Greater Shepparton City Council

FLOOD EMERGENCY PLAN

A Sub-Plan of the Municipal Emergency Management Plan

For Greater Shepparton City Council

VICSES Unit(s) Murchison and Tatura
and
Shepparton Search & Rescue Squad

Version 2.5, December 2021

GREATER SHEPPARTON

VICTORIA State Government

SES

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Distribution of MFEP

Once endorsed and signed the, MFEP should be distributed to all MFEP committee members, MEMPC Chair, council, MEMO, Deputy MEMO, Representatives from; BoM, CMA, DELWP, Parks Victoria, Ambulance Victoria, VicRoads, DFFH, relevant utilities, FRV, 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 Northeast@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
V2.0	March 2018	M Cawood	Update of flood intelligence (Appendices A, B, C, etc) drawing on recent events and flood studies – Shepparton-Mooroopna, East Shepparton, Murchison, Merrigum & Tatura. Checked and adjusted EMMV & VFMS references. Updated agency names as well as Section 4.3 re Animal Welfare. Added references. Selected Appendices reviewed by Ben Tate of Water Technology.
V2.1	June 2018	Ben Tate	As discussed with GSCC, GBCMA, VICSES, MCA – May 2018
V2.2	June 2018	M Cawood	Further edits based on discussion and feedback from GSCC, GBCMA, VICSES. Other minor edits.
V2.3	July 2018	M Cawood	Added flood intel and history for Congupna, Dainton's, Pine Lodge, O'Keefe & Gulfus creeks from the 27Feb2014 report from Greg Sidebottom to GSCC.
V2.4	August 2018	Ben Tate	Changed Flood Class Level table on page 48, had incorrect levels for the Goulburn River at Arcadia Downs site. The updated levels have come directly from Section 5.2.2 from the Flood Warning Service Charter.
V2.5	2021	J Newlands M Cawood Trudi Pratt	Updates and edits to accommodate corrections to the hydraulic modelling at the East Goulburn Main Channel immediately north of Channel Road. Changes to numbers of properties inundated. Text also edited. Now consistent with the Shepparton Mooroopna Study reports delivered 1 March 2019. Updated to the new SES MFEP template.

This Plan will be maintained on the VICSES website at www.ses.vic.gov.au/get-ready/your-local-flood-information and www.greatershepparton.com.au website.

List of Abbreviations & Acronyms

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

Part 1. Introduction

1.1 Approval and Endorsement

This Municipal Flood Emergency Plan (MFEP) has been prepared by (Shepparton MFPC) and with the authority of the Shepparton MEMPC –pursuant to Section 20 of the Emergency Management Act 1986 and the Emergency Management Legislation Amendment Act 2018.

The Shepparton MFPC have undertaken the following consultations with the CMA, Flood Studies, Shepparton MEMP committees and the surrounding communities of Shepparton about the arrangements contained within this plan:

This MFEP is a sub plan to the Shepparton Emergency Management Plan (MEMP), is consistent with the State Emergency Management Plan (SEMP) 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 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 Greater Shepparton City Council MEMPC as a sub-plan to the MEMP.

Approval

.....

Brendan Corboy Date

Region VICSES Regional Manager

Endorsement

L. Mitchell

.....

Louise Mitchell Date 21/6/2022

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 the Greater Shepparton City Council

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 Municipal Flood Planning Committee (MFPC)

Membership of the Greater Shepparton City Council Flood Planning Committee (MFPC) comprises of the following representatives from the following agencies and organisations:

- VICSES (i.e. Regional Officer – Emergency Management) **(Chair)**,
- Council (i.e. Municipal Emergency Management Officer) (MEMO)
- Victoria Police (i.e. Municipal Emergency Response Co-ordinator) (MERC),
- Catchment Management Authority (CMA),
- Department of Families, Fairness and Housing (DFFH) as required,
- Department of Environment, Land, Water and Planning (DELWP) as required,
- Water Authorities as required,
- Bureau of Meteorology as required,
- Local community representatives and
- List other agencies as required

1.4 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 Greater Shepparton City Council.

VICSES with the support of Greater Shepparton City Council and Goulburn Broken Catchment Management Authority will coordinate targeted community flood engagement programs within the council area.

A Community Engagement/Communication Plan can be developed in addition to any Local Flood Guides.

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

2.2 Structural Flood Mitigation Measures

The following summary of structural flood mitigation measures exist within the Council area:

- Levees in Murchison, Kialla, Mooroopna and Shepparton. These are on private and Crown land and maintenance responsibility is to be determined.
- Flood pumps are positioned at strategic locations to protect urban areas
- Penstocks are located along waterways to prevent backflow
- There are more than 70 retardation basins (47 in East Shepparton) across the municipality, owned and maintained by Council.

Refer to appendix C for detailed information of structural flood mitigation measures.

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 an 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 D**.

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 F**.

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 North East 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 Greater Shepparton City Council. These agencies will be engaged through the EMT.

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

Agreed roles of supporting agencies **may** be listed/are in a separate appendix to this plan or link back to the MEMP.

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 SEMP.

3.2 The six C's

Arrangements in this MFEP must be consistent with the six C's detailed in State and Regional Flood Emergency Plans and the MEMP.

- **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 and the Emergency Management Legislation Amendment Act 2018* detail the authority for VICSES to plan for and respond to flood.

The SEMP prepared under the *Emergency Management Act 1986 and the Emergency Management Legislation Amendment Act 2018*, 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 the SEMP.

All flood response activities within the Greater Shepparton City Council 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 the SEMP.

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

Incident Level	Location	ICC Location	Facility owner	Key contact
2 - 3	64 Sydney Road	Benalla	VicSES	North East RAC
3	195 – 205 Numurkah Road	Shepparton	CFA	CFA RAC

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
Tatura	Tatura, Murchison, Nagambie and Mooroopna
Shepparton	Shepparton, Kialla

Pre-determined Division Command locations are:

- Tatura Division Command location Corner Russell and Martin Street Tatura
- Shepparton S&R Division Command location 15 Dudley St Shepparton

Pre-determined Sector Command locations are:

- Tatura Sector Command location is Corner Russell and Martin Streets Tatura
- Shepparton S&R Sector Command location is 15 Dudley Street Shepparton
- Murchison Sector Command location is 10a Watson Street, Murchison
- Nagambie Sector Command location is Vine Street, Nagambie
- Kialla Sector Command location is Central Kialla Road, Kialla

3.2.5 Incident Management Team (IMT)

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

Refer to the SEMP for guidance on IMTs and Incident Management Systems (IMSs).

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 Greater Shepparton City Council, 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 section 3 of the SEMP for guidance on IEMTs.

3.2.7 On Receipt of a Flood Watch / Severe Weather Warning

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

- Develop an appreciation of current flood levels and predicted levels. Are floodwaters rising, steady, 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 (eg. Water, 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
- Liaise with relevant flood mitigation infrastructure managers

3.3 Initial Impact assessment

Initial impact assessments will be conducted in accordance with the SEMP 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 DFFH 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 time or options safety advice needs to be provided to people at risk. Advise should be given to not attempt to flee by entering floodwater. If people 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 Greater Shepparton City Council MERC and MEMO 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 for all flooding

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 SEMP 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 Greater Shepparton City Council to assist with rescue operations:

Shepparton Search and Rescue:
- Boat one – MSV 11306 4.7 Horizon
- Boat two – MSV 11305 4.1 Zodiac

Tatura SES:
- Rescue Boat – RB557 Savage 475 Jabiru

Numurkah SES:
- Rescue Boat – RB593 Savage Jabiru

Kyabram SES:
- Rescue Boat – RB530 Savage 545 Jabiru

Benalla SES:
- Rescue Boat – RB546 Semi ridged 420 Gemini

Cobram SES:
- Rescue Boat – RB511 Semi ridged A500 Gemini

Rushworth SES:
- Rescue Boat – RB520 Ridged Savage 470 Jabiru

Known high-risk areas/communities (i.e. low-lying islands) where rescues might be required include:

- Goulburn River flood plain
- Broken River
- Kialla

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:

- The Shepparton Aerodrome is located on Melbourne Road, Kialla; 5.5 kilometres south from the Shepparton CBD. It is at latitude S 36° 25'7", longitude E 145°a 23'6" and altitude 374 feet.

Shepparton Airport

IATA: SHT · ICAO: YSHT

Summary	
Airport type	Public
Operator	Greater Shepparton City Council
Location	Shepparton, Victoria
Opened	c. 1954[1][2][3]
Elevation AMSL	374 ft / 114 m
Coordinates	36°25′33″S 145°23′31″E
Website	greatershepparton.com.au/region/aerodrome

Map

Location in Victoria

Runways

Direction	Length		Surface
	m	ft	
09/27	423	1,388	Gravel
18/36	1,378	4,521	Asphalt

Sources: Australian AIP and aerodrome chart[4]

The following facilities at the Shepparton Aerodrome may be at risk of flooding during a 1 in 100 flood event:	
Facility Name Potential water level over land	Water Level
Terminal Building 7810 Goulburn Valley Highway KIALLA 3631	0.25 to 0.5m
Hangar 15 7810 Goulburn Valley Highway KIALLA 3631	0.25 to 0.5m
Emergency Equipment Shed 7810 Goulburn Valley Highway KIALLA 3631	0.25 to 0.5m

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.

The Greater Shepparton City Council maintains a small stock of sandbags Doyles Road Complex, 315 Doyles Road; Orrvale and back-up supplies are available through the VICSES 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 point(s).

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 Greater Shepparton City Council.

3.12 Road Closures

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

VICROADS and Greater Shepparton City Council 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 described in **Appendix A**.

3.14 Wastewater 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 responsible 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 Greater Shepparton City Council Environmental Health Officer to inspect and report to the MEMO and the ICC on any water quality issues relating to flooding.

3.15 Access to Technical Specialists

VICSSES 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 and / or storm event within the Greater Shepparton City Council municipality are detailed in the Greater Shepparton City Council MEMP and/or the Recovery Sub-plan.

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 of the SEMP.

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 or storm. Refer to the SEMP for details of the range of emergency relief services that may be provided.

Suitable relief facilities identified for use during floods are detailed in the Greater Shepparton City Council MEMP.

Details of the relief arrangements are available in the Greater Shepparton City Council MEMP.

4.3 Animal Welfare

Matters relating to the welfare of livestock and companion animals (including feeding and rescue) are to be referred to Department of Jobs, Precincts and Regions (DJPR (Agriculture Victoria)).

Requests for emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue are passed to DJPR (Agriculture Victoria).

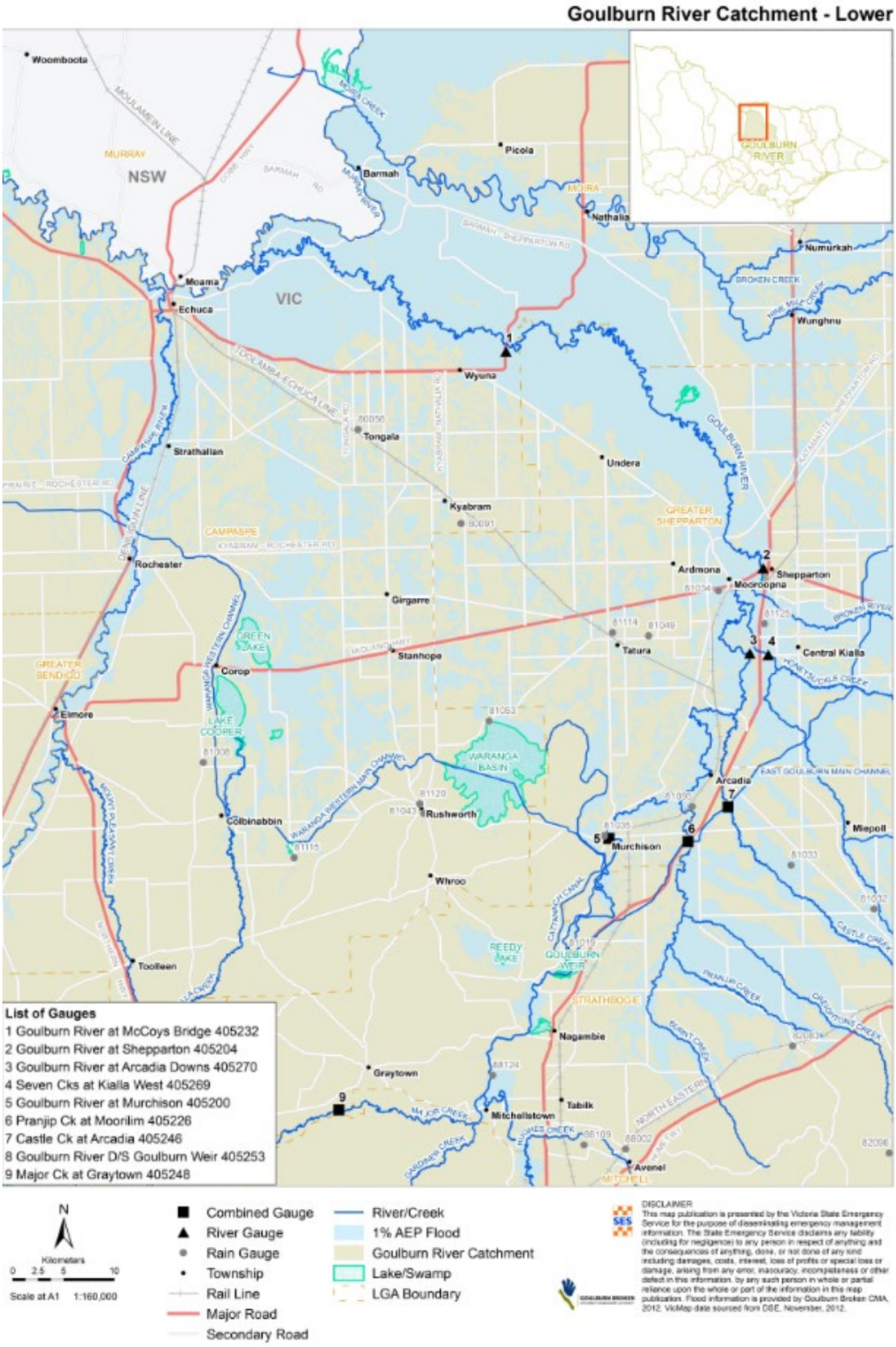
Matters relating to the welfare of wildlife are to be referred to DELWP.

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

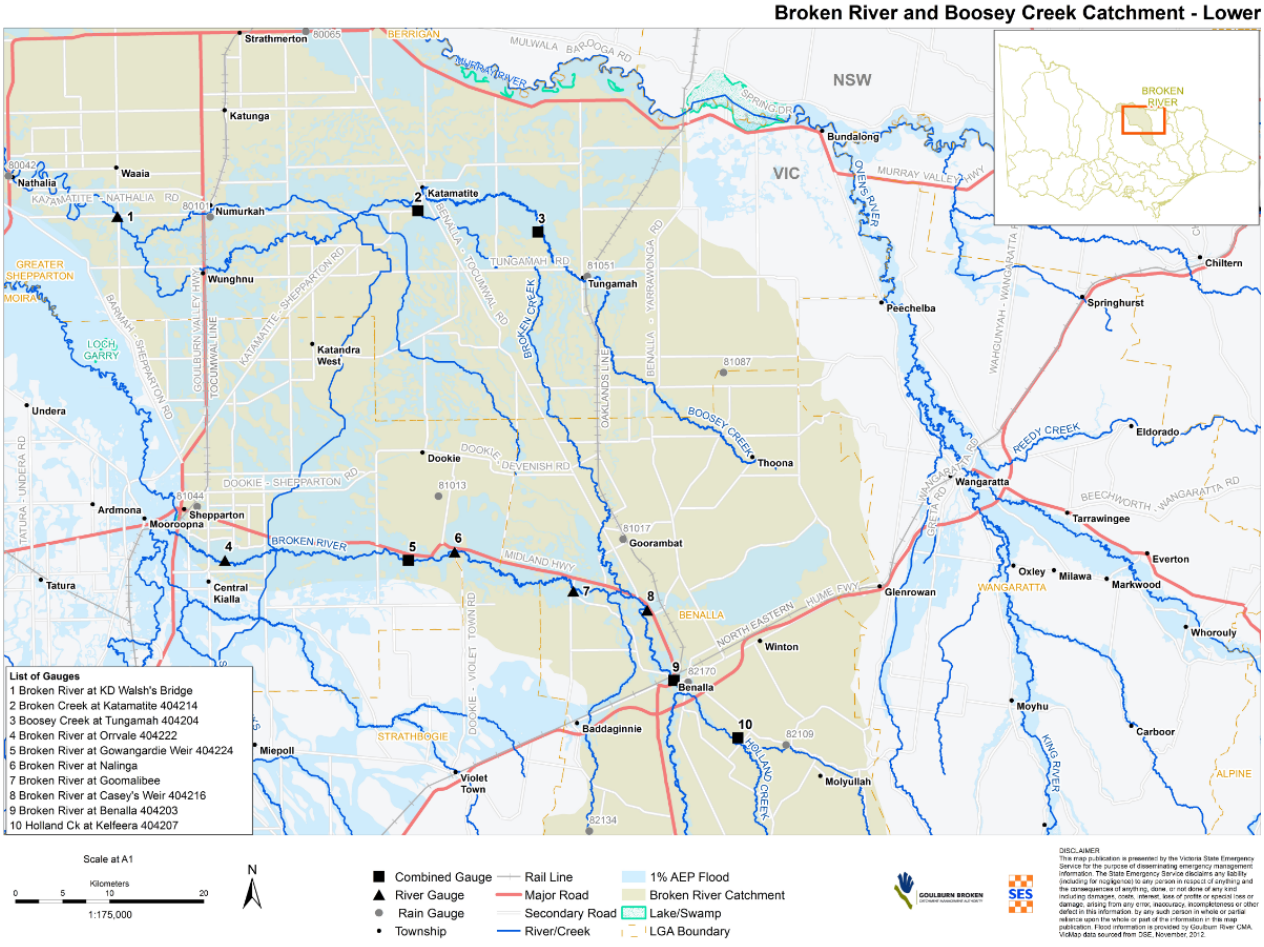
4.4 Transition from Response to Recovery

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 the SEMP or location of the transition arrangements is available in the MEMP.

Appendix A: Flood threats for Greater Shepparton City Council Municipality



Broken River and Boosey Creek Catchment - Lower



General - Goulburn and Broken Rivers and Seven Creeks

Shepparton and Mooroopna are situated on the Goulburn River downstream from the Seven Creeks[1] – Goulburn River confluence and a little downstream from where the Broken River[2] joins the Goulburn. Two other tributaries enter the Goulburn River between Murchison and Shepparton; Pranjip Creek at Moorilim and Castle Creek at Arcadia.

The Goulburn Broken catchment comprises the Goulburn and Broken River catchments and part of the Murray Valley and covers 2.4 million hectares, or 10.5% of Victoria[3]. It provides 11% of the Murray Darling Basin's stream flow although it occupies just 2% of the basin. It stretches from near the outskirts of Melbourne to the Murray River and includes the municipalities of Moira Shire Council, Benalla Rural City, Mansfield Shire Council, Mitchell Shire Council, Murrindindi Shire Council, Strathbogie Shire Council and the Greater Shepparton City Council. The Goulburn River stretches from the headwaters near Woods Point, and flows to the west through Lake Eildon, Alexandra and Yea. At Seymour it turns to the north and continues through Nagambie / Goulburn Weir, Murchison, and Shepparton to its confluence with the Murray River upstream of Echuca. The total length of the Goulburn River is 570 km. It has a mean annual discharge of 3,040 GL. This volume of water is approximately 14% of the total water discharge from Victoria (Goulburn Broken CMA, 2005).

The Goulburn Broken catchment produces approximately 11% of the Murray Darling Basin's water and is a key food producing area. Production from irrigation supports a large food processing industry, contributing to 25% of Victoria's export earnings, approximately 70% of the land has been cleared and public land makes up 28% of the catchment.

Major Floods

Major floods in the Shepparton-Mooroopna area generally occur after moderate to heavy widespread rainfall across the catchment. This can be the result of prolonged periods of regular rainfall or one or more significant storms. Due to the relatively large catchment area above Shepparton and the number of major tributary streams the timing and distribution of rainfall across the catchment can significantly influence the nature of flooding in and around Shepparton-Mooroopna. Apart from the base flow in the Goulburn River and tributaries prior to a major flood producing storm, the other factors such as Lake Eildon storage conditions and possible diversion operations at Goulburn Weir could affect the magnitude of flooding at the Shepparton gauge. These will be discussed further in the following sections.

There are several small ephemeral watercourses, structures, irrigation channels, levees, railways and roadways across the floodplain which all influence flood behaviour. The pipe

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1 Seven Creeks and Honeysuckle Creek join 1.8 km upstream of the Seven Creeks @ Kialla West gauge.

2 During large events (i.e. more than about 18,000 ML/d or around 3.0 m at Benalla), the Broken River spills to the north into the Broken Creek catchment with a corresponding reduction in flow increases at Orrvale.

3 The total catchment area of the Goulburn River at Shepparton is approximately 16,000 km^2. 2,525 km^2 in the Broken River catchment, 1,510 km^2 in the Seven Creeks/Honeysuckle Creek catchment, 800 km^2 in the Pranjip Creek catchment and 280 km^2 in the Castle Creek catchment (Water Technology, 2017).

drainage networks within Shepparton and Mooroopna also influence flood behaviour: some of the urban area is inundated due to backflow within these pipes.

Effect of Lake Eildon

Goulburn Murray Water (G-MW) operates Lake Eildon to ensure the safety of the structure while, as far as is possible within the operating rules of the structure, minimising peak flood outflows. Flood mitigation potential is greatest when there is storage capacity (i.e. air-space with the level below FSL) prior to a flood event.

The peak inflow to Lake Eildon during the October 1993 flood was estimated at 170,000 ML/d (Hydro Technology, 1995) with the peak outflow now estimated at 46,630 ML/d. The dam was operated to achieve a significant reduction in the peak outflow and thereby avoid more serious flooding at Seymour and downstream. This was achieved by surcharging the storage but is unlikely to occur in the future due to current G-MW policy.

The potential for Eildon to deliver indirect flood mitigation benefits to the Goulburn River immediately and further downstream of the dam is significant as demonstrated in October 1993. However, due to changes to G-MW operations policies this degree of attenuation is unlikely to be experienced again if conditions that occurred in 1993 were to be repeated.

Effect of Goulburn Weir & Waranga Basin Diversions

Low flood flows in the Goulburn River at Shepparton can be significantly influenced by the operation of Goulburn Weir and diversions to Waranga Basin via the Stuart Murray Canal (SMC) or Cattanach Canal (CC) where the combined diversion flow capacity is 7,290 ML/d.

For example, at the start of the June 1996 rain event the Goulburn Weir pool was well below full supply level (FSL) with close to maximum diversions via the SMC and CC to Waranga Basin occurring during the subsequent flood event. Whether diversions are occurring or not will depend on the status of Waranga Basin. If Waranga Basin is full or close to full then the diversion flow will be nil or very low. Even if diversions are occurring at the start of the flood they may cease during the flood event once Waranga Basin is full or reaches the interim FSL.

If heavy rain occurs following releases from Lake Eildon for irrigation purposes, there is a rapid and substantial reduction in the need for the water for irrigation. As a result, G-MW may need to rapidly increase discharge downstream of Goulburn Weir. This results in what G-MW call a “rain rejection event”. While the resulting flush is often well below minor flood level, there may be recreational users within the river bank who could be caught unawares and impacted by a rapid rise in river level. This is a problem more likely to occur during the summer months than at other times of the year.

G-MW has an arrangement with VICSES at Benalla to alert VICSES when a release of greater than 3,000 ML/d is expected from Goulburn Weir. While it is possible for these releases to have some impact on the Goulburn River in Shepparton-Mooroopna the full impact is more likely to occur upstream from Murchison. DELWP and Parks Victoria also are stakeholders in this issue.

Effect of Irrigation Channels

There are a number of irrigation channel banks within the Goulburn and Broken floodplains, all of which form hydraulic barriers across the floodplain of various size and effectiveness. In producing the flood mapping for the Shepparton Mooroopna Flood

Mapping and Flood Intelligence project (2017), Water Technology stamped the irrigation network onto the topography as thin break lines in the TUFLOW hydraulic model. Thus flood mapping produced by that study and available through FloodZoom and other means, reflects the influence on conveyance of the existing irrigation channel network.

Irrigation channel banks are designed to convey irrigation water, not act as flood levees. Channel banks may fail (or be deliberately breached) during a flood and inundation may differ during an event.

Historic Floods

The Shepparton-Mooroopna area has a long history of major flooding on the Goulburn River dating back to 1870. The largest flood in the recent past occurred in September 1916. It is difficult to rank the 1916 flood in terms of current conditions due to the Big Eildon Dam not being constructed at that time and because of major changes within the floodplain as well as to bridges and the causeway between Shepparton and Mooroopna.

Since the completion of the Eildon dam in 1955 there have been seven floods exceeding the Major Flood Level of 11.0 metres on the Shepparton gauge. These occurred in 1956, 1958, 1974, 1975, 1981, 1993 and 2010 resulting in a major flood on average every 7-8 years prior to the onset of major drought in late 1996.

Flooding at Shepparton is caused by a combination of Goulburn River, Broken River and Seven Creeks flows. Due to the rainfall patterns of any given event, each waterway is likely to respond differently. The May 1974 flood was a Goulburn River dominated event while the October 1993 and September 2010 floods were Broken River and Seven Creeks dominant events.

Specific flood information for the key flood gauges in the Shepparton-Mooroopna area is contained in the various Appendix C's to this document.

September 1916 Flood

The September 1916 flood on the Goulburn River at Shepparton is the highest flood on record with an estimated peak flow of 233,000 ML/d (SKM 2002) and a peak level at Shepparton of 12.25 m (SKP 1982). The rainfall ranged from 130 mm in the Broken River catchment, to 178 mm in the Goulburn above Seymour, with Seven Creeks catchment receiving around 170 mm. Rainfall accumulations were recorded over a six day period (SKP 1982, *Shepparton-Mooroopna Flood Study* Appendices, p B10).

May 1974 Flood

The flood in May 1974 reached 12.08 metres on the Shepparton gauge with a peak flow of 214,000 ML/d[4] (SKM, 2002). At Shepparton, it was the largest flood since 1955 when Eildon was completed (important as Eildon changed flow frequencies) and also the largest flood since 1916.

Around 600 residential and commercial buildings were inundated above floor due to large breakouts from the Goulburn River, Broken River and Seven Creeks (VICSES, 2013). If a

[4] The peak flow estimate for the 1974 event has changed a number of times since it was first published with revisions to the rating curve, the most recent estimate on the DELWP WIMS system is 191,000 ML/d (Water Technology, 2017).

flood of similar magnitude occurred now, it is estimated that around 7,000 residential, commercial and industrial properties are likely to be affected.

This was a “Goulburn River dominated flood” in that flows in the Goulburn were larger than those in the Broken River and Seven Creeks system.

October 1993

The major flood of October 1993 reached 11.72 metres on the Shepparton gauge with a peak flow estimated at 150,000 ML/d. Around 30 residential and commercial buildings were inundated above floor (VICSES, 2013). If a flood of similar type and magnitude was to occur now, it is expected that around 2,700 residential, commercial and industrial properties would be affected.

The Goulburn River had sustained high water levels for the majority of September 1993. The Broken River and Seven Creeks were relatively low until they both received a big inflow that started around 3rd October and lasted until early on the 9th October. The Goulburn River peaked at Shepparton on the 6th October and stayed high until around the 16th when it finally receded. Even though the peak in the Goulburn River upstream of Shepparton wasn’t as high as in September (as most of the flow was contained within the lower floodplain), the combination of flows from the three systems caused a peak water level of 11.72 m at the Shepparton gauge on Wednesday 6th October.

Parts of Shepparton were inundated during the event and significant areas downstream of Shepparton were also inundated, particularly around the water treatment plant.

This event was a “Broken River and Seven Creeks dominated flood” in that flows in these watercourses were larger than in the Goulburn River, particularly in Seven Creeks where significant overbank flood flow occurred in surrounding low lying areas.

September 2010 Flood

The September 2010 flood reached 11.09 metres on the Shepparton gauge with a peak flow of 93,500 ML/d[5]. During this flood, 13 houses and 31 structures were damaged, 620 houses were isolated and more than 60 people attended the relief and recovery centre. While approx. 30 local roads were closed due to flooding, all major roads surrounding Shepparton remained open for the duration of the event.

Heavy rain fell across the north east of Victoria on Saturday 4th and Sunday 5th September 2010, particularly in the alpine areas including the upper Goulburn and Broken catchments. On Monday 6th September, the Seven Creeks at Kialla West peaked just above the major flood level of 6.6 m while the Broken River at Orrvale peaked overnight at 8.19 m, above the major flood level of 7.9 m. On Wednesday 8th September, the Goulburn River at Shepparton peaked just above the major flood level (11 m) at 11.09 m. Both Castle Creek and Pranjip Creek also flooded.

Low lying areas between Archer Road and the East Goulburn Main Channel along the Broken River were inundated as were parts of the lower Goulburn River floodplain. Areas outside the lower Goulburn River floodplain were not affected.

This event was a “Broken River dominated event” with significant contributing flows from the Broken River.

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[5] Water Technology (2017) quote a revised peak flow of 78,600 ML/d.

A report on this event and the subsequent floods in December 2010 and January 2011, has been drafted by the Goulburn-Broken Catchment Management Authority (GBCMA, 2012). Key data is documented along with assessment of "flood dominance".

History of Flood Levels & Discharges

At Shepparton, the largest floods this century have occurred in 1916, 1939, 1974 and 1993[6]. These were ranked 1, 3, 2 and 4, respectively by HydroTechnology (1995) - see Table 1-1. However, Big Eildon Dam was not constructed prior to the 1916 and 1939 events, and it is estimated that it would have had some effect in reducing the peaks of those floods. Given that the estimated peak discharges in 1939 and 1993 were very similar, allowance for the effect of Eildon would likely elevate the 1993 flood to the third largest this century.

The effect of Eildon Reservoir in reducing flood peaks has been studied previously (SRWSC, 1981). It was estimated that at Shepparton the impact on flood peaks during large floods is approximately 7%. Nathan (1992) estimated a reduction of 27% in large floods in the Goulburn River at Murchison. The impact is larger in more frequent floods of smaller magnitude, and the impact is also greater further upstream near Eildon. The effect diminishes downstream because of the effect of unregulated tributary inflows and floodplain storage.

There is also fairly clear indirect evidence that a flood larger than any this century occurred in 1870. Although there were no gauges operating on the Goulburn at that time, the Murray River at Echuca peaked much higher in 1870 (and in 1867) than in 1916. It should be noted that the effect on flooding at Echuca from the Murray River downstream of Barmah is restricted by the effect of the Bama Sandhills, so that little more than the "choke" capacity of approximately 35,000 ML/d can pass along the Murray without forcing additional flow north along the Edward River into NSW. Therefore, the magnitude of flood peaks at Echuca above this capacity is very dependent on the magnitude of flows received from the Goulburn and Campaspe Rivers, and to a much lesser extent the Broken Creek.

A comparison of the highest ranked floods last century is presented in the following table for the Goulburn River at Shepparton. A continuous recorder has operated at this location since 1939. A staff gauge was observed daily from 1921 to 1939.

Magnitudes and Ranking of Major Floods at Shepparton

Flood / Year	Gauge Height (m)	Peak Discharge (ML/d)	Rank
September 1916	12:25	233,300	1
May 1974	12:08	214,000 [7]	2
1939		161,000	3

[6] The Shepparton gauge was moved from upstream of Dainton's Bridge (built in the late 1960s) to the current downstream location in 1986. There is about 100mm head loss through the bridge.

[7] Water Technology (2017) quote a revised peak flow of 191,000 ML/d.

Flood / Year	Gauge Height (m)	Peak Discharge (ML/d)	Rank
October 1993	11:72	160,500 [8]	4
1956	11:42	121,000	5
1934		118,400	6
1975	11:24	105,000	7
1924		103,300	8
1958	11:21	103,000	9
1921		97,500	10
September 2010	11.09	81,328 [9]	11
The Goulburn River at Shepparton gauge has changed locations three times. It was located upstream of Dainton's Bridge from 1968 to 1986. It was moved to the current downstream location in 1986. There is about 100mm head loss through the bridge.			

At Shepparton, the October 1993 (11.72 m) and September 2010 (11.09 m) are the two floods that many residents can relate to because they were recent floods on the main rivers. However, the March 2012 localised rainfall event, which caused small rural creeks to flood in the north-east region of the municipality (and a record flood along Broken Creek), has served to advise that any area may be subject to flooding. The heavy rain event of 27th / 28th February 2013 which resulted in severe flooding through East Shepparton reinforced that message.

Magnitudes and Ranking of Major Floods at Murchison

Flood / Year	Gauge Height (m)	Peak Discharge (ML/d)	Rank
1916	12:22	178,180	1
1934	11.55	132,750	2
1956	11.38	123,200	3
1974	11.29	117,860	4
1917	11.28	117,030	5
1939	10.79	91,490	6
1923	10.67	84,870	7
1912	10.64	83,700	8
1993	10.57	80,010	9

[8] Water Technology (2017) quote a revised peak flow of 150,000 ML/d.

[9] Water Technology (2017) quote a revised peak flow of 78,600 ML/d.

Flood / Year	Gauge Height (m)	Peak Discharge (ML/d)	Rank
1920	10.52	76,620	10

The table below provides a summary of most floods in the Goulburn since 1955 (i.e. since Big Eildon Dam was constructed). Peak flow data (ML/d) and peak level data has been extracted from available sources for the key gauging stations upstream of Shepparton. Note that a number of flow estimates have changed over time, with revisions to gauge rating curves. The 'WT quote….' comments in the table relate to.

Gauging Station, Site Number, Peak Flow, Peak Level M12/59542						
Date	Goulburn River Murchison 405200	Goulburn River Arcadia Downs 405270	Seven Creeks Kialla West 405269	Broken River Orrvale 404222	Goulburn River Shepparton 405204	Flood Category / Dominance
Aug-55	45,170 9.69				68,900 10.72	Moderate
Jul-56	123,200 11.38				121,000 11.42	Major
Aug-58	60,330 10.17				103,000 11.21	Major
Sep-60	512,750 9.97				77,600 10.86	Moderate
Oct-64	47,430 9.80				67,800 10.70	Moderate
Jun-68	41,460 9.53				55,900 10.47	Minor
Sep-73	42,490 9.57				54,400 10.47	Minor
May-74	111,000 WT quote 117,900 11.29	135,000 12.10	50,200 7.85	40,000 8.33	191,166 WT quote 191,000 12.08	Major / Goulburn
Sep-75	72,500 ~10.46				105,000 11.24	Major / Neutral
Aug-78	30,200 ~9.02	28,959 9.79			31,626 9.74	Minor / Goulburn
Oct-79	39,000 9.40	37,375 10.28	10,979 5.53	18,257 7.24	43,900 10.20	Minor / Neutral
Jul-81	49,690 9.87	59,352 10.70	40,230 7.48	30,061 7.99	87,300 11.00	Major / Broken-Seven
Sep-83	50,200 9.88	51,954 10.62	10,128 5.42	7,961 5.74	60,800 10.57	Minor / Goulburn
Oct-92	63,380 10.24	11.05	8,086 5.13	13,369 6.76	81,800 10.93	Moderate / Goulburn
Sep-93	80,010 10.57	11.33	19,097 6.32	15,936 7.01	95,667 11.12	Major / Goulburn
Oct-93	60,903 WT quote 63,500 10.26	11.08	68,000 8.23	43,852 WT quote 42,900 8.44	150,000 11.72	Major / Broken-Seven
Aug-96	47,220 9.80	10.74	15,348 6.02	12,140 6.56	60,183 10.56	Minor / Goulburn
Oct-96	44,010 9.69	10.66	15,384 6.02	27,155 7.86	58,156 10.52	Minor / Goulburn
Sep-10	58,237 WT quote 50,200 10.15	NA	19,653 WT quote 20,500 6.69	8.14 WT quote 27,300	81,328 WT quote 78,600 11.09	Major / Broken
Mar-12	18,619 7.13	NA	11,718 6.03	7.00	38,549 9.97	Major / NE creeks

Note: In the above table "WT quote" refers to Water Technology (2017)

revised flows quoted in the Water Technology (2017) report, which have come from the latest DELWP WIMS streamflow data website.

Description of Major Waterways and Drains around Shepparton

Waterway	Description
Goulburn River	Emanates from the Great Dividing Range near Jamieson and is mitigated by Eildon and Goulburn weirs
Broken River	Rises in the Tolmie Highlands of the Great Dividing Range
Seven Creeks	Rises in the Strathbogie Ranges east of Euroa
Honeysuckle Creek	Emanates from the Strathbogie Ranges east of Violet Town
Castle Creek	Emanates from runoff upstream of Euroa
Congupna Creek	Emanates from farmland run-off near Cosgrove and is fed by Broken River, when it floods
Pine Lodge Creek	Emanates from farmland run-off near Pine Lodge and is fed by Broken River, when it floods
Dainton's Creek	Emanates from farmland run-off near Cosgrove and is fed by Broken River, when it floods
O'Keefe Creek	Emanates from farmland run-off near Pine Lodge and is fed by Broken River, when it floods

The Goulburn River around Shepparton-Mooroopna experiences localised flooding initially along Watts Road, the main alternative route and short cut from Mooroopna south to the Goulburn Valley Highway, once the Shepparton gauge exceeds 8.75 m. A series of levees are located on the east side of the Goulburn River from Knight Street in Shepparton to Furphy Avenue in Kialla and prevent flooding up to 10.98 m on the Shepparton gauge, just below the major flood level of 11.0 m.

Mitchell Road at Kialla West is the first area to be affected by flooding from Seven Creeks with the low-level bridge overtopped at about 4.5 m on the Kialla West gauge. Raftery Road becomes impassable after the Kialla West gauge exceeds 5.0 m with Seven Creeks breaking its bank at the floodway west of the bridge. The first residential properties to be flood ed are located on Central Kialla Road in Kialla. These properties can be affected by either backwater flooding up Seven Creeks from the Goulburn River once the Shepparton gauge reaches 10.5 m, or by flooding directly from Seven Creeks after the Kialla West gauge has exceeded around 6.5 m.

Minor flooding of rural properties along Broken River upstream of Doyles Road commences once the Orrvale gauge reaches 6.8 m. The flooding of Gordon Drive (located in the Broken River anabranch) follows soon after and the major arterial road of Archer Street is overtopped by floodwater backing up across the floodway on the north side of the Broken River Bridge.

The first house in Mooroopna to be flooded above floor level is on the Midland Highway when the Shepparton gauge approaches 11.1 m. Properties in The Boulevard area of North Shepparton can expect flooding above floor level to commence once the Shepparton gauge has reached 11.6 m.

The Midland Highway Causeway between Shepparton and Mooroopna also begins to be affected by floodwater around 12.0 m with higher flows progressively disrupting traffic along this vital road link. However, at the Mooroopna side of the Causeway (Chinaman's Gardens), the road is overtopped at a lower flood level (from about 11.6 m on the Shepparton gauge).

The first properties flooded by location:

Location	Street	Level on the Shepparton gauge at which inundation starts (m)
Kialla West	Archer Road	Between 10.5 & 10.7
Kialla	Central Kialla Road	As level approaches 10.5
Shepparton	Doyles Road	Between 10.5 & 10.7
Shepparton North	Daldy Road	Between 11.1 & 11.3
Bunbartha	Barmah-Shepparton Road & McCleland Road	Between 11.5 & 11.7
Mooroopna	Midland Highway	Between 10.7 & 10.9
Mooroopna North	Koenig Road	Between 11.5 & 11.7
Coomboona	Koenig Road	Between 11.5 & 11.7
Ardmona	Excelsior Avenue	Between 11.7 & 11.9

The first buildings flooded above floor by location:

Location	Street	Level on the Shepparton gauge at which inundation starts (m)
Bunbartha	Barmah-Shepparton Road	Between 11.7 & 11.9
Kialla West	Archer Road	Between 10.5 & 10.7
Kialla	Central Kialla Road	Between 10.5 & 10.7
Shepparton	The Boulevard, Wanganui Road and the Caravan Park on Fitzjohn Road	Between 11.3 & 11.5
Shepparton North	Daldy Road	Between 11.3 & 11.5
Mooroopna	Midland Highway	Between 11.0 & 11.1
Mooroopna North	Echuca Road	Between 11.7 & 11.9
Ardmona	Excelsior Avenue	Between 12.1 & 12.2

Dam Failure

Flooding resulting from failure of the following dams is likely to cause significant structural and community damage within the municipality.

Location	Owner	Dam Height	Dam Capacity (ML)	Comments
 Eildon Dam	G-MW	84.25m	3,334,158	ANCOLD & AIIMS compliant Dam Safety Emergency Plan in place.
 Lake Waranga Reservoir	G-MW	12.2m (ave)	432,260	ANCOLD & AIIMS compliant Dam Safety Emergency Plan in place.
 Goulburn Weir	G-MW	13.7m (ave)	25,000	ANCOLD & AIIMS compliant Dam Safety Emergency Plan in place.
 Lake Nillahcootie Reservoir	G-MW	35m (ave)	40,400	ANCOLD & AIIMS compliant Dam Safety Emergency Plan in place.
 Caseys Weir	G-MW	3m	<150	
 Gowangardie Weir	Committee of Management	3m	140	Stock & Domestic Committee from local farmers manage the flow from the weir. Greater Shepparton City Council assists with maintenance of the channels.

Appendix B: Typical flood peak travel times

Definitive information on the time it takes flash flooding (i.e. resulting from heavy rainfall associated with severe weather or thunderstorm activity) to develop (i.e. to arrive at a location) following the start of heavy rain and the time it takes for the maximum water depth / extent to be reached is not available.

In the case of riverine flooding, the time of travel of a flood peak will be influenced by antecedent conditions. A flood on a 'dry' watercourse will generally travel more slowly than a flood on a 'wet' watercourse (e.g. the first flood after a dry period will travel more slowly than the second flood in a series of floods) and big floods tend to travel faster than small floods. Hence, the size of the flood, recent flood history, soil moisture and forecast weather conditions all need to be considered when using the following information to direct flood response activities. This first flood can be significantly altered by floodwater filling the floodplain storage. ***This phenomena is particularly important for the floodplain upstream of Shepparton and thus flood volume and dominance (i.e. whether the Broken – Seven Creeks system or Goulburn River or neither will dominate – the Broken and Seven Creeks appear to dominate most often with a neutral situation observed a little less often) is a key consideration in determining both travel times and flood attenuation.*** In very simplistic terms, due to the wide floodplain and opportunity for significant loss as well as friction, a flood on a wet floodplain will behave very differently from one on a dry floodplain.

Dominance and the timing of flows in the three key contributing catchments (i.e. Goulburn, Broken and Seven) is key to determining peak levels and thus impacts within Shepparton and Mooroopna. The Broken – Seven Creeks system appears to dominate most often with the Goulburn dominating least often.

The Goulburn, Broken and Sevens waterways present a significant flood risk to the Shepparton / Mooroopna urban area and the immediate surrounds because their confluences are located within or adjacent to the urban area. A further significant flood risk arises from locally intense storms over urban and peri-urban areas, such as East Shepparton. The generally flat nature and poor drainage characteristics of the East Shepparton area make it particularly vulnerable to intense and heavy continuous rain.

Location From	Location To	Typical Travel Time	Comments
RIVERINE FLOODING – Goulburn River – see diagram below			
Floods are characterised by steady rises, peaks that extend for a number of hours and recessions that are around one-half to one-third the rate of rise (i.e. takes around 2.5 to 3 times longer). The further down the catchment the longer the peak and the slower the recession. Flood volume determines rise and recession characteristics.			
Eildon	Seymour	48 hours	
Seymour	Goulburn Weir	30 to 40 hours	
Seymour	Murchison	40 to 60 hours	
Goulburn Weir	Murchison	9 to 18 hours	Generally around 10 hours or a little less. Can be as short as 3 hours
Murchison	Kialla West (Goulburn River)	15 to 25 hours	In 1974, peak on Goulburn at Kialla West occurred 15 hours after the Broken at Orrvale peaked while in 1993 the difference was 60 hours.
Murchison	Shepparton	18 to 30 hours	20 hours or less if Goulburn dominant. 24 to 36 hours if Broken – Sevens dominant. In 1992 & 2010, travel time for peak from Murchison to Shepparton was ~1.5 days.
Kialla West (Goulburn)	Shepparton	Up to 12 hours	When Broken – Sevens dominant, peak at Shepparton can be at the same time or a little before peak at Goulburn at Kialla West.
Shepparton	McCoys Bridge	46 hours	

Shepparton	Echuca	7 days	
RIVERINE FLOODING – Seven Creeks – see diagram below			
The recession at Kialla West is around one-third to one-quarter the rate of rise (i.e. takes around 3 to 4 times longer).			
Euroa	Kialla West (Mitchell Road Bridge over Seven Creeks)	26 to 50 hours	26 to 30 hours for floods ~6m and over at Kialla West. 35 to 48 hours if between 4.5m and 6m but 30 to 36 hours if 2nd flood in past 3 weeks or rain across lower catchment similar to upper catchment.
Kialla West (Seven Cks)	Shepparton	18 to ~60 hours	18 to 21 hours if Broken and Seven Creeks dominant. Time increases towards 30+ hours under neutral conditions but can be as high 60 hours.
Peak at Kialla West (the gauge is located immediately downstream from the Mitchell Road Bridge) occurs around 6 – 24 hours earlier than at the Broken River at Orrvale. Median time is around 15 hours but the usual range is 12-18 hours. In general terms, peak occurs at about the same time as at (or within a few hours of) the Broken River at Gowangardie. Travel time from Kialla West to Shepparton increases as Goulburn dominance builds.			
RIVERINE FLOODING – Broken River – see diagram below			
After a slow peak, the recession at Orrvale is around one-third the rate of rise (i.e. takes around 2.5 to 3 times longer).			
Benalla	Casey's Weir	6 to 12 hours	Tends to cluster around 7 to 9 hours.
Benalla	Gowangardie Weir	18 to 37 hours	Think in terms of 26 to 30 hours but faster if good rain downstream from Benalla or 2nd flood.

Benalla	Orrvale	31 to 54 hours	Tends to cluster around 36 to 42 hours.
Casey's Weir	Gowangardie Weir	12 to 30 hours	Tends to cluster around 20 – 26 hours.
Gowangardie Weir	Orrvale	10 to 18 hours	Usually in the 13-15 hour range (as per 2003) but ~24 hours in 1993 & 2010.
Orrvale	Shepparton	4 to 40+ hours	Generally 8 to 14 hours with Broken River dominant. 20 to 28 hours as Goulburn flows increase (Murchison around 7.5m to 8.5m – neutral). 30+ hours with Goulburn dominant and Murchison above flood level.
In general terms, for a Broken – Seven Creeks dominant flood, the peak occurs at Gowangardie a few hours after the peak occurs at Kialla West on Seven Creeks. The difference between peak timings is longer (of order 12+ hours) for a neutral flood. Travel time from Orrvale to Shepparton increases as Goulburn dominance builds.			
RIVERINE FLOODING – Congupna Creek			
Gowangardie Weir	Congupna	52 hours	Flooding in these creeks results from local runoff and from breakouts from the Broken River during major floods. Breakouts from near Casey's Weir occur when flow in the Broken River reaches approximately 18,000ML/d or around 3.0m at Benalla. At Casey's Weir the trigger flow is around 17,250ML/d (~200m^3/s) or at a water surface elevation of 158.73mAHD (around 1.81m at the gauge).
RIVERINE FLOODING – Pine Lodge Creek			
Gowangardie Weir	Tallygaroopna	3.5 days	

RIVERINE FLOODING – Guilfus Creek			Further details are provided in the Moira Shire MFEP.
Gowangardie Weir	Katandra West (rural areas to the west)	52 hours	

Appendix C1: MURCHISON FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Murchison is a small rural town located on the Goulburn River 40 km from Shepparton and is within the Great Shepparton City Council. It is surrounded by countryside which contains orchards, vineyards and dairy farms. HM Prison Dhurringile is just down the road.

Murchison town centre has been developed on a land locked depression which could flood during a Goulburn River flood or a major rain event (flash flooding).

Around Murchison, the major flood risk is from the Goulburn River which can result in flooding which lasts from one (24hrs) to three days (72 hrs). When floods affect areas around Murchison, road access in and out of the area can be compromised, resulting in isolation for some areas.

River levels can rise within several hours of heavy rain, and during floods, floodwater can travel from Goulburn Weir to Murchison in 12 – 15 hours and from Seymour to Murchison in 40 to 60 hours (sometimes a little longer). Be aware that floods can affect properties before the peak arrives and no two floods are the same.

Areas likely to be affected:

- During "**Minor**" flooding the low lying rural properties upstream and downstream of Murchison are likely to be flooded. This may necessitate the removal of stock and equipment to higher ground and the closing of some local roads. Camping and fishing spots north of the Bridge will also need to be evacuated.
- During **"Moderate"** flooding, such as occurred in 2010 (10.15 m) people were moved to Murchison Relief centre in Watson Street and caravans were moved to higher ground.
- When **"Major"** flooding occurs (10.7 m and above), the area around High Road and River Haven Caravan Park will be impassable.
- At 11.92 m (the 1% AEP flood level) low lying areas are flooded including Willoughby Street, Phillip Lane, Hutchison Street, Gillam Streets and the cemetery

Caravan Parks likely to be affected

- **River Haven Caravan** Park, 88 High Road (or Low Road), Phone 03-5826 2403
  - Sites – 36 powered, 6 unpowered and cabins.
  - Low areas affected in Moderate flood event (10.2 m), and evacuation required in Major flood events (10.7 m).
- **River Road Caravan Park,** 101 River Road, Phone 03-5826 2546
  - Sites – 8 powered, 10 unpowered and 8 on-site cabins.
  - Not impacted by Goulburn River flooding up to 1916 flood event – levee protects.
- **Murchison Caravan Park,** 4925 Goulburn Valley Hwy, Phone 03-5826 2229
  - Sites – 20 powered, 48 unpowered and cabins.
  - Not impacted by Goulburn River flooding up to 1916 flood event.
- Campers regularly camp along the banks of the Goulburn Rivers at Murchison; they will need to be notified when high or flood waters are approaching.

How many properties.

During a Major Goulburn River flood:

- East of Willoughby Street and East on the Old Weir Road up to 6 properties may be affected by flooding.
- South along the old railway line up to 2 km may see flooding affects.
- River Haven Caravan Park on High Road will be affected during a major flood.

How much warning time

- The Goulburn River in flood will generally take somewhere between 40 and 60 hours to travel from Seymour to Murchison and half a day (12 to 15 hours) to travel from Goulburn Weir to Murchison. Murchison to Arcadia Downs (now referred to as Kialla West) will take approximately 1 day (15 to 25 hours).

Isolation risks

- Flooding in and around Murchison can last 1 to 3 days (24 to 72 hours). This depends on the amount of rain that has fallen around the area.

Major road closures

- Willoughby Street would be closed south of the town and Old Weir Road should be monitored for closure.
- The Causeway does not overtop until the river reaches 11.9 m.
- River Road appears to remain dry, even in very large floods, with modelling showing it dry up to and including at 12.22 m.

Locations where evacuation difficulties may occur (e.g. low flood islands)

- Evacuation of the River Haven Caravan Park could be difficult if the Goulburn River rises quicker than expected.
- Campers on the banks of the Goulburn River could be caught if there is a lot of rain which will prevent them from leaving their camp site.

Flood Mitigation

There are a number of rain and river gauges in the general vicinity and upstream of Murchison that can provide flood information for the town. For example:

- One at Murchison Bridge.
- Goulburn Weir.
- Seymour.
- Trawool.
- Ghin Ghin.
- Lake Eildon dam (downstream of the wall).
- Hughes Creek at Tarcombe Road and a rain gauge at Temagong which can provide early indications of rainfall intensity east of Seymour.
- Data from additional sites are available from the BoM website. FloodZoom also provides access to this and other data relevant to flooding at Murchison.

The following levees exist in Murchison:

- There is a 200 m long earthen levee, approximately 600 mm in height, along the bank of the Goulburn River north from High Street (Bendigo / Murchison Road) to the back of the playground. This levee protects from backwater flooding along the depression that runs past Stevenson Street back towards Watson Street. This levee has a minimum crest elevation of 121.04 m AHD, which provides a freeboard of 610 mm during a 1%

AEP flood event (i.e. water level is 120.43 m AHD at this location) and a freeboard of 310 mm during a repeat of the 1916 flood.

- The River Road Caravan Park on River Road is protected by a levee that is not overtopped in a repeat of the 1916 flood (i.e. 12.22 m).

Details of any levee closure points such as railway crossing etc, which may need to be sandbagged.

- During an extreme flood event (i.e. from above 12.1 m or so and similar to what occurred in 1916) and as a consequence of a breakout from the Goulburn River upstream of Murchison establishing a flow path through the western side of the town, there is a possibility of flooding of the depression that runs through the town. Given the long lead times, sandbagging could prevent this flooding at the location shown on the figure below. The location is suggested as it is at a natural constriction and is where flows are the shallowest. However, as this location appears to be on private land, an arrangement with the landholder would need to be agreed. The matter is discussed further in Water Technology (2014).

Flood Mapping

A set of flood inundation maps for Murchison has been produced for emergency management and response purposes (Water Technology, 2014). Maps were produced for 12 incremental gauge heights from 9.0 to 12.2 m, including the 1% AEP gauge height (11.92 m)

Flood mapping is available of the Goulburn River from where the Stuart Murray Canal crosses under Old Weir Road downstream to Follett Rd. Flood mapping is available through GBCMA and FloodZoom. The study report (Water Technology, 2014) is also available through FloodZoom.

Flood Frequency

AEP	ARI (1 in X years)	Adopted Peak Flow (ML/d)	Gauge Height (m)
20%	5	49,100	9.9
10%	10	69,000	10.4
5%	20	90,900	10.8
2%	50	123,900	11.4
1%	100	152,600	11.9
0.5%	200	166,500	12.1
0.2%	500	196,900	12.4

Past Flood Experience – History

The highest flood recorded at Murchison was in 1916 when up to a meter of water flowed down the main street. Other floods above the major flood level (10.7 m on the Murchison Gauge) have occurred in the region in 1917, 1934, 1939 and 1974.

- Eildon Weir, built in 1956, and water diversions at Goulburn Weir now control most water flows including irrigation into the lower Goulburn River. Although Eildon Weir and Goulburn Weir were not specifically designed for flood mitigation, these weirs have reduced how often minor and moderate floods affect Murchison and the damage this causes. However, in a major flood these two weirs may not be able to reduce the impact of severe flooding on Murchison.

- Extreme heavy local rainfall between Eildon Weir and Murchison can also result in floods, such as in 1974, the highest floods since Eildon Weir and Lake Eildon were created.

Community or agency flood awareness material

SES in conjunction with the Greater Shepparton City Council has produced a "Local Flood Guide" for Murchison (see Appendix G). The Guide has been distributed to all residents in areas likely to be impacted by flood.

Community and agency knowledge

- To be identified:

Known or possible community infrastructure impacts including:

- Impacts on essential community infrastructure.
- There are no known / identified groundwater wells likely to be inundated;
- Water treatment plants and water storage areas along with pumps and other service equipment etc likely to be inundated.

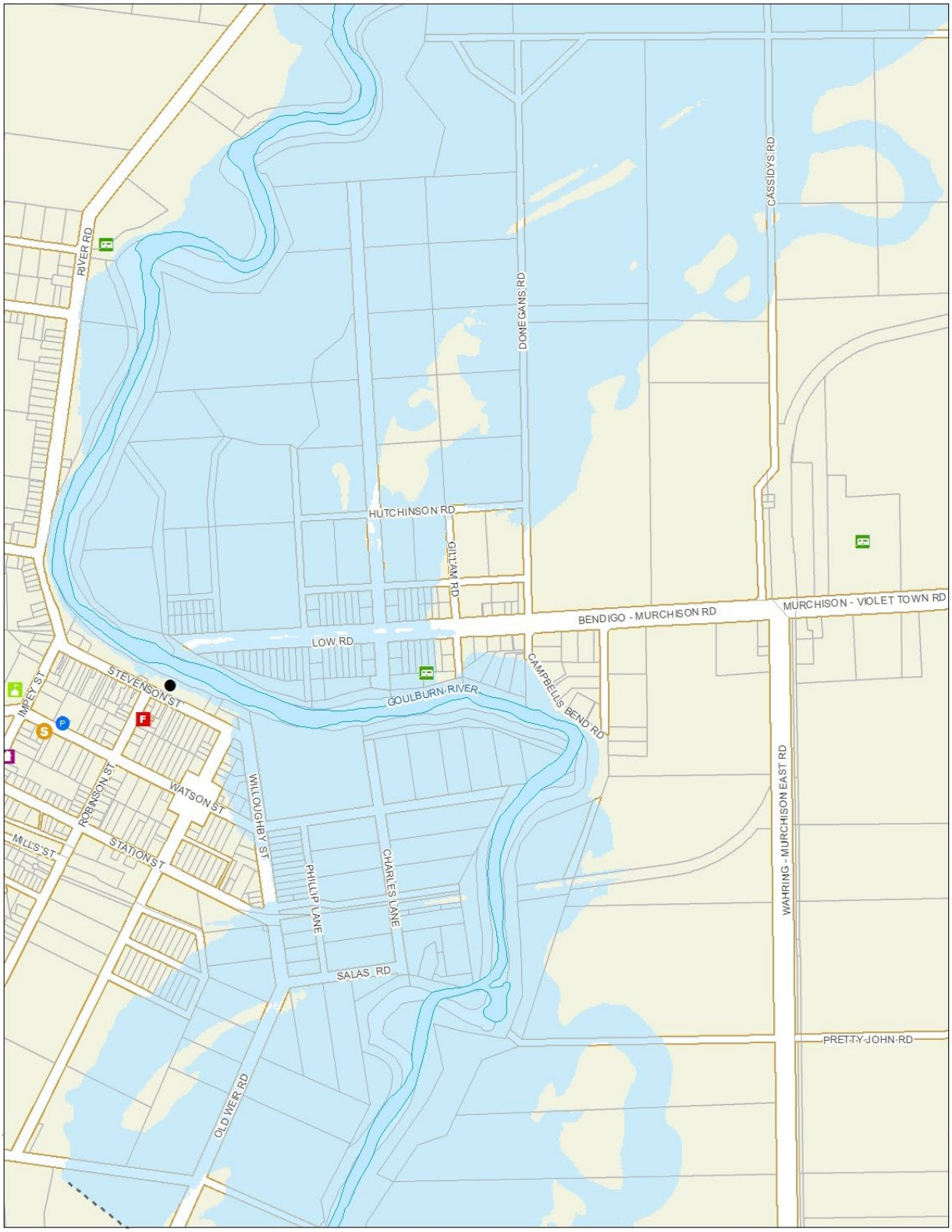
GV Water	Murchison WTP	Water Treatment Plant	52 Stevenson St, Murchison
GV Water	Murchison WWTP	Waste water treatment plant	Murchison
GV Water	Murchison SPS 1	Sewer pump station	Watson Ave, Murchison
GV Water	Murchison SPS 2	Sewer pump station	McKenzie St, Murchison
GV Water	Murchison SPS 3	Sewer pump station	Station St, Murchison
GV Water	Murchison SPS 4	Sewer pump station	Meteorite St, Murchison
GV Water	Murchison SPS 5	Sewer pump station	Murray Lane, Murchison
GV Water	Murchison water tower	Water Tower	71 Stevenson St, Murchison
GV Water	Murchison WTP	Water Treatment Plant / Water Tower	Stevenson St (opposite water tower), Murchison

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the SEMP. During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Shepparton and Tatura to manage the Murchison community.

Goulburn River 1% AEP Design Flood Extent (Map Shows revised 1% AEP)


RIVER RD
DONEGANS RD
CASSIDYS RD
HUTCHINSON RD
GILLAM RD
BENDIGO - MURCHISON RD
MURCHISON - VIOLET TOWN RD
LOW RD
CAMPBELLS BEND RD
GOULBURN RIVER
STEVENSON ST
IMPEY ST
WATSON ST
ROBINSON ST
MILLS ST
STATION ST
WILLOUGHBY ST
PHILLIP LANE
CHARLES LANE
SALAS RD
WAHRING - MURCHISON EAST RD
PRETTY JOHN RD
OLD WEIR RD
N
Scale at A4
Metres
0 100 200 400
1:15,000
Murchison Gauge
Fire Station
Police Station
SES Unit
Schools
Nursing Home
Caravan Park
Road
River/Creek
Creek/Stream
Extent of Flood Data
11.92 m at Murchison Gauge (1% AEP Flood)
Cadastre
SES
GOULBURN BROKEN
DISCLAIMER
This map publication is presented by the Victoria State Emergency Service for the purpose of disseminating emergency management information. The State Emergency Service disclaims any liability (including for negligence) to any person in respect of anything and the consequences of anything, done, or not done of any kind including damages, costs, interest, loss of profits or special loss or damage, arising from any error, inaccuracy, incompleteness or other defect in this information by any such person in whole or partial reliance upon the whole or part of the information in this map publication. Flood information is sourced from Goulburn Broken CMA (2014). VicMap data sourced from DEPI, December, 2013.

Gauge Location: Goulburn River at Murchison Gauge

Note to convert gauge level to m AHD, add 108.679 (i.e. gauge zero is 108.679 m AHD)

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
5.62	**Dec 2017 flood**	• Was a Seven Creeks – Broken River dominant flood	•
7.12	**March 2012 flood**	• Was a Seven Creeks – Broken River dominant flood	•
Minor flood level 9.0 m 34,900	50% AEP (<2 year ARI)	• Low lying rural properties upstream and downstream of Murchison are likely to be flooded. • Floodwater approaching the downstream side of High Road and Hutchison Road.	• Move stock and equipment to higher ground. • Close local roads adjacent to river. • Evacuate camping and fishing spots north of the bridge. • Note flood impacts for later update of this table.
9.40	**Oct 1979 flood**		•
9.57	**Sept 1973 flood**		•
9.43	**Nov 2011 flood**	• No significant impacts in Murchison.	•
9.791	**Dec 2010 flood**	• No significant impacts in Murchison.	•
9.80	**Aug 1996 flood**		•
9.87	**July 1981 flood**		•
9.88	**Sept 1983 flood**		•
9.93	**Jan 2011 flood**	• No significant impacts in Murchison.	•
10.15	**Sept 2010 flood**	• People were moved to Murchison Relief Centre in Watson Street and caravans were moved to higher ground.	•
Moderate flood level 10.2 62,600	12% AEP (8 year ARI)	• Overland flooding south of High Road covering western side of River Haven Caravan Park. • Extensive inundation of floodplain and shallow water over Willoughby Street south of Station Street. • High Road and Hutchison Road wet.	• Move caravans in River Haven Caravan Park to higher ground. • Willoughby Street – consider for closure. • High Road – consider for closure.

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
10.24	**Oct 1992 flood**	•	•
10.26	**Oct 1993 flood**	•	•
10.57	**Sept 1993 flood**	•	•
Major flood level 10.7 86,400	6% AEP (18 year ARI)	• Shallow inundation of Hutchinson Road, Old Weir Road and more extensive inundation of Willoughby Street south of Station Street. • Water up against River Road downstream of town • Cemetery beginning to flood.	• Evacuate residents on Hutchinson Road • Evacuate River Haven Caravan Park • Close Willoughby Street south of Station Street • Old Weir Road – Consider for Closure
10.79	**1939 flood**	•	•
10.8 92,200	5% AEP (20 year ARI)	• Inundation of properties on east side of Willoughby Street, including cemetery, south of Station Street. • Water encroaching onto the foreshore opposite the CBD in Stevenson Street.	• Consider opening evacuation centre • Warn residents along Willoughby Street
11.0 103,500	3.3% AEP (30 year ARI)	• Inundation of several properties on east end of Willoughby Street near Watson Street. (i.e. properties east of McKenzie Street) • Phillip Lane wet.	• Consider closing Willoughby Street.
11.2 114,000	2.5 % AEP (40 year ARI)	• Inundation of Willoughby Street between Watson Street and Stevenson Street and adjacent properties. Water up to 1m deep. • Inundation of Watson Street east of Willoughby Street.	• Close Willoughby Street between Station Street and Stevenson Street • Close Watson Street near Willoughby Street
11.25	**1934 flood**		•
11.28	**1917 flood**		•
11.29	**May 1974 flood**		•
11.38	**July 1956 flood**		•
11.4 123,600	2% AEP (50 year ARI)	• Further inundation of properties east of Willoughby Street between Watson Street and Station Street. • Flow across Donegans Road north of Hutchinson Road – has broken out of the immediate floodplain downstream of town.	• Close Donegans Road

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
11.55	**Dec 1934 flood**		
11.6 134,700	1.4% AEP (70 year ARI)	• Flow across Watson Street west of Willoughby Street.	
11.8 147,700	1.1% AEP (90 year ARI)	• Inundation of additional property west of Willoughby Street between Watson Street and Stevenson Street. • Extensive flow across Donegans Road.	• Warn residents along McKenzie Street and Watson Street.
11.92 152,600	1% AEP (100 year ARI)	• Flow will begin to overtop Murchison-Bendigo Road causeway.	• Monitor Murchison-Bendigo Road Causeway – consider closing
12.0 160,200	0.7% AEP (150 year ARI)	• Breakout flow across Gillam Road towards Hutchinson Road across several properties. • Intersection of Stevenson and McKenzie streets now wet. • Breakout immediately to the south of town will soon activate and the overland flow path begin flowing. Substantial property flooding and over-floor likely.	• Close Murchison-Bendigo Road Causeway. • Close Gillam Road. • Sandbag low area south of Station Street between Willoughby Street and Robinson Street –across the flow path of the breakout in order to prevent flooding through town. • Consider relocating VICSES and VicPol operations. • Warn residents in the overland flow path of possible / likely flooding.
12.22 175,300	**Sept 1916 flood** 0.3% AEP (300 year ARI)	• Breakout from river south of Station Street and the rail trail with flow path through town. Crosses Robinson Street south of Station Street, then across Station Street, Watson Street and Stevenson Street between Impey Street and Robinson Street. • Substantial number of properties, including in the CBD, wet. • Above floor flooding likely in properties along High, Station, Willoughby, Hutchison and Gillam streets, Phillip Lane and River Road. Intersection of Stevenson Street and High Road wet. • Extensive flooding of River Haven Caravan Park. • Significant number of rural properties isolated. • VICSES depot surrounded by water. • Police station surrounded by water.	• If not already done, sandbag low area south of Station Street between Willoughby Street and Robinson Street in order to prevent breakout and flooding through town.

Appendix C2: SHEPPARTON / MOOROOPNA AND KIALLA FLOOD EMERGENCY PLAN

Overview of the Catchment and Flooding Consequences

Shepparton-Mooroopna lies at the confluence of three main river systems, the Goulburn River, the Broken River and Seven Creeks. Large floods can originate from any one of the three systems or from a combination of the three systems.

The total catchment area to Shepparton is 16,125 km^2.

The Goulburn River catchment at its confluence with Seven Creeks has an approximate catchment area of 12,000 km^2. The river rises in the Great Dividing Range above Jamieson. The upper catchment flows into Lake Eildon which has a storage capacity of 3,390,000 ML and provides irrigation supplies to a large part of northern and central Victoria. During floods, the storage may reduce flow peaks from the upper catchment. From Lake Eildon to Seymour, several tributaries including the Rubicon, Acheron and Murrindindi Rivers join the Goulburn as it flows to the west. From Seymour, the Goulburn River turns to flow in a northern direction to the Goulburn Weir near Nagambie. Downstream of Goulburn Weir, the river continues to flow in a northerly direction to Shepparton. Just upstream of Shepparton, the Goulburn River is joined by Seven Creeks and the Broken River. Downstream of Shepparton at Bunbartha, the Goulburn flows in a north westerly direction to join the River Murray upstream of Echuca.

The Broken River rises in the Tolmie highlands and flows to the west before flowing to the north into Lake Nillahcootie. Lake Nillahcootie has a storage capacity of 39,800 ML and is not large enough to have a significant effect on major floods (HydroTechnology 1995a). Nevertheless Cardno (2008) found that without Lake Nillahcootie, flood levels at Benalla would be up to 0.23m higher (a situation that could occur if Nillahcootie was at FSL at the start of a major flood event). Holland Creek joins the Broken River just upstream of Benalla. The river continues flowing north until downstream of Benalla where the river turns and flows west to join the Goulburn River. The catchment area of the Broken River at the Goulburn River confluence is 2,510 km^2. During large floods, the flow in the Broken River break out to the north in the vicinity of Casey's Weir and joins the Broken Creek system (see footnote [10] below, additional details are provided in the Moira Shire MFEP). Further breakouts to the north and south occur during large floods along the Broken River between Casey's Weir and Shepparton. About 10 km upstream of the Broken River's confluence with the Goulburn River, the East Goulburn Main Channel passes under the Broken River via a siphon. The channel causes a constriction in the floodplain and during major floods this constriction results in a ponding of water upstream of the channel. Flood flow may break out upstream of the channel and flow to the south to join Honeysuckle Creek, a tributary of Seven Creeks or to the north to the Broken Creek via a number of tributaries including Pine Lodge, Congupna and Dainton's

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[10] During major floods, flows spill into the Broken Creek catchment from the Broken River near Casey's Weir and downstream from Gowangardie Weir through minor watercourses such as Guilfus, Congupna, Dainton's, Pine Lodge and O'Keefe creeks and moves north across a broad area west of Gowangardie Weir. Extensive inundation of the surrounding land results. These creeks discharge into Nine Mile Creek downstream from Wunghnu and then into the Broken Creek between Numurkah and Walsh's Bridge

Breakouts from near Casey's Weir occur when flow in the Broken River reaches approximately 18,000 ML/d or around 3.0 m at Benalla. At Casey's Weir the trigger flow is around 17,250 ML/d (~200 m^3/s) or at a water surface elevation of 158.73 m AHD (or around 1.81 m at the gauge).

creeks[3]. The breakouts and the floodplain storage result in a reduction of the peak flow for the Broken River from Benalla to its confluence with the Goulburn River.

Seven Creeks flows to the north-west from the Strathbogie Ranges through Euroa and to its confluence with the Goulburn River. The catchment area of Seven Creeks at the confluence is about 1,550 km^2. Honeysuckle Creek is a tributary of Seven Creeks and joins just upstream of Kialla West. During major flood events in the Broken River, the flow may break out of the Broken River and flow to the south joining Honeysuckle Creek. Some exchange of flow from Seven Creeks to the Broken River may occur during major floods. This exchange occurs downstream of Kialla West, spilling across Riverview Drive toward Kalinga Park (Lincoln Drive).

Two other tributaries enter the Goulburn downstream from Murchison: Pranjip Creek at Moorilim and Castle Creek at Arcadia.

The Goulburn and Broken Rivers in particular have a number of tributary and effluent flow paths. These facilitate flow transfers during large floods which further complicates flood behaviours.

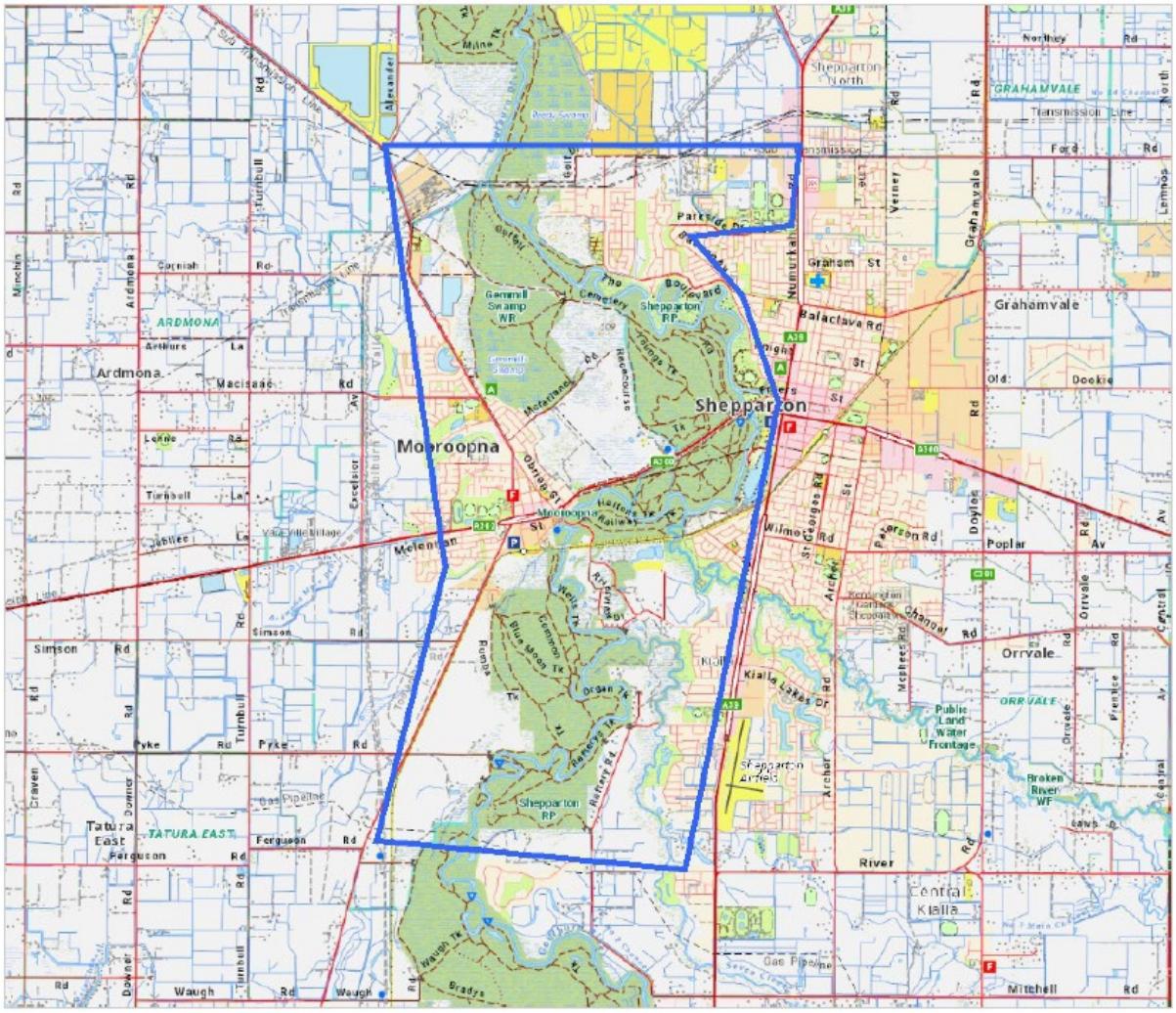
The City of Greater Shepparton is built on a floodplain and can expect flooding across the majority of the municipality from time to time. Historical records indicate that the areas directly adjacent to the major waterways are obviously most at risk from major floods; however, because of the flat terrain, most areas will experience localised 'flash flooding' from intense storms. See for example Appendix C3 for East Shepparton.

Generally Shepparton and surrounds will have between 3 and 5 days' notice of the approach of major flooding within the river system. Flash flooding (e.g. East Shepparton) occurs within a few hours.

The main highways to Shepparton will begin to be inundated from around the start of major flooding (i.e. greater than 11.0 m). Details are provided in the Shepparton flood intelligence card.

- The Midland Highway will be impassable near the eastern boundary of the municipality when the Broken River breaks its banks at Gowangardie.
- The Midland Highway will be wetted in Mooroopna from around 11.66 m and may need to be closed.
- The Midland Highway in Shepparton begins to get wet between Mitchell and Florence Streets from around 12.05 m and may need to be closed.
- The Barmah – Shepparton Road will be wetted to the north of its intersection with the Goulburn Valley Highway from around 11.7 m and may need to be closed.
- The Goulburn Valley Highway will be inundated opposite Victoria Park Lake (north of the railway line) from around 11.4 m as well as north and south of the town.
- The Goulburn Valley Highway will be wetted at the Brauman Street – Pine Road intersection in North Shepparton from around 11.8 m.
- Some other roads will be closed at creek and river crossings – see the table below giving the depth of water over the pavement and where "pink" indicates within 100 mm of over-topping.

In December 2017, Castle Creek was against the underside of the lower Goulburn Valley Highway Bridge with the Castle Creek at Arcadia gauge showing 2.39 m.



Created:	Thursday 13. May 2021 @ 04:37PM
Area derived from:	User drawn polygon
Area:	4909.6 hectares
Perimeter:	33.0 kilometres

Commonwealth and State Jurisdiction

SES Response Boundaries	2	SHEPPARTON S&R TATURA
CFA Districts	1	22
FRV Districts	1	SOUTH & EAST REGIONAL
Local Government Areas	1	GREATER SHEPPARTON CITY
Catchment Management Areas	1	GOULBURN BROKEN
L3ICC Footprint	1	Shepparton
Water Corporation Boundaries	2	Goulburn Valley Water Goulburn-Murray Water
Power Company Boundaries	1	POWERCOR
Localities	7	ARDMONA KIALLA MOOROOPNA MOOROOPNA NORTH SHEPPARTON SHEPPARTON NORTH TOOLAMBA
Water Basins	2	Broken River Goulburn River
Irrigation District Boundaries	2	Central Goulburn Shepparton

Catchments and Flood Warning

Flood Warning Sub-catchment Boundary	4	BROKEN RIVER GOULBURN RIVER SEVEN AND CASTLE CREEKS
Melbourne Water Catchments	0	
Water Supply Catchments	0	

Life

Townships	1	Mooroopna
Properties	7388	
Hospitals	0	
Health Care Facilities	0	
Care Facilities	12	Alexandra Street Kindergarten (child care) Apple Blossoms Early Learning - Mooroopna (child care) Aquamoves Lakeside Shepparton (child care) Echuca Road Kindergarten (child care) Frank R Pullar Childcare Centre (child care) Guthrie Street Child Care Centre (child care) Guthrie Street Primary After School Care Program (child care) Inspira Kids Early Learning Centre Shepparton (child care) Mooroopna Place Residential Aged Care Service (aged care) Rodney Neighbourhood Steiner Kindergarten (child care) Save The Children Kindergarten - Mooroopna (child care) Stepping Stones Mooroopna Oshc (child care)
Retirement Villages	3	Freedom Place Retirement Village, Rodney Park Retirement Village, Royal Freemasons Goulburn Court
Schools/Pre-schools	10	Greater Shepparton Secondary College - Greater Shepparton Secondary College Deaf Facilit (special school) Greater Shepparton Secondary College - Mooroopna Campus (secondary school) Greater Shepparton Secondary College - Wanganui Park Campus (secondary school) Greater Shepparton Secondary College (secondary school) Guthrie Street Primary School Shepparton - Guthrie Street Primary School (primary school) Guthrie Street Primary School Shepparton - Shepparton Deaf Facility (special school) Guthrie Street Primary School Shepparton (primary school) Mooroopna Park Primary School (primary school) Mooroopna Primary School (primary school) St Marys School (primary school)

Life

Prisons	0	
Camp Grounds	20	Bonds Bend Boat Ramp And Camping Area Bonds Bend Camping Area Darcys Camping Area 1 Hattens Bend Camping Area 1 Hattens Bend Camping Area 2 Hattens Bend Camping Area 3 Mooroopna Common Camping Area 1 Mooroopna Common Camping Area 2 Mooroopna Common Camping Area 3 Mooroopna Common Camping Area 4 Rafterys Bend Boat Ramp & Camping Rafterys Bend Camping 1 Rafterys Bend Camping 2 Rafterys Bend Camping 3 Rafterys Bend Camping 5 Rafterys Bend Camping 6 Rafterys Bend Camping 7 Sheilds Bend Camping Area Wells Hole Camping Area Youngs Bend Camping Area 1
Caravan Parks	4	Aspen Lodge Caravan Park Big4 Shepparton Parklands Finborough Caravan Park Victoria Lake Caravan Park
Group Camps	0	
Cultural Centres	3	Mooroopna Museum And Gallery (museum) Shepparton Library (library) The Shepparton Heritage Centre Museum (museum)
Places of Worship	5	Church Of Jesus Christ Of Latter Day Saints (church) Mooroopna Anglican Church (church) Mooroopna Mosque (mosque) Mooroopna Uniting Church (church) St Marys Catholic Church (church)
Community Venues	2	Mooroopna Scout And Guide Hall (hall) None (hall)
Sport Facility (point)	2	None (swimming pool)
Sport Facility (polygon)	59	Aquamoves Lakeside (sports complex) Deca (motor track) Equestrian Centre (equestrian facility) Mooroopna And District War Memorial Pool (sports complex) Mooroopna Bowls Club (bowling green) Mooroopna Croquet Club (croquet green) Mooroopna Golf Bowls Club (bowling green) Mooroopna Golf Club (golf course) None (baseball field) None (hockey ground) None (netball court) None (sports ground) None (tennis court) None (training track) None (velodrome) Shepparton Golf Bowls Club (bowling green) Shepparton Golf Club (golf course) Shepparton Lawn Tennis Club (tennis court) Shepparton Motocross Track (motor track) Shepparton Park Bowls Club (bowling green) Shepparton Sports Stadium (sports complex)
Commercial Facility (point)	0	
Commercial Facility (polygon)	1	None (shopping centre)
Municipal Office	0	
Census - Population	15885	
Census - Dwellings	6873	

Economic

Plantations	0.0 (ha)	
Intensive Animal Production	78.8 (ha)	Horse Stud / Training Facilities / Stables
Irrigated Horticulture	14.5 (ha)	Orchards, Groves and Plantations
General Farming / Grazing	924.2 (ha)	General Cropping (generally more than 20ha plantings) Livestock Production (Dairy Cattle) Mixed farming and grazing (generally more than 20ha) Specialised Cropping
EPA Stockpile Sites	2	High,Shepparton Resource Recovery Centre Medium,34 Wanganui Rd, Shepparton North

Assets / Infrastructure

Power Facilities	0	
Road Bridges	13	Midland Hwy Raftery Rd Riverview Dr Unnamed Watt Rd
Foot Bridges	4	Unnamed
Pathways (bicycle/walking trails)	21.8 (km)	Unnamed
Major Roads	16.5 (km)	Echuca Road High Street Mclennan Street Midland Highway Toolamba Road
Major Rail	8.3 (km)	TOCUMWAL LINE (bridge_rail_o) TOCUMWAL LINE (railway)
Light Rail	0.0 (km)	
Rail Stations	1	MOOROOPNA
Solar Farms	1	GVCE Mooroopna Solar Farm (UNDER CONSIDERATION)
Emergency Services - Police, Fire, Ambulance, SES	5	Mooroopna Ambulance Station Mooroopna Fire Station Mooroopna Local Command Facility Mooroopna Police Station Shepparton Police Station
Communication Services	1	Mooroopna Telephone Exchange
Proclaimed Water Supply Catchments	0.0 (ha)	

Water Asset (point)	58	MOOROOPNA - PUMP SOURCE (POTABLE) MOOROOPNA - PUMPSTATION PUB (SEWERAGE) MOOROOPNA - RESERVOIR (POTABLE) MOOROOPNA - WATER TOWER - (RAW) MOOROOPNA WATER TREATMENT PLANT (POTABLE) NORTHERN WATER STORAGE & WATER TOWER SIT (UNKNOWN) SHEPPARTON - PUMPSTATION PUB (SEWERAGE) SHEPPARTON - RESERVOIR (POTABLE) SHEPPARTON WATER TREATMENT PLANT (POTABLE) SPS 19 (SEWERAGE) SPS-09 (SEWERAGE) SPS-24 (SEWERAGE) SPS-31 (SEWERAGE)
Water Asset (line)	34.2 (km)	PIPELINE FOR MOOROOPNA PIPELINE FOR SHEPPARTON
Water Asset (polygon)	9.1 (ha)	MOOROOPNA - NORTHERN WATER STORAGE & WATER TOWER SIT MOOROOPNA - SPS 19 MOOROOPNA - SPS-01 MOOROOPNA - WATER RESERVOIR MOOROOPNA - WTP MOOROOPNA - WWTP SHEPPARTON - SPS 05 - WANGANUI RD SHEPPARTON - SPS-09 SHEPPARTON - SPS-24 SHEPPARTON - SPS-31 SHEPPARTON - WTP

Assets / Infrastructure

Farm Dams	57	AllVicPoly101107 (Rural Irrigation Storage), AllVicPoly101290 (Rural Storage), AllVicPoly102180 (Rural Storage), AllVicPoly102205 (Rural Storage), AllVicPoly102298 (Rural Storage), AllVicPoly103072 (Rural Irrigation Storage), AllVicPoly103073 (Rural Storage), AllVicPoly103074 (Rural Storage), AllVicPoly103075 (Rural Storage), AllVicPoly103351 (Rural Storage), AllVicPoly103356 (Rural Storage), AllVicPoly103886 (Rural Storage), AllVicPoly103903 (Rural Storage), AllVicPoly103914 (Rural Storage), AllVicPoly104687 (Rural Storage), AllVicPoly104689 (Rural Storage), AllVicPoly105078 (Rural Storage), AllVicPoly106648 (Rural Storage), AllVicPoly108033 (Rural Storage), AllVicPoly111824 (Town Rural Storage), AllVicPoly112277 (Rural Storage), AllVicPoly112283 (Rural Irrigation Storage), AllVicPoly112284 (Rural Storage), AllVicPoly112475 (Rural Irrigation Storage), AllVicPoly112498 (Rural Storage), AllVicPoly112504 (Rural Irrigation Storage), AllVicPoly114463 (Rural Storage), AllVicPoly114464 (Rural Storage), AllVicPoly117031 (Rural Irrigation Storage), AllVicPoly117088 (Rural Irrigation Storage), AllVicPoly117109 (Rural Storage), AllVicPoly117150 (Rural Storage), AllVicPoly117229 (Rural Storage), AllVicPoly117234 (Rural Storage), AllVicPoly117536 (Rural Storage), AllVicPoly117558 (Rural Storage), AllVicPoly117853 (Rural Storage), AllVicPoly117886 (Rural Storage), AllVicPoly117956 (Rural Storage), AllVicPoly118065 (Rural Storage), AllVicPoly118078 (Rural Storage), AllVicPoly118079 (Rural Storage), AllVicPoly118117 (Rural Storage), AllVicPoly118314 (Rural Storage), AllVicPoly118563 (Rural Storage), AllVicPoly118564 (Rural Storage), AllVicPoly119017 (Rural Storage), AllVicPoly119043 (Rural Storage), AllVicPoly119046 (Rural Storage), AllVicPoly119047 (Town Rural Storage), None (Industrial Storage), None (Town Rural Storage)
Piers and Jetties	0	

PTV School Bus Route	59	Arcadia - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Ardmona - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Bayunga - Shepparton (jan 2011 - shares in CO were bought by Jacobson entity and changed name into a TRUST - VENDOR No. previously 213844- see file, 03 5820 3700) Bunbartha - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Burton Hall-Tatura-Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Caniambo - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Coomboona - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Cosgrove(Kialla) - Shepparton (L C Dyson's Bus Services P/L, 9463 3878) Dhurringile - Shepparton (jan 2011 - shares in CO were bought by Jacobson entity and changed name into a TRUST - VENDOR No. previously 213844- see file, 03 5820 3700) Dookie - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Harston - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Karramomus - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Kyabram - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Marungi-Zeerust-Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Merrigum - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Midlands Hwy - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Murchison-Tatura-Shepparton (Nosboc Nominees P/L, 5820 3700) Nalinga - Shepparton (Adderley Holdings Pty Ltd as Trustee For Jacobson Trust, 03 5820 3700) Numurkah - Shepparton (Cardwell Enterprises Pty Ltd, 5862 1833) Pine Lodge - Shepparton (FROTARK PTY LTD, 0429 590 888) Shepparton East - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) St Germains - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Tallygaroopna - Shepparton (Accreditation under Jeffrey William George Fitzpatrick, 5829 2637) Tatura (3) - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Tatura - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Tatura - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Tatura No 2 - Shepparton (Mooroopna Passenger Serv P/L, 5825 2323) Toolamba-Mooroopna-Shepparton (jan 2011 - shares in CO were bought by Jacobson entity and changed name into a TRUST - VENDOR No. previously 213844- see file, 03 5820 3700) Tucketts Corner - Shepparton (Fords Shepparton Bus Services Pty Ltd, 5821 3777) Yabba North - Shepparton (Adderley Holdings Pty Ltd as Trustee For Jacobson Trust, 03 5820 3700)

Assets / Infrastructure

PTV Regional Bus Route	16	Aquamoves - Shepparton (Dysons Shepparton) Kialla - Shepparton (Dysons Shepparton) Mooroopna Park Via Echuca Road and Gange Street (Jacobsons Bus Lines) Parkside Gardens via GV Health (Dysons Shepparton) Parkside Gardens via The Boulevard (Dysons Shepparton) Rodney Park Via Rumbalara Co-Op, Echuca Road (Jacobsons Bus Lines) Shepparton - Golf Drive/TAFE (Dysons Shepparton) Shepparton - Mooroopna Via McLennan St (Jacobsons Bus Lines) Shepparton Station - Bendigo Station (Dysons Shepparton)
PTV Regional Coach Route	22	Albury - Mildura Via Shepparton & Kerang (V/Line) Barmah - Melbourne Via Shepparton & Heathcote (V/Line) Bendigo - Albury Via Shepparton & Wangaratta (V/Line) Echuca/Moama - Melbourne Via Shepparton (V/Line) Griffith - Melbourne Via Shepparton (V/Line) Sydney - Adelaide Via Albury (V/Line)
PTV Night Bus Route	0	
PV Camping Grounds	0	
PV Visitor Facility Assets	1	Gemmill Swamp Information Shelter
PV Aquatic Assets	0	
Recweb Sites	0	
Recweb Tracks	0.0 (km)	
Mine Shafts	0	
Storage Facility (point)	4	None (silo)
Storage Facility (polygon)	0	
Airports/Airfields	0	

Cultural Heritage

Ruins	0	
Historical Places	1	Haulage Track (Local significance, Water Transport)
Heritage Register	1	BANGERANG CULTURAL CENTRE (HERMES: 13104, VHI: None)
Heritage Inventory	15	ARDPATRICK PRE-EMPTIVE RIGHT (HERMES: 10511, VHI: H7925-0001) BROKEN RIVER RAILWAY BRIDGE (HERMES: 10524, VHI: H7925-0014) CHINAMAN'S RESERVE H1 (HERMES: 12577, VHI: H7925-0041) GEMMILLS TRACK HISTORICAL SCATTER (HERMES: 10516, VHI: H7925-0006) GOULBURN RIVER HAULAGE TRACK (HERMES: 10528, VHI: H7925-0018) GOULBURN RIVER WEIR (HERMES: 10527, VHI: H7925-0017) MCGUIRES RESERVE HISTORICAL SCATTER (HERMES: 12830, VHI: H7925-0042) MOOROOPNA CEMETERY (HERMES: 10534, VHI: H7925-0024) PYKES ROAD, HISTORICAL HOMESTEAD (HERMES: 13551, VHI: H7925-0046) RIVERVIEW H1 FIREPLACE & WELL (HERMES: 13067, VHI: H7925-0043) RIVERVIEW H2 IRRIGATION FLOW REGULATOR (HERMES: 13068, VHI: H7925-0044) SEVEN CREEKS SCARRED TREE (HERMES: 10525, VHI: H7925-0015) THE FLAT SCARRED TREE (HERMES: 10531, VHI: H7925-0021) WANGANUI ROAD FARM COMPLEX (HERMES: 11888, VHI: H7925-0040) YOUNG BEND STATE FOREST HISTORIC AREA (HERMES: 10530, VHI: H7925-0020)
PV Cultural Heritage	0	

Evacuation issues

The majority of properties have satisfactory egress in the event of rising floodwaters. However, there are three (3) locations that may present evacuation issues, if the residents are not notified early. These are:

- Kialla Settlement, Riverview Drive
- Arcadia Downs Estate
- Kidstown Tourist facility

Evacuation of areas close to the Goulburn and Broken rivers and Seven Creeks may be required once the Shepparton gauge is expected to exceed 11.1 m.

Depth of flooding at key creek and river crossings

Bridge or Causeway name	Depth of flooding over bridge deck or causeway for various levels at Shepparton gauge										
	9.5m	10.1m	10.7m	10.9m	11.1m	11.3m	11.7m	12.1m	12.2m	12.3m	12.5m
Watt Rd - Goulburn River	-	-	-	-	-	-	-	-		0.08	0.16
Shep - Euroa Rd - Broken River	-	-	-	-	-	-	-	-	-	-	-
Mitchell Rd - Seven Cks	0.36	1.30	2.62	2.89	3.18	3.46	3.84	4.09	4.09	4.17	4.44
GV Highway - Seven Cks	-	-	-	-	-	-	-	0.09	0.09	0.16	0.44
GV Highway River Rd	-	-	-	-	-	-	-	0.17	0.17	0.31	0.70
Doyles Rd - Broken River	-	-	-	-	-	-	-	-	-	-	-
Archer Rd - Broken River	-	-	-	-	-	-	-		0.08	0.21	0.50
GV Highway - Broken River	-	-	-	-	-	-	-	-		0.09	0.31
Railway - Goulburn River	-	-	-	-	-	-	-	-	-	-	-
Railway - Broken River	-	-	-	-	-	-	-	-	-	-	-
Chinamans Gardens Culvert	-	-	-	-	-	-	-	-	-	-	-
Causeway Br1	-	-	-	-	-	-	-	-	-	-	-
Causeway Br 2	-	-	-	-	-	-	-	-	-	-	-
Causeway Br 3	-	-	-	-	-	-	-	-	-		0.09
Causeway Br 4	-	-	-	-	-	-	-	-	-	-	-
Dainton's Br	-	-	-	-	-	-	-	-	-	-	-
Midland Hwy Culvert Mooroopna	-	-	-	-	-	-	-	0.36	0.73	0.99	1.14
Trevaskis Rd - Honeysuckle Ck	-	0.55	1.21	1.29	1.37	1.42	1.49	1.54	1.54	1.56	1.65
Central Kialla Rd - Honeysuckle Ck	-	-	-	-	-	-	-	-	-	-	-

Note – refer to the map on the following page for bridge and causeway locations.
Caravan parks are also susceptible to flooding. The main sites in Shepparton and Mooroopna are:

- **Victoria Lake Holiday Park**
  536 Wyndham Street or Fitzjohn Road, Shepparton Tel 03 5821 5431
  The grounds begin to flood at around 11.18m at Shepparton while the first floors begin to flood from about 11.4m.
- **Shepparton Riverside Cabin Park**
  8049 Goulburn Valley Highway, Shepparton South Tel 03 5823 1561
  The grounds begin to flood at around 12.0m at Shepparton.
- **Big4 Shepparton Park Lane Holiday Park**
  7835 Goulburn Valley Highway, Kialla Tel 03 5823 1576
  The grounds begin to flood at around 12.4m at Shepparton
- **Aspen Lodge Caravan Park**
  1 Lawson Street, Mooroopna Tel 03 5825 2245
  The grounds begin to flood at around 11.4m at Shepparton while the first floors begin to flood from about 11.6m.

Property Flooding

There are in excess of 9,000 properties within the current 1% AEP flood extent.

Property Data Summary

The property data on which the following count is based was collected as part of the SKM 2002 study and targeted all land parcels and buildings then determined to lie within the 1% AEP flood extent. It is assumed that all buildings constructed since 2002 have their floors at the 100-year ARI flood level plus a minimum of 300 mm freeboard, and therefore no further floor levels have been collected as part of this study. There are likely to be other properties not included in the list of buildings inundated. Those buildings are likely to be above flood level but inundation on or surrounding the property is observed. In addition to the above, the property use and / or floor level may have changed since 2002. For example, the building at


Daintons Br
Causeway Br 4
Causeway Br 3
Chinamans Gardens Culvert
Causeway Br 2
Watt Rd Goluburn River
Causeway Br 1
Railway Broken River
Midland Hwy Culvert Mooroopna
Goulburn River - Railway
GV Highway - Broken River
Archer Rd Broken River
Shep - Euroa Rd Broken River
Doyles Rd - BrokenRiver
GV Highway - River Rd
GV Highway - Seven Creeks
Seven Creeks - Mitchell Rd
Central Kialla Rd Honeysuckle Creek
Trevaskis Rd - Honeysuckle Creek

195-205 Numurkah Road is now occupied by the CFA and hosts the Shepparton ICC, and both the Mooroopna Police Station and Mooroopna Hospital are no longer located in McLennan Street.

The number of properties and buildings assessed as being subject to inundation has also changed due to updated flood extent and depth modelling. This is mostly due to the higher resolution of the recent study, incorporating the impacts of channel embankments in the modelling, reducing areas of inundation in some locations.

Number and type of properties within the 1% AEP flood extent

Building Type as at 2002	Total within 2002 study area	2017 study
Urban Residential	8,958	8505
Rural Residential (including farm buildings)	415	385
Commercial	453	379
Recreational	20	14
Industrial	27	23
Public	82	49
Total	**9,955**	**9355**

A summary of the number of properties and floors inundated at various levels at Shepparton is provided in the following table (Water Technology, 2017).

Number of properties and floors flooded at various levels

	Shepparton gauge level (m)	Properties				Floors			
		Flooded and almost flooded	Flooded	Almost flooded	Number of properties not "flood affected"	Flooded and almost flooded	Flooded	Almost flooded	Number of floors not "flood affected"
	10.5	2	2	0	9353	0	0	0	9355
Moderate	10.7	13	10	3	9342	4	4	0	9351
10% AEP	10.9	31	23	8	9324	5	5	0	9350
Major	11	64	36	28	9291	11	9	2	9344
	11.1	164	98	66	9191	18	18	0	9337
5% AEP	11.3	308	193	115	9047	31	28	3	9324
~1993	11.5	498	322	176	8857	64	45	19	9291
	11.7	1337	878	459	8018	142	109	33	9213
2% AEP	11.9	4200	3565	635	5155	800	552	248	8555
~1974	12.1	5742	5065	677	3613	1429	1022	407	7926
1% AEP	12.2	7206	6684	522	2149	2301	1734	567	7054
0.5% AEP	12.3	8134	7777	357	1221	3862	3010	852	5493
0.2% AEP	12.5	8624	8404	220	731	5555	4567	988	3800

Properties likely to be first affected by flooding

The following list has been compiled from a combination of local knowledge and the property listings produced by the 2019 study. Levels at which key public buildings and services are impacted along with a more detailed listing of flood consequences is included in the Flood Intelligence Card included in this Appendix.

A listing of properties affected by flooding (including over-floor) is not included in this document but is available as a separate Excel spreadsheet. That spreadsheet will be added to FloodZoom along with this MFEP document.

685 DOYLES ROAD, KIALLA
The property begins to be affected from 6.3 m at Orrvale. The house is a fair bit higher (approx. 1 m) with levels known by the owner. Does not need to be sandbagged until Orrvale likely to approach 7.3 m.

68 DOYLES ROAD, KIALLA
When the Broken River reaches 7.8 m at Orrvale there will be water lapping at the house

SHEPPARTON VILLAGES
Ensure that the chief project officer and management of Tarcoola Village and Waranga Drive Village are advised of predicted flood levels so that they can activate their flood response plan for both sites.

470 MADILL ROAD, UNDERA
Levee banks in the area of his farm will over-top when we have a flood in excess of approximately 11.2 m on the Shepparton gauge.

95 JAMIESON ROAD, ORRVALE
The Broken River will flood up around the house at around 7.8 m at Orrvale; they need a Road Closed sign at Channel Road to stop people driving down there.

25 FURPHY AVENUE, KIALLA
Will always ring to find out what is going on because she lives in the deepest part of Furphy Avenue. Property starts to flood around 11.2 m at Shepparton with over-floor flooding likely to start from approx. 11.4 m

3 & 5 McLENNAN STREET, MOOROOPNA
Right beside the river in the service road. Both properties start to flood around 11.0 m at Shepparton. No 3 will be flooded over-floor to a depth of around 10mm at 11.1 m at Shepparton while the lower level of No 5 will begin to flood as the river exceeds 11.1 m.

489 ARCHER ROAD, KIALLA
Owns the house and land at the floodway south of Kialla Lakes Drive, on the east side of Archer Road. Knows it is his responsibility to keep the floodway, watercourse clear and has assisted us with his tractor to rescue stranded motorists when Archer Road flooded.

60 HOOPER ROAD, KIALLA
The property will start to be flooded if the Broken River reaches 7.7 m at Orrvale as the anabranch will flow out from the Broken across to the Archer Road culverts.

56, 60 & 100 HOOPER ROAD, KIALLA
All properties begin to flood from about 10.8 m at Shepparton with over-floor flooding at No 60 likely of Shepparton exceeds 11.5 m.

360 & 370 CENTRAL KIALLA ROAD, KIALLA
These are the first properties flooded in Kialla from around 10.4 m at Shepparton.

966, 970 & 980 ARCHER ROAD, KIALLA WEST
These are the first properties flooded in Kialla West from around 10.6 m at Shepparton. Nos 966 & 980 are also likely to begin experiencing over-floor flooding around this level.

650 DOYLES ROAD, SHEPPARTON
The first property flooded in Shepparton from around 10.6 m.

118 MCPHEES ROAD & 89 MALCOLM CRESCENT, SHEPPARTON
These two properties are likely to be the first to suffer over-floor flooding in Shepparton, beginning from around 11.8 m.

7275 MIDLAND HIGHWAY, MOOROOPNA
The first property flooded in Mooroopna from around 10.8 m at Shepparton.

3 MCLENNAN STREET, MOOROOPNA
This is the first property likely to suffer over-floor flooding in Mooroopna, beginning from around 11.0 m at Shepparton.

4.5 Essential Services

Essential services such as **electricity supply** (Powercor) will be impacted by floodwaters. Ground level electrical substations are at extreme risk and will need to be protected with sandbags. Failure to protect the substations may result in shut down, causing localised outages.

The Shepparton water treatment plant is well protected but if the levees are breached, **water supply** will be affected; the town has only a single week's supply of treated water available, if the plant were to become inoperable due to flood damage. The **sewerage system** will become overloaded if floodwater is allowed to flow back into the system through private gully traps and such; all inlets must be closed. **Goulburn Valley Water,** the responsible agency for water supply and sewerage management in the City of Greater Shepparton municipal area, has its own detailed response plan which includes details of tasks to be conducted when river levels rise. Their works commence when the level reaches 8.5 m at the Shepparton gauge. The water treatment plant and sewerage pumps will be adversely affected at a river height of 11.9 m.

If the Shepparton gauge is forecast to exceed 12.0m, the Municipal offices at 90 Welsford Street will be impacted and the Municipal Emergency Coordination Centre (MECC) should be relocated. The alternative facility is located at 315 Doyles Road. **Accessibility will depend on Broken River flood levels and flooding along Doyles Road.**

4.6 Flood Mitigation

- Shepparton, Murchison, Kialla and Undera regions have levees at strategic locations. However, these only provide protection up to just over the Shepparton major flood level of 11.0 m and have been overtopped twice in the past 40 years.
- Penstocks are in place on most inlet pipes to the rivers, preventing backflow of floodwaters. The closing and opening of these penstocks is correlated closely to the levels recorded at the 3 major automated flood level gauges on the Broken, Sevens and Goulburn waterways.
- There are large volume pumps at some locations to lift and discharge waters when penstocks are closed.
- All new subdivisions are being developed with sufficient retardation basin capacity to slow up the inflow of water into the town stormwater drainage systems.

- Greater Shepparton City Council manages and maintains floodwater infrastructure.

4.7 Flood Impacts and Required Actions

Totems for the Goulburn and Broken Rivers and Seven Creeks waterways display the impacts and actions required when the waterways reach certain levels. They were developed in 1994 using historical data and reviewed after each flood event for the past 18 years to refine and improve Council's preparedness.

Flood reaction 'totems' have recently been prepared for local communities at Tallygaroopna, Congupna and Katandra; these will need to be checked for practical function during future events.

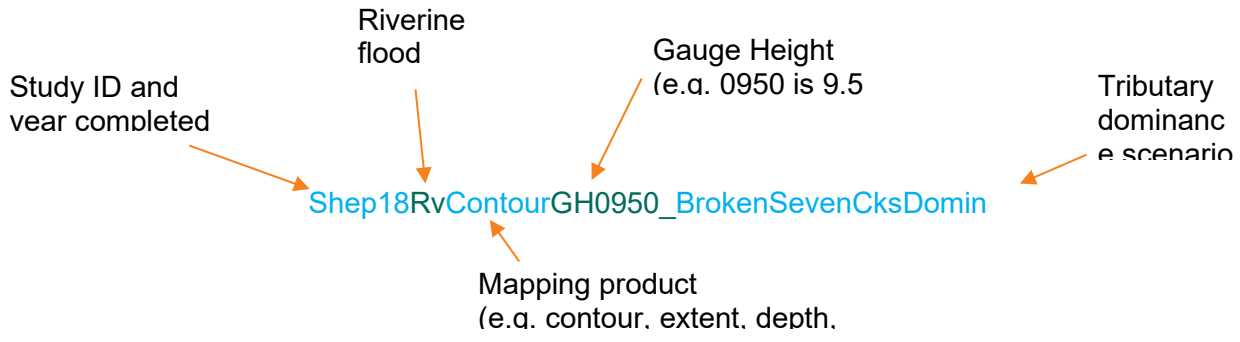
Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Flood Mapping

A comprehensive set of riverine flood inundation maps for Shepparton-Mooroopna has been produced for emergency management and response purposes (Water Technology, 2017) for Goulburn dominant, Broken – Seven Creeks dominant and neutral flood scenarios. Maps were produced for the design event combinations shown in the table below from the minor flood level (9.5 m at Shepparton) up to the 0.2% AEP (500-year ARI) event (12.5 m at Shepparton). Each map set comprises:

- Flood extent;
- Flood depth in metres;
- Flood level in m AHD;
- Velocity;
- Hazard;
- Floor level survey points (9,355 floors); and
- Flood affected properties and those flooded over-floor (these are the properties listed in the separate Excel spreadsheet referred to on the previous page).

Mapping is available through FloodZoom – see naming convention below. The study reports (Water Technology, 2019) are also available through FloodZoom.



Flow Dominance Matrices

Matrices have been developed for each of the modelled and mapped flood (or dominance) scenarios. Determining dominance is key to determining peak flood levels and impacts within Shepparton and Mooroopna.

One matrix comprises flood levels at each of the Broken River at Orrvale, Seven Creeks at Kialla West and Goulburn River at Kialla West gauges, that in combination produce the

listed key levels at the Goulburn River at Shepparton gauge for each of the mapped scenarios. This can be used to determine the most appropriate flood map and consequence table to be used as well as to determine the likely (peak) flood level at Shepparton.

A similar matrix comprising flows at the Broken River at Orrvale, Seven Creeks at Kialla West and Goulburn River at Kialla West gauges has also been developed. This can be used to assist the selection of flood mapping and consequence tables.

Both matrices are provided at the end of this Appendix.

Shepparton gauge heights for flood inundation map sets

Event	Goulburn River @ Shepparton Gauge Height (m AHD)	Goulburn River @ Shepparton Gauge Level (m)
Minor Flood	109.627	9.5
20-10%	110.227	10.1
Moderate Flood	110.827	10.7
10%	111.027	10.9
Major Flood 2010	111.127	11.0
10-5%	111.227	11.1
5%	111.427	11.3
5-2%	111.627	11.5
1993	111.827	11.7
2%	112.027	11.9
1974	112.227	12.1
1%	112.327	12.2
0.5%	112.427	12.3
0.2%	112.627	12.5
PMF		

Flood Class Levels

Flood Class Level	Goulburn River at Shepparton	Goulburn River at Arcadia Downs	Broken River at Orrvale	Seven Creeks at Kialla West
Minor	9.5 m	9.0 m	6.8 m	4.5 m
Moderate	10.7 m	10.4 m	7.2 m	5.0 m
Major	11.0 m	10.7 m	7.9 m	6.6 m

Using the flood inundation map sets

The first step in using the flood mapping data sets is to determine which dominance scenario applies (i.e. Broken–Seven Creeks, neutral or Goulburn). This will dictate which map set is appropriate to determine flood extents and consequences in the vicinity of each of Orrvale, Seven Creeks at Kialla West, Goulburn River at Kialla West and Shepparton. The appropriate map and summary of likely consequences (read from the flood intelligence card for each gauge) at a location will be the one that matches the expected level at that location.

As the event progresses and peak level forecasts are refined, the appropriateness of map sets being used and thus likely consequences should be reviewed and adjustments made as necessary.

While a conservative approach would be to use the maximum extent map sets, on-ground flood impacts will in general be less than expected in some locations. See for example, the 1% AEP flood extent maps below for each of the dominance scenarios.

Getting a heads-up of likely flood severity and impacts

Tools and instructions for their use are provided at the end of this Appendix to enable a user to quickly determine an indication of likely flood severity and consequences through the lower reaches of the Broken - Seven Creeks - Goulburn system.

The earliest an initial heads-up of the expected peak level at Shepparton can be determined is after a forecast peak level is available for Benalla and Euroa and a peak outflow forecast (or estimate) is available for Goulburn Weir (i.e. a peak level for the Goulburn Weir tail gauge). The use of actual flood peaks will generally result in more accurate estimates.

The tools provide an estimate of the likely flood peak. They are not infallible and are unlikely to be as precise as BoM flood forecasts.

Use of FloodZoom and other tools is encouraged in order to better inform the early heads-up estimate and assist response activity planning and implementation.

Past flood experience

The City of Greater Shepparton has a history of flooding including major floods (i.e. above 11 m) in 1870, 1916, 1939, 1974, 1981, 1993 and more recently in 2010, recent moderate floods in 1981 and 1983 and minor floods in 1996 and 2016.

- 1974 was a Goulburn River dominant flood.
- 1993 was a Broken River dominant flood.
- 2010 was a flood which saw gauges on the Goulburn, Broken and Seven Creeks peak at major level. During this flood, 13 houses and 31 buildings were flooded in Shepparton, 620 houses were isolated and approx. 40 houses inundated in Kialla and more than 60 people attended the relief and recovery centre.

Flooding from the rivers and creeks in this area usually lasts about four to seven days depending on the rainfall. Roads and properties can also flood due to water backing up in the stormwater drain system.

Flash flooding caused by heavy rainfall can also occur in low-lying areas, especially in the industrial and business areas of Mooroopna and Shepparton East and around the Doyle's Road-Midland Highway roundabout. These flash floods only last a few hours but can be dangerous and cause extensive damage.

Community Education

An important deliverable from the Shepparton-Mooroopna Flood Mapping and Intelligence Study (Water Technology, 2019) was a web-based flood and property information portal for community use. The portal enables flood maps for the various dominance scenarios (e.g. neutral, Goulburn River dominant, Broken-Sevens dominant) to be displayed as well as flood related information for a user-specified property.

The maps display the projected inundation for a variety of river heights: from 9.5, 10.1, 10.7, 10.9, 11.0, 11.1, 11.3, 11.5, 11.7, 11.9, 12.1, 12.2 and 12.3 m; as measured on the Goulburn River at Shepparton (Dainton's Bridge) gauge.

The flood information for a user-specified property is presented as a report that includes all available flood information for that property.

The maps and reports provide a means for community members to inform themselves of the likelihood of their property being inundated and the likely depths of inundation for a range of levels at the Shepparton gauge.

A typical map is included in Appendix E.

The web-based flood and property information portal can be accessed http://www.floodreport.com.au/

The full range of flood inundation maps for the Shepparton area are kept electronically on Greater Shepparton City Council's Crisisworks and the VICSES G drive: G:\Data\AAA North East Operations\Flood Management\Flood Intelligence and Planning\Shepparton-Mooroopna Flood maps will also be available via FloodZoom.

Local Flood Guides are available for all residents within the City of Greater Shepparton to assist them in preparing for future flood events. Refer to Appendix F for a sample. These Local Flood Guides need to be kept current and should consider the latest flood information and the web-based flood and property information portal.

Command, Control and Coordination

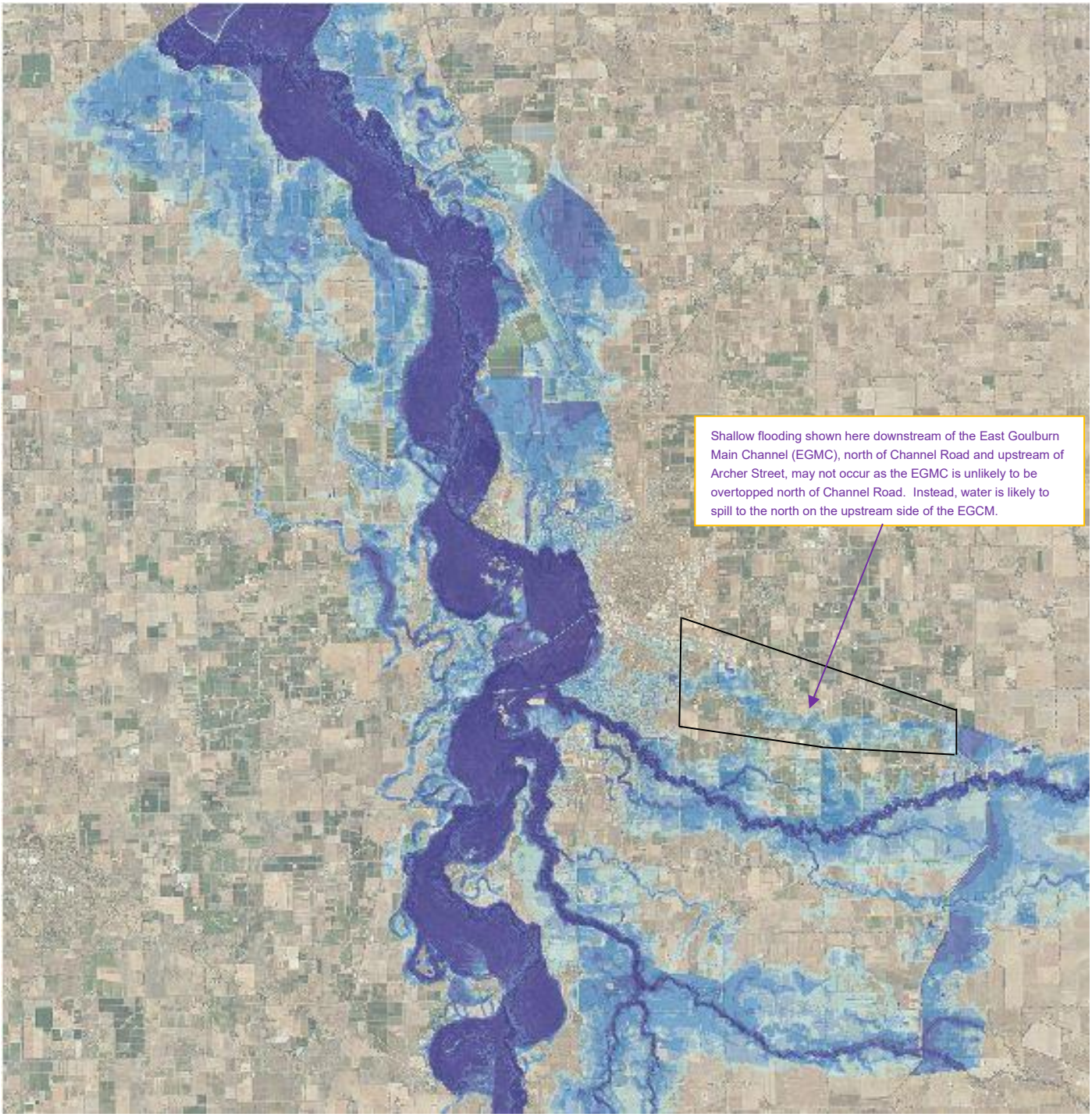
The responsible agency for the Command, Control and Coordination of floods is the Victorian State Emergency Service (VICSES).

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the SEMP. During significant events, VICSES will conduct incident management using multi-agency resources.

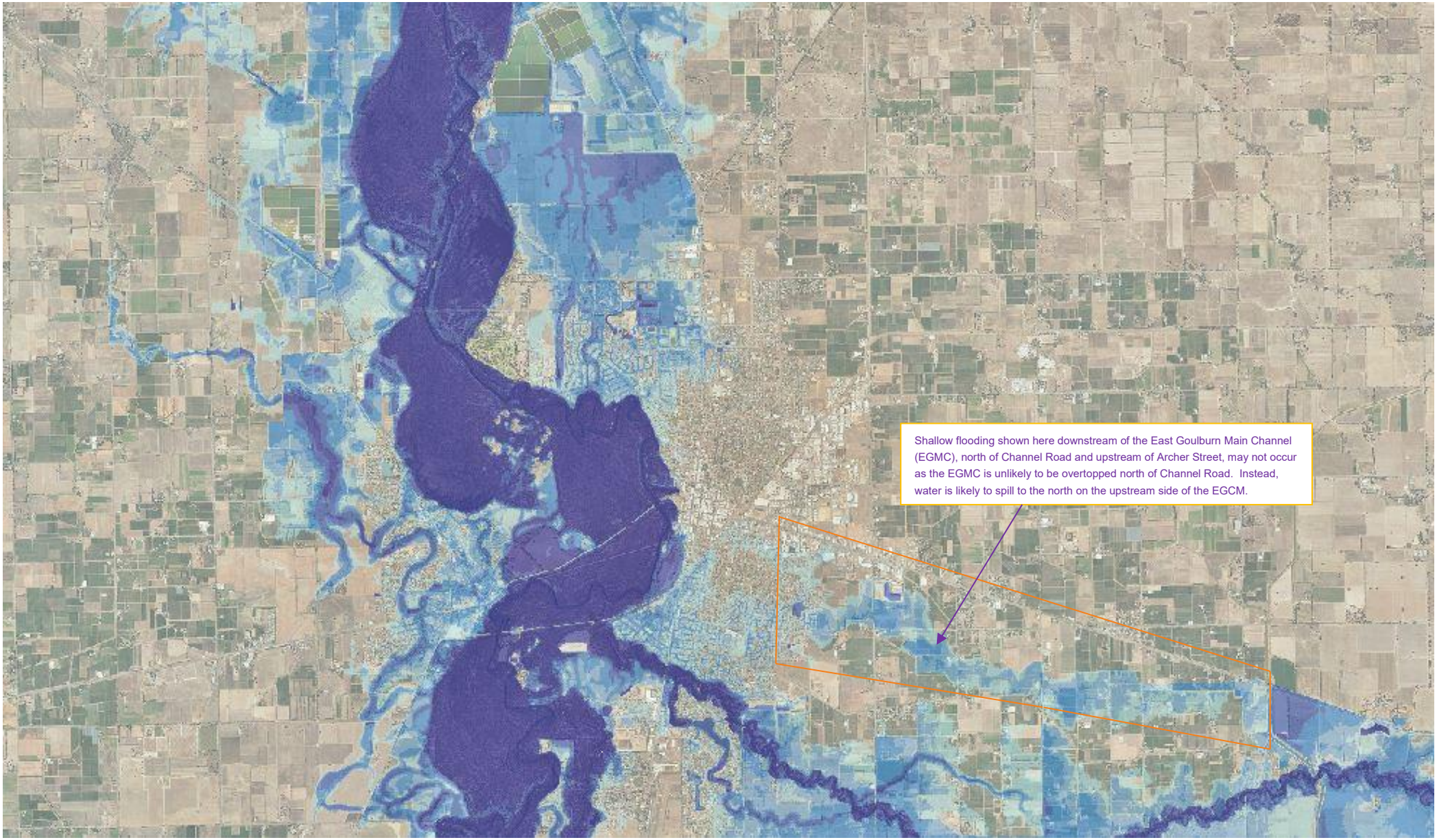
Divisional Command will be located at the Hume Region Divisional Command Centre Shepparton and Tatura to manage the Shepparton community.

The Incident Control Centre (ICC) for management of floods is located at the CFA Headquarters, 195 Numurkah Road, North Shepparton or at the VICSES North East Regional Headquarters, 64 Sydney Road, Benalla.

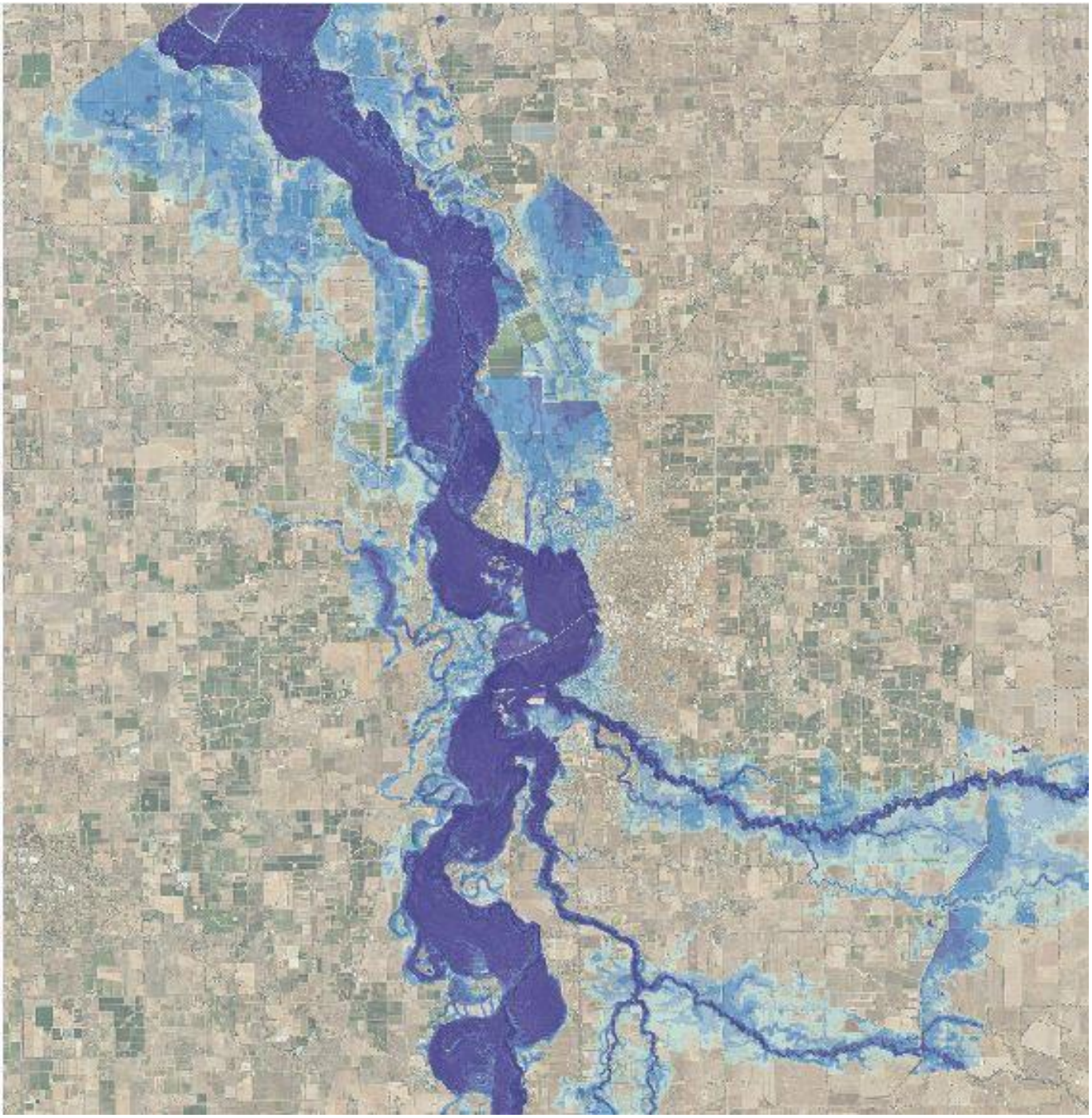
1% AEP flood extent for Broken River and Seven Creek dominant – view 1



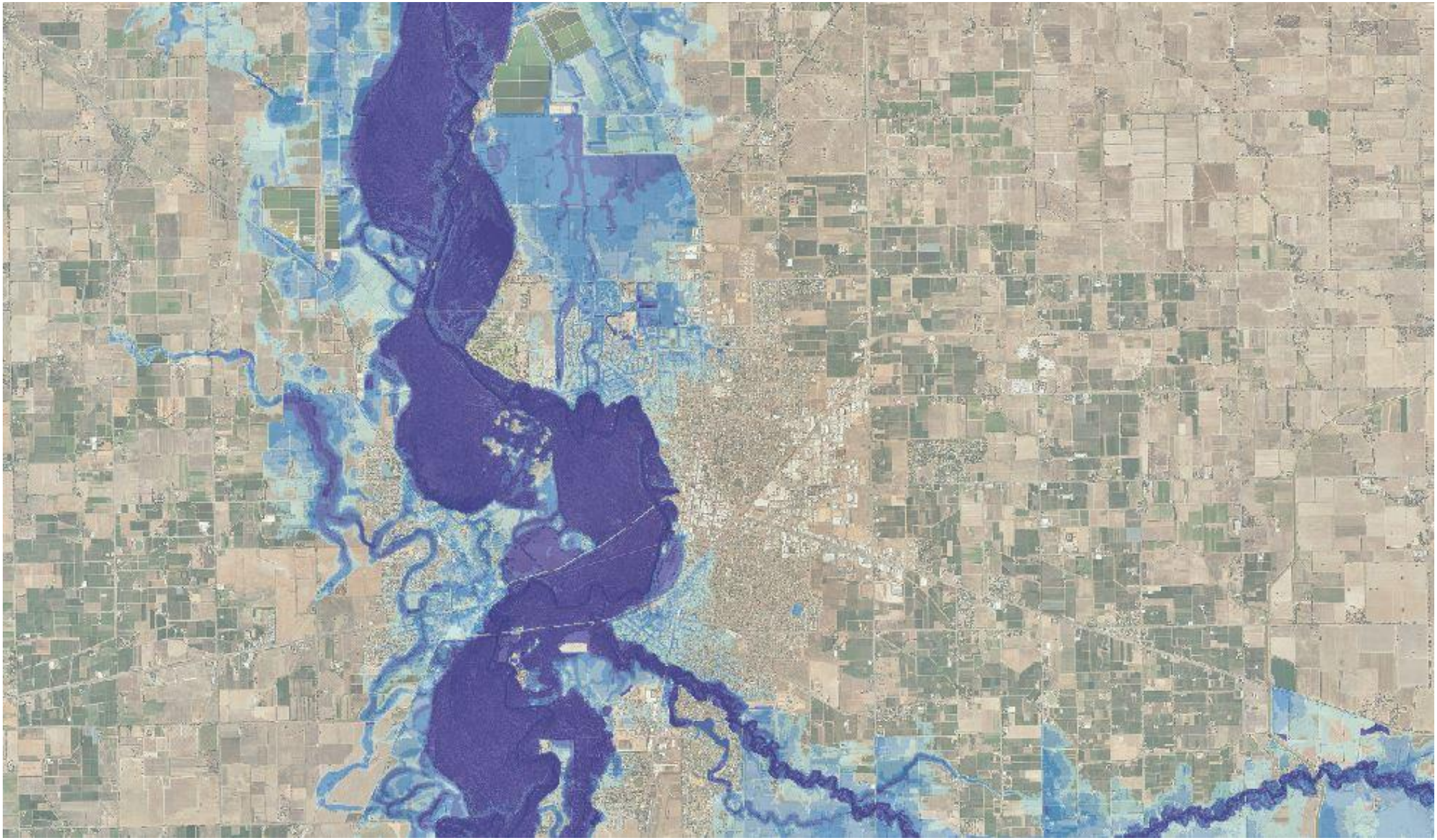
1% AEP flood extent for Broken River and Seven Creek dominant – view 2 – zoomed in



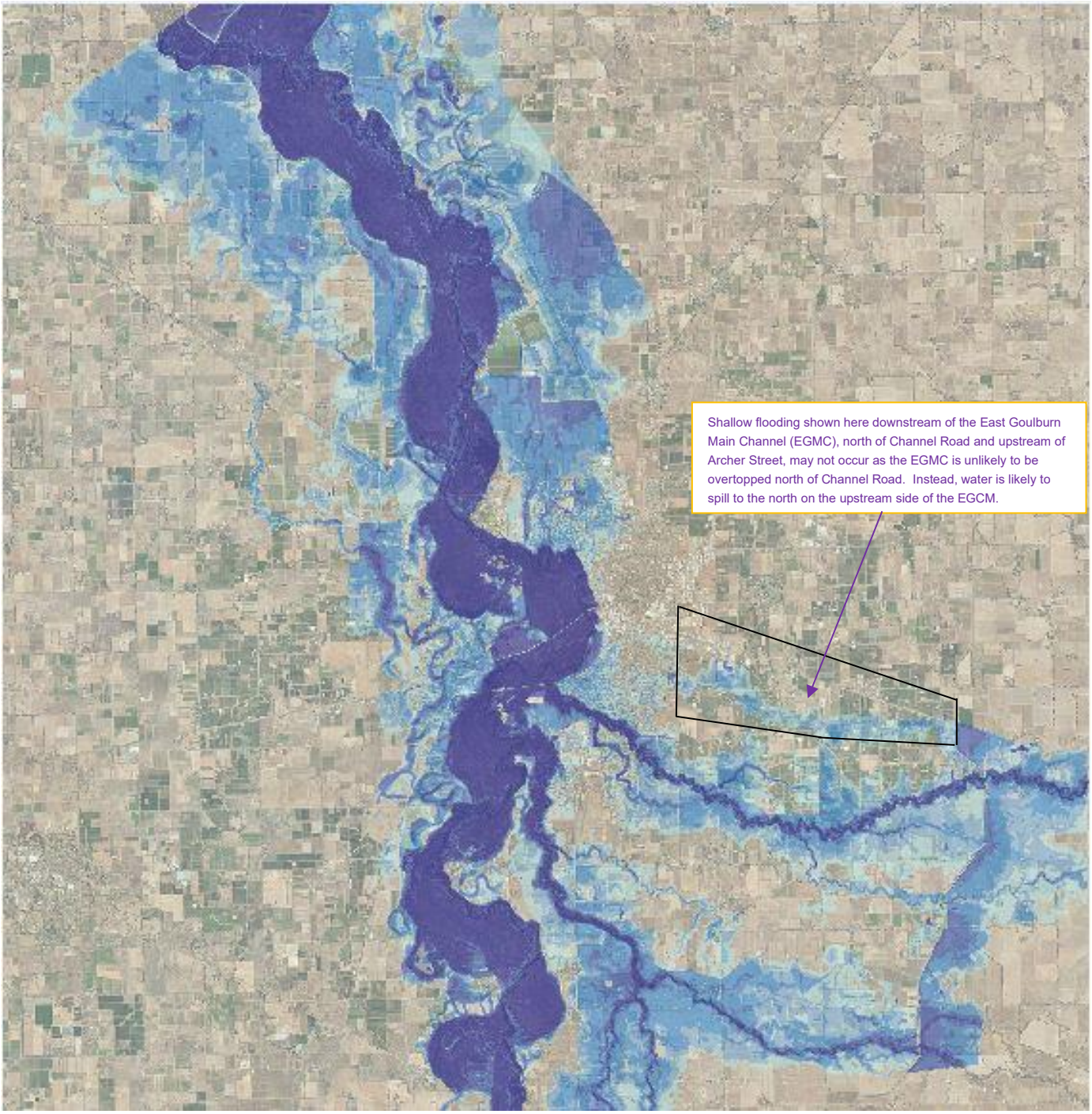
1% AEP flood extent for Goulburn River dominant – view 1



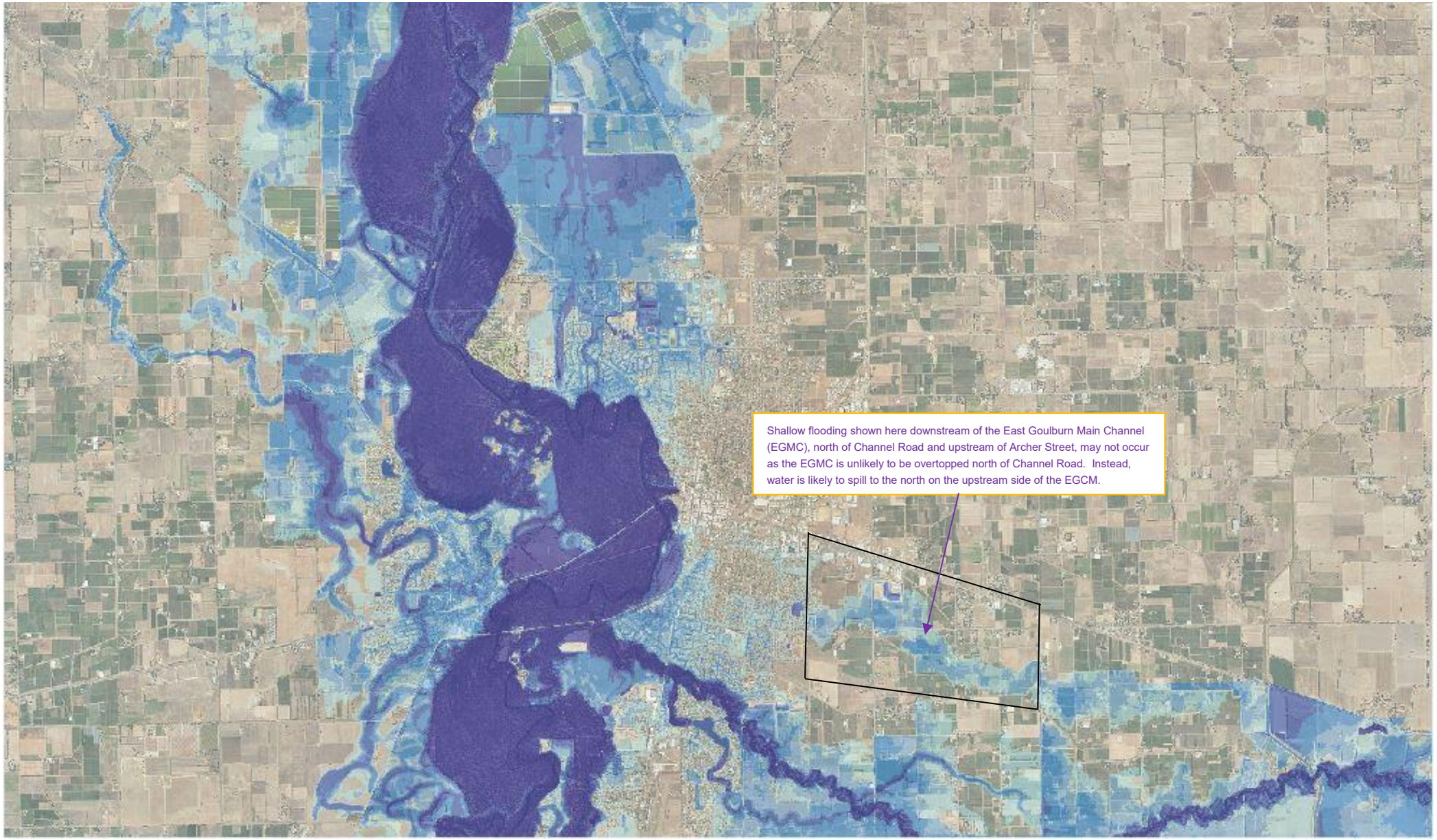
1% AEP flood extent for Goulburn River dominant – view 2 – zoomed in



1% AEP flood extent for neutral scenario – view 1



1% AEP flood extent for neutral scenario – view 2 – zoomed in



GOULBURN RIVER

Gauge Location: Goulburn River at Shepparton

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
7.93m		• Princess Park north end beside bike path, near end of Knight Street	• First Penstocks to be closed • Note flood impacts for later update of this table.
8.54m		• Macguire Reserve north end near Jetty; Penstock is in the middle of the bike path	• Close penstock
8.70m			• Greater Shepparton City Council internal Flood Management Group Briefing
8.75m		• Watt Road (back road or alternative route to Mooroopna) flooded. The trigger for this is when the Goulburn River @ Kialla West reaches 9.0m. • Raftery Road at the bridge through to Edgewater Road flooded.	• Close Watt Road • Close Raftery Road at the bridge through to Edgewater Road. • Monitor conditions for variation of flood flow down each river/creek. • Monitor Toolamba Bridge Road for need to close.
8.92m	**Dec 2017 event**	•	•
9.15m		• Welsford St behind Lawn Tennis Court	• Check that pump is operating
9.45m		• Hassett Street near Lincoln Drive • Princess Park south end near BOCCE Club	Check all OK
9.50m	**Minor flood level** <50% AEP (<2yr ARI)		• Greater Shepparton City Council internal Flood Management Group Briefing. • VICSES may coordinate an EMT meeting / teleconference and briefing regarding flood predictions and or actions. • If an ICC has not been established or an EMT has not been conducted, contact with the VICSES RDO should be considered (1800 899 927 requesting the NEDO be paged with your name and contact details).
9.80m			• McFarlane Road – consider for closure • Lenne Street Penstock to be closed • If rain continues in Mooroopna will need to monitor pump on Toolamba Road pipe (it is a manual pump)
9.97m	**March 2012 flood**		

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
10.1m	20% - 10% AEP (5yr – 10yr ARI)		
10.20m			• Creek Street (Kialla Park) - Check the gate is closed
10.21m			• Newton Street Pump Station (Turn on pump and pump out well) • 58 The Boulevard - pit behind house
10.30m		• The Boulevard at Kittles Road	• Close Tom Collins Drive to traffic at Fitzjohn Road and at Aquamoves entrance
10.36m		• Loch Gary Regulator Operates - G-MW will commence removing bars and they are responsible for advising the farms downstream of Loch Garry	• All bars are removed at 36ft / 10.96m
10.37m			• Provide flexi-pump to Manager of Victoria Lake Caravan Park. • Tom Collins Drive on drain into Caravan Park. • There are 2 penstocks along this levee.
10.40m		• First properties flooded at Kialla – 360 & 370 Centre Kialla Road, Kialla	•
10.50m		• In North Shepparton, Goulburn is about to break-out into the overland flow path that travels north from near the corner of The Boulevard and Hovell Court.	• Penstock – Carr Crescent in Mooroopna • Penstock – Lenne Street, Mooroopna; check operation of pump • If rain continues in Mooroopna will need to close Penstock on the Gange Estate. • Check River Road Toolamba, • Operate Echuca Road pump near Ann Street • Check levels at Gemmill's Swamp and consider closing Gange Estate Penstock.
10.52m			• Balaclava Road / The Boulevard roundabout on Parkside drain
10.60m		• First property flooded in Shepparton – 650 Doyles Road. • First properties flooded at Kialla West – 966, 970 & 980 Archer Road. Nos 966 & 980 close to over-floor flooding. • Properties in Adams Road, Watt Road and Watt Road, Kialla wetted.	•
10.70m	**Moderate flood level**	• Flooding of Watt Road and along Victoria Park more extensive.	• Consider opening Evacuation Centres • Check Echuca Road north of Mooroopna in anticipation of closure • Briefing MERC, MEMO, MRM & Support Agencies listed

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
10.80m		• Balmoral Street Estate flooding will occur • East end McLennan Street, Mooroopna both sides of Highway • Properties at 56, 60 & 100 Hooper Road, Kialla begin to flood • First property flooded in Mooroopna – 7275 Midland Highway • Properties in Doyles Road & Hoopers Road in Kialla wetted • Goulburn Valley Highway properties at Kialla & Kialla West wetted	• Turn on Creek Street pump, if it is still raining. • Car park opposite old Mooroopna hospital – McLennan Street south side block pit inside levee. • Main drain outlet or Main drain near Fairway Drive • Block culverts under railway line from Mooroopna Station to Pyke Road.
10.82m			• Set up pump and pump out drain in Vaughan Street west of Welsford Street. Use 8" diameter centrifugal pump.
10.81m	**2010 flood**		
10.90m	10% AEP (10yr ARI)	• Grounds of swimming pool on Tom Collins Drive about to be wetted. Will need to remove electric motors if flood likely to be ~250mm higher.	• Activate Flood Operations Centre
10.98m		• Macguire Reserve Levee overtopped near Dainton's Bridge • Fitzjohn Road at Tom Collins Drive • Break-out from the Goulburn into Mooroopna near the intersection of Toolamba Road and Lenne Street about to commence.	• Warn property owners in Welsford Street, adjacent to Macguire Reserve of levee breach. Rear yards and their car parking area only should be affected. • Set up pump and pump out Wilmot Road drain
11.00m	**Major flood level** **July 1981 flood**	• Flooding of properties at 3 & 5 McLennan Street, Mooroopna about to start with 3 McLennan Street and 7275 Midland Highway about to be flooded over-floor. • Properties in Cameron Avenue, McPhees Road & Newton Street in Shepparton about to be flooded • Properties in Riverview Drive, Kialla about to be flooded • Main Highways into Shepparton begin to be inundated. First affected is the Midland Highway near the Municipality's eastern boundary when the Broken River breaks out at Gowangardie.	• Open Flood Information Centre at Welsford Street Offices • Assess need to place levee across Alternate Route at Channel No. E.G. 16/10 in Doyles Road to stop water from flowing west from here and inundating residential areas of South Shepparton. • Penstock – Archer Street • Penstock – Ardmona Cannery – Railway Yard • Ardmona Cannery Office Penstock (Cannery usually control) • Mooroopna Waterworks Trust Office (Trust usually control) • Consider need to close the Midland Highway to the east of Shepparton
11.06m		• Premises at 3 McLennan Street, Mooroopna about to be flooded over-floor	
11.09	**Sept 2010 flood**		

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
11.10m	10%-5% AEP (10yr – 20yr ARI)	• Furphy Ave overtopped. • Balmoral Estate levee is overtopped. • Lower level of 5 McLennan Street, Mooroopna about to be flooded over-floor • In North Shepparton, a second break-out is about to activate from the Goulburn into the overland flow path near Watters Reserve at intersection of The Boulevard and Kittles Road. • First property on The Boulevard is about to be flooded	• Gemmill Crescent outlet – block at Gemmill Crescent • Centennial Drive outlet – block on high ground • Outlet on Echuca Road south of Paisley Crescent – block in Paisley Crescent • Paisley Crescent & Wishaw Court outlet – block in street by sandbagging perimeter of pits • Operate Lenne Street pump and manipulate rural inflow from the south to keep Lenne Street area dry. May need to bank to restrict rural flow entering Lenne Street area • Penstock – Lenne Street penstock. Lift pit lid on river side of railway line so as to release pressure on pipeline. • Monitor drain culvert under railway line at Ferguson Road, close as necessary • Warn G.V. Estate area. • McFarlane Road, Mooroopna drain near Rodney Park • Assess need to sandbag Echuca – Mooroopna Road in low section near Gange Estate and houses in Carr Crescent. Sand to be stockpiled at Recreation Reserve • Baker Crescent Mooroopna outfall; block at outlet • Consider / commence evacuation of Balmoral Estate • Warn The Boulevard, Wanganui Estate and Tassicker Estate properties and DECA of break-out.
11.13m			• Close Penstocks at:
11.18m		• Victoria Park Lake Levee overtopped • Victoria Lake Holiday Park (536 Wyndham Street / Fitzjohn Road) begins to flood.	• Warn Tennis Club • Close Fitzjohn Road at Wyndham Street • Remove electric motors from pool pumps and lake pumps • Turn off sewerage pumps and plug sewer at Caravan Park and Aquamoves. • Evacuate Victoria Lake Caravan Park and remove all equipment • Close Welsford Street at Sobroan Street • Consider need to evacuate Victoria Lake Holiday Park

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
11.20m		• Lincoln Drive at Varcoe Street • Lincoln Drive at Gourlay Street • Lincoln Drive at Abernethy Street • Lincoln Drive at Coppin Crescent • Levees at the farm at 470 Madill Road, Undera about to be overtopped. • Water onto property at 25 Furphy Avenue, Kialla (at lowest part of the road) • River breaks its banks near Watters Reserve at intersection of The Boulevard and Kittles Road and floods north	• Check sewers and plug or shut down pumps affected as required. • Evacuate houses in lower lying areas as necessary.
11.30m	5% AEP (20yr ARI)	• Broken River breaks its banks near Railway Bridge	• Warn Taylors Estate (western end), Halls Estate and Longstaff Street area. • Evacuate houses in western end of Halls Estate not built to current 1% AEP flood level. • Consider / commence evacuating The Boulevard and Wanganui Estate. • GVW will check sewers and plug or shut off as required.
	Summary of flood characteristics for the 20yr ARI event:	▪ Large amount of inundation along the Broken River upstream of the East Goulburn Main Channel and a transfer of flow to Honeysuckle Creek. ▪ Flow along Seven Creeks confined to the adjacent floodplain downstream of Mitchell Road. Immediately upstream, flows extend from the No 6 Main Channel to the Goulburn Valley Highway. Further upstream, flows again confined generally to the immediate floodplain. ▪ Goulburn River adjacent to Arcadia Downs generally confined to the floodplain. ▪ Floodplain flow constricted at the railway and Midland Highway. ▪ Flow breaking out into Mooroopna through some private properties. Further downstream, flow breaking out to the Echuca - Mooroopna Road north of Homewood Drive, some private property inundated. Flow heading through the floodway to the north. ▪ In North Shepparton, flow breaking out over The Boulevard to the north inundating some private property. Overland flow constricted by Wanganui Rd and Channel No. 7. Flows extend to alongside the Barmah – Shepparton Road.	
11.38m		• Broken River breaks its banks at Gourlay Street and Wyndham Street (GVH) bridge	• Warn area east of Wyndham Street between Broken River and railway line, Riverpark Estate and Housing Commission area. • Consider evacuation - check area for necessity to evacuate particular houses – refer to spreadsheet of addresses of flooded properties and buildings. • GVW will check sewers and pump stations.

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
11.40m		• Water about to flood over-floor at 25 Furphy Avenue, Kialla (at lowest part of the road) • The first house flooded over-floor on The Boulevard • Goulburn Valley Highway in Shepparton north of the railway line / opposite Victoria Park Lake about to get wet. Highway also wet north & south of town • The lowest floors at Victoria Lake Holiday Park (536 Wyndham Street / Fitzjohn Road) begin to flood. • Grounds of Aspen Lodge Caravan Park (1 Lawson Street, Mooroopna) begin to flood	• Consider need to close Goulburn Valley Highway in Shepparton north of the railway line / opposite Victoria Park Lake. • Consider need to evacuate Aspen Lodge Caravan Park.
11.50m	5% - 2% AEP (20yr -50yr ARI)	• Premises at 60 Hooper Road, Kialla about to flood over-floor. • Flooding around GVW asset at 35 McLennan Street, Mooroopna	• Check Riverside Cabin Park • Grant Street drain at Fairway Drive – may need to sand bag perimeter of pits in Ann Street, Harding Street etc.
11.53m		• Further break-out from the Goulburn at the Boulevard / Balaclava Road roundabout	• Warn all residents north of Balaclava Road and west of Numurkah Road. • Evacuate Tarcoola Retirement Home • Check sewers and pump stations.
11.60m		• The lowest floors at Aspen Lodge Caravan Park (1 Lawson Street, Mooroopna) begin to be wetted	
11.66m		• Princess Park Levee overtopped • Midland Highway in Mooroopna beginning to get wet • The grounds of Wanganui Park Primary School are about to be wetted:	• Warn Shepparton Swans Football Club and Shepparton United Cricket Club and property owners adjoining Princess Park • Consider evacuating the Princess Park Sports Complex • Remove sewerage ejector pump. • Consider need to close Midland Highway in Mooroopna • Close the school?

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
11.70m		• Grounds of swimming pool at 24 Morrell Street, Mooroopna will be wetted if water rises further. Will need to remove electric motors if flood likely to reach 11.9m. • Grounds of (old) Mooroopna Police Station at 119 McLennan Street flooded • Grounds of the old Hospital at 2-8 McLennan Street, Mooroopna flooded. Access may be an issue. • Flooding outside and over-floor at Goulburn Medical Centre at 113 – 115 McLennan Street, Mooroopna • Grounds of the Wastewater Treatment Plant on McCracken Road in North Shepparton begin to flood • Grounds of the Wastewater Treatment Plant at 5440 Barmah-Shepparton Road, Bunbartha begin to flood • Adams Road, Kialla is impassable • The Barmah – Shepparton Road will be wetted to the north of its intersection with the Goulburn Valley Highway.	• Make sure Adams Road, Kialla is closed • Consider closing the Barmah – Shepparton Road
11.71m	**October 1993 flood**		
11.80m		• First premises about to be flooded over-floor in Shepparton – 118 McPhees Road & 89 Malcolm Crescent • Water outside the Mooroopna Fire Station in Ann Street, Mooroopna • Abernethy Street is impassable • The grounds of these schools are about to be wetted: ➢ Gowrie Street Primary School ➢ Guthrie Street Primary School ➢ Mooroopna Primary School • The Goulburn Valley Highway will be wetted at the intersection of Brauman Street & Pine Road in North Shepparton.	• Make sure Abernethy Street is closed • Close schools? • Consider closing the Goulburn Valley Highway through North Shepparton.
11.81m	**August 1939 flood**	•	•
11.9m	2% AEP (50yr ARI)	• Welsford Street - Water Treatment plant and sewerage pumps affected • Floors of Swimming pool at 24 Morrell Street, Mooroopna just being wetted. • Grounds of Shepparton Police Station at 195 Welsford Street flooded • Grounds of Valley Residential Aged Care Facility, 195-205 McLennan Street, Mooroopna flooded • Floor of the Mooroopna Fire Station in Ann Street beginning to flood • Over-floor flooding at the Wastewater Treatment Plant at 5440 Barmah-Shepparton Road, Bunbartha • Over-floor flooding of GVW asset at 35 McLennan Street, Mooroopna • Flooding around GVW asset at 242 Riverview Drive, Kialla • Flooding around GVW pump station at 104 Numurkah Road, Shepparton	• GVW plans implement to address WTP and sewerage pump issues. • Remove electric motors from pool pumps.

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
	Summary of flood characteristics for the 50yr ARI event:	▪ Large amount of inundation along the Broken River upstream of the East Goulburn Main Channel. Break-outs to the north well established. ▪ Inundation occurs in South Shepparton (Lincoln & Broken River Drives) ▪ Increased Goulburn River flow through Arcadia Downs but still predominantly contained within the general floodplain. ▪ A large amount of flow heading through Mooroopna inundating the majority of the private properties in the eastern parts. ▪ In North Shepparton, increased flow breaking out over The Boulevard inundating many properties to the north. Overland flow constricted by Channel No. 7. ▪ Increased flood extent to the east and around Coomboona. ▪ Flooding extends across the Barmah - Shepparton Road. ▪ Flood depths and extent increase as move downstream.	
12.00m		• A large part of North Shepparton north from around Mason Street & Balaclava Road is flooded • Grounds of Shepparton Riverside Cabin Park (8049 Goulburn Valley Highway) begin to flood • The Midland Highway and the P.R Edwards Causeway flooded – loss of connection between Shepparton and Mooroopna (east & west)	• Close the Midland Highway at the Causeway
12.05m		• Midland Highway in Shepparton between Mitchell & Florence Streets about to get wet	• Consider need to close Midland Highway in Shepparton
12.09m	**May 1974 flood**		
12.10m		• Access to the CFA (and ICC) facility at 195-205 Numurkah Road, Shepparton is about to be compromised as surrounding access roads get flooded	• Relocate the ICC
12.20m	1% AEP (100yr ARI) **1916 flood event**	• Old Mooroopna Police Station at 119 McLennan Street inundated (below floor). Police Station rebuilt since floor level survey was captured. • Old Mooroopna Hospital at 2-8 McLennan Street, Mooroopna flooded over-floor. • The Valley Residential Aged Care Facility, 195-205 McLennan Street, Mooroopna flooded over-floor • The car park of the Hospital off Graham Street, Shepparton beginning to get wet. Surrounding roads get wetter as levels increase. Access increasingly becoming an issue. • Over-floor flooding of GVW asset at 242 Riverview Drive, Kialla • Over-floor flooding of GVW pump station at 104 Numurkah Road, Shepparton	
12.3m	0.5% AEP (200yr ARI)	• Shepparton Police Station at 195 Welsford Street flooded over-floor • The CFA (and ICC) facility at 195-205 Numurkah Road, Shepparton is flooded over-floor	
12.40m		• Grounds of the Big4 Shepparton Park Lane Holiday Park (7835 Goulburn Valley Highway, Kialla) begin to flood	

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) evacuation, closure of road, sandbagging, issue warning and who is responsible
Refer to the spreadsheet of addresses of flooded properties and buildings – covers Kialla, Kialla West, Kialla Lakes, Shepparton, Mooroopna and nearby areas			
12.5m	0.2% AEP (500yr ARI)	• Council offices in Welsford Street surrounded by mostly shallow water	
x.xxm	Probable Maximum Flood (PMF)		

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 Emergency Management Manuals flood series.

BROKEN RIVER

Gauge Location: Broken River at Orrvale Gauge

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
		• The Midland Highway near the Municipality's eastern boundary is flooded when the Broken River breaks out at Gowangardie.	• Close Midland Highway to the east of Shepparton • Note flood impacts for later update of this table.
4.90m	**Dec 2017 flood**	•	
6.30m		• 685 Doyles Road begins to be wetted but house is about 1m higher with levels known by owner. Sandbagging not required until ~7.3m.	Place "water over road" signs and monitor for closures.
6.80m	**Minor flood level**	• Rural properties upstream of Doyles Road flooded.	
7.00m	**March 2012 flood**	•	
7.15m		• Gordon Drive (Broken River anabranch) will be over-topped at western end by waters flowing out of Lake Kialla. Affects Gordon Drive.	
7.20m	**Moderate flood level**	• Lake Amaroo will over top and flow under the new Kialla Lakes Drive bridge . • Kialla Lakes Drive likely to be wetted. • Traffic disruption in and around Kialla Lakes residential area.	• Monitor for road closures.
7.30m		• Archer Street at Oxbow Court. • Floodway on Archer Street about to be over-topped by the Broken River. • Kialla Lakes Drive likely to be impassable.	• Close boom gate at Oxbow Court and open the gate into Kensington Gardens; their Manager has a key. • Consider closing Archer Street. • Close Kialla Lakes Drive.
7.50m		• First properties flooded at Kialla West – 966, 970 & 980 Archer Road. Nos 966 & 980 close to over-floor flooding. • Gordon Drive likely to be impassable.	• Close Gordon Drive.
7.61m	**October 2016 flood**	•	•
7.70m		• Inundation of land beginning at 56, 60 & 100 Hooper Road, Kialla • Water over northern causeway on Archer Street around 500mm deep.	• Inundation at 60 Hooper road premises starts to occur. • No access over causeway.
7.80m		• 68 Doyles Road – starting to flood over-floor • 95 Jamieson Road – starting to flood over-floor	• Sandbag houses at 68 Doyles Road and 95 Jamieson Road and / or assist residents. • Close Jamieson Road at Channel Road

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
7.85m		• Archer Road, south of Kialla Lakes Drive, about to be over-topped by overflow from Broken River anabranch.	• Consider closing Archer Road as over-topped by anabranch flow • 4WD access only at this stage
7.86m 27,155ML/d	**October 1996 flood**		
7.90m	**Major flood level** 10% AEP (10 year ARI)	• Likely that residents north and east of Lake Kialla and east of Lake Amaroo are isolated.	
7.99m	**July 1981 flood**	•	
8.10m 33,032ML/d	20% AEP (5 year ARI)	• First homes in Guthrie, Nicholls and Abernathy begin flooding	
8.14m		• Kialla Lakes Drive	• Engineers estimate that the new bridge will start to over-top at this water level. • To be confirmed at next event
8.19m	**Sept 2010 flood**	•	
8.33m 40,000ML/d	2% AEP (50 year ARI) **May 1974 flood**	•	
8.41m	**October 1993 flood**	• Water over southern causeway on Archer Road approaching 500mm deep.	• No access over causeway.
8.44m 43,852ML/d	1% AEP (100 year ARI)	•	
8.50m 48,300ML/d	0.5% AEP (200 year ARI)	• Over-floor flooding at 60 Hooper Road, Kialla.	

SEVEN CREEKS

Gauge Location: Seven Creeks at Kialla West

River Height (m) and / or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
4.50m	**Minor flood level**	• Floodwater will overtop Mitchell Road Bridge and road floods between the Goulburn Valley Highway and Archer Road	• Consider closing road • Note flood impacts for later update of this table.
5.00m	**Moderate flood level**	• Raftery Road will be over-topped between the bridge and Edgewater Road. Also occurs when the Goulburn River @ Kialla West gauge reaches 10.4m.	• Detour traffic
5.46m	**October 2016 flood**	•	•
6.02m	**October 1996 flood** **March 2012 flood**	•	•
6.03m	**June 1995 flood**	•	•
6.33m	**July 1981 flood** **Dec 2017 flood**	•	•
6.5m		• First properties flooded in Kialla – 360 & 370 Centre Kialla Road.	•
6.60	**Major flood level** 1% AEP (5 year ARI)	• First residential floor flooded in Balmoral Estate • Over-floor flooding at 360 & 370 Central Kialla Road, Kialla • Also occurs when Goulburn River @ Kialla West reaches 10.7m	• Consider evacuation of Balmoral Estate.
6.70m	**Sept 2010 flood**	•	•
6.90m	1% AEP (10 year ARI)	• Houses flood in Archer Road South	• Advise residents • Close Archer Road South at Mitchell Road
7.25m		• First residential floors flooded in Kialla West – 966 & 980 Archer Road	•
7.40m		• Water onto property at 25 Furphy Avenue, Kialla (at lowest part of the road)	•
7.50m		• Water about to flood over-floor at 25 Furphy Avenue, Kialla (at lowest part of the road)	•
7.66m		• Properties in Riverview Drive, Kialla about to be flooded	•
7.85m	1% AEP (35 year ARI) **May 1974 flood**	•	•
8.23m	1% AEP (100 year ARI) **October 1993 flood**	•	•

4.8 Flood Forecast Tools and How to Use Them

The purpose of the following flood forecast tools is to enable an early heads-up of likely flood severity and consequences through the lower reaches of the Broken - Seven Creeks - Goulburn system.

It is important to be fully aware that the tools provide an estimate of the likely flood peak. They are not infallible and are unlikely to be as precise as BoM flood forecasts. While they should not be used to generate competition with BoM, they may provide a basis for informed discussion with BoM about the flood forecasts for Seven Creeks at Kialla West, Broken River at Orrvale and Goulburn River at Shepparton.

Use of FloodZoom and other tools is encouraged in order to better inform the early heads-up and assist response activity planning and implementation.

The earliest an initial heads-up of the expected peak level at Shepparton can be determined is after a forecast peak level is available for Benalla and Euroa and a peak outflow forecast (or estimate) is available for Goulburn Weir (i.e. a peak level for the Goulburn Weir tail gauge). The use of actual flood peaks will generally result in more accurate estimates.

To repeat the above as a word of caution. The following flood forecast tools provide estimates of the likely flood peaks and timings at Orrvale, Seven Creeks at Kialla, and the Goulburn River at both Kialla West and Shepparton. Those estimates and the associated timings are unlikely to be exact but will be sufficiently accurate to indicate, when used in conjunction with the flood intelligence tables and flood mapping, likely consequences and to guide and inform early response planning and related activity.

1. Determine the expected peak level for Seven Creeks at Kialla West using the Euroa peak level. The relationship implicitly includes an allowance for Stony and Honeysuckle Creek flows. If these are exceptionally high (look at data from Tamleugh and U/S Violet Town) and noting the comment on the tool about upper and lower catchment rainfall, increase the level suggested by the tool up by 100 mm or so (i.e. bias to the upper side of the curve).
2. Determine the expected peak level for Orrvale using either the Benalla peak level and / or the Gowangardie Weir peak level. The relationship implicitly accommodates the flow transfers to the Broken Creek system that occur from a level at Casey's Weir of around 1.81 m.
3. Determine the expected peak level for the Goulburn at Kialla West using either Goulburn Weir tail gauge peak level and / or the Murchison peak level.
4. Using information at Appendix B, determine likely timings for all locations, including Shepparton. If and as appropriate and in order to increase confidence in estimated timings, use FloodZoom to look at relative timings in similar past events (i.e. similar in terms of rainfall distributions and / or levels at key gauges).
5. Determine dominance: Broken – Seven Creeks, neutral or Goulburn. This will dictate which map is appropriate to determine flood extents and consequences in the vicinity of each of Orrvale, Seven Creeks at Kialla West, Goulburn River at Kialla West and Shepparton. The appropriate map and summary of likely consequences (read from the flood intelligence card) at a location will be the one that matches the expected level at that location.

As the event progresses and peak level forecasts are refined, the appropriateness of map sets being used and thus likely consequences should be reviewed and adjustments made as necessary.

While a conservative approach would be to use the maximum extent maps, the resulting expected peak level for Shepparton is likely to be incorrect.

6. Determine the expected peak level for Shepparton. Two approaches are suggested.
   a. **APPROACH 1**: Using the dominance scenario matrix (see below) and the following rules. This involves extracting the Shepparton value associated with the expected peak at each of Orrvale, Seven Creeks at Kialla West and Goulburn River at Kialla West for the selected dominance scenario. This will always give you 3 values.

      IMPORTANT NOTE: If the results of the following give at least 2 Shepparton values that are less than 9.5 m, the peak at Shepparton will be below the minor flood level (i.e. less than 9.5 m) unless Murchison is above minor flood level (i.e. 9.0 m) in which case Shepparton will almost certainly exceed minor flood level (i.e. 9.5 m). If only 1 of the values is less than 9.5 m, that value should be changed to 9.5 m.

      i. If the expected peak at Seven Creeks at Kialla West is GREATER THAN 6 m, use the NEUTRAL matrix to determine the 3 Shepparton values. Add these 3 values together and divide by 3. The result is the expected peak at Shepparton. It can generally be expected to be within +/- ~100 mm of the actual peak.

      ii. If the expected peak at Seven Creeks at Kialla West is LESS THAN 6 m and the expected peak at Murchison is GREATER THAN 8 m, use the GOULBURN dominant matrix. Add the Shepparton values associated with the expected peaks at Orrvale and Seven Creeks at Kialla West and divide by 2. If the expected peak at Orrvale is GREATER THAN 7 m, add 100 mm to the above result otherwise add 50 mm. This is the expected peak at Shepparton. It can generally be expected to be within +/- ~100 mm of the actual peak.

      iii. At all other times (unless the Goulburn is clearly dominant) use the Broken – Seven Creeks dominant matrix. Add the Shepparton values associated with the expected peaks at Orrvale and Seven Creeks at Kialla West and divide by 2. This is the expected peak at Shepparton.

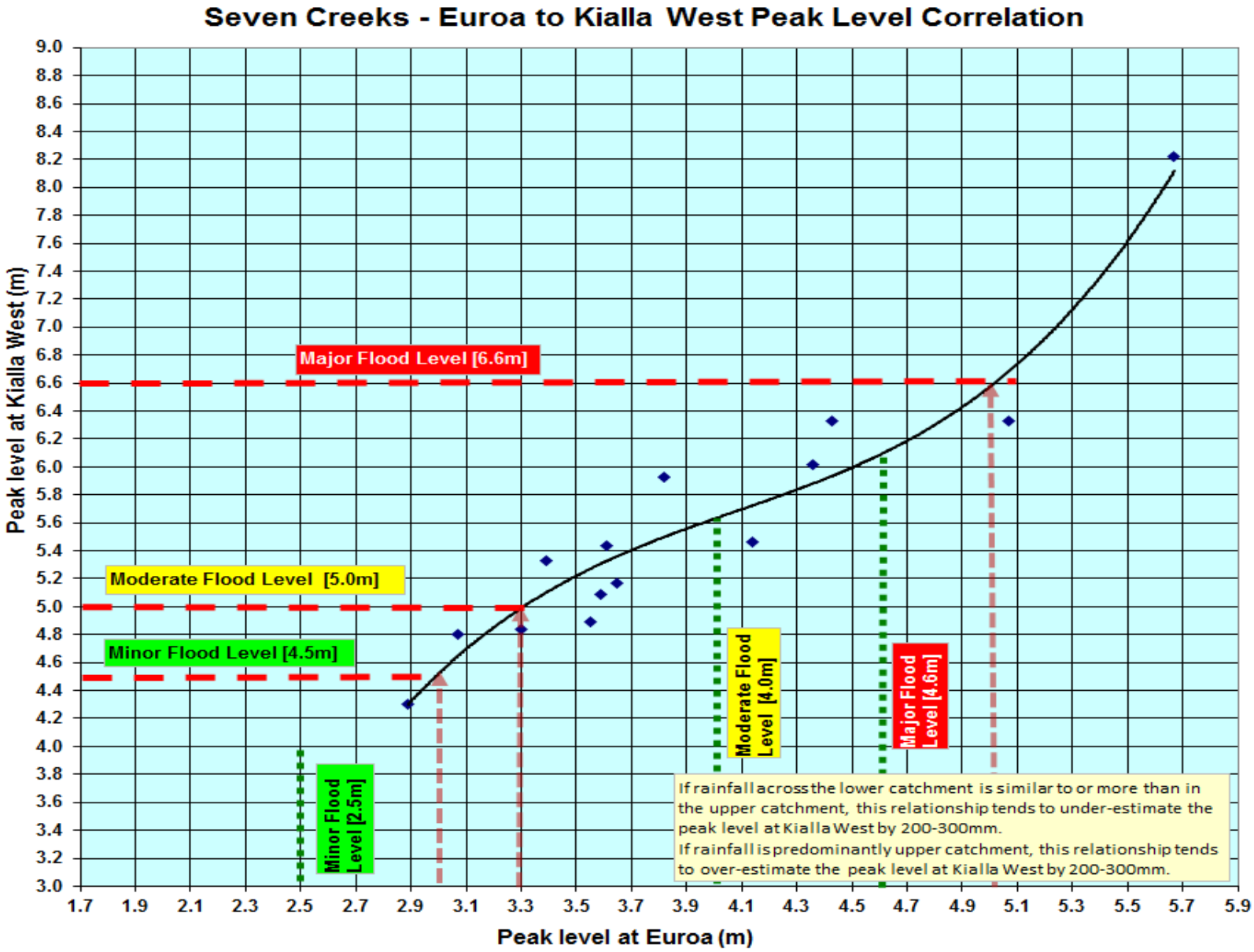
   b. **APPROACH 2**: Using current rating tables for each of Orrvale, Seven Creeks at Kialla West, Goulburn River at Kialla West and Shepparton.

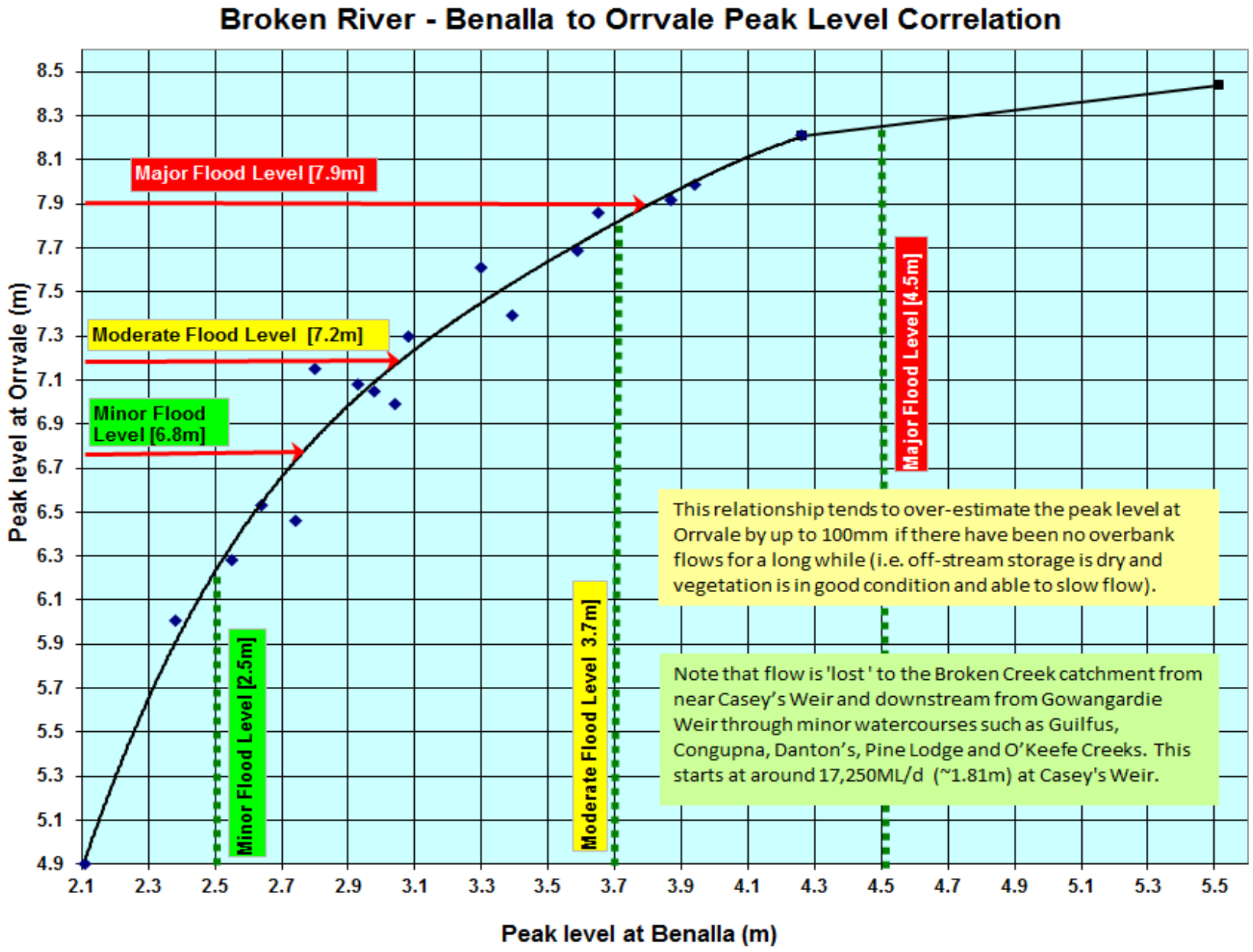
      i. Determine the expected peak flows at Orrvale, Seven Creeks at Kialla West and Goulburn River at Kialla West.

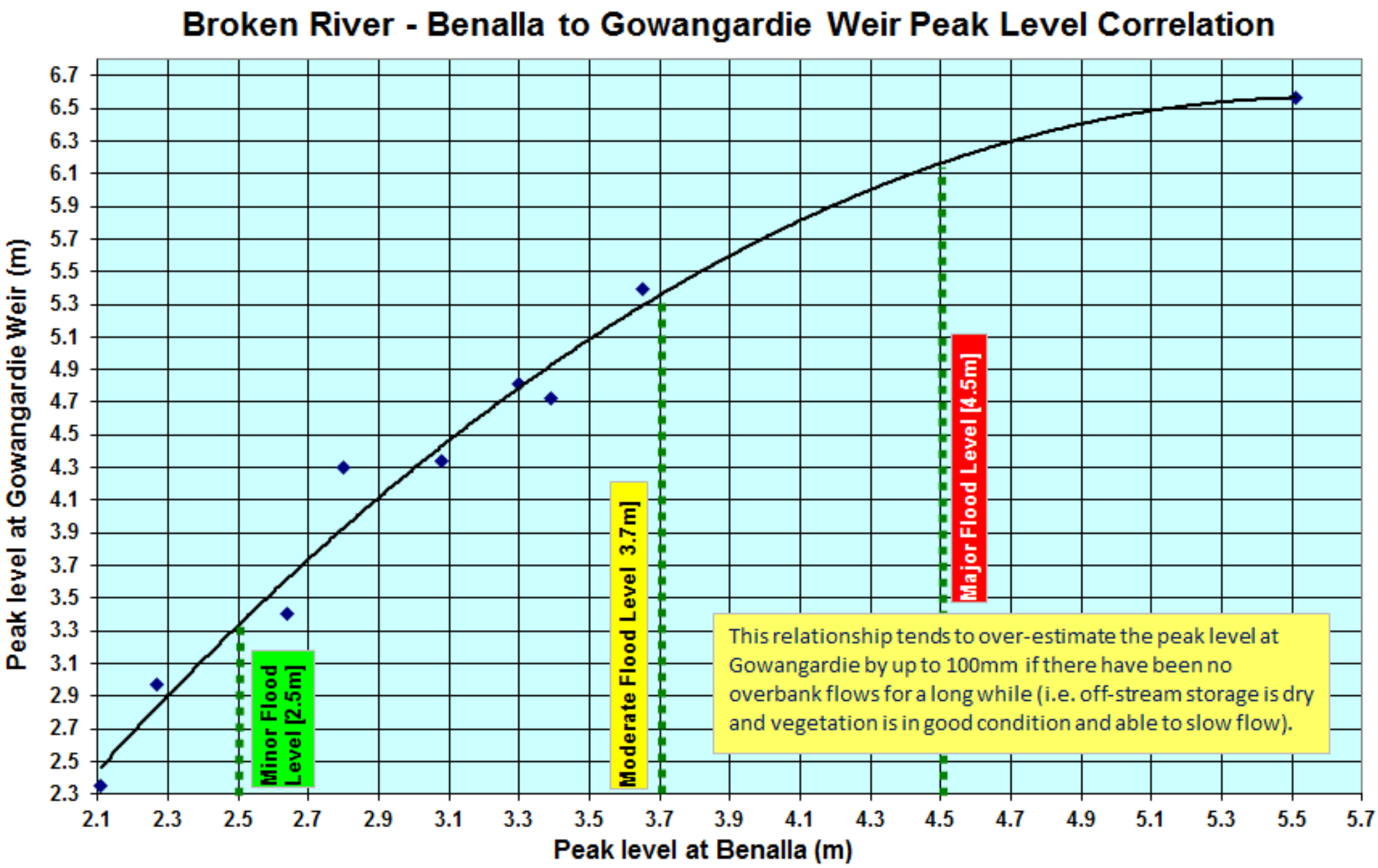
      ii. Add these flows and reduce by between 10% and 20%.

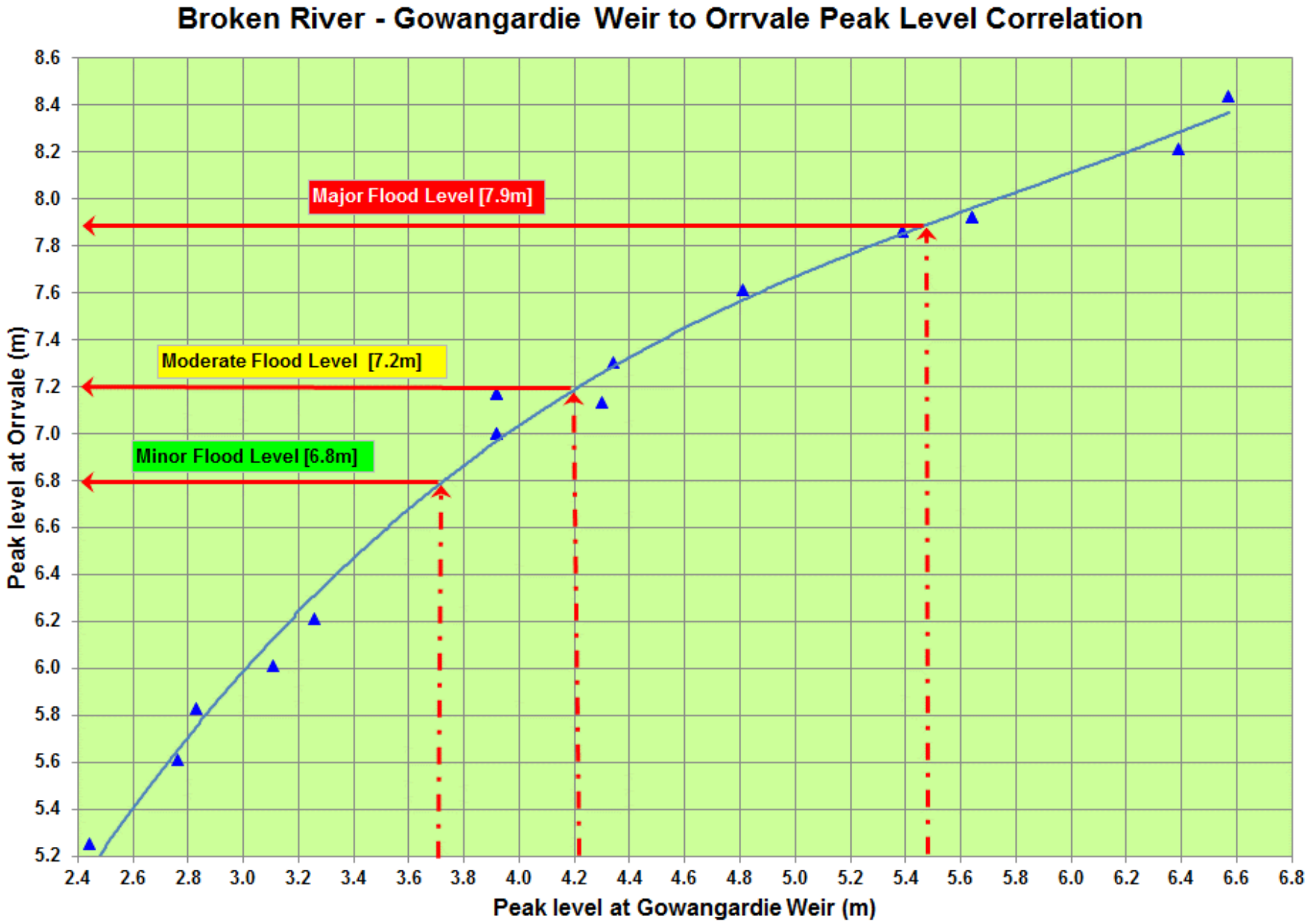
      Use 20% when the floodplain and off-stream storage are dry and waterways are running at normal levels (i.e. not elevated).

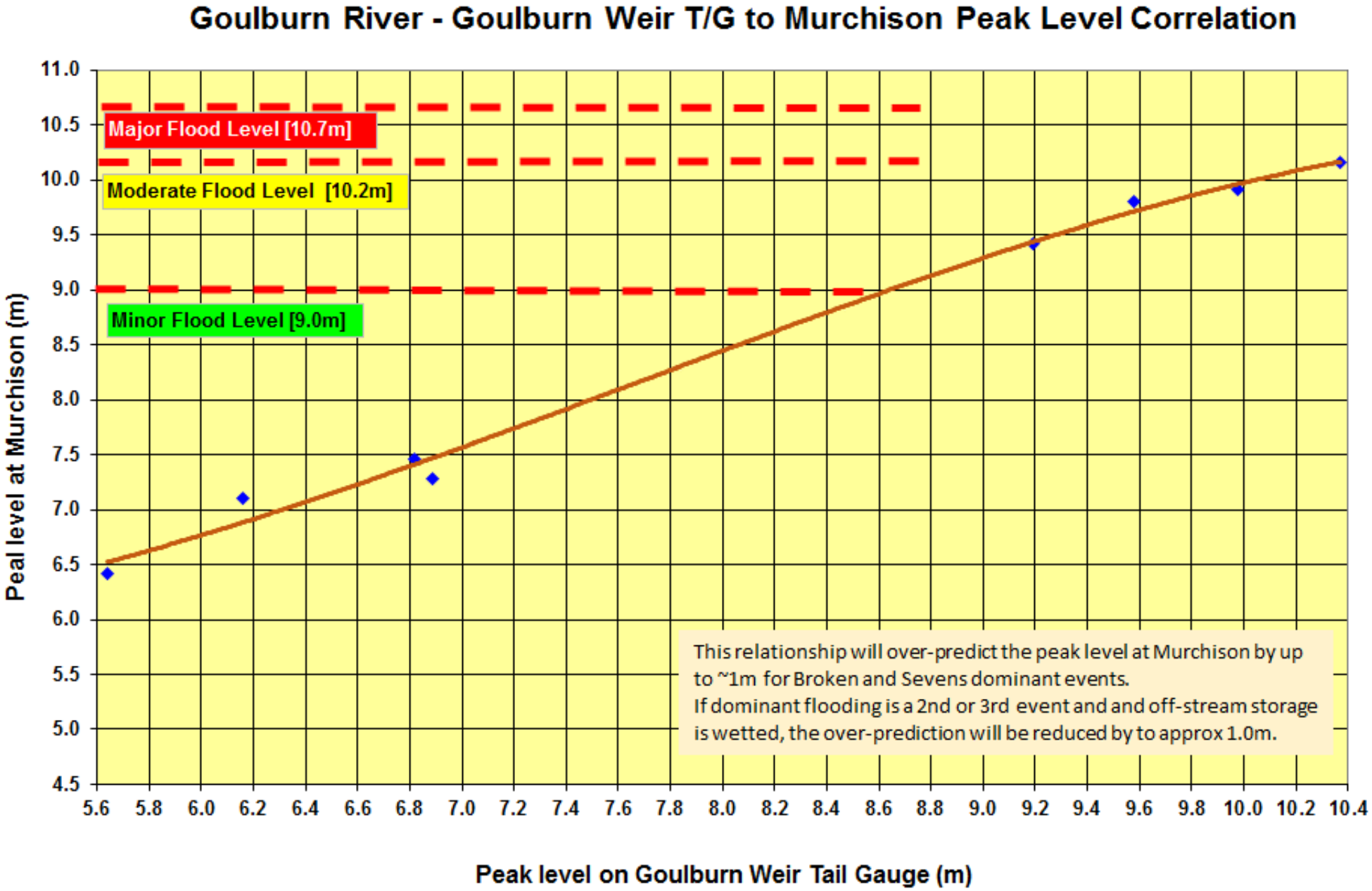
      Reduce by 10% if the area is wet and / or this is a follow-on flood with off-stream floodplain storage wetted and elevated levels in waterways.

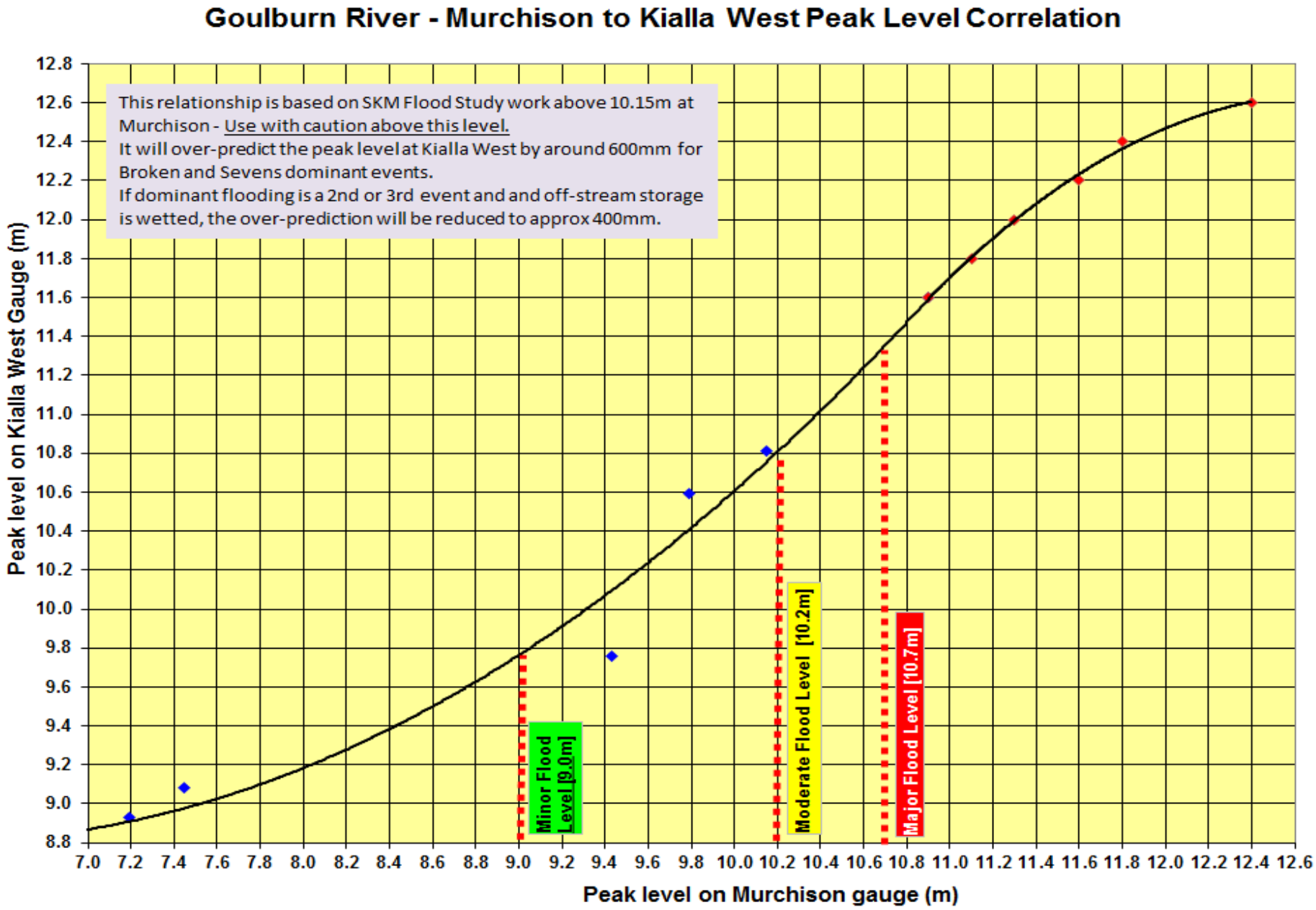

Seven Creeks - Euroa to Kialla West Peak Level Correlation
Peak level at Kialla West (m)
Peak level at Euroa (m)
Major Flood Level [6.6m]
Moderate Flood Level [5.0m]
Minor Flood Level [4.5m]
Minor Flood Level [2.5m]
Moderate Flood Level [4.0m]
Major Flood Level [4.6m]
If rainfall across the lower catchment is similar to or more than in the upper catchment, this relationship tends to under-estimate the peak level at Kialla West by 200-300mm.
If rainfall is predominantly upper catchment, this relationship tends to over-estimate the peak level at Kialla West by 200-300mm.


Broken River - Benalla to Orrvale Peak Level Correlation
Peak level at Orrvale (m)
Peak level at Benalla (m)
8.5
8.3
8.1
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
6.3
6.1
5.9
5.7
5.5
5.3
5.1
4.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
3.7
3.9
4.1
4.3
4.5
4.7
4.9
5.1
5.3
5.5
Major Flood Level [7.9m]
Moderate Flood Level [7.2m]
Minor Flood Level [6.8m]
Minor Flood Level [2.5m]
Moderate Flood Level 3.7m]
Major Flood Level [4.5m]
This relationship tends to over-estimate the peak level at Orrvale by up to 100mm if there have been no overbank flows for a long while (i.e. off-stream storage is dry and vegetation is in good condition and able to slow flow).
Note that flow is 'lost ' to the Broken Creek catchment from near Casey's Weir and downstream from Gowangardie Weir through minor watercourses such as Guilfus, Congupna, Danton's, Pine Lodge and O'Keefe Creeks. This starts at around 17,250ML/d (~1.81m) at Casey's Weir.


Broken River - Benalla to Gowangardie Weir Peak Level Correlation
Peak level at Gowangardie Weir (m)
6.7
6.5
6.3
6.1
5.9
5.7
5.5
5.3
5.1
4.9
4.7
4.5
4.3
4.1
3.9
3.7
3.5
3.3
3.1
2.9
2.7
2.5
2.3
2.1 2.3 2.5 2.7 2.9 3.1 3.3 3.5 3.7 3.9 4.1 4.3 4.5 4.7 4.9 5.1 5.3 5.5 5.7
Peak level at Benalla (m)
Minor Flood Level [2.5m]
Moderate Flood Level 3.7m]
Major Flood Level [4.5m]
This relationship tends to over-estimate the peak level at Gowangardie by up to 100mm if there have been no overbank flows for a long while (i.e. off-stream storage is dry and vegetation is in good condition and able to slow flow).


Broken River - Gowangardie Weir to Orrvale Peak Level Correlation
Major Flood Level [7.9m]
Moderate Flood Level [7.2m]
Minor Flood Level [6.8m]
Peak level at Orrvale (m)
Peak level at Gowangardie Weir (m)
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8


Goulburn River - Goulburn Weir T/G to Murchison Peak Level Correlation
Major Flood Level [10.7m]
Moderate Flood Level [10.2m]
Minor Flood Level [9.0m]
This relationship will over-predict the peak level at Murchison by up to ~1m for Broken and Sevens dominant events.
If dominant flooding is a 2nd or 3rd event and and off-stream storage is wetted, the over-prediction will be reduced by to approx 1.0m.
Peal level at Murchison (m)
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
5.6 5.8 6.0 6.2 6.4 6.6 6.8 7.0 7.2 7.4 7.6 7.8 8.0 8.2 8.4 8.6 8.8 9.0 9.2 9.4 9.6 9.8 10.0 10.2 10.4
Peak level on Goulburn Weir Tail Gauge (m)


Goulburn River - Murchison to Kialla West Peak Level Correlation
This relationship is based on SKM Flood Study work above 10.15m at Murchison - Use with caution above this level.
It will over-predict the peak level at Kialla West by around 600mm for Broken and Sevens dominant events.
If dominant flooding is a 2nd or 3rd event and and off-stream storage is wetted, the over-prediction will be reduced to approx 400mm.
Minor Flood Level [9.0m]
Moderate Flood Level [10.2m]
Major Flood Level [10.7m]
Peak level on Kialla West Gauge (m)
Peak level on Murchison gauge (m)

Dominance scenario matrix – PART 1

Broken - Sevens dominant			
Gauge levels in metres			
Goulburn River @ Shepparton	Broken River @ Orrvale	Seven Creeks @ Kialla West	Goulburn River @ Kialla West
9.5 (minor)	6.15	4.98	9.73
9.7			
9.9			
10.1	7.53	5.92	10.58
10.5			
10.7 (moderate)	7.97	7.25	11.09
10.9 (10% AEP)	8.16	7.52	11.18
11 (major)			
11.1	8.37	7.81	11.40
11.3 (5% AEP)	8.45	8.09	11.62
11.5	8.52	8.32	11.81
11.7	8.57	8.46	12.08
11.9 (2% AEP)			
12.1	8.67	8.61	12.47
12.2 (1% AEP)	8.71	8.61	12.74
12.3 (0.5% AEP)	8.80	8.80	12.87
12.5 (0.2% AEP)			

Goulburns dominant			
Gauge levels in metres			
Goulburn River @ Shepparton	Broken River @ Orrvale	Seven Creeks @ Kialla West	Goulburn River @ Kialla West
9.5 (minor)	5.55	4.58	10.20
9.7			
9.9			
10.1	6.77	5.93	10.90
10.5			
10.7 (moderate)	7.32	5.95	11.46
10.9 (10% AEP)	7.35	5.95	11.53
11 (major)			
11.1	7.75	6.36	11.76
11.3 (5% AEP)	7.94	6.60	11.93
11.5	8.06	6.86	12.09
11.7	8.23	7.12	12.30
11.9 (2% AEP)			
12.1	8.44	7.17	12.75
12.2 (1% AEP)	8.55	7.64	12.84
12.3 (0.5% AEP)	8.56	8.17	12.92
12.5 (0.2% AEP)			

Dominance scenario matrix – PART 2

Neutral scenario			
Gauge levels in metres			
Goulburn River @ Shepparton	Broken River @ Orrvale	Seven Creeks @ Kialla West	Goulburn River @ Kialla West
9.5 (minor)	5.97	4.82	9.91
9.7			
9.9			
10.1	6.90	5.92	10.76
10.5			
10.7 (moderate)	7.32	5.95	11.46
10.9 (10% AEP)	7.38	7.15	11.48
11 (major)			
11.1	7.79	7.44	11.77
11.3 (5% AEP)	7.91	7.44	11.82
11.5	8.14	7.58	12.05
11.7	8.26	7.76	12.20
11.9 (2% AEP)			
12.1	8.57	8.57	12.60
12.2 (1% AEP)	8.70	8.72	12.90
12.3 (0.5% AEP)	8.76	8.79	13.05

Maximum envelope			
Gauge levels in metres			
Goulburn River @ Shepparton	Broken River @ Orrvale	Seven Creeks @ Kialla West	Goulburn River @ Kialla West
9.5 (minor)	6.15	4.98	10.20
9.7	6.45	5.11	10.44
9.9	6.77	5.11	10.48
10.1	7.53	5.93	10.90
10.5	7.33	6.60	11.20
10.7 (moderate)	7.97	7.25	11.46
10.9 (10% AEP)	8.16	7.52	11.53
11 (major)	8.25	7.66	11.65
11.1	8.37	7.81	11.77
11.3 (5% AEP)	8.45	8.09	11.93
11.5	8.52	8.32	12.09
11.7	8.57	8.46	12.30
11.9 (2% AEP)	8.62	8.59	12.63
12.1	8.67	8.72	12.75
12.2 (1% AEP)	8.71	8.72	12.90
12.3 (0.5% AEP)	8.80	8.80	13.05
12.5 (0.2% AEP)	9.02	9.06	13.31

Event	Goulburn River at Shepparton Gauge (m)	Goulburn-Dominant			Broken/Seven-Dominant			Neutral		
		Goulburn River Flow	Broken River Flow	Seven Creeks Flow	Goulburn River Flow	Broken River Flow	Seven Creeks Flow	Goulburn River Flow	Broken River Flow	Seven Creeks Flow
Minor Flood	9.5	19,100 ML/d	6,000 ML/d	4,300 ML/d	13,000 ML/d	8,700 ML/d	6,000 ML/d	15,000 ML/d	7,800 ML/d	5,200 ML/d
		1EY	2EY	1EY	1EY	50% AEP	1EY	1EY	50% AEP	1EY
°	10.1	34,900 ML/d	12,500 ML/d	11,000 ML/d	24,300 ML/d	21,600 ML/d	11,200 ML/d	32,000 ML/d	13,800 ML/d	11,300 ML/d
		50% AEP	50% AEP	50% AEP	1EY	20% AEP	50% AEP	50% AEP	50% AEP	50% AEP
°	10.5	43,200 ML/d	13,000 ML/d	11,000 ML/d	34,900 ML/d	18,000 ML/d	18,800 ML/d	39,700 ML/d	15,600 ML/d	18,300 ML/d
		50-20% AEP	50% AEP	50% AEP	50% AEP	20% AEP	50-20% AEP	50-20% AEP	20% AEP	50-20% AEP
Moderate Flood	10.7	52,300 ML/d	18,100 ML/d	11,300 ML/d	34,900 ML/d	32,700 ML/d	29,400 ML/d	45,800 ML/d	17,300 ML/d	22,500 ML/d
		20% AEP	20% AEP	50% AEP	50% AEP	5% AEP	20-10% AEP	20% AEP	20% AEP	20% AEP
°	10.9	56,200 ML/d	28,100 ML/d	11,300 ML/d	36,700 ML/d	34,700 ML/d	35,400 ML/d	54,400 ML/d	20,700 ML/d	28,500 ML/d
		20-10% AEP	10-5% AEP	50% AEP	50% AEP	5% AEP	10% AEP	20% AEP	10% AEP	20-10% AEP
Major Flood (2010)	11	62,600 ML/d	10%	13,800 ML/d	40,300 ML/d	37,400 ML/d	38,900 ML/d	69,100 ML/d	24,200 ML/d	32,000 ML/d
		20-10% AEP	20% AEP	50% AEP	50% AEP	5-2% AEP	10-5% AEP	10% AEP	10% AEP	10% AEP
°	11.1	69,100 ML/d	24,200 ML/d	32,000 ML/d	43,200 ML/d	42,300 ML/d	42,300 ML/d	62,000 ML/d	25,900 ML/d	32,800 ML/d
		10% AEP	10% AEP	10% AEP	50-20% AEP	2% AEP	5% AEP	10% AEP	10% AEP	10% AEP
°	11.3	82,000 ML/d	27,600 ML/d	18,100 ML/d	51,800 ML/d	46,700 ML/d	49,200 ML/d	73,400 ML/d	30,200 ML/d	33,700 ML/d
		10-5% AEP	10-5% AEP	20% AEP	20% AEP	2-1% AEP	5% AEP	10% AEP	5% AEP	10% AEP
°	11.5	92,900 ML/d	30,200 ML/d	22,500 ML/d	60,500 ML/d	50,100 ML/d	56,200 ML/d	86,400 ML/d	34,600 ML/d	36,800 ML/d%
		5% AEP	5% AEP	20% AEP	20-10% AEP	1% AEP	5-2% AEP	10-5% AEP	5% AEP	10% AEP
1993	11.7	108,800 ML/d	34,600 ML/d	26,400 ML/d	77,800 ML/d	53,600 ML/d	62,200 ML/d	96,800 ML/d	37,800 ML/d	40,600 ML/d
		5-2% AEP	5% AEP	20-10% AEP	10% AEP	1% AEP	2% AEP	5% AEP	5-2% AEP	10-5% AEP
		138,200 ML/d	43,200 ML/d	34,600 ML/d	111,400 ML/d	57,500 ML/d	68,600 ML/d	121,00 ML/d	44,000 ML/d	49,700 ML/d

¤	11.9¤	2-1%·AEP¤	2%·AEP¤	10%·AEP¤	5-2%·AEP¤	1%·AEP¤	2-1%·AEP¤	2%·AEP¤	2-1%·AEP¤	5%·AEP¤
1974¤	12.1¤	151,200·ML/d¤	47,500·ML/d¤	35,900·ML/d¤	116,600·ML/d¤	58,800·ML/d¤	69,100·ML/d¤	137,400·ML/d¤	60,500·ML/d¤	58,800·ML/d¤
		1%·AEP¤	5-2%·AEP¤	10%·AEP¤	5-2%·AEP¤	1%·AEP¤	2-1%·AEP¤	2-1%·AEP¤	0.5-0.2%·AEP¤	5-2%·AEP¤
¤	12.2¤	162,500·ML/d¤	53,100·ML/d¤	36,700·ML/d¤	125,300·ML/d¤	71,300·ML/d¤	79,500·ML/d¤	164,200·ML/d¤	71,700·ML/d¤	79,500·ML/d¤
		1%·AEP¤	1%·AEP¤	10-5%·AEP¤	2%·AEP¤	0.2%·AEP¤	1%·AEP¤	0.50%·AEP¤	0.20%·AEP¤	1%·AEP¤
¤	12.3¤	216,000·ML/d¤	69,100·ML/d¤	69,100·ML/d¤	155,500·ML/d¤	86,400·ML/d¤	88,100·ML/d¤	186,600·ML/d¤	75,600·ML/d¤	82,100·ML/d¤
		0.50%·AEP¤	0.2%·AEP¤	2%·AEP¤	1%·AEP¤	0.2-0.1%·AEP¤	0.50%·AEP¤	0.5-0.2%·AEP¤	0.2%·AEP¤	1-0.5%·AEP¤
¤	12.5¤	259,200·ML/d¤	82,100·ML/d¤	82,100·ML/d¤	190,100·ML/d¤	151,200·ML/d¤	151,200·ML/d¤	216,000·ML/d¤	121,000·ML/d¤	121,000·ML/d¤
		0.2-0.1%·AEP¤	0.2-0.1%·AEP¤	1%·AEP¤	0.2%·AEP¤	0.10%·AEP¤	0.2-0.1%·AEP¤	0.2-0.1%·AEP¤	0.2-0.1%·AEP¤	0.20%·AEP¤
¤	PMF¤	1,330,000·(ML/D)¤	388,000·(ML/D)¤	622,000·(ML/D)¤	Note·that·Broken/Seven·dominant·events·may·show·high·Goulburn·River·flows·to·achieve·some·of·the·higher·gauge·levels·at·Shepparton.·¤					

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation

To be updated when relevant data is available

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C3: EAST SHEPPARTON FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Land use through East Shepparton is mainly residential and agricultural (e.g. orchards) with some industrial and commercial.

The area drains through an extensive network of man-made open drains rather than a natural drainage system – see figure on following page. The area is generally flat and drainage relatively poor with raised irrigation channels forming barriers to overland flows. Large portions of the area take considerable time to drain after a flood with many requiring the water to be pumped away.

East Shepparton is susceptible to widespread and generally shallow slow-moving flooding following heavy rain. While flooding is extensive across the area, it is generally confined to the road reserves, particularly within the urban portion. Flood depths within the road reserves are typically between 250mm and 400mm with isolated areas up to 1.0m. Depths greater than 1.0m only occur within the 47 retarding basins within the area (see list below).

Where flooding occurs within residential or commercial properties, the depth of inundation is typically shallow (i.e. less than 250mm) and slow moving.

The Goulburn Valley Highway acts as a hydraulic control as it holds back some of the overland flow in North Shepparton. Water levels are therefore elevated on the upstream side.

In the rural and farm areas of East Shepparton, flooding is widespread at even the 20% AEP (5 year ARI) event with floodwater filling local depressions and backing up behind roadways or other ridges through the catchment. Flood depths are typically shallow and rarely exceed 500mm, even in the 1% AEP (100 year ARI) event.

As the area is generally quite flat with widespread shallow flooding, flood velocities are typically slow, rarely exceeding 0.25m/s. They are a bit higher but mostly less than 0.5m/s in the road reserves within urban areas. Across residential and commercial properties they are typically less than 0.1m/s.

With the exception of the 47 retarding basins throughout the area, at a small number of roadways and within a small number of road reserves in the urban areas, the flood risk (as per ARR 2016) is low for adults, children and vehicles.

The Drainage Network (see figure on following page)

Goulburn-Murray Water Main Drain No 2 flows west from the East Goulburn Main Channel and drains agricultural land between the Midland Highway and the Broken River as well as some urban areas. It is 12.5km long. It discharges into the Broken River between Archer Street and McPhees Road.

Goulburn-Murray Water Main Drain No 3 flows for 20km north-west from the East Goulburn Main Channel, crossing Central Avenue, Doyles Road and the Goulburn Valley Highway before discharging into the Goulburn River at Reedy Swamp.

Open drains from agricultural properties combine with Main Drain No 2 and Main Drain No 3 to form a dense drainage network.

In addition to the Main Drain catchments, there are a number of small urban catchments that drain directly to the Broken and Goulburn rivers through the urban drainage system.

The Midland Highway forms a significant ridge which largely prevents cross-flows between the areas contributing flow to Main Drain No 2 and Main Drain No 3.

There are 47 retarding basins spread through East Shepparton. 5 are privately owned with the remaining 42 owned by Greater Shepparton City Council. Due to the general lack of grade across the area, all but 3 of these basins are pumped (or balanced) and as such operate as depression storages rather than the more typical gravity outlet controlled retarding basin. See table below. Further details are provided in WBM (2017).

There are no flow or water level gauges in any of the channels in East Shepparton.

Basin Name	Ownership	Outfall from Basin
Big 4 Shepparton	Private	
The Boulevard	GSCC	Pumped
Channel Road Estate (Support Basin)	GSCC	Balance pipe
Connolly Park Estate	GSCC	Pumped
Connolly Park (Support Basin)	GSCC	Balance pipe
Crestwood Estate	GSCC	Pumped
Ducat Reserve (Relief Basin)	GSCC	Gravity
Enterprise Drive	GSCC	Pumped
Grammar Park Estate	GSCC	Pumped
Ivanhoe	GSCC	Pumped
Kensington Gardens	Private	Pumped
Kialla Greens	GSCC	Gravity
Kialla Lakes (Lake Kialla)	GSCC	
Kialla Lakes (Lake Amaroo)	GSCC	Balance pipe
Kialla Lakes (Lowanna Waters)	GSCC	Balance pipe
Lifestyle Communities	GSCC	Pumped
Lifestyle Communities (Support Basin)	GSCC	Balance pipe
Market Place	Private	Pumped
Mercury Drive	GSCC	Pumped
Orchard Circuit	GSCC	Pumped
Parkside Gardens Estate (Wetland Basin)	GSCC	Pumped
Parkside Gardens Estate (Support Basin 1)	GSCC	Balance pipe
Parkside Gardens Estate (Support Basin 2)	GSCC	Balance pipe
Parkside Gardens Estate (Support Basin 3)	GSCC	Balance pipe
Parkside Gardens Estate (Support Basin 4)	GSCC	Balance pipe
Perrivale	GSCC	Pumped
Perrivale (Support Basin)	GSCC	Balance pipe
Pine Park Estate	GSCC	Pumped
River Rise Estate	GSCC	
Riverview Estate	GSCC	Pumped
Ross Alan Drive	GSCC	Pumped
Seven Creeks Estate	GSCC	
Shepparton East Drainage Scheme	GSCC	Pumped

Basin Name	Ownership	Outfall from Basin
Sherbourne Estate	GSCC	Pumped
Sherbourne Estate (Support Basin)	GSCC	Balance pipe
Smythe Street	GSCC	Gravity
Sofra Drive	GSCC	Pumped
Southdown Estate	GSCC	Pumped
Southdown Estate (Support Basin)	GSCC	Balance pipe
Telford Drive	GSCC	Pumped
Telford Drive (Support Basin)	GSCC	Balance pipe
Vision Australia	Private	
Windsor Park Estate	GSCC	Pumped
Windsor Park Estate (Support Basin 1)	GSCC	Balance pipe
Yakka Estate	GSCC	Pumped
Zurcas Lane	GSCC	Pumped
405 Goulburn Valley Highway	Private	Pumped

Properties at Risk of Flooding

An estimate of the number of properties at risk from flooding was produced by WBM (2017) using a simplified schema. A number of assumptions underpin the approach as surveyed floor levels were not available to the study team.

Due to the flat nature of the area (and absence of floor level data), the majority of properties have been categorised at the highest risk category (category 5). This is because the assessment is based on property boundaries and as such if any water, no matter how shallow or expansive, is on more than 5% of the property it is deemed at risk.

Schema: Category 1 – the property is above the 2% AEP but below the 1% AEP flood level

Category 2 – the property is above the 5% AEP but below the 2% AEP flood level

Category 3 – the property is above the 10% AEP but below the 5% AEP flood level

Category 4 – the property is above the 20% AEP but below the 10% AEP flood level

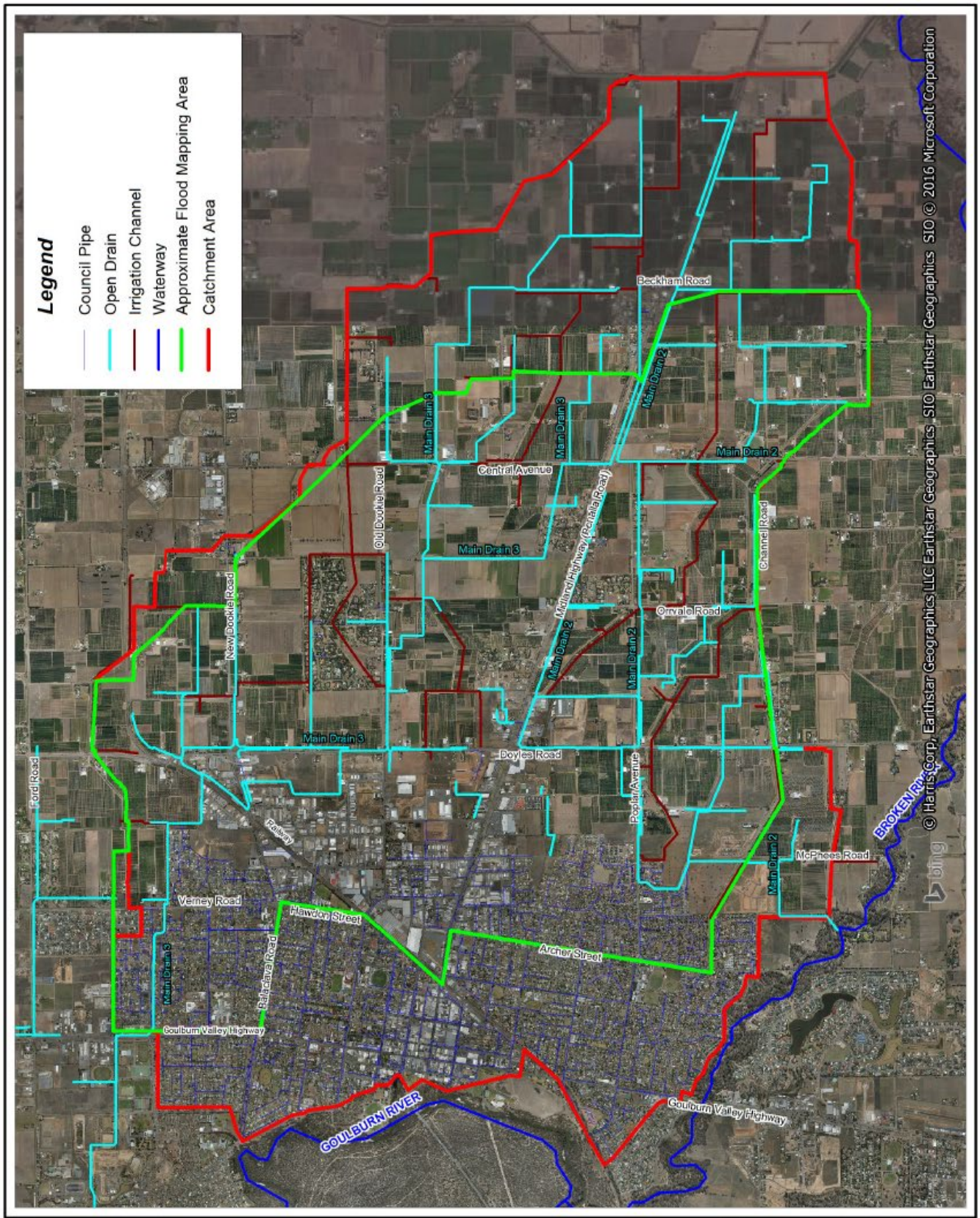
Category 5 – the property is below the 20% AEP

Existing conditions	Category 1	Category 2	Category 3	Category 4	Category 5
No of properties within category	321	564	408	279	1,585
Flood size	**Up to 1% AEP**	**Up to 2% AEP**	**Up to 5% AEP**	**Up to 10% AEP**	**Up to 20%AEP**
No of properties at risk of flooding	3,157	2,836	2,272	1,864	1,585

Past Floods

A significant rain and flood event occurred on 27th & 28th February 2013. The flood was estimated by WBM (2017) as between a 0.5% and 0.2% AEP (200 to 500 year ARI) event. Peak discharges at key locations and the approximate AEPs are listed in the table below.

- ABC Shepparton reported that "*Flash flooding has inundated homes, closed roads and caused the evacuation of residents from an aged-care facility in the Goulburn Valley. Official rainfall gauges* (the BoM AWS at Shepparton airport) *say 50 to 65 millimetres of rain has fallen in Shepparton since yesterday afternoon however some residents have reported over 100 millimetres of rainfall.*"



Title:
Shepparton East Catchment Plan

Figure: **1-2**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 1 2km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\Fig1-2_Catchment_Plan_RevA.wor

East Shepparton drainage network

- One resident reported that the rain started at 5 o'clock. By 7 o'clock there was 98mm in the gauge and by morning it had a further 42mm in it (a total of 140mm).
- Further local rainfall recordings are provided in the table below.
- SES reported 4 houses inundated with water above the floor boards.
- The following roads were closed in Shepparton:
  - Drummond Road
  - King Richard Drive
  - Ross Allen drive
  - Kakadu Drive
  - Matilda Drive
  - Mehmet Drive
  - Orchard Circuit
  - Grace Road between Barmah Road and Shepparton Zeerust Road
  - Pine Road
  - Merino Drive
  - Byass Street

LOCAL RAINFALL DATA – COLLECTED AFTER THE EVENT						
Collected by:	Easting	Northing	Reading 1	Reading 2	Reading 3	Total
Trevor Birch 47 Archer St, Solar City Market	357700	5972680	to 5:15pm 45mm	to ~7pm 65mm	to 10:45pm 25mm	135mm
Megan McFarlane 1300 Midland Hwy East Shepparton	368800	5968080	to 7pm 102mm	to 7am (28.02.2013) 50mm		152mm
Don Colbert 1 Bregan Court, Grahamvale)	360410	5973210	to 8:30pm 170mm	Said it stopped raining for ~15mins at ~6:30 to 7pm	Neighbour's gauge overtopped at 150mm	170mm
Lorraine and Gordon Threlfull 14 Dobson Road Grahamvale 0427214627	360570	5973710	4pm to 7:15pm 114mm	7:15pm to 8am (28.02.2013) 48mm		162mm
Owen Power 27 Hicken Cres. 58214195	356090	5974950	4pm to 8am 125mm			125mm
Helen Williams 65 Ebbott Road 58292522	364800	5969260	4pm to 7am 140mm			140mm
Helen Williams 535 Old Dookie Rd 58292522	363290	5973300	4:10pm to 7:15pm 75mm	7:15pm to 9pm 50mm	9pm to 7am (28.02.2013) 10mm	135mm

LOCAL RAINFALL DATA – COLLECTED AFTER THE EVENT						
Collected by:	Easting	Northing	Reading 1	Reading 2	Reading 3	Total
Dimits Orchard 223 Doyles Road	359420	5972210	to 6pm 96mm	6pm to 9pm 44mm	9pm to 7am (28.02.2013) 16mm	156mm
Sue Wallington 6 Holstein Court	357780	5976220	4pm to 9am (28.02.2013) 136.9mm			136.9mm
Graeme Jackson Unit 100 / 80 Channel Road, Kensington Gardens 5831 5877	358070	5969480	5pm to 7:30am (28.02.2013) 66mm			66mm
Dennis Collins 590 Old Dookie Road	363780	5972970	Total to the following day 140mm			140mm
			(same rainfall depth recorded by his neighbours at 710 Old Dookie Road and at 285 Boundary Road)			
Brett Laws 365 Hosie Road 0419144351	366480	5970840	4:30pm to 6:30pm 100mm	6:30pm to 7am (28.02.2013) 72mm		172mm
			(same rainfall depth recorded by his brother at 339 Hosie Road)			
Ron Davies 405 Midland Hwy 58292323	360330	5971600	4:30pm to 6:30pm 100mm	6:30pm to 7am (28.02.2013) 60mm		160mm
Ross Reddrop 540 New Dookie Road, Lemnos 0412606341	363140	5974380	Has an AWS			128mm
Peter Moller Rubicon Water 8 Grammar Court 5820 8851						130mm
Charles DuBourg Kialla 0428210477	360643.1	5966723.7	Guy Tierney at GBCMA has Excel spreadsheet of weather station data			59mm
IK Caldwell Grahamvale 0428210477	360098.7	5974651.5				150mm

Estimated flow and AEP of the flood at key locations							
Location	**Beckham Road**	**Central Avenue**	**Doyles Road**	**Main Drain No 2 Outlet**	**314 Old Dookie Road**	**Railway**	**Main Drain No 3 Outlet**
Peak flow (m^3/s)	17.8	16.2	20.9	20.1	25.9	36.4	35.6
AEP	>0.2%	0.5% - 0.2%	~0.5%	~1%	~0.5%	0.5% - 0.2%	0.5% - 0.2%

Rain to Flood and Peak – Typical Response Times

Under heavy continuing rain conditions, floods develop and rise quickly across East Shepparton, more so when the area is wet. Warning times are short with flooding likely to develop within an hour or so of heavy rain starting.

MAIN DRAIN No 2				
Location	Time from start of heavy rain			
	To start of rise	To inundation	To peak	To reduced flows
Beckham Road	45 - 60 minutes	60 - 75 minutes	65 - 90 minutes	~6 hours
Central Avenue	~1 hour	~90 minutes	~ 2 hours	~10 hours
Doyles Road	~1 hour	~90 minutes	3.5 - 4 hours	10 - 15 hours
Outlet	~2 hours	2.5 - 3 hours	4 - 6 hours	18+ hours

MAIN DRAIN No 3				
Location	Time from start of heavy rain			
	To start of rise	To inundation	To peak	To reduced flows
314 Old Dookie Rd	~60 minutes	75 minutes	2 – 4 hours	~8 hours
Railway	~2 hours	3 - 4 hours	8 – 10 hours	~15 hours
Outlet	1 - 2 hours	2 to 3 hours	~10 hours	15 – 20 hours

Flood Mapping

A comprehensive set of flood inundation maps has been produced for East Shepparton (WBM, 2017) – see Appendix F. Maps were produced for the 20%, 10%, 5%, 2%, 1%, 5% and 0.2% AEP flood events under existing conditions. While future conditions including climate change scenarios were modelled and mapped, those results are not presented or discussed herein. Each map set comprises:

- Flood extent;
- Flood depth in metres;
- Flood level in m AHD;
- Velocity; and

- Hazard.

Mapping is available from GBCMA and through FloodZoom. The study reports (WBM, 2017) are also available through FloodZoom.

Command, Control and Coordination

The responsible agency for the Command, Control and Coordination of floods is the Victoria State Emergency Service (VICSES).

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the SEMP. During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Shepparton and Tatura to manage the Shepparton community.

The Incident Control Centre (ICC) for management of floods is located at the CFA Headquarters, 195 Numurkah Road, North Shepparton or at the VICSES North East Regional Headquarters, 64 Sydney Road, Benalla.

Indicative Flood / No Flood Guidance Tool for East Shepparton

As the BoM does not currently provide flash flood forecasts other than in very general terms, all actions must be driven by rain and / or observations of elevated flows in drain and the start of overland flows.

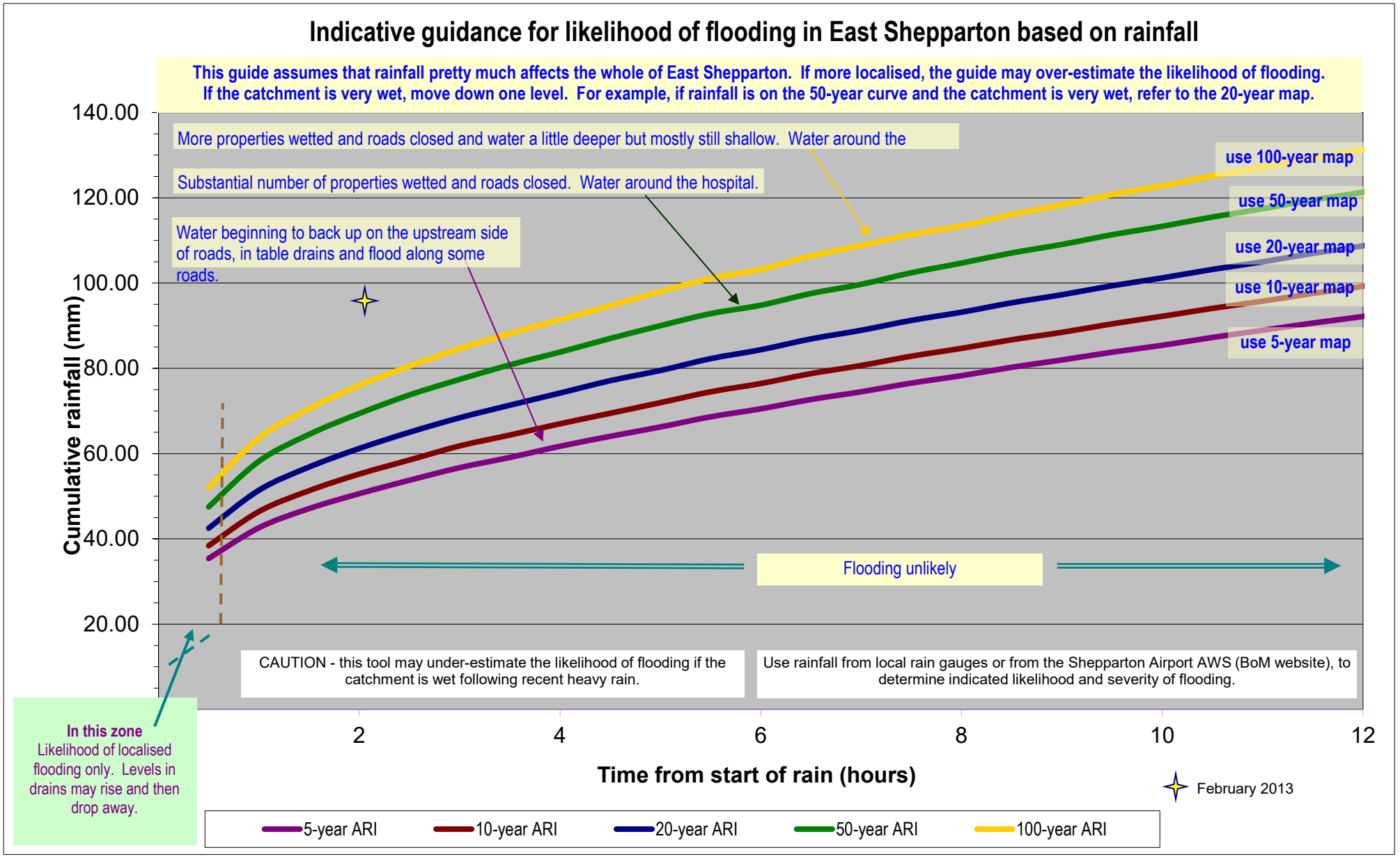
It is suggested that the indicative quick look 'flood / no-flood' tool developed for East Shepparton (see below) will provide an initial heads-up of the likelihood and scale of possible flooding. **Local rainfall data** determined from local reports or from an **interpretation of BoM weather radar images** can be used to determine an appropriate rainfall depth for use in the tool. Rainfall reported from the **Shepparton Airport AWS** (available from the BoM website at 30-minute intervals and occasionally more frequently) will provide near real-time data as well as a basis for calibration of radar imagery.

It should be noted that the tool provides indicative guidance only that can then be related to the flood inundation maps (and GIS datasets) produced by WBM (2017), a sub-set of which is provided in Appendix F. The flood extent mapping and report are also available through FloodZoom.

The rainfall that produces each new flood event should be added to the indicative tool as a dot along with the date. It is also suggested that information about the area over which the rainfall occurred and the consequences should be added to the *past floods* and *flooding consequences* sections of this Appendix C.

Local Data

Source local knowledge (e.g. collect private rain gauge data).


Indicative guidance for likelihood of flooding in East Shepparton based on rainfall
This guide assumes that rainfall pretty much affects the whole of East Shepparton. If more localised, the guide may over-estimate the likelihood of flooding.
If the catchment is very wet, move down one level. For example, if rainfall is on the 50-year curve and the catchment is very wet, refer to the 20-year map.
140.00
120.00
100.00
80.00
60.00
40.00
20.00
Cumulative rainfall (mm)
More properties wetted and roads closed and water a little deeper but mostly still shallow. Water around the
Substantial number of properties wetted and roads closed. Water around the hospital.
Water beginning to back up on the upstream side of roads, in table drains and flood along some roads.
use 100-year map
use 50-year map
use 20-year map
use 10-year map
use 5-year map
Flooding unlikely
CAUTION - this tool may under-estimate the likelihood of flooding if the catchment is wet following recent heavy rain.
Use rainfall from local rain gauges or from the Shepparton Airport AWS (BoM website), to determine indicated likelihood and severity of flooding.
In this zone
Likelihood of localised flooding only. Levels in drains may rise and then drop away.
2
4
6
8
10
12
Time from start of rain (hours)
February 2013
5-year ARI
10-year ARI
20-year ARI
50-year ARI
100-year ARI

4.9 Write a brief summary of the consequence of flooding. Further information will be detailed below in tables.

AEP Event XX%	Properties Affected	Number of properties	Description of risk	Warning Time	Road Closure	Bus Route disruption
	Residential	***To be updated when relevant data is available***				
	Commercial					
	Industrial					
	Public Land					
	Rural					

* Modify Table to suit.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation ***To be updated when relevant data is available***

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C4: TALLYGAROOPNA FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

The township of Tallygaroopna is located 15km north of Shepparton. The 2007 census recorded a population of 270 people while the 2016 census recorded 579 people in the Tallygaroopna Census area. The town itself encompasses a total land area of approximately one square kilometre and is defined by the railway line and Goulburn Valley Highway to the west and general farmland to the east.

Three distinct waterways flow around the town itself:

- The Pine Lodge Creek flows approximately 3 kilometres to the south,
- Dainton's and Congupna Creek flow north-westerly past the town to the east.

Essentially rural in character, the town has a Primary School and a significant recreation reserve which services a number of different sports.

Greater Shepparton City Council has a pump and retarding basin on the northern side of the town near the silos.

Flood history.

- The Tallygaroopna area has a history of flooding with big floods recorded in 1919, 1939, 1956, 1974, 1993 and 2012. The highest recorded flood in Tallygaroopna occurred in 1993.
- The Tallygaroopna area has a flat landscape with grades of approximately a slope of 1 metre per kilometre.
- Tallygaroopna has experienced flash flooding caused by heavy rain over a short period of time (generally greater than 75mm in a 24 hour period).
- March 2012 – substantial flooding occurred due to very intense rainfall (up to 300mm occurring to the east of Tallygaroopna over three days).
- October 1993 - there was a slow onset flood caused primarily by the Broken River spilling over its banks at Gowangardie; which resulted in significant overland flows reaching Tallygaroopna and the surrounding districts.
- Tallygaroopna has experienced some inconvenience caused by overflowing of the Pine Lodge, Dainton's and Congupna Creek systems. These systems are sometimes filled by waters flowing out of the Broken River when it is in flood, which then take up to 3 days to peak in Tallygaroopna.
- There are no regulated water storages (e.g. dams) or large wetlands in this area.
- Large pockets of water can collect in low-lying areas before slowly draining away/drying out.

- Road closures are likely to include Victoria Road, Goulburn Valley Highway (north and south bound), Bowey Road and Tallygaroopna West / Bunbartha Road.

Aerial view of flooding at Tallygaroopna in March 2012
(source: Tallygaroopna Local Flood Guide, December 2016)

Slow onset flooding

The township has experienced slow moving flooding in the past primarily from the overflow of the Broken River via its creek system, which may last for one or more weeks, or even months on some occasions.

There are three water level gauges located on the Broken River at different points including:

- Broken River at Benalla

- Broken River at Casey's Weir
- Broken River at Orrvale near Shepparton (does not affect Tallygaroopna)

Flood warnings from the Broken River Gauges at Benalla and Casey's Weir will give an indication of the possibility and potential size of a flood based on historical records.

Flash flooding

Severe storm warnings will usually give an indication of what rainfall to expect during the storm event. The BoM may also issue warnings that include mention of flash flooding for particular areas depending on the estimated intensity of the expected rainfall.

HISTORIC FLOOD LEVELS AND FLOW ASSUMPTIONS

Note that no two floods are ever the same. Water flows and impacts of weather can be highly variable, especially after changes to the floodplain (road works, laser levelling).
The following levels and information are provided as a guide only and should be considered flexible and changeable according to the conditions at the time of an event.

The emergency service providers will be in charge of determining what actions to take according to information and data provided to them at the time by BoM and the Goulburn Broken CMA. The following information can assist in their decision making, however it should be noted that this may not be appropriate for the circumstances at the time of the event.

The following assumptions about flooding in the Tallygaroopna area are based on historic observations and the past behaviour of our river and creek systems as they peak at varying times. Historic records indicate that flooding usually occurs when;

- Generally there has not been any significant rain recorded in previous days,
- The catchments are saturated,
- The rainfall intensity has been evenly spread over a 24 hour period.

When the Broken River floods, it can spill over its banks in many places. If it spills over near Gowangardie Weir (from about 1km east of Gowangardie Weir through to Pine Lodge at the East Goulburn Main Channel), the water usually flows in a generally north easterly direction into five waterways:

- Congupna Creek
- Dainton's Creek
- Pine Lodge Creek
- Guilfus Creek
- O'Keefe Creek.

All five creeks flow toward the Tallygaroopna area as per the map.

A number of staff gauges have been installed along these creeks. See map of gauge locations, photos of gauges, key data and local contacts at Appendix H. A summary of data collected for these gauges is provided below.

	Gauge reading				
	Centreline of road	1993	2010	2012	
Benalla		5.50	4.43	N/A	
Caseys Weir		4.18	3.6	N/A	
O'Keefe Creek (refer to Appendix H)					
New Dookie Road 1.7km west of Pine Lodge North Road	2.078	2.34	1.71	1.82	
Pine Lodge Creek (refer to Appendix H)					
New Dookie Road 0.6km east of Pine Lodge North Road Road first covered 20m west of bridge	1.623	2.578	1.838	1.948	
Lemnos North Road 0.2km north of Congupna East Road	2.283	2.358	1.965	2.208	
Katamatite-Shepparton Road 1.9km north of Congupna East Road Road first covered 30m south of bridge	2.328	2.448	2.050	2.300	
Dainton's Creek (refer to Appendix H)					
New Dookie Road 0.3km east of Sidebottom Road	1.850	1.855	1.326	1.436	
Congupna East Road 0.3km west of Hudson Road	1.995	2.500	2.109	2.218	
Congupna Creek (refer to Appendix H)					
New Dookie Road 0.3km west of Kellows Road Road first covered 15m west of bridge	1.900	2.065	1.536	1.646	
Tungamah-Boundary Road 0.2km east of Sidebottom Road	2.074	2.938	2.409	2.519	
Katamatite-Shepparton Road 0.3km south of Thompsons Road Road first covered 20m north of bridge	2.125	2.585	2.176	2.235	
Guilfus Creek (refer to Appendix I)					
Katandra Main Road 0.8km east of Boundary Road Road first covered 20m west of bridge	2.050	2.025	1.495	1.795	
		Indicates road is wet across the centreline			

River Level (metres)	Gauge	Significant flood event	Impact on Tallygaroopna township
Not applicable	Benalla Gauge Gowangardie Weir Gauge	**March 2012**	Flash Flood: This flood was caused by localised intense rainfall of 300mm over a period of 3 days; not from the Broken River.
4.26m **6.39m**	Benalla Gauge Gowangardie Weir Gauge	**September 2010**	Tallygaroopna township was not flooded.
3.87m **5.64m**	Benalla Gauge Gowangardie Weir Gauge	**December 2010**	Tallygaroopna township was not flooded.
5.51 **6.57**	Benalla Gauge Gowangardie Weir Gauge	**October 1993**	Slow Onset flood – overland from creek system. Township flooded.

Possible Rainfall impacts based on local knowledge

The following rainfall measurements are based on readings from local resident rainfall gauges.

Bureau of Meteorology warnings are not in place on these systems.

- The first 50mm or so of localised rainfall should not cause any significant flooding; for example, 28 mm of rainfall was accumulated at the Numurkah gauge (15.3 km from Tallygaroopna) in the 24 hours to 09:00 on 4 September 2010 and no flooding was recorded.
- 75mm+ over a wide area may cause minor flooding; for example, 73 mm of rainfall was accumulated at the Numurkah gauge in the 48 hours prior to 09:00 on 9 December 2010.
- 125mm+ of localised rainfall event may cause widespread minor to moderate flooding
- 150mm+ of localised rainfall event may cause moderate flooding and some major
- 200mm+ of localised rainfall event will most likely result in major flooding; for example, 300mm of rainfall accumulated over a period of 3 days lead to flash flooding at Tallygaroopna.

If the above rainfall amounts happen over a shorter time frame; it is likely localised flash flooding will occur

ESTIMATED FLOOD TRAVEL TIMES

The flood travel times are estimates based on local resident knowledge and observations at previous events. These times were not provided from a formal source or Authority.

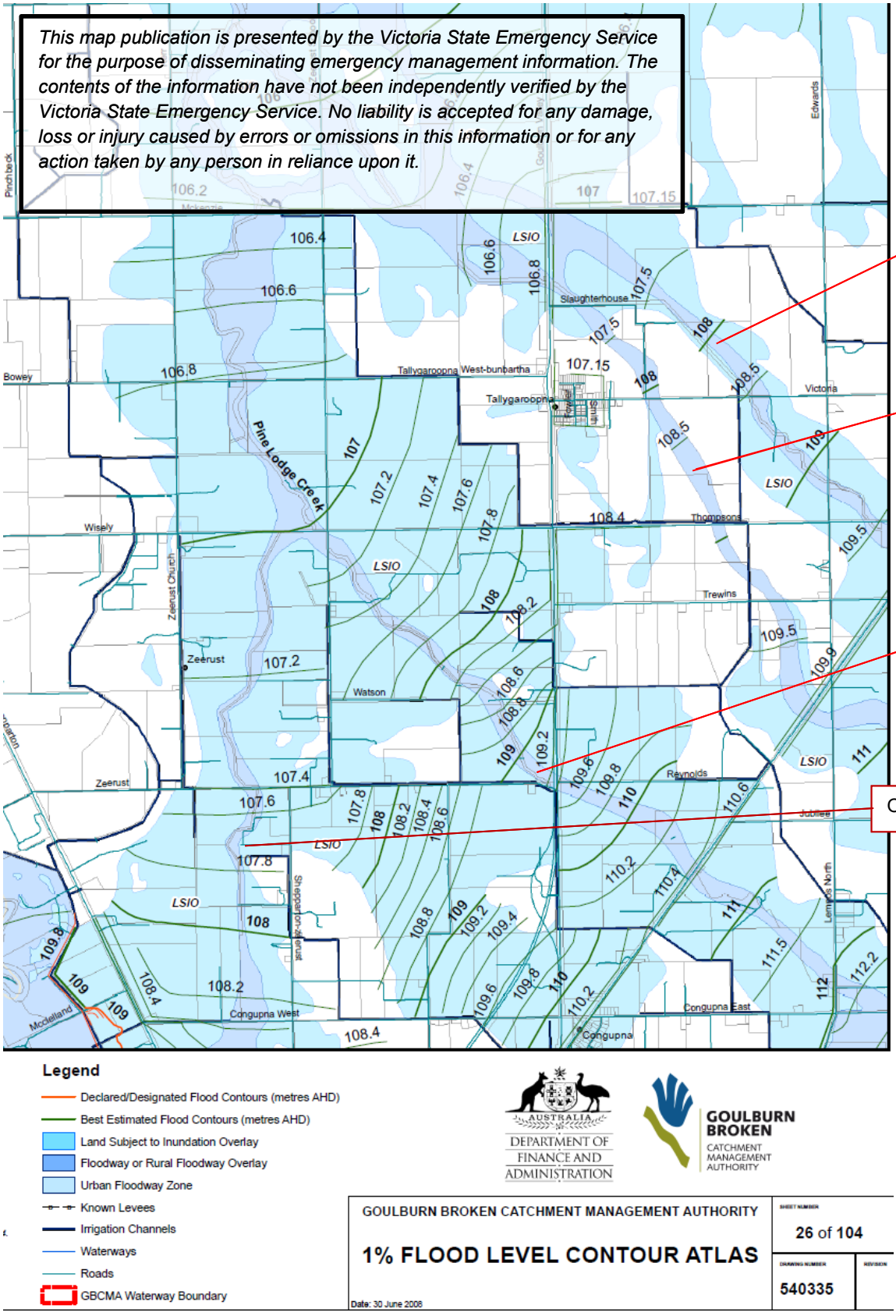
BENALLA TO GOWANGARDIE WEIR	**Varies but 29 hours is a reasonable estimate – see Appendix B**
GOWANGARDIE WEIR TO NEW DOOKIE ROAD	12 HOURS
NEW DOOKIE ROAD TO CONGUPNA EAST ROAD	1 DAY
CONGUPNA EAST ROAD TO KATAMATITE ROAD	1 DAY
KATAMATITE ROAD TO TALLYGAROOPNA	1 DAY
Between staff gauges at bridges over the Creeks – see Appendix H	

For the 1993 flood the passage of the flood peak from Gowangardie to Tallygaroopna took approximately 2.5 days.

Note: These flow times are based on observations from previous floods and may vary considerably depending on the weather and other conditions at the time of the event.

AUTOMATIC GAUGE READINGS

Tallygaroopna has no automatically monitored flood gauges. The Broken River Gauge at Benalla can help to provide a guide as to the potential for floodwater that may come this way. Refer to Bureau of Meteorology website for River Heights http://www.bom.gov.au/cgi-bin/wrap_fwo.pl?IDV60150.html


This map publication is presented by the Victoria State Emergency Service for the purpose of disseminating emergency management information. The contents of the information have not been independently verified by the Victoria State Emergency Service. No liability is accepted for any damage, loss or injury caused by errors or omissions in this information or for any action taken by any person in reliance upon it.
Congupna Creek
Dainton's Creek
Pine Lodge Creek
O'Keefe Creek
Pine Lodge Creek
LSIO
Bowey
Tallygaroopna
West-bunbartha
Slaughterhouse
Victoria
Wisely
Zeerust Church
Zeerust
Watson
Trewins
Thompsons
Reynolds
Jubilee
Lemnos North
Congupna East
Congupna
Congupna West
Mcclelland
Shepparton-Zeerust
Edwards
Pinchback
Legend
Declared/Designated Flood Contours (metres AHD)
Best Estimated Flood Contours (metres AHD)
Land Subject to Inundation Overlay
Floodway or Rural Floodway Overlay
Urban Floodway Zone
Known Levees
Irrigation Channels
Waterways
Roads
GBCMA Waterway Boundary
AUSTRALIA
DEPARTMENT OF FINANCE AND ADMINISTRATION
GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
1% FLOOD LEVEL CONTOUR ATLAS
Date: 30 June 2008
SHEET NUMBER
26 of 104
DRAWING NUMBER
540335
REVISION

River level / rainfall gauge prompts and actions

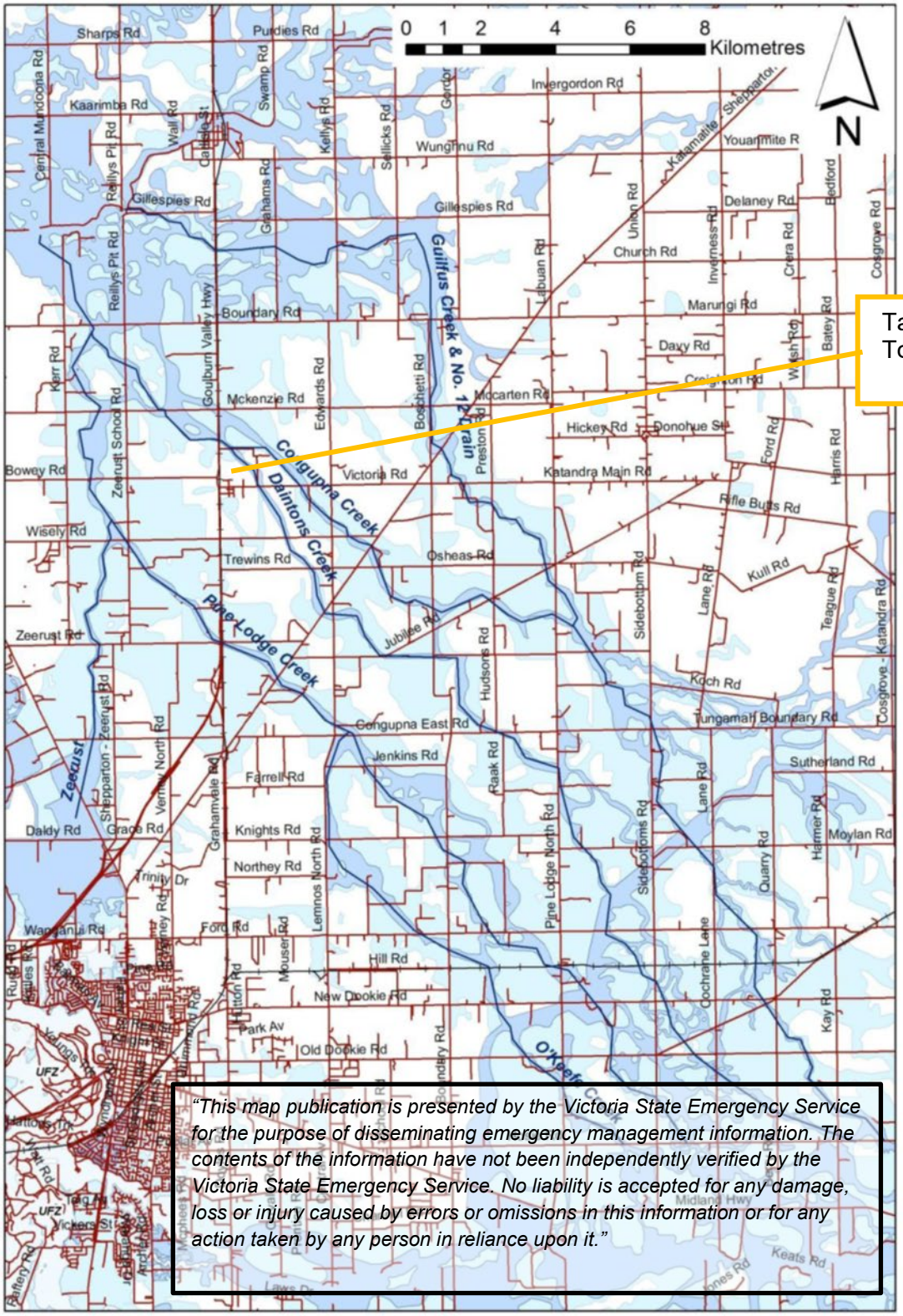
River Level (metres)	Gauge location	General Information	General Action	Drain/Penstock/ Other Action	Roads
NA	**Localised Heavy rainfall or Thunderstorms may cause widespread minor to moderate flash flooding**	Flash flooding can occur at any time with short notice. Can only be guided for likelihood of flooding by BoM heavy rainfall /storm warnings.	Monitor BoM weather sites for rainfall indicators and flash flooding warnings. Source local knowledge (e.g. collect private rain gauge data). Creek level markers have been installed which may assist authorities in assessing the risk of flood. **Refer to Appendix H.**		
5.51 **6.57**	**Benalla Gauge** **Gowangardie Weir Gauge (Oct 1993 event level)**	Water overflow from Broken River at Gowangardie Weir will affect New Dookie Road at the Congupna, Dainton's, Pine Lodge and O'Keefe Creeks. Based on past events, the estimated flow time is 3 days to Tallygaroopna.	Consider delivery of 120m^3 sand and 3000 sandbags to car park beside Tallygaroopna CFA building	Communicate with G-MW to consider the possibility of directing flood flow into the East Goulburn Main Channel where there is capacity	Midland Highway possibly closed by VicRoads New Dookie Road possibly closed the next day
		First farm vulnerable properties to be affected are in Edwards, Trewins and Thompsons Roads.	Ensure VICSES is aware of vulnerable properties. Ensure residents/ landholders are advised of situation.		

River Level (metres)	Gauge location	General Information	General Action	Drain/Penstock/ Other Action	Roads
		First township vulnerable properties to be affected are in North, Fowler, Church and Victoria Streets	Ensure VICSES is aware of vulnerable properties. Ensure residents/ landholders are advised of situation.		
			Inspect retardation basin pump and the outfall to ensure pump is operating.	Table drain pipes in Tallygaroopna West Road are clear to be checked to ensure clean and clear.	Council to provide road closure signs at appropriate locations by advised.
		4 x 150mm pumps were deployed in 2012	Consider installing flood pumps at this railway bridge site as necessary. Contact VicTrack, V-Line and VicRoads to ensure they are aware of the emergency situation and imminent installation of flood pumps on Congupna Creek.	Check the outlet pipe and penstock into Congupna Creek at the railway bridge to ensure positive flow. Close this penstock once Congupna Creek exceeds the inflow level and positive flow is no longer possible.	
		1 x 150mm pump was deployed in 2012	Consider installing additional flood pump at retardation basin if town streets are not clearing quickly enough.		
				Request G-MW to review inlet gates into Congupna Creek at the end of Slaughterhouse Lane and others to ensure positive flow; otherwise these gates are to be closed	

River Level (metres)	Gauge location	General Information	General Action	Drain/Penstock/ Other Action	Roads
				Consult with G-MW to consider opening channel gates along Thompson's Rd until positive flow no longer possible, then close.	Consider closing Thompsons & Trewins Roads to deter sightseeing traffic.
				Consult with G-MW to consider opening channel gates at Trewins and Reynolds Roads until positive flow is no longer possible then close.	
			Monitor channel bank on Congupna Creek on Edwards Road adjacent to Bagley property.	Consider installing slides either side of Edwards Rd when Congupna Creek is full; 100mm Pump to be located on Congupna Creek Bank to discharge water from table drains into creek.	
			Consult with G-MW monitoring the gates at back of Maddison property in Edwards Road on Channel 17, 400m north of Trewins Road; Request G-MW to consider installing 150mm Pumps x2 to allow discharge of Dainton's Creek water into Channel 17.	Consult with G-MW to consider opening channel gates into this channel until positive flow is not possible, and then close. Ask G-MW to consider the possibility of lowering the level of the channel to accept this water.	

River Level (metres)	Gauge location	General Information	General Action	Drain/Penstock/ Other Action	Roads
			Channel bank 5/17 east of Tallygaroopna to be monitored for integrity.		
			Consider sandbagging across Victoria Road itself on the 5/17 channel, 400m east of Slaughterhouse Lane.		Consider closing Victoria Road if required.
			Consider sandbagging across Victoria Road at Slaughterhouse Lane to direct water down the Lane.		
			Check that Congupna Creek (Drain 2/11) flows within its banks and does not surcharge back toward the township.		
			Consider sandbagging at Trewins/Edwards Road corner.		

Creek names and locations



4.10 Write a brief summary of the consequence of flooding. Further information will be detailed below in tables.

AEP Event XX%	Properties Affected	Number of properties	Description of risk	Warning Time	Road Closure	Bus Route disruption
	Residential	***To be updated when relevant data is available***				
	Commercial					
	Industrial					
	Public Land					
	Rural					

* Modify Table to suit.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation

To be updated when relevant data is available

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C5: CONGUPNA FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Community spirit in Congupna. Photo taken by Carolyn Allen.

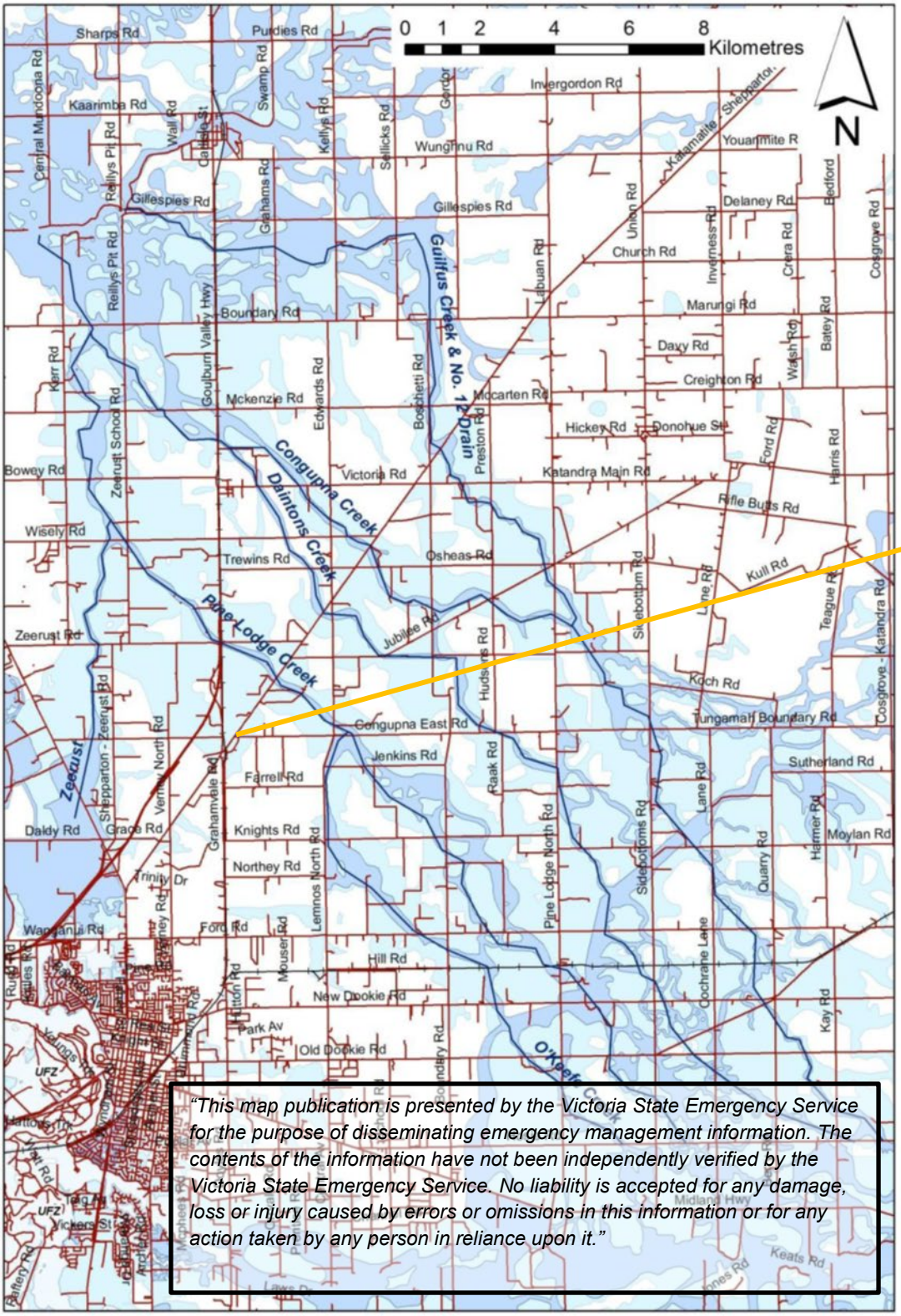
The township of Congupna is located 8 km north of Shepparton and has a population of 230 people (605 for Congupna Census area, 2016).

The town itself only encompasses a total land area of approximately one square kilometre and is situated at the crossroads of Goulburn Valley Highway and Katamatite-Shepparton Road and is surrounded by farmland on all sides

There are no distinct waterways that flow through the town itself, with over land run-off being the major source of floodwater. However, the Pine Lodge Creek will flood and threaten farming properties approximately 2 kilometres to the north and east of the town; with O'Keefe Creek also contributing to these flows.

Essentially rural in character, the town has a Primary School and a significant recreation reserve which services a number of different sports.

The map on the next page outlines the areas and river and creek systems, relative to the Shepparton urban development.



Flood level maps are available on the Goulburn Broken CMA website:

http://www.gbcma.vic.gov.au/default.asp?ID=floodplain_and_drainage

Are you at risk of flood?

- Congupna Township has had a significant history of flash flooding. Heavy rain over a short period of time (generally greater than 75mm in a 24 hour period) will result in the urban drainage network being overwhelmed, causing streets to flood for many hours.
- There are approximately six homes in the town itself which will be inundated during extreme events.
- In times of flood, five homes adjacent to Pine Lodge Creek will also experience some inconvenience through inundation. This creek system is often charged by waters flowing out of the Broken River when it is in flood, which then take up to two days to peak in the Congupna area.
- Road closures are likely to include Wallace Street and Katamatite-Shepparton Main Road.
- Congupna has a flat landscape with grades of approximately a slope of one metre per kilometre across the region.
- There are no regulated water storages (e.g. dams) or large wetlands in this area.
- Large pockets of water can collect in low-lying areas before slowly draining away/drying out.

Slow onset flooding

The township has experienced slow moving flooding in the past from the overflow of the Broken River via its creek system, which may last for one or more weeks, or even months on some occasions.

There are three water level gauges located on the Broken River at different points including:

- Broken River at Benalla
- Broken River at Casey's Weir
- Broken River at Orrvale near Shepparton (does not affect Congupna)

Flood warnings from the Broken River Gauges at Benalla and Casey's Weir will give an indication of the possibility and potential size of an overland slow onset flood based on historical records.

Flash flooding

Severe storm warnings will usually give an indication of what rainfall to expect during a storm event. The BoM may also issue warnings that include mention of flash flooding for particular areas depending on the estimated intensity of the expected rainfall.

HISTORIC FLOOD LEVELS AND FLOW ASSUMPTIONS

Note that no two floods are ever the same. Water flows and impacts of weather can be highly variable, especially after changes to the floodplain (road works, laser levelling). **The following levels and information are provided as a guide only and should be considered flexible and changeable according to the conditions at the time of an event.**

The emergency service providers will be in charge of determining what actions to take according to information and data provided to them at the time by BoM and the Goulburn Broken CMA. The following information can assist in their decision making, however it should be noted that this may not be appropriate for the circumstances at the time of the event.

The Congupna area has a history of flooding with big floods recorded in 1919, 1939, 1956, 1974, 1993 and 2012.

Aerial view of flooding at Congupna in March 2012
(source: Congupna Local Flood Guide, December 2016)

The following assumptions about flooding in the Congupna area are based on historic observations and the past behaviour of our river and creek systems as they peak at varying times. Historic records indicate that flooding usually occurs when;

- Generally there has not been any significant rain recorded in previous days,
- The catchments are saturated,
- The rainfall intensity has been evenly spread over a 24 hour period.

When the Broken River floods, it can spill over its banks in many places. If it spills over near Gowangardie Weir (from about 1km east of Gowangardie Weir through to Pine Lodge at the East Goulburn Main Channel), the water usually flows in a generally north easterly direction into five waterways:

- Congupna Creek
- Dainton's Creek
- Pine Lodge Creek
- Guilfus Creek
- O'Keefe Creek.

NB. Only Pine Lodge and O'Keefe Creeks flow toward Congupna area (see previous map).

A number of staff gauges have been installed along these creeks. See map of gauge locations, photos of gauges, key data and local contacts at Appendix I. A summary of data collected for these gauges is provided below.

	Gauge reading				
	Centreline of road	1993	2010	2012	
Benalla		5.50	4.43	N/A	
Caseys Weir		4.18	3.6	N/A	
O'Keefe Creek (refer to Appendix H)					
New Dookie Road 1.7km west of Pine Lodge North Road	2.078	2.34	1.71	1.82	
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New Dookie Road 0.6km east of Pine Lodge North Road Road first covered 20m west of bridge	1.623	2.578	1.838	1.948	
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Dainton's Creek (refer to Appendix H)					
New Dookie Road 0.3km east of Sidebottom Road	1.850	1.855	1.326	1.436	

	Gauge reading				
	Centreline of road	1993	2010	2012	
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Congupna Creek (refer to Appendix H)					
New Dookie Road 0.3km west of Kellows Road Road first covered 15m west of bridge	1.900	2.065	1.536	1.646	
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Katamatite-Shepparton Road 0.3km south of Thompsons Road Road first covered 20m north of bridge	2.125	2.585	2.176	2.235	
Guilfus Creek (refer to Appendix H)					
Katandra Main Road 0.8km east of Boundary Road Road first covered 20m west of bridge	2.050	2.025	1.495	1.795	
		Indicates road is wet across the centreline			

River Level (metres)	Gauge	Significant Flood event	Impact on Congupna township
Not applicable	Benalla Gauge Gowangardie Weir Gauge	**March 2012**	Flash Flood: This flood was caused by localised intense rainfall of 300mm over a period of 3 days; not from the Broken River.
4.26m **6.39m**	Benalla Gauge Gowangardie Weir Gauge	**September 2010**	Congupna township was not flooded.
3.87m **5.64m**	Benalla Gauge Gowangardie Weir Gauge	**December 2010**	Congupna township was not flooded.
5.51 **6.57**	Benalla Gauge Gowangardie Weir Gauge	**October 1993**	Slow onset flood – overland from creek system. Township flooded.

Possible Rainfall impacts based on local knowledge

The following rainfall measurements are based on readings from local resident rain gauges.
Bureau of Meteorology warnings are not in place on these systems. In general the following totals over around 12 hours:

- 50mm or so of localised rainfall should not cause any significant flooding
- 75mm+ over a wide area may cause minor flooding
- 125mm+ of localised rainfall may cause widespread minor to moderate flooding

- 150mm+ of localised rainfall may cause moderate flooding and some major
- 200mm+ of localised rainfall will most likely result in major flooding

If the above rainfall amounts happen over a shorter time frame; it is likely localised flash flooding will occur

ESTIMATED FLOOD TRAVEL TIMES

The flood travel times are estimates based on local resident knowledge and observations at previous events. These times were not provided from a formal source or Authority.

BROKEN RIVER BENALLA TO GOWANGARDIE WEIR	Varies from 18 to 37 hours but 29 hours is a reasonable first estimate – see Appendix B
BROKEN RIVER BREAKOUT GOWANGARDIE WEIR TO NEW DOOKIE ROAD	~12 HOURS
BROKEN RIVER BREAKOUT NEW DOOKIE ROAD TO CONGUPNA EAST ROAD	~1 DAY
BROKEN RIVER BREAKOUT CONGUPNA EAST ROAD TO KATAMATITE ROAD	~1 DAY
BROKEN RIVER BREAKOUT KATAMATITE ROAD TO TALLYGAROOPNA	~1 DAY
Between staff gauges at bridges over the Creeks – see Appendix H	

For the 1993 flood the passage of the flood peak from Gowangardie to Tallygaroopna took approximately 2.5 days so would be less for Congupna.

Note: These flow times are based on observations from previous floods and may vary considerably depending on the weather and other conditions at the time of the event.

AUTOMATIC GAUGE READINGS

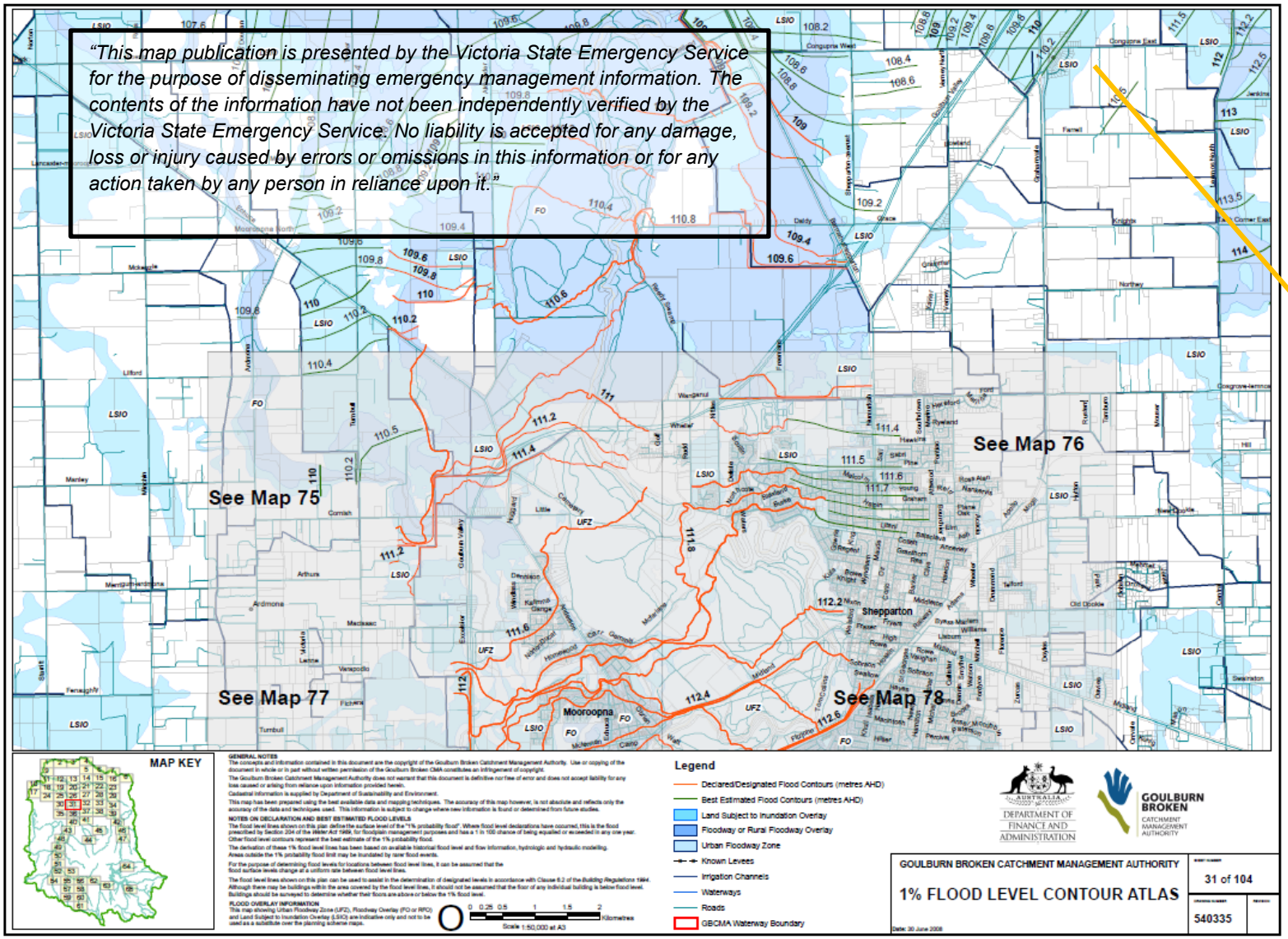
Congupna has no automatically monitored flood gauges.

The Broken River Gauge at Benalla can help to provide a guide as to the potential for floodwater that may come this way. Refer to Bureau of Meteorology website for River Heights http://www.bom.gov.au/cgi-bin/wrap_fwo.pl?IDV60150.html

River level / Creek marker prompts and actions

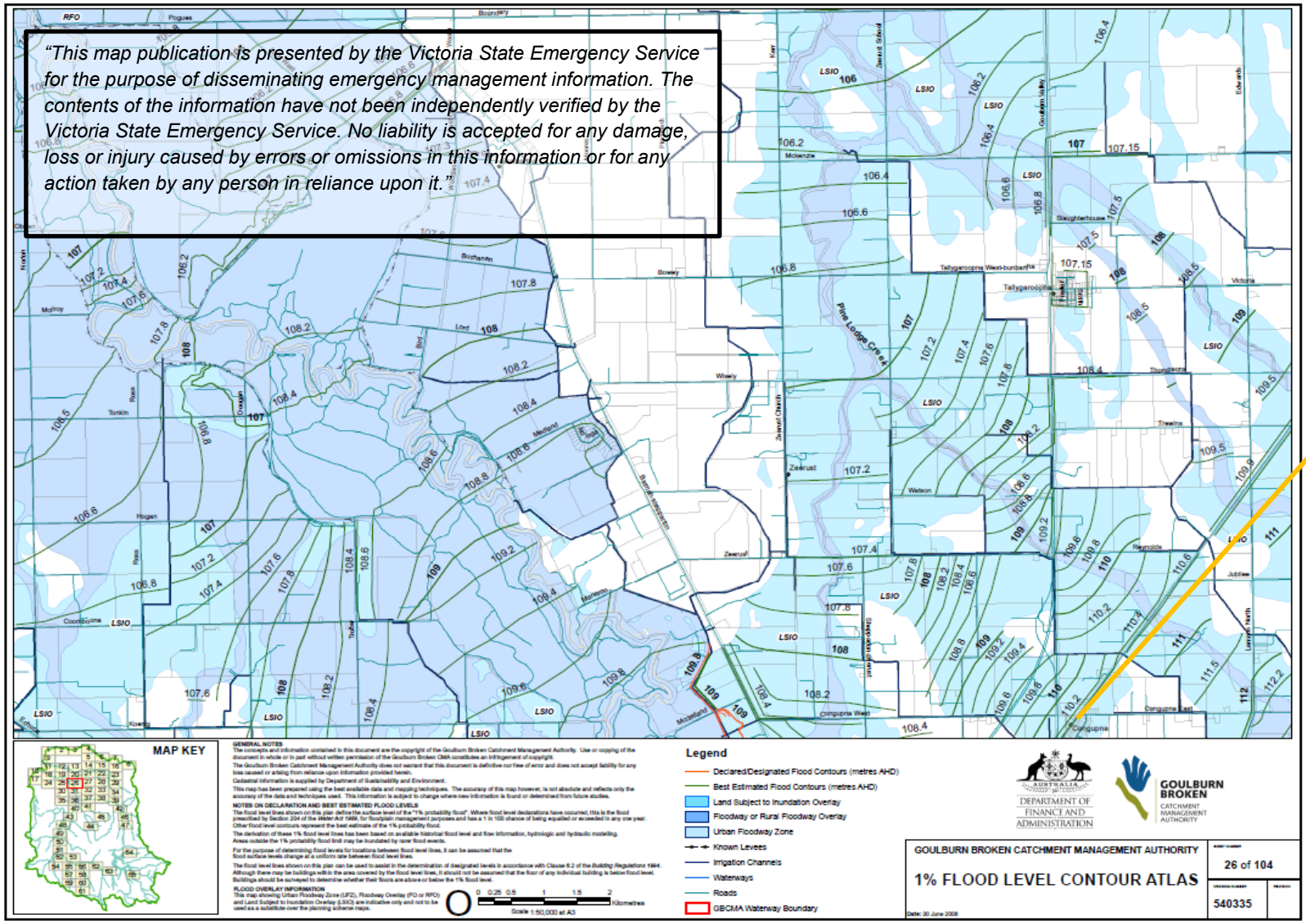
River Level	Location	General Information / Impact	General Action	Drain/Penstock Other Action	Roads
	Localised Heavy rainfall or Thunderstorms may cause widespread minor to moderate flash flooding	Flash flooding can occur at any time with short notice. Can only be guided for likelihood of flooding by BoM heavy rainfall warnings.	Monitor BoM weather sites. Source local knowledge (e.g. collect private rain gauge data). Creek level markers have been installed which may assist authorities in assessing the risk of flood. **Refer to Appendix H.**		
5.51 **6.57**	**Benalla Gauge** **Gowangardie Weir Gauge** **(Oct 1993 event level)**	New Dookie Road is likely to over-top at Pine Lodge and O'Keefe Creeks which gives approximately 28 hours' notice to Congupna & 22 hours to Lemnos North	Ensure VICSES is aware of vulnerable properties in Congupna and Lemnos North. Ensure residents/landholders are aware of the situation.	Communicate with G-MW to inspect outfall pipe into G-MW drain, 600m north of the township to ensure it is clear and positive flow occurring. This pipe/penstock should be closed when negative flow occurs and install a high flow pump.	VicRoads will have closed Midland Highway and then New Dookie Road the next day.
			Consider delivery of 60m^3 sand and 1000 sandbags to Congupna recreation reserve; behind the goals at eastern end of oval.		Consider closing Old Dookie and Lemnos-Cosgrove Roads
			Consider sandbagging across Lemnos North Road at the flood flap pipes as necessary.	Consult with to G-MW to consider opening the gates into G-MW channels to the East of township until positive flow ceases and then close these gates.	Consider closing Lemnos North Road

River Level	Location	General Information / Impact	General Action	Drain/Penstock Other Action	Roads
				In consultation with G-MW, inspect outfall pipe into G-MW drain, 600m north of the Congupna township to ensure it is clear and positive flow occurring (this is an on-going maintenance issue). This flood flap will close when negative flow occurs and there is a need to consider installing a high flow pump.	
			Consider installing pumps at each end of Wallace Street to remove further rainfall; if necessary.	Check Penstocks in Wallace Street and keep open until positive flow ceases; then close.	
			Consider blocking 12 inch pipe/drain at South side of Congupna East Road. 400-500 metres from the corner of Lemnos North Road. That may help impede a small flow west to the Congupna Township.	Consult with G-MW to consider to opening gates into G-MW channels to the East of town until positive flow ceases and then close these gates.	Monitor Lemnos North and Congupna East Roads and prepare for closure.
			Consider sandbagging across Old Grahamvale Road where the pipe goes under the railway line.		Consider closing Old Grahamvale Road.
			It was noted that Drains need to be maintained and kept clear of weeds and debris to lessen the impact of floods.		



Congupna Township

Flood level maps are available on the Goulburn Broken CMA website: http://www.gbcma.vic.gov.au/default.asp?ID=floodplain_and_drainage


"This map publication is presented by the Victoria State Emergency Service for the purpose of disseminating emergency management information. The contents of the information have not been independently verified by the Victoria State Emergency Service. No liability is accepted for any damage, loss or injury caused by errors or omissions in this information or for any action taken by any person in reliance upon it."
Congupna Township
MAP KEY
Legend
Declared/Designated Flood Contours (metres AHD)
Best Estimated Flood Contours (metres AHD)
Land Subject to Inundation Overlay
Floodway or Rural Floodway Overlay
Urban Floodway Zone
Known Levees
Irrigation Channels
Waterways
Roads
GBCMA Waterway Boundary
DEPARTMENT OF FINANCE AND ADMINISTRATION
GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
1% FLOOD LEVEL CONTOUR ATLAS
26 of 104
540335

"Floods can go higher than the 100-year flood level. In Australia, the flood planning level is usually defined by the 100-year flood. This is not a flood which happens once every 100 hundred years but one which has a 1 in 100 or 1% chance of occurring in each and every year. In a 70 year lifetime there is a 50/50 chance of a 1 in 100 flood being exceeded at any location." Text sourced from Flood Victoria Website:
http://www.floodvictoria.vic.gov.au/centric/faq/common_misconceptions_about_flooding.jsp

4.11 Write a brief summary of the consequence of flooding. Further information will be detailed below in tables.

AEP Event XX%	Properties Affected	Number of properties	Description of risk	Warning Time	Road Closure	Bus Route disruption
	Residential	***To be updated when relevant data is available***				
	Commercial					
	Industrial					
	Public Land					
	Rural					

* Modify Table to suit.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation ***To be updated when relevant data is available***

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C6: KATANDRA WEST FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

The Rath family property in Katandra Main Road, Katandra. Taken by Tori Rath.

The township of Katandra West is located 20km north east of Shepparton and has a population of 230 people (476 in Katandra West Census area, 2016).

The town itself only encompasses a total land area of approximately one square kilometre and is situated at the crossroads of Hickey and Sidebottom's Roads and is surrounded by farmland on all sides.

There are no distinct waterways that flow close to the town itself; with farmland run-off being the major source of floodwater. The Guilfus Creek will flood and threaten farming properties approximately 2 kilometres to the west of the town.

It is important to recognise that Guilfus Creek impacts the rural areas west of the Katandra West township, and not the township itself. The township of Katandra West is primarily impacted by direct rainfall. It is not impacted directly by riverine flooding at all.

Essentially rural in character, the town has a Primary School and a significant recreation reserve which services a number of different sports.

Greater Shepparton City Council has:

- A pump and basin in the grounds of the Katandra Football ground, Hickey Road.; and
- A pump in Black Street Katandra West (pumps into a nearby drain).

The map below outlines the areas and river and creek systems, relative to Katandra West and the Shepparton urban development.

Flood History

- The Katandra West district experienced flooding in 1919, 1939, 1956, 1974, 1993 and in March 2012.
- During significant events, the nearby Congupna and Guilfus creeks will flood the surrounding area and threaten farming properties to the west of town.
- Congupna and Guilfus creeks also flood if heavy rain falls in the Dookie Hills, as occurred in March 2012.
- The 2012 event overwhelmed the town's drainage network causing Black Street, Coleman Street, Burgman Street, Hickey Road, Donohue Street and King Street to flood for several days. Flooding in the Labuan Road area lasted longer than in the town
- Katandra West township has not had a significant history of flash flooding; however, heavy rain over a short period of time (generally greater than 75mm in a 24 hour period) will result in the urban drainage network being overwhelmed, causing streets to flood for a few hours.
- Generally no homes in the town should be inundated; however, the water will flow to the west and has flooded two houses on Labuan Road in the past.
- In times of flood, homes adjacent to Guilfus Creek may experience some inconvenience. This creek system is often charged by waters flowing out of the Broken River when it is in flood, which then take up to 2 days to peak in the Katandra West area.
- Katandra West has a flat landscape with an approximate slope of 1 metre per kilometre across the region.
- The township of Katandra West is only at risk of overland flooding from local storm events.
- There are no regulated water storages (e.g. dams) or large wetlands in this area, meaning that large pockets of water can collect in low-lying areas before slowly draining away / drying out.

Significant Flood Events

March 2012 – substantial flash flooding occurred due to very intense rainfall (300mm occurring to the east of Katandra West over three days).

October 1993 - was a flood caused primarily by the Broken River breaking its banks at Gowangardie; which resulted in significant overland flows reaching the rural areas west of the Katandra West township.

Aerial view of flooding at Katandra West in March 2012
(source: Katandra West Local Flood Guide, December 2016)

Slow onset flooding

The township has experienced slow moving flooding in the past primarily from the overflow of the Broken River via its creek system, which may last for one or more weeks, or even months on some occasions.

There are three water level gauges located on the Broken River at different points including:

- Broken River at Benalla
- Broken River at Casey's Weir
- Broken River at Orrvale near Shepparton (does not affect Katandra West)

Flood warnings from the Broken River Gauges at Benalla and Casey's Weir will give an indication of the possibility and potential size of a flood based on historical records.

Flash flooding warnings

Severe storm warnings will usually give an indication of what rainfall to expect during the storm event. The BoM may also issue warnings that include mention of flash flooding for particular areas depending on the estimated intensity of the expected rainfall.

HISTORIC FLOOD LEVELS AND FLOW ASSUMPTIONS

Note that no two floods are ever the same. Water flows and impacts of weather can be highly variable, especially after changes to the floodplain (road works, laser levelling).

The following levels and information are provided as a guide only and should be considered flexible and changeable according to the conditions at the time of an event.

The emergency service providers will be in charge of determining what actions to take according to information and data provided to them at the time by BoM and the Goulburn Broken CMA. The following information can assist in their decision making, however it should be noted that this may not be appropriate for the circumstances at the time of the event.

The following assumptions about flooding in the Katandra West area are based on historic observations and the past behaviour of our river and creek systems as they peak at varying times. Historic records indicate that flooding usually occurs when;

- Generally there has not been any significant rain recorded in previous days,
- The catchments are saturated,
- The rainfall intensity has been evenly spread over a 24 hour period.

When the Broken River floods, it can spill over its banks in many places. If it spills over near Gowangardie Weir (from about 1km east of Gowangardie Weir through to Pine Lodge at the East Goulburn Main Channel), the water usually flows in a generally north easterly direction into five waterways:

- Congupna Creek
- Dainton's Creek
- Pine Lodge Creek
- Guilfus Creek
- O'Keefe Creek.

Nb. Only the Congupna and Guilfus Creeks flow toward the Katandra West area.

A number of staff gauges have been installed along these creeks. See map of gauge locations, photos of gauges, key data and local contacts at Appendix I. A summary of data collected for these gauges is provided below.

	Gauge reading				
	Centreline of road	1993	2010	2012	
Benalla		5.50	4.43	N/A	
Caseys Weir		4.18	3.6	N/A	
O'Keefe Creek (refer to Appendix H)					
New Dookie Road 1.7km west of Pine Lodge North Road	2.078	2.34	1.71	1.82	
Pine Lodge Creek (refer to Appendix H)					
New Dookie Road 0.6km east of Pine Lodge North Road Road first covered 20m west of bridge	1.623	2.578	1.838	1.948	
Lemnos North Road 0.2km north of Congupna East Road	2.283	2.358	1.965	2.208	
Katamatite-Shepparton Road 1.9km north of Congupna East Road Road first covered 30m south of bridge	2.328	2.448	2.050	2.300	
Dainton's Creek (refer to Appendix H)					
New Dookie Road 0.3km east of Sidebottom Road	1.850	1.855	1.326	1.436	
Congupna East Road 0.3km west of Hudson Road	1.995	2.500	2.109	2.218	
Congupna Creek (refer to Appendix H)					
New Dookie Road 0.3km west of Kellows Road Road first covered 15m west of bridge	1.900	2.065	1.536	1.646	
Tungamah-Boundary Road 0.2km east of Sidebottom Road	2.074	2.938	2.409	2.519	
Katamatite-Shepparton Road 0.3km south of Thompsons Road Road first covered 20m north of bridge	2.125	2.585	2.176	2.235	
Guilfus Creek (refer to Appendix H)					
Katandra Main Road 0.8km east of Boundary Road Road first covered 20m west of bridge	2.050	2.025	1.495	1.795	
		Indicates road is wet across the centreline			

River Level (metres)	Gauge	Significant Flood event	Impact on Katandra West township
Not applicable	Benalla Gauge Gowangardie Weir Gauge	**March 2012**	Flash Flood: This flood was caused by localised intense rainfall of 300mm over a period of 3 days; not from the Broken River.
4.26m **6.39m**	Benalla Gauge Gowangardie Weir Gauge	**September 2010**	Katandra West township was not flooded.
3.87m **5.64m**	Benalla Gauge Gowangardie Weir Gauge	**December 2010**	Katandra West township was not flooded.
5.51 **6.57**	Benalla Gauge Gowangardie Weir Gauge	**October 1993**	The rural areas west of the Katandra West township were flooded from breakouts from the Broken River

Possible Rainfall impacts based on local knowledge

The following rainfall measurements are based on readings from local resident rain gauges.
Bureau of Meteorology warnings are not in place on these systems. In general the following totals over around 12 hours:

- 50mm or so of localised rainfall should not cause any significant flooding
- 75mm+ over a wide area may cause minor flooding
- 125mm+ of localised rainfall may cause widespread minor to moderate flooding
- 150mm+ of localised rainfall may cause moderate flooding and some major
- 200mm+ of localised rainfall will most likely result in major flooding

If the above rainfall amounts happen over a shorter time frame; it is likely localised flash flooding will occur

ESTIMATED FLOOD TRAVEL TIMES

The flood travel times are estimates based on local resident knowledge and observations at previous events. These times were not provided from a formal source or Authority.

BROKEN RIVER BENALLA TO GOWANGARDIE WEIR	Varies from 18 to 37 hours but 29 hours is a reasonable first estimate – see Appendix B
BROKEN RIVER BREAKOUT GOWANGARDIE WEIR TO NEW DOOKIE ROAD	~12 HOURS
BROKEN RIVER BREAKOUT NEW DOOKIE ROAD TO CONGUPNA EAST ROAD	~1 DAY
BROKEN RIVER BREAKOUT CONGUPNA EAST ROAD TO KATAMATITE ROAD	~1 DAY
BROKEN RIVER BREAKOUT KATAMATITE ROAD TO TALLYGAROOPNA	~1 DAY
Between staff gauges at bridges over the Creeks – see Appendix H	

For the 1993 flood the passage of the flood peak from Gowangardie to Tallygaroopna took approximately 2.5 days.

Note: These flow times are based on observations from previous floods and may vary considerably depending on the weather and other conditions at the time of the event.

AUTOMATIC GAUGE READINGS

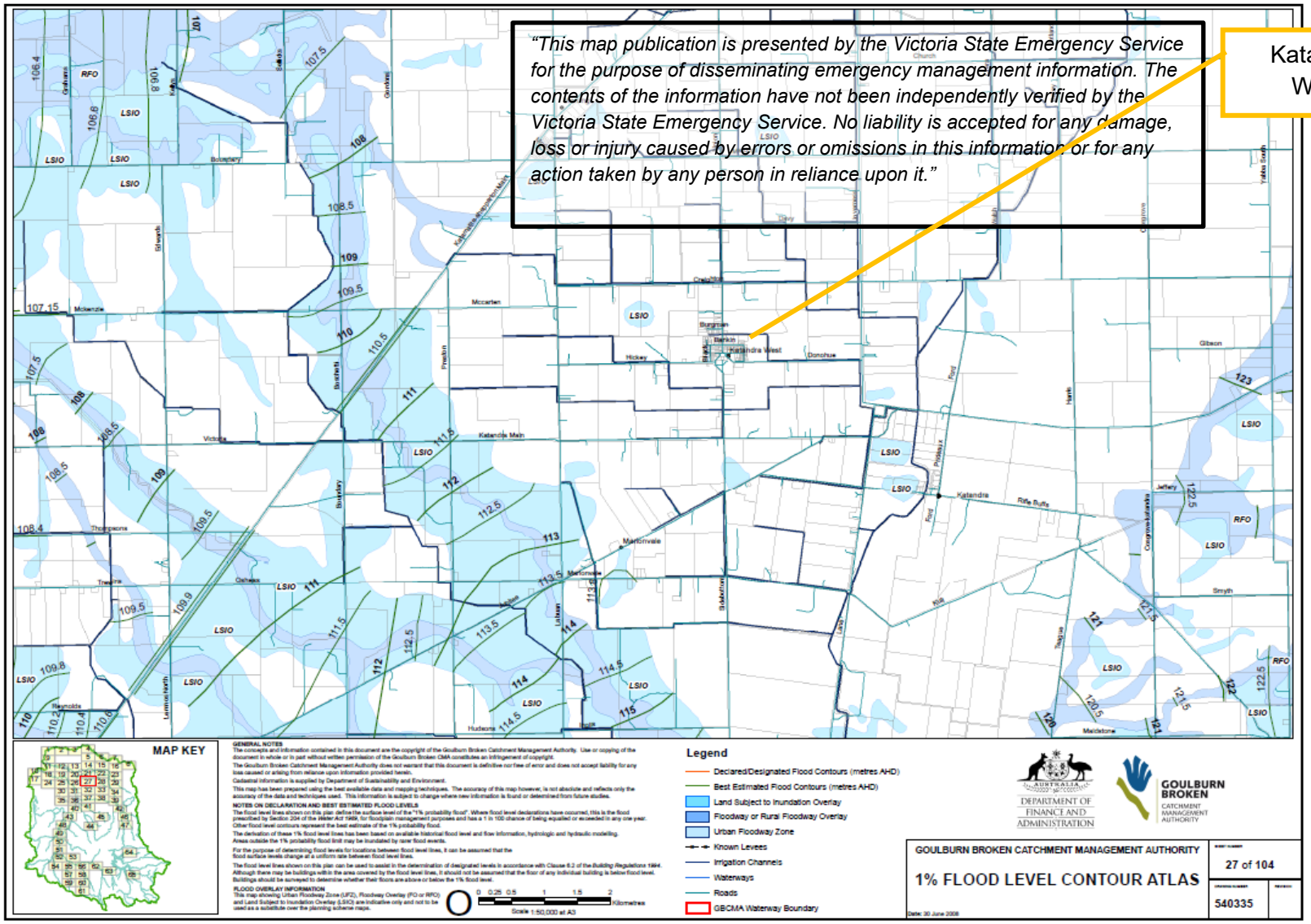
Katandra West has no automatically monitored flood gauges.

The Broken River Gauge at Benalla can help to provide a guide as to the potential for floodwater that may come this way. Refer to Bureau of Meteorology website for River Heights http://www.bom.gov.au/cgi-bin/wrap_fwo.pl?IDV60150.html

River level / Creek marker prompts and actions

River Level	Gauge	General Information	General Action	Drain/Penstock/Other Action	Roads
	Localised Heavy rainfall or Thunderstorms may cause widespread minor to moderate flash flooding	Flash flooding can occur at any time with short notice. Can only be guided for likelihood of flooding by BoM heavy rainfall warnings.	Monitor BoM weather sites for rainfall indicators and flash flooding warnings. Source local knowledge (e.g. collect private rain gauge data). Creek level markers have been installed which may assist authorities in assessing the risk of flood. **Refer to Appendix H.**		
5.51 **6.57**	**Benalla Gauge** **Gowangardie Weir Gauge** **(Oct 1993 event level)**	New Dookie Road will over-top at Congupna, Dainton's, Pine Lodge and O'Keefe Creeks which gives just over 2 days' notice to Katandra West.		Communicate with G-MW to consider the possibility of directing flood flow into the East Goulburn Main Channel where positive flow is possible	VicRoads will most likely close Midland Highway and then New Dookie Road the next day
			Alert vulnerable properties in Sidebottom, Hickey, Labuan Roads and township	Check the drain from the retardation basin discharge point, to the west is clear	Consider placing "Road Closed" signs at these sites in preparation for closing
			Consider delivery of 80m3 sand and 2000 sandbags to the car park in front of the Recreation Reserve pavilion	Check pump is running in Bankin Street retardation basin. Check the outlet to the north is also clear.	
			Ensure appropriate channel banks are secure in Hickey Street	Check the pump is running in Hickey Street retardation basin	

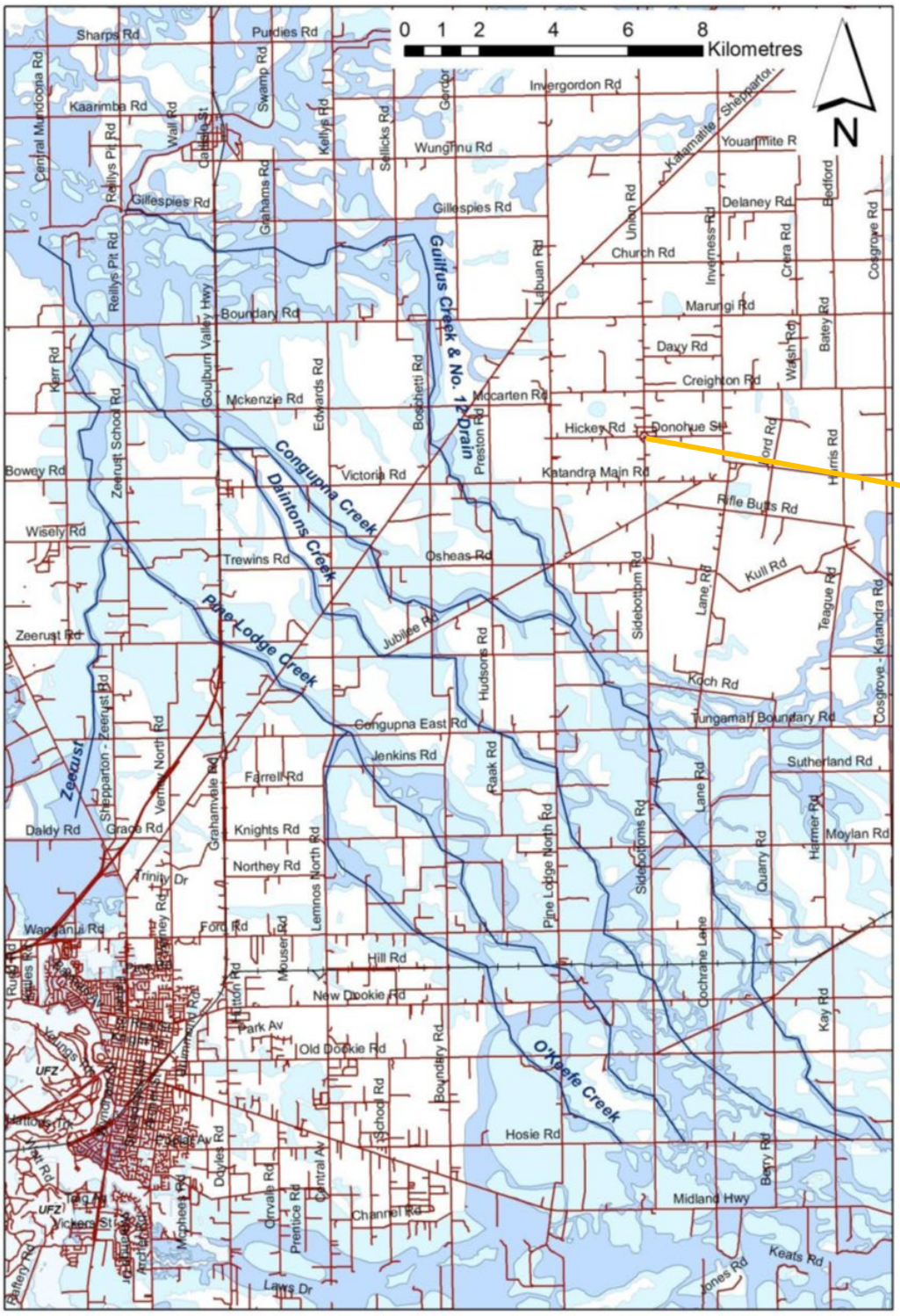
River Level	Gauge	General Information	General Action	Drain/Penstock/Other Action	Roads
As above				Flood flap on pipe in Union Road, north of the town to be closed to avoid any negative flow back south toward the township	



Flood level maps are available on the Goulburn Broken CMA website: *http://www.gbcma.vic.gov.au/default.asp?ID=floodplain_and_drainage*

"Floods can go higher than the 100-year flood level. In Australia, the flood planning level is usually defined by the 100-year flood. This is not a flood which happens once every 100 hundred years but one which has a 1 in 100 or 1% chance of occurring in each and every year. In a 70 year lifetime there is a 50/50 chance of a 1 in 100 flood being exceeded at any location." Text sourced from Flood Victoria Website: http://www.floodvictoria.vic.gov.au/centric/faq/common_misconceptions_about_flooding.jsp

Locality Creek System Map



Katandra West

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4.12 Write a brief summary of the consequence of flooding. Further information will be detailed below in tables.

AEP Event XX%	Properties Affected	Number of properties	Description of risk	Warning Time	Road Closure	Bus Route disruption
	Residential	***To be updated when relevant data is available***				
	Commercial					
	Industrial					
	Public Land					
	Rural					

* Modify Table to suit.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
	To be updated when relevant data is available					

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation ***To be updated when relevant data is available***

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C7: TATURA FLOOD EMERGENCY PLAN

Overview of the Catchment

Tatura lies 17km south-west of Shepparton and 20km directly north of Murchison within the Mosquito Depression East Arm floodplain. In turn, the Depression is within the Deakin Basin. The eastern boundary of the Basin parallels the east side of the Depression's route.

The Mosquito Depression East Arm is a sub-catchment of the Mosquito Depression which originates south of Tatura in the general vicinity and to the west of Murchison. It drains into the Deakin Main Drain about 15km upstream from where the Drain outfalls into the Murray River, east (i.e. upstream) of Echuca.

The Mosquito Depression East Arm drains a highly modified 6.15km^2 catchment of rural pasture and orchards to Tatura. It comprises a network of shallow and wide interconnecting drainage paths on a low grade. Important features of the upstream catchment include agricultural storages / farm dams, irrigation channels, flood protection levees, road and rail embankments and culverts, and shallow interconnecting floodways. These features substantially attenuate flows.

Upstream of Tatura, the Mosquito Depression East Arm exists as two distinct branches, one from the south, the other from the east. The two branches are of similar length and have comparable catchment areas. However, agricultural storages and levees in the Eastern Branch impede the arrival of flood peaks at the town boundary by days.

The branches converge at Tatura to form a series of meandering and interlinked shallow depressions. Floodwaters enter the town via four flow paths from the south and east and drain through the town to the northwest before joining the main branch of Mosquito Depression.

Downstream from Tatura and on its way past Merrigum, the Depression winds through the catchment as a series of defined ephemeral flow paths although drainage is generally via the Mosquito Depression Drain, an open trapezoidal earth lined channel.

An extensive underground pipe network drains runoff from the developed areas of Tatura to the Southern and Eastern Branches of the Mosquito Depression East Arm. While drainage reserves have been designated along the Eastern Branch, significant development has occurred within the flood prone Southern Branch.

Tatura is cut diagonally by the Toolamba - Echuca railway embankment, which acts as a constriction to flows along the Southern Branch. Flows are conveyed via an underpass (~3.2m wide and 1.8m high). The majority of the town's flood prone properties are located along the Southern Branch in the area upstream of the embankment.

Flood History

Tatura's first experience with suburban flooding occurred in March 1950, when floodwaters rose rapidly in the area that is now Lake Bartlett and broke across Martin Street flooding shops and businesses in the Depression's natural course. Flooding occurred again in 1955, 1956, May 1974 and October 1993.

The 1955 flood is considered to be the largest on record. The May 1974 flood was not as

severe and was contained by locals using portable and tractor-mounted pumps to pump flows down Service Street and into the Eastern Branch.

Large amounts of fill became available as the town's sewerage system was constructed and many low lying allotments within the floodplain were raised. Concern about development in the floodplain led to planning controls being put in place and construction by Council of banks of culverts within the Eastern Branch. A flood management plan was also implemented. The Plan utilised penstocks at Lake Bartlett to hold back flows in the Southern Branch while flows within town receded. Once sufficient capacity had returned within the town's drainage network, the penstocks were to be opened to allow Southern Branch flows to drain away via the natural depression. Local flood management has also involved cutting through roads and the deployment of pumps once the capacity of penstocks has been exceeded.

There is no rainfall or stream gauge data available for any flood producing storms within the catchment in the vicinity of Tatura.

Flood Behaviour

Flooding at Tatura has two sources: high intensity short duration storms that lead to localised rapid onset stormwater flooding within the township and long duration (36 hours or so) rainfall events that cause elevated flows within Mosquito Depression.

Overland flows through Tatura follow multiple flow paths with interconnections controlled by a range of constructed and natural features. For example, topography is flat, sinuosity is high, and there are numerous culverts, crossings and both natural and man-made levees. Further, the underground (trunk) stormwater drainage system can potentially convey a considerable portion of flow during some events as there are no restrictions on the exchange of water between the underground drainage network and overland flow paths. As a result, individual flow paths (and their relationship with others) are not always easily defined or predictable.

Localised stormwater flooding within town due to capacity constraints within the minor drainage network occurs, in general, much earlier, and is much smaller in magnitude, than resulting from flows in the Mosquito Depression East Arm.

Five electric pumps remain on standby at the Margaret Street Pumping Station to lift flows over an embankment into the Cussen Park Wetland once stormwater enters the Margaret Street pump well. The combined capacity of the pumps is approx. 3.4m^3/s (294ML/d).

The depth of flooding along drainage lines and in flood storage areas can be substantial. However, grades are flat and flows sluggish within the Depression. Floods travel slowly along the Depression and through Tatura with the result that the rise and recession are also slow. It can take several days for a flood to reach a peak and many more for it to drain. In the lower reaches, flooding can persist for anywhere from 14 days to 2 months.

Flood risk (based on depths and velocities as per ARR 2016) outside the drainage lines and storage areas is consider to be low for adults, children and vehicles

Blockages at drainage infrastructure, particularly in the vicinity of the railway bypass, will increase flood levels and extents.

A remote pocket of flooding will begin to develop in the vicinity of Hunter Street and between Unilever Foods and William Street as flood levels approach the 10% AEP (10yr ARI) event. This is backwater flooding caused by elevated water levels at the railway underpass pushing water back up the minor stormwater drainage network. It could be prevented by placing sandbags at drain outlets north and south of the railway embankment (i.e. those that drain the area affected) after any local runoff has escaped via the drainage network and before the peak of the flood passes through town.

Flood Impacts

Overview

Flood impacts in and around Tatura can be significant: multiple road closures, loss of access for residents, disruption to schools, child care centres and the hospital, property isolation, over-floor flooding, risks to emergency personnel during sand bagging and evacuation operations, and damage to buildings constructed below flood level. During major floods, there are also likely to be substantial rural and infrastructure flood damages.

Properties at Risk of Flooding

The number of properties at risk of flooding along with the number of buildings (those that are habitable: does not include garages or carports) at risk of over-floor flooding was calculated by WBM (2006). A summary of that analysis is provided in the table below.

ARI (years)	AEP	Number of properties at risk	
		Flooded above ground level	**Flooded above floor level**
10	10%	163	32
20	5%	220	46
50	2%	312	92
100	1%	399	132
500	0.2%	483	201

Caravan Parks

The Tatura Caravan Park is inundated from around the 10-year ARI (10% AEP) event.

Known or possible community infrastructure impacts including:

- Telstra exchange
- CFA Fire Station / Incident Command Centre
- Hospital and Aged Care Facility
- Schools and Child Care Centres
- Ovals and sporting facilities including the bowls club, tennis courts and swimming pool

Road closures

These are listed in the Flood Intelligence Card below and can also be determined from the flood mapping delivered by WBM (2006). See also FloodZoom.

Flood Mapping

A set of flood inundation maps for Tatura (depth and water surface elevation) has been produced for emergency management and response purposes (WBM, 2006). Maps were produced for 5 design events (i.e. 10, 20, 50, 100- & 500-year ARI).

Mapping is available from and through FloodZoom. The study report (WBM, 2006) is also available through FloodZoom.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Management Plan (SEMP). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Shepparton and Tatura to manage the local community.

Flood Intelligence and Action Table for Tatura

Introduction

Flood impacts described in the following tables relate primarily to flooding from the Mosquito Depression. It should be noted that local impacts, or impacts in excess of those indicated, may occur, especially in the event of locally heavy rain in and around Tatura, especially if that rain coincides with high flows within the Depression. Similarly, local increases in flood levels and impacts may result from local factors such as blockages at culverts and from obstructions within overland flow paths.

Notes:

1. While flood intelligence cards provide guidance on the relationship between flood magnitude and flood consequences, 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. Further, the hydrologic and hydraulic modelling that underpins much of the intell detailed below is informed by a number of assumptions and approximations that are unlikely to be replicated exactly during a flood event. Actual impacts under similar rainfall conditions are therefore expected to be similar but may not be exactly the same: there are likely to be some differences. Additional details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series in particular in Manual 20 "Flood Preparedness".
2. All levels, impacts and actions listed in the following flood intelligence card may need to be adjusted to better reflect experience.

Flood Intelligence Card

Observed Rainfall	**~AEP of flood**	**Consequence / Impact at Tatura** Refer to FloodZoom and to maps at Appendix E	**Action** Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
▪ It is important that sand and sandbags are delivered to Tatura and made available to residents as soon as possible after it becomes apparent that flooding is likely. Sandbags are only likely to be efficient for masonry or brick buildings on a concrete slab. All others should concentrate on lifting furniture and other valuables. ▪ Consider how best to assist nursing staff attend the Tatura Public Hospital and Parkvilla Aged Care Facility in Hunter Street if flooding more severe than 10 year ARI is considered likely.			
USING THIS INTELLIGENCE CARD. The observed rainfall range and duration is provided as a guide only. Greater depths of rainfall over a shorter period may also lead to rises and possible flooding along the Mosquito Depression and through Tatura. While heavy short duration rainfall may lead to localised flash stormwater flooding within Tatura, the consequences of that are not detailed in this intelligence card. Rainfall reported from the **Tatura AWS** (available from the BoM website at 30 minute intervals and occasionally more frequently and also from FloodZoom) or from local gauges (or perhaps from the Castle Creek at Arcadia gauge - available from the BoM website and FloodZoom)) will provide near real-time data for use herein in order to determine the approximate flood severity. Consider the appropriate flood inundation map remembering that water will rise slowly and travel slowly. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Some actions may need to be initiated in an order that is different from their relative placement in this table.			
~50 to 70mm in 24hrs	<10% AEP (<10yr ARI)	▪ Flow in Mosquito Depression through Tatura. ▪ Heavy local rain resulting in stormwater flooding and / or high flows within the stormwater drainage network.	▪ Manage the penstocks at Lake Bartlett as per the Flood Management Plan.

Observed Rainfall	~AEP of flood	Consequence / Impact at Tatura Refer to FloodZoom and to maps at Appendix E	Action Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
~55 to 80mm in 36hrs			▪ Periodically check that the 5 electric pumps at the Margaret Street Pumping Station are operating as required and lifting water over the embankment into the Cussen Park Wetland. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. This could include removing any build-up of soil in the culverts at Gowie St and Hogan St.
~55mm in 12hrs ~70mm in 24hrs ~80mm in 36hrs	10% AEP (10yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Tatura.* ▪ Flooding into the racecourse and into Cussen Park Wetland. ▪ Frank Howley Oval and adjacent oval flooded. ▪ Tatura Caravan Park flooded by up to 300mm deep. Both Hastie St and Galloway St are also flooded to a similar depth. ▪ Hunter St flooded in front of the Tatura Public Hospital and Parkvilla Aged Care Facility to around 300mm depth. ▪ VICSES Tatura unit HQ is dry but there water is close to Martin St either side. ▪ Flooding of a number of roads, mostly less than 300mm depth but up to 500mm: Albert St, Alexander Av, Bartlett St, Brown St, Casey St, Cussen St, Dhurringile Rd, Edgar St, Francis St, Fraser St, Gowie Park Rd, Johnstone Rd, Kerford St, Galloway St, Hampton Rd, Hastie St, Hogan St, Hunter St, Langdon Rd, Martin St, Murton Rd, O'Reilly Rd, Park St, Pyke St, Ross St, Serra Ct, Service St, Taylor Rd. ▪ 163 properties flooded along these roads and 32 buildings flooded over-floor. ▪ Most of the over-floor flooding is in the properties immediately downstream from Lake Bartlett: 55-59 Albert St, 28-35 Francis St, 11-17 Fraser St, 47 Hastie St, 16 Hunter St, 22-30 Kerford St, 103-142 Martin St, 100 O'Reilly Rd, 22-34 Service St. ▪ Water banked up on the upstream side of Pyke Road north of town.	▪ Consider delivering sand and sandbags (60m3 and 1,000 respectively?) into Tatura to the nominated collection point (where is it?) sufficient for the expected severity of flooding. *Note that the Shire Depot on Cussen St remains mainly dry but that access is about to be compromised / it becomes isolated.* ▪ Evacuate Tatura Caravan Park. ▪ Review road flooding, place "Water over road" signs and consider closing roads as necessary. ▪ Place sandbags at drain outlets north and south of the railway embankment (i.e. those that drain Hunter Street and the area between Unilever Foods and William Street) after any local runoff has escaped via the drainage network and before the peak of the flood passes through town in order to prevent backwater flooding into this pocket. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix F of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. This could include removing any build-up of soil in the culverts at Gowie St and Hogan St. ▪ Review evacuation plan and prepare for implementation noting that there are very few shrinking islands but that the likelihood of isolation does increase as flood severity increases. A number of properties do become isolated – see flood depth maps available through FoodZoom.

Observed Rainfall	~AEP of flood	Consequence / Impact at Tatura Refer to FloodZoom and to maps at Appendix F	Action Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
		▪ Water through George Reilly Park and Lions Park Playground. ▪ **This flood will pass through Merrigum. Is there anything that can be done now to assist response? For example, advice re likely flood size? See Appendix C8 of this MFEP.**	▪ With the ICC and Goulburn Broken CMA, raise the possibility of installing one or more PALS in Mosquito Depression upstream of, at, and downstream from Tatura. The intention is to collect height data to enable development of more robust flood guidance tools. ▪ Record flood levels and impacts for later update of this table. This information could assist the development of a flood warning / prediction system for Merrigum.
~64mm in 12hrs ~81mm in 24hrs ~92mm in 36hrs	5% AEP (20yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Tatura.* ▪ Flooding into the Bowls Club and alongside the Netball courts in Hastie St. ▪ Shallow water on Casey St in front of the CFA fire station (also local incident command centre). ▪ Tatura telephone exchange in Casey St surrounded by water. ▪ Tatura Public Hospital and Parkvilla Aged Care Facility may be isolated. ▪ Mostly shallow flooding though the majority of the CBD in Casey St. ▪ All flow paths are running deeper and a bit wider with a few more roads now flooded (e.g. Elizabeth St, Erica Av, Davey St, Hughes St, Margaret St, Peter Av, Thomson St, Toro Ct, William St). Velocities still slow. ▪ 220 properties flooded and 46 buildings flooded over-floor.	▪ Review road flooding, place "Water over road" signs and consider closing roads as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Consider how to assist nursing staff maintain access to the hospital and aged care facility in Hunter St. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. This could include removing any build-up of soil in the culverts at Gowie St and Hogan St.
~76mm in 12hrs ~99mm in 24hrs ~112mm in 36hrs	2% AEP (50yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Tatura.* ▪ All flow paths are running a bit deeper and a bit wider. Velocities still slow. ▪ 312 properties flooded and 92 buildings flooded over-floor. ▪ Tatura Public Hospital and Parkvilla Aged Care Facility isolated. ▪ Water just beginning to overtop Pyke Rd downstream / north of town.	▪ Review road flooding, place "Water over road" signs and consider closing roads as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. .

Observed Rainfall	~AEP of flood	Consequence / Impact at Tatura Refer to FloodZoom and to maps at Appendix F	Action Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
~85mm in 12hrs ~111mm in 24hrs ~128mm in 36hrs	1% AEP (100yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Tatura.* ▪ All flow paths are running deeper and a bit wider with a few more roads now flooded. Velocities still slow. Flood depths on roads now between 300mm and 800mm. ▪ Buildings in the Tatura Caravan Park are flooded over-floor. ▪ Water up against the Tatura library building in Casey St. ▪ Water surrounds the CFA Fire Station in Casey St. ▪ 399 properties flooded and 132 buildings flooded over-floor. ▪ Over-floor flooding is concentrated in: ➢ The block surrounded by O'Reilly Rd, Hastie St, Albert St & Davey St. ➢ The area immediately downstream from Lake Bartlett through to the railway embankment. ➢ Hunter St and Park St either side of the railway embankment.	▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 1% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Review road flooding, place "Water over road" signs and consider closing roads as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary.
	0.2% AEP (500yr ARI)	▪ All flow paths are running deeper and a bit wider. Velocities still slow. ▪ 483 properties flooded and 201 buildings flooded over-floor. ▪ The hospital grounds are partially flooded. ▪ VICSES unit HQ is dry but there is water across Martin St either side.	▪ Review road flooding, place "Water over road" signs and consider closing roads as necessary. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary.

4.13 Write a brief summary of the consequence of flooding. Further information will be detailed below in tables.

AEP Event XX%	Properties Affected	Number of properties	Description of risk	Warning Time	Road Closure	Bus Route disruption
	Residential	***To be updated when relevant data is available***				
	Commercial					
	Industrial					
	Public Land					
	Rural					

* Modify Table to suit.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation ***To be updated when relevant data is available***

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix C8: MERRIGUM FLOOD EMERGENCY PLAN

Overview of the Catchment

Merrigum lies approx. 25km west of Shepparton and 12km north-west of Tatura within the Mosquito Depression floodplain. In turn, the Depression is within the Deakin Basin. The eastern boundary of the Basin parallels the east side of the Depression's route.

The Mosquito Depression originates south of Tatura. It drains into the Deakin Main Drain about 15km upstream from where the Drain outfalls into the Murray River, east (i.e. upstream) of Echuca.

The catchment upstream of Merrigum consists of a mix of around 228km^2 of irrigated and non-irrigated crops, orchards and pastoral land. The Depression winds through the catchment as a series of defined ephemeral flow paths although drainage is generally via the Mosquito Depression Drain, an open trapezoidal earth lined channel. The Drain was originally cut in the mid-1890's and extended in the early 1990's. Further minor extensions occurred during the 2000's.

The Drain has a design capacity of 150ML/d (1.8m^3/s), the flow estimated to result from a 2-year ARI (50% AEP) design storm of 50mm over a period of 24 hours. In comparison, the 10-year ARI (10% AEP) design storm delivers around 75mm in 24 hours.

Embankments were added to the floodway between Waverley Avenue and the railway embankment (through the urban area of Merrigum) in 1994 with crest levels set at 500mm above the 1993 flood levels.

Upstream of Tatura there are many obstructions in the Depression, all of which impact on flow conveyance (see Appendix C7). Between Tatura and Merrigum, there are substantially fewer obstructions (only 15 or so).

The local relatively small upper Byrneside – Merrigum catchment contributes to flows in the Depression at Merrigum upstream of the railway line. These flows arrive in the Depression well ahead of flows from further upstream.

There is significant storage within the catchment upstream of Merrigum, including wetlands upstream of Tatura, Cussen Park Wetland and Lake Bartlett at Tatura, a number of other named storages in other parts of the catchment, and swampy areas between Tatura and Merrigum.

Approximately 5km downstream from Tatura, there is a diversion out of the Depression to the north into the Rodney Main Drain system. Capacity is around 240ML/d (2.8m^3/s).

An underground pipe network drains stormwater runoff from the developed areas of Merrigum to the Mosquito Depression Drain.

Flood History

Flooding is known to have occurred at Merrigum in May 1974 and October 1993. Community feedback (WBM, 2005) also identified flooding in 1950, 1954, 1955, 1956 and 1982.

The '74 and '93 events resulted in inundation of roads and properties within the town (see photos below). Both events are thought to be around the 10-year ARI (10% AEP) level.

There is no rainfall or stream gauge data available for any flood producing storms within the catchment in the vicinity of Merrigum.

Flooding in Waverley Avenue, October 1993 (source: WBM, 2005)

Flooding at corner of Judd and Waverley Avenues, October 1993 (source: WBM, 2005)

Flood Behaviour

Flooding at Merrigum has two sources: high intensity short duration storms that lead to localised rapid onset stormwater flooding within the township and long duration (36 hours or so) rainfall events that cause elevated flows within Mosquito Depression.

The nature of flooding in Merrigum is influenced by the very flat grade and meandering nature of the Depression, the railway embankment and associated bridges and culverts, and the Waverly Avenue culverts. Irrigation channels contained by levees affect flood flows outside the town.

Grades are flat and flows sluggish within the Depression. Floods travel slowly with the result that the rise and recession are also slow. It can take several days for a flood to reach a peak and many more for it to drain. In the lower reaches, flooding can persist for anywhere from 14 days to 2 months.

At Merrigum, an initial rise is likely at around 24 to 36 hours after the start of rain. Peak flow could be expected around 4 days later with a return to “non-flood” conditions in a further 5 to 7 days.

Velocities are up to 0.2m/s on the floodplain, 0.2 to 0.5m/s in the natural depression, and up to 1.0m/s in the confined and straightened sections of the Drain.

The depth of flooding along drainage lines and in flood storage areas is generally in the range 1.5m to 2m. Depth on the floodplain varies but is generally less than 500mm.

Flood risk (based on depths and velocities as per ARR 2016) outside the drainage lines and storage areas is consider to be low for adults, children and vehicles

Localised stormwater flooding within town due to capacity constraints within the minor drainage network occurs, in general, much earlier, and is much smaller in magnitude, than resulting from flows in the Mosquito Depression. Similarly, local catchments contribute flows to the Depression ahead of upstream flows. These give the initial rises.

Blockages at drainage infrastructure will increase flood levels and extents.

Flood Impacts

Overview

Flood impacts in and around Merrigum can be significant: multiple road closures, loss of access for residents, disruption to school and child care centre, property isolation, over-floor flooding, risks to emergency personnel during sand bagging and evacuation operations, and damage to buildings constructed below flood level. During major floods, there are also likely to be substantial rural and infrastructure flood damages.

Properties at Risk of Flooding

The majority of the buildings in Merrigum are residential with a small number of commercial and industrial. WBM (2005) noted 218 buildings in Merrigum and a population of around 470.

The number of habitable buildings at risk of being flooded over-floor flooding was calculated by WBM (2005). A summary of that analysis is provided in the table below.

Depth of over-floor flooding (m)	Number of buildings flooded over-floor				
	10% AEP (10yr ARI)	**5% AEP (20yr ARI)**	**2% AEP (50yr ARI)**	**1% AEP (100yr ARI)**	**0.2% AEP (500yr ARI)**
0 – 0.10	4	8	12	17	
0.10 – 0.60	3	9	22	32	
0.60 – 1.50	0	0	1	1	
>1.5	0	0	0	0	
TOTAL	7	17	35	50	73

Caravan Parks

The northern half of the Merrigum Caravan Park begins to be inundated from somewhere between the 100 and 500-year ARI (1% to 0.2% AEP) event.

Known or possible community infrastructure impacts including:

- Telstra exchange
- CFA Fire Station
- Primary school and kindergarten
- Judd Memorial Park including the tennis courts, swimming pool and oval
- Merrigum Golf Course
- Public Hall

Road closures

These are listed in the Flood Intelligence Card below and can also be determined from the flood mapping delivered by WBM (2005). See also FloodZoom.

Flood Mapping

A set of flood inundation maps for Merrigum (depth and water surface elevation) has been produced for emergency management and response purposes (WBM, 2005). Maps were produced for 5 design events (i.e. 10, 20, 50, 100 & 500 year ARI).

Mapping is available from GBCMA and through FloodZoom. The study report (WBM, 2005) is also available through FloodZoom.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the SEMP. During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Shepparton and Tatura to manage the local community.

Flood Intelligence and Action Table for Merrigum

Introduction

Flood impacts described in the following tables relate primarily to flooding from the Mosquito Depression. It should be noted that local impacts, or impacts in excess of those indicated, may occur, especially in the event of locally heavy rain in and around Tatura, especially if that rain coincides with high flows with the Depression. Similarly, local increases in flood levels and impacts may result from local factors such as blockages at culverts and from obstructions within overland flow paths.

Notes:

3. While flood intelligence cards provide guidance on the relationship between flood magnitude and flood consequences, 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. Further, the hydrologic and hydraulic modelling that underpins much of the intell detailed below is informed by a number of assumptions and approximations that are unlikely to be replicated exactly during a flood event. Actual impacts under similar rainfall conditions are therefore expected to be similar but may not be exactly the same: there are likely to be some differences. Additional details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series in Manual 20 "Flood Preparedness".
4. All levels, impacts and actions listed in the following flood intelligence card may need to be adjusted to better reflect experience.

Flood Intelligence Card

Observed Rainfall	**~AEP of flood**	**Consequence / Impact at Tatura** Refer to FloodZoom and to maps at Appendix E	**Action** Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
USING THIS INTELLIGENCE CARD. The observed rainfall range and duration is provided as a guide only. Greater depths of rainfall over a shorter period may also lead to rises and possible flooding along the Mosquito Depression and through Merrigum. While heavy short duration rainfall may lead to localised flash stormwater flooding within Merrigum, the consequences of that are not detailed in this intelligence card. Rainfall reported from the **Tatura AWS** (available from the BoM website at 30 minute intervals and occasionally more frequently and also from FloodZoom) or from local gauges (or perhaps from the Castle Creek at Arcadia gauge - available from the BoM website and FloodZoom)) will provide near real-time data for use herein in order to determine the approximate flood severity. Consider the appropriate flood inundation map remembering that water will rise slowly and travel slowly. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Some actions may need to be initiated in an order that is different from their relative placement in this table.			
~50 to 70mm in 24hrs ~55 to 80mm in 36hrs	<10% AEP (<10yr ARI)	▪ Flow in Mosquito Depression. ▪ Heavy local rain resulting in stormwater flooding and / or high flows within the stormwater drainage network.	▪ Check drainage infrastructure for blockages and clean out as necessary. ▪ Check for flooding over the Merrigum – Ardmona Road town side of Ryan Road and close as necessary. ▪ Check for flooding over Waverly Av north of Judd Av and close as necessary.

Observed Rainfall	~AEP of flood	Consequence / Impact at Tatura Refer to FloodZoom and to maps at Appendix E	Action Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
~55mm in 12hrs ~70mm in 24hrs ~80mm in 36hrs	10% AEP (10yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Merrigum.* ▪ Merrigum Golf Course is flooded and access compromised. ▪ Flooding of all road in town and immediately upstream (i.e. to the east), mostly less than 300mm depth with the exception of the Merrigum – Ardmona Rd which is up to 600mm deep along the edges and Waverly Rd which is up to 500mm deep: Judd Av, Merrigum - Ardmona Rd, Palmer Ct, Ryan Rd, Waverley Av, Wilson Av. ▪ A number of buildings flooded over-floor along Waverley Rd. ▪ 2 buildings flooded over-floor in Judd Av. ▪ Water is encroaching on the Merrigum CFA site at the corner of Morrissey St and Waverley Av with 2 buildings wetted over-floor. The site will soon be fully wet. ▪ Merrigum telephone exchange surrounded by water. ▪ Kindergarten surrounded by water. ▪ 7 buildings flooded over-floor, 3 up to a depth of 600mm.	▪ Close the Merrigum – Ardmona Road and Morrissey Av if not already done. ▪ Review road flooding and adjust signage and closures as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Merrigum at Appendix E of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure for blockages and clean out as necessary. ▪ Review evacuation plan and prepare for implementation noting that water will soon cover the entire town if it continues rising to the 5% AEP flood level. ▪ With the ICC and Goulburn Broken CMA, raise the possibility of installing one or more PALS in Mosquito Depression upstream of, at, and downstream from Merrigum. The intention is to collect height data to enable development of more robust flood guidance tools. ▪ Record flood levels and impacts for later update of this table. This information, when used in conjunction with similar information from Tatura, could assist the development of a flood warning / prediction system for Merrigum.
~64mm in 12hrs ~81mm in 24hrs ~92mm in 36hrs	5% AEP (20yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows but no real flooding issues in Merrigum.* ▪ All flow paths are running a bit deeper and a bit wider. Velocities still slow. ▪ Most of the town on the upstream (i.e. east) side of the railway line is now wet. ▪ 17 buildings flooded over-floor, 9 up to a depth of 600mm. ▪ Primary school flooded and access along Judd Av compromised. ▪ Water beginning to pond on the upstream (i.e. east) side of No 7 channel on the east side of Byrneside - Kyabram Rd. ▪ Isolation likely to become an issue.	▪ Consider evacuating the town if flooding likely to get any worse. ▪ Review road flooding and adjust signage and closures as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Consider how to assist nursing staff maintain access to the hospital and aged care facility in Hunter St. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. This could include removing any build-up of soil in the culverts at Gowie St and Hogan St.

Observed Rainfall	~AEP of flood	Consequence / Impact at Tatura Refer to FloodZoom and to maps at Appendix E	Action Actions may include (but not limited to) evacuation, closure of roads, sandbagging, issue of warnings and who is responsible
~76mm in 12hrs ~99mm in 24hrs ~112mm in 36hrs	2% AEP (50yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows at Merrigum with the possibility of some flooding.* ▪ All flow paths are running a bit deeper and a bit wider. Velocities still slow. ▪ The Judd Memorial Park and oval, tennis courts and public pool are beginning to flood – the recreational facilities on the west side of the railway line. ▪ Public Hall surrounded by water. ▪ 35 buildings flooded over-floor, 22 up to 600mm and 1 up to a depth of 1.5m. ▪ Water has broken over No 7 channel and is flowing across the Byrneside - Kyabram Rd.	▪ Review road flooding and adjust signage and closures as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary. .
~85mm in 12hrs ~111mm in 24hrs ~128mm in 36hrs	1% AEP (100yr ARI)	*The 12 hour rainfall is likely to cause some increase in flows at Merrigum with the possibility of some flooding.* ▪ All flow paths are running a bit deeper and a bit wider. Velocities still slow. ▪ 53 buildings flooded over-floor, 32 up to 600mm and 1 up to a depth of 1.5m. ▪ All buildings along Waverley Av and around the corner into Morrissey St are flooded over-floor. ▪ Most of the buildings on Judd Av and Wilson Av and 1 in Palmer Ct are flooded over-floor. ▪ Railway station is wet and railway line is flooded.	▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 1% AEP flood map for Tatura at Appendix E of this MFEP. ▪ Review road flooding and adjust signage and closures as necessary. ▪ Sandbag or otherwise assist household likely to flood over-floor. Refer to the 10% AEP flood map for Tatura at Appendix F of this MFEP. ▪ Monitor water levels. ▪ Check drainage infrastructure, particularly in vicinity of the railway bypass for blockages and clean out as necessary.
	0.2% AEP (500yr ARI)	▪ All flow paths are running deeper and a bit wider. Velocities still slow. ▪ 73 buildings flooded over-floor. ▪ Skate park flooded.	▪ Move caravans and other assets from the northern half of the Caravan Park to higher ground. ▪ Review road flooding and adjust signage and closures as necessary. ▪ Monitor water levels. ▪ Check drainage infrastructure for blockages and clean out as necessary.

Asset register						
	Asset Name and location	Observed Rainfall	AEP % of flood	Water level [insert location gauge]	Consequence / Impact	Mitigation/ Action
To be updated when relevant data is available						

Provide a general overview of flooding consequence. * Modify Table to suit.

What areas are affected? ***To be updated when relevant data is available***

- Caravan parks likely to be affected
- How many properties?
- How much warning time?
- Impacts on essential community infrastructure
- Isolation risks
- Major road closures
- Locations where evacuation difficulties may occur

Flood Mitigation

To be updated when relevant data is available

Provide a broad overview of any flood mitigation systems/measures:
Where do levees and retarding basins exist? What communities do they protect? Who manages them? What are their design heights relative to gauge? What are their crest heights relative to gauge? Location of any spillways? Details of any levee closure points such as railway crossing, which may need to be sandbagged.

Flood Impacts and Required Actions *To be updated when relevant data is available*

Populate the following tables using all available information. Typically, this includes:

- Deliverables from flood, drainage and other studies;
- Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);
- Hydraulic modelling / flood inundation animations;
- Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (i.e. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc.
- Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent); NOTE: Local Flood Guides in **Appendix G**
- Community and agency knowledge;
- Any known or possible community infrastructure impacts including:
  - Any sewer pumps likely to be inundated;
  - Any groundwater wells likely to be inundated;
  - Water treatment plants and water storage areas to be affected;
  - Telecommunications equipment
- Pumps and other service equipment etc. likely to be inundated;
- Look to agencies – BoM FW directives, Council's MEMP, CMA FW directive and associated information, etc.

Note: intelligence MUST have regard for changes within catchments that modify likely flood behaviour (e.g. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note: In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Appendix D - Flood evacuation arrangements

Phase 1 - Decision to Evacuate

The role of evacuation manger is the responsibility of Victoria Police. Therefore, the decision to evacuate is to be made in consultation with the MEMO, MERC, DFFH, Health Commander and other key agencies and expert advice (CMA's and Flood Intelligence specialists).

Once the Incident Controller has made the decision to evacuation the IC must notify Victoria Police representative, IMT, IEMT, agency chain of command and incident personnel.

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.

The table below details triggers for evacuation, if these heights are predicted or are likely to occur evacuation should be considered

Sector	Gauge	Trigger
Balmoral Estate	Shepparton Seven Creeks	11.10 6.60
Victoria Lake Caravan Park	Shepparton	11.18
The Boulevard & Wanganui Estate	Shepparton	11.30
Taylors & Halls Estate	Shepparton	11.30
Riverpark Estate	Shepparton	11.38
Tarcoola Retirement Homes	Shepparton	11.53
Princess Park Sports Complex	Shepparton	11.66

The table below details time required to evacuate established areas.

Sector	Likely time required for evacuation (including resource assumptions)
Balmoral Estate	8 hours
Victoria Lake Caravan Park	24 hours
The Boulevard & Wanganui Estate	48 hours
Taylors & Halls Estate	20 hours
Riverpark Estate	40 hours
Tarcoola Retirement Homes	24 hours
Princess Park Sports Complex	10 hours

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/VICROADS 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.

Possible Evacuation Routes to be used:

Sector	Evacuation Route	Evacuation route closure point and gauge height of closure
Balmoral Estate	Goulburn Valley Highway	Balmoral Street/GV Highway; 11.10m
Victoria Lake Caravan Park	Goulburn Valley Highway	Fitzjohn Street & GV Highway 11.18m
The Boulevard & Wanganui Estate	Balaclava Road, Parkside Drive, Wanganui Road	Balaclava Road, Parkside Drive, Wanganui Road 11.28m
Taylors & Halls Estate	Goulburn Valley Highway	Guthrie and Longstaff Streets 11.30m
Riverpark Estate	Goulburn Valley Highway	Macintosh & Wilmot Roads and Lachlan Crescent 11.38m
Tarcoola Retirement Homes	Balaclava Road	Balaclava Road/The Boulevard 11.53m
Princess Park Sports Complex	Nixon Street	Nixon and Marungi Streets 11.66m

Landing zones for helicopters (if possible) are located at:

- Shepparton Airport (Greater Shepparton City Council: Shepparton Aerodrome Manager)
- Sports fields (as necessary)

Special needs groups will be/are identified in Council's 'residents at risk' register. This can be done through community network organisations. Further information on Council's 'residents at risk' register can be obtained from MEMO, MRM and VicPol

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. The flood relief centres and/or Assembly Areas are listed in the table below:

Sector	Shelter type (Relief Centre/ Assembly Area (include address)	Comments

VICPOL in consultation with VICSES will liaise with Local Government and DFFH (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. These facilities may be located at locations detailed below and coordinated by Shepparton MEMP.

Sector	Animal Shelter (include address)	Comments
Greater Shepparton	Municipal Pound Wanganui Road, Shepparton 5821 2813	Pets and other small animals
Greater Shepparton	Municipal Saleyards New Dookie Road, Shepparton 5821 4462	Large animals and livestock

Caravans

Caravans or caravan parks may be relocated to the following locations:

Sector	Caravan evacuation location (include address)	Comments

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.

Service	Impact	Trigger Point for action	Strategy/ Temporary Measures
Victoria Lake Caravan Park Sewerage system	Possible backflow of sewerage	11.18m	Turn off pumps and plug the sewer
Victoria Park Lake filling & recycle pumps	Damage to pumps if flooded	11.18m	Remove the electric motors
Sewerage to The Boulevard, Wanganui and Tassiker Estates	Inflow of floodwater into sewerage system- overload	11.28m	GVW to plug sewer system
Sewerage to Taylors Estate and surrounds	Inflow of floodwater into sewerage system- overload	11.30m	GVW to plug sewer system
Midland Highway access across causeway to Mooroopna	Loss of access	12.00m	VicRoads to manage access for emergency vehicles only

Essential Community Infrastructure and Property Protection

Essential Community Infrastructure and properties (e.g. residences, businesses, roads, power supply etc.) that require protection are:

Facility	Impact	Trigger Point for action	Strategy/ Temporary Measures
Municipal Offices **90 Welsford Street**	Loss of MECC	12.00m	Relocate MOC to 315 Doyles Road, Orrvale. **However, accessibility will depend on Broken River flood levels and flooding along Doyles Road.**
Power supply	Loss of electricity, safety	300mm of water around ground level substations	Powercor to sandbag
GVW Treatment Plant	Treatment plant issues, but production will continue.	11.9m	GVW have detailed action plan
GVW sewerage pumps	Adversely affected.	11.9m	GVW have detailed action plan

Greater Shepparton City Council will establish a sandbag collection point at:

- Shepparton Showgrounds, Thompson Street, Shepparton
- Council depot in Mooroopna Recreation Reserve, Midland Highway, Mooroopna

Rescue

Known high-risk areas/communities where rescues might be required include:

1. **Kialla Settlement, Riverview Drive**
2. **Arcadia Downs Estate**
3. **Kidstown Tourist facility**

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.

Local Flood Warning System Arrangements

G-MW monitors levels and flows at gauging stations on the Goulburn River and tributaries upstream of Lake Eildon, between Lake Eildon and Goulburn Weir and downstream of Goulburn Weir to meet its core business requirements and in the past has also provided considerable assistance in flood predictions for Shepparton.

A 1925 agreement established the Loch Garry Flood Protection District to reduce the frequency of flooding to downstream landholders. The operating rules for Loch Garry were developed in 1932 and have until recently changed little in the interim. The original rules required a staged removal of drop bars from the Loch Garry regulator to commence 24 hours after the Goulburn River at Shepparton reached 10.36 m (34 feet). If the river continued to rise at Shepparton, drop bars would be progressively removed until all bars were removed by the time the river reached 10.97 m (36 feet) at Shepparton. Drop bars would be replaced in reverse order when the flood peak at Shepparton has passed.

The operation of the Loch Garry regulator requires timely forecasts of river level at Shepparton to mobilise and deploy work crews and provide sufficient notification to landholders to enable stock to be removed from land that will be flooded.

A review by G-MW in early 2006 identified safety issues associated with night time operation of the existing Loch Garry regulator. As a consequence of this review, G-MW has decided to confine operation of the Loch Garry regulator in its current form to daylight hours. As far as is possible, G-MW will operate the Loch Garry regulator to preserve the intent of the 1932 operating rules.

G-MW's existing flood prediction technique for the Goulburn River at Shepparton involves manual extraction of river level data obtained from a variety of telephone based telemark and synthesised voice recorders. The flow for each site is then manually derived from rating tables and entered on a spread sheet where forecasts

of peak flows and river levels at Shepparton are produced by lagging flows and making appropriate allowance for losses on the floodplain.

While this flood forecast spread sheet technique has been updated and refined since 2004, including a graphical component, the method is cumbersome, labour intensive and requires a considerable amount of skill to arrive at a reliable estimate of the peak flood level at Shepparton. G-MW believes that it is no longer appropriate for G-MW to provide a flood prediction service for Shepparton, and this role better rests with the Bureau of Meteorology. G-MW is also of the view that the development of a suite of rainfall-runoff models by the Bureau of Meteorology for the Goulburn River and tributaries utilising an enhanced data collection network and sophisticated computer models will render G-MW's present flood forecasting role redundant.

In an exchange of letters G-MW, Bureau of Meteorology and Greater Shepparton City Council have agreed that G-MW will as from 1 July 2006 cease providing a flood forecasting service and the Greater Shepparton City Council has agreed to rely on flood forecasts provided by the Bureau of Meteorology.

Appendix E: Maps and Schematics

The Shepparton Mooroopna Flood Mapping and Flood Intelligence project (Water Technology, 2019) produced a suite of flood maps for each flow dominance scenario (e.g. Goulburn River dominant, Broken River/Seven Creeks dominant, and a neutral or no dominance scenario) that include maximum depth, velocity, water surface and flood hazard, similar to the one above. The suite comprises mapping for seventeen (17) different heights at the Goulburn River at Shepparton gauge. The approximate gauge heights are 9.5 (minor flood level), 9.7, 9.9, 10.1, 10.5, 10.7 (moderate flood level), 10.9, 11.0 (major flood level), 11.1, 11.3, 11.5, 11.7, 11.9, 12.1, 12.2, 12.3 and 12.5 m. There are a total of 204 maps.

All of the flood maps (and reports) are available through FloodZoom.

Further, a deliverable from the study was a web-based flood and property information portal for community use. The portal enables flood maps for the various dominance scenarios (e.g. neutral, Goulburn River dominant, Broken-Sevens dominant) to be displayed as well as flood related information for a user-specified property. That information is presented as a report that includes all available flood information for that property.

The maps and reports provide a means for community members to inform themselves of the likelihood of their property being inundated and the likely depths of inundation for a range of levels at the Shepparton gauge.

The web-based flood and property information portal can be accessed at http://www.floodreport.com.au/

The full range of flood inundation maps for the Shepparton area are kept electronically on Greater Shepparton City Council's Crisisworks and the VICSES G drive: G:\Data\AAA North East Operations\Flood Management\Flood Intelligence and Planning\Shepparton-Mooroopna

Flood mapping is also available through FloodZoom (this will be uploaded on completion of the study).

Local Flood Guides are available for all residents within the City of Greater Shepparton to assist them in preparing for future flood events. Refer to Appendix G for a sample.


Murray River
SHEPPARTON
IRRIGATION REGION
Cobram
Lake Mulwala
Yarrawonga
Nathalia
Numurkah
Echuca
Goulburn River
Broken Creek
Kyabram
Shepparton
Broken River
Tatura
Waranga Reservoir
Rushworth
BROKEN
GOULBURN REGION
Benalla
Broken River
Lake Nagambie
Euroa
Nagambie
Lake Nillahcootie
Seymour
Lake Eildon
Mansfield
Goulburn River
Alexandra
Yea
Broadford
Kilmore
Jamieson
Marysville
Woods Point
N
W
E
S
1:1,000,000
0 10 20 Kilometers

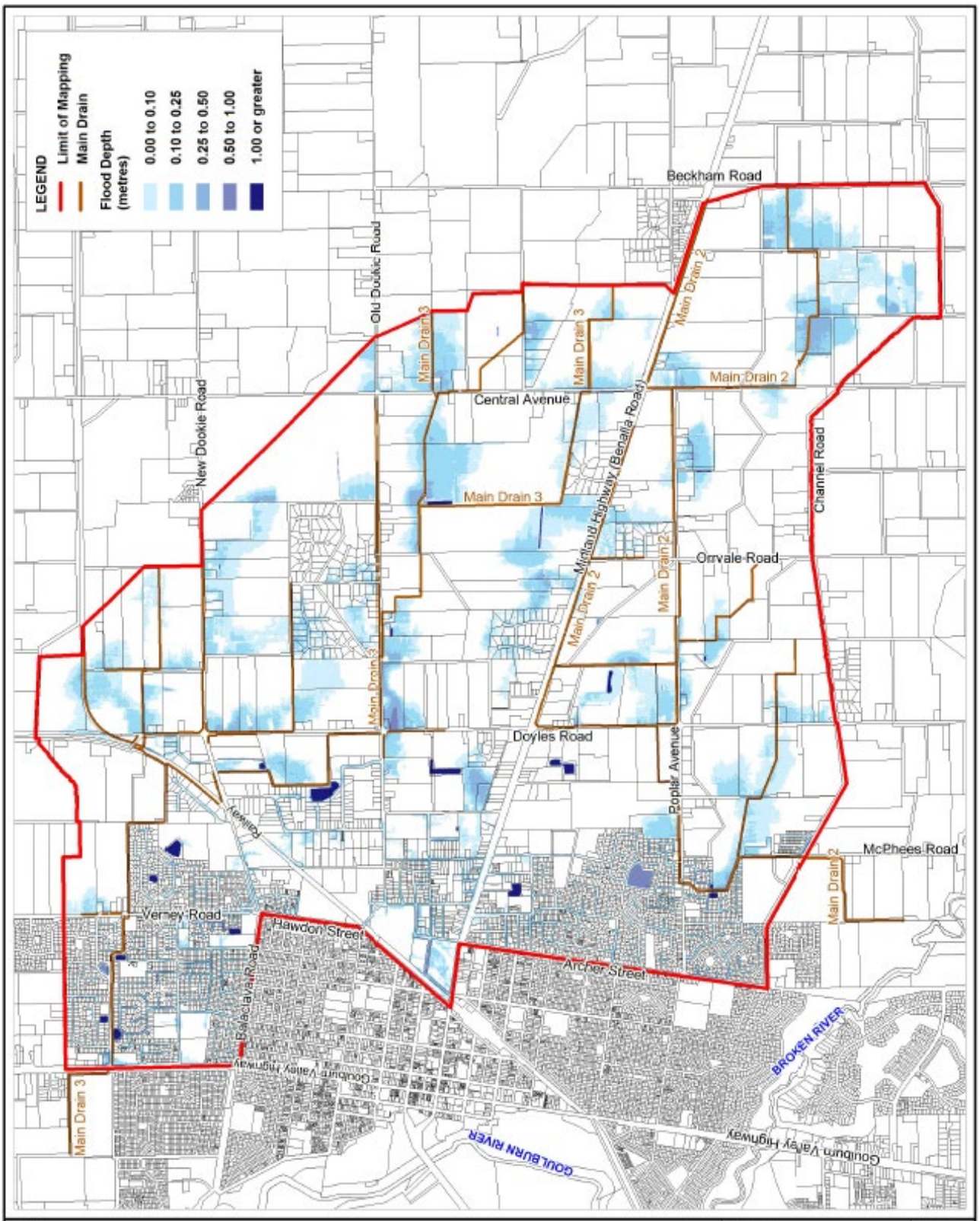
Goulburn River Catchment

N

Kilometers
0 10 20 40

Scale at A4 1:1,000,000

- Township
- Rail Line
- Major Road
- Major River
- River/Creek
- 1% AEP Flood
- Goulburn River Catchment
- Lake/Swamp



Title:
Shepparton East
Existing Conditions 20% AEP Peak Flood Depth

Figure: **E-1**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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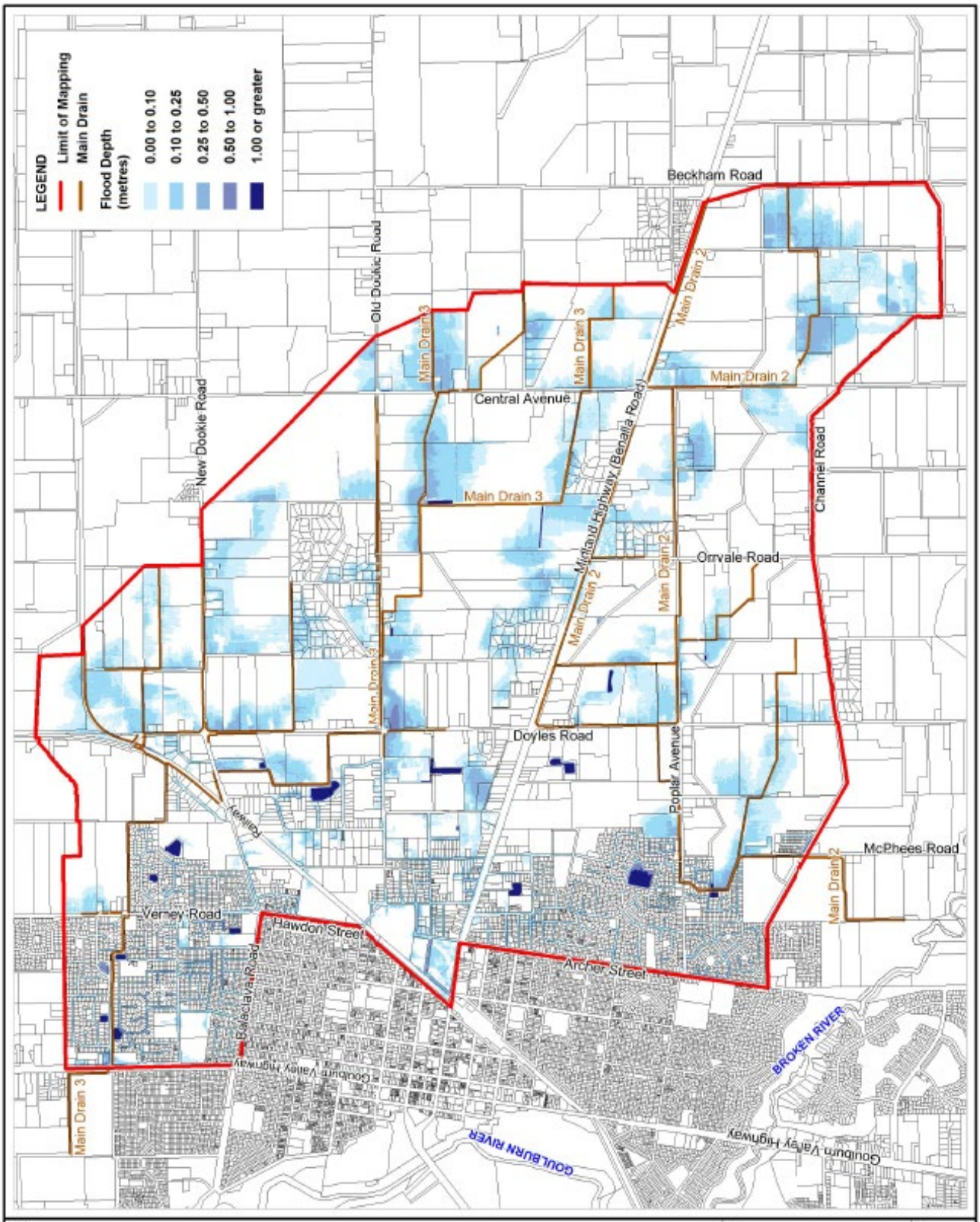

Title:

Shepparton East
Existing Conditions 10% AEP Peak Flood Depth

Figure: **E-2**

Rev: **A**

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N

0 0.75 1.5km

Approx. Scale

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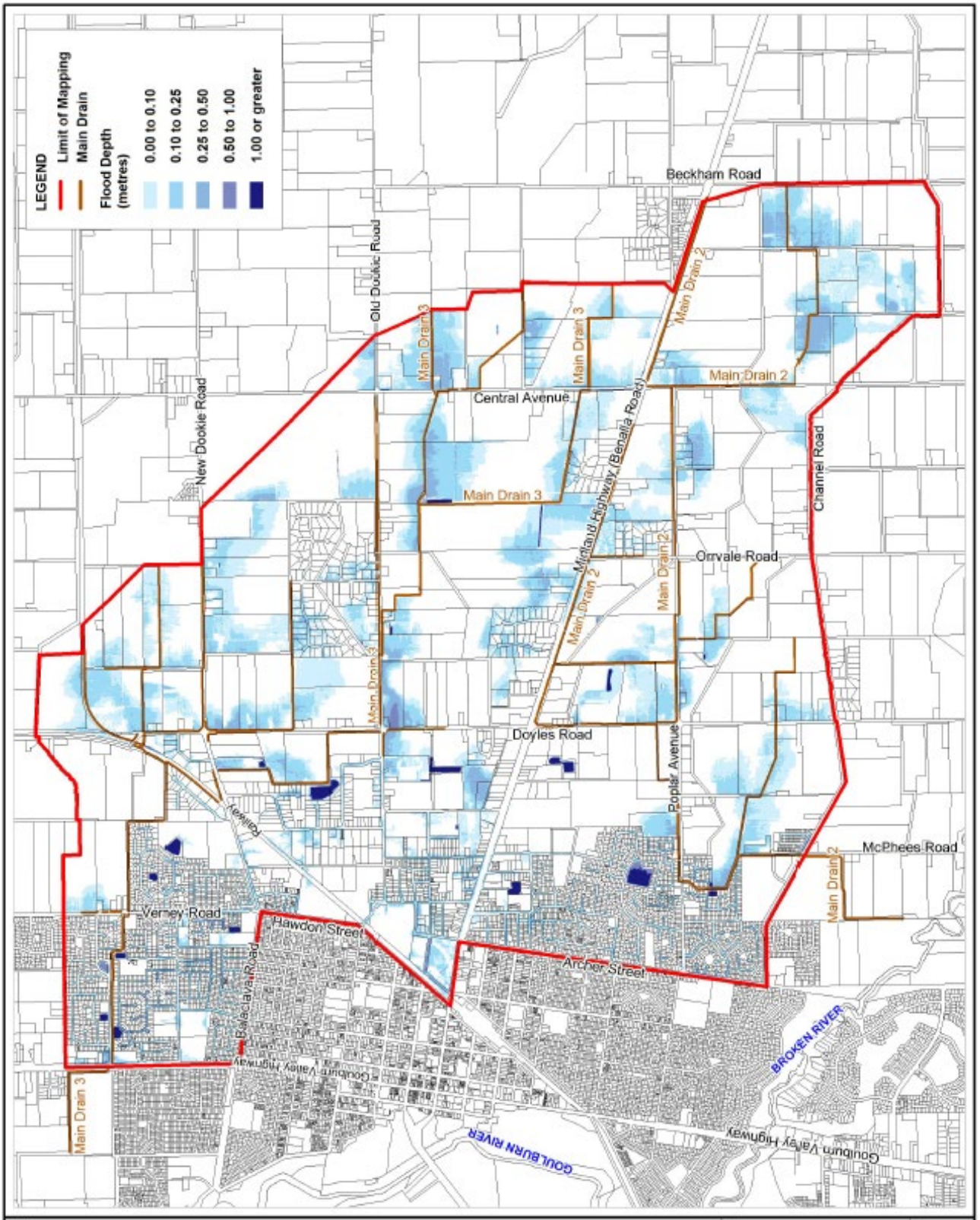

Title:

Shepparton East
Existing Conditions 10% AEP Peak Flood Depth

Figure: **E-2**

Rev: **A**

N

0 0.75 1.5km

Approx. Scale

BMT WBM
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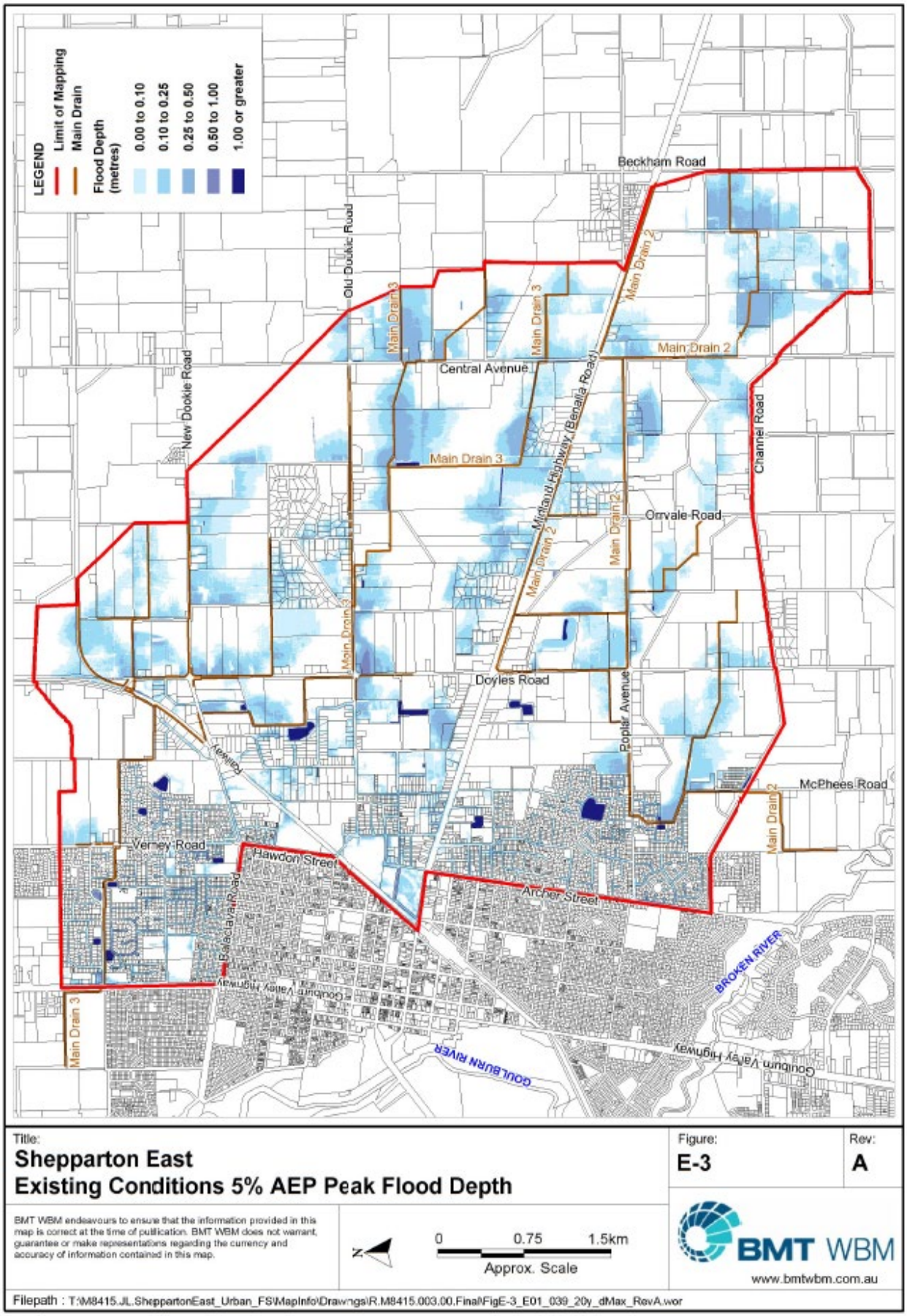

Title:

Shepparton East
Existing Conditions 5% AEP Peak Flood Depth

Figure: **E-3**

Rev: **A**

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N

0 0.75 1.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

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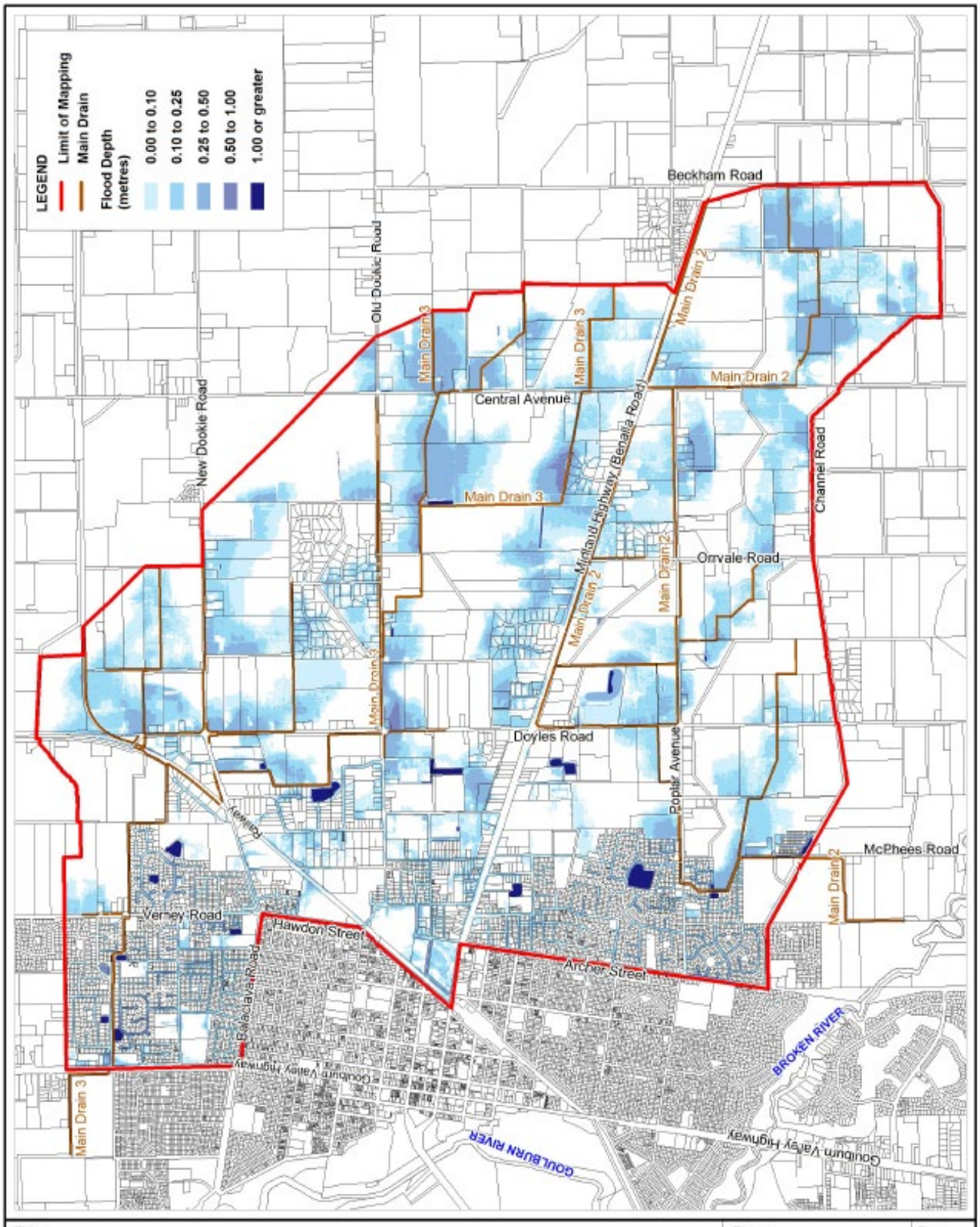

Title:

Shepparton East
Existing Conditions 2% AEP Peak Flood Depth

Figure: **E-4**

Rev: **A**

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0 0.75 1.5km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

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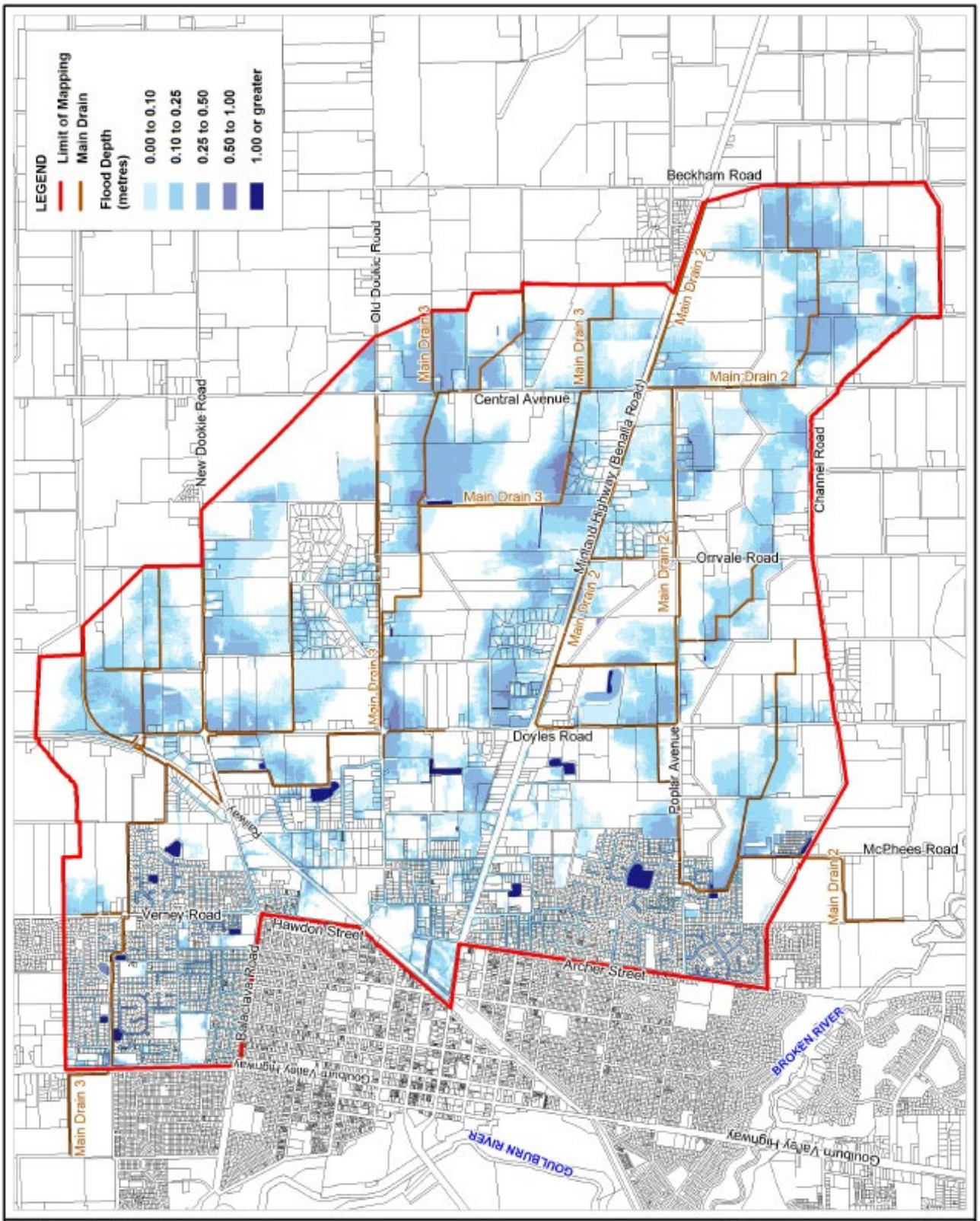


Title:
Shepparton East
Existing Conditions 1% AEP Peak Flood Depth

Figure: **E-5**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

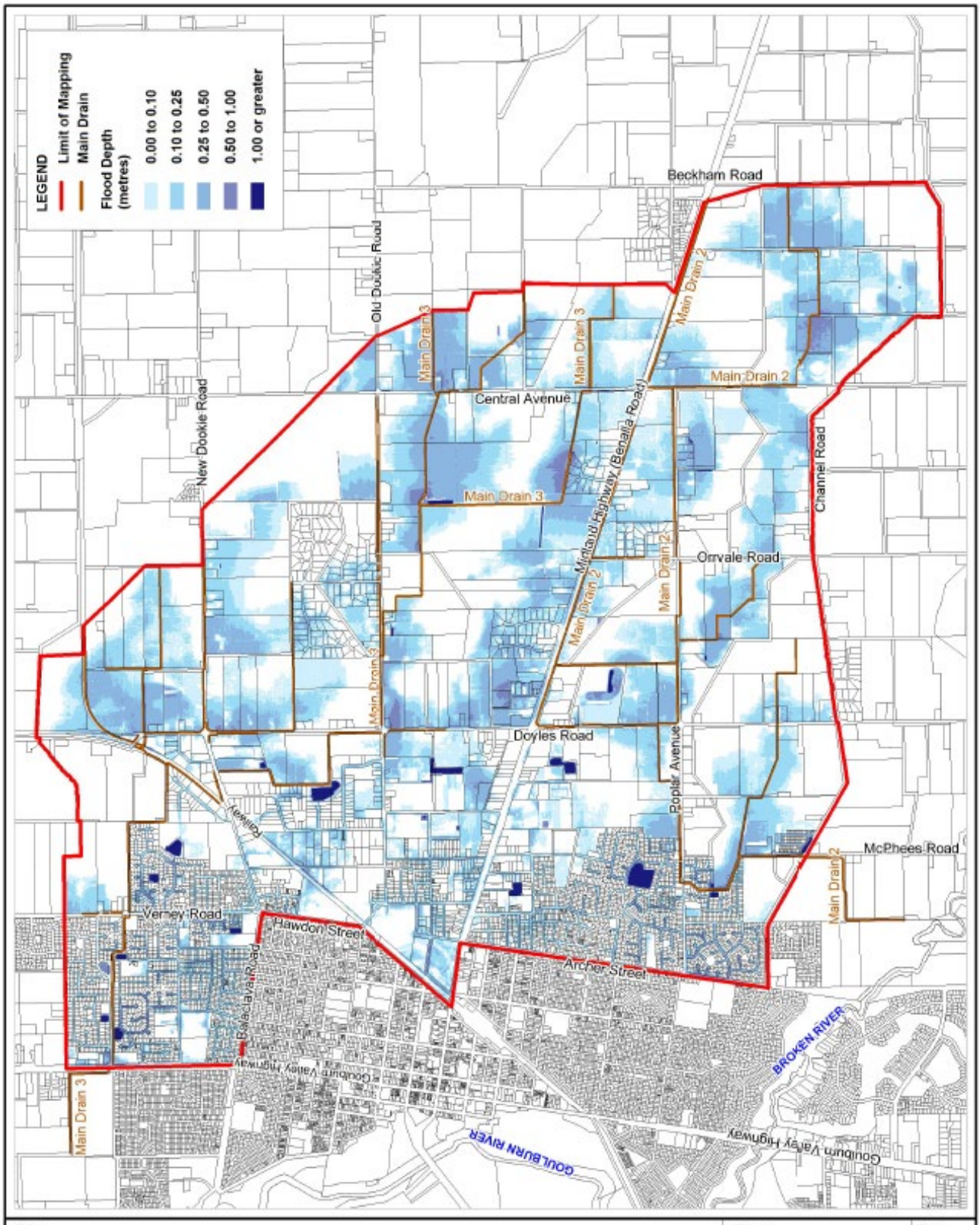
N

0 0.75 1.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\FigE-5_E01_039_100y_dMax_RevA.wor



Title:

Shepparton East
Existing Conditions 0.5% AEP Peak Flood Depth

Figure: **E-6**

Rev: **A**

N

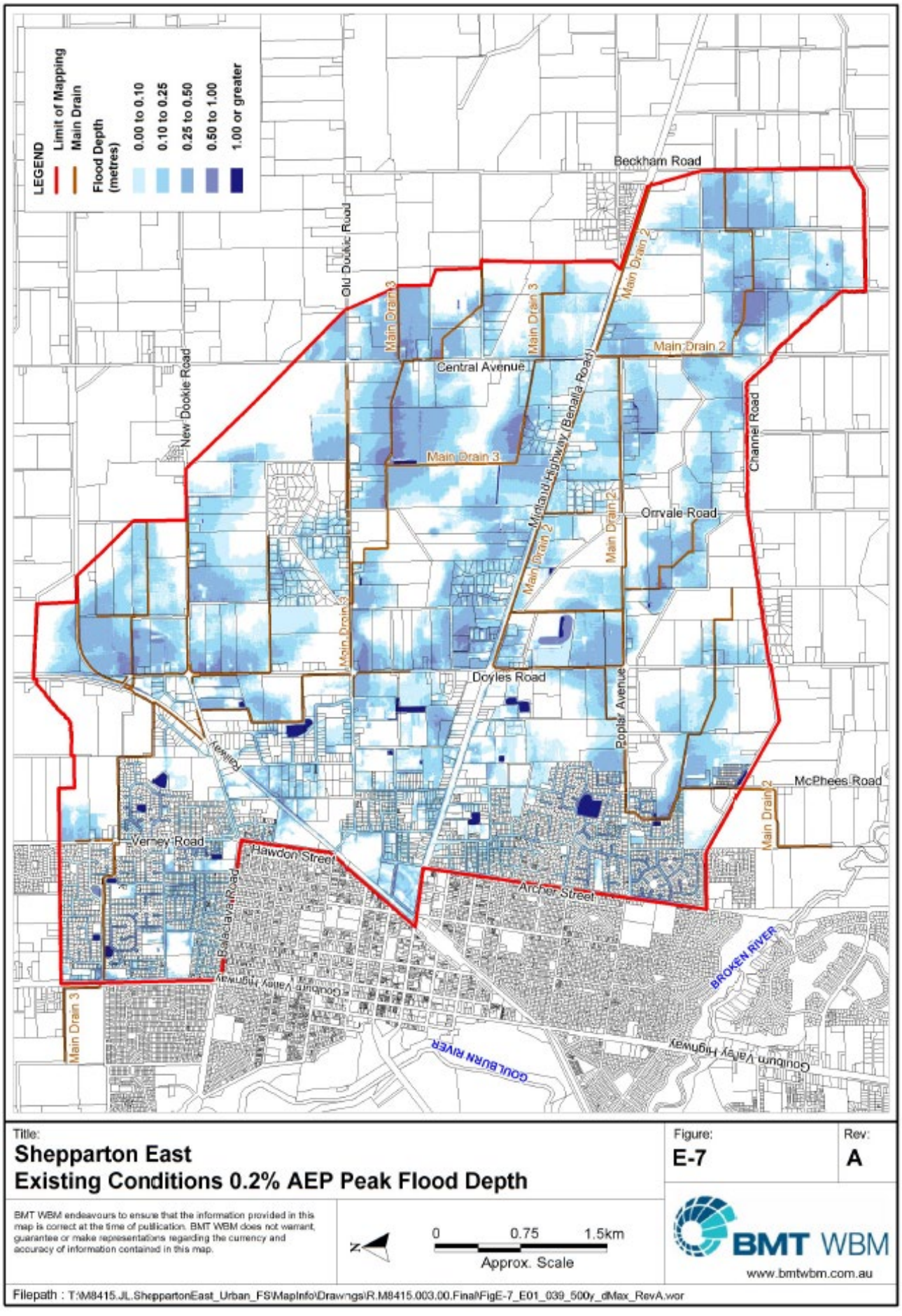
0 0.75 1.5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\FigE-6_E01_039_200y_dMax_RevA.wor



Title:

Shepparton East
Existing Conditions 0.2% AEP Peak Flood Depth

Figure: **E-7**

Rev: **A**

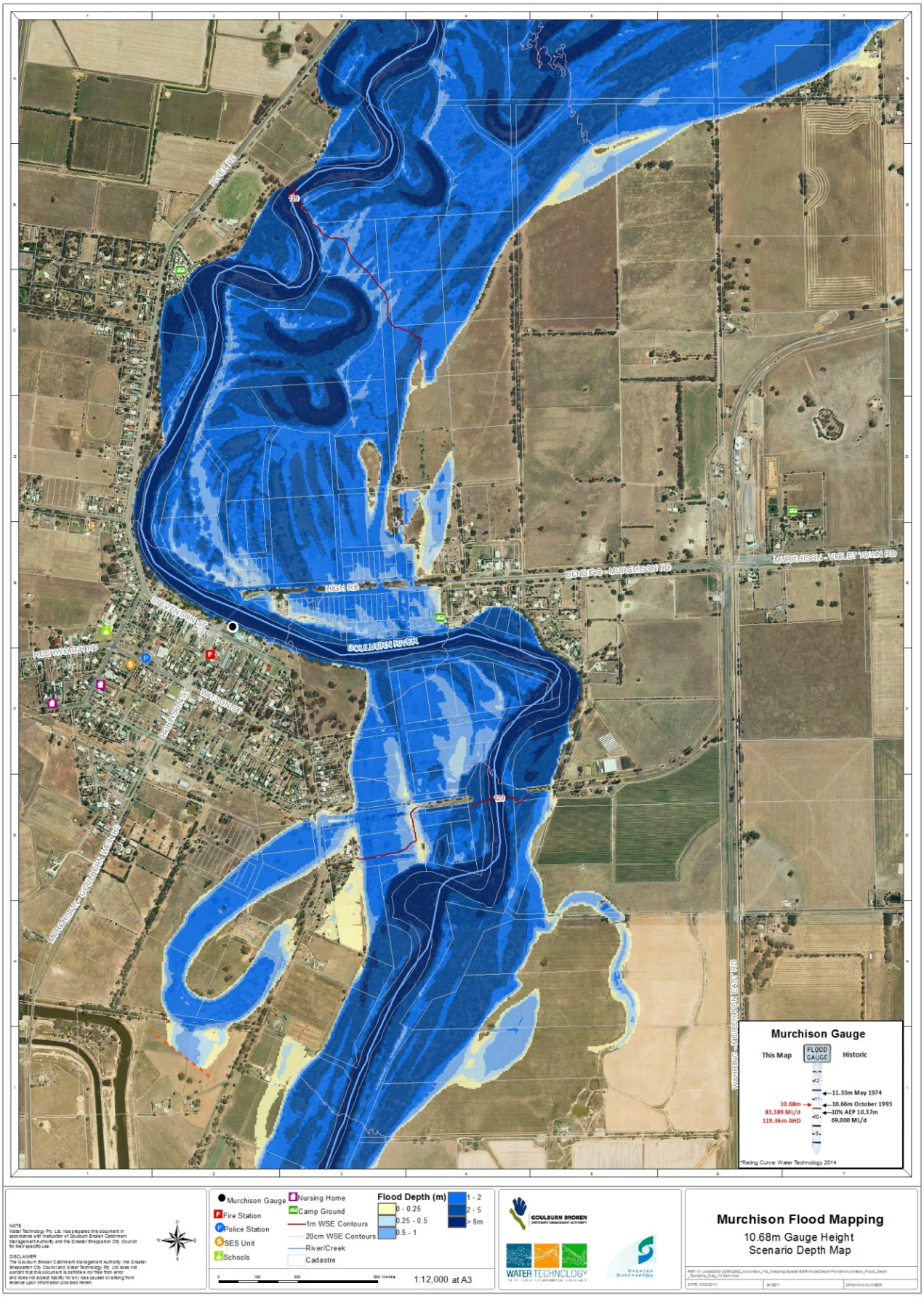
N

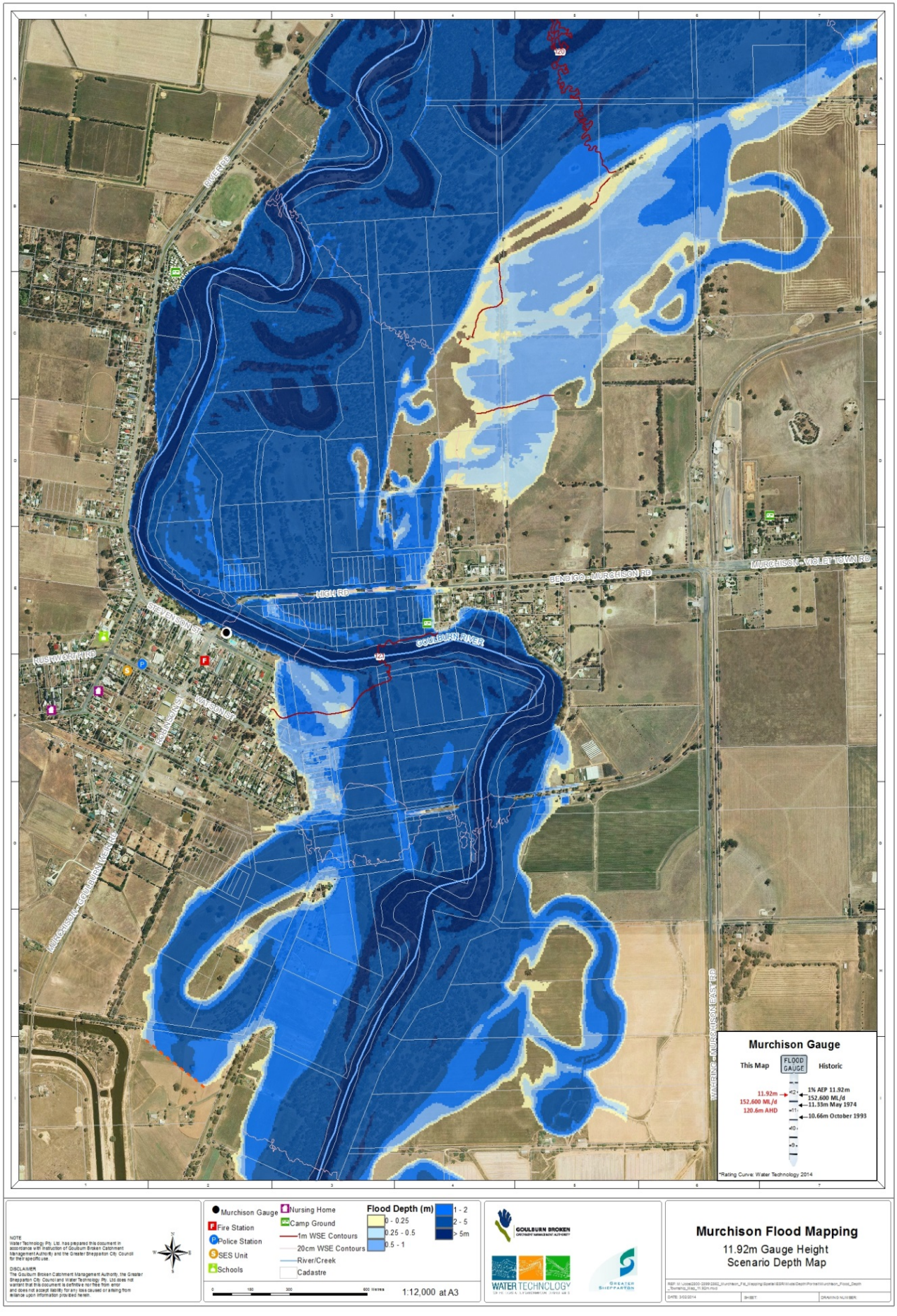
0 0.75 1.5km

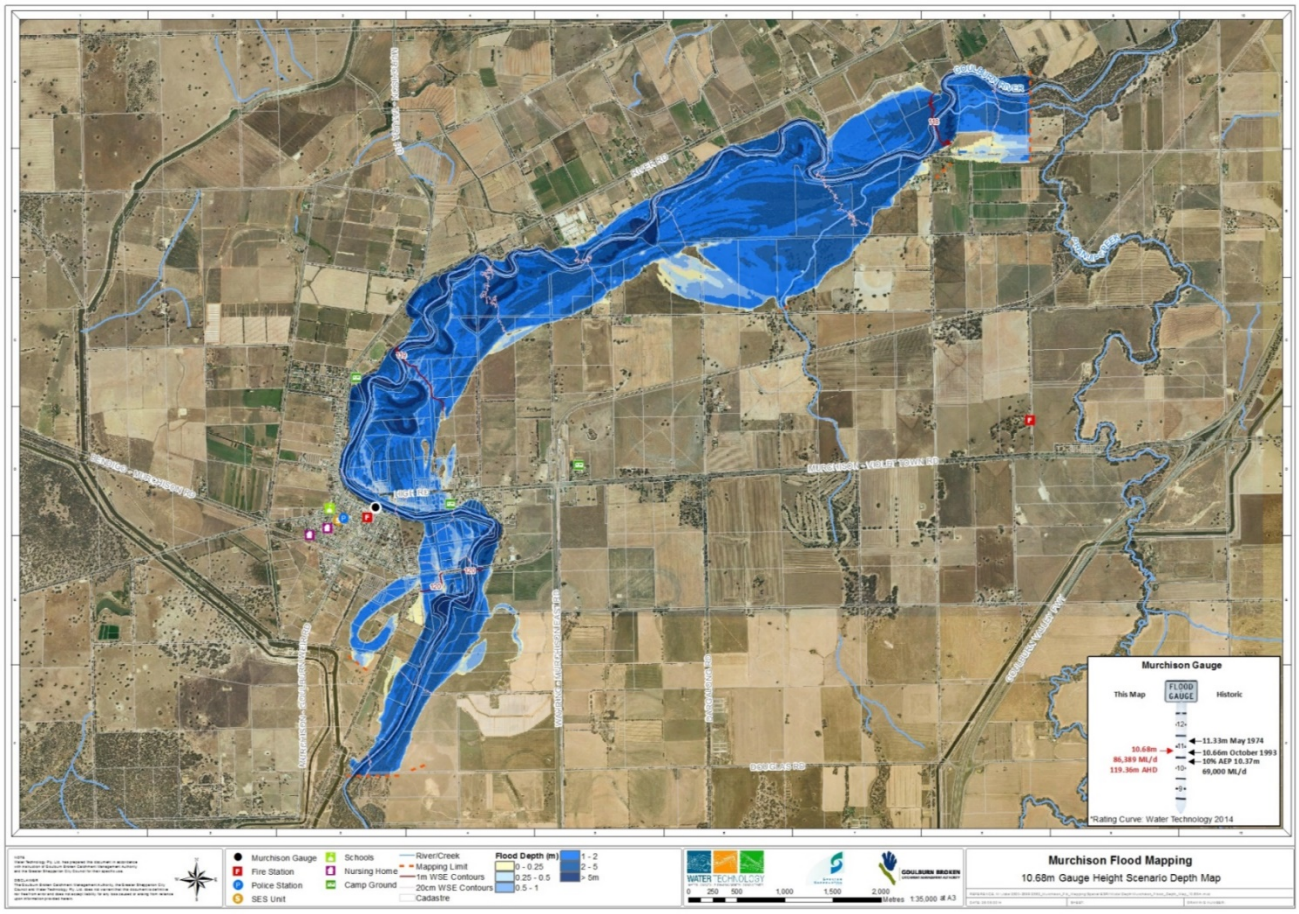
Approx. Scale

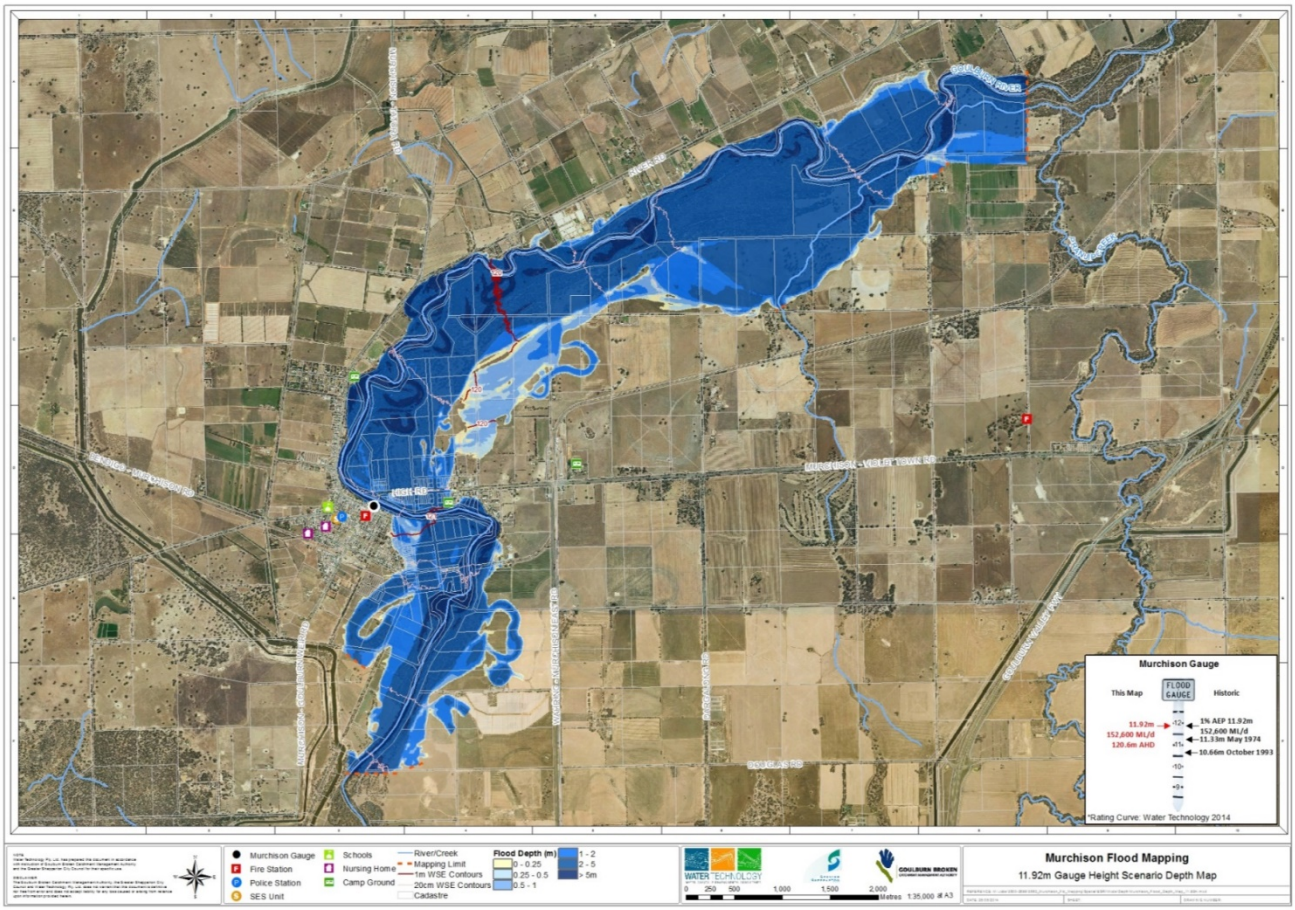
BMT WBM
www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\FigE-7_E01_039_500y_dMax_RevA.wor


RIVER RD
HIGH RD
BENDIGO - MURCHISON RD
MURCHISON - VIOLET TOWN RD
GOULBURN RIVER
MURCHISON - GOULBURN WEIR RD
WAHRING - MURCHISON EAST RD
Murchison Gauge
This Map
FLOOD GAUGE
Historic
11.33m May 1974
10.68m
83,389 ML/d
119.36m AHD
10.66m October 1993
10% AEP 10.37m
69,000 ML/d
*Rating Curve: Water Technology 2014
Murchison Gauge
Fire Station
Police Station
SES Unit
Schools
Nursing Home
Camp Ground
1m WSE Contours
20cm WSE Contours
River/Creek
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
1:12,000 at A3
Murchison Flood Mapping
10.68m Gauge Height
Scenario Depth Map


RIVER RD
HIGH RD
GOULBURN RIVER
BENDIGO - MURCHISON RD
MURCHISON - VIOLET TOWN RD
MURCHISON - TATURA RD
MURCHISON - GOULBURN WEIR RD
Murchison Gauge
This Map
FLOOD GAUGE
Historic
11.92m
152,600 ML/d
120.6m AHD
1% AEP 11.92m
152,600 ML/d
11.33m May 1974
10.66m October 1993
*Rating Curve: Water Technology 2014
Murchison Gauge
Fire Station
Police Station
SES Unit
Schools
Nursing Home
Camp Ground
1m WSE Contours
20cm WSE Contours
River/Creek
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
1:12,000 at A3
GOULBURN BROKEN
WATER TECHNOLOGY
Murchison Flood Mapping
11.92m Gauge Height
Scenario Depth Map


Murchison Gauge
This Map
FLOOD GAUGE
Historic
11.33m May 1974
10.66m October 1993
10% AEP 10.37m
69,000 ML/d
10.68m
86,389 ML/d
119.36m AHD
Rating Curve: Water Technology 2014
Murchison Gauge
Fire Station
Police Station
SES Unit
Schools
Nursing Home
Camp Ground
River/Creek
Mapping Limit
1m WSE Contours
20cm WSE Contours
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
Metres
1:35,000 @ A3
Murchison Flood Mapping
10.68m Gauge Height Scenario Depth Map


Murchison Gauge
This Map
FLOOD GAUGE
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152,600 Ml/d
120.6m AHD
1% AEP 11.92m
152,600 Ml/d
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10.66m October 1993
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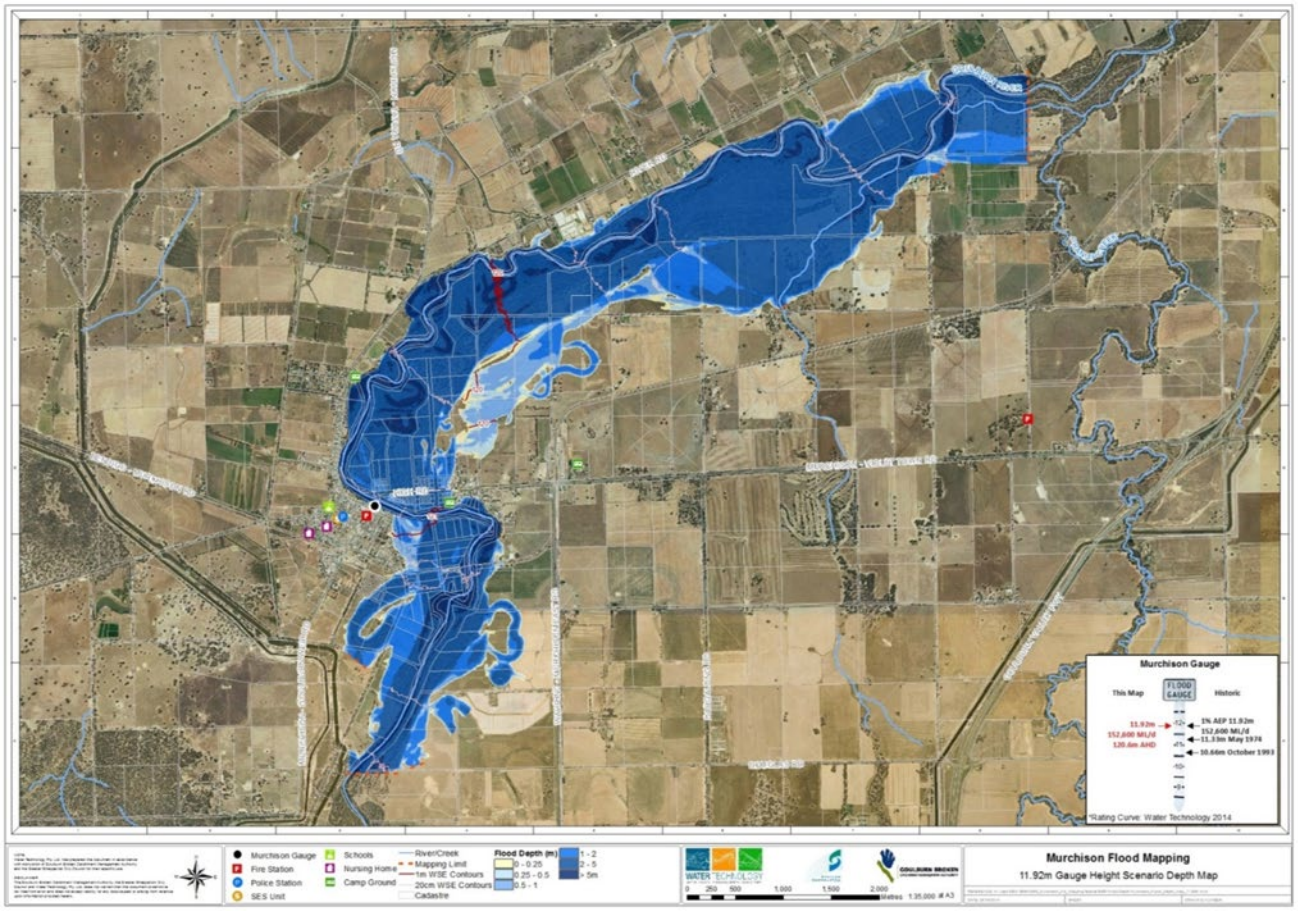
Mapping Limit
1m WSE Contours
20cm WSE Contours
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
Metres
1:35,000 @ A3
Murchison Flood Mapping
11.92m Gauge Height Scenario Depth Map


Murchison Gauge
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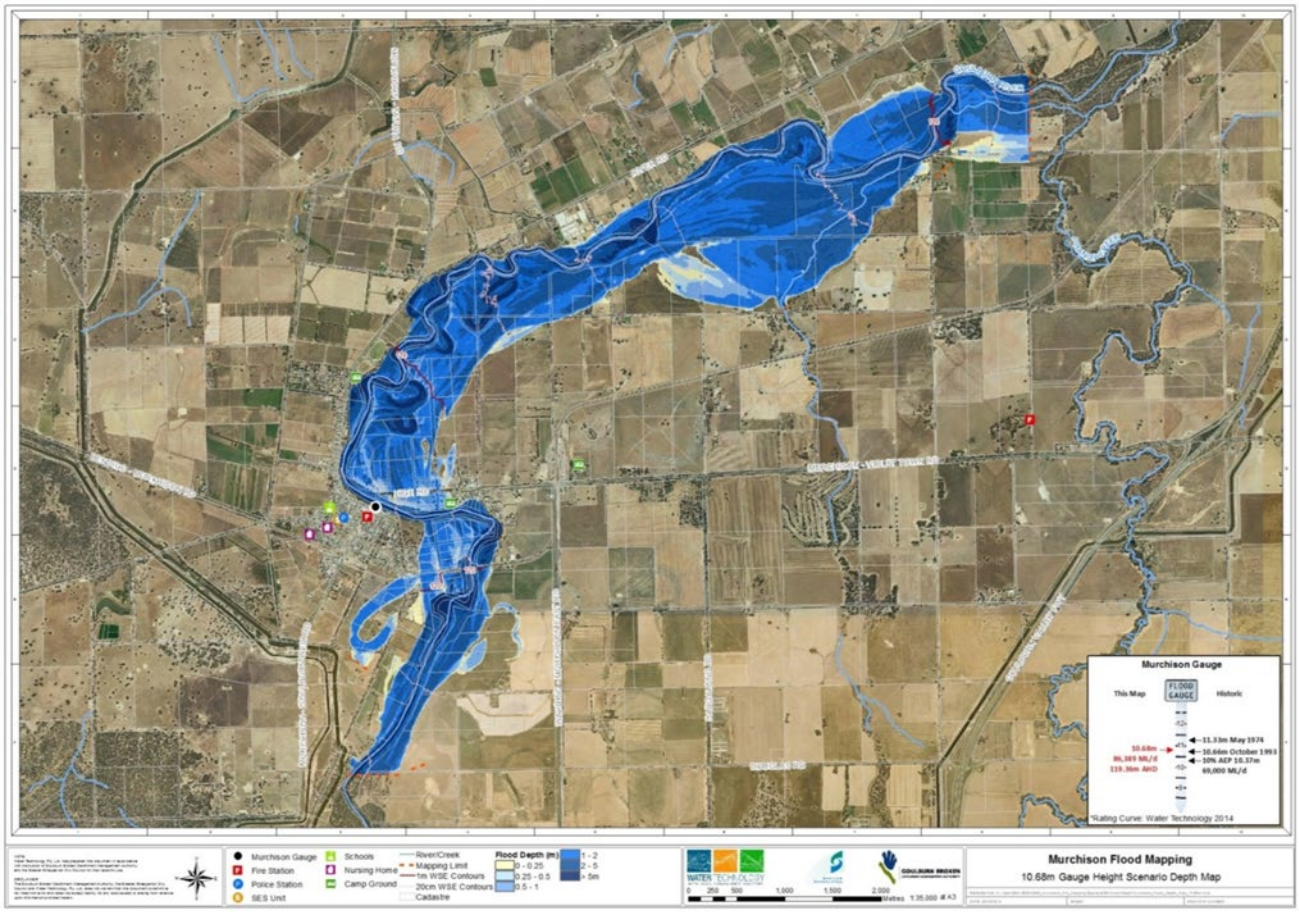
120.4m AHD
1% AEP 11.92m
152,600 ML/d
11.13m May 1974
10.66m October 1993
*Rating Curve: Water Technology 2014
Murchison Gauge
Fire Station
Police Station
SES Unit
Schools
Nursing Home
Camp Ground
River/Creek
Mapping Limit
1m WSE Contours
20cm WSE Contours
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
Murchison Flood Mapping
11.92m Gauge Height Scenario Depth Map


Murchison Gauge
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11.13m May 1974
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10% AEP 10.37m
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86,389 ML/d
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Fire Station
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Camp Ground
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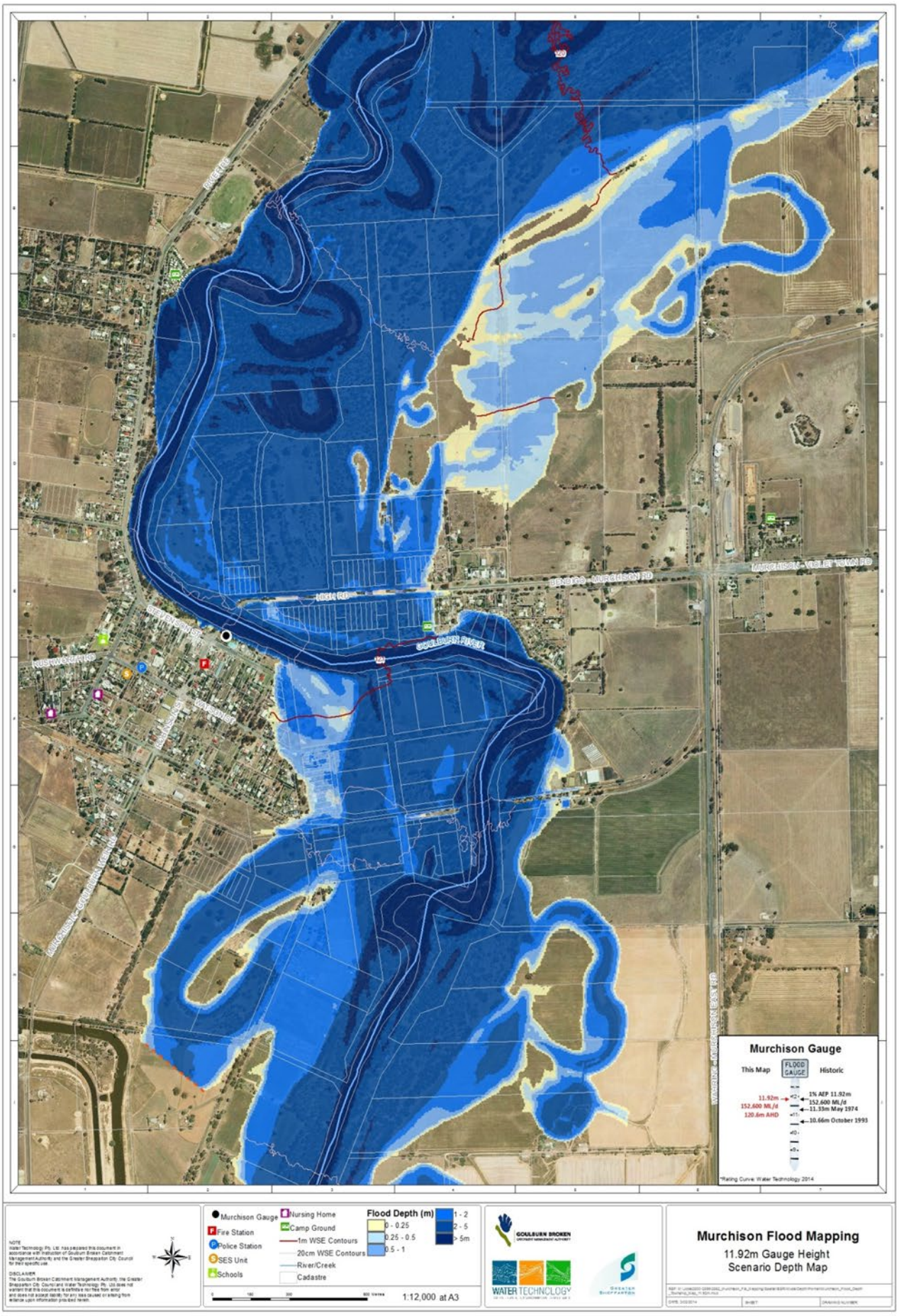
1m WSE Contours
20cm WSE Contours
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
Murchison Flood Mapping
10.68m Gauge Height Scenario Depth Map


Murchison Gauge
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Historic
11.92m
152,600 ML/d
120.6m AHD
1% AEP 11.92m
152,600 ML/d
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SES Unit
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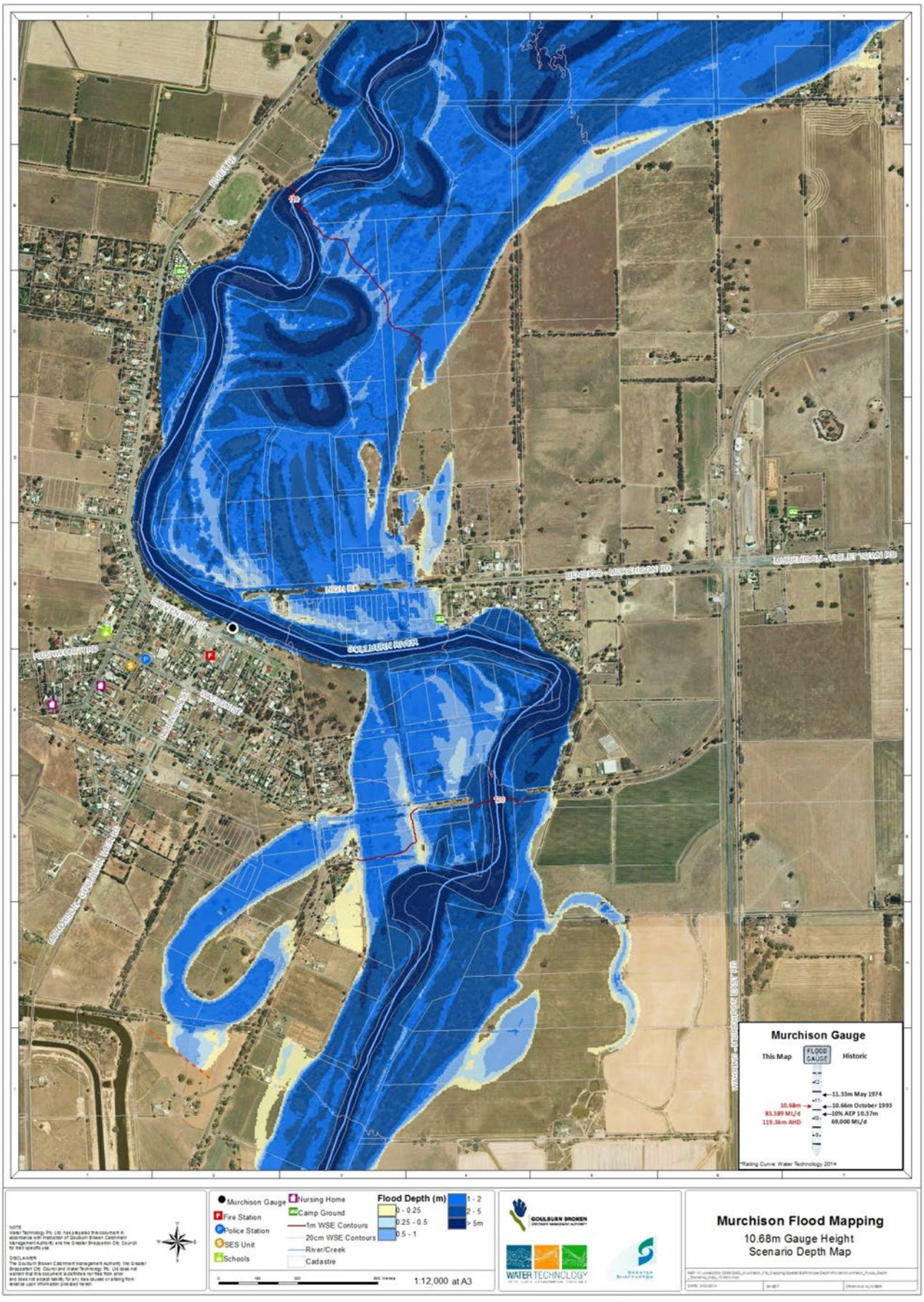
1m WSE Contours
20cm WSE Contours
River/Creek
Cadastre
Flood Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
> 5m
1:12,000 at A3
GOULBURN BROKEN
WATER TECHNOLOGY
Murchison Flood Mapping
11.92m Gauge Height
Scenario Depth Map


Murchison Gauge
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10% AEP 10.37m
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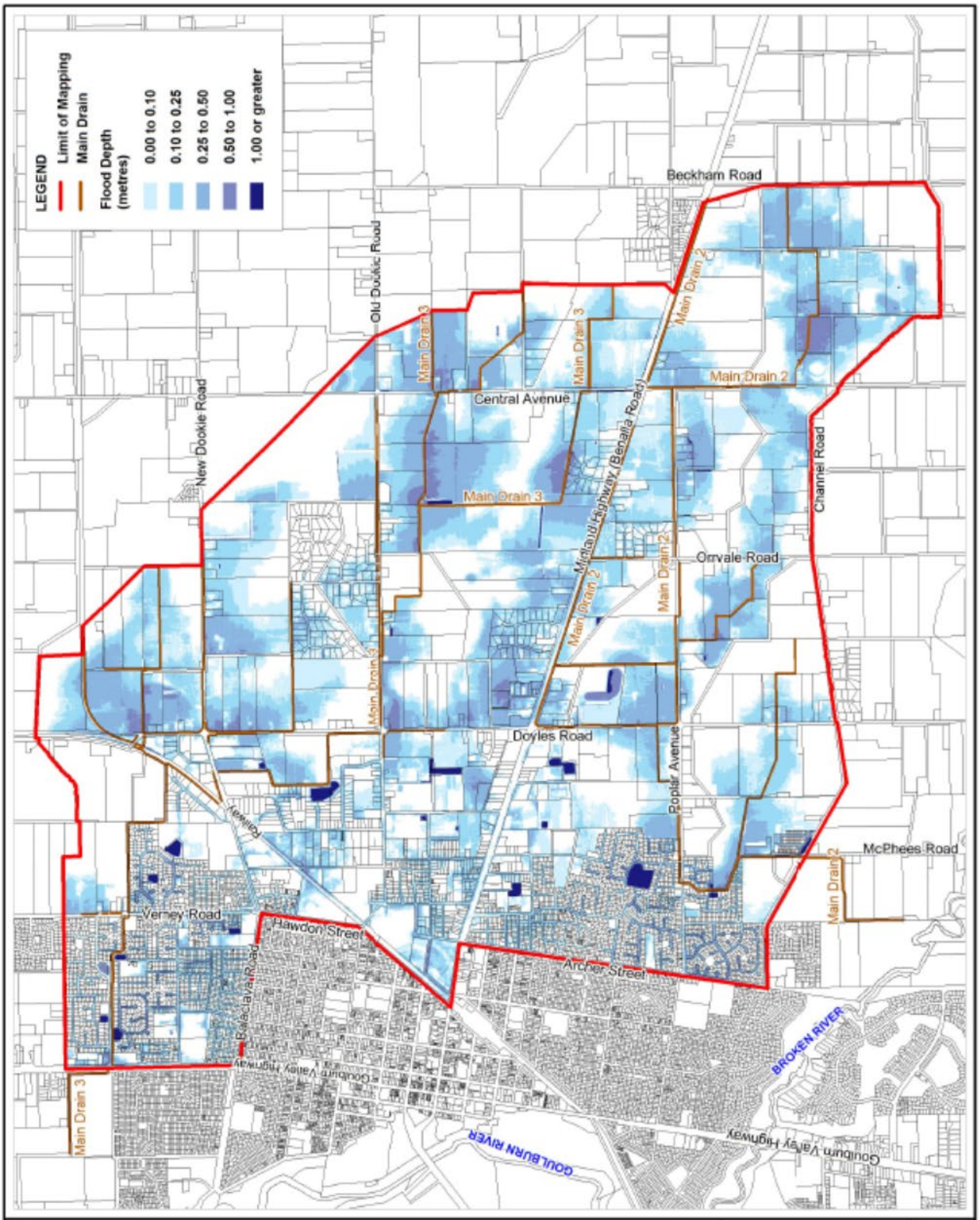
Scenario Depth Map



Title:

Shepparton East
Existing Conditions 0.2% AEP Peak Flood Depth

Figure: **E-7**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

0 0.75 1.5km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

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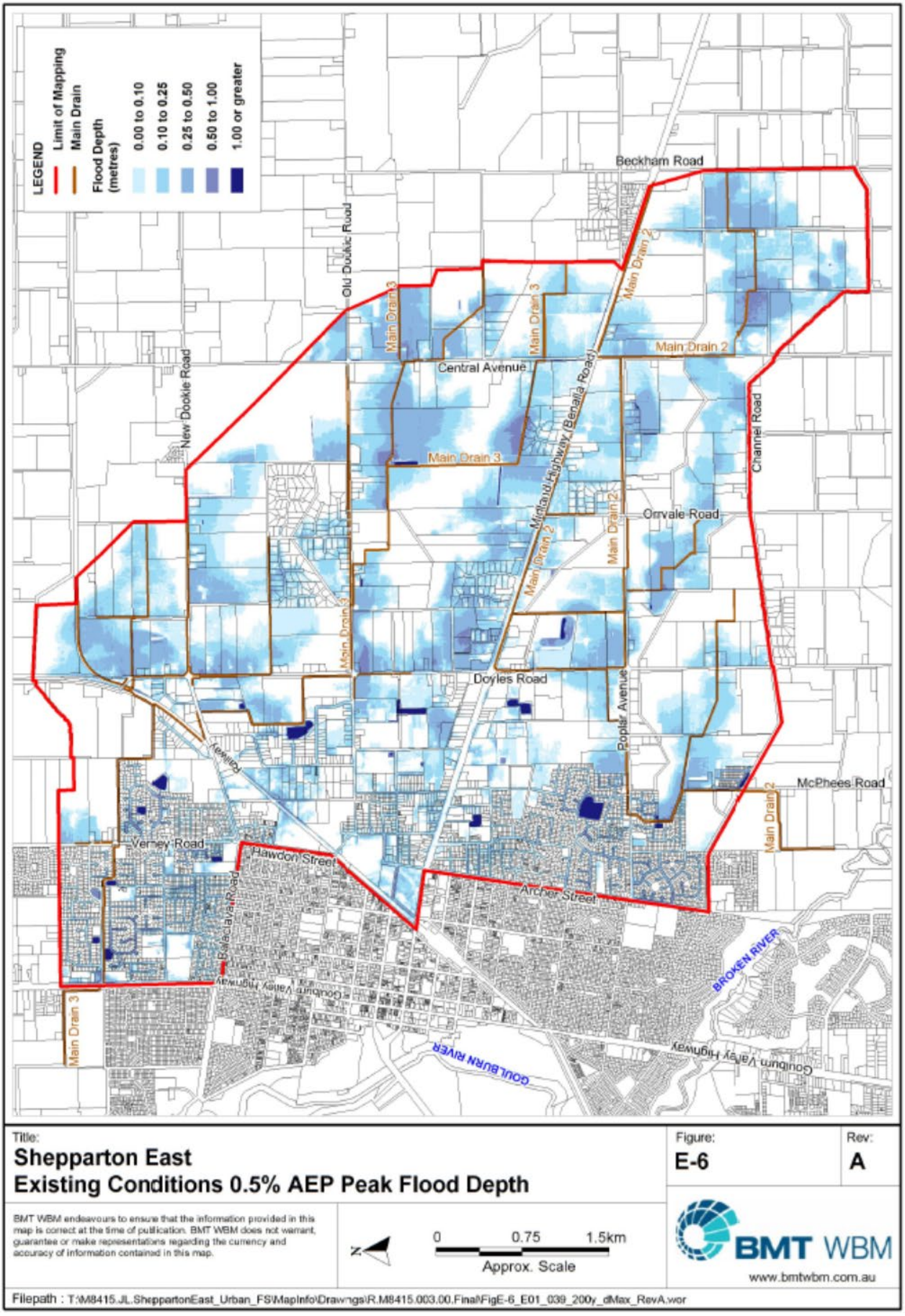

Title:
Shepparton East
Existing Conditions 0.5% AEP Peak Flood Depth

Figure: **E-6**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

0 0.75 1.5km
Approx. Scale

BMT WBM
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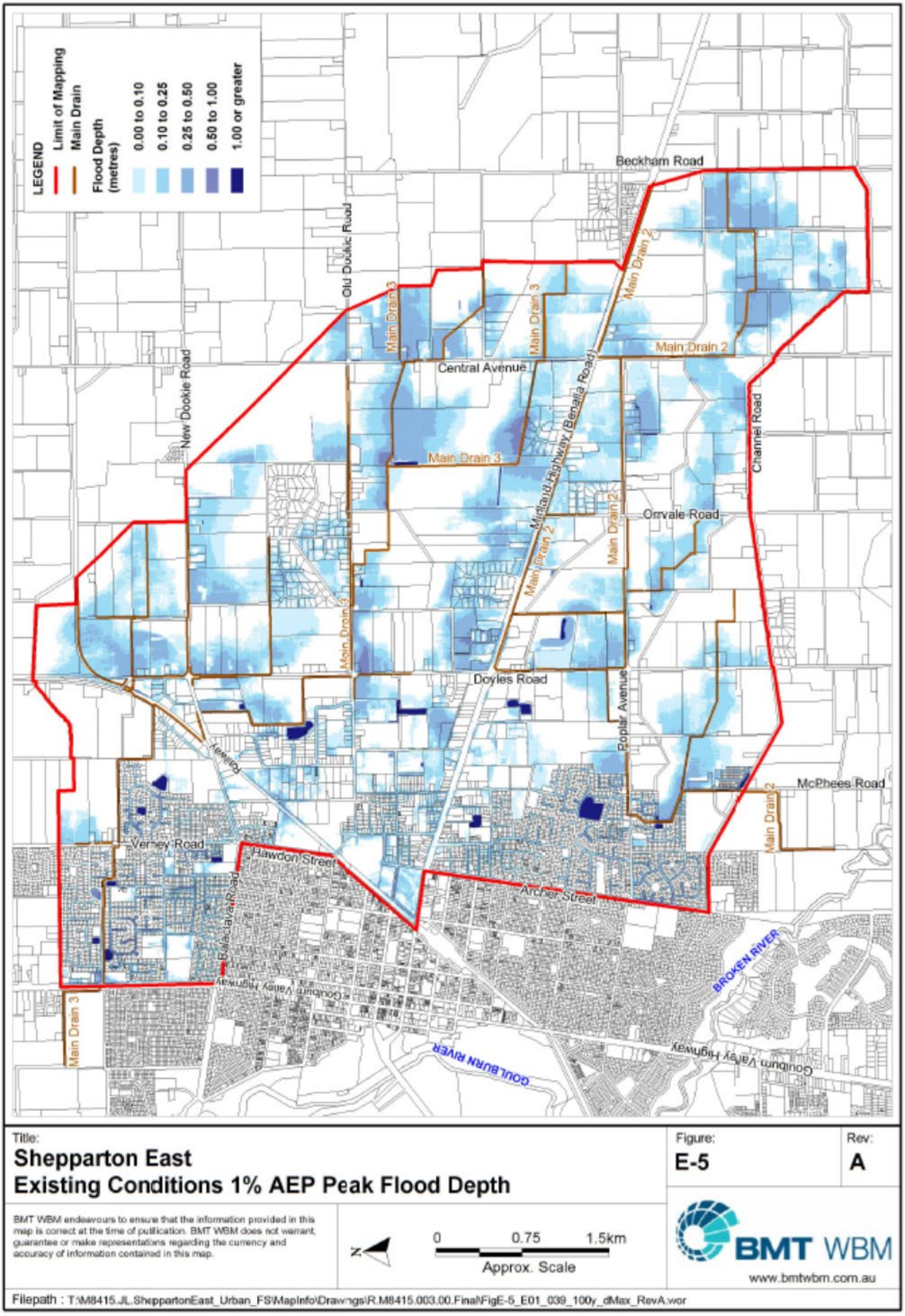


Title:

Shepparton East
Existing Conditions 1% AEP Peak Flood Depth

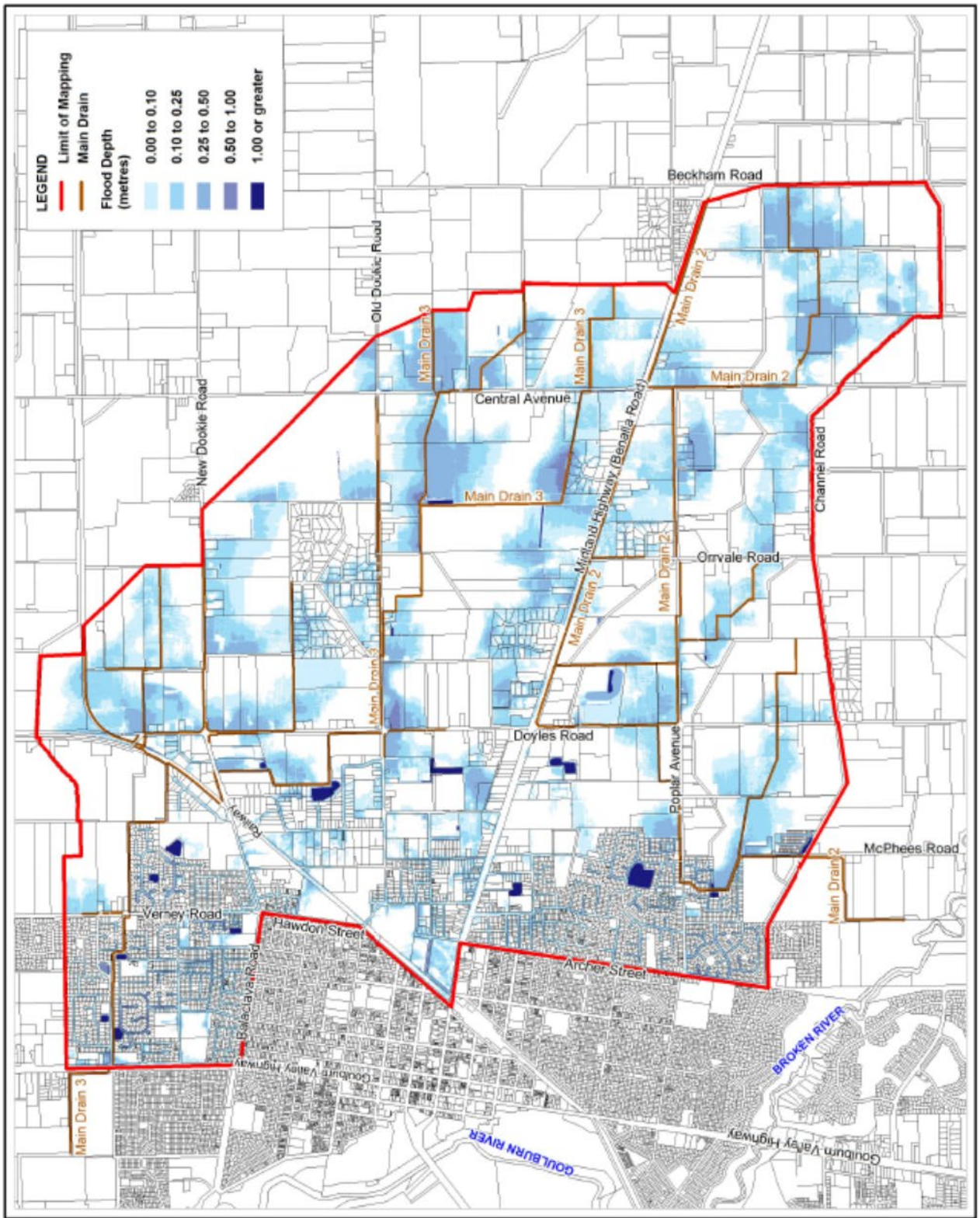
Figure: **E-5**

Rev: **A**

0 0.75 1.5km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\FigE-5_E01_039_100y_dMax_RevA.wor



Title:

Shepparton East
Existing Conditions 2% AEP Peak Flood Depth

Figure: **E-4**

Rev: **A**

N

0 0.75 1.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : T:\M8415.JL.SheppartonEast_Urban_FS\MapInfo\Drawings\R.M8415.003.00.Final\FigE-4_E01_039_50y_dMax_RevA.wor

Appendix F: Local knowledge arrangements

To be updated in the next version of the Greater Shepparton Flood Plan.

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, Local Information Officers (LIOs) and other agency networks] identified in [this plan/xxx register] will help support this process.

LIOs provide a key communication interface to community observers and other sources of local knowledge.

For the [Enter Location - Community/Municipality/River system] community observers identified are:

Community Observer Name	Community Observer contact details	LIO Contact	Key areas of local knowledge expertise
[Enter Name]	[Enter contact details]	[Enter name of LIO key point of contact]	[Enter key areas of local knowledge expertise that is consistent with the Local Knowledge Policy arrangements]
[Enter Name]	[Enter contact details]	[Enter name of LIO key point of contact]	[Enter key areas of local knowledge expertise that is consistent with the Local Knowledge Policy arrangements]

For the [Enter SES unit location] the Local Information Officer identified is:

LIO Name	LIO contact details	Community Observer contacts
[Enter Name]	[Enter contact details]	[Enter names of Community observer and other key local knowledge points of contact]

For the [Enter Location - Community/Municipality/River system] other agency networks identified are:

- [Enter other relevant agency network details including the capability and management of these networks and the contact details if appropriate]

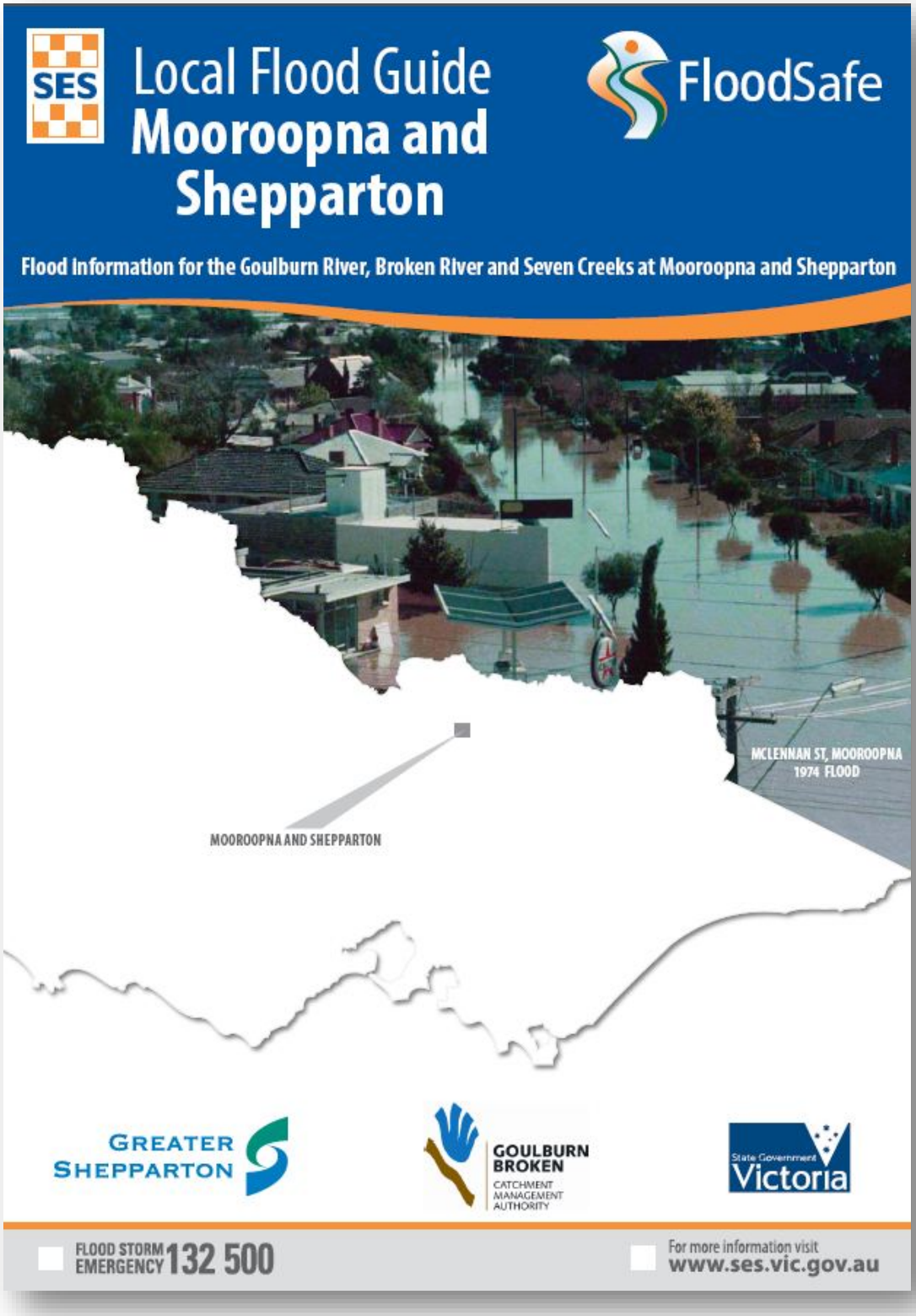
Important Notes:

These arrangements do not permit community observers and existing agency networks any responsibility for operational decisions and do not permit community observers and existing agency networks to direct operational activity, including the management of flood levees.

Information provided from sources of local knowledge must be processed and validated before it can become intelligence to inform decision making.

Appendix G: Local flood information

- www.ses.vic.gov.au/get-ready/your-local-flood-information



Local Flood Guide Murchison

FloodSafe

SES

Flood information for the Goulburn River at Murchison

GREATER SHEPPARTON

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

State Government Victoria

FLOOD STORM EMERGENCY 132 500

For more information visit www.ses.vic.gov.au

Local Flood Guide Tallygaroopna

FloodSafe

Flood information for the Pine Lodge Creek and Congupna Creek at Tallygaroopna

GREATER SHEPPARTON

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

VICTORIA State Government

FLOOD STORM EMERGENCY 132 500

For more information visit ses.vic.gov.au

Local Flood Guide
Congupna

FloodSafe

Flood information for the Pine Lodge Creek and O'Keefe Creek at Congupna

GREATER SHEPPARTON

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

VICTORIA State Government

FLOOD STORM EMERGENCY 132 500

For more information visit ses.vic.gov.au

Local Flood Guide
Katandra West

FloodSafe

Flood information for the Guilfus Creek and Congupna Creek at Katandra West

GREATER SHEPPARTON

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

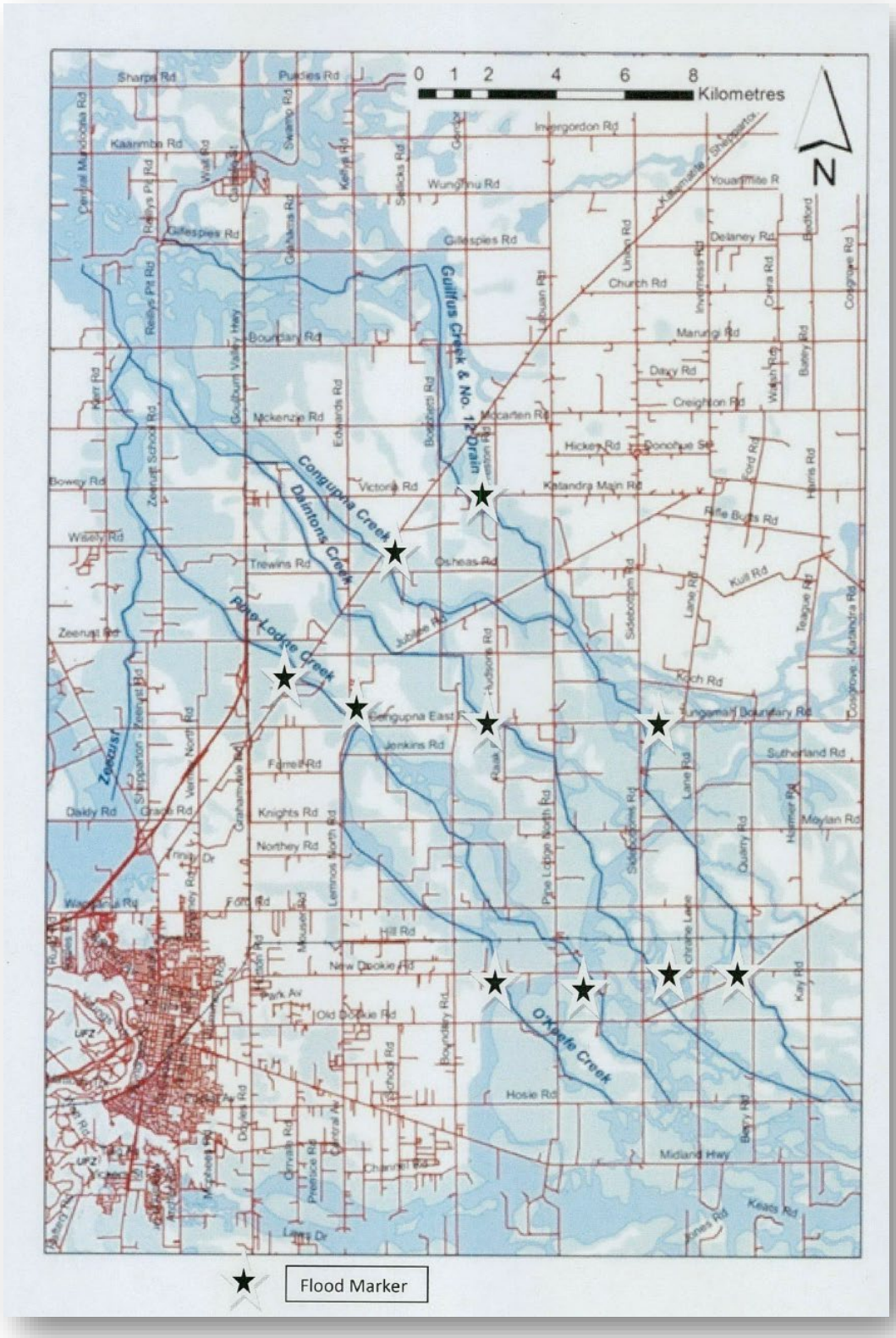
VICTORIA State Government

FLOOD STORM EMERGENCY 132 500

For more information visit ses.vic.gov.au

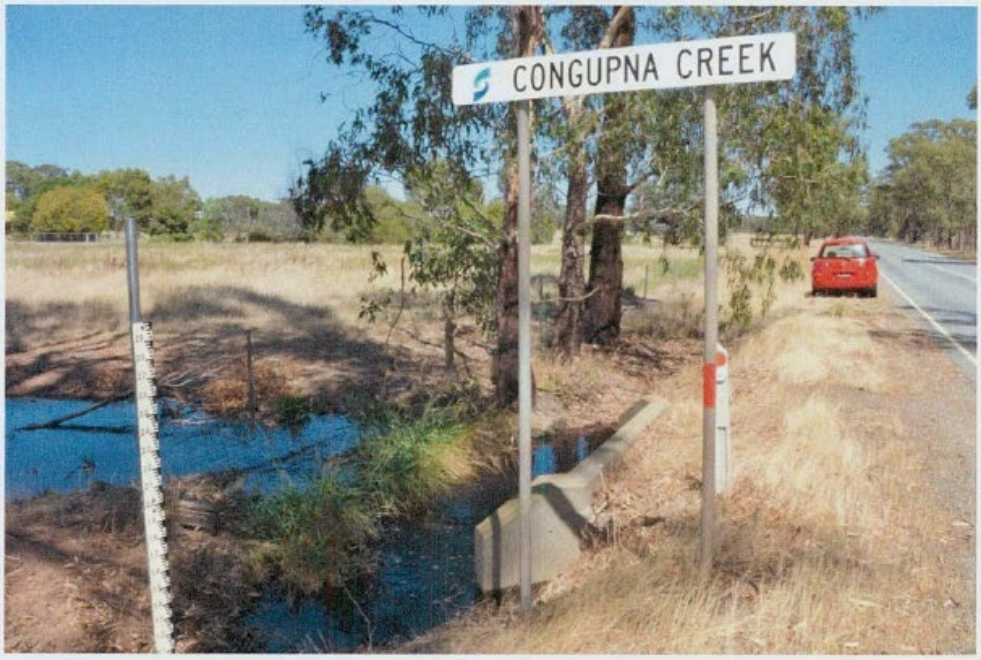
APPENDIX H – STAFF GAUGES ON THE CREEKS

A number of staff gauges (flood markers) have been installed along Congupna, Dainton's, Pine Lodge, O'Keefe and Guilfus creeks as shown on the following maps.


0 1 2 4 6 8
Kilometres
N
Gulfus Creek & No. 12 Drain
Congupna Creek
Daintons Creek
Pine Lodge Creek
Zeerust
O'Keefe Creek
Flood Marker

CONGUPNA CREEK

NEW DOOKIE ROAD, 0.3km WEST OF KELLOWS ROAD

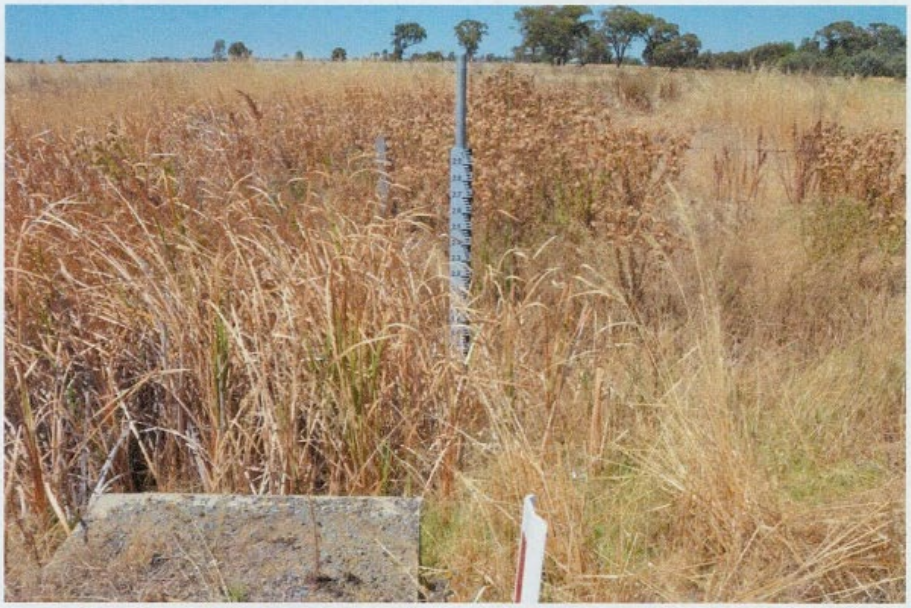


	Gauge Reading	Benalla Gauge
October 1993	2.065	5.500
September 2010	1.536	4.430
March 2012	1.646	Not applicable

- Water will peak at this gauge approximately 41 hours after peaking in Benalla
- Road will be first covered 15m west of the bridge at 1.900m on the gauge

CONGUPNA CREEK

TUNGAMAH-BOUNDARY ROAD 0.2km EAST OF SIDEBOTTOM ROAD



	Gauge Reading	Benalla Gauge
October 1993	2.938	5.500
September 2010	2.409	4.430
March 2012	2.519	Not applicable

- Water will peak at this gauge approximately 53 hours after peaking in Benalla
- Road will be first covered at 2.074m on the gauge

Greg Howard	340 Tungamah Boundary Road	5828 8353	0428 387462

CONGUPNA CREEK

KATAMATITE-SHEPPARTON ROAD 0.3km SOUTH OF THOMPSONS ROAD

	Gauge Reading	Benalla Gauge
October 1993	2.585	5.500
September 2010	2.176	4.430
March 2012	2.235	Not applicable

- Water will peak at this gauge approximately 77 hours after peaking in Benalla
- Road will be first covered 20m north of the bridge at 2.125m on the gauge

Pegasus Lodge Stud (Sarah)	Katamatite-Shepparton Road	0431 987535

DAINTONS CREEK

NEW DOOKIE ROAD 0.3km EAST OF SIDEBOTTOM ROAD

	Gauge Reading	Benalla Gauge
October 1993	1.855	5.500
September 2010	1.326	4.430
March 2012	1.436	Not applicable

- Water will peak at this gauge approximately 43 hours after peaking in Benalla
- Road will be first covered at 1.850m on the gauge

Ron & Sandra Anstee	1340 New Dookie Road	5828 8227

DAINTONS CREEK

CONGUPNA EAST ROAD 0.3km WEST OF HUDSON ROAD

	Gauge Reading	Benalla Gauge
October 1993	2.500	5.500
September 2010	2.109	4.430
March 2012	2.218	Not applicable

- Water will peak at this gauge approximately 59 hours after peaking in Benalla
- Road will be first covered at 1.995m on the gauge

Alan Reynolds	585 Congupna east Road	5829 9256

PINE LODGE CREEK

NEW DOOKIE ROAD 0.6km EAST OF PINE LODGE NORTH ROAD (CHURCH)

	Gauge Reading	Benalla Gauge
October 1993	2.578	5.500
September 2010	1.838	4.430
March 2012	1.948	Not applicable

- Water will peak at this gauge approximately 51 hours after peaking in Benalla
- Road will be first covered 20m west of bridge at 1.623m on the gauge

Grant Dainton	1110 New Dookie Road	5828 8311 (w)

PINE LODGE CREEK

LEMNOS NORTH ROAD 0.2km NORTH OF CONGUPNA EAST ROAD

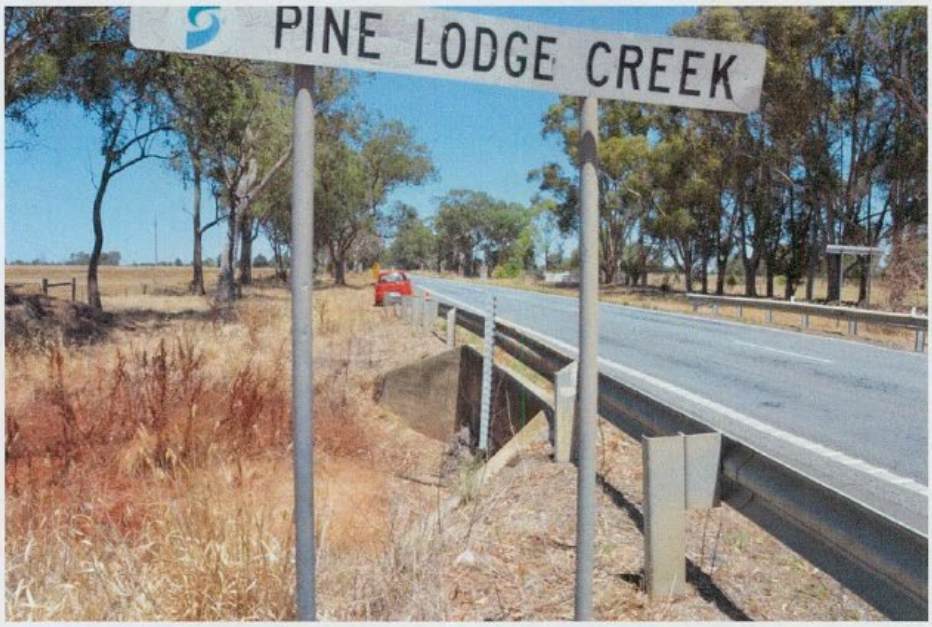
	Gauge Reading	Benalla Gauge
October 1993	2.358	5.500
September 2010	1.965	4.430
March 2012	2.208	Not applicable

- Water will peak at this gauge approximately 72 hours after peaking in Benalla
- Road will be first covered at 2.283m on the gauge

John Edwards	765 Lemnos North Road	5829 9101	0459 299101

PINE LODGE CREEK

KATAMATITE-SHEPPARTON ROAD 1.9km NORTH OF CONGUPNA EAST ROAD



	Gauge Reading	Benalla Gauge
October 1993	2.448	5.500
September 2010	2.050	4.430
March 2012	2.300	Not applicable

- Water will peak at this gauge approximately 78 hours after peaking in Benalla
- Road will be first covered 30m south of the bridge at 2.328m on the gauge

Rob & Liz Grant	3390 Katamatite-Shepparton Road	5829 9206

O'KEEFE CREEK

NEW DOOKIE ROAD 1.7km WEST OF PINE LODGE NORTH ROAD (CHURCH)

	Gauge Reading	Benalla Gauge
October 1993	2.340	5.500
September 2010	1.710	4.430
March 2012	1.820	Not applicable

- Water will peak at this gauge approximately 55 hours after peaking in Benalla
- Road will be first covered at 2.078m on the gauge

Maree & Adrian Fitzsimmons	835 New Dookie Road	0418 358516

GUILFUS CREEK

KATANDRA MAIN ROAD 0.8km EAST OF BOUNDARY ROAD

	Gauge Reading	Benalla Gauge
October 1993	2.025	5.500
September 2010	1.495	4.430
March 2012	1.795	Not applicable

- Water will peak at this gauge approximately 80 hours after peaking in Benalla
- Road will be first covered 20m west of the bridge at 2.050m on the gauge

Henry Humphreys	Katandra Main Road	5829 8245	0428 298245

APPENDIX I – REFERENCES AND INTEL SOURCES

The following studies may be useful in understanding the nature of flooding within the City of Greater Shepparton.

- **FLOODZOOM** – for all available flood extent, depth and related mapping, studies reports and MFEPs as well as cadastral and related information
- http://planningschemes.dpcd.vic.gov.au/index.html Department of Planning and Community Development for planning scheme flood maps
- http://www.vicwaterdata.net/vicwaterdata/home.aspx for historical data on water quality, river heights and flows
- http://www.bom.gov.au Bureau of Meteorology for river gauge readings and flood warnings
- http://www.floodvictoria.vic.gov.au for information on historic floods in Victoria
- http://www.ses.vic.gov.au Victoria State Emergency Service
- http://www.ema.gov.au Emergency Management in Australia
- http://www.delwp.vic.gov.au/fire-and-other-emergencies Department of Environment Land Water and Planning emergency management.
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