ROY COSTA PLANNING & DEVELOPMENT
164 Eighth Street Mildura
PO Box 2925 Mildura 3502
Phone (03) 50210031 Email: reception@roycosta.com.au

PLANNING PROPOSAL

LOTS 1-16 DP 286903

142 SWAN HILL ROAD, MURRAY DOWNS

CHANGING OF ZONING TO

R1 GENERAL RESIDENTIAL

PLANNING INSTITUTE AUSTRALIA – REGISTERED PLANNER (RPIA)
CERTIFIED PRACTISING PLANNER (CPP)

Rokar Pty. Ltd. ACN 087 497 685 Trading As Roy Costa Planning & Development

Planning Institute Australia

TABLE OF CONTENTS

Introduction 3
Part 1 –Objectives or intended outcomes 4
Part 2 –Explanation of provisions 5
Part 3 –Justification 6
Section A – Need for the planning proposal 6
Section B – Relationship to strategic planning framework 7
Section C – Environmental, social and economic impact 10
Section D – State and Commonwealth interests 10
Part 4 – Mapping 11
Part 5 –Community consultation 12
Part 6 – Project timeline 13
Conclusion 14

ATTACHMENTS

A Consistency with the Riverina Murray Regional Plan

B Due Diligence Assessment Aboriginal Cultural Heritage

C Murray River Council - Murray Downs Floodplain Risk Management Study and Plan, Final Report

INTRODUCTION

This is a planning Proposal seeking an amendment to the Wakool Local Environmental Plan 2013 (WLEP) to rezone 142 Swan Hill Road, Murray Downs from RE2 Private Recreation to R1 General Residential.

The site is approximately 4 hectares in size located north of the Murray River and south of Swan Hill Road, Murray Downs, approximately 1.5km east of the Swan Hill township and approximately 1km north west of the Murray Downs township. As recently as 2018 the land was subdivided into 16 lots for residential purposes. The context of the subject land is shown in maps 1 and 2.

The Planning Proposal has been structured and prepared in accordance with the Department of Planning and Environment's *A guide to preparing planning proposals* ("the Guide").

Table 1: Lots contained in the Subject land

No.	Lot	Address	Land Tenure	Current Zoning
1.	Lot 1 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
2.	Lot 2 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
3.	Lot 3 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
4.	Lot 4 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
5.	Lot 5 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
6.	Lot 6 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
7.	Lot 7 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
8.	Lot 8 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
9.	Lot 9 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
10.	Lot 10 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
11.	Lot 11 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
12.	Lot 12 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
13.	Lot 13 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
14.	Lot 14 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
15.	Lot 15 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation
16.	Lot 16 DP286903	142 Swan Hill Road	Freehold	RE2 Private Recreation

PART 1 –OBJECTIVES OR INTENDED OUTCOMES

To amend the zoning of 142 Swan Hill Road, Murray Downs, being Lots 1- 16 DP286903 within the WLEP from RE2 Private Recreation to R1 General Residential zone to allow for the development of 'traditional dwellings' being constructed onsite.

The objective of this planning proposal intends to amend to the land zoning map and land use table of the Wakool Local Environmental Plan (WLEP) 2013. The specific objectives and intended outcomes of the planning proposal are to:

a) Ensure the zoning of the subject land accurately reflects the actual uses and purposes of the site relevant to Councils Community Strategic Action Plan and the LSPS

b) Achieve optimum planning, land use and management outcomes and public interest for the subject land

PART 2 –EXPLANATION OF PROVISIONS

The subject land is proposed to be rezoned to R1 General Residential based on the assessed current uses and potential future uses under the Murray River Community Strategic Plan Objective 1.3.5 and the Murray River Local Strategic Planning Statement Planning Priority that addresses housing growth and supply.

The intended outcome of the Planning Proposal will be achieved by amending the WLEP as follows:

- Amending Land Zoning Map LZN_005B in the WLEP to show the subject land as R1 General Residential

PART 3 –JUSTIFICATION

This section of the Planning Proposal sets out the justification for the intended outcomes and provisions, and the process for their implementation. The questions to which responses have been provided are taken from the Guide.

SECTION A – NEED FOR THE PLANNING PROPOSAL

- **Is the planning proposal a result of an endorsed local strategic planning statement, strategic study of report?**

  This planning proposal is responding to and addressing a real time land use planning issue and it is supported by the Murray River Community Strategic Plan and the Murray River Local Strategic Planning Statement.

  The Murray River Community Strategic Plan sets out a series of objectives and strategies that seek to have a well planned connected built environment that is designed to support the local community. Objective 1.3.5 seeks to encourage greater housing choice and development to meet the needs of a changing population.

  The Murray River Local Strategic Planning Statement identifies a number of planning priorities. Under the theme of 'Livable Communities with Social Capital' Planning Priority 4 addresses housing growth, supply and density within its LGA.

- **Is the planning proposal the best means of achieving the objectives or intended outcomes, or is there a better way?**

  Recently a 16-lot subdivision for a 'Manufactured Home Estate' was approved and the current RE2 zone constrains the development of the land to homes that are manufactured offsite and transported to the location.

  Manufactured homes are constructed in 'portions' as defined under the Local Government (Manufacture Home Estate, Caravan Parks, Camping Grounds and Moveable Dwellings) Regulation 2005. As such these portions are at least 20 cubic metres and contain the total living space that is made up of the chassis/frame, external and internal walls, the roof, ceiling, floors windows and doors. It also includes the internal plumbing, wiring, tiling, kitchen, bathroom and laundry fittings as well as all built in cupboards. Additionally, Clause 135 of this regulation provides that relocatable homes are to be constructed off site.

  The Swan Hill-Murray River Road bridge is a timber truss, steel frame lift span bridge that is 3.1m wide with single lane access. Therefore, given the size and nature of the portions of relocatable homes, the physical dimensions of this bridge cannot support the logistical requirements needed to transport relocatable homes.

  An alternative approach to this problem would be to detour the transport of these homes to the nearest VIC/NSW access road capable of handling wide loads. However, given the nearest access point is a bridge located in Moama NSW, and is approximately 200km from the subject site, this makes the cost for establishing a manufactured home on these lots prohibitive.

  Given the inadequacy of the Swan Hill-Murray River Road bridge to allow the size of deliveries required for manufactured homes, the LSPS states 'the Swan Hill Bridge is due to be upgraded in the coming years as the first priority for investment.' (pg 27.)

Council cannot ignore the landowners desire to construct traditional homes that have concrete slabs where a significant portion of the dwelling can be constructed on the subject land.

Therefore, based on the reasons discussed above, this planning proposal is the most time efficient and economical means of achieving the objectives and intended outcomes. Consequently, the objective of traditional residential development on the subject land can only be achieved through an amendment to the WLEP via a Planning Proposal.

SECTION B – RELATIONSHIP TO STRATEGIC PLANNING FRAMEWORK

- **Will the planning proposal give effect to the objectives and actions of the applicable regional, or district plan or strategy (including any exhibited draft plans or strategies)?**

The regional plans applicable to this planning proposal are the Riverina Murray Regional Plan 2036 (RMRP) adopted by the NSW government in 2017, the Draft Murray Regional Strategy 2009-2036 and the Murray Regional Economic Development Strategy (REDS)

Riverina Murray Regional Plan

The Riverina Murray Regional Plan is the NSW Government's 20-year development blueprint for the future of this region. The goal of the plan is to create a diverse economy supported by the right infrastructure, an exceptional natural environment with strong and connected communities.

This planning proposal is consistent with the plan as the rezoning will facilitate a growing diverse economy.

An assessment of the directions contained within the RMRP as they relate to the Planning Proposal is undertaken at Attachment 'A'. In summary, this assessment concludes that the Planning Proposal does not contradict the overall purpose of the RMRP or any Direction relating to the planning proposal as there will be no change to the current purpose of the land use, only in the way it is developed.

Draft Murray Regional Strategy

This strategy represents the NSW Government's position on the future of the Murray Region. It is one of a number of regional strategies prepared by the department of planning to complement the NSW State Plan and other State and local strategies. The goal of this strategy is to create a prosperous and resilient place that can sustain liveable communities. It aims to achieve this by catering to a housing demand of 13,900 new dwellings by 2036 as well as protecting and managing the riverine environment of the Region's river system.

This planning proposal is consistent with the goal and objectives of this strategy.

Murray Regional Economic Development Strategy

The Murray Regional Economic Development Strategy 2018–2022 (the Strategy) sets out a long-term economic Vision and associated strategy for the Region's economic development. This strategy builds on the Regions endowments, economic strengths and specialisations to guide investment until 2022 and aims to ensure a long-term sustainable future for the Region through a number of strategies including boosting and

sustaining the supply of skilled workers for core industries in the region as well as developing and growing the tourism sector.

This planning proposal is consistent with this strategy because is it aims to provide housing needs for resident to be able to live and work in the area which will only serve to enhance and develop the area and provide greater market value for the region and supports the endowment of riverine lifestyle offerings.

- **Will the planning proposal give effect to a council's endorsed local strategic planning statement, or another endorsed local strategy or strategic plan?**

The planning proposal is supported within the Murray River Council's *Local Strategic Planning Statement 2020-2040* where the document specifically notes that *Murray Downs* has significant potential to develop *river-lifestyle properties and larger-lot residential housing.*[1] Planning priority 4, 5 and 6 are all supported by this planning proposal.

Several objectives and strategies of the Community Strategic Plan 2018-2028 support the proposal as identified below:

1.1.2 Provide, maintain and improve safe, accessible footpaths, cycle ad walking tracks.

1.3.5 Encourage greater housing choice and development to meet our changing populations needs.

2.2.3 Enable access to rivers and waterways for recreational enjoyment.

The planning proposal is consistent with the objectives and strategies as identified above, with the added benefit of improved outcomes for the land owners and Council. It will allow 15 new traditional dwellings to be constructed on the existing residential lots that have existing road and accessible footpath connections to both Swan Hill and Murray Downs townships. The planning proposal also increases the supply of in demand traditional riverfront lifestyle dwellings that have connections to the Murray River for recreational enjoyment, rather than manufactured dwellings that cannot be constructed onsite.

- **Is the planning proposal consistent with applicable State Environmental Planning Policies?**

There is no applicable SEPP for this site.

[1] Page 27 Murray River Council's Local Strategic Planning Statement 2020-2040

- **Is the planning proposal consistent and applicable Ministerial Directions (s. 9.1 directions)?**

Table 1: Assessment of Lots 1-16 DP DP286903 against applicable Ministerial Directions

Section 9.1 Direction	Applicable (Y/N)	Consistent (Y/N)	Comment/Justification
2. Environment & Heritage			
2.1 Environment Protection Zones	Y	Y	The planning proposal does not seek to reduce the environmental protection standards that apply to the land.
2.3 Heritage Conservation	Y	Y	The planning proposal does not seek to modify or reduce any heritage protection and conservation standards applying to heritage items at the subject land.
2.4 Recreational Vehicle Areas	Y	Y	This planning proposal seeks to rezone the land to General Residential only. It does not seek to provide any area for recreational vehicles.
3. Housing, Infrastructure and Urban Development			
3.1 Residential Zones	Y	Y	The planning proposal seeks to rezone land to broaden the choice of building types and locations available in the local housing market.
3.2 Caravan Parks and Manufactured Home Estates	Y	Y	The planning proposal does not seek to extinguish provisions that permit development for the purposes of this direction to be carried out.
3.3 Home Occupations	Y	Y	This planning proposal is consistent with this Direction as it will encourage the carrying out of home occupations.
3.4 Integrating Land Use and Transport	Y	Y	This planning proposal is consistent with this direction as the site is within walking and cycling distance and as such will not increase car dependent travel.
4. Hazard and Risk			
4.3 Flood Prone Land	Y	N	The planning proposal is inconsistent with this direction as the land subject to the 1:100-year flood area. This is of minor significance as performance-based development standards including but not limited to 1:100 plus 500m freeboard relative to the AHD can be addressed during the development assessment stage and placed as a condition on any consent determination for this site.
6. Local Plan Making			
6.1 Approval and Referral Requirements	Y	Y	Council has consulted with DPIE and obtained in-principle agreement to proceed with the proposed rezoning.
6.2 Reserving Land for Public Purposes	N	Y	This planning proposal does not seek to create, alter or reduce existing zonings or reservations of land for public purposes.
6.3 Site Specific Provisions	Y	Y	This planning proposal seeks to allow that land use on the relevant land without imposing any development standards or requirements in addition to those already contained in the principal environmental planning instrument being amended.

SECTION C – ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACT

- **Is there any likelihood that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the proposal?**

  The proposed rezoning will not have adverse impact on critical habitat or threatened species, populations or ecological communities, or their habitats.

- **Are there any other likely environmental effects as a result of the planning proposal and how are they proposed to be managed?**

  There are no other foreseen significant environmental effects associated with the proposed rezoning of the subject land.

- **Has the planning proposal adequately addressed any social and economic effects?**

  Yes, as detailed previously the planning proposal will have increased social benefits and increased economic effect for the Murray Downs community.

SECTION D – STATE AND COMMONWEALTH INTERESTS

- **Is there adequate public infrastructure for the planning proposal?**

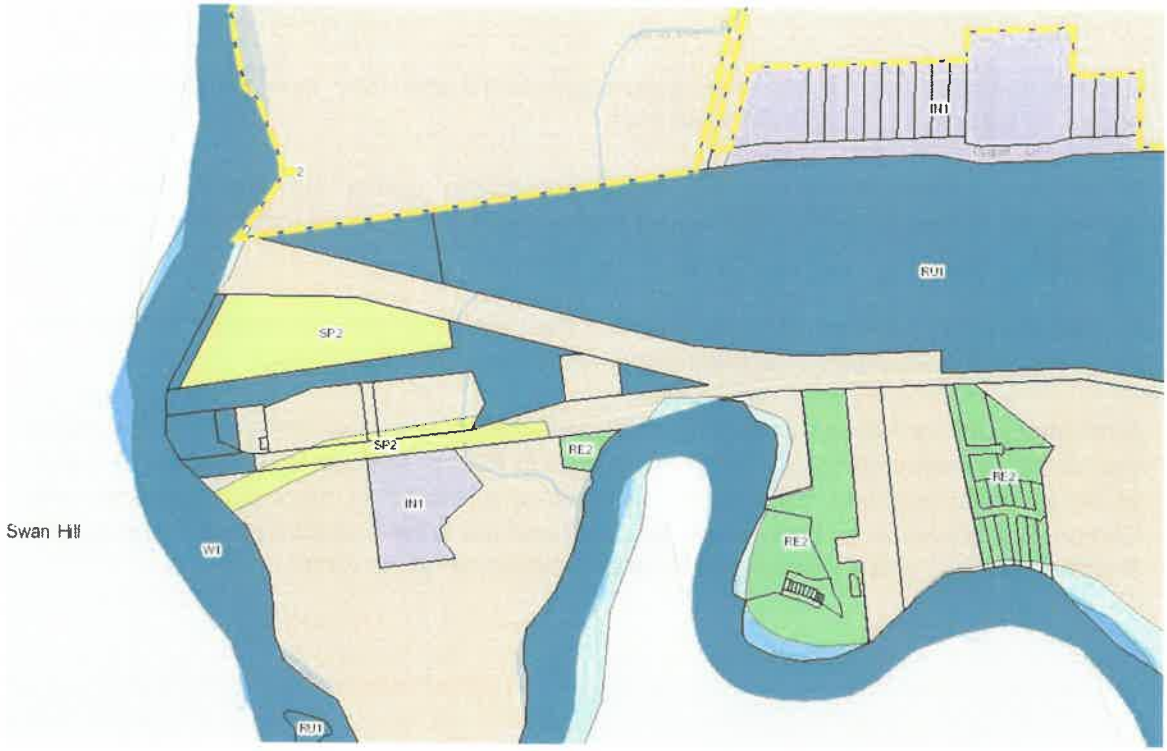
- Yes, adequate infrastructure exists as there is no change to the current land use for residential purposes but rather an amendment to the desired construction methods which will have positive environmental impacts and tighter regulatory requirements.

- **What are the views of State and Commonwealth public authorities consulted in accordance with the Gateway Determination?**

Table 1: View of State and Commonwealth Authorities

Name of Agency	Is PP supported Y/N?	Comments
NSW OEH	Y	Council need to include their four (4) recommendations as conditions on the consent determination.
NSW DPIE	Y	In principle agreement to re-zone land

PART 4 – MAPPING



Map 1 – Location of subject site within the zoning context (Source; SIX Maps)

Map 2 – Subject site within the context of land uses in immediate area (Source; SIX Maps)

PART 5 –COMMUNITY CONSULTATION

Council has conducted initial consultation with DPIE and they have consented to the proposed rezoning of those parcels of land.

In addition, community consultation was undertaken during the preparation of the Community Strategic Action Plan and the LSPS which forms the basis of this planning proposal.

As part of the consultation all land owners of the parcels of land affected by this planning proposal have been notified and numerous discussions have been held.

Additional public exhibition and community consultation will be undertaken by Council as part of the Gateway determination process. Given the minor scale and low impact nature of the planning proposal, it will be exhibited for a period of 28 days in accordance with Clause 4 of Schedule 1 of the EP&A Act 1979 and the NSW Department of Planning and Environment's: *A guide to preparing local environmental plans 2016*.

PART 6 – PROJECT TIMELINE

There are many factors that can influence the timeline although it is anticipated for completion within 6 months.

The indicative timeframe for completing the planning proposal is presented in Table 3 below.

Table 3: Indicative Project Timeline

Task	Timeframe
Anticipated commencement date (date of Gateway Determination	
Anticipated timeframe for the completion of required technical information	
Timeframe for government agency consultation as required by Gateway determination: Pre exhibition Post exhibition	
Commencement and completion dates for public exhibition period	
Dates for public hearing (if required)	
Timeframe for consideration of submissions	
Timeframe for the consideration of a proposal post exhibition	
Date of submission to the Department to finalise the LEP	
Anticipated date RPA will make the plan (if delegated	
Anticipated date RPA will forward to the Department for notification	

CONCLUSION

The Planning Proposal is to rezone a parcel of land at 142 Swan Hill Road, Murray Downs from RE2 Private Recreation to R1 General Residential Zone.

Currently under the RE2 provisions, DA approval was given in 201 8 for a 'Manufactured Home Estate' and 16 lot subdivision, the subdivision certificate was issued in April 2020.

An amendment to the WLEP is necessary as landowners within the development site desire to construct homes of traditional construction methods. No other requirements are sought to be varied other than to ability to build traditional homes, which cannot be undertaken under the current planning regime for the subject land.

In summary, the Planning Proposal is considered to have merit because:

- the subject land is located within close proximity to Swan Hill and Murray Downs townships;
- the density of development for the subject land is not increasing;
- it is consistent with planning strategy and statement;
- it is consistent with the broader planning framework (e.g. State provisions);
- the subject land can be provided with all services.

ATTACHMENT A

CONSISTENCY WITH THE RIVERINA MURRAY REGIONAL PLAN

GOAL, DIRECTION & ACTION TITLE	APPLICABLE TO THE PLANNING PROPOSAL	CONSISTENCY
Goal 1 – A growing and diverse economy		
Direction 1: Protect the region's diverse and productive agricultural land.	Not applicable, as the subject land is not zoned for agricultural purposes.	N/A
Direction 2: Promote and grow the agribusiness sector.	Not applicable, as the land does not relate to agribusiness.	N/A
Direction 3: Expand advanced and value-added manufacturing.	Not applicable, as the land does not relate to value-added manufacturing.	N/A
Direction 4: Promote business activities in industrial and commercial areas.	Not applicable, as the land is not zoned for industrial or commercial purposes.	N/A
Direction 5: Support the growth of the health and aged care sectors.	Not applicable.	N/A
Direction 6: Promote the expansion of education and training opportunities.	Not applicable, as the land does not relate to education.	N/A
Direction 7: Promote tourism opportunities.	Not applicable, as the land does not relate to tourism.	N/A
Direction 8: Enhance the economic self-determination of Aboriginal communities.	Not applicable to this proposal.	N/A
Direction 9: Support the forestry industry.	Not applicable, as the land does not relate to forestry industry.	N/A
Direction 10: Sustainably manage water resources for economic opportunities.	Not applicable to this proposal.	N/A

GOAL, DIRECTION & ACTION TITLE	APPLICABLE TO THE PLANNING PROPOSAL	CONSISTENCY
Direction 11: Promote the diversification of energy supplies through renewable energy generation.	Not applicable to this proposal.	N/A
Direction 12: Sustainably manage mineral resources.	Not applicable to this proposal.	N/A
Goal 2 – A healthy environment with pristine waterways		
Direction 13: Manage and conserve water resources for the environment.	Not applicable to this proposal.	N/A
Direction 14: Manage land uses along key river corridors.	Yes, as the land is adjacent the Murray River.	The planning proposal will require increased/improved development standards than currently exist; therefore, increased protection of the river corridor will occur though this planning proposal.
Direction 15: Protect and manage the region's many environmental assets.	Yes, as the land is adjacent the Murray River.	As identified above increased regulatory standards will exist with the approval of the planning proposal, therefore improving the protection of environmental assets.
Direction 16: Increase resilience to natural hazards and climate change.	Yes, this subject land is affected by flooding overlay.	In 2017 the Murray River Council Murray Downs Floodplain Risk Management Study and Plan final report was developed and includes the subject site. It should be noted that although the subject land is located within the flood planning area, majority is not subject to 100-year ARI flooding as identified on figure A1 of the report. The planning proposal would increase resilience to potential flooding due to increased controls on development.

GOAL, DIRECTION & ACTION TITLE	APPLICABLE TO THE PLANNING PROPOSAL	CONSISTENCY
Goal 3 – Efficient transport and infrastructure networks		
Direction 17: Transform the region into the eastern seaboard's freight and logistics hub.	Not applicable to this proposal.	N/A
Direction 18: Enhance road and rail freight links.	Not applicable to this proposal.	N/A
Direction 19: Support and protect ongoing access to air travel.	Not applicable to this proposal.	N/A
Direction 20: Identify and protect future transport corridors.	Not applicable to this proposal.	N/A
Direction 21: Align and protect utility infrastructure investment.	Not applicable to this proposal.	N/A
Goal 4 – Strong, connected and healthy communities		
Direction 22: Promote the growth of regional cities and local centers.	Yes	The planning proposal will increase an in-demand style of housing development to both townships of Swan Hill and Murray Downs as a cross-border community.
Direction 23: Build resilience in towns and villages.	Yes	An increase in traditional residential development will build resilience through an increasing population.
Direction 24: Create a connected and competitive environment for cross-border communities.	Yes	The ability to create residential growth of choice will have a positive effect on the cross-border community of Swan Hill and Murray Downs.

GOAL, DIRECTION & ACTION TITLE	APPLICABLE TO THE PLANNING PROPOSAL	CONSISTENCY
Direction 25: Build housing capacity to meet demand.	Yes	This planning proposal will allow traditional dwellings to be constructed which are in high demand due to the close proximity to natural recreational areas such as the Murray River
Direction 26: Provide greater housing choice.	Yes	The proposal will offer greater housing choice where a limited supply exists.
Direction 27: Manage rural residential development.	Not applicable to this proposal as the land is not rural.	N/A
Direction 28: Deliver healthy built environments and improved urban design.	Yes	This planning proposal will improve the amenity and urban design of the development site due to the improved construction methods.
Direction 29: Protect the region's Aboriginal and historic heritage.	Yes	A due diligence assessment of aboriginal cultural heritage was completed for the subject site (see attachment 'B') where no concerns were raised regarding future development although mitigation measures were noted for any future potential discovery.

ATTACHMENT B

DUE DILIGENCE ASSESSMENT ABORIGINAL CULTURAL HERITAGE

Due Diligence Assessment Aboriginal Cultural Heritage as part of a Development Application Amendment

142 Swan Hill Road, Murray Downs NSW, 2734

(M. McNeill)

Revised Report for the Development Application Amendment

February 2020

ADVANCED ENVIRONMENTAL SYSTEMS
CREATING A SUSTAINABLE FUTURE

Phone: (03) 5482 5882 or 0412 151 225 Email: aes@echuca.net.au

Web: www.environmentalsystems.com.au

Client Details	
Name of company	McNeill Subdivision Project
Address of site	Swan Hill-Moulamein Road, Murray Downs NSW 2734 Lot Numbers: Lot 1 DP 1134873
Name of site manager	Mark McNeil
Company phone number	0408 357 441

Assessor Details	
Name of investigating company	Advanced Environmental Systems P/L (AES)
Nominated individual/s	Mr Peter Clinnick (B. Ag. Sci. Hons. MASSSI) Dr Tim Stone (Doctor of Philosophy, Earth Sciences)
Date of assessment commencement	16th July 2017
Phone number	(03) 5482 5882 Mob: 0412 151 225
Email address	pc@environmentalsystems.com.au

Authors' Expertise

Mr Peter Clinnick has a Degree in Agricultural Science with Honours from La Trobe University and is a recognized soil scientist and Member of the Soil Science Society of Australia since 1980. He has over 15 year's experience in cultural heritage management and routinely undertakes cultural heritage assessments including Due Diligence Assessments and Cultural Heritage Management Plans (CHMPs) for rural landholders, developers and utilities. His experience in the rural sector spans over 30 years addressing issues related to natural and industrial resource assessment and management. He has been engaged by CSIRO Forestry, industry and local government to work in extension, research and statutory planning throughout Australia.

Dr. Tim Stone is a qualified archaeologist, geomorphologist and Cultural Heritage Advisor, with twenty eight years experience as a cultural heritage practitioner. Specifically, Dr. Stone has a BA (Hons, completed 1985) and M.Sc (completed 1992) from the Australian National University and a PhD (completed 2006) from the University of Melbourne. His three degrees combined Australian archaeology and geomorphology, with a specialization in optically stimulated luminescence (OSL) dating for his PhD.

Disclaimer

This report has been prepared based on the information available to AES – Advanced Environmental Systems at the time and represents to the best of AES's knowledge and the client's intentions at the time of printing of the document. The assessment of potential issues and impacts and conclusions drawn reflect our best judgment, based on that information. Although all possible care is taken, AES – Advanced Environmental Systems Pty Ltd, together with its employees accepts no responsibility for any resultant errors contained herein and any damage or loss, howsoever caused, and suffered by any individual or corporation.

TABLE OF CONTENTS

EXECUTIVE SUMMARY III

INTRODUCTION 1

1. PLANNING AND STATUTORY CONSIDERATIONS 3

1.1 Current Zoning 3

1.2 Murray River Council Development Control Plan 3

1.3 Murray Regional Environmental Plan No 2 - Riverine Land 4

1.4 Statutory Protection and the Burra Charter 5

2. LOCAL NATURAL FEATURES 7

2.1 Geomorphology and Topography 7

3. SITE ASSESSMENT 8

3.1. Methodology 8

4. ABORIGINAL HERITAGE (DESKTOP REVIEW) 9

4.1 Aboriginal Setting 9

4.2 Aboriginal Historic Sites 11

4.4 AHIMS Search 11

4.5 Types of Aboriginal Heritage Sites 11

4.6 Results and Discussion 13

4.7 Aboriginal Concerns 14

5. MITIGATION MEASURES 14

CONCLUSION 15

BIBLIOGRAPHY 16

APPENDIX 1 - ABORIGINAL SITES IN THE AREA (AHIMS DATABASE) 18

APPENDIX 2 - LOCAL ABORIGINAL REPRESESENTATIVE LETTER 19

APPENDIX 3 - GLOSSARY 20

EXECUTIVE SUMMARY

This revised Due Diligence Report (Previously prepared for land rezoning) has been provided as support for a Subdivision Amendment Application to Murray River Council for four additional lots, in addition to the 12 lots already approved by Council. The report addresses matters relating to Aboriginal Cultural Heritage and provides an information base that will enable planners and stakeholders to understand the local heritage context and assess any impacts of the proposed activity on potential Aboriginal heritage values.

The archaeological assessment for the McNeill Subdivision Project was conducted at 142 Swan Hill, Road Murray Downs (~4.05 ha) and was originally undertaken on 6th May 2017 to determine the potential impact of the proposed rezoning and subsequent subdivision in relation to Aboriginal cultural heritage. Fieldwork was undertaken by cultural heritage investigator Peter Clinnick from AES, in consultation with Mr Stephen Moore of the Wamba Wamba local Aboriginal community, with desktop research also conducted by archaeologist Dr Tim Stone.

The key objectives of the archaeological assessment were to:

1. Assess the potential for any Aboriginal cultural heritage sites in the area of the proposed original rezoning and subsequent subdivision;
2. Find measures to mitigate any possible damage to potential archaeological finds or cultural heritage sites;
3. Consult representatives of the local Aboriginal community to ascertain their concerns in relation to any site heritage issues relating to the development activities.

The report was prepared following field investigations and an updated (17-02-2020) Aboriginal Heritage Information Management System (AHIMS) database search, as well as relevant archaeological and environmental information. Aerial imagery and topographic maps relating to the site and surrounding area were also used.

The key findings are:

1. The field assessment of the site did not reveal the presence of any artefacts or other items of Aboriginal Cultural Heritage.
2. That the archaeological potential of the area is low, because of previous ground disturbance; and
3. Accordingly, there are no specific management strategies required for the subdivision area and no impediment to any proposed future works proceeding providing the mitigation measures outlined in Section 4 of this report are followed.

The property owner will need to keep the Wamba Wamba Local Aboriginal Land Council apprised of any artefacts unearthed during any future works.

Aboriginal Cultural Heritage Assessment

142 Swan Hill Road, Murray Downs, NSW

INTRODUCTION

In June 2017 an archaeological survey of the proposed rezoning and subsequent subdivision area (Lot 1) was undertaken to determine the potential impact of the proposed development on Aboriginal cultural heritage. The key objectives of the archaeological survey were to:

1. Locate and record any archaeological or heritage sites in the area;
2. Find measures to mitigate any potential damage to archaeological or heritage sites;
3. Consult representatives of the local Aboriginal community to ascertain the importance of the site to the Wamba Wamba community.

Preparation of this report involved collation of relevant archaeological and environmental information and the use of aerial imagery and topographic maps to identify areas with archaeological potential. Fieldwork was undertaken by a geomorphologist with experience in archaeology Mr Peter Clinnick, with desktop research also conducted by archaeologist Dr Tim Stone. The report has also been prepared in order to satisfy the requirements of the NSW State National Parks and Wildlife Act 1974, National Parks and Wildlife Amendment Act 2001 and Environmental Planning and Assessment Act 1979 and the Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act 1984.

The subdivision and proposal for four additional lots, is located along the Swan Hill Road, Murray Downs, abutting the Murray River. The proponent is applying to Murray River Council (previously Wakool Shire) for development approval of the land (Lot 1, DP1134973, ~4.05 ha) for subdivision with 12 Community lots with a subsequent amendment which relates to 4 additional lots (Figures 1-3).

Council and the Office of Environment and Heritage originally requested an archaeological survey of the proposed rezoning (and subdivision) area. A survey was subsequently undertaken on the 20th June 2017 to determine the potential impact of the proposed rezoning on Aboriginal cultural heritage. In order to bring the report up to date, the Aboriginal Heritage Information Management System database (AHIMS) was accessed on 17th February 2020 (Appendix 1). The key objectives of the archaeological survey were to:

1. Assess the potential for any Aboriginal cultural heritage sites in the area of the proposed original rezoning and subsequent subdivision;
2. Find measures to mitigate any possible damage to potential archaeological finds or cultural heritage sites;
3. Consult representatives of the local Aboriginal community to ascertain their concerns in relation to any site heritage issues relating to the development activities.

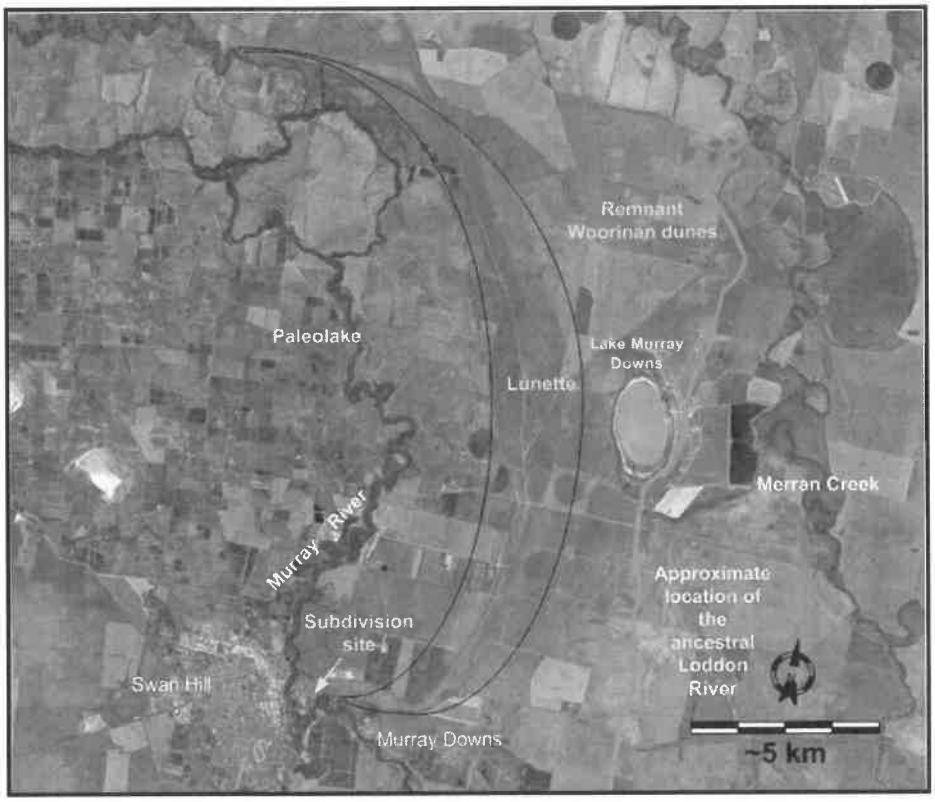


Figure 1. Subdivision location

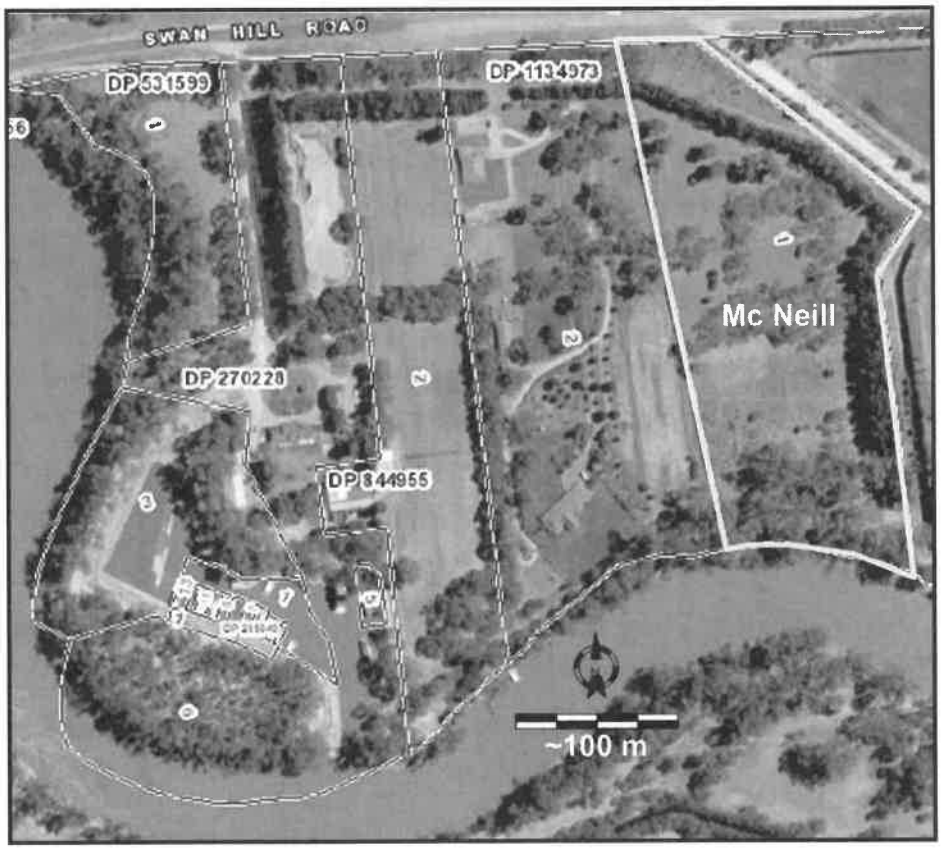


Figure 2. Subdivision area - aerial overview

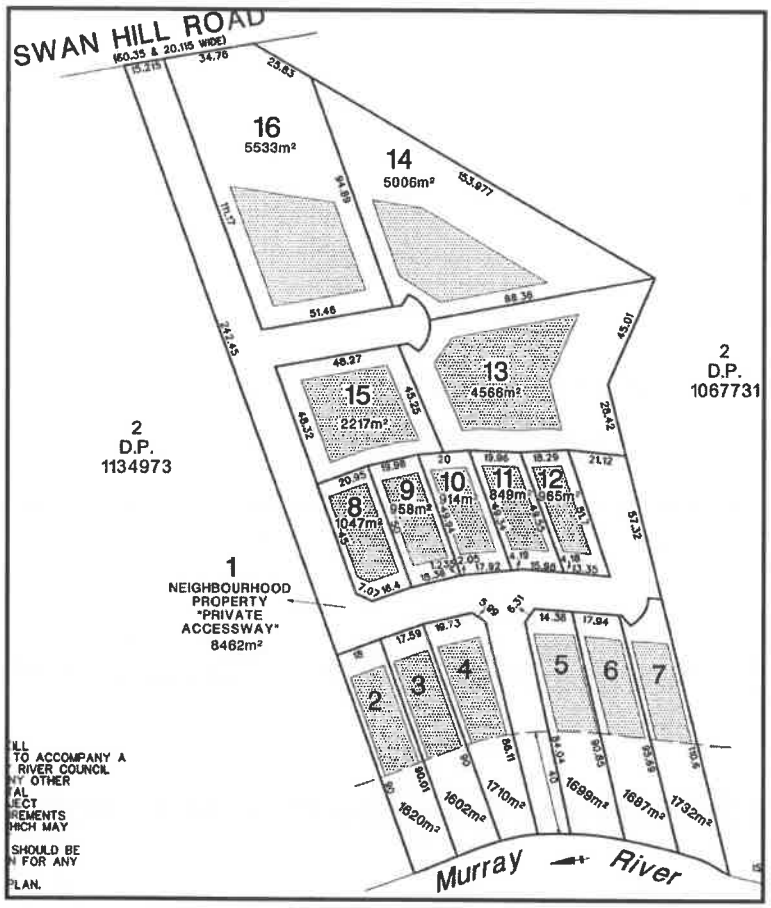


Figure 3. Proposed subdivision lots (Refer Figure 2 for scale)

1. PLANNING AND STATUTORY CONSIDERATIONS

1.1 Current Zoning

The subject site is zoned RE1 – Public Recreation.

1.2 Murray River Council Development Control Plan

The aims of the Murray River Council's (MRC - previously Wakool Shire) Development Control Plan (DCP) are to:

- Protect and enhance the environmental qualities of the Council area including, but not limited to, its land, water and biodiversity values and ecology and promote sustainable development;
- Ensure that development enhances the character and desired qualities of the Council area including, but not limited to, the river and landscape settings, its heritage items and historic streetscapes, its town and village character, and the rural setting;

- Recognise the importance of the river and watercourses systems in the Council area for local amenity, recreation and tourism and facilitate public access to the banks of the Murray, Edwards and Wakool Rivers;
- Minimise risk and impacts of natural hazards on humans and development;
- Promote economic development and growth of the Council area;
- Protect and enhance the agricultural production capacity of the Council area;
- Avoid or minimise land use conflicts;
- Encourage development that responds to its context and is compatible with the existing and desired built environment, local infrastructure, landscape, and public domain;
- Encourage sustainable development that minimises consumption of natural resources and maximises energy and water efficiency, re-use of materials, and recycling;
- Recognise and complement development in Victoria and adjacent local government areas.

The approved subdivision and proposed amendment meets of the key objectives of the DCP will not compromise Aboriginal cultural heritage values in any way.

1.3 Murray Regional Environmental Plan No 2 - Riverine Land

The Environmental Planning and Assessment Act 1979; Regulation 8 of the Murray Regional Environmental Plan (MREP) No 2 applies when:

(a) Council prepares any local environmental plan, or

(b) A consent authority determines a rezoning application, or

(c) A public authority or person proposes to carry out development which does not require development consent, but which has the potential to adversely affect the riverine environment of the River Murray.

Items (b) and (c) are applicable to the land under consideration for rezoning and subdivision. In the context of protecting Aboriginal cultural heritage, the following elements of the REPT-2 are relevant:

Land degradation

Development should seek to avoid land degradation processes such as erosion, native vegetation decline, pollution of ground or surface water, groundwater accession, salination and soil acidity, and adverse effects on the quality of terrestrial and aquatic habitats (i.e. Protecting potential artefact scatters and scarred trees).

Landscape

Measures should be taken to protect and enhance the riverine landscape by maintaining native vegetation along the riverbank and adjacent land, rehabilitating degraded sites and stabilising and revegetating riverbanks with appropriate species (i.e. Protecting potential artefact scatters, camp sites and scarred trees).

1.4 Statutory Protection and the Burra Charter

All historical sites in New South Wales are protected by the *NSW Heritage Act 1977* and the *Environmental Planning and Assessment Act 1979*. These Acts prohibit the wilful destruction or disturbance of any cultural heritage site, place or object, whether on private or public land. These places are considered to have significance according to the guidelines of the Australian Charter for the Conservation of Places of Cultural Significance (the Burra Charter).

Department of Planning and Environment and specifically the Office of Environment and Heritage (Cultural Heritage Branch) are the NSW State Government agencies that administer the following Acts.

In NSW, the *National Parks and Wildlife Act 1974* and the *National Parks and Wildlife Amendment Act 2001* provide legislative protection for all Aboriginal (and historic) cultural heritage sites, places and objects. Section 90 of the *National Parks and Wildlife Amendment Act 2001* states:

> *"A person must not destroy, deface, damage or desecrate, or cause or permit the destruction, defacement, damage of desecration of, an Aboriginal object or Aboriginal place."*

Section 87 of the National Parks and Wildlife Act 1974 refers to permits to research, excavate or collect Aboriginal objects or places.

The *Environmental Planning and Assessment Act 1979* also recognizes the need to protect the cultural and natural heritage of New South Wales. It compliments the *National Parks and Wildlife Act 1974* in that it provides for planning before development occurs and it obliges the developer to consult persons with relevant expertise or experience. The heritage scope of this legislation is wider than that of the *National Parks and Wildlife Act 1974* and there is no doubt that sites of significance to contemporary communities are included.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984. This Commonwealth Act provides for the blanket protection of all Australian Aboriginal and Torres Strait Islander archaeological sites, places and objects

whether privately or publicly owned. Whereas the State provides legislative protection for all physical evidence of past Aboriginal occupation, the Commonwealth Act also protects Aboriginal cultural property in the wider sense so as to include contemporary and ancient traditions and folklore. Importantly, this Act recognises that the Aboriginal people of NSW are the prior occupants of this State and the owners of their heritage and heritage sites regardless of public or private land ownership.

The Burra Charter. The Australian Burra Charter was adopted at a conference at the historic mining town of Burra, South Australia, in 1979. This charter defines the procedures and basic principles to be followed in the preservation of all types of sites, for example, Aboriginal shell middens, ancient campsites represented by stone artefact scatters, or historic mining shafts. These places are considered to have cultural significance either to Aboriginal people or to Australians in general. Cultural significance is a term used to encompass all the meanings and values that a particular place may have to people, beyond its utilitarian value. It refers to 'aesthetic, historical, scientific or social value for past or present generations, or for its likely value to future generations' (Marquis-Kyle and Walker 1992).

Under the guidelines of The Burra Charter any Aboriginal sites found in the area will have social value. According to the charter, social value is defined as:

> *"the qualities for which a place has become a focus of spiritual, political, national, or other cultural sentiment to a majority or minority group."* (Marquis-Kyle and Walker 1992).

Some sites in the area may also have scientific value. This is assessed according to each particular site's research or scientific potential to provide information about past Aboriginal culture, the environment, or human behaviour generally. According to the Burra Charter:

> *"The scientific or research value of a place will depend upon the importance of the data involved or its rarity, quality or representativeness and on the degree to which the place may contribute further substantial information."* (Marquis-Kyle and Walker 1992).

While the scientific or research value of a place may vary, the Murray Downs Local Aboriginal Land Council considers all Aboriginal archaeological sites to be significant. The Aboriginal people of the area have a very

ancient and unique traditional culture and these sites are important to them because they are a link to their ancestral lands and help to keep their traditional culture alive.

2. LOCAL NATURAL FEATURES

2.1 Geomorphology and Topography

The proposed subdivision area is located in the Murray Basin and forms part of the stream levee that is within 200 m of the Murray River. Dominant geomorphic features of the local area are depicted in Figure1.

The Murray Basin formed following uplift of the Eastern Australian Highlands, some 60 million years ago (Mackay and Eastburn, 1990). The stratigraphy of the Murray Basin is known from boreholes sunk throughout the region (Macumber, 1991). The uppermost unit beneath the proposed subdivision area is the Shepparton Formation. This unit is represented by 30 m of fluvio-lacustrine clayey sediments, which have been accumulating since the Pliocene (5.3 - 2.6 million years ago). The unit underlying this formation is the marine Parilla Sands. These deposits exert a strong control on the geomorphology of the south western region of NSW.

Formation of the Swan Hill palaeolake complex lunette (actually a double lunette) was the result of a much earlier glacial episode, which pre-dates the period of Aboriginal occupation. The complex lunette is built up from sands and clay blown from the bed of a dry lake by prevailing west to south-westerly winds (Figure 2 1). Conditions for dune formation would have been much cooler and drier than today (Butler et. al, 1973; Bowler, 1978). Optically stimulated luminescence (OSL) dating of dunes on the Murray River upstream has shown that the last major episode of riverine source-bordering dune activity in the region was at the height of the Last Glacial Maximum (LGM), some 18,000 years ago (Stone, 2006a).

Aboriginal people had occupied the region by this time and were adapting to the harsh climatic conditions. On the lee side of the lunette there appears to be a palaeodrainage channel that is most likely the ancestral course of the Loddon River. It has been truncated in the north by the Wakool River system and in the south by the Murray-Goulburn system. Flow of these later river systems was directed by movement of the Cadell Fault further to the east, near Mathoura. The proposed Loddon palaeochannel and associates source-bordering dunes therefore pre-date movement of the Cadell Fault. According to Stone (2006a), the Cadell Fault dates from before 75,000 years ago.

3. SITE ASSESSMENT

3.1. Methodology

Preparation of this report involved collation of relevant archaeological and environmental information and the use of aerial imagery and topographic maps to identify areas with archaeological potential. Field assessment was conducted on 20th June 2017 by Mr Peter Clinnick (AES) in consultation with Mr Stephen Moore who also discussed the importance of the three sites with Hazel Atkinson of the Wamba Wamba local Aboriginal Community. A literature search and desktop assessment was conducted by archaeologist Dr Tim Stone.

Survey Strategy

The survey was designed to firstly inspect anywhere in the vicinity of the proposed original rezoning and subdivision area with the potential to contain aboriginal artefacts or skeletal remains and secondly to locate any older trees, which may show evidence of Aboriginal scarring.

Conditions of ground surface visibility will affect the ease with which sites are located. Visibility may also skew the results of a survey. If, for example, conditions of ground surface visibility vary dramatically between environmental zones, then this in turn will be reflected in the numbers of sites reported for each zone. The zone with the best visibility may be reported as having the most sites (because they are visible on the ground) while another zone with less visibility, but perhaps more sites will be reported as having very little occupation. It is important therefore to consider the nature of ground surface visibility as part of any archaeological investigation. For this study conditions of ground surface visibility were moderate being on average about 20% due to dense grass coverage.

The subdivision area and surrounding land was surveyed by walking along a number of transects. These were distributed (transects ~7m apart) across the survey site and around the perimeter. Within the survey area there has been considerable site disruption from graders, small machinery movement, high levels of foot traffic and ground cultivation. In addition, all areas of very high ground surface visibility were surveyed. Older Red gum (*Eucalyptus camaldulensis*) trees within and near the site were also inspected. Aerial photography was assessed for any patterns or signs of historical evidence of occupation or site activities relating to Aboriginal heritage.

Recording Methods

Aboriginal sites are defined in this investigation as any culturally sensitive location with, or without, Aboriginal cultural material. When an Aboriginal site is located the following variables are recorded:

Site designation: Sites are allocated names according to the sequence of discovery.

Site type: Potential archaeological deposits (PADs) and scarred trees are recorded.

Grid co-ordinates: Information was derived from a hand-held Global Positioning System (GPS). GDA grid reference system used in recording sites.

Environmental setting: This describes the sites environmental context, including such features as geomorphology and vegetation.

Aspect: Direction at which the site faces. Aspect is a key determinant of site location.

Site size: Refers to the dimensions of the culturally sensitive areas.

Visibility: A measurement of the conditions of ground surface visibility in the survey area. Ground visibility conditions will affect whether sites are detected and whether their full extent has been recorded.

Site contents: This is a description of the archaeological traces at the site. With scarred trees, the features recorded would include the size and shape of the scar and its position on the trunk of the tree.

Site condition: Describes the condition of the site in terms of factors which may have disturbed it (such as kangaroos or rabbits) or which have the potential to disturb.

Management considerations: These detail the potential threat to the site specifically in terms of the possible future works. In addition, specific ameliorative measures are recommended if warranted. In some cases the recommendation is simply that no active management is necessary apart from avoiding any established site during the course of the works activities.

4. ABORIGINAL HERITAGE (DESKTOP REVIEW)

4.1 Aboriginal Setting

An understanding of the Aboriginal archaeology of southern NSW has begun to emerge from a number of studies including some undertaken in the Swan Hill region. These studies include those of the Nyah State Forest (e.g. Coutts, 1977; Coutts et al., 1979; Cusack, 2000) and Barmah Forest (Bonhomme, 1990), which is along the Murray River upstream of Swan Hill. Mounds along the Wakool River north of Swan Hill have been investigated by Berryman and Frankel (1984). Aboriginal burial sites along the Murray River are described by Webb (1984) and Pardoe (1988). These studies indicate the nature of the regional archaeological record.

The oldest known Aboriginal site in the region is at Lake Tyrrell, some 60 km west of Swan Hill. The lunette on the eastern shore of the lake contains stone artefacts, faunal remains and evidence of burning, which Macumber (1991) and Stone (2006) dated to older than 27,000 years ago, using 14C and OSL dating methods respectively. Charcoal excavated from lower down in the site by Richards and Webber (2004) returned a 14C age of 40,384 ± 766 years Before Present (AHU-171), but whether this sample is related in time to Aboriginal occupation is uncertain.

The Nyah State Forest contains earth mounds, freshwater mussel shell middens and trees scarred by Aboriginal people when removing bark or wood. Some of the earth mounds have been excavated and dated by 14C and TL to less than 3,000 years old (Coutts and Witter, 1977; Downey and Frankel).

Near the Loddon palaeochannel several mounds can be found (Clinnick and Stone 2007). The mounds are composed of earth (predominantly silt) and are distributed randomly in the landscape. In height, they vary from ~10 cm to 2 m high and most of the mounds have a radial symmetry. Tongway *et al.* (1989) describes similar mounds elsewhere in semi-arid NSW as mulga log mounds. These mounds form by the accumulation of sediment around fallen logs. The silt in them probably derives from aeolian and fluvial activity in the local landscape and from rainwash depositing material brought to the surface by termites living in the fallen logs. These mounds may have also been used by Aboriginal people as campsites or for interring the dead.

Other archaeological assessments that have resulted in the identification of Aboriginal sites include:

Anutech Pty Ltd. 1989. *An archaeological investigation on stage one of the Murray downs golf and country club project area.*

- Two areas with archaeological remains near Murray Downs Golf Club.

Austral Archaeology (1996). *Northern Mallee pipeline project desktop archaeological study report for Mallee Wimmera Water.*

- Four previously recorded sites found including burials and mounds and an oven, midden/fish traps on the Victorian side of the river at or near Pental Island.

du Cross and Associates (1997) *An Archaeological Investigation of Proposed Levee Banks Swan Hill, Victoria. Report to Swan Hill Rural City Council.*

- Five sites around Swan Hill township stone artefact scatter, one midden and three mound sites.

Hope J. (Undated) – *Refer Long and Associates In the vicinity of Murray Downs (and Appendix 1 AHIMS Search).*

- Four listed sites that include burials, artefacts, a mound (oven), a midden and an open camp site.
- One of the sites (a burial) is within one kilometre of the subdivision area and is close to Murray Downs homestead.

Long and Associates (2011) *Swan Hill Bridge Aboriginal Cultural Heritage Addendum Report.*

- No sites found, but the site investigators identified a predicted area close to the bridge across the Murray that had been disturbed.

Terra culture (2001) *Pental Island Levee Bank Project: Archaeological report. A report prepared for North Central Catchment Management Authority.*

- One hearth on the Victorian side of the Murray River.

4.2 Aboriginal Historic Sites

Long et al, (2011) listed ten aboriginal post contact /historical sites on the Victorian side of the Murray River that have been registered with Aboriginal Victoria. The locations have not always been precisely mapped or associated with physical evidence, but are reported to include camp sites, depot sites and Aboriginal Reserves.

4.4 AHIMS Search

According to the NSW Department of Environment and Heritage (OE&H) Aboriginal Heritage Information Management System (AHIMS), no Aboriginal sites have been recorded previously in the proposed subdivision and development area or along the relevant sections of the Swan Hill - Moulamein Travelling Stock Route access road. Detailed investigations of reports and site card provided by AHIMS indicates that the closest known Aboriginal site is the Murray Downs burial (NPWS Site No. 53-3-0017), which is located ~900 m south-east of the subdivision area. It was recorded by archaeologist Jeanette Hope. The site is not threatened by the proposed subdivision or future works.

In addition, there have been numerous Aboriginal cultural heritage finds located across the Murray River in Victoria (Long *et. al,* 2011. Refer page 11). There is extensive evidence of Aboriginal occupation with burials, scar trees, middens and artefact scatters distributed along the Murray River. Sand hills with possible burial sites are also evident on the local area (Stone and Clinnick 2007).

4.5 Types of Aboriginal Heritage Sites

The types of archaeological site which have been recorded previously in southern NSW, which might therefore be expected to occur in the Murray Downs area are described below.

Local and regional archaeological studies have shown that most Aboriginal sites in the Murray Downs region are concentrated on the Murray River, with scarred trees far outnumbering stone artefact scatters and shell middens (e.g. Bonhomme, 1990). The paucity of stone artefact sites is generally believed to be a product of distance from highland stone sources.

Open campsites

Open campsites are one of the most commonly occurring types of archaeological site in the region. These sites are represented by scatters of stone artefacts lying on the ground surface. The remains of fire hearths may also be associated with the artefacts. In rare instances, open campsites which were used over a long period of time may have accumulated sediments and become stratified. That is, there may be several layers of occupation buried one on top of another.

The open campsites are almost invariably located near permanent or semi-permanent water sources. Local topography is also important in that campsites tend to occur on level, well-drained ground elevated above the

local water source. In the Murray Downs area they are most likely to be located on river terraces, lunettes, along creeks and also around the margins of lakes and wetlands.

Freshwater shell middens

Shell middens are deposits of shell and other food remains accumulated by Aboriginal people as food refuse. In inland SE Australia these middens typically comprise shells of the freshwater mussel (*Velesunio ambiguus*), or the river mussel (*Alathyria jacksoni*). Freshwater middens are most frequently found as thin layers or small patches of shell and often contain stone or bone artefacts and evidence of cooking. Such sites are relatively common along the Murray River and its tributaries.

Earth mounds

Earth mounds may have been used by Aboriginal people as cooking ovens or as campsites. They are common along the Murray River and in the Wakool District further to the north. They appear to have ranged from 3 to 35 metres in diameter and from 0.5 to 2 metres in height. Today, however, they may be difficult to recognise because of the effects of ploughing, grazing and burrowing rabbits. Earth oven material, stone artefacts, food refuse and the remains of hut foundations have been exposed in some excavated earth mounds.

Quarry sites

These are locations where Aboriginal people obtained ochre for their art and decoration. Materials commonly used for making flaked stone tools include chert, silcrete, quartz and quartzite were not freely available in the area and were obtained by trade.

Carved trees

These are trees on which Aboriginal people have cut designs through the bark onto the wood beneath. They are thought to have once had a wide distribution in SE Australia, but because of age and widespread tree clearance few remain today. Ethnohistoric records indicate that some carved trees were associated with burials whilst others may have been sacred or totemic sites.

Scarred trees

Slabs of bark were cut from trees by Aboriginal people and used for a variety of purposes including roofing shelters and constructing canoes, shields and containers. Scars also resulted from the cutting of toe holds for climbing trees to obtain honey or to capture animals, such as possums. The classification of scarred trees as natural, European or Aboriginal is often problematic; however, if the scar is Aboriginal, the tree must now be more than 150 years old.

Burial grounds

Aboriginal burial grounds may consist of a single interment or a suite of burials. In the drier parts of western NSW skeletal material is regularly found in eroding sand deposits, but near the slopes of the Great Dividing Range burial sites are rare because conditions for the preservation of bone are usually poor.

4.6 Results and Discussion

Watercourses would have been the foci of Aboriginal occupation in the local area. Riverine source-bordering dunes along the Murray River and its palaeochannels are well-known repositories of Aboriginal cultural material, including burials (e.g. Webb, 1984; Pardoe, 1988). The three rezoning areas on the Murray River would have attracted Aboriginal occupation and be part of a hunting and gathering area. These sites are situated on uniformly compacted grey medium clay Vertosol soils that have little potential for stratified cultural material at depth (Figure 5).

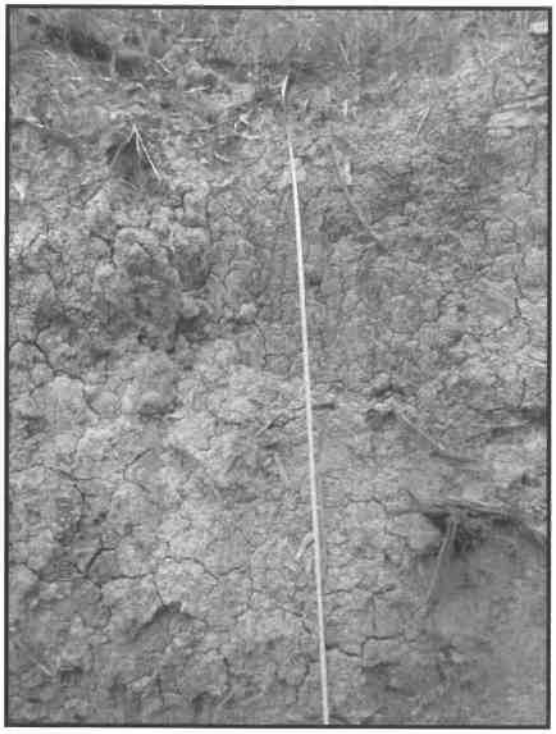


Figure 4. Grey clay Vertosol compacted profile evident across the floodplain

Figure 5. Lot 1 - Previously cleared and used for cropping (Low ACH potential)

The vast majority of alluvial soil material was deposited as part of the Murray River floodplain sequence long before Aboriginal people arrived in Australia (~65,000 years ago). Consequently, any archaeological potential is limited to the surface. At the site there has been extensive disturbance including grading, excavating or ploughing for crops (Figures 5). When all the intrinsic environmental factors together with anthropogenic influences are taken into account, the potential for discovering Aboriginal Cultural Heritage items or deposits is extremely low. No cultural material was recorded or located within the property.

4.7 Aboriginal Concerns

Aboriginal people living in southern NSW are apprehensive about any development that might impact upon Aboriginal sites in the region. In discussions with Stephen Moore and information from Hazel Atkinson of the Wamba Wamba Local Aboriginal Land Council, based in Swan Hill, Mr Moore stated that they have previously surveyed the areas under consideration and have no concerns about rezoning or subdivision development affecting Aboriginal Cultural Heritage. Furthermore, Mr Moore expressed the view that the area (Stream levee) along the relevant stretch of the river is not of significance for the Wamba Wamba Community (Refer correspondence Appendix 2).

5. MITIGATION MEASURES

Cultural heritage encountered during any earth moving activities

In the unlikely event that items of Aboriginal cultural heritage are uncovered during a works activity, the person who discovers the Aboriginal cultural heritage will immediately notify the person in charge of the activity. The person in charge must then suspend works at the location of the find and put in place a buffer zone with a radius of 25 m to temporarily protect the find and ensure that it is not further disturbed.

To ensure compliance with legislation in place to protect Aboriginal sites and objects in NSW the **inclusion of the following conditions are recommended** to ensure that no additional harm is caused should Aboriginal sites or objects be encountered:

If any Aboriginal object is discovered and/or harmed in, or under the land, while undertaking the any future works activities, the proponent must:

1. *Not further harm the object;*
2. *Immediately cease all work at the particular location;*
3. *Secure the area so as to avoid further harm to the Aboriginal object;*
4. *Notify OE&H as soon as practical on 131 555, providing any details of the Aboriginal object and its location; and*
5. *Not recommence any work at the particular location unless authorised in writing by OE&H.*

If skeletal remains are unexpectedly encountered during the activity, work must stop immediately, the area secured to prevent unauthorized access and contact made with NSW Police and OE&H. The following information outlines three basic steps that should be followed in the event that human remains are uncovered:

1. Discovery

- If suspected human remains are discovered, all activity in the vicinity must stop to ensure minimal damage is caused to the remains;
- The remains must be left in place and protected from harm or damage.

2. Notification

- Once suspected human skeletal remains have been found, the NSW Police must be notified immediately;
- All details of the location and nature of the human remains must be provided to the relevant authorities.

3. Reburial

- Any reburial site(s) must be fully documented by an experienced and qualified archaeologist, clearly marked and all details provided to National Parks;
- Appropriate management measures must be implemented to ensure that the remains are not disturbed in the future.

CONCLUSION

Based on the results of this investigation and consultation with the Wamba Wamba Aboriginal Representative it is recommended that:

- Subdivision of Lot 1, DP1134973 (12 +4 lots) could proceed without further archaeological investigation
- The property owners should keep the Wamba Wamba Local Aboriginal Land Council apprised of any artefacts unearthed during any future works.

BIBLIOGRAPHY

Anutech Pty Ltd. (1989). *An archaeological investigation on stage one of the Murray downs golf and country club project area.*

Austral archaeology (1996). *Northern Mallee pipeline project desktop archaeological study report for Mallee Wimmera Water.*

Berryman, A. and Frankel, D. (1984). Archaeological investigation of mounds on the Wakool River, near Barmah, New South Wales. A preliminary account. Australian Archaeology, 19:15-20.

Butler, B.E. Blackburn, G. Bowler, J.M. Lawrence, C.R. Newell, J.W. and Pels, S (1973). A geomorphic map of the Riverine Plain of south-eastern Austalia (Australian National Univrsity Pres: Canberra).

Bonhomme, T. (1990). An archaeological survey of the Barmah Forest. Department of Conservation and Environment.

Bowler, J.M. (1970) *Late Quaternary environments: a study of lakes and associated sediments in south-eastern Australia*. Unpublished PhD thesis, Australian National University, Canberra ACT.

Clinnick, P.F. and Stone T. (2007). *Murramel Sand Mine Murray Downs NSW Environmental Impact Assessment.* Prepared for D. Lewis Murray Downs.

Coutts, P. J. F. (1977). *Aboriginal prehistory of North Western Victoria.* Victorian Archaeological Survey, Melbourne.

Coutts, P. J. F. and Witter, D. 1977. New radiocarbon dates for Victorian archaeological sites. Victorian Archaeological Survey, Melbourne.

Coutts, P. J. F., Henderson, P. and Fullager, R. L. K. (1979). A preliminary investigation of Aboriginal mounds in North-Western Victoria. Ministry for Conservation, Melbourne.

Cusack, J. (2000). *An Aboriginal heritage assessment of three proposed forestry coupes.* Report to Aboriginal Affairs Victoria.

Downey, B. and Frankel, D. (1992). *Radiocarbon and thermoluminescence dating of a central Murray mound*. The Artefact, 15:31-35.

du Cross and Associates (1997) *An Archaeological Investigation of Proposed Levee Banks Swan Hill, Victoria. Report to Swan Hill Rural City Council.*

Harris, W.J. (1939). *The physiography of the Echuca district*. Proceedinghs of the Royal society of Victoria 51, 45-60.

Hope J. (Undated) – *Refer Long and Associates In the vicinity of Murray Downs and AHIMS Search July 2017.*

Irish, P. (2005). *When is a scar a scar? Evaluating scarred and marked trees at Sydney Olympic Park.* Australian Archaeology, 59:59-61.

Long and Associates (2011) *Swan Hill Bridge Aboriginal Cultural Heritage Addendum Report.*

Mackay, N. and Eastburn, D. (eds.) (1990). *The Murray.* Murray-Darling Basin Commission, Canberra.

Macumber, P. 1991. *Interaction between ground water and surface systems in northern Victoria,* Department of Conservation and Environment, Victoria.

Marquis-Kyle, P. and Walker, M. (1992). *The Illustrated Burra Charter.* Australian ICOMOS, Sydney.

Office of Environment and Heritage (2017). http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx

Pardoe, C. (1988). *The cemetery as symbol. The distribution of prehistoric Aboriginal burial grounds in south-eastern Australia.* Archaeology in Oceania, 23:1-16.

Richards, T. and Webber, H. 2004. Lake Tyrrell Aboriginal cultural heritage field school. Aboriginal Affairs Victoria, Melbourne.

Rhodes, D. and Long, J. (2015) *Report on Assessment for Aboriginal Cultural Heritage Values, Echuca-Murray Downs Bridge project.* Report prepared for VicRoads. Collingwood, Vic.

Stone, T. (2006) *The Late Holocene origin of the modern Murray River Course, southeatern Australia*. . Eart Sciences University of Melbourne, Vic Australia.

Stone, T. (2006a). *Late Quaternary Rivers and Lakes of the Cadell Tilt Block region, Murray Basin, Southeast Australia.* Unpublished PhD thesis, The University of Melbourne Vic Australia.

Terra culture (2001) *Pental Island Levee Bank Project: Archaeological report. A report prepared for North Central Catchment Management Authority.*

Tongway, D. J., Ludwig, A. J. and Whitford, W.G. (1989). *Mulga log mounds: fertile patches in the semi-arid woodlands of eastern Australia.* Australian Journal of Ecology, 14:263-268.

Webb, S. (1984). *Intensification, population and social change in south-eastern Australia: the skeletal evidence.* Aboriginal History, 8:154-172.

APPENDIX 1 – ABORIGINAL SITES IN THE AREA (AHIMS DATABASE)

Office of Environment & Heritage
NSW GOVERNMENT

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : McNeil Subdivision
Client Service ID : 484637

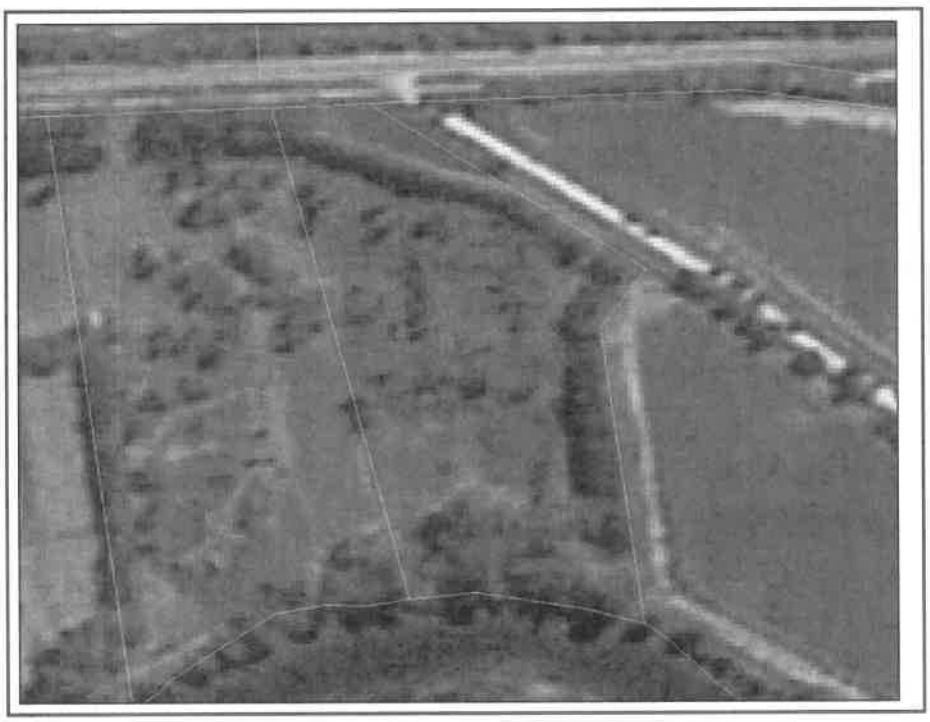
AES Consulting - Echuca
443 High Street
Echuca Victoria 3564
Attention: Peter Clinnick
Email: pc@environmentalsystems.com.au

Date: 17 February 2020

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 1, DP:DP1134973 with a Buffer of 50 meters, conducted by Peter Clinnick on 17 February 2020.

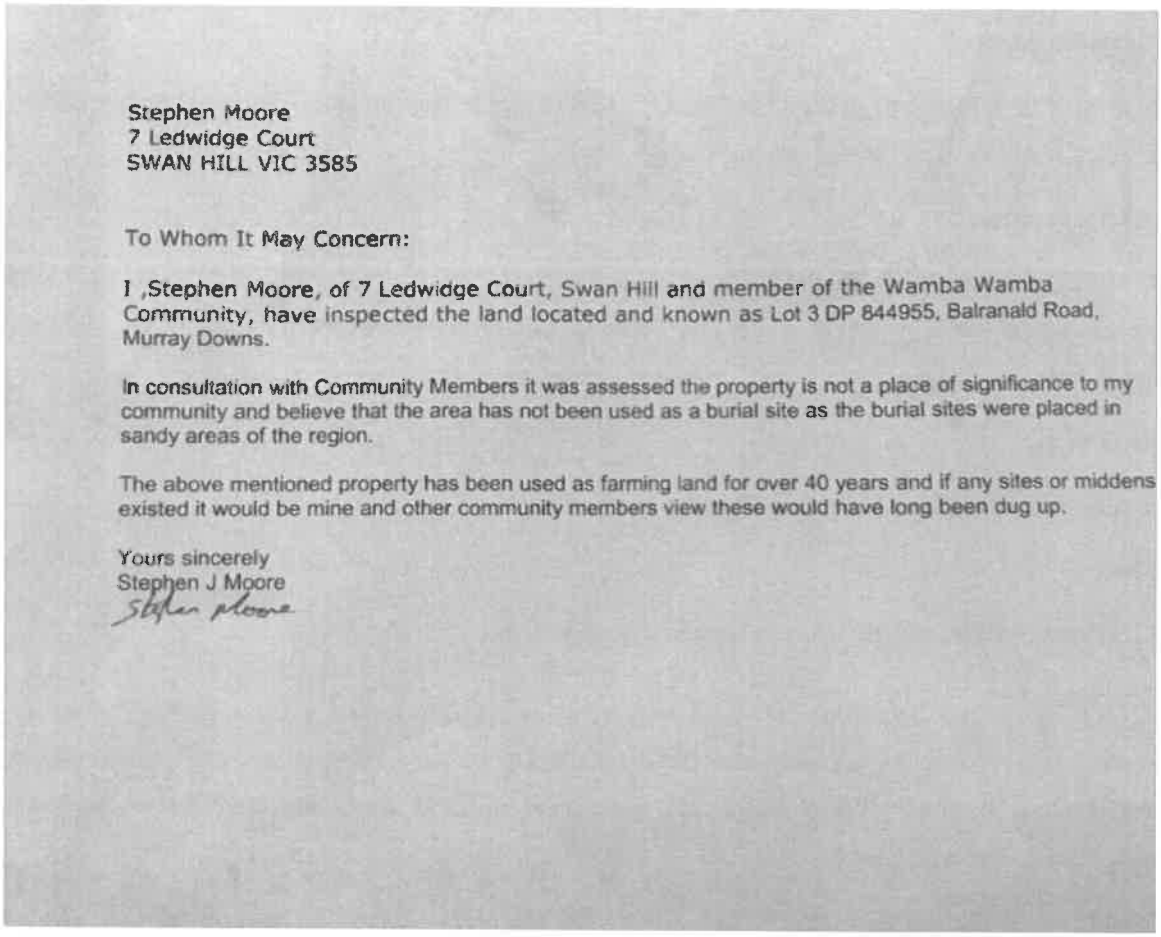
The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

APPENDIX 2. LOCAL ABORIGINAL REPRESESENTATIVE LETTER



Stephen Moore
7 Ledwidge Court
SWAN HILL VIC 3585

To Whom It May Concern:

I ,Stephen Moore, of 7 Ledwidge Court, Swan Hill and member of the Wamba Wamba Community, have inspected the land located and known as Lot 3 DP 844955, Balranald Road, Murray Downs.

In consultation with Community Members it was assessed the property is not a place of significance to my community and believe that the area has not been used as a burial site as the burial sites were placed in sandy areas of the region.

The above mentioned property has been used as farming land for over 40 years and if any sites or middens existed it would be mine and other community members view these would have long been dug up.

Yours sincerely
Stephen J Moore
Stephen Moore

Note: The Lot number and DP have been superseded and includes the area that is now covered by Lot 2 DP 844955 and Lots 1 and 2 of DP 1134973 (2008). The Swan Hill–Moulamein Road is also referred to as the Balranald Road.

APPENDIX 3. GLOSSARY

Archaeological site

A place with evidence of past human activity. This evidence may include Aboriginal and/or historic artefacts, features, structures or organic traces.

Artefact scatter

A surface scatter of Aboriginal or historic cultural material. Scatters of stone artefacts are a common archaeological site type. These scatters may also contain charcoal, discarded animal bones, shell and ochre.

Assemblage

A collection of artefacts from a single archaeological site.

Blade

An elongated flake, usually twice as long as it is wide.

Burial site

A place with a concentration of human remains. Ochre, stone tools, charcoal and grave goods may be associated with burials. Most burial sites are found in sand dunes but dead trees, caves and rockshelters were also used.

Chert

A fine-grained opaline rock ranging in color from white to black, but most often grey, brown, grayish brown and light green to rusty red.

Core

A piece of stone from which flakes have been removed. They usually have negative flake scares that have resulted from the removal of flakes.

Cortex

The original, weathered surface of a rock or mineral.

Cultural material

Any material remains or objects resulting from human activity.

Flake

A piece of stone detached from a core that typically displays a striking platform, bulb of percussion and flake scars on the ventral surface.

Flaked piece

Small fragments of stone resulting from the manufacture of stone tools. A striking platform or bulb of percussion may not be evident.

Formalized tools

An artefact that has been deliberately shaped by flaking, retouch or grinding to produce a predetermined tool type. Examples include scrapers, backed artefacts and axe heads.

Ground surface visibility

The amount of bare ground exposed, usually expressed as a percentage.

in situ

An artefact or other feature that has not been disturbed from its original position.

Isolated artefact

An isolated artefact is defined as five or less artefacts in a ~100m^2 area.

Microblade

Small blade more than twice as long as it is wide.

Microlith

A symmetrical tool backed along a thick margin and pointed at both ends. It is a component of the Australian Small Tool Tradition.

Quarry

An outcrop of stone or ochre where Aboriginal people have extracted the raw material for use or trade. Stone quarries are identifiable by a dense scatter of broken stone and flakes or consist of pits or hollows where material has been dug out of the ground.

Quartz

Quartz is a silica mineral resistant to weathering because of its hardness. It is commonplace in the landscape as a consequence.

Quartzite

A metamorphic rock formed by the re-crystallization of quartz.

Retouch

A stone artefact with fine, secondary flaking along one or more edges.

Scarred tree

A tree with a scar on its trunk caused by bark removal. A scar may have been produced by Aboriginal people but more often by natural processes.

Scraper

A flake, flaked piece or core with retouch on one or more edges. Scraper types include steep edge, thumbnail and side.

Shell midden

A surface scatter or heap of discarded shell often with charcoal, animal bones and stone artefacts. Middens may found near coastlines, rivers, creeks, swamps and ancient lakes.

Silcrete

A hard, fine-grained rock composed of silica cement.

Stratified deposit

Material that has been laid down over time forming a sequence of events.

Subsurface testing

A method of excavation used for detecting cultural material below the ground surface. Testing is commonly by shovel, trowel or hand auger.

Survey

An inspection of land either by foot or vehicle for the purpose of identifying archaeological sites.

Transect

A predetermined area or a path that directs the course of a survey.

ATTACHMENT C

MURRAY RIVER COUNCIL - MURRAY DOWNS FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN FINAL REPORT

Murray River Council

Murray Downs Floodplain Risk Management Study and Plan
Final Report

January 2017

Cover photograph: View looking downstream from Moulamein Road at Murray Downs.

Preface

The NSW State Government's Flood Policy aims to provide solutions to existing flooding problems and ensure that new development within flood prone areas is compatible with the prevailing flood risk and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land is the responsibility of local government. State government subsidises flood mitigation works to alleviate existing problems and provide specialist technical advice to assist councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government during the following four sequential stages:

- Flood Study – determines the nature and extent of the flooding problem.
- Floodplain Risk Management Study – evaluates management options for the floodplain in respect of both existing and proposed development.
- Floodplain Risk Management Plan – the formal plan adopted by Council for the management of the floodplain.
- Plan Implementation – implementation of the various structural and non-structural measures proposed by the Plan.

This report documents the above second and third stages in the process (Floodplain Risk Management Study and Floodplain Risk Management Plan). It follows the completion of the Murray Downs Flood Study in 2014.

The Murray River Council has prepared this document with financial assistance from the NSW and Commonwealth Governments through the Natural Disaster Resilience Program. This document does not necessarily represent the opinions of the NSW or Commonwealth Governments.

The Murray River Council was formed on the 12 May 2016 as a result of the merger of the Wakool Shire Council and the Murray Shire Council. Murray Downs is located within the previous Wakool Shire Council area.

Table of Contents

1. Introduction 1
2. Community Consultation 3
   - 2.1 Overview 3
   - 2.2 Floodplain Risk Management Committee 3
   - 2.3 Other Stakeholders 3
   - 2.4 Community Consultation Activities 4
   - 2.5 Public Exhibition of the Draft FRMS&P Report 5
3. Flood Study Summary 6
   - 3.1 Overview of 2014 Flood Study 6
   - 3.2 Catchment Description 6
   - 3.3 Floodplain Description 6
   - 3.4 Flooding Conditions 8
4. Flooding Impacts 11
   - 4.1 Approach 11
   - 4.2 Above Floor Flooding 12
   - 4.3 Flood Damages 12
   - 4.4 Summary of Flooding Impacts 13
5. Preliminary Assessment of Mitigation Options 14
   - 5.1 Overview of Types of Measures 14
   - 5.2 Property Modification Measures 15
   - 5.3 Response Modification Measures 17
   - 5.4 Flood Modification Measures 20
   - 5.5 Summary and Recommendations 21
6. Property Modification Options - Detailed Assessment 23
   - 6.1 LEP and DCP 23
   - 6.2 Development Control FPLs 23
   - 6.3 FPA 25
   - 6.4 True Flood Hazard 25
   - 6.5 Local Flood Policy 26
7. Response Modification Options - Detailed Assessment 27
   - 7.1 Swan Hill Flood Warning Station 27
   - 7.2 Flooding Duration 28
   - 7.3 Local Flood Plan 30
   - 7.4 SES Flood Data Outputs 31
   - 7.5 Flood Response Discussion 32
   - 7.6 Flood Data 33
   - 7.7 Community Awareness Measures 33

8. Flood Modification Options - Detailed Assessment 35
8.1 Existing Levees 35
8.2 Murray Downs Creek 39
8.3 Future Development 45
9. Floodplain Risk Management Plan 47
9.1 Overview 47
9.2 Recommended Mitigation Measures 48
9.3 Implementation/Funding 51
10. Acknowledgements 52
11. Abbreviations and Glossary 53
11.1 Abbreviations 53
11.2 Glossary 54
12. References 57

Table Index

Table 1 Issues Raised in Questionnaire Responses 4
Table 2 Design Flow Estimates 8
Table 3 Murray Downs Above Floor Flooding Assessment Results 13
Table 4 Murray Downs Flood Damage Estimates 13
Table 5 BOM Flood Warning Thresholds - Murray River Gauges 18
Table 6 Preliminary Assessment of Flood Management Options 22
Table 7 Swan Hill Murray River Flood Warning Station 27
Table 8 Rate of Rise and Duration 28
Table 9 Recommended Floodplain Management Plan Measures 50

Figure Index

Figure 1 Murray Downs - Floodplain Risk Managment Plan Area 2
Figure 2 Questionnaire Responses – Favoured Mitigation Options 5
Figure 3 Murray Downs Photographs 7
Figure 4 BOM Flood Warning Stations 18
Figure 5 Flooding Durations – 1975 and 1993 Floods 29
Figure 6 Private Levee – South side of Moulamein Road 36
Figure 7 Private Levee - North Side of Moulamein Road 38
Figure 8 Murray Downs Creek Floodway 40
Figure 9 Murray Downs Creek – 1986 Report Extract 41
Figure 10 Murray Downs Replacement Bridge – Preferred Route 41
Figure 11 Hydraulic ModellingResults – Murray Downs Creek Floodway 44
Figure 12 Murray Downs Drive - Residential Development 46

Appendices

Appendix A – Draft Local Flood Policy for Murray Downs

Appendix B – SES Flood Data Outputs

Appendix C – Community Consultation

Appendix D – 100 Year ARI Flood Maps

Executive Summary

The Murray Downs Floodplain Risk Management Study and Plan was commissioned as part of a combined project for the three Murray River townships of Murray Downs, Barham and Tooleybuc, all located within the previous Wakool Shire area.

The study has been carried out in accordance with the NSW Government's Floodplain Development Manual (2005). The primary objective of the NSW Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce the risk of private and public losses resulting from floods.

The management of flood-prone land within urban areas remains the responsibility of local government. The NSW State Government provides funding to assist local councils with the development of floodplain risk management plans and their implementation.

The development of a Floodplain Risk Management Plan for Murray Downs follows the completion of the Murray Downs Flood Study in 2014. The Flood Study report (GHD, 2014) documents Murray River flooding conditions at Murray Downs based on an assessment of historical records and computer modelling using detailed terrain data for the floodplain.

This Floodplain Risk Management Plan relates to the Murray Downs town area as defined on Figure 1. It does not address rural flooding issues outside this area.

Community Consultation

Community consultation activities are documented in Section 2 of this report.

The study has been overseen by Council's Floodplain Risk Management Committee. The Committee met regularly during the study to review progress and provide direction for future activities.

A Project Fact Sheet was distributed to all residents of Murray Downs during the early stages of the project in July 2015. The information provided in the Project Fact Sheet included an overview of the project and advance notice of the Community Forum which was held in late July 2015. A Questionnaire was distributed with the Project Fact Sheet to obtain information regarding the impact of past floods and residents views on possible flood mitigation works.

The draft Murray Downs FRMS&P report was placed on public exhibition in October and November 2016. A public information meeting was held at Murray Downs in October 2016 during the public exhibition period. No submissions were subsequently received by Council at the conclusion of the public exhibition period.

Flooding Conditions and Impacts at Murray Downs

Flooding conditions and impacts are described in Sections 3 and 4 of this report.

Detailed Murray River flood levels and flows have been recorded at the Swan Hill gauging station since 1909. The most notable more recent floods have occurred in 1975, 1981 and 1993. Recorded flood levels at Murray Downs prior to 1970 are marginally lower than those after 1970 most likely due to the closure of NSW side effluent flow paths.

The hydraulic modelling carried out as part of the 2014 Murray Downs Flood Study has enabled detailed flood mapping to be prepared for a range of floods. Events modelled consist of the 5, 20, 100 and 200 year ARI floods and an extreme event. Mapping prepared for each event defines the height, depth and extent of flooding.

Private levees provide protection to development on either side of the Moulamein Road between the river bridge crossing and Murray Downs Drive. The private levees are not urban standard levees, with little or no freeboard above the 100 year ARI flood levels and are of unknown structural integrity. If the private levees are breached due to structural failure or are overtopped, some above floor flooding is likely to occur. The levees have not been overtopped or breached in more recent floods (e.g. October 1993 flood which was equivalent to a 50 year ARI and the February 2011 flood which was equivalent to a 5 year ARI flood).

Development off Murray Downs Drive does not rely on levee protection. Flooding impacts in a 100 year ARI flood are limited to grounds flooding only of a small number of residential properties.

The estimated average annual flood damage at Murray Downs is a relatively low $17,000 per annum.

Floodplain Management Options

Floodplain management options are described in Sections 4 to 8 of this report.

An upgrade of the private levee system to an urban standard would require the Murray River Council to effectively take on ownership of the levees including future maintenance costs and also responsibilities if the levees fail. The levees provide protection to primarily industrial and commercial development. The floor levels of the limited residential development in this area are mostly located above the 100 year ARI flood levels.

An upgrade of the private levee system has not been adopted after taking into account the limited flood impacts on existing development, the absence of residential zoned land in this area and the presence of non flood affected currently undeveloped residential zoned land off Murray Downs Drive.

An assessment of the benefits of restoring flood access to the Murray Downs Creek anabranch was undertaken. Benefits would lie mainly with environmental benefits which fall outside the objectives of this Plan. Flood mitigation benefits are minimal and not economically justifiable.

The existing Swan Hill - Murray Downs bridge will be replaced at some point. The VicRoads bridge replacement planning study has identified possible culvert structures on the Moulamein Road side approach to supplement bridge opening flows. It is recommended that as part of the replacement bridge and associated road works, limited capacity culvert structures be installed at the two feeder waterways into Murray Downs Creek with regulators fitted to allow for the control of flows. The western most culvert will provide for the drainage of local runoff and any residual floodwater pondage from within the private levee enclosed area. The eastern most culvert will allow for the potential discharge of limited flood flows into Murray Downs Creek.

Integral to all floodplain risk management plans is the development of flood based planning and development controls. These are important for ensuring that future development occurs in a manner which is compatible with the flood risk. This includes excluding development from high risk areas and imposing appropriate controls (e.g. minimum floor levels) in low risk areas.

The proposed flood based planning and development controls for Murray Downs are documented in Appendix A. Figures A1, A2 and A3 in Appendix A are the maps which define the respective areas which are subject to these controls.

Also integral to all floodplain risk management plans is an assessment of flood response modification measures. This can include improvements to the flood warning system and activities to increase the level of flood awareness in the local community.

The flood warning system for the Murray River upstream of Murray Downs consists of an extensive network of gauges on the Murray River and all its major tributaries. Adequate real time data is currently available without the need for further improvements.

Community awareness related measures which are recommended for Murray Downs consist of establishing a flood information portal on Council's web site and the inclusion of expanded flooding information on Section 149 certificates issued by Council. Further measures are not needed given the low frequency of flooding and the substantial flood warning time available.

Floodplain Risk Management Plan

The draft Floodplain Risk Management Plan for Murray Downs is presented in Section 9 of this report. It summarises the adopted floodplain management measures. The adopted measure priorities, indicative capital costs and responsible implementation organisations are listed in Table 9.

Recommended floodplain management measures consist of:

- Implementation of the various land use planning and development control actions (e.g. incorporation of flood related controls into Council's LEP and DCP)
- Inclusion of expanded flooding information on Section 149 certificates issued by Council
- Establishment of a flood information portal on Council's web site
- Update of the Local Flood Plan
- Ongoing collection of flood data during future floods
- Installation of Moulamein Road regulated culvert structures at the waterway entries to Murray Downs Creek as part of the future new river crossing works
- Pending installation of Moulamein Road culverts, an investigation and subsequent installation of a Murray Downs Creek outlet structure at the downstream end of the creek.

Council will be able to apply for funding assistance to implement the recommended floodplain management measures which do not form part of their core activities. Potential funding sources include:

- NSW State Government and Australian Commonwealth Government funding programmes for the implementation of flood risk mitigation measures
- SES for flood response improvement measures
- Moulamein Road culvert structures would need to be funded as part of the future Murray River bridge replacement and associated road works project

1. Introduction

The primary objective of the NSW Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce the risk of private and public losses resulting from floods.

The Murray Downs Floodplain Risk Management Study and Plan (FRMS&P) project has been undertaken to provide the Murray River Council and other stakeholders with a Floodplain Risk Management Plan which clearly defines flooding risks at Murray Downs and identifies preferred mitigation options for implementation to reduce future flood risks and associated damages.

The FRMS&P represent the second and third steps in the floodplain management process as set out by the NSW Floodplain Development Manual (NSW Government, 2005). The four steps are:

- Flood Study – technical assessment to define the nature and extent of flooding under existing conditions. The Murray Downs Flood Study completed in 2014 documents this step
- Floodplain Risk Management Study (FRMS) - evaluates management options for the floodplain giving consideration to hydraulic, environmental, social and economic issues
- Floodplain Risk Management Plan (FRMP) – formal plan prepared which outlines the adopted strategies to manage flood risk and flood management issues
- Plan Implementation – measures nominated by the plan are put in place

The extent of the area for which this FRMP applies is shown on Figure 1. It encompasses the Murray Downs township area which includes industrial zoned land on the Moulamein Road and residential zoned land on Murray Downs Drive.

The FRMP takes into account flooding risks associated with the Murray River. There are no other significant waterways in the vicinity of the town.

The Murray Downs FRMP will assist the Murray River Council and other government agencies to take into account flooding risks when making appropriate decisions in relation to future land use planning and development within the FRMP area.

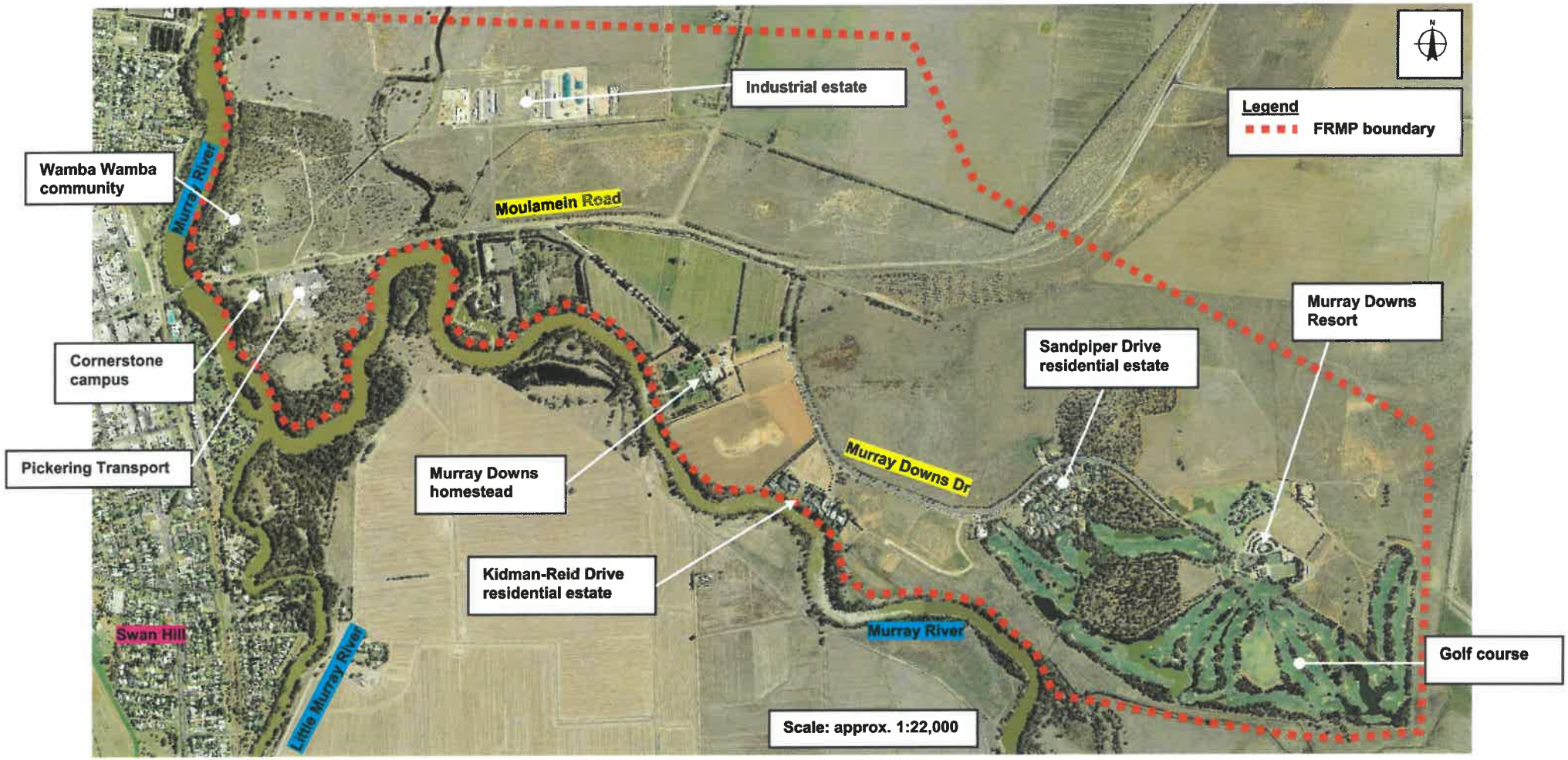


Figure 1 Murray Downs - Floodplain Risk Managment Plan Area

2. Community Consultation

2.1 Overview

Community consultation forms an integral component of the floodplain management plan process. It is important that communities embrace ownership of the floodplain risk management plans and this requires their engagement during the preparation of the plans.

The objectives of the community consultation activities undertaken were as follows:

- To obtain any data held by the general public, local community groups or government agencies of relevance to the project
- To provide information to the community concerning the project including opportunities for the community to provide input into the development of the plan
- To seek feedback from the community on floodplain management issues and what views are held by the community in relation to flood mitigation options
- To seek feedback on the draft report documents produced including the Flood Study report and the FRMS&P report

The Murray Downs Flood Study (GHD, 2014) report was placed on public exhibition in July 2014 and subsequently adopted by Council at the August 2014 Council monthly meeting.

2.2 Floodplain Risk Management Committee

Council established a Floodplain Risk Management Committee (hereafter referred to as the Committee) to oversee the preparation of the floodplain risk management plans for Murray Downs, Barham and Tooleybuc. The Committee included the following members:

- Council engineering and planning staff
- Councillor representatives
- Office of Environment and Heritage (OEH) and State Emergency Service (SES) officers
- Local community representatives

During the FRMS&P, the Committee met in June 2015, July 2015, October 2015, July 2016, August 2016 and December 2016. The Committee provided feedback on progress reports, input into the nature of community consultation activities during the project and discussion on potential flood mitigation options.

2.3 Other Stakeholders

Other government agency stakeholders contacted during the project include:

- North Central Catchment Management Authority (CMA). The North Central CMA was contacted at various times during both the Flood Study and the FRMS. The CMA provided flood data of relevance to Murray Downs.
- Swan Hill Shire Council. Council were contacted and provided with details of the FRMS project and invited to advise of any specific issues or concerns held in relation to the Murray Downs project.
- Murray Darling Basin Authority (MDBA). The MDBA were contacted and advised that an FRMP was being prepared for Murray Downs

- Other government agencies contacted included Roads and Maritime Services, VicRoads and Goulburn-Murray Water. Consultation with these agencies was focused on what data was available with relevance to flooding at Murray Downs

2.4 Community Consultation Activities

The following community consultation activities were undertaken:

- Project Fact Sheet was distributed to residents and businesses within the study areas in mid July 2015. The Project Fact Sheet provided an overview of the project, identifies the local community representatives on the FRM Committee and provided notice of the community forums held in late July
- Distributed with the Project Fact Sheet in July 2015 was a Questionnaire. The Questionnaire sought to obtain some basic flood data information (e.g. dates past floods, description of impacts) and obtain resident views on what they see as worthwhile in terms of flood mitigation measures
- Community Forum was held at Council's the Murray Downs Golf and Country Club on the 30 July 2015. The Forum provided those with an interest in flooding at Murray Downs an opportunity to find out more about the project and / or raise issues or concerns that they have in regards to floodplain management issues

A copy of the Project Fact Sheet and the Questionnaire is provided in Appendix C.

A total of 19 questionnaire responses were received. Notable feedback received is summarised in Table 1. Maintaining and improving the levee bank system was the most favoured mitigation option nominated by questionnaire respondents as shown on Figure 2.

Table 1 Issues Raised in Questionnaire Responses

Issue	Source	Description
1	Questionnaire	Comment that restoring floodwater access into Murray Downs Creek would assist in reducing the flood risk.
2	Questionnaire	Levee banks need to be maintained.
3	Questionnaire	Reference to past raising / filling on floodplain.

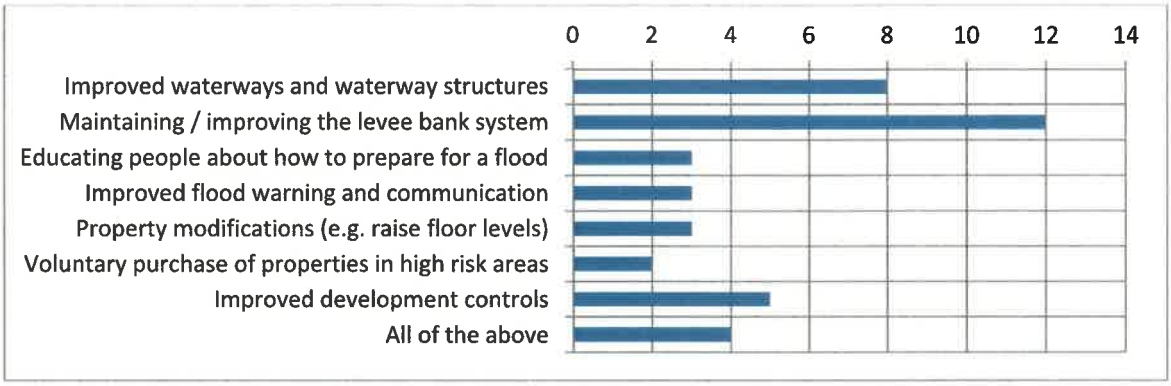


Figure 2 Questionnaire Responses – Favoured Mitigation Options

2.5 Public Exhibition of the Draft FRMS&P Report

Council adopted the draft Murray Downs FRMS&P report at the September 2016 Council monthly meeting for the purpose of placing the draft report on public exhibition.

The draft Murray Downs FRMS&P report was subsequently placed on public exhibition in October/ November 2016. The public exhibition process included:

- Posting of the draft document on Council's web site
- Hard copies of the draft FRMS&P document were made available for viewing at notified locations
- Community public information forum was held at Murray Downs on the 12 October 2016

No public submissions on the draft Murray Downs FRMS&P report were received by Council. The final Murray Downs FRMS&P report was subsequently adopted by Council at the January 2017 Council monthly meeting.

3. Flood Study Summary

3.1 Overview of 2014 Flood Study

The Murray Downs Flood Study (GHD, 2014) identifies flooding conditions for a range of varying size Murray River flood events. The flood study consisted of the following stages:

- Estimation of design flows for the Murray River floodplain at Murray Downs using flood frequency analysis of gauged streamflow data and other techniques
- Estimation of design flood levels, velocities and extents for a range of flood events using the TUFLOW two dimensional hydraulic model
- Preparation of hydraulic category and provisional flood hazard mapping

The Flood Study was initiated by the then Wakool Shire Council as part of a joint project for the Murray River townships of Murray Downs, Barham and Tooleybuc.

A levee crest height survey was completed in 2013 for the NSW side levees at Murray Downs. The length of levee surveyed upstream of the Moulamein Road was 10.8 km. The length of levee surveyed downstream of the Moulamein Road was 4.7 km.

The Flood Study was limited to an assessment of river flooding impacts. Parts of Murray Downs may be affected by local overland flow flooding which did not form part of the Flood Study or the FRMS.

3.2 Catchment Description

The Murray River catchment upstream of Murray Downs is large, encompassing the catchments of the upper Murray River, Mitta Mitta River, Kiewa River, Ovens River, Goulburn River, Campaspe River, Loddon River and the Avoca River. The total Murray River catchment area at Murray Downs is more than 50,000 km^2.

Flooding at Murray Downs is largely dependent on the rate and timing of flows being discharged by the Avoca, Loddon, Campaspe and Goulburn River tributaries. These tributaries discharge into the Murray River downstream of the Barmah Choke. The Barmah Choke forces the majority of upstream Murray River flood flows into the Edward River anabranch system, which bypasses Murray Downs. Flooding conditions at Murray Downs are consequently not sensitive to tributary inflows upstream of the Barmah Choke or the condition of the upper Murray River storages (Hume Dam and Dartmouth Dam).

3.3 Floodplain Description

Murray Downs is located on the NSW side of the Murray River, opposite the larger Victorian township of Swan Hill (refer to Figure 1).

Murray Downs includes the existing development on either side of the Moulamein Road between the Murray River bridge and the Murray Downs Drive intersection, and development located along the length of Murray Downs Drive (refer to Figure 1).

The Murray River channel at Murray Downs is typically approximately 90 to 110 metres wide measured from the top of bank and 6 to 7 metres deep. The average floodplain hydraulic gradient based on historical flood event recorded flood levels is 1 in 5,000.

There is one bridge crossing over the Murray River linking Murray Downs to Swan Hill (refer to Figure 3). Construction of this bridge was completed in 1897. The historic bridge has an uplift span which allows large marine craft to pass through the opening. A planning study for a replacement bridge crossing was carried out during the period 2009 to 2011.

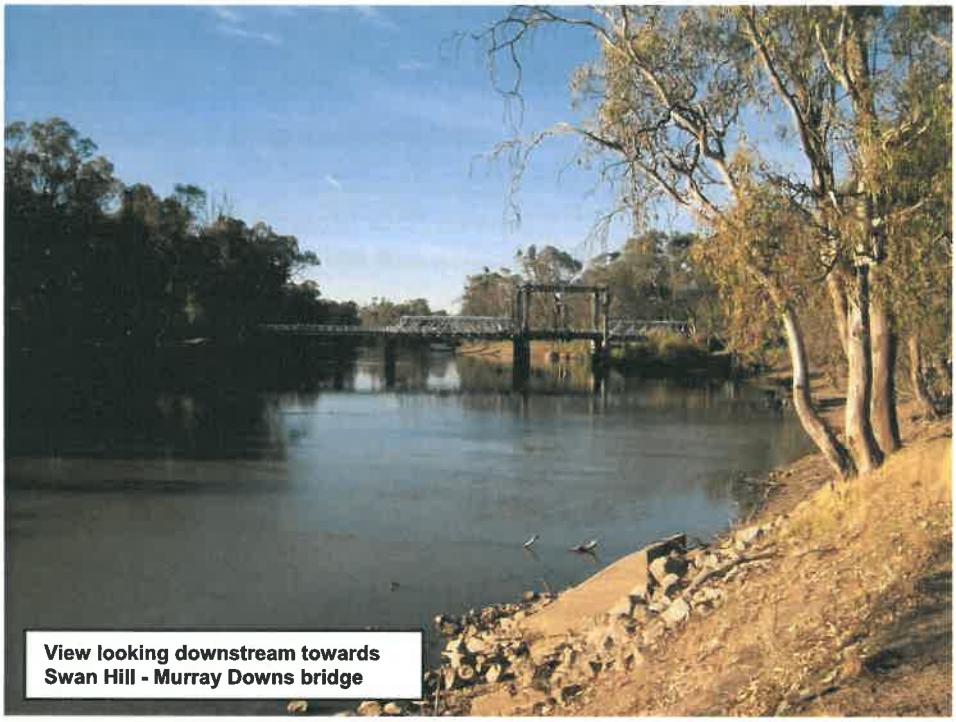


Figure 3 Murray Downs Photographs

Murray Downs Creek is a remnant floodplain channel located north of the Moulamein Road. The creek has been isolated from floodwater access since the closure of the last remaining road bridge structure in 1990. Murray Downs Creek rejoins the main river course 3 km north of the Moulamein Road.

Existing development on either side of the Moulamein Road relies to some extent on flooding protection from aging private levees. Impacts in past floods are not well documented. The levee which protects the Pickering Transport site (refer to Figure 3) is a private levee understood to be licensed to the Pickering company. During the recent February 2011 flood, some localised topping up of the levee was done in response to the threat posed by rising floodwater. The levee was subsequently not overtopped in 2011. The levee is also understood to have not been overtopped in the larger 1993 flood.

The houses within the residential estates off Murray Downs Drive (Kidman-Reid Drive estate and the Sandpiper Drive estate) do not rely on levee protection. Housing construction is currently proceeding in the Kidman-Reid Drive estate.

Swan Hill on the Victorian side of the river is protected by a public urban standard levee system completed in 2003. The Swan Hill levee has a design freeboard of 600 mm above the 100 year ARI flood level. The Pental Island rural area is enclosed by the Murray River and the Little Murray River anabranch channels on the upstream side of Swan Hill. A levee is present around the internal perimeter of Pental Island. This levee has little or no freeboard above the 100 year ARI flood level.

3.4 Flooding Conditions

3.4.1 Flows

The design flows at Murray Downs are based on flood frequency analysis of gauged streamflow records at the Swan Hill station, located 0.9 km downstream of the Swan Hill-Murray Downs bridge.

The adopted design flows are given in Table 2. The design flows are spread over a relatively narrow range due to upstream influences, notably the discharge of Murray River flows into the Wakool River system upstream of Murray Downs.

Table 2 Design Flow Estimates

ARI (years)	Peak Design Flood Level at Swan Hill Gauge		Peak Design Flow (ML/day)	
	m	m AHD	Adopted flow (2014 study)	5% & 95% confidence limits (2014 study)
2	4.11	67.03	25,700	24,900 – 26,500
5	4.55	67.47	29,400	28,600 – 30,300
10	4.64	67.56	31,200	30,300 – 32,200
20	4.71	67.63	32,600	31,600 – 33,700
50	4.74	67.66	34,000	32,900 – 35,400
100	4.77	67.69	35,000	33,700 – 36,600
200	4.80	67.72	35,700	34,400 – 37,600
Extreme	5.30	68.22	105,000	-

Notes:

1. Design flows are based on flood frequency analysis of gauged flows at the Swan Hill station (gauge zero 62.92 m AHD).
2. Extreme event flow coincides with three times the 100 year ARI flow.

The highest recorded peak flow at the Swan Hill gauge occurred in October 1975. The equivalent ARI of the 1975 event is estimated to be 80 years. The second highest recorded event in 1993 is estimated to be equivalent to a 50 year ARI flood. The highest flood since 2000 occurred in February 2011 and is estimated to be equivalent to a 5 year ARI flood.

3.4.2 Flood Levels / Extents

Hydraulic modelling of the study area floodplain at Murray Downs was carried out using the two dimensional TUFLOW hydraulic model. All of the study area floodplain was represented using two dimensional modelling techniques based on a 10 metres grid. The terrain data sources used consisted of 2001 LiDAR data, surveyed cross sections of the river channel obtained in the 1980s by Victorian authorities and surveyed crest heights of the NSW side levee banks obtained in 2013 for this project.

The TUFLOW model was calibrated using recorded flood height data from the November 1975 and the October 1993 floods. The model was calibrated to achieve the optimum level of agreement between the available recorded flood heights and the modelled flood heights.

Flood extent and flood height contour mapping derived from the hydraulic modelling is presented in the 2014 Flood Study report for 5, 20, 100 and 200 year ARI design events. Flood mapping for a further 'extreme event' based on a flow equal to three times the 100 year ARI flow is also included in the Flood Study report.

Notable features of flooding conditions at Murray Downs are as follows:

- 100 year ARI flood levels are 0.2 to 0.4 metres above the 5 year ARI flood level. This is reflective of the narrow design flow range for this reach of the Murray River.
- Peak 100 year ARI flood level is 68.12 m AHD at the Moulamein Road bridge. This is well below the bridge soffit level.
- Moulamein Road to the west of the river bridge is not subject to 100 year ARI flooding. The road low point of 68.20 m AHD located opposite the Pickering site is marginally above the 100 year ARI flood level of 68.12 m AHD.
- The private levee on the south side of the Moulamein Road (Pickering levee) is not overtopped by the 100 year ARI flood, with a freeboard of 0.10 metres.
- The private levee on the north side of the Moulamein Road is locally very marginally overtopped by the 100 year ARI flood, 550 metres north of the road.
- The Kidman Reid Drive estate is elevated above the 100 year ARI flood level.
- The area between the golf course and the Murray River is subject to 100 year ARI flooding, as are low lying parts of the golf course and the grounds of a number of residential properties on the south side of Goldfinch Court.

An anecdotal account recently obtained confirms that the October 1993 flood did not overtop the Moulamein Road. The private levee banks on both sides of the Moulamein Road are also reported to have not overtopped in the 1993 flood.

The extent of 100 year ARI flooding is shown on the following plans included in Appendix D:

- Figure D1 – 100 year ARI Flood Event – Levee System Breached. This shows the extent of inundation assuming that the levee system breaches once flood levels rise to within 0.2 metre of the levee crest.
- Figure D2 – 100 year ARI Flood Event – Levee System Intact. The flood extents shown in this plan assume that the levee system does not breach resulting in the confinement of floodwaters to the dry side of the levee.

3.4.3 Hydraulic Categories

The Floodplain Development Manual (NSW Government, 2005) defines the following three hydraulic categories:

- **Floodway** – are those parts of the floodplain where a significant volume of water flows during floods and if blocked or partially blocked, would result in a significant redistribution of flow.
- **Flood Storage** – are those parts of the floodplain that are important for the temporary storage of floodwater during the passage of a flood.
- **Flood Fringe** – are the remaining parts of the floodplain after floodway and flood storage areas have been defined.

Planning and development controls vary for the above hydraulic categories. Development constraints are more restrictive for floodway areas.

The 100 year ARI hydraulic category map for Murray Downs is shown on Figure A3 in Appendix A. It coincides with levee breached conditions.

3.4.4 Provisional Hazard Categories

The FDM (NSW Government, 2005) defines the following two hazard categories:

- **High Hazard** – are those parts of the floodplain where there is possible danger to personal safety, evacuation by trucks would be difficult, able-bodied adults would have difficulty in wading to safety and there is potential for significant structural damage to buildings.
- **Low Hazard** – are those parts of the floodplain where trucks could evacuate people and their possessions and able-bodied adults would have little difficulty in wading to safety.

Provisional hazard mapping is included in the 2014 Flood Study report. The provisional hazard mapping reflects hydraulic conditions only (i.e. depth and velocity of floodwaters).

The provisional hazard mapping has been reviewed as part of this current FRMS. This is discussed in Section 6.4. Additional considerations in updating the provisional hydraulic category mapping include the rate of rise of floodwaters, duration of flooding, available flood warning time, level of flood awareness/readiness in the community and flood access and evacuation considerations.

4. Flooding Impacts

4.1 Approach

4.1.1 Overview

Flood damages are categorised as follows:

- Tangible damages. These are financial in nature and can be measured in monetary terms. Tangible damages are further subcategorised into:
  - Direct damages. These are caused by floodwaters wetting goods and possessions, thereby reducing their value.
  - Indirect damages. These are the additional financial losses caused by a flood and include accommodation and food costs for evacuees, loss of wages due to disruption to employment, loss of business sales.
- Intangible damages. These include the stress and illness caused to those during and after a flood. By definition, they cannot be quantified in monetary terms.

4.1.2 Floor Levels

All of the main buildings located within the area subject to flooding in the extreme event modelled were included in the damages property database. Minor buildings (e.g. sheds, garages, carports etc) were excluded.

A total of 85 properties / buildings were subsequently included in the Murray Downs property database. Building floor levels were assigned as follows:

- Drive by survey – for all buildings located on either side of the Moulamein Road and the low side Goldfinch Court properties within the Sandpiper Drive residential estate (total 27 properties)
- Ground level plus 300 mm – for all other buildings within the database (total 58 properties)

4.1.3 Levee Crest Heights

In the case of the Murray Downs levees, the surveyed crest heights in 2013 were used to define the levee bank crest heights.

It was assumed that the levees are not topped up to prevent overtopping.

4.1.4 Flood Levels

Flood levels for the range of floods modelled (5, 20, 100, 200 and extreme event) at building locations were derived from the hydraulic model outputs.

For the purpose of the flood damages assessment at Murray Downs, it was assumed that the existing private levees breach when the flood level is within 0.2 metre of the levee crest. This results in flooding of the levee protected areas in a 100 year ARI event, but not a 5 or 20 year ARI event.

Although the above approach could be argued to overestimate damages, it is consistent with the philosophy that freeboard is necessary for protection to be realised as put forward by the Floodplain Risk Management Guideline 'Modelling Urban Levees for the Estimation of Flood Damages' (DECC, 2007).

4.1.5 Flood Damages

The flood damages were estimated as follows:

- Flood behaviour and Australian Bureau of Statistics data for Murray Downs was used to configure the 2001 OEH Residential Damages Spreadsheet input parameters and to produce direct residential flood damages specifically for this study.
- TUFLOW modelled design flood water surfaces were exported to WaterRide for analysis. Flood levels and underlying terrain levels were used to calculate the flood depth over the assigned floor level at each premise, and to determine the corresponding flood damages for each premise.

Key parameter values assigned for the 2001 Residential Damages Spreadsheet are as follows:

- Post 2001 adjustment factor – 1.67 (accounts for increase average weekly earnings since 2001)
- Additional accommodation / loss of rent - $220/week
- Average contents value - $50,000
- Average house size - 200 m^2
- Clean up costs - $4,000
- External damage - $6,700
- Typical duration on inundation - 3 days
- Threshold of flood damage - 5 year ARI
- Typical table / bench height 0.9 m
- Design life – 20 years (consistent with the NSW Treasury Guidelines)
- Discount factor for present value calculations – 7%

The flood damage analysis produces the following outputs:

- The number of properties / buildings which are estimated to be subject to above floor flooding.
- The estimated financial damage as a result of floodwaters wetting goods and possessions outside and inside buildings (direct damages) and other losses associated with clean up costs, temporary accommodation costs, disruption to employment etc (indirect damages).

4.2 Above Floor Flooding

The above floor flooding results for Murray Downs are summarised in Table 3. No above floor flooding occurs in a 20 year ARI event.

In a 100 year ARI event, above floor flooding of three properties on the south side of the Moulamein Road occurs.

In the extreme event modelled (three times the 100 year ARI flow), the number of properties subject to above floor flooding is 22.

4.3 Flood Damages

The flood damages estimates for Murray Downs are given in Table 4.

The average annual damage is $17,000. This is quite a low figure and reflects the high flooding threshold (greater than 20 years ARI) and the relatively small number of properties subject to above floor flooding.

4.4 Summary of Flooding Impacts

The main flooding impacts on existing development within Murray Downs are summarised as follows:

- No above floor flooding up to and including the 20 year ARI flood
- Above floor flooding at three properties in a 100 year ARI flood
- Above floor flooding at 22 properties in an extreme flood

Table 3 Murray Downs Above Floor Flooding Assessment Results

Flood ARI	Number of properties subject to above floor flooding		
	Residential	Commercial / Industrial	Total
5	0	0	0
20	0	0	0
100	0	3	3
200	0	3	3
Extreme	12	10	22

Table 4 Murray Downs Flood Damage Estimates

	Estimated Flood Damage ($)		
	Residential	Commercial / Industrial	Total
5 year ARI	0	0	0
20 year ARI	0	0	0
100 year ARI	101,000	301,000	402,000
200 year ARI	128,000	305,000	433,000
Extreme flood	1,081,000	858,000	1,939,000
Average Annual Damage (AAD)		17,000	
Net present value of AAD over 20 years at a discount rate of 7 %		180,000	
NPV over 20 years @ 4%		231,000	
NPV over 20 years @ 11%		135,000	

Notes (Tables 3 and 4):

1. Above floor flooding data in Table 3 relates to the main building on each property (excludes sheds, carports garages etc).

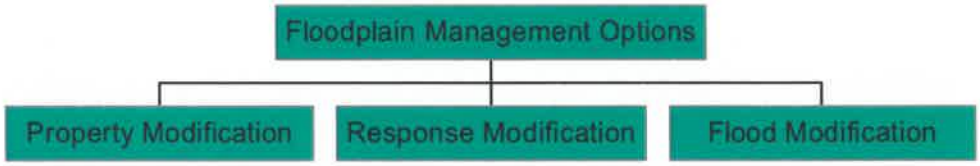
2. Properties were confined to those within the FRMP study area (refer to Figure 1).

3. The results assume that the private levees breach once the flood level is within 0.2 metre of the surveyed levee crest.

5. Preliminary Assessment of Mitigation Options

5.1 Overview of Types of Measures

As described in the Floodplain Development Manual (NSW Government, 2005), flood mitigation options can be categorised into the following three approaches:



Property modification measures are designed to avoid any future development within areas which have a high flood risk and to also reduce the damage inflicted on existing development by means of flood proofing. Property modification measures include:

- Land use planning including zonings and development control
- Voluntary house raising
- Flood proofing of buildings
- Improvements to flood access
- Voluntary purchase of high hazard properties

Response modification measures are designed to modify the response of the population at risk prior to, during and after a flood. Response modification measures include:

- Flood education and awareness
- Flood warning system establishment/improvements
- Flood response improvements
- Flood recovery improvements

Flood modification measures are designed to modify the behaviour of the flood itself by reducing flood levels or velocities or by excluding floodwaters from the area under threat. Flood modification measures include:

- Retarding basins
- Levees
- Waterway channel and structure modifications
- Bypass floodways
- Vegetation management and maintenance of creeks and culverts

5.2 Property Modification Measures

5.2.1 Land Use Planning

Land use planning controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Planning not to develop land within high flood hazard areas or land that has the potential to impact adversely on flood behaviours in other areas represents an essential component of a floodplain risk management plan.

Land use planning controls can be achieved through zoning in the Local Environment Plan (LEP) and associated flood related controls incorporated into a Development Control Plan (DCP). Planning documents can be used as a floodplain management tool by controlling where and how development occurs.

The LEP guides land use and development through the zoning of land. Development is limited to complying land uses within each zone. Wakool Shire Council adopted their LEP in 2013. The LEP includes a section on Flood Planning.

Wakool Shire Council adopted a DCP in October 2013. The DCP contains development standards, guidelines and requirements for various types of development. It includes a detailed section on Flood Planning.

The development of the FRMP for Murray Downs has included the drafting of land use planning and development controls for the defined Flood Planning Area (FPA) within the Murray Downs study area.

The Flood Planning Level (FPL) is the combination of flood levels and freeboards selected for floodplain risk management purposes.

The FPA is the area of land which is subject to flood related development controls. It generally coincides with the area of land which is below the adopted FPL.

Land use planning issues required to be further assessed and recommendations made within the FRMP for Murray Downs are:

- Basis for defining the FPA and the FPL (i.e. freeboard adopted above the 100 year ARI event)
- Finalisation of the previous provisional flood hazard mapping
- Local flood planning policy and associated development controls

5.2.2 Voluntary House Raising

House raising is generally only implemented in low hazard and / or flood fringe residential areas. House raising involves lifting building floor levels above the flood planning level to avert damage to buildings, improve personal safety and reduce stress and post-flood trauma. House raising is often a potential solution to flooding in rural areas for isolated houses, particularly for dwellings constructed from fibro or timber.

Consideration must be given to the type of house being raised, the level of hazard to be avoided, the duration of the flooding expected and social issues (access to balance of funding). An important consideration is that house raising will not mitigate flood risk entirely, since the effects of a flood of greater magnitude than the FPL (potentially up to the PMF) could still result in risk and damage.

Voluntary house raising is not recommended at Murray Downs as there are no residential properties subject to above floor flooding in a 100 year ARI event.

No further more detailed investigations associated with voluntary house raising are therefore needed.

5.2.3 Flood Proofing of Buildings

Flood proofing of buildings includes designing and constructing buildings with appropriate water resistant building materials to reduce flood damage to the building. This solution reduces the flood damage to the building itself but may not always protect building contents if floodwater is still able to enter the building.

Flood proofing of buildings also encompasses erecting temporary barriers (e.g. sand bags, plastic sheeting) at points of potential floodwater entry into buildings (e.g. doorways) at the owners cost. Temporary flood proofing is suited where there is typically sufficient flood warning time available to have the barriers in place. The most vulnerable buildings on the south side of the Moulamein Road could potentially benefit from flood proofing.

No further detailed investigations associated with flood proofing are recommended.

5.2.4 Voluntary Purchase of High Hazard Properties

Voluntary purchase is generally only considered as a last resort option within high hazard and / or floodway areas where all other mitigation options are either not effective or not practical. Voluntary purchase generally attracts two-thirds funding from the NSW State Government, with the balance of funding provided by Council.

Properties eligible for voluntary purchase are limited to those located in high hazard area where there is a significant risk of loss of life to residents. There are no examples of this scenario at Murray Downs.

Consequently no further detailed investigations associated with voluntary purchase are recommended.

5.3 Response Modification Measures

Response modification measures are changes in how the community reacts to forecast flooding in order to reduce the potential social, economic and environmental flood damage. While response modifications will reduce the risk to life and may reduce direct damages, they will not prevent flooding.

5.3.1 Flood Warning System – Regional Overview

Flood warnings are issued by the BOM when rainfall runoff is expected to translate into stream rises to certain expected levels. Issued flood warnings can be quite effective at reducing flood damages, particularly where sufficient warning time is available to enable those at risk to complete actions to minimise the potential damage.

Depending on warning time and resources available, flood warning systems and evacuation plans can be used to protect buildings, evacuate people, provide relief to evacuees and provide recovery assistance to those in flood affected areas.

The amount of flood warning time available to Murray Downs is substantial given its location on the large Murray River system. The Murray River system has an extensive flood warning network. Murray River flood warning stations of importance to residents at Murray Downs are located at Echuca, Torrumbarry Weir, Barham and Swan Hill.

The main Murray River tributaries which influence flooding at Murray Downs are as follows:

- Goulburn River – flood warning station located at Shepparton
- Campaspe River – flood warning station located at Rochester
- Loddon River – flood warning station located at Appin South (15 km south of Kerang)
- Avoca River – flood warning station located at Quambatook

The BOM flood warning levels for the Murray River flood warning stations of interest to Murray Downs are given in Table 5. The location of these stations and the tributary stations is shown on Figure 4.

The available equivalent ARIs for the minor warnings vary from 2 to 4 years. This increases to 3 to 6 years for the moderate warnings and 10 to 25 years for the major warnings.

The peak flood level at Murray Downs is dependent on flows in the upstream Murray, Loddon and Avoca Rivers. The forecast peak at Barham and the forecast peaks for the Loddon and Avoca Rivers are therefore of most interest. A 100 year ARI flood at Murray Downs will most likely require coincident flood peaks in both the Murray River and the Loddon / Avoca Rivers.

Typical Murray River flood peak travel times are as follows:

- Echuca to Barham – 4 to 7 days
- Barham to Swan Hill / Murray Downs – 3 to 5 days

The actual time lag between flood peaks can vary markedly depending on the relative timing of incoming Loddon and Avoca River peaks compared to the upstream Murray River peak.

The peak level at Murray Downs can be induced by the peak flows from the Loddon and Avoca River systems. This can occur in advance of the peak at Barham. If however the peak at Swan Hill is induced by the peak flows from the upstream Murray River, this will typically occur within five days of the upstream Murray River peak at Barham.

Table 5 BOM Flood Warning Thresholds - Murray River Gauges

Gauge	BOM Flood Warning					
	Minor		Moderate		Major	
	Level (m)	ARI equivalent (years)	Level (m)	ARI equivalent (years)	Level (m)	ARI equivalent (years)
Echuca (409200)	93.5 *	2	93.9 *	5	94.4 *	10
Torrumbarry (409207)	7.3	-	7.6	-	7.8	-
Barham (409005)	5.5	2	5.8	3	6.1	13
Swan Hill (409204)	**4.5**	**4**	**4.6**	**6**	**4.7**	**25**

Note:

1. * The Echuca flood level heights are in metres AHD. The other station flood level heights are in metres.

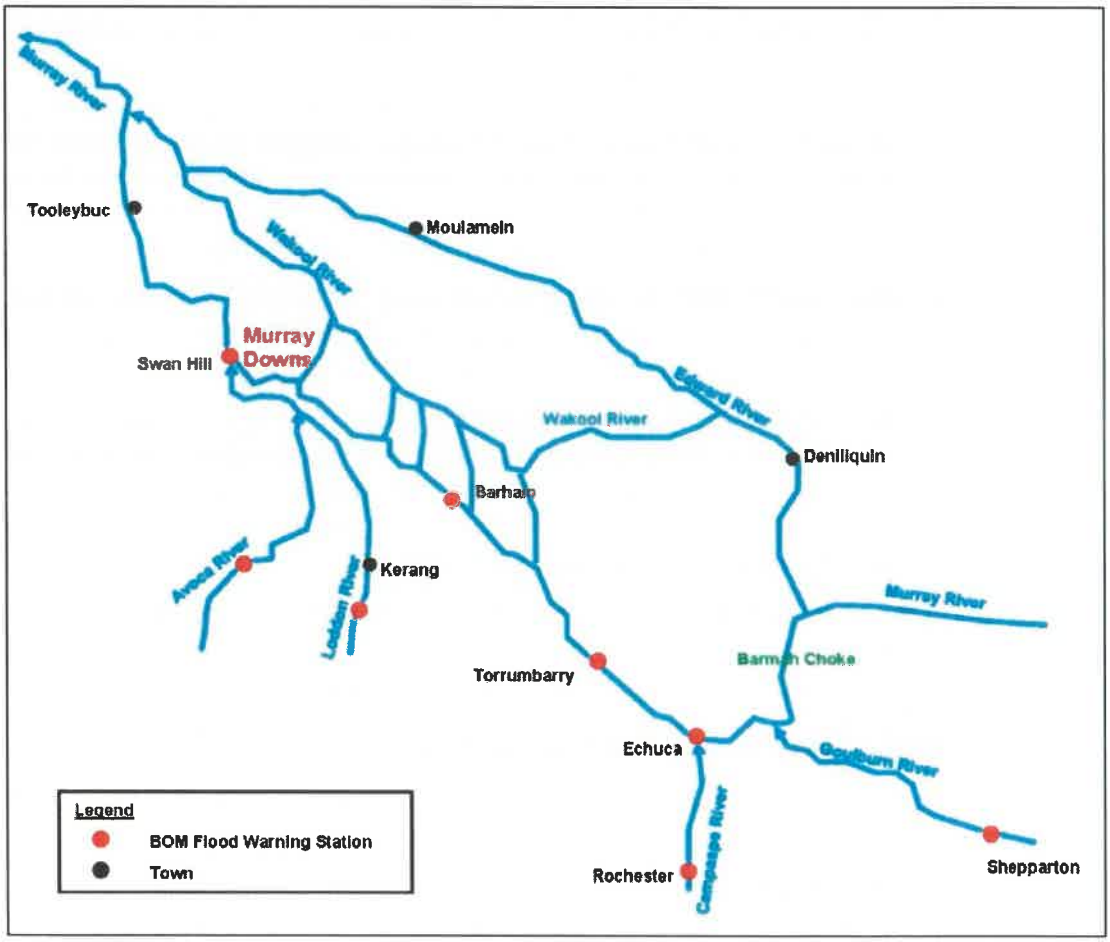


Figure 4 BOM Flood Warning Stations

5.3.2 Flood Awareness Measures

Increasing public awareness of flooding risks assists in increasing the readiness of the community to prepare for and respond to floods. Potential measures to increase flood awareness within the local community include:

- **Distribution of flood information brochures to the community**. Brochures generally aim to provide information which will inform community members of how they will know when a flood is coming, what they can do to prepare for a flood, what they should do if they need to evacuate and where to obtain further information on flooding.
- **Provide flood information on Council's web site**. The same information typically included within a flood information brochure can be permanently posted on Council's web site and periodically updated to reflect any changed circumstances. A large amount of information can be included on the web site including documents such as flood study reports, flood maps, floodplain risk management plan reports and flood warning system information.
- **Flood markers**. Flood markers are another measure which can raise the level of flood awareness in the community. Flood markers erected in prominent locations showing the level of past floods act as a good reminder to the community of what can happen in a flood. Flood markers are typically erected within the floodplain in prominent locations (e.g. within a public park area adjoining the waterway source).
- **Section 149 Certificates**. When land is bought or sold, a Section 149 (2) Planning certificate is legally required to be attached to the contract of sale. The Section 149 (2) Certificates are issued by Council and include mandatory information relating to flooding, specifically any planning controls and policies relating to flooding which are relevant to the property being sold. Section 149 (5) Certificates are not mandatory and are usually only issued by councils if specifically requested. Section 149 (5) Certificates include advice on 'such other relevant matters affecting the land of which it may be aware'.
- **Flood Certificates**. An alternative non statutory approach to Section 149 Certificates would be for Council to issue a 'Flood Certificate' for all properties on the floodplain. The Flood Certificate could also be appended to a Section 149 Certificate.
- **Commemorative and flood awareness weeks**. This measure typically involves commemorating major floods in subsequent anniversary years. Events can include Council web site article releases, press releases, radio and television interviews by SES and Council staff, and school projects focusing on flooding. An annual flood awareness week can be set aside for these types of activities.

There is generally a low level of flood awareness in the Murray Downs community. This reflects the reality that flood risks are very low. There is also a lengthy flood warning time available for response agencies to notify the local community of any impending flooding risks.

5.3.3 Further Detailed Investigations

Further detailed investigations into flood response modification measures documented in Section 7 include:

- The classification of communities at Murray Downs in accordance with the DECC Guideline "Flood Emergency Response Planning Classification of Communities'
- Preparation of outputs to assist the SES in effective emergency response planning in accordance with the DECC Guideline 'SES Requirements from the FRM Process'
- Review of the Wakool Shire Local Flood Plan (SES, 2012)

5.4 Flood Modification Measures

Flood modification measures are those that alter the flood conditions to reduce the flood hazard or change the flood behaviour. Flood modification is generally the only measures that will minimise both the social impacts and the risk to property and life. However, it is rarely viable to design for the PMF (the upper envelope of floods) and thus a residual risk will exist, associated with floods which exceed the design level of service provided by the flood modification scheme.

5.4.1 Retarding Basins

Retarding or detention basins are temporary water storages which release flows at a controlled reduced rate in order to attenuate downstream peak flows and therefore flood levels.

Retarding basins are typically used on smaller catchments (e.g. stormwater catchments) where it is practical to provide a sufficiently large detention storage volume such that worthwhile peak flow reductions can be achieved.

In the case of the Murray River, flood volumes are simply too large for retarding basins to be feasible.

5.4.2 Waterway Structure Improvements

There is a single Murray River road bridge crossing at Murray Downs. The afflux at the bridge crossing is small, due to the bridge spanning the full width of the river channel and the deck and support beams being elevated above the 100 year ARI flood level.

The planning study for a new river bridge crossing at Murray Downs has adopted a preliminary preferred replacement bridge design alignment 100 metres upstream of the existing bridge crossing. The new bridge will span the full width of the river channel. Hydraulic modelling carried out as part of the planning study (Cardno, 2009 and 2011) for the preferred route option (Option 9A) nominates two potential banks of culverts under the Moulamein Road, the first positioned just west of the Federal Hotel and the second positioned just west of the Pickering Transport site at an entry point into Murray Downs Creek.

The 2009 Cardno planning study report indicate that the culvert banks under the Moulamein Road are required to offset the afflux which results from elevating the road above the 100 year ARI flood level. The existing bridge waterway area is approximately 470 m^2. The proposed bridge waterway area is expected to be similar. The combined waterway area of the two culvert banks is 40 m^2.

The detailed investigations assess the impacts of providing overbank waterway structures on the NSW side Moulamein Road approach (refer to Section 8).

5.4.3 Murray River Waterway Channel Improvements

Vegetation management works on waterways which have become excessively choked with vegetation and / or debris can improve the hydraulic efficiency of the waterway and thereby lower flood levels.

The river channel at Murray Downs is relatively clear of debris and vegetation and is not therefore in a condition which lends itself to this approach.

River channel widening is also not a viable or practical option.

The Murray Downs Creek is a flood runner which has been isolated from floodwater since 1990 when the final waterway structure was removed from the Moulamein Road. Reconnecting floodwater access to Murray Downs Creek could potentially be provided as part of the future Murray River bridge crossing works or as a specific flood mitigation measure.

The issue of floodwater access to Murray Downs Creek is subject to further detailed investigations in Section 8.3.

5.4.4 Levees

The purpose of a levee is to mitigate the economic and social consequences of flooding by preventing floodwaters from entering the area affected by flooding. Whilst levees can be effective at reducing the impact of flooding, it is important to ensure that the flood risk for other areas outside the levee protected area is not significantly increased.

Levees can also create increased risks in extreme events which are large enough to overtop the design crest of the levee. This can result in rapidly rising flood levels within the previously protected area resulting in a high risk to the safety of any persons present. Spillways are incorporated into the design of levees to prevent uncontrolled overtopping in extreme events.

Parts of Murray Downs rely on existing levees to provide protection against river flooding. The levees vary markedly in terms of their condition and height. The existing levees present are private levees.

Further investigations into the levees present are required (refer to Sections 8.1 and 8.2).

5.5 Summary and Recommendations

From the preceding discussion, the various flood management options and their status are listed in Table 6.

Further detailed investigations into those options which have been selected are documented as follows:

- Section 6 – Property modification measures
- Section 7 – Response modification measures
- Section 8 – Flood modification measures

Table 6 Preliminary Assessment of Flood Management Options

Option No.	Description	Recommended for further detailed assessment
1.	Define the basis for FPLs, FPA.	**Yes**
2.	Develop draft Local Flood Policy for the FRMP study area.	**Yes**
3.	House raising. Not favoured as a broad floodplain risk management option.	**No**
4.	Flood proofing of high risk buildings. Not favoured as a broad floodplain risk management option.	**No**
5.	Voluntary purchase. Not favoured as a broad floodplain risk management option.	**No**
6.	Review flood warning and response measures.	**Yes**
7.	Education and awareness measures.	**Yes**
8.	Flow retardation. Not suited.	**No**
9.	Waterway structure / channel improvements. Detailed assessment of Murray Downs Creek and Moulamein Road culvert structures.	**Yes**
10.	Levee bank detailed assessment.	**Yes**

6. Property Modification Options - Detailed Assessment

6.1 LEP and DCP

Flood based planning and development controls aim to ensure that future development is compatible with the flood risk. To achieve this, Council's incorporate or link appropriate flood based planning and development controls to their Local Environmental Plans (LEPs) and Development Control Plans (DCPs). As a statutory document, the LEP takes precedence over the non-statutory DCP document.

The LEP guides land use and development through the zoning of land. Development is limited to complying land uses within each zone. The previous Wakool Shire Council's 2013 LEP includes a generic section on Flood Planning. It is noted that the 2013 LEP Clause 6.2 refers to the clause as being applicable to 'flood liable land'. The NSW Floodplain Development Manual definition of 'flood prone land' is land which is susceptible to flooding by the PMF event.

Wakool Shire Council adopted a DCP in October 2013. The DCP contains development standards, guidelines and requirements for various types of development. The DCP includes a section on Flood Planning. It is noted that the 2013 DCP Clause B2.4. refers to the clause as being applicable to 'flood liable land which is all land below the Flood Planning Level'. This use of the term 'flood liable land' is not consistent with the NSW Floodplain Manual Definition for the Flood Planning Area.

6.2 Development Control FPLs

6.2.1 Overview

The Flood Planning Level (FPL) is the combination of flood levels and freeboards selected for floodplain risk management purposes.

FPLs can vary depending on the intended application (e.g. minimum floor levels for development, minimum crest levels for levee banks). This section of the report relates to FPLs as they apply to future development.

The NSW Floodplain Development Manual states that in general the FPL for standard residential development is the 100 year ARI flood plus a freeboard of typically 0.5 metre.

The 100 year ARI flood is almost always adopted as the design flood for floodplain management purposes in NSW. The freeboard selected can however vary significantly depending on local flooding characteristics. Freeboard provides a factor of safety to provide protection against:

- Uncertainties in the estimation of flood levels
- Differences in water levels due to local factors
- Increases in flood level as a result of wave action
- Changes in rainfall patterns as a result of climate change

Individual FPLs can be specified for different types of development (e.g. residential, non-residential), for different flooding sources (e.g. riverine flooding, local overland flow) and for different locations (e.g. very broad floodplain reach, very confined floodplain reach). Selecting a higher FPL will reduce the risk of future flood impacts. It may however result in a social and economic cost associated with the more restricted land use in flood prone areas.

Residential development tends to be viewed as warranting a higher FPL due to the increased exposure associated with habitable buildings including people being present at the time of flooding.

Commercial and industrial development can be less sensitive to flooding with property owners tending to be willing to take on a higher risk. Allowing commercial and industrial buildings to have reduced minimum floor levels whilst require flood proofing to the residential FPL is also an option.

Some types of especially vulnerable development (e.g. hospitals, critical infrastructure, senior's housing) can be assigned a higher FPL than that for other development types.

6.2.2 100 Year ARI Flood Levels

The 100 year ARI flood levels for the areas adjoining Murray Downs Drive are not influenced by levees.

The 100 Year ARI flood levels within the areas adjoining the Moulamein Road are however complicated by the presence of the levee system. What assumptions are made in relation to the levee conditions influences the resulting 100 year ARI flood levels for this area. Given that the private levees present are not urban standard levees either in terms of the levee crest height or in terms of their structural integrity, the levee protected areas will remain subject to flood based development controls. The 100 year ARI flood levels for development within this area are to coincide with the adjoining Murray River flood levels.

6.2.3 Freeboard for Development FPLs

The freeboard is a factor of safety added to the design flood level. The individual factors which are taken into account when selecting an appropriate development control freeboard are described as follows with respect to flooding conditions at Murray Downs.

Uncertainties in the estimation of flood levels. The design flood levels at Murray Downs are spread over a narrow range as confirmed by the 100 years of semi continuous recorded flood levels. The 100 year ARI flood level is only 0.22 metre higher than the 5 year ARI flood level. The 200 year ARI flood level is only 0.02 metre higher than the 100 year ARI flood level. Given the narrow range of flood levels and the 100 years of recorded flood levels at the Swan Hill gauge, an allowance of say 0.10 metre is considered appropriate for taking into account uncertainties in the estimation of flood levels.

Differences in water levels due to local factors. This factor accounts for afflux due to waterway blockages and other local disturbances not able to be taken into account by the hydraulic model. Debris blockage within waterway structures (e.g. culvert and bridge openings) can lead to afflux effects. Local disturbances can be due to a range of other physical objects including buildings. An allowance of 0.10 metre is nominated.

Local wave action. Waves can be generated by wind and also by trucks and other vehicles. An allowance of 0.10 metre is nominated.

Climate Change. Climate change impacts, particularly for a very large catchment system such as the Murray River are subject to a high level of uncertainty. Possible changes in rainfall vary from small reductions to increases of up to 30% (DECC, 2007). Climate change effects have little likelihood of increasing flood levels at Murray Downs. The reason for this is the presence of the effluent flow paths between Tocumwal and Murray Downs. Any further increases in Murray River flows associated with climate change effects will be mostly conveyed by the NSW side effluents into the Edward and Wakool River system. On this basis a freeboard allowance of 0.10 m would seem appropriate for taking into account climate change effects.

The above suggests that a cumulative freeboard of at least 0.4 metre is warranted (i.e. 0.10 metre for 'uncertainties in the estimation of flood levels', 0.10 metre for 'local factors', 0.10 metre for 'wave action' and 0.10 metre for 'climate change').

At Murray Downs, 500 mm of freeboard has been adopted for planning purposes historically. The current and future development areas off Murray Downs Drive which are within the FPA are generally above the 100 year ARI flood extent limit. The building pads within the FPA will therefore be less than 0.5 metre high assuming 0.5 metres of freeboard.

On this basis, the recommendation for Murray Downs is for the continued adoption of 0.5 metre freeboard for development FPLs.

6.3 FPA

The Flood Planning Area (FPA) is the area which is subject to flood related planning and development controls. Planning certificates issued under Section 149 (2) of the EP&A Act would make reference to a property being within the FPA.

For main stream flooding (e.g. flooding from water which overtops the banks of an incised waterway), the FPA is defined as the area below the FPL.

As discussed in the preceding section on FPLs, although areas on either side of the Moulamein Road are protected by a private levee system, the levee system is not an urban standard levee given the crest height is lower than that required and the levees are of unknown structural integrity. The extent of 100 year ARI inundation is therefore based on an assumption that the levee system is breached resulting in inundation as shown on Figure A1 of Appendix A.

The FPA for Murray Downs based on a freeboard of 0.5 metre is shown on Figure A1.

The FPA covers all of the area on both sides of the Moulamein Road. For properties off Murray Downs Drive, the FPA does partly extend north of Murray Downs Drive as shown on Figure A1.

6.4 True Flood Hazard

Provisional flood hazard mapping is presented in the Murray Downs Flood Study report (GHD, 2014). The provisional hazard mapping is based on hydraulic conditions (i.e. depth and velocity of floodwaters) as determined using the hydraulic model and the Floodplain Development Manual (NSW Government, 2005).

The provisional flood hazard is reviewed during a FRMS, taking into account factors other than hydraulic conditions. Other factors taken into account include:

- Effective warning time. In regards to Murray Downs, there will generally be at least one week of warning time available in advance of a major flood peak.
- Flood readiness. Given the infrequent nature of flooding and limited impacts at Murray Downs, flood awareness and readiness within the community is not high.
- Rate of rise of floodwaters. The rate of rise of floodwater at Murray Downs is very slow (refer to Section 7.2).
- Duration of flooding. The duration of flooding at Murray Downs will normally be quite protracted, with inundation continuing for weeks, even months.
- Evacuation access considerations. Evacuation access at Barham is expected to be reasonable favourable via the Moulamein Road. The adjoining larger town of Swan Hill is not expected to be flooded given its urban standard levee system.

The provisional flood hazard mapping assumes that the private levees which are present do not fail through structural breaching. Consequently the areas on the protected side of the private

levees on either side of the Moulamein Road are not shown as subject to inundation in a 100 year ARI flood (as per Figure D2 in Appendix D).

Given the limitations of the private levees in terms of their limited freeboard and unknown existing and future structural condition, development controls within the levee protected areas should be applied consistent with assuming that the levees are breached (as per Figure D1 in Appendix D).

The true 100 year ARI flood hazard mapping is shown on Figure A2 in Appendix A. It coincides with the assumption that the levee system breaches.

The areas on either side of the Moulamein Road are mostly defined as Low Hazard. This will consequently not impose overly onerous controls on the already developed properties in this area. The land use zonings in this area are such that extending development further is not currently possible given the RU1 zoning limitations.

6.5 Local Flood Policy

A draft Local Flood Policy for Murray Downs is included in Appendix A. The key aspects of the Local Flood Policy are:

- The Local Flood Policy applies to the area shown on Figure 1
- Flood related development controls detailed in the Local Flood Policy apply to the FPA as defined by Figure A1
- Development generally excluded from High Hazard areas (refer to Figure A2) and Floodway areas (refer to Figure A3)
- The minimum floor level of any new residential building is to be at the FPL (i.e. 0.5 metres above the 100 year ARI flood level)
- Commercial and industrial development. At Council's discretion, the minimum floor level is to be at the FPL or the building is to be flood proofed to at least the FPL at the owners cost

Council's LEP should be updated to be consistent with the Department of Planning standard flood clause which states that the 'clause applies to land at or below the flood planning level'. Council's existing LEP refers to flood liable land which the NSW Floodplain Development Manual (NSW Government, 2005) defines as all land inundated by the FMF.

Council's DCP should be updated to incorporate the Local Flood Policy including the FPA map, the Hazard category map and the Hydraulic Category map. Flood based development controls are to apply to the FPA.

7. Response Modification Options - Detailed Assessment

7.1 Swan Hill Flood Warning Station

The Swan Hill flood warning station is located 900 metres downstream of the Swan Hill-Murray Downs bridge. The minor, moderate and major flood warning flood heights are listed in Table 7.

The warning thresholds for the Swan Hill station have limited meaning in relation to Murray Downs or for that matter Swan Hill. The warnings are of more relevance to rural landholders upstream and downstream of Swan Hill where minor and moderate flood warnings alert rural landholders to flooding of low lying areas.

The major warning level of 4.7 metres is equivalent to a 20 year ARI flood level. This is not sufficiently high to overtop the private levees at Murray Downs. Flood impacts will therefore be minimal unless a serious levee breach occurs due to structural failure.

The flood warning levels for the Swan Hill station are spread over a very narrow range (i.e. major flood level only 0.2 metre above the minor flood level). This is because of the prevailing flooding conditions with little variation in flow past Swan Hill with increasing flood ARI due to the discharge of high flows into the Wakool River system to the north.

The highest flood level recorded at the Swan Hill station is 4.78 m AHD during the 1975 flood. The only known flood level which is thought to have exceeded the 1975 flood level occurred in 1870. The 1993 flood peaked at 4.72 m. The highest flood since 1993 peaked at 4.56 metres in February 2011.

Table 7 Swan Hill Murray River Flood Warning Station

Warning	Gauge height (m)	Flow (ML/day)	Equivalent ARI (years)
Minor	4.5	28,800	4
Moderate	4.6	29,900	6
Major	4.7	32,900	20
-	4.77	35,000	100
-	4.8	35,700	200
-	5.3	105,000	100,000

Note:

1. Design flows and equivalent ARIs are based on the Murray Downs Flood Study (GHD, 2014).
2. Gauge zero datum is 62.92 m AHD.

7.2 Flooding Duration

The rate of rise and duration of significant floods since 1974 is specified in Table 8 and shown on Figure 5 based on records at the Swan Hill gauge.

The rate of rise varies from 0.01 to 0.04 m/day. The rising limb in 1975, 1981 and 1993 continued over a 2 to 3 month period. The more recent 2011 peak occurred following a lower peak approximately one month earlier and rose off a base of 3.7 m to peak approximately 20 days later at 4.56 metres.

Given past flood durations (refer to Table 8), flood levels at Murray Downs are typically expected to remain above 4.55 m (5 year ARI flood level) for between 5 and 40 days.

If the areas on either side of the Moulamein Road are flooded as a result of levees overtopping or breaching, these areas are likely to remain inundated for a period of weeks as the floodwaters slowly recede.

The 2014 Flood Study indicates that the Moulamein Road is not overtopped in a 100 year ARI flood. The low point in the Moulamein Road is located opposite the Pickering transport site offices.

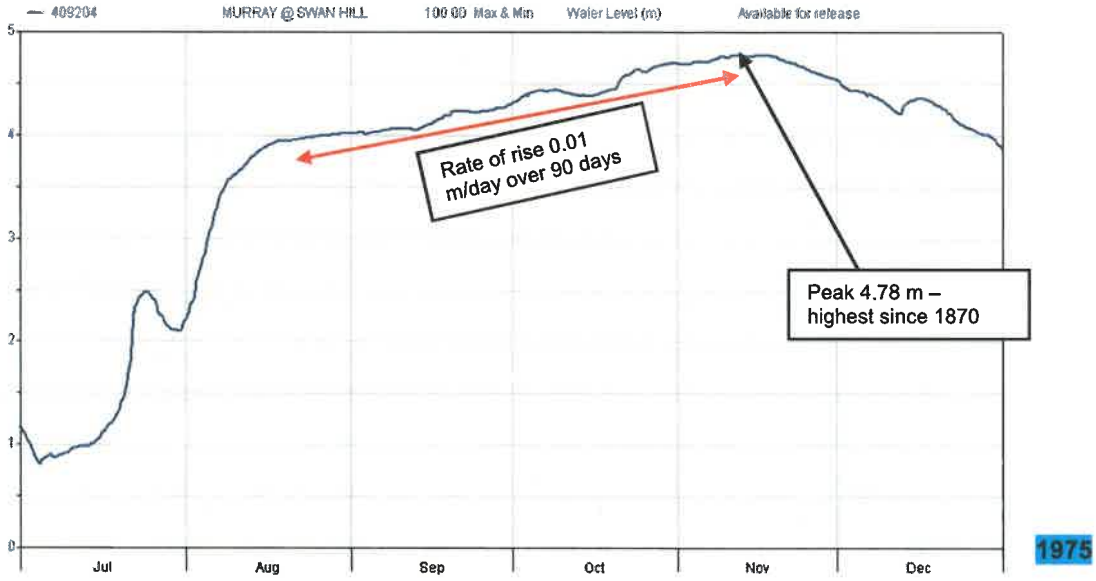
Based on the 2014 study flood modelling results, it requires in excess of a 200 year ARI event to initiate overtopping of the Moulamein Road. The indicative nominated gauge height at which this occurs is 4.8 m.

Table 8 Rate of Rise and Duration

Flood	Peak (m)	Rate of Rise (m/day)	Duration of rise (days)	Number of days above 4.55 m
February 2011	4.56	0.04	30	6
October 1993	4.72	0.03	60	24
October 1983	4.63	0.02	50	5
August 1981	4.73	0.02	60	32
November 1975	4.78	0.01	90	40

Notes:

1. Gauge zero datum is 62.92 m AHD (Swan Hill station 409204).
2. Gauge height of 4.55 m is equal to the 5 year ARI flood level.



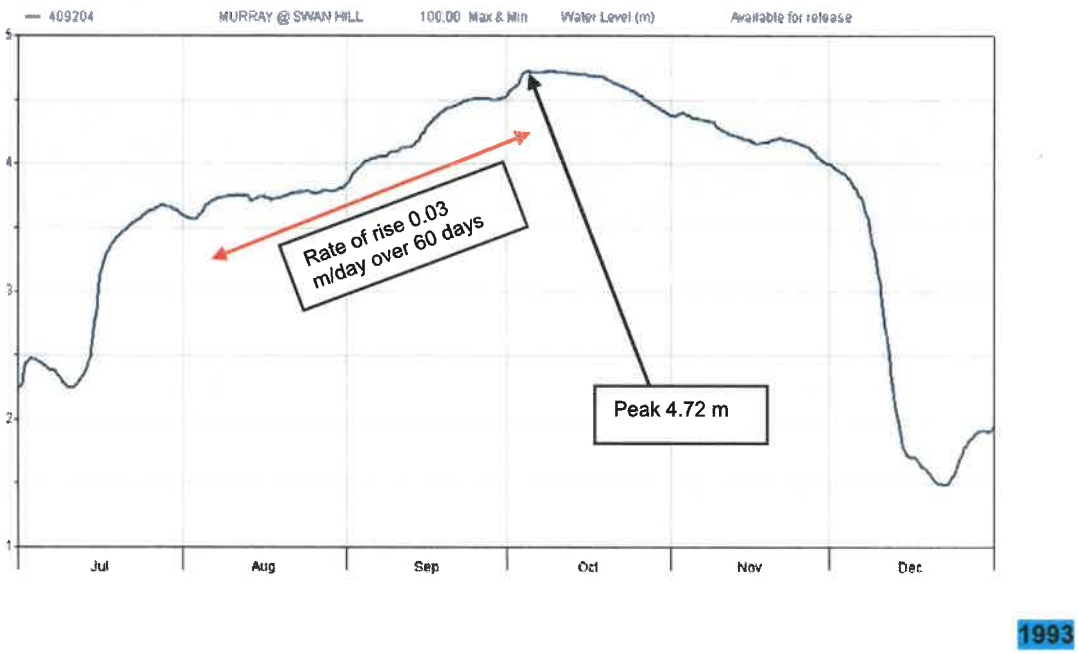


Figure 5 Flooding Durations – 1975 and 1993 Floods

7.3 Local Flood Plan

7.3.1 2012 Local Flood Plan

The Wakool Shire Local Flood Plan (SES, 2012) is a sub-plan of the Wakool Shire Local Emergency Management Plan (Wakool Shire Council, 2013). Notable aspects of the Local Flood Plan, particularly those relevant to Murray Downs are as follows:

- The Sub-Plan is applicable to all flooding within the previous Wakool Shire local government area, which forms part of the SES Murray Region, and for emergency management purposes is part of the South West Emergency Management Region.
- Nominates the NSW SES Local Controller, Barham, as responsible for dealing with floods as detailed in the State Flood Plan.
- Lists the general responsibilities of the different government agencies and other groups in relation to flood preparedness, response and recovery activities.
- The Sub Plan indicates that response operations will begin either upon receipt of a BOM issued Flood Warning or where other evidence leads to an expectation of flooding within the council area.
- The SES Wakool Operations Centre is located at 51 Forest Street, Barham. This site is potentially affected by grounds flooding if floodwaters breach the levee system and enters the town. The building at the site is not expected to flood to above floor level up to at least a 200 year ARI event.
- The NSW SES maintains stocks of sandbags at the Barham Unit Headquarters.
- A flood evacuation centre is not nominated for Murray Downs.

Given the limited impacts of flooding at Murray Downs and the close proximity of Swan Hill, there would appear little or no need for an evacuation centre at Murray Downs. The Murray Downs Resort facility is located in an area not affected by extreme flooding and could potentially be used as an evacuation centre, if required.

The Local Flood Plan should be updated to reflect the outcomes of the 2014 Murray Downs Flood Study report and the Floodplain Risk Management Study and Plan report.

The following description of flooding conditions at Murray Downs is provided for inclusion within a future update of the Local Flood Plan:

Murray Downs consists of mixed land use development on the Moulamein Road and Murray Downs Drive.

Development on the Moulamein Road is protected up to a point from Murray River flooding by private levees. These levees are not of a standard compatible with modern urban levees and there is a risk of failure through breaching and / or overtopping in flood events.

Levee failure through structural breaching could occur randomly. Breaches in more recent past floods (e.g. 1993, 2011) did not occur.

The levees have little or no freeboard above the 100 year ARI flood levels. The slow rate of rise of floodwaters (typically 0.01 to 0.04 m/day) can allow time for topping up of levee low points as floodwaters threaten to overtop.

Failure of the levee system on the south side of the Moulamein Road will result in inundation of properties on the south side of the road and possible above floor flooding. Similarly failure of the levee system on the north side of the Moulamein Road will result in inundation of properties on the north side of the road and possible above floor flooding.

The Moulamein Road is expected to remain free from flooding in a 100 year ARI event. The Moulamein Road is not expected to be overtopped until a flood level of 4.8 m at the Swan Hill gauge is reached. This is approximately equivalent to a 200 year ARI event.

Properties on Murray Downs Drive are not expected to be subject to above floor flooding up to at least a 100 year ARI event. Limited grounds flooding of residential properties may occur from rising river floodwater, notably some low side lots in Goldfinch Court. Properties on Murray Downs Drive do not rely on levee protection.

Murray Downs Drive itself is not expected to be flooded up to in excess of a gauge height of 4.8 metres.

7.4 SES Flood Data Outputs

Flood data for Murray Downs is provided in Appendix B. The data includes:

- Plan defining the Emergency Response Planning (ERP) classifications (Figure B1)
- Table defining the consequences of flooding within Murray Downs for incremental Swan Hill gauge height increments

7.4.1 Emergency Response Planning Classifications

Emergency response planning (ERP) classifications provide the SES with an indication of the relative vulnerability of the community to flooding. The classification then assists the SES in response planning for that particular community or portion of the floodplain.

ERP classification mapping for Murray Downs is made problematic by the presence of the private levee system. Until the levee system is breached or overtopped, Murray Downs is not flooded. An unexpected levee breach will occur in a random location. The extent and severity of the area affected will depend on the location and size of the breach.

In an extreme event, most of the area on either side of the Moulamein Road will be inundated. The following notable High Flood Islands are present in an extreme event:

- Wamba Wamba pad for four adjoining houses
- House site opposite the Marina
- Part of the Industrial Estate

Properties on either side of the Moulamein Road can be described as Areas with Rising Road Access given that the Moulamein Road is not overtopped in a 100 year ARI event. Cygnet Lane linking the industrial estate to the Moulamein Road is lower and consequently the industrial estate area is better described as an Area with Overland Escape Route.

7.4.2 Consequences

The flood impacts on development either side of the Moulamein Road at Murray Downs largely depends on whether the private levees present are breached or overtopped. The threshold for overtopping based on a 2013 levee crest survey is marginally in excess of a 100 year ARI flood. Providing the private levees are not therefore breached due to structural failure, impacts are not expected to be significant. If the levees fail due to structural failure, some above floor flooding is likely to result.

The levees in question are private levees. They are not urban standard levees. Breaching due to structural failure is therefore a real possibility.

Importantly the Moulamein Road is elevated marginally above the 100 year ARI flood level. Up to a gauge height of at least 4.8 metres, the road provides a means of evacuation access for properties on either side of the Moulamein Road, even in the event of the private levees failing.

Flood impacts are described as follows:

- **5 year ARI flood (4.5 metres).** Hydraulic pressure on the private levees means that a breach is possible. Levee breaches could lead to grounds flooding of the properties on either side of the Moulamein Road.
- **20 Year ARI flood (4.7 metres).** Less than 0.1 metres of freeboard to the private levees overtopping. Levee breaches could lead to above floor flooding of properties on either side of the Moulamein Road.
- **100 year ARI flood (4.8 metres).** Zero freeboard or marginal overtopping of private levees. Above floor flooding will result once levees are overtopped or breached, notably for the area on the south side of the Moulamein Road.
- **Extreme flood (5.3 metres).** Private levee system overwhelmed. Above floor flooding of 22 properties including some properties in the Murray Downs Drive residential estates.

7.5 Flood Response Discussion

The areas at most risk of flooding at Murray Downs are the areas on either side of the Moulamein Road which rely on levee protection.

If the Pickering Levee breaches, floodwater on the southern side of the Moulamein Road will start to pond within the levee enclosed area. Depending on the site of the breach and the height of the flood, above floor flooding may occur relatively quickly.

If the levee on the north side of Moulamein Road breaches, flood levels will rise more slowly given the larger area affected and the drainage of water northwards via Murray Downs Creek.

Evacuation triggers for Murray Downs Drive are difficult to nominate given the levees are private levees and below the standard of urban levees. Hydraulic pressure is present on the lower portion of the levees once the gauge height at Swan Hill exceeds 4.0 metres (around a 2 year ARI flood level). Complicating evacuation considerations for those areas at risk are the protracted nature of flooding.

During the 1975 flood, flood levels remained above 4.5 metres for six weeks. Evacuating occupants for this period of time without indications of a breach or probable overtopping will be difficult to justify. Flood levels remained above 4.7 metres for 2 weeks.

In the recent February 2011 flood (peak 4.56 metres) the private levee on the south side of the Moulamein Road was monitored by Pickering employees with some toping up of the levee at low points to guard against overtopping.

If the levees happen to breach on either side of the Moulamein Road, evacuation is expected to be possible as floodwaters will take some time to rise within the levee protected areas. The Moulamein Road provides close access to the areas at risk.

At a gauge height of 4.7 metres (20 year ARI flood level), there is less than 0.1 metre of freeboard for both the levee south and north of the Moulamein Road.

The recent February 2011 flood peaked at 4.56 metres (approximately a 5 year ARI flood). If the private levees had of breached during this flood, above floor flooding may have resulted for the lower most buildings on the north and south sides of the Moulamein Road.

On the basis of the above, the following is suggested in relation to occupants on both the north and south sides of the Moulamein Road:

- Gauge height of 4.5 metres (equivalent to a 5 year ARI flood) – issue warning that there is a risk of private levee breaching. In the event of a breach, extensive grounds flooding of the Moulamein Road properties at Murray Downs will result.
- Gauge height 4.7 metres (equivalent to 20 year ARI flood) – issue warning that there is a high risk of private levees breaching. In the event of a breach, above floor flooding of the lowest buildings will result.
- Gauge height 4.8 metres (equivalent to 100 year ARI flood) – issue warning that private levees are almost certain to be overtopped and fail. Above floor flooding of all low buildings will result.

7.6 Flood Data

Comprehensive and up to date flood data / information is essential for effectively responding to flood events. With the completion of the Murray Downs Flood Study and FRMS&P, it is important that Council planning documents such as the DCP are updated to reflect the most up to date flooding information showing:

- Flood prone land, as per the land inundated by the PMF.
- Flood Planning Area (FPA) as the land inundated by the 100 year ARI flood plus the adopted freeboard.
- Flood category maps defining the Floodway, Flood Storage and Flood Fringe areas.
- Flood hazard maps defining the Low Hazard and High Hazard flood areas.

It is important that flood data be collected both during and in the aftermath of future flood events. The data can be used for future investigations associated with the update of the Murray Downs FRMP.

Future data collection should focus on:

- Large floods (e.g. peak level at Swan Hill higher than 4.6 metres)
- Performance of levee system (e.g. any breaches, overtopping, seepage etc).
- Photographs if possible at or near the peak of flooding. Where possible, photographs to be date and time stamped
- Recording reliable peak flood levels and their subsequent survey to the AHD datum
- Details of any instances of above floor flooding

7.7 Community Awareness Measures

The level of flood awareness at Murray Downs varies but could generally be described as low. This however reflects the reality that flood risks are low with little or no impacts on the community since at least the 1970s.

There is also a lengthy flood warning time available for response agencies to notify the local community of any impending flooding risks. Given these conditions, there is limited benefit to be gained by implementing an intensive strategy to raise awareness levels.

Of the various measures available, the following are considered most suited to Murray Downs.

- **Council Web Site.** Council should maintain a flood information facility on its web site including the Flood Study report, the FRMS&P report, Local Flood Plan, links to BOM and SES web sites and other flood warning and response information. It is easy to implement and maintain with minimal associated costs.
- **Flood Safe Brochure.** Preparation and dissemination of a brochure specific to Murray Downs that could be sent to all owners, business operators and residents of potential flood impact properties.
- **Certificates.** With the completion of the flood study and FRMS&P for Murray Downs, Council has detailed knowledge of flooding risks. Section 149 Certificates issued by Council should include the relevant flood information known to Council which impacts on the subject property. This would typically include with the issue of 149 (2) certificates whether the property is within the FPA, the Hydraulic Category of the property and the Hazard Category of the property, and the subsequent flood based planning and development controls applicable to the property. Further detailed flood information could be provided if a section 149 (5) is issued including frequency, level, depth and extent of flooding for a range of events.

8. Flood Modification Options - Detailed Assessment

8.1 Existing Levees

8.1.1 South Side of Moulamein Road

A levee parallels the NSW side of the Murray River on the south side of the Moulamein Road as shown on Figure 6. The levee is understood to be a private levee licensed to the Pickering Transport company. Levee details are as follows:

- Length 1,400 metres
- Height varies from 0.1 to 1.2 metres
- Levee provides protection for the Pickering Transport site, the Cornerstone campus complex and a BuildPro landscape supply retail outlet
- Pickering Transport Group has occupied the site for more than 20 years and is understood to own all of the land enclosed by the levee
- Most of the land enclosed by the levee is zoned RU1 (Primary Production). The Pickering Transport site is zoned IN1 (General Industrial)

Ground levels on the Pickering Transport and BuildPro sites vary from 67.5 to 67.9 m AHD. The 5 year ARI site flood level is 67.7 m AHD. The 20 year ARI flood level is 67.9 m AHD. The 100 year ARI flood level is 68.1 m AHD. Without the levee, the site would be subject to partial inundation in a 5 year ARI event and all of the site would be subject to inundation in a 20 year ARI event. There are offices and three large storage sheds on the Pickering site. These would all be subject to above floor flooding in a 100 year ARI event if the levee was to be breached or overtop.

Anecdotal accounts indicate that the private levee around the Pickering site was not overtopped in the 1993 flood. The 1993 flood peaked at 4.72 metres on the Swan Hill gauge and is estimated to be equivalent to a 50 year ARI flood.

Properties on the north side of the Moulamein Road opposite the Pickering site do not depend on the Pickering levee for protection. The Moulamein Road is located on an embankment which is marginally above the 100 year ARI flood level as determined by the 2014 Flood Study report. Anecdotal accounts indicate that the Moulamein Road was not overtopped in the 1993 flood.

The crest height of the Pickering levee, based on a 2013 survey, is a minimum of 0.10 metre above the 100 year ARI flood level. The levee condition varies but could be described as being equivalent to a low to medium standard rural levee. The levee segment adjacent to the Murray River channel is being undermined and is in poor condition (refer to Figure 6).

An upgrade of the private levee to equivalent to an urban standard would most likely involve complete removal of the existing levee and replacement with a new levee approximately 0.5 metre higher. The indicative total cost would be in the order of $1.5 million.

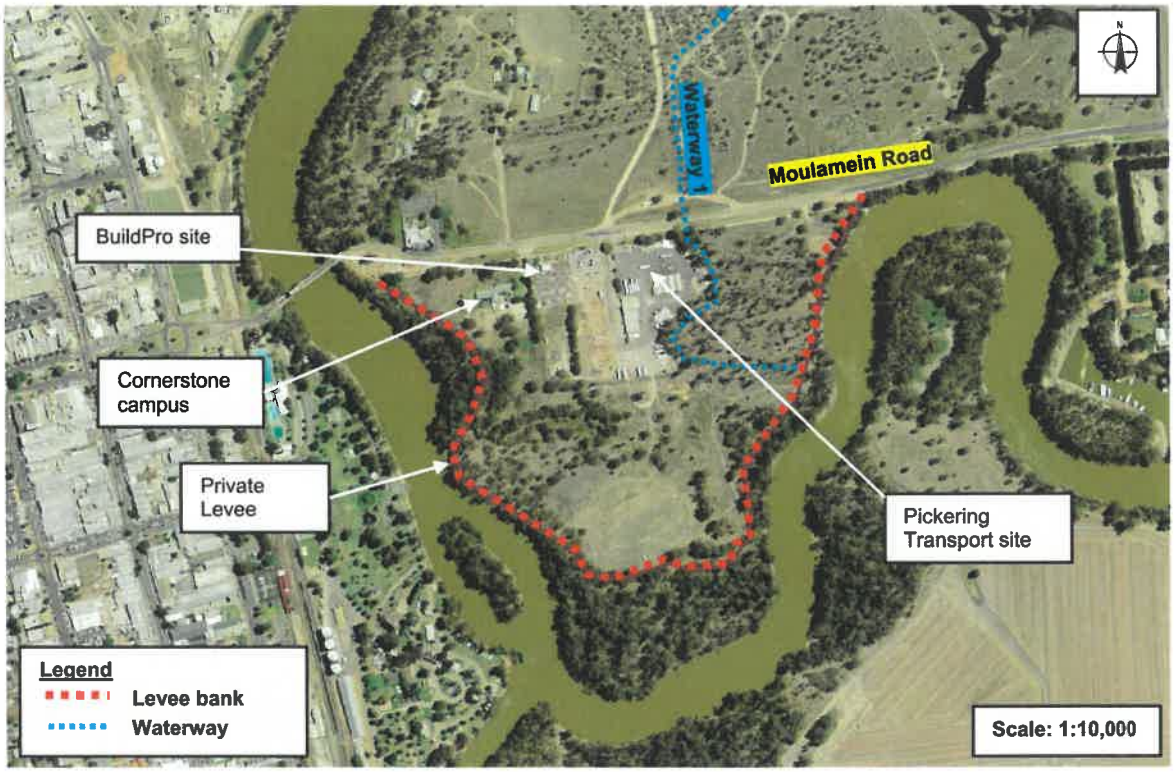


Figure 6 Private Levee – South side of Moulamein Road

All of the land enclosed by the Pickering levee is believed to be in single ownership. Given the existing single owner and the type of land use on the site, the use of Council and State Government funds to carry out an upgrade of the private levee is not a suitable option.

One option being considered as part of the proposed new Murray River bridge crossing is the inclusion of culverts under the Moulamein Road opposite the Pickering site. A culvert outlet would benefit the occupants of the levee enclosed area in the event that the Pickering levee is breached or overtopped. A Moulamein Road culvert positioned at the waterway on the east side of the Pickering site will provide an outlet for the levee enclosed area, thereby reducing the rate of rise and the height of floodwater within the levee enclosed area. This is further discussed in Section 8.2.

8.1.2 North Side of Moulamein Road

Existing development at Murray Downs on the north side of the Moulamein Road consists of (refer to Figure 7):

- Federal Hotel complex
- Wamba Wamba community site
- Murray Downs industrial estate
- Rural homestead

The floor level of the Federal Hotel is located more than 500 mm above the 100 year ARI flood level.

Within the Wamba Wamba community site, there are four dwellings positioned on an elevated pad of fill approximately 0.5 metre above the 100 year ARI flood level. There are a number of other buildings at the Wamba Wamba site, including at least one other dwelling. The floor levels of these other buildings, although lower than the four newer dwellings, were not found to be subject to above floor 100 year ARI flooding for the levee breach scenario modelled.

The Murray Downs Industrial Estate is located on the east side of Murray Downs Creek. The Industrial Estate is protected from flooding by the Moulamein Road and the remnant Murray Downs Creek floodway levees. The existing buildings at the Industrial Estate were not found to be subject to above floor 100 year ARI flooding for the levee breach scenario modelled.

A farm house is located close to the river channel, 850 metres north of the Moulamein Road. The house is located on ground which is 0.3 metre above the 100 year ARI flood level.

The low point in the Moulamein Road of 68.20 m AHD is located opposite the Pickerings site. This is 0.08 metres above the 100 year ARI flood level. The Moulamein Road is a sealed two way regional road.

The levee paralleling the river adjacent to the Wamba Wamba site is an aging private levee (refer to Figure 7). The levee crest is generally close to or above the 100 year ARI flood level. There is however one section of the levee which is marginally below the 100 year ARI flood level based on 2013 survey crest heights.

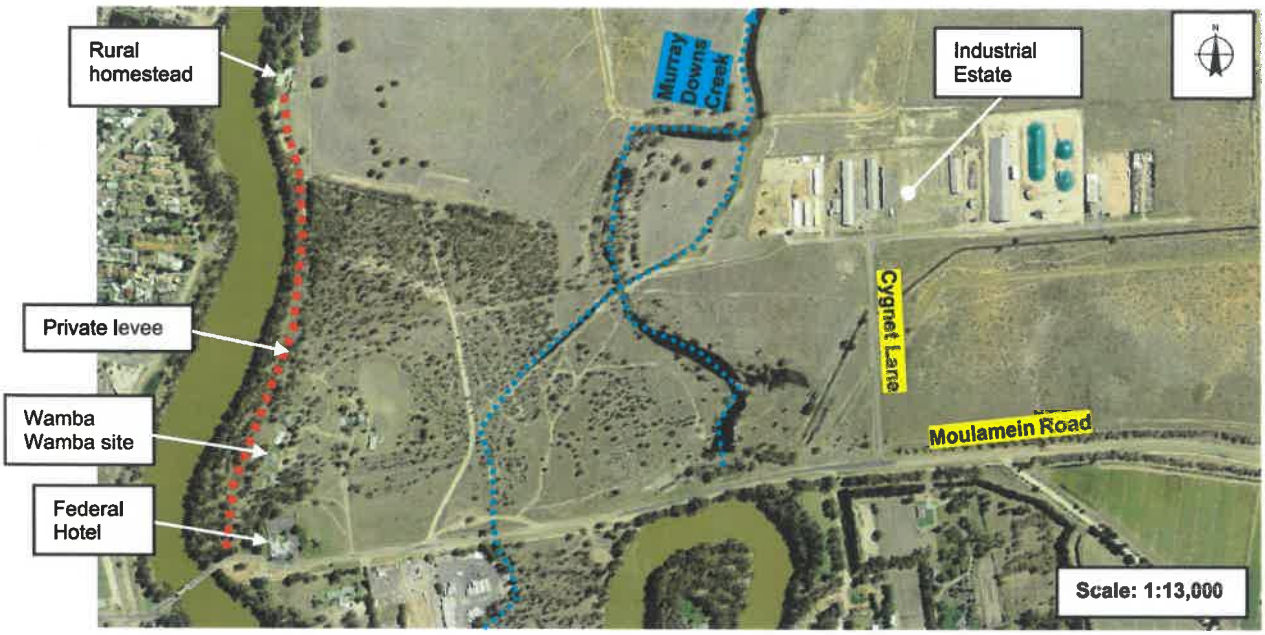


Figure 7 Private Levee - North Side of Moulamein Road

Anecdotal accounts indicate that the Wamba Wamba site was not flooded in the 1993 flood (equivalent to a 50 year ARI flood). Both the river side levee and the Moulamein Road were not overtopped in the 1993 flood. Residents at the Wamba Wamba site are understood to vacate the site whenever there is a significant Murray River flood, as occurred recently in February 2011 (equivalent to a 5 year ARI flood).

Council has indicated that they have no further plans for development of the area on the north side of the Moulamein Road. Aside from the Wamba Wamba site and the industrial estate, the remaining land is zoned RU1 (Primary Production).

Given the above circumstances, upgrading the existing private levee bank or providing additional new levees north of the Moulamein Road is not favoured.

8.2 Murray Downs Creek

8.2.1 Background

Murray Downs Creek is shown on Figure 8. Murray Downs Creek was essentially a high flow anabranch for floodwaters, exiting the main river course upstream of the Swan Hill bridge, and re-joining approximately 3 km downstream.

The upstream (southern) end of the Murray Downs Creek system consists of two waterway channels connecting to the main river channel on the south side of the Moulamein Road (referred to as Waterways 1 and 2 as shown on Figure 8).

There is currently no connection with the river channel however due to the absence of waterway structures under the Moulamein Road and a private levee bank (Pickering Levee) across the entry point into Waterway 1 at the river channel. The existing height of the Moulamein Road is such that it is not overtopped in a 100 year ARI flood as determined by the 2014 Murray Downs Flood Study. The road low point of 68.20 m AHD is located opposite the Pickering Transport site. The 100 year ARI flood level at the road low point is 68.12 m AHD.

Notable Murray Downs Creek background details are as follows:

- 1986 Murray River Flood Plain Management Study. This report refers to the removal of waterway structures from the Moulamein Road opposite Murray Downs Creek. The 1986 report refers to one remaining bridge located at Waterway 1 (refer to Figure 9). The report notes that the Murray Downs Creek floodway discharge capacity may not be critical given that the capacity of the main river channel course at Swan Hill is thought to be equivalent to the river channel capacity downstream of Swan Hill. The 1986 report concludes that the option of restoring the inlet capacity to the floodway is worth further investigation.
- 1992 Swan Hill Tyntynder Flats Floodplain Management Study. The 1992 report indicates that the last remaining Moulamein Road bridge was removed in 1990. The threshold river flow at which flows previously entered the Murray Downs Creek at Waterway 1 is given as 13,000 ML/day in the 1992 report.
- 1999 Swan Hill Regional Flood Strategy. This report recommends that flood access to Murray Downs Creek should be restored by constructing a single structure under the Moulamein Road with a capacity equal to the combined capacity of the previous bridge and culvert structures. The reason given in the report for the recommendation is to restore intermittent flood flows into Murray Downs Creek and therefore lead to an improvement in its environmental condition.

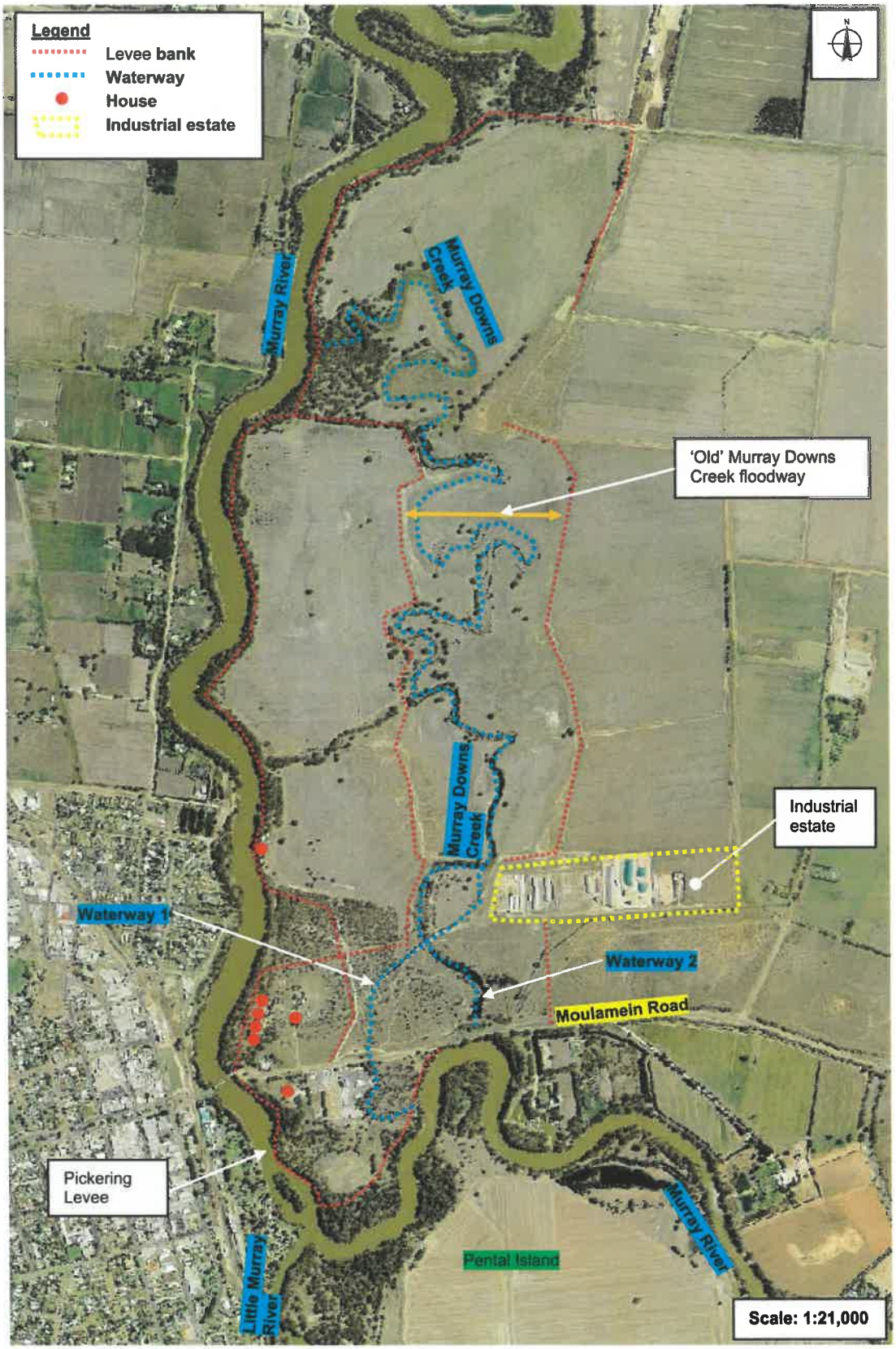


Figure 8 Murray Downs Creek Floodway

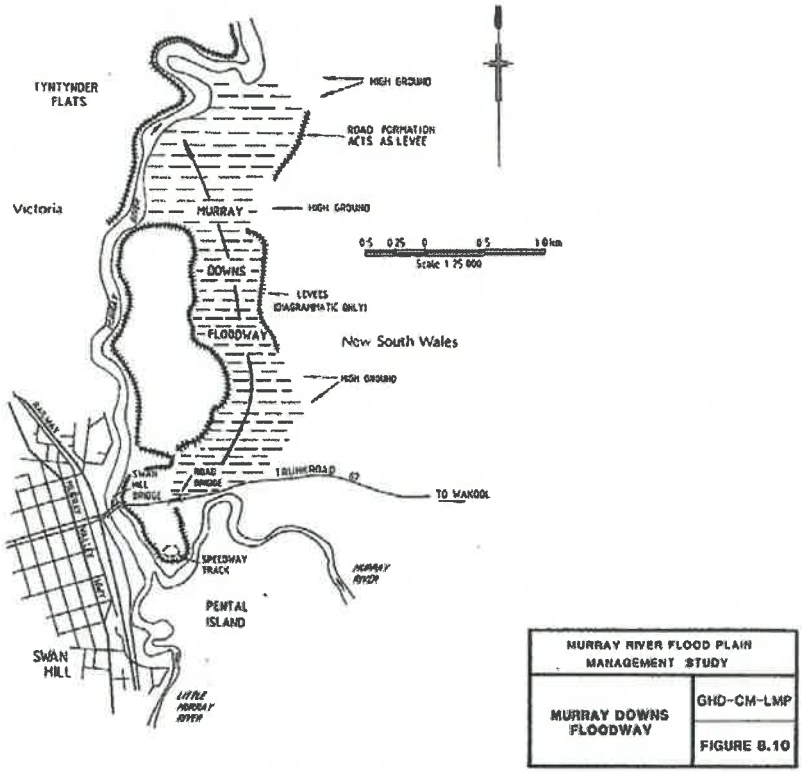


Figure 9 Murray Downs Creek – 1986 Report Extract

(extract from Murray River Flood Plain Management Study Detailed Report (Gutteridge et al, 1986)

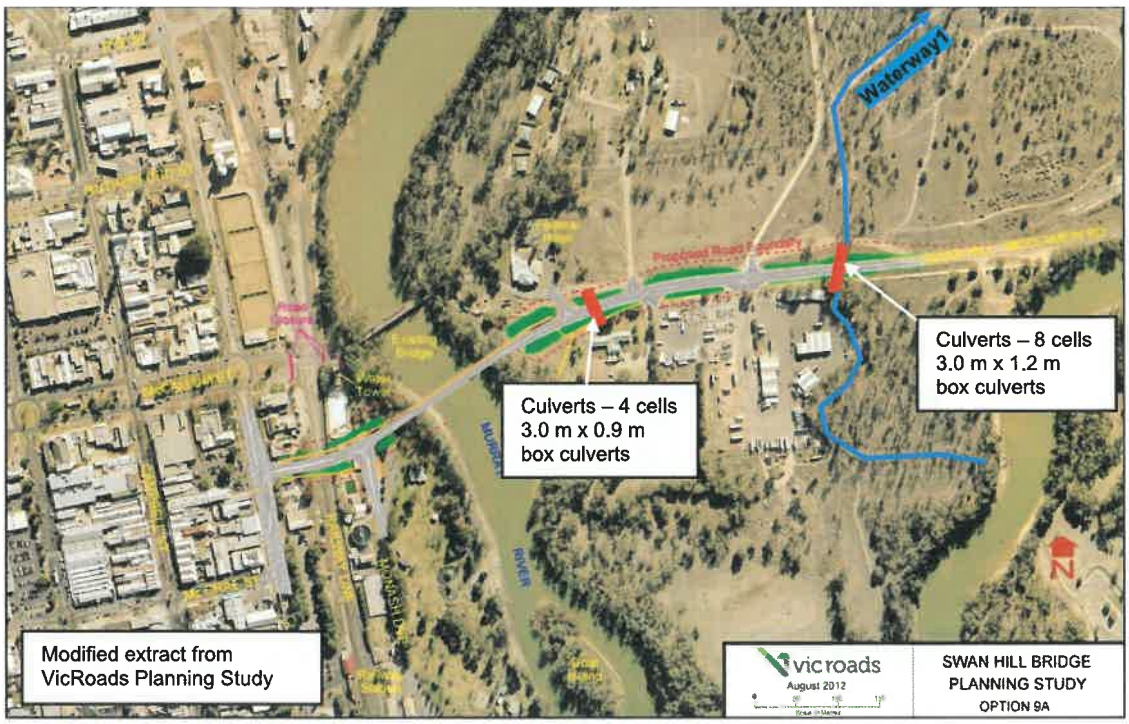


Figure 10 Murray Downs Replacement Bridge – Preferred Route

The final bridge removal in 1990 effectively isolated the Murray Downs Creek from floodwater access at its upstream end. This included the subsequent October 1993 flood which is estimated to be equivalent to a 50 year ARI event at Swan Hill. Based on anecdotal accounts, the Pickering private levee or the Moulamein Road were not overtopped in the 1993 flood.

A Planning Study for a replacement bridge at Swan Hill has recently been carried out by VicRoads. The preliminary preferred route is shown on Figure 10. In addition to the proposed new bridge structure spanning the full width of the river channel, two banks of culvert structures are nominated on the NSW side approach. One bank is positioned on the north side of the Cornerstone Community building. The other bank of culverts is positioned at the Waterway 1 site.

Road culvert structures as proposed by the replacement bridge planning study will convey local runoff and flood flows if the levee protecting the Pickering Transport site is breached or overtopped. This will be beneficial to the existing development on the south side of the Moulamein Road if the levee enclosed area is subject to river flooding. Without the road culvert structures, in the event of a levee breach or overtopping, flood levels will tend to rise quite quickly leading to potential above floor flooding of the Pickering Transport property buildings, the adjoining Build Pro portable office building and the Cornerstone Community building.

Properties on the north side of the Moulamein Road could however be impacted adversely as a result of the road culverts allowing floodwater to access the north side area. This would depend on the size of the culverts, whether flow through the culverts is able to be regulated and the capacity of the re-entry structure at the downstream end of Murray Downs Creek.

8.2.2 Restoring Flood Access to Murray Downs Creek

Although the 1999 Swan Hill Regional Flood Study recommends that floodwater access to the Murray Downs Creek be restored, the rationale is to provide environmental benefits to the creek system, rather than mitigate flood impacts at Swan Hill / Murray Downs.

Restoring floodwater access to the Murray Downs Creek could involve one or all the following:

- Provision of a waterway structure under the Moulamein Road at Waterway 1. By itself, this would only direct flow into the downstream creek when floodwater either breaches or overtops the Pickering levee. This has not occurred for at least 25 years.
- Modifications to the Pickering levee to allow floodwater access to the above structure (e.g. removal of the levee across the mouth of Waterway 1 and the construction of a new realigned levee along the west side of the creek between the river mouth and the Moulamein Road.
- Provision of a waterway structure under the Moulamein Road at Waterway 2.

The current Planning Study for a new Murray River bridge crossing at Swan Hill provides a potential opportunity for securing a new road culvert structure at Waterway 1 or Waterway 2. The Planning Study work nominates an eight cell 3.0 m (W) x 1.2 m (H) bank of culverts at Waterway 1 (refer to Figure 10).

The existing 'bed' (commence to flow) level in Waterway 1 is approximately 66.3 m AHD on the north side of the Moulamein Road. Waterway 2 also has a similar bed level on the north side of the Moulamein Road. The estimated river flow required to generate inflows into the two creeks, based on a commence to flow level of 66.3 m AHD, is 18,000 ML/day. This is lower than the 2 year ARI Murray River design flow at Murray Downs of 25,700 ML/day.

Consideration could be given to splitting the Moulamein Road culverts between Waterway 1 and Waterway 2. Waterway 1 will remain isolated from floodwater unless the Pickering Levee is

modified to allow floodwater access to a Moulamein Road culvert. Culverts at Waterway 2 will however have direct access to river flows.

Such a proposal would likely require regulating gates on any Moulamein Road culverts to allow for the regulation of inflows into Murray Downs Creek to avoid any undesirable flooding impacts.

8.2.3 Hydraulic Modelling - Results

The TUFLOW hydraulic model set-up was modified as follows:

- Eight 3.0 m (wide) x 1.2 m (high) box culverts positioned at the Moulamein Road end of Waterway 2 to allow flows into the Murray Downs Creek
- Perimeter levee positioned around the outside of the Murray Downs Creek corridor to confine flows
- Opening in the Murray River levee positioned at the downstream (northern) end of the Murray Downs Creek system to allow flows back into the Murray River

The above and the resulting change in 100 year ARI flood levels is shown on Figure 11. The results are summarised as follows:

- Flow conveyed by Murray Downs Creek for the scenario modelled is 4,100 ML/day. This coincides with 12% of the total 100 year ARI flow of 35,000 ML/day
- The reduction in flood level in the adjoining reach of the Murray River channel varies from zero (at the downstream junction of Murray Downs Creek and the river) to 0.13 metres (at the upstream junction of the creek and the river)

The flow in Murray Downs Creek will require a perimeter levee to present flooding of adjoining development and agricultural land on either side of the floodway. This perimeter levee will vary considerably in height. Without freeboard, the height of the perimeter levee to confine the scenario modelled will vary from 0.5 to 1.5 metre.

Existing rural levee banks are present along the Murray Downs Creek corridor. These banks are in some places higher than the modelled 100 year ARI flood levels. Upgrading these banks such that they are equivalent to urban standard levee banks in terms of structurally soundness would represent a major undertaking.

8.2.4 Discussion Benefits

The hydraulic modelling results for the scenario modelled indicate that flood levels will be reduced by up to 0.13 metre as a result of 12% of the total 100 year ARI flow being conveyed by Murray Downs Creek. The reduction in flood damages associated with this will be very small.

The total perimeter levee length around the Murray Downs Floodway is 9 km. Constructing an urban standard levee will cost in the vicinity of $5 million.

The existing conditions AAD at Murray Downs is $17,000/annum. The net present value of future flood damages over a period of 50 years assuming a discount rate of 7% is $235,000. Only a relatively small portion of the future flood damages would however be reduced as a result of the Murray Downs Creek works.

Given the above, restoring floodwater access to Murray Downs Creek is not economically viable on the basis of flood mitigation benefits.

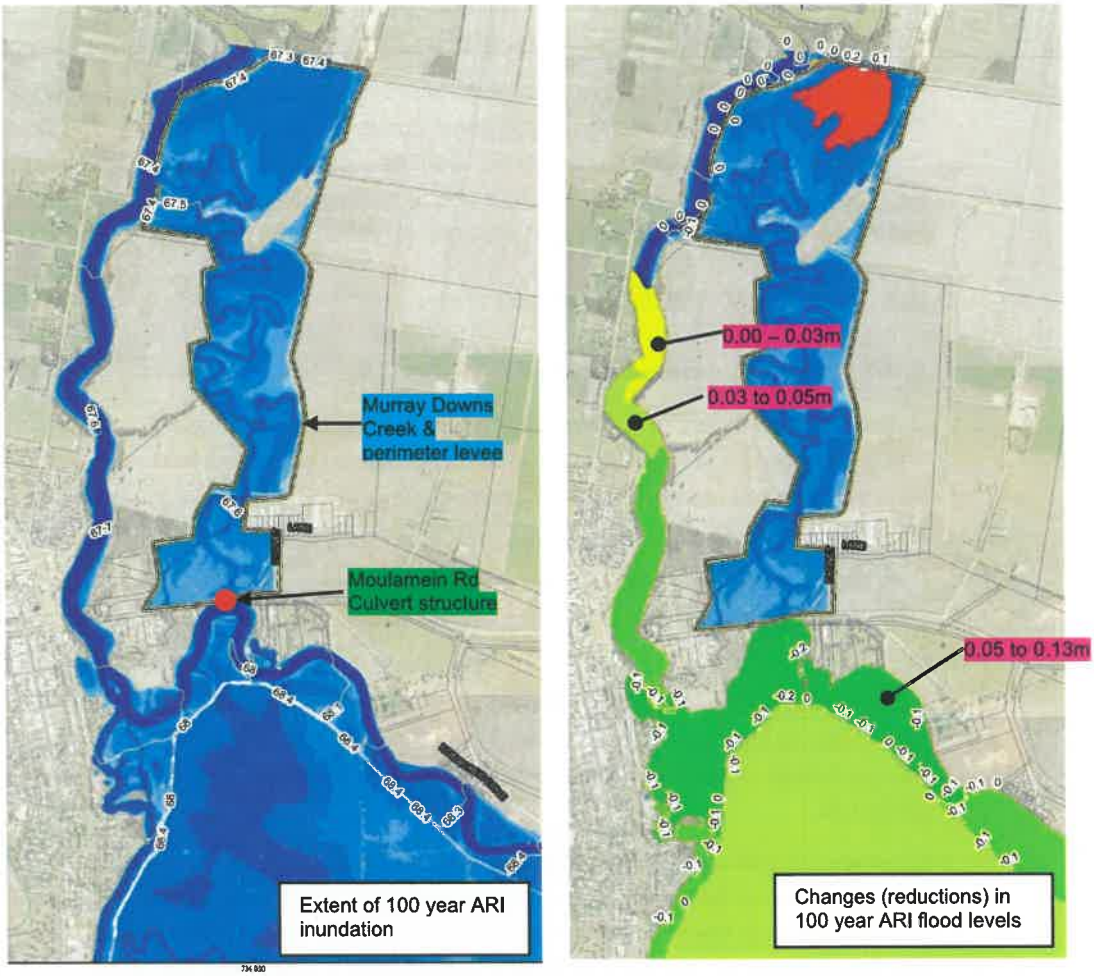


Figure 11 Hydraulic ModellingResults – Murray Downs Creek Floodway

Restoring floodwater access to Murray Downs Creek will provide environmental benefits. As such, Council could consider securing a culvert structure at the location shown on Figure 11 as part of the design for the new river bridge crossing. The culvert structure would need to have a regulator fitted to it to allow flows to be manipulated in order to maximise environmental benefits to the creek whilst minimising adverse flooding impacts on properties adjoining the creek route.

8.2.5 Summary

Moulamein Road culverts at the two feeder waterways into Murray Downs Creek will provide the following benefits:

- The western most culvert will allow for the drainage of floodwater which has entered the Pickering levee protected area. This culvert can also cater for local runoff
- The eastern most culvert can discharge environmental flows into Murray Downs Creek once the river flow exceeds approximately 18,000 ML/day. This is equivalent to between the 1 and 2 year ARI Murray River design flow

Both the above culverts should have regulators fitted to allow for the control of flow. The culverts would need to be funded as part of the future new river crossing works, given their limited flood mitigation benefits.

A nominal size of 1200 mm diameter is nominated for each culvert structure. Larger culverts are unnecessary given they are designed to cater for the residual drainage of floodwater, local runoff and environmental flows rather than a significant amount of flood flows.

Ideally a flap gated culvert outlet structure at the downstream river re-entry end of Murray Downs Creek would be needed to provide a controlled means of discharging Murray Downs Creek flows back into the Murray River. Confirmation of the need and design arrangements for the culvert structure at the downstream end of Murray Downs Creek should be assessed once the culverts at the Moulamein Road are confirmed as part of the new river crossing works.

8.3 Future Development

8.3.1 Murray Downs Drive

Residential development is continuing within the intervening area between Murray Downs Drive and the Murray River. Residential development is expected to over time occupy the intervening area between the Murray Downs homestead property and the western edge of the golf course (refer to Figure 12).

Both the Kidman Reid Drive estate and the current undeveloped R1 zoned land on the west side of the estate are above the 100 year ARI flood level. The area does not rely on levee protection.

Between the Kidman Reid Drive estate and the western edge of the golf course, the RU1 zoned land closer to the river channel is subject to 100 year ARI flooding. The R1 zoned land closer to Murray Downs Drive is not subject to 100 year ARI flooding. This area does not rely on levee protection.

Opposite the golf course, river flooding spills into this area in a 100 year ARI flood, overtopping irrigation channel banks which parallel the river course. This results in infrequent flooding of the low lying parts of the golf course and also grounds flooding on the south side Goldfinch Court lots (numbers 9, 11, 13, 15, 17, 19, 21, 23 and 25). In a 20 year ARI flood, flows are confined to the river side of the irrigation channel.

Given the low frequency of flooding, and the limited impacts (i.e. grounds flooding only) any further flood modification works (e.g. levees) do not appear warranted.

The second potential residential estate within the golf course for which development is yet to commence is located above the 100 year ARI flood level with the exception of the perimeter edges of the R1 zoned area (see Figure 12). It is noted that there is a woodland over the majority of this site which may limit development options.

A further parcel of R1 zoned land is located on the north side of Murray Downs Drive adjoining the golf course. Development has not commenced on this area. The area is not affected by river flooding.

Although partly located within the FPA, the land along the north side of Murray Downs Drive between the Moulamein Road and the Golf Course Resort is not affected by flooding up to in excess of a 200 year ARI event. This area is currently zoned RU1. Based solely on a flood risk comparison, this area is more suited to residential development in comparison to land fronting onto the Moulamein Road between the river bridge and the Murray Downs Drive intersection.

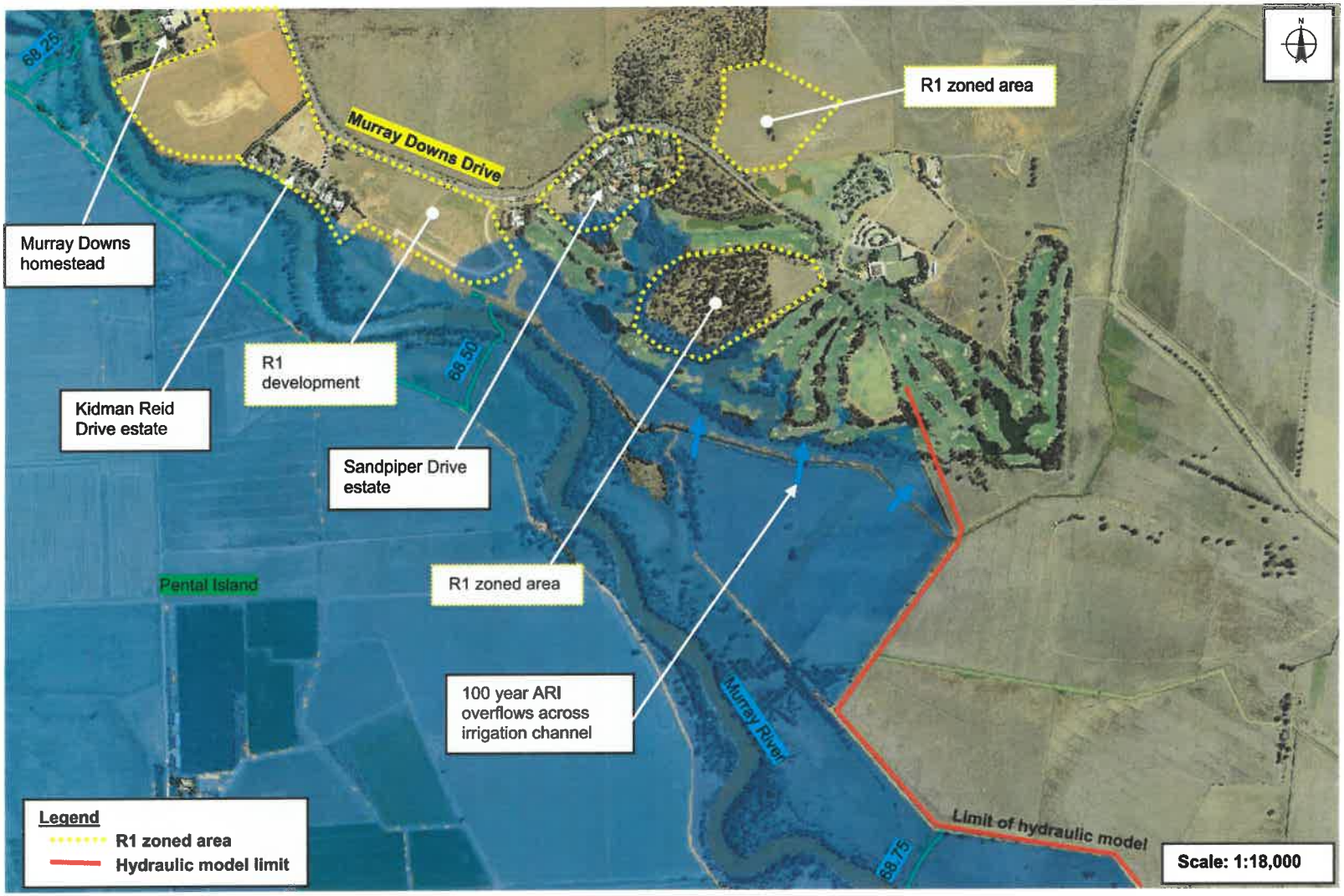


Figure 12 Murray Downs Drive - Residential Development

9. Floodplain Risk Management Plan

9.1 Overview

Murray Downs is positioned on the NSW side of the Murray River opposite the larger Victorian township of Swan Hill. Flooding conditions within this reach of the river are mainly influenced by tributary inflows from the Loddon, Avoca, Campaspe and Goulburn Rivers.

Based on streamflows records at Swan Hill, the highest flow event since 2000 occurred in February 2011. The 2011 flood was equivalent to around a 5 year ARI flood.

Prior to 2000, the highest flow events occurred in October 1975 (80 year ARI equivalent event), October 1993 (50 year ARI event) and August 1981 (20 year ARI event).

This Floodplain Risk Management Plan applies to the Murray Downs township area only as defined by Figure 1. It does not consider flooding impacts in rural areas outside the town area.

Murray Downs primarily consists of a mixture of commercial, industrial and residential development on either side of the Moulamein Road within 2 km of the Murray River bridge crossing, and residential development on the south side of Murray Downs Drive on route to the golf course. The Murray Downs Resort complex at the golf course is on high ground and is not inundated in an extreme flood.

The development on either side of the Moulamein Road relies to some extent on flooding protection from an aging private levee system. Anecdotal accounts indicate that the levee system was not overtopped in the 1993 flood or any floods since. Based on surveyed levee crest heights in 2013, the existing private levee upstream and downstream of the Moulamein Road is not overtopped by the 100 year ARI flood, although close to zero freeboard is present at multiple locations. Moulamein Road is elevated marginally above the 100 year ARI flood level.

Flooding impacts on residential development between Murray Downs Drive and the river are limited to grounds flooding of the lower most sections of the estates. The houses within the residential estates (Kidman-Reid Drive estate and the Sandpiper Drive estate) do not rely on levee protection.

Average annual flood damages at Murray Downs are estimated to amount to a relatively low $17,000 per annum.

Flood mitigation measures which can be used to reduce flooding impacts are:

- **Property modification measures** which are designed to avoid future development within areas which have a high flood risk or to reduce damages by flood proofing existing development. They land use include planning and development controls.
- **Response modification measures** which are designed to modify the response of the population at risk prior to, during and after a flood. They include flood warning system improvements and raising the level of community flood awareness.
- **Flood modification measures** which are designed to modify flooding conditions by lowering flow rates, flood levels or velocities and excluding floodwaters from protected areas. They include levees to exclude floodwaters, temporary storage of floodwaters to reduce downstream peak flows and waterway capacity improvements to lower flood levels.

Development at Murray Downs is currently proceeding on land off Murray Downs Drive. The areas zoned residential which are yet to be developed and the existing residential estates off Murray Downs Drive are not at risk of 100 year ARI flooding and do not rely on levee protection.

Existing development off the Moulamein Road is most limited to industrial and commercial development. The floor levels of the few houses in this area are above floor 100 year ARI flood levels without relying on protection from the private levees present.

An upgrade of the private levee system would require the Murray River Council to effectively take on ownership of the levees, including future maintenance costs and also responsibilities if the levees fail. An upgrade of the private levee system has not been adopted after taking into account the limited flood impacts on existing development, the substantial cost of a levee system upgrade and the availability of non flood affected developable land off Murray Downs Drive.

9.2 Recommended Mitigation Measures

The adopted flood mitigation measures are listed in Table 9. They are described as follows.

9.2.1 Property Land Use Planning and Development Controls

Implementing appropriate land use planning and development controls is an integral component of all floodplain risk management plans. In relation to Murray Downs, the following measures are recommended:

- Adoption of development control Flood Planning Levels (FPLs) based on the 100 year ARI flood level plus 0.5 metre of freeboard
- Adoption of a Flood Planning Area (FPA) based on the area below the FPL as shown on Figure A1 of Appendix A
- Update of the Wakool LEP to include a map defining the FPA at Murray Downs
- Update of the Wakool DCP to incorporate the Local Flood Policy planning and development controls for Murray Downs (refer to Appendix A)

9.2.2 Flood Warning System Improvements

The following flood warning system improvement measures are recommended:

- Ensure that personnel who have roles and responsibilities in relation to the flood warning system understand the significance of the various gauge heights at Swan Hill in relation to impacts at Murray Downs.
- Local Flood Plan to be updated to reflect the outcomes of the 2014 Murray Downs Flood Study report and the final Murray Downs Floodplain Risk Management Study and Plan report.

9.2.3 Community Flood Awareness and Education Measures

The following community awareness measures are recommended:

- Establishment of a Flood Information facility on Council's web site where flood response information (e.g. Flood Sub Plan), detailed flood information (e.g. reports and maps from this project) and any other useful information relating to flooding can be accessed by the community.
- Inclusion of expanded flooding information on Section 149 certificates issued by Council.

9.2.4 Flood Data

It is important that flood data be collected both during and in the aftermath of future flood events. The data can be used for future investigations associated with the update of the Murray Downs FRMP.

Future data collection should focus on:

- Large floods (e.g. peak level at Swan Hill higher than 4.6 metres)
- Performance of the private levee system.
- Photographs if possible at or near the peak of flooding. Where possible, photographs to be date and time stamped
- Recording reliable peak flood levels and their subsequent survey to the AHD datum
- Details of any instances of above floor flooding

9.2.5 Flood Modification Measures

The existing Swan Hill-Murray Downs Murray River bridge crossing is likely to be replaced in the next five years. The VicRoads Planning Study for the new bridge crossing has identified culvert structures on the Moulamein Road side approach for 'flood mitigation and local drainage'.

It is recommended that two Moulamein Road culvert structures be provided. The two culverts structures should be positioned at the two feeder waterways into Murray Downs Creek.

The western most culvert will allow for the drainage of local runoff from within the Pickering site private levee enclosed area and will also allow any residual floodwater from within the private levee enclosed area to be drained.

The eastern most culvert will allow for flows to be directed into Murray Downs Creek when the Murray River flow exceeds approximately 18,000 ML/day which is between the 1 and 2 year ARI Murray River design flow. Both culverts should be fitted with regulators to allow for flows to be controlled.

The culverts would need to be funded as part of the new Murray River crossing works (new bridge). The culverts will not be eligible for funding via the NSW Government Floodplain Management Program due to their limited mitigation benefits.

If the Moulamein Road culverts are to be implemented as part of the future new river crossing works, the need for an upgraded controlled outlet structure at the Murray Downs Creek re-entry point into the Murray River should be investigated.

Table 9 Recommended Floodplain Management Plan Measures

Measure Description	Priority	Indicative Capital Cost ($)	Responsible organisation
Property Modification Measures			
- Endorse land use planning approach outlined in Plan	High	Nil	Council
- Refine & incorporate flood planning and development controls into LEP & DCP	High	Nil	Council
Response Modification Measures			
- Include expanded flooding information on S149 certificates	High	Ongoing	Council
- Develop and maintain flood information on Council's web site	Medium	5,000	Council / OEH / SES
- Update Local Flood Plan	Medium	5,000	SES
- Data collection and documentation in future floods	Medium	Ongoing	Council / OEH / SES
Flood Modification Measures			
- Install regulated culvert structures at Moulamein Road entries to Murray Downs Creek as part of new river crossing works	Low	100,000	RMS (part of Moulamein Rd new river crossing road works)
- Subject to Moulamein Road culverts being installed, investigate and install outlet structure upgrade at Murray Downs Creek re-entry to Murray River	Low	100,000	Council

Note:

1. Costs are indicative only and should be reviewed following any further design or investigation activities.

9.3 Implementation/Funding

There are a number of possible funding sources that could be considered by Council to assist with the implementation of the Floodplain Risk Management Plan. Potential funding sources include:

- Council contributed funds
- NSW State Government and Australian Commonwealth Government funding programmes for the implementation of flood risk mitigation measures
- SES for flood response improvement measures

The majority of financial assistance is likely to come via the NSW Government Floodplain Management Program (the Program). The Program is administered by OEH. Applications under the most recent round of funding within this Program were also eligible for funding assistance under the jointly funded NSW and Commonwealth Government's Natural Disaster Resilience Program.

Funding under the Program is not available for assistance with measures associated with the applicant's core activities. This would include implementing land use planning and building development controls for example which is a core local government task. Eligible measures include implementing structural mitigation works, flood warning systems, evacuation management, voluntary house raising and voluntary purchase. Applicants are required to provide a certain level of funds for every $1 of grant funding. Funding of investigation and design activities is available. Funding for maintenance activities is generally not available.

It is envisaged that the Moulamein Road culvert structures would form part of the new river crossing works and as such would be funded as part of these works.

10. Acknowledgements

The Murray River Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.

The project has been completed with the assistance of the Council's Floodplain Risk Management Committee, Council's staff, Office of Environment of Heritage's staff, NSW SES staff and the other government agency and local residents who have had involvement in the project. The assistance which has been provided is very much appreciated by Council.

11. Abbreviations and Glossary

11.1 Abbreviations

AAD	Average annual damage
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
BOM	Bureau of Meteorology
DEM	Digital elevation model
EMPLAN	Emergency Management Plan
LEP	Local Environmental Plan
FDM	Floodplain Development Manual (2005)
FPA	Flood planning area
FPL	Flood planning level
FRMS	Floodplain Risk Management Study
FRMP	Floodplain Risk Management Plan
OEH	Office of Environment and Heritage
PMF	Probable maximum flood
SES	State Emergency Service

11.2 Glossary

Annual Exceedance Probability (AEP) - AEP (measured as a percentage) is a term used to describe flood size. AEP is the long-term probability between floods of a certain magnitude. For example, a 1% AEP flood is a flood that occurs on average once every 100 years. It is also referred to as the '100 year ARI flood' or '1 in 100 year flood'.

0.2% AEP sometimes referred to as the 500 year ARI event

0.5% AEP sometimes referred to as the 200 year ARI event

1% AEP sometimes referred to as the 100 year ARI event

2% AEP sometimes referred to as the 50 year ARI event

5% AEP sometimes referred to as the 20 year ARI event

10% AEP sometimes referred to as the 10 year ARI event

20% AEP sometimes referred to as the 5 year ARI event

50% AEP sometimes referred to as the 2 year ARI event

Afflux - The increase in flood level upstream of a constriction of flood flows. A road culvert, a pipe or a narrowing of the stream channel could cause the constriction.

Australian Height Datum (AHD) - A common national plane of level approximately equivalent to the height above sea level. All flood levels; floor levels and ground levels in this study have been provided in meters AHD.

Average annual damage (AAD) - Average annual damage is the average flood damage per year that would occur in a nominated development situation over a long period of time.

Average recurrence interval (ARI) - ARI (measured in years) is a term used to describe flood size. It is a means of describing how likely a flood is to occur in a given year. For example, a 100-year ARI flood is a flood that occurs or is exceeded on average once every 100 years.

Catchment - The land draining through the main stream, as well as tributary streams.

Development Control Plan (DCP) - A DCP is a plan prepared in accordance with Section 72 of the *Environmental Planning and Assessment Act, 1979* that provides detailed guidelines for the assessment of development applications.

Design flood level - A flood with a nominated probability or average recurrence interval, for example the 100 year ARI flood is commonly use throughout NSW.

OEH (formerly DECCW, DECC, DNR, DLWC, DIPNR) - Office of Environment and Heritage. Covers a range of conservation and natural resources science and programs, including native vegetation, biodiversity and environmental water recovery to provide an integrated approach to natural resource management. The NSW State Government Office provides funding and support for flood studies.

Discharge - The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s) or megalitres per day (ML/day). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving.

Effective warning time - The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

Extreme flood - An estimate of the probable maximum flood (PMF), which is the largest flood likely to occur.

Flood - A relatively high stream flow that overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

Flood awareness - An appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response and evacuation procedures.

Flood Fringe - The remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and / or flood levels.'

Flood hazard - The potential for damage to property or risk to persons during a flood. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.

Flood level - The height of the flood described either as a depth of water above a particular location (e.g. 1m above a floor, yard or road) or as a depth of water related to a standard level such as Australian Height Datum (e.g. the flood level was 77.5 m AHD). Terms also used include flood stage and water level.

Flood liable land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood prone land. Note that the term flood liable land now covers the whole of the floodplain, not just that part below the flood planning level, as indicated in the superseded Floodplain Development Manual (NSW Government, 2005).

Flood Planning Area (FPA) – the area of land below the FPL and thus subject to flood related development controls.

Flood Planning Levels (FPLs) - The combination of flood levels and freeboards selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. The concept of flood planning levels supersedes the designated flood or the flood standard used in earlier studies.

Flood Prone Land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood liable land.

Flood Storage - Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood Study - A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood sizes.

Floodplain - The area of land that is subject to inundation by floods up to and including the Probable Maximum Flood event, that is, flood prone land or flood liable land.

Floodplain Risk Management Study – Studies carried out in accordance with the Floodplain Development Manual and assess options for minimising the danger to life and property during floods.

Floodplain Risk Management Plan - The outcome of a Floodplain Management Risk Study.

Floodway - Those areas of the floodplain where a significant discharge of water occurs during floods. Floodways are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

Flows or discharges - It is the rate of flow of water measured in terms of volume per unit time.

Freeboard - A factor of safety expressed as the height above the design flood level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change.

High Flood Hazard - For a particular size flood, there would be a possible danger to personal safety, able-bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be a potential for significant structural damage to buildings.

Hydraulics Term - given to the study of water flow in waterways, in particular, the evaluation of flow parameters such as water level and velocity.

Hydrology Term - given to the study of the rainfall and runoff process; in particular, the evaluation of peak discharges, flow volumes and the derivation of hydrographs (graphs that show how the discharge or stage/flood level at any particular location varies with time during a flood).

Local catchments - Local catchments are river sub-catchments that feed river tributaries, creeks, and watercourses and channelised or piped drainage systems.

Local Environmental Plan (LEP) – A Local Environmental Plan is a plan prepared in accordance with the *Environmental Planning and Assessment Act*, 1979, that defines zones, permissible uses within those zones and specifies development standards and other special matters for consideration with regard to the use or development of land.

Local overland flooding - Local overland flooding is inundation by local runoff within the local catchment.

Local runoff - local runoff from the local catchment is categorised as either major drainage or local drainage in the NSW Floodplain Development Manual, 2005.

Low flood hazard - For a particular size flood, able-bodied adults would generally have little difficulty wading and trucks could be used to evacuate people and their possessions should it be necessary.

Overland flow path - The path that floodwaters can follow if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Floodwaters travelling along overland flow paths, often referred to as 'overland flows', may or may not re-enter the main channel from which they left — they may be diverted to another watercourse.

Peak discharge - The maximum flow or discharge during a flood.

Probable Maximum Flood (PMF) - The largest flood likely to ever occur. The PMF defines the extent of flood prone land or flood liable land, that is, the floodplain.

Risk - Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

Runoff - the amount of rainfall that ends up as flow in a stream, also known as rainfall excess.

SES - State Emergency Service of New South Wales

Stage–damage curve - A relationship between different water depths and the predicted flood damage at that depth.

Velocity - the term used to describe the speed of floodwaters, usually in m/s (metres per second). 10km/h = 2.7m/s.

Water surface profile - A graph showing the height of the flood (flood stage, water level or flood level) at any given location along a watercourse at a particular time.

12. References

Binnie & Partners (July 1992). *Swan Hill / Tyntynder Flats Floodplain Management Study*. Prepared for the Shire of Swan Hill.

Cardno (May 2011). *Swan Hill Bridge Flood Study Detailed Hydraulic Study Addendum Report*. Prepared for VicRoads.

Cardno Lawson Treloar March 2009). *Detailed Hydrology Study for the Swan Hill Bridge Planning Study*. Prepared for VicRoads.

Collie, Ivey, Geolyse and Groupwork (April 2009). *Wakool Shire LEP Review – Land Use Strategy Report*. Prepared for Wakool Shire Council.

Department of Environment & Climate Change (2007). *Flood Emergency Response Planning Classification of Communities.*

Department of Environment & Climate Change (2007). *Residential Flood Damages.*

Department of Environment & Climate Change (2007). *SES Requirements for the FRM Process.*

GHD (January 2013). *Wakool Shire Flood Scoping Study – Barham, Murray Downs and Tooleybuc*. Prepared for Wakool Shire Council.

GHD (October 2014). Murray Downs Flood Study. Prepared for Wakool Shire Council.

Lawson & Treloar (April 1995). *Swan Hill Regional Flood Strategy – Hydraulic Evaluation of Strategies*.

Lawson & Treloar (April 1998). *Swan Hill Regional Flood Strategy – Hydraulic Assessment*.

NSW Government (April 2005). *Floodplain Development Manual.*

NSW State Emergency Services (December, 2012). *Wakool Shire Local Flood Plan*.

Sinclair Knight Merz (September 1999). *Swan Hill Regional Flood Strategy Completion Phase – Report to Community*.

SES (December 2012). *Wakool Shire Local Flood Plan.*

Victoria Department of Environment, Land, Water & Planning (2015). *Levee Management Guidelines.*

Wakool Shire Council (November 2013). *Wakool Shire Local Emergency Management Plan (EM Plan).*

Wakool Shire Council (October 2013). *Wakool Shire Development Control Plan.*

Wakool Shire Council (November 2013). *Wakool Local Environmental Plan 2013.*

Appendices

Appendix A – Draft Local Flood Policy for Murray Downs

Figure A1 Flood Planning Area

Figure A2 Hydraulic Category Plan

Figure A3 Hazard Category Plan

Draft Local Flood Policy

1. Land to which these Development Controls Applies

The development controls in this Local Flood Policy apply to the Flood Planning Area at Murray Downs as defined by Figure A1.

2. Objectives

The floodplain development controls are intended to:

- Guide the development of flood prone land, applying balanced strategies to economically, socially and environmentally manage the potential flood risk to life and property.
- Ensure that sufficient land is set aside to convey and/or store floodwaters and to protect and enhance the riparian zone.
- Ensure that development, when considered both individually and in the context of cumulative development trends, will not cause unreasonable adverse flooding impacts in other locations.

3. Definitions

Floodway	Those parts of the floodplain where a significant discharge of water occurs during floods. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Storage	Those parts of the floodplain important for the temporary storage of floodwaters during the passage of a flood.
Flood Fringe	The remaining area of land affected by flooding, after floodway and flood storage areas have been defined.
Low Flood Hazard	Those parts of the floodplain where able bodied adults would generally have little difficulty wading and trucks could evacuate people and their possessions should it be necessary.
High Flood Hazard	Those parts of the floodplain where there would be a possible danger to personal safety, able bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be potential for significant structure damage to buildings.
Flood Planning Area (FPA)	Represents the area below the FPL and thus subject to flood related development controls.
Flood Planning Levels (FPLs)	Is the combination of flood levels and freeboards selected for floodplain risk management purposes.
Flood Prone Land	Land susceptible to flooding by the Probable Maximum Flood event. Flood prone land is synonymous with flood liable land.
Freeboard	Refers to a designated height above the design flood which is stipulated to incorporate a suitable factor of safety into development.

4. Site Classifications

- Flood Planning Area means land as defined by the attached Figure A1, coinciding with the area below the 100 year ARI flood level plus a freeboard of 0.5 metres.
- Flood Planning Levels coincide with the 100 year ARI flood level plus 0.5 metre as determined by this FRMS&P. The 100 year ARI flood levels coincide with levee breach conditions (i.e. as per Figure D1 of this FRMS&P).
- Low Hazard and High Hazard Areas means land as defined by the attached Figure A2.
- Floodway, Flood Storage and Flood Fringe Areas means land as defined by the attached Figure A3.

5. General - Development within the Flood Planning Area

General Development Standards applicable to the Flood Planning Area are as follows:

a) All development within the Flood Planning Area requires the consent of Council.

b) All development shall be generally assessed in accordance with the latest edition of the NSW Floodplain Development Manual as issued by the NSW Government.

c) Development will not be permitted unless Council is satisfied that the proposed development will not increase the flood hazard rating or likely flood damage to any other property.

6. Development within Floodway Areas

Development Standards applicable to Floodway Areas are as follows.

High Hazard Floodway Areas

Development within High Hazard Floodway areas is generally discouraged. Council may consider granting permission to minor developments including extensions provided the requirements for Low Hazard Floodway areas can be met.

Low Hazard Floodway Areas

a) No alteration in ground levels by more than 100 mm will be permitted, whether by excavation or filling, without the submission of a local hydraulic study and prior development consent.

b) The erection of any new habitable structure on land within Floodway Areas will only be permitted if the land is outside the High Hazard area and supported by a local hydraulic impact study demonstrating that the works will have no adverse flooding effect on any other property.

c) Extensions to existing residential buildings:

   i. Where the area of the extension is less than 50% of the existing floor area, the floor level of the extension may be constructed to the same level as the existing floor level.

   ii. Where the extension is greater than 50% of the existing floor area, the minimum floor level of the extension is to be at the FPL.

d) Fencing. Fences of a continuous (impermeable) design, such as metal cladding, shall not be permissible. Post and rail fences will be permitted providing they are designed to permit the unimpeded flow of floodwater.

7. Development within Flood Storage Areas and Flood Fringe Areas

Development Standards applicable to Flood Storage Areas and Flood Fringe Areas are as follows.

High Hazard Flood Storage and Flood Fringe Areas

The same requirements as those listed under Low Hazard Floodway Areas apply.

Low Hazard Flood Storage and Flood Fringe Areas

a) Development consent is required to be obtained prior to any work or building activity being carried out within the Flood Planning Area. A hydraulic study may be required to be submitted with any Development Application at the discretion of Council.

b) The minimum floor level of any new residential building is to be at the FPL (i.e. 0.5 metres above the 100 year ARI flood level).

c) Commercial and industrial development. At Council's discretion, the minimum floor level is to be at the FPL or the building is to be flood proofed to at least the FPL.

d) Extensions to existing residential buildings.

   iii. Where the area of the extension is less than 50% of the existing floor area, the floor level of the extension may be constructed to the same level as the existing floor level.

   iv. Where the extension is greater than 50% of the existing floor area, the minimum floor level of the extension is to be at the FPL.

e) Extensions to existing non-residential buildings. Extensions to existing non-residential buildings may be constructed at the same level as the existing building. At Council's discretion, the complete building is to be flood proofed to the FPL.

f) Carports and open sheds. Carports and open sheds may be constructed at existing ground levels. They must be constructed from flood compatible materials.

g) Fencing. Fencing of a continuous design (e.g. metal cladding) shall be permissible.

8. Development Application Requirements

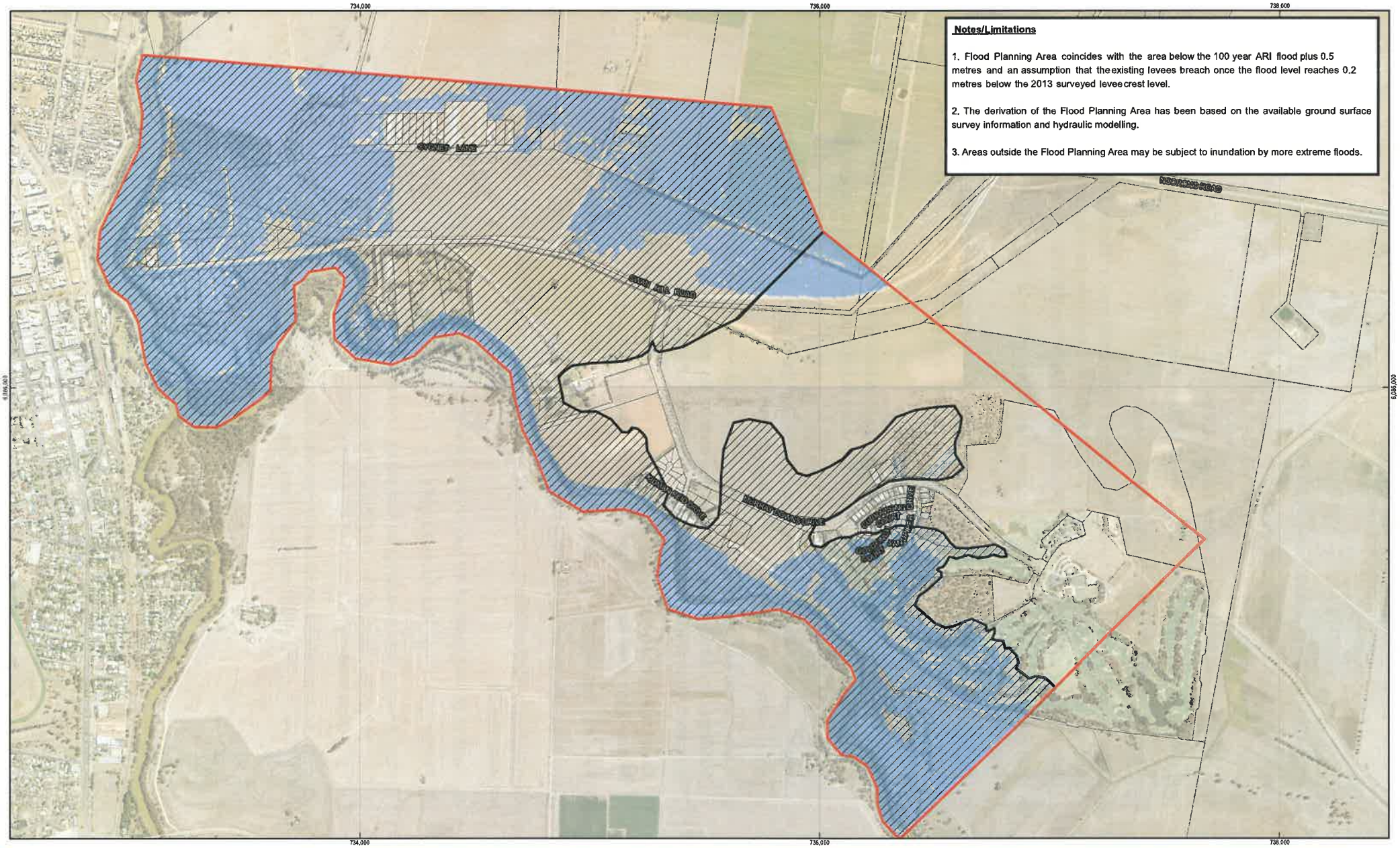
A development application lodged for development within the Flood Planning Area is to be accompanied by:

a) Existing ground levels of the subject site certified by a registered surveyor.

b) Floodway and High Hazard Areas only:

   a. A report from an accredited Consulting Engineer detailing any adverse effects of the proposed development on potential flood damages to the subject property and any other property as a result of the development.

   b. An evacuation plan for the development accompanied by evidence that the local division of the SES has been consulted in the formulation of the plan.



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Area Subject to 100 Year Flooding
- Cadastre
- Study Area Boundary
- Flood Planning Area

Murray River Council
Murray Downs Floodplain Risk Management Plan

Job Number 31-32610
Revision 0
Date 24 Jan 2017

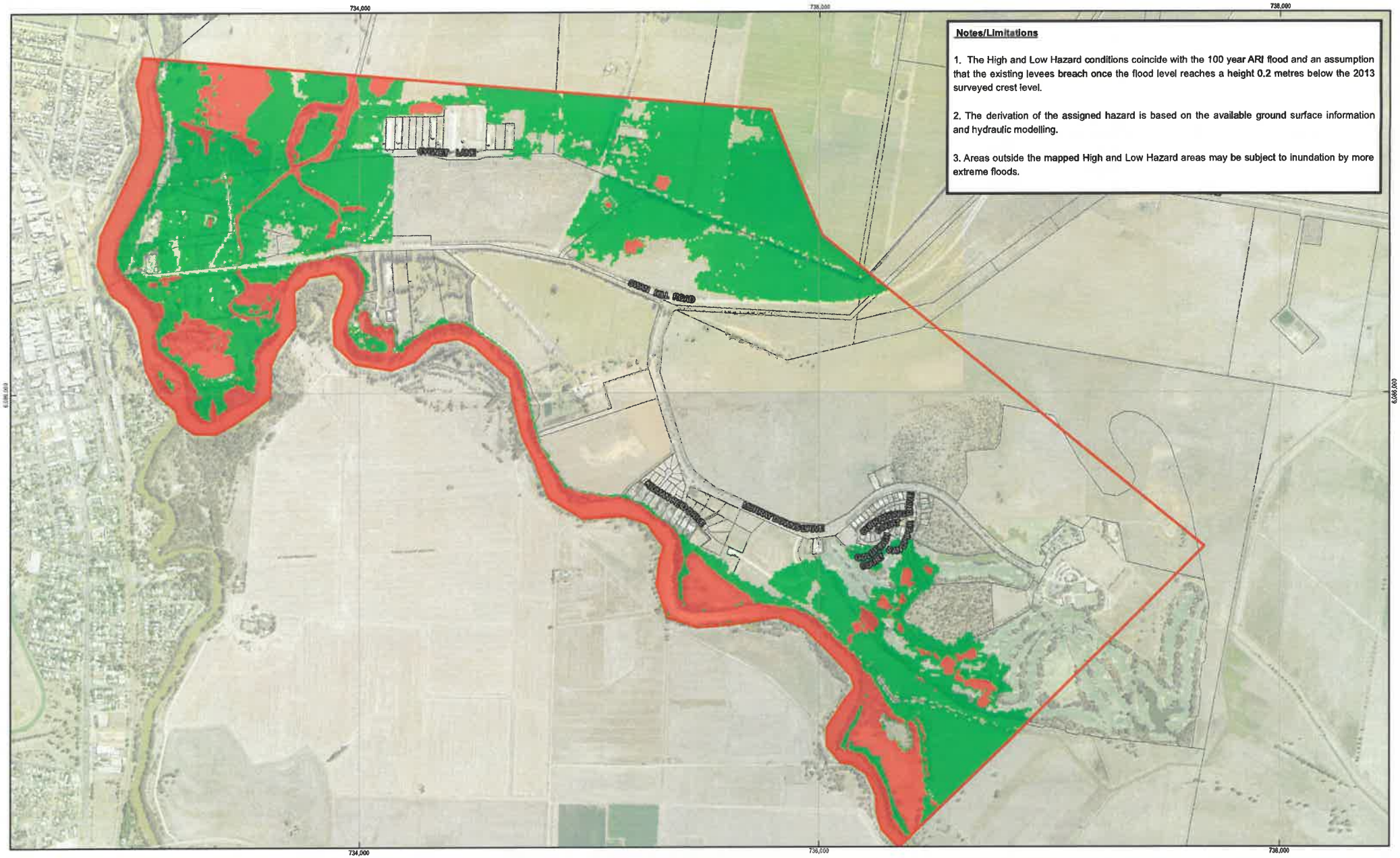
100 Year ARI Flood Event
Flood Planning Area

Figure A1

G:\31\32610\GIS\Maps\Deliverables\31_32610_MurrayDowns_FRMP_Fig_A1_Rev_0.mxd

Data source: GHD, Flood Extents and Contours, 2015; Wakool Shire Council, Aerial Imagery, 2013; LPI, DTDB & DCDB, 2012. Created by:sldouglas

Suite 5, 105 Hume Street, Wodonga, VIC 3690 Australia T 61 2 6043 8700 F 61 2 6043 8701 E melmail@ghd.com W www.ghd.com



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Low Hazard
- High Hazard
- Study Area Boundary
- Cadastre

Murray River Council
Murray Downs Floodplain Risk Management Plan

Job Number	31-32610
Revision	0
Date	24 Jan 2017

100 Year ARI Flood Event

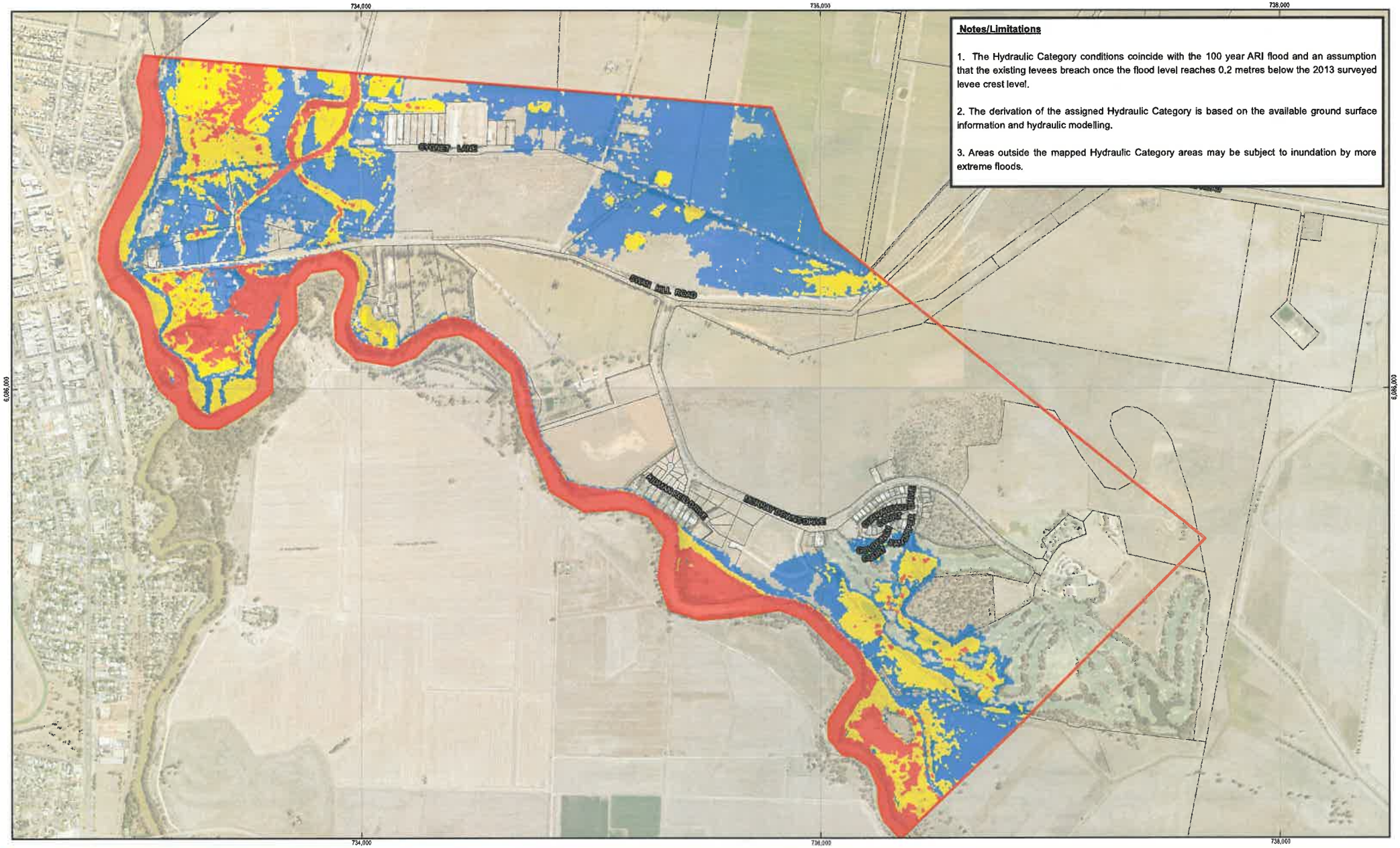
Flood Hazard

Figure A2

G:\31\32610\GIS\Maps\Deliverables\31_32610_MurrayDowns_FRMP_Fig_A2_Rev_0.mxd

Data source: GHD, Flood Extents and Contours, 2015; Wakool Shire Council, Aerial Imagery, 2013; LPI, DTDB & DCDB, 2012. Created by:sldouglas

Suite 5, 105 Hume Street, Wodonga, VIC 3690 Australia T 61 2 6043 8700 F 61 2 6043 8701 E melmail@ghd.com W www.ghd.com



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Flood Fringe
- Flood Storage
- Flood Way
- Study Area Boundary
- Cadastre

Murray River Council
Murray Downs Floodplain Risk Management Plan

Job Number 31-32610
Revision 0
Date 24 Jan 2017

100 Year ARI Flood Event
Hydraulic Category

Figure A3

G:\31\32610\GIS\Maps\Deliverables\31_32610_MurrayDowns_FRMP_Fig_A3_Rev_0.mxd

Data source: GHD, Flood Extents and Contours, 2015; Wakool Shire Council, Aerial Imagery, 2013; LPI, DTDB & DCDB, 2012. Created by:sldouglas

Suite 5, 105 Hume Street, Wodonga, VIC 3690 Australia T 61 2 6043 8700 F 61 2 6043 8701 E melmail@ghd.com W www.ghd.com

Appendix B – SES Flood Data Outputs

Table B1	Response required for ERP Classified Areas
Table B2	Consequences Relative to Gauge Height at Murray Downs
Figure B1	Murray Downs ERP Classifications – Extreme Event

Table B1 Response Required for ERP Classified Areas

Classification	Response Required		
	Resupply	Rescue / Medivac	Evacuation
Areas with rising road access	No	Possibly	Yes
Areas with overland escape routes	No	Possibly	Yes
High flood island	Yes	Possibly	Possibly
Low flood island	No	Yes	Yes
Low trapped perimeter	No	Yes	Yes
High trapped perimeter	Yes	Possibly	Possibly
Indirectly affected areas	Possibly	Possibly	Possibly

ERP Definitions

- **Areas with rising road access** – those areas where access roads rise steadily uphill and away from the rising floodwaters.
- **Areas with overland escape route** – those areas where access roads to flood free land cross lower lying flood prone land or where escape to flood free land is possible by walking overland to flood free land.
- **High flood island** – the flood island includes enough land above the PMF level to cope with the people in the area.
- **Low flood island** – the flood island is either lower than the limit of flooding or cannot cope with the number of people in the area.
- **Low trapped perimeter** – similar to a low flood island, except that the accessible area will eventually be completely covered with floodwater, with higher ground unable to be reached due to topography or impassable structures.
- **High trapped perimeter** – those areas above the PMF level, but access out via road or foot is cut during a flood.
- **Indirectly affected areas** – those areas above the PMF level but are indirectly affected as a result of flooding (e.g. loss of power, isolation doe to damages road).

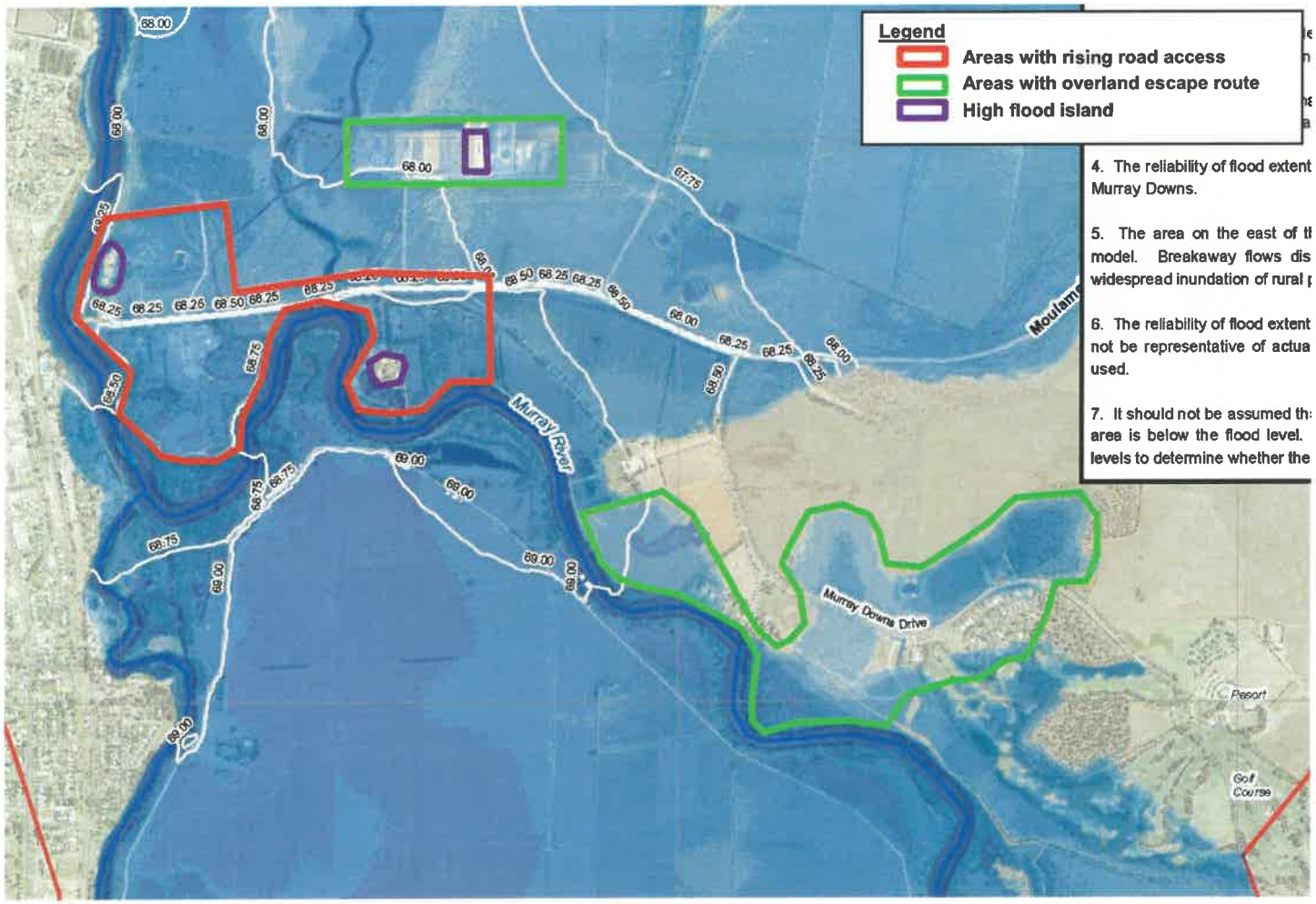


Figure B1 **Murray Downs ERP Classifications – Extreme Event**

Table B2 Consequences Relative to Gauge Height at Murray Downs

Swan Hill gauge height (m)	ARI (years)	Description	Consequences - number of buildings affected	
			Residential	Other
4.5 (Minor)	4	No significant impacts expected. Water banked up against private levees.	0	0
4.6 (Moderate)	6	No significant impacts expected. Water banked up against private levees.	0	0
4.7 (Major)	25	No significant impacts expected unless private levees are breached. Private levee freeboard adjacent to Wamba Wamba site and Pickering Transport site is minimal (< 0.1 metre). Consider evacuating: • Wamba Wamba site • Cornerstone site • Pickerings Transport site	0	0
4.8	100	Private levee overtopping or breaching likely. In addition to the above, consider evacuating: • Industrial Estate site • Residential properties in vicinity of the Marina	0	3
5.3	100,000	Private levee overtopping inevitable. Consider evacuating: • All of the Moulamein Road properties. • Murray Downs Drive residential estates.	12	10

Note:

1. The Swan Hill gauge is located 900 metres downstream of the Swan Hill Moulamein Road bridge. Gauge zero datum is 62.92 m AHD.

Flood Risk Groups – Discussion Notes

There are five main groups of occupants potentially affected by flooding at Murray Downs as follows:

- Cornerstone Community site
- Pickering Transport Group site
- Wamba Wamba site
- Murray Downs Industrial Estate
- Residential occupants

Comments in relation to the flood risk status of the above groups are provided as follows.

Cornerstone Community Site

The Cornerstone Community site is a Christian religious group campus site located on the south side of the Moulamein Road. The main building is a split level residential communal building. The site relies on levee protection by the private levee. The private levee protecting this site has minimal freeboard (0.1 metre) above the 100 year ARI flood level.

The lower most floor level of the split level communal main building is just above the 5 year ARI flood level (gauge height 4.5 metres). The upper most floor of the split level main building is 0.1 metre above the 100 year ARI flood level. The depth of 100 year ARI flooding around the building is approximately 0.9 metre in a 100 year ARI flood if the levee is breached or overtopped.

Modelling indicates that the adjoining Moulamein Road will remain free of flooding up to marginally in excess of the 100 year ARI flood.

Suggested Flood Response Actions:

- Issue warning that above floor flooding is possible in the event of a levee breaching once the flood level exceeds 4.5 metres at the Swan Hill gauge.
- Consider evacuating the site once the flood level reaches 4.7 metres at the Swan Hill gauge or upon any signs of private levee breaching due to structural failure.

Pickering Transport Group Site

This site located on the south side of the Moulamein Road includes offices and multiple storage buildings. The site relies on levee protection by the private levee. The private levee has minimal freeboard (0.1 metre) above the 100 year ARI flood level.

The storage buildings are at risk of flooding in the event of a levee breach and a 20 year ARI flood level (4.5 metres at Swan Hill gauge). The offices are not expected to flood unless a gauge height of 4.8 metres is exceeded.

Modelling indicates that the adjoining Moulamein Road will remain free of flooding up to the 100 year ARI flood.

Suggested Flood Response Actions:

- Issue warning that above floor flooding is possible in the event of a levee breaching once the flood level reaches 4.5 metres at the Swan Hill gauge.
- Consider evacuating the site once the flood level reaches 4.7 metres at the Swan Hill gauge or upon any signs of private levee breaching due to structural failure.

Wamba Wamba Community Site

The Wamba Wamba site is an indigenous residential community site. There are four houses located on the site which are elevated on a building pad approximately 0.5 metres above the 100 year ARI flood level. Other buildings on the site are located marginally above ground level and are at risk of above floor flooding if the private levee on the downstream side of the Moulamein Road was to breach or overtop. The adjoining private levee has zero freeboard above the 100 year ARI flood level. It is not an urban standard levee.

The depth of 100 year ARI flooding over the site is approximately 0.5 metre if the levee breaches. Modelling indicates that the adjoining Moulamein Road will remain free of flooding up to the 100 year ARI flood.Occupants are understood to have vacated the Wamba Wamba site during the recent February 2011 flood.

Suggested Flood Response Actions:

- Issue warning that above floor flooding is possible in the event of a levee breaching once the flood level reaches 4.5 metres at the Swan Hill gauge.
- Consider evacuating the site once the flood level reaches 4.7 metres at the Swan Hill gauge or upon any signs of private levee breaching due to structural failure.

Industrial Estate Site

The Industrial Estate site is located 800 metres east of the river on the north side of the Moulamein Road. The site is protected from flooding by the Moulamein Road and the private riverside levee north of the road.

The site is at some risk of flooding if the riverside private levee breaches. The depth of above ground 100 year ARI flooding at the site is up to 0.3 metre if the levee fails.

Modelling indicates that the adjoining Moulamein Road and Cygnet Lane will remain free of flooding up to the 100 year ARI flood.

Recommendations:

- Issue warning that above floor flooding is possible in the event of a levee breaching once the flood level reaches 4.6 metres at the Swan Hill gauge.
- Consider evacuating the estate once the flood level reaches 4.75 metres at the Swan Hill gauge or upon any signs of private levee breaching due to structural failure.

Murray Downs Drive Residential Estates

The Murray Downs homestead does not rely on levee protection and is not subject to flooding in the extreme event modelled.

The estates in Murray Downs Drive (Kidman Reid Drive and Sandpiper Drive) are not at risk of above floor flooding up to at least the 100 year ARI flood. Murray Downs Drive and Moulamein Road remain free of flooding in a 100 year ARI flood. These areas do not rely on levee protection.

Recommendations:

- Issue warning that above floor flooding is possible for the lowest houses in the event of the flood level exceeding 4.8 metres at the Swan Hill gauge (yet to do this since records commenced in 1909).
- Consider evacuating the area once the flood level reaches 4.9 metres at the Swan Hill gauge (to prevent isolation by road).

Appendix C – Community Consultation

Murray Downs FRMS&P - Community Fact Sheet – July 2015

Murray Downs FRMS&P – Survey Questionnaire – July 2015

MURRAY DOWNS FLOOD PLAN
Floodplain Risk Management Study and Plan

Community Fact Sheet - July 2015

WAKOOL SHIRE naturally

ABOUT THE PROJECT

Wakool Shire Council has received a funding grant from the NSW Government to assist with the development of Floodplain Risk Management Plans for the townships of Barham, Murray Downs and Tooleybuc.

The NSW Government's Flood Prone Land Policy is aimed at providing solutions to existing flooding problems as well as ensuring that new development within flood prone areas is compatible with the prevailing flood risk and does not create additional problems.

Council has contracted consultants GHD to investigate river flooding impacts within the town areas at Barham, Murray Downs and Tooleybuc over the coming months and to assess floodplain management options. The findings will then be compiled into a Floodplain Risk Management Plan for each town.

The most severe floods at Murray Downs since 1900 have occurred in 1916, 1917, 1956, 1975 and 1993. The levee bank system present has limited the impacts of these past floods.

Parts of the levee system are not of a standard compatible with current urban levee standards. A Plan is therefore required which clearly outlines how the levee bank system and other floodplain issues are to be managed and funded in the future.

Council and GHD are committed to listening to the concerns and issues of the community and stakeholders. Throughout the study there will be opportunities for the local community and stakeholders to provide feedback during the project.

> ***'A Plan that clearly outlines how the levee bank system and other floodplain issues are to be managed and funded in the future is required.'***

FLOODPLAIN RISK MANAGEMENT COMMITTEE

Council has formed a Floodplain Risk Management Committee (FRMC) to oversee the preparation of the Floodplain Risk Management Plan. Members of this Committee include local community representative Councillor Ann Crowe.

The FRMC will provide a link between the flood study team and the community throughout the various stages of the project. The FRMC will meet regularly during the course of the project.

QUESTIONNAIRE

The project team is keen to learn from local residents when and where past flooding has occurred at Murray Downs. We are interested in how you and your property have been affected and how you prepare for a flood.

We are also interested in getting an understanding of your thoughts towards particular flood management options.

Attached is a survey questionnaire that all members of the community are being encouraged to fill out and return to Council. Your questionnaire and completed details will only be used by Council and its consultant and will not be released to other parties.

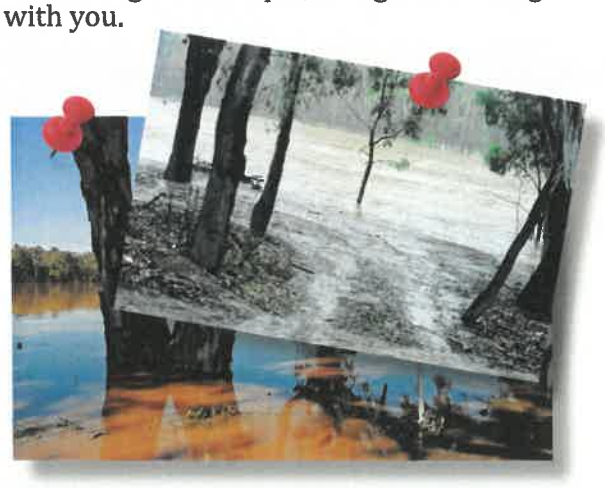
COMMUNITY FORUM

A community forum is to be held to provide residents with an opportunity to speak to the consultant's project manager and members of the FRMC in regards to any aspects of the project. The forum details are as follows:

The forum details are as follows:

4.00 to 7.00 pm,
Thursday 30 July 2015
Top Lounge, Murray Downs Golf Club

You can call in at any time during the session for as short or as long a time as you want and have an individual discussion with someone from the FRMC or the consultant. If you have any photographs of flooding for example, bring these along with you.



CONTACT DETAILS

Contact details are provided below if you have any questions concerning the project. You can also contact members of the FRMC to discuss any issues or concerns you may have relevant to the project.

GHD Project Manager
Trevor Clark
PO Box 992, Wodonga VIC 3689
P: 02 6043 8700
E: trevor.clark@ghd.com

Council Project Supervisor
Paul O'Brien
Private Bag 40, Moulamein NSW 2733
P: 03 5453 3200
E: paul.obrien@wakool.nsw.gov.com

Murray Downs Floodplain Risk Management Study and Plan
-Survey Questionnaire-

Name _____

Address _____

Telephone _____

Email _____

1. How long have you lived in Murray Downs? _____years _____months

2. Have you ever seen/experienced flooding at Murray Downs? Yes No

3. If yes, in what year and month did the flood take place?_____

4. What effects did the previous floods have on you and your property (e.g was your house flooded to above floor level, garage/carport/shed flooding, or grounds only flooding?)

_____

_____

5. How do you prepare for a flood?

_____

_____

6. To reduce the effects of flooding, do you believe Council should focus its efforts on:

	please tick if yes
• improved waterways and waterway structures (bridges/culverts/drainage)	☐
• maintaining/improving the levee bank system	☐
• educating people about how to prepare for a flood	☐
• improved flood warning and communication	☐
• encouraging residents to make property modifications (e.g house raising)	☐
• voluntary purchase of properties in high risk areas	☐
• improved development controls	☐
• all of the above	☐

Murray Downs Floodplain Risk Management Study and Plan
-Survey Questionnaire-

7. Are there any other issues you would like us to take into consideration?

Thank you for taking the time to complete this survey. If you would like to provide any further information, please attach it to the questionnaire.

Please return the completed questionnaire and any supporting information to:
Wakool Shire Council:
Private Bag 40, Moulamein NSW 2732
or email to mail@wakool.nsw.gov.au.

GHD

WAKOOL SHIRE COUNCIL

Appendix D – 100 Year ARI Flood Maps

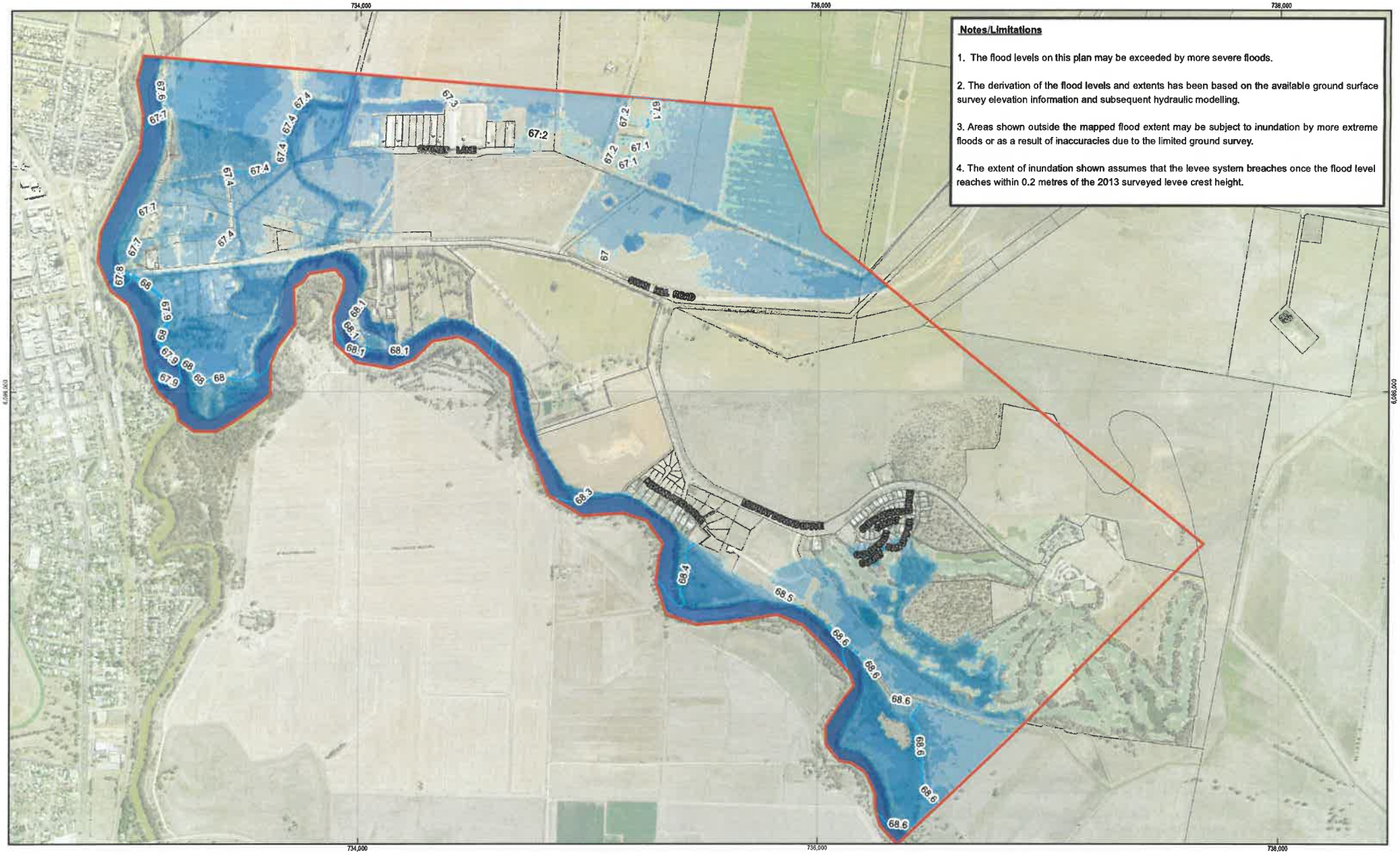
Figure D1 – 100 Year ARI Flood Extent and Depth – Levee Breach Scenario

Figure D2 - 100 Year ARI Flood Extent and Depth – Levee Intact Scenario

Notes:

Figure D1 - Levee Breach Scenario. This shows the extent of inundation assuming that the levee system breaches once the flood level reaches within 0.2 metre of the 2013 surveyed levee crest height.

Figure D2 - Levee Intact Scenario. This shows the extent of inundation assuming that the levee system remains intact with any flooding outside the levee system due to overtopping only.



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- < 0.10
- 0.10 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 4.00
- > 4.00
- Flood Level Contours (mAHD)
- Study Area Boundary
- Cadastre

Murray River Council
Murray Downs Floodplain Risk Management Plan

Job Number 31-32610
Revision 0
Date 24 Jan 2017

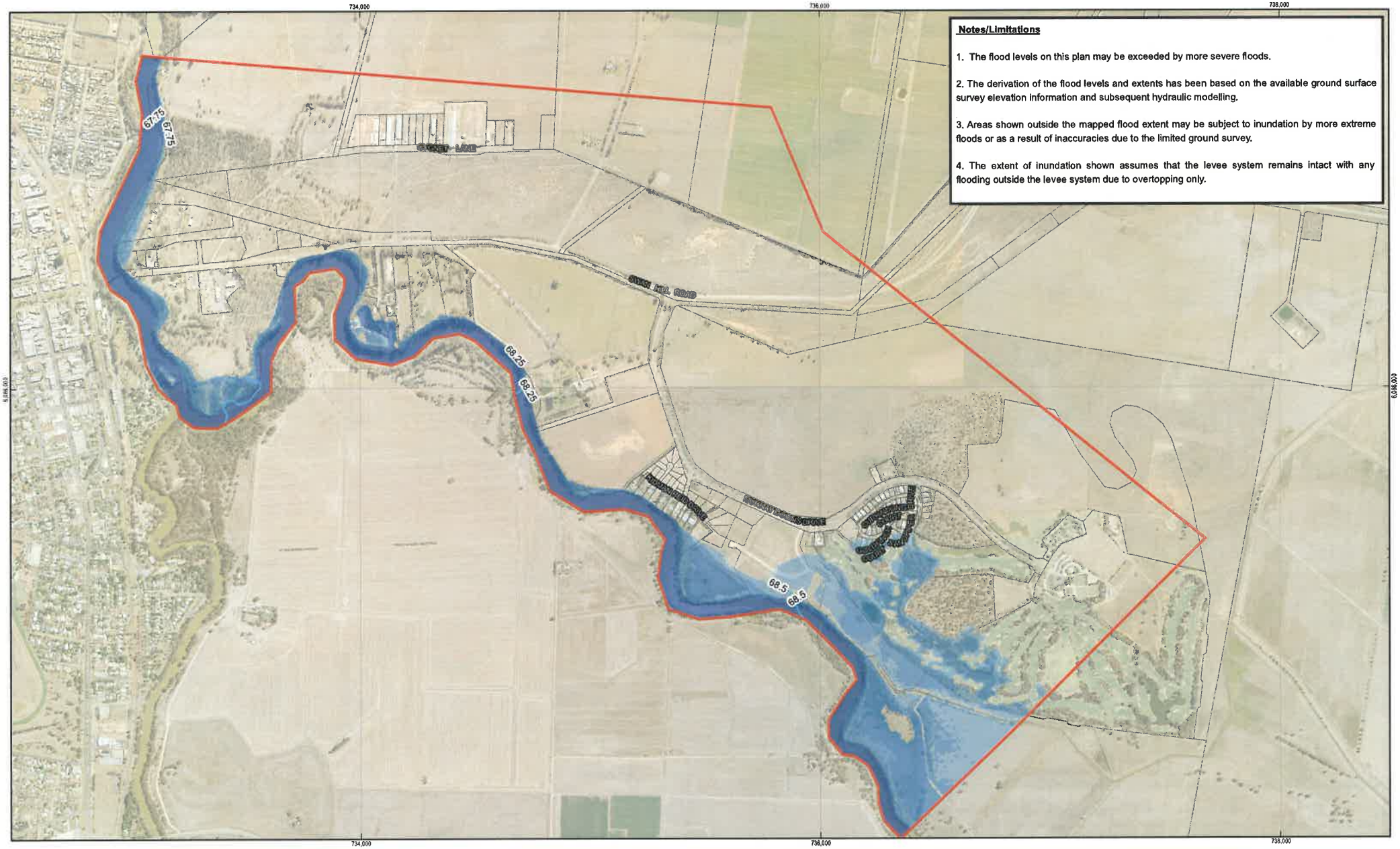
100 Year ARI Flood Event
Levee Breach Conditions

Figure D1

G:\31\32610\GIS\Maps\Deliverables\31_32610_MurrayDowns_FRMP_Fig_D1_Rev_0.mxd

Data source: GHD, Flood Extents and Contours, 2015; Wakool Shire Council, Aerial Imagery, 2013; LPI, DTDB & DCDB, 2012. Created by:sldouglas

Suite 5, 105 Hume Street, Wodonga, VIC 3690 Australia T 61 2 6043 8700 F 61 2 6043 8701 E melmail@ghd.com W www.ghd.com



Notes/Limitations

1. The flood levels on this plan may be exceeded by more severe floods.
2. The derivation of the flood levels and extents has been based on the available ground surface survey elevation information and subsequent hydraulic modelling.
3. Areas shown outside the mapped flood extent may be subject to inundation by more extreme floods or as a result of inaccuracies due to the limited ground survey.
4. The extent of inundation shown assumes that the levee system remains intact with any flooding outside the levee system due to overtopping only.

Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- < 0.10
- 0.10 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 4.00
- > 4.00
- Flood Level Contours (mAHD)
- Study Area Boundary
- Cadastre

Murray River Council
Murray Downs Floodplain Risk Management Plan

Job Number 31-32610
Revision 0
Date 24 Jan 2017

100 Year ARI Flood Event
Levee Intact Conditions

Figure D2

G:\31\32610\GIS\Maps\Deliverables\31_32610_MurrayDowns_FRMP_Fig_D2_Rev_0.mxd

Data source: GHD, Flood Extents and Contours, 2015; Wakool Shire Council, Aerial Imagery, 2013; LPI, DTDB & DCDB, 2012. Created by:sidouglas

Suite 5, 105 Hume Street, Wodonga, VIC 3690 Australia T 61 2 6043 8700 F 61 2 6043 8701 E melmail@ghd.com W www.ghd.com

GHD

105 Hume Street
Wodonga VIC 3690 Australia PO Box 992
T: 61 2 6043 8700 F: 61 2 6043 8711 E: abxmail@ghd.com

G:\31\32610\WP\8260 Murray Downs.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	T Clark	R Berg		R Berg		30/3/2016
B	T Clark	R Berg		R Berg		28/6/2016
C	T Clark	R Berg		R Berg		7/9/2016
0	T Clark	R Berg		R Berg		30/1/2017

www.ghd.com