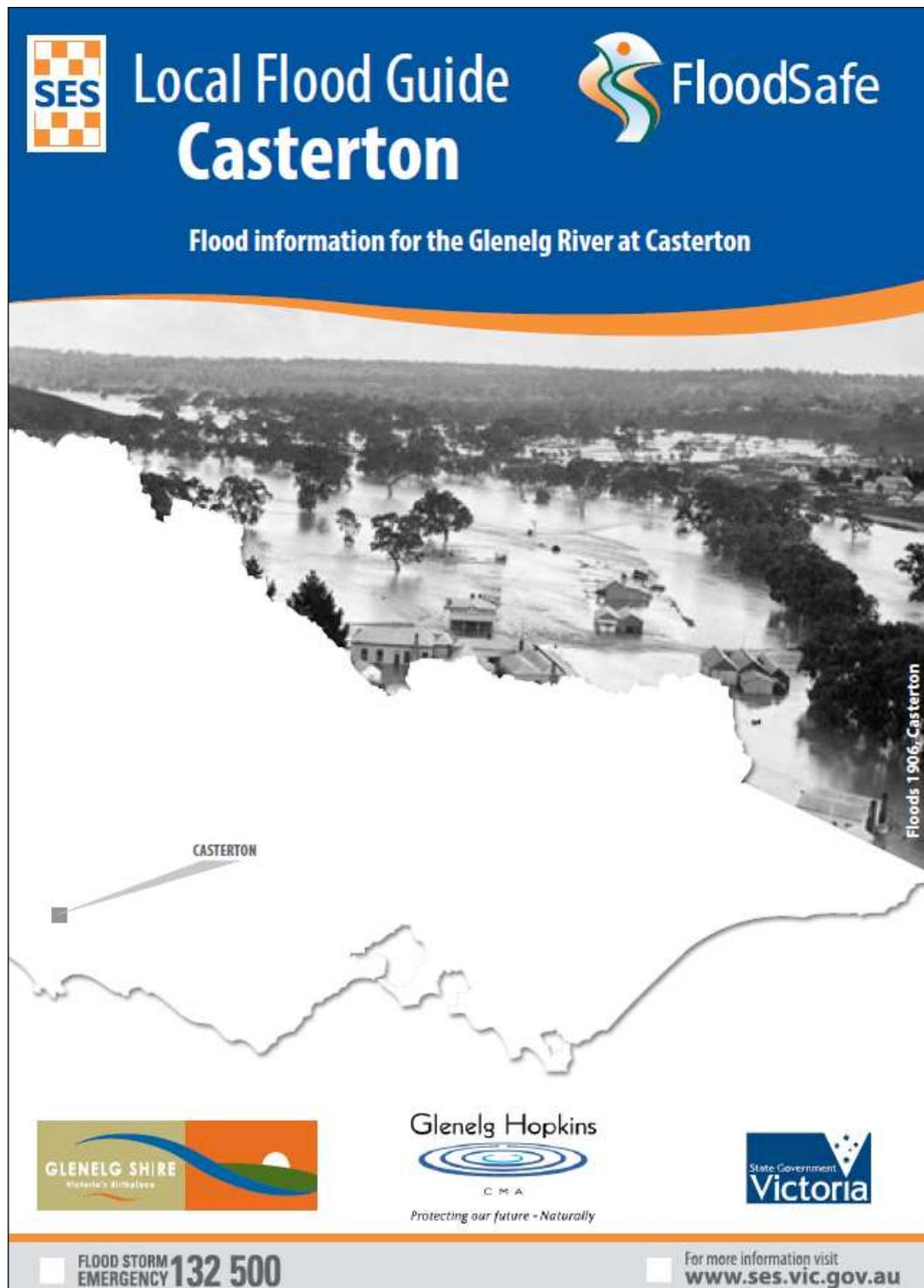
For the Glenelg Shire region community observers identified are:

Town	Observer Details	Community Observer Name	Contact Details
Casterton	Glenelg Inn, 2 Henty Street Casterton	Pub Owner	5581 41988
Casterton	Casterton CFA Brigade Captain	Leigh Condon	0427 865 530
Casterton	VICSES Dartmoor Unit Controller	Dallas Oakley Kaye Oakley	0428 281 438 0427 281 438
Portland	VICSES Portland Unit Controller	Bernadette Stiles	0400 130 464
Heywood	VICSES Heywood Unit Controller	Jeffrey Filliponi	0413 264 697
Heywood	VICSES Heywood Unit Deputy Controller	John Stirling	0404 880 131
Narrawong	Narrawong Holiday Park Caravan Park, 20 Caravan Park Road, Narrawong	Caravan Park Owner	5529 5282

Appendix G: Local flood information

There have been two Local Flood Guides developed for the Glenelg Shire Region;

- Refer to the link below for the Casterton Local Flood Guide Casterton
<https://www.ses.vic.gov.au/documents/112015/134969/Casterton+Local+Flood+Guide/776b047d-c17d-429c-b8d2-6443c9c47496>



- Portland Local Flood Guide (in draft, will be available soon)