

Stanton Grant Legal
215 Mitchell Road, Kialla

Flood assessment report for Investigation Area 1




23 June 2017

V1177_001

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JOB NO. AND PROJECT NAME: V1177_001 215 Mitchell Road					
DOC PATH FILE: V:\Projects\V1177 Basic Property Holdings\V1177_001 215 Mitchell Rd Flood Advice\07 Deliverables\Documents\Report\Revisions\Engeny Report 215 Mitchell Road V1177_001 23 June 2017 client issue.docx					
REV	DESCRIPTION	AUTHOR	REVIEWER	APPROVED BY	DATE
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Signatures					

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1. INTRODUCTION

This report has been commissioned by Stanton Grant Legal on behalf of Basic Property Holdings Pty Ltd. Basic Property Holdings are the owners of 215 Mitchell Road, Kialla.

This report addresses issues related to flooding and the Area 1 Investigation Area defined by the City of Greater Shepparton.

1.1 Author Details

1.1.1 Name and Address

Andrew Prout

Suite 15, 333 Canterbury Road

Canterbury, Victoria, 3126

1.1.2 Qualifications

Andrew Glen Prout has the following qualifications and professional memberships:

Education

Bachelor of Engineering (Civil), Swinburne Institute of Technology, 1984

Postgraduate Diploma in Management Studies, Melbourne University, 1992

Registrations/Affiliations

Member, Institution of Engineers, Australia

Member, College of Civil Engineers, I.E. Aust.

1.1.3 Experience and Expertise of the Author / Reviewer

Andrew is a Senior Principal Engineer in the Melbourne branch of Engeny Water Management (Engeny). Andrew has gained more than 30 years professional experience both in the consulting engineering field and with government and semi-government authorities. Andrew is a leader in the surface water management field, having updated Melbourne Water's Drainage Design Guide and having lectured at university level. Andrew's has extensive experience in the design and construction of retarding basins, wetlands, and drainage works. Andrew is also highly experienced in flood mapping, hydrology, hydraulics, water sensitive design and waterways. Andrew is familiar with the changes in flooding policies and procedures and drainage design standards in Victoria over the years and the standards, policies and other issues related to master planning, flooding and urban drainage.

Andrew has undertaken expert witness work for a number of clients, including Melbourne Water, Southern Rural Water, Goulburn Murray Water, Councils and landowners.

Andrew has prepared this report and reviewed all of the inputs to the report. A CV with more details regarding Andrew's experience is included in **Appendix A** (Andrew Prout CV).

This report has been reviewed in accordance with Engeny's Quality Assurance system.

This report was reviewed by Glenn Ottrey who is a senior environmental engineer with Engeny. Glenn is a specialist flood modeller and flood management engineer. Glenn also assisted in the preparation of this report in terms of extracting information from flood models, running models and preparing plans.

1.2 Subject Site

Basic Property Holdings are the owners of 215 Mitchell Road, Kialla. The location of the property is shown on the plan in **Appendix B** (site locality plan).

2. INSTRUCTIONS

Instructions were received from Stanton Grant Legal. A copy of the instructions is provided in **Appendix C** (instructions).

3. REFERENCE DOCUMENTS

Documents were provided to Engeny by Stanton Grant Legal and Lachlan Watts. These documents were:

1. Aerial photographs (with date and time stamps) of the 1993 flood in the area (see **Appendix D** (composite 1993 flood photograph) which provides the composite aerial flood photograph from 6 October 1993 produced by HydroTechnology).
2. Investigation Area 1 – Model of Flood Behaviour Report – July 2016, Water Technology for City of Greater Shepparton.
3. Goulburn Valley Harness and Greyhound Racing Precinct Feasibility Study and Master Plan, City of Greater Shepparton, July 2016.
4. Information from Water Technology, including:
 - Flood hydrographs used to input flows into the Investigation Area 1 TUFLOW models for both the 1993 and 1 % AEP flood
 - TUFLOW flood model for Investigation Area 1 for the 1993 flood
 - TUFLOW flood model for Investigation Area 1 for the 1 % AEP flood
 - TUFLOW model results for the Shepparton – Mooroopna regional flood model showing the maximum flood extents for the 1993 flood.
5. Shepparton – Mooroopna, Designation of Flood Levels Plan – by Sinclair Knight Merz and Lawson & Treloar for City of Greater Shepparton and Goulburn Broken Catchment Management Authority. See plan (first page in Appendix E) and blown up section of plan covering Investigation Area 1 in **Appendix E** (designated flood level plans).
6. Guide to Expert Evidence – April 2015.
7. Copies of affidavits by S. Fichera, M. Lorenzini and G. Lorenzini regarding the 1993 flood.
8. Copy of correspondence from the Goulburn Broken CMA to the City of Greater Shepparton dated 4 November 2015 (GBCMA reference F-2015-0379) related to Investigation Area 1 and the status of the existing flooding controls in the Planning Scheme.
9. Copy of a letter dated 4 September 2016 from City of Greater Shepparton discussing how Council proposed to manage flooding related work and the Planning Scheme in the area.

Engeny also sought and obtained the following information:

1. Flood gauge data for the Seven Creeks gauge located on the subject property
2. Current planning scheme zone information and planning scheme overlay information.

4. ASSESSMENT

In undertaking my assessment for this report I have:

- Visited the site and surrounds
- Reviewed supplied information
- Sought and reviewed further information
- Overseen flood modelling using the supplied models and adjusted as described in this report, and
- Responded to my instructions.

4.1 Site Visit

A site visit was undertaken to the subject site on 31 January 2017. Andrew was accompanied on the inspection of the subject site by Gordon Hamilton, representing the owner. Andrew also undertook inspection of other areas within and adjacent to the subject site. Some photographs from the site visit are provided below.



Figure 4-1 Seven Creeks at Goulburn Valley Highway looking south



Figure 4-2 **Seven Creeks upstream side of Goulburn Valley Highway looking south**



Figure 4-3 **Seven Creeks Gauging Station on Subject Site, from Mitchell Road**



Figure 4-4 **Seven Creeks Gauging Station on Subject Site**

The Seven Creeks Gauging Station is located on the property at 215 Mitchell Road and records flood levels.



Figure 4-5 **Seven Creeks from Mitchell Road looking downstream into Subject Site**



Figure 4-6 **Seven Creeks and Mitchell Road bridge at Subject Site**



Figure 4-7 **Subject Site, looking east, Seven Creeks on the right**



Figure 4-8 Main Channel No. 6 from Goulburn Valley Highway looking east

4.2 Assessment work undertaken

In undertaking this assessment we have:

- Reviewed information provided, including:
 - Aerial photographs (with date and time stamps) of the 1993 flood in the area
 - Investigation Area 1 – Model of Flood Behaviour Report – July 2016, Water Technology for City of Greater Shepparton
 - Goulburn Valley Harness and Greyhound Racing Precinct Feasibility Study and Master Plan, City of Greater Shepparton, July 2016.
- Visited the site and surrounds with Gordon Hamilton on 31 January 2017.
- Obtained and reviewed flood gauge data for the Seven Creeks gauge located on the subject property.
- Obtained and plotted current planning scheme zone information and planning scheme overlay information.
- Sought and obtained additional information from City of Greater Shepparton and their consultants (Water Technology) including flood models used to produce the results in the supplied reports.

- Confirmed with Water Technology that we were correctly using all of the flow data that they used for the 1993 and 1 % AEP flood models for Investigation Area 1 and that there were no inflows or other details that had not been included (see email, **Appendix F** (email from Water Technology)).
- Run the Water Technology flood model for the 1993 flood and compared details in the model with the actual flooding that was recorded by the aerial photographs and stream gauge in 1993 in the southern part of Investigation Area 1 (including the subject property).
- Run the Water Technology flood model for the 1993 flood and compared details in the model with the actual flooding that was recorded by the aerial photographs and stream gauge in 1993 in the northern part of Investigation Area 1.
- Run the Water Technology flood model for the 1 % AEP flood event to reproduce the flood results published in the Area 1 Investigation Report to ensure that we are using the models as intended by Water Technology.
- Run the 1993 flood model with adjustments to better match the model to the observed flooding for the southern part of Investigation Area 1, including Seven Creeks through our clients land.
- Used the adjusted flood model for the 1 % AEP flood event to better represent the flood results for the southern part of Investigation Area 1, including Seven Creeks through our clients land.
- Used the adjusted flood model 1 % AEP results and applied the appropriate guidelines for delineating LSIO and FO areas for the southern part of Investigation Area 1, including Seven Creeks through our clients land.

Note that our work has not included any adjustments to the hydrology provided by Water Technology for the catchments either for the 1993 flood or the 1 % AEP flood event. Note that our work has not included an independent assessment of the hydrology for the catchments either for the 1993 flood or the 1 % AEP flood event.

4.3 Findings

I have divided our findings into the following sections:

- Comparison of the Water Technology model and the records of the actual flood for 1993 for the Southern part of Investigation Area 1 (south of the existing harness racing and greyhound facilities), including our client's property at 215 Mitchell Road.
- Comparison of the Water Technology model and the records of the actual flood for 1993 for the Northern part of Investigation Area 1.
- Consideration of suitable 1% AEP flood results for the Investigation Area.

- Consideration of potential updates to the flood overlays for the Southern Part of Investigation Area 1.
- Consideration of the suitability of the proposed Master Plan development for the Investigation Area in relation to flooding.

4.3.1 **Modelling of the 1993 flood for the Southern part of Investigation Area 1**

In relation to the southern part of Investigation Area 1 we note that this includes our client's property and Seven Creeks. In this area we found:

- The peak gauge height in the Water Technology report agrees with the records from the Seven Creeks at Kialla West gauge. The peak gauge height occurred at 12 noon on 5 October 1993.
- The Seven Creeks at Kialla West flood gauge data did not include flows (the data contained codes that state that the flood levels were above the rating curve).
- We have not been provided with any information on how Water Technology derived the 1993 flood flows that they have used in their modelling. We have asked Water Technology for more information and no more information has been made available to date.
- In their report (page 4) Water Technology quotes the peak flood flows at the Seven Creeks at Kialla West gauge on the subject property as:
 - 718 m³/s for the 1993 flood event
 - 834 m³/s for the 1 % flood.
- Also on page 4 of their Investigation Area 1 report Water Technology state that the aerial photographs from 1993 require careful consideration and that the information from the photographs and the gauge were used to validate their flood model.
- The Sevens Creek at Kialla West gauge height at 12 noon on 5 October 1993 at the peak of the 1993 flood was 8.234 m, which is a level of 115.058 m AHD.
- The Seven Creeks at Kialla West gauge peak flow at 12 noon on 5 October 1993 was estimated by Hydrotechnology to be 62,000 ML/day. This flow is provided on the Hydrotechnology composite 1993 flood photograph (see tabulation on plan in **Appendix D**). A flow of 62,000 ML/day converts to a flow of 718 m³/s, which is the same as the peak flow quoted by Water Technology. Note that Water Technology adjusts this flow in their 1993 flood model as described below.
- We have reviewed the flows used as inputs to the Water Technology model for the 1993 flood and note:

- Flood hydrographs are input to the flood model at three locations, as shown on the plan produced from information supplied by Water Technology in **Appendix G** (plan of TUFLOW model extent and inflow locations).
- In the 1993 event we were provided with two identical hydrographs each with a peak of 359 m³/s:
 - One of the 359 m³/s hydrographs is applied by Water Technology as an inflow to Honeysuckle Creek marked as inflow 1 in **Appendix G**.
 - The other 359 m³/s hydrograph is split and applied as inflows to Sevens Creek marked inflow 2 and 3 in attachment 5. Inflow 2 received 56.5 % of the 359 m³/s hydrograph and inflow 3 also receives 56.5 % of the 359 m³/s hydrograph. This is a total increase in flow of 13 % for Sevens Creek and increases the flow compared with the flow quoted by Hydrotechnology for the 1993 flood.
 - The TUFLOW model records a peak flow rate in the 1993 event of 780 m³/s just upstream of Mitchell Road.
- In the 1 % AEP event there is a different flow split in the information provided by Water Technology to that used in the 1993 event, as follows:
 - Honeysuckle Creek (inflow 1 in **Appendix G**) has a hydrograph with a peak inflow of 504 m³/s.
 - The inflow on Sevens Creek is split into inflow 2 and inflow 3 each of which receive 56.5 % of a hydrograph with a peak flow rate of 399 m³/s. The inflow hydrographs for Sevens Creek in the TUFLOW model are therefore increased by a total of 13 %.
 - The TUFLOW model records a peak flow rate in the 1 % AEP event of 965 m³/s just upstream of Mitchell Road.
 - We have not been provided with any information as to how this different flow split was determined.
- The Water Technology 1993 flood model estimates a peak flood level approximately **135 mm** higher than the gauged flood level for the Seven Creeks at Kialla West gauge on the site.

It is unclear to me as to why Water Technology has increased flows by 13% for Seven Creeks. This increase has meant that the inflow to the 1993 model does not match the actual 1993 flow from Hydrotechnology. Water Technology has not provided any justification or information to explain this increase in flow for Seven Creeks.

We have produced a plan which demonstrates the differences between the Water Technology modelling of the 1993 flood and the actual flooding in 1993 on the Southern part of Investigation Area 1 (including the property at 215 Mitchell Road). **Appendix H** (southern area 1993 flood photograph with Water Technology 1993 flood extent) shows the Water Technology model flood extent at 14:00 on 6 October 1993 overlaid onto the aerial photograph taken at 14:25 on the same day.

These images are not at the time of the peak of the 1993 flood, which occurred on the previous day, but the modelled flood extent shown on **Appendix H** is taken from the Water Technology model at virtually the same time as the photograph was taken. The image in **Appendix H** clearly shows that the Water Technology flood model is over estimating the flood extent at this point in time.

The Water Technology 1993 flood model for the Southern part of Investigation Area 1 overestimates the extent and depth of flooding compared with the flooding that was recorded in 1993.

To get the Water Technology 1993 TUFLOW flood model peak flood level to match the actual recorded peak flood level in 1993 for the southern part of Investigation Area 1 would require either a reduction in the flood flows and/or a reduction of surface roughness factors used in their TUFLOW model. Given the complexity of the hydrology and the information that Engeny has been provided, we adjusted the Mannings n roughness factors in the TUFLOW model rather than adjusting the flows.

The Victorian Flood Strategy requires that flood studies “*model the hydraulic behaviour of floods – including flood heights, extents and velocities as they vary with time – calibrated against historical floods*”. To achieve a better calibration to the 1993 flood Engeny adjusted the roughness factors¹ to obtain a match between the 1993 model peak flood level and the actual 1993 gauged peak flood level. The roughness parameters used by Water Technology and Engeny are provided in **Table 4-1** and the results are provided in **Table 4-2** below.

Table 4-1 **Roughness Factors**

Land Use / model material definition	Water Technology Mannings n roughness value	Engeny adjusted Mannings n roughness value
"Medium Density Vegetation"	0.070	0.060
Main Channel (1d channel in flood model)	0.060	0.055

Appendix I (TUFLOW materials layer plan) provides a plan that shows the areas covered by the various roughness factors (TUFLOW “materials”).

¹ Engeny has not adjusted the extents of different land uses (TUFLOW model materials layer) in the flood model

Table 4-2 1993 flood model results

Result	Water Technology Result	Engeny adjusted result
Peak modelled flood level at gauge (difference from actual recorded value)	115.187 (+135 mm)	115.052 (-6 mm)

As can be seen from the flood levels in the Table above the 1993 flood model adjusted by Engeny better matches the peak 1993 flood level at the Kialla West Seven Creeks gauge.

Summary regarding the 1993 flood modelling for the Southern Part of Investigation Area 1

The Water Technology 1993 flood model for the Southern part of Investigation Area 1 overestimates the extent and depth of flooding compared with the flooding that was recorded in 1993.

My opinion is that a flood model that is calibrated to historic observed flooding (similarly to how Engeny has adjusted the Water Technology model to match the observed 1993 flood) would be a suitable basis for assessing development footprints in the southern part of Investigation Area 1. Once the calibrated model is suitably reviewed it could then be used to assess development options using a similar approach to that used by Water Technology in Section 3 of their report.

4.3.2 Modelling of the 1993 flood for the Northern part of Investigation Area 1

In relation to the Northern part of Investigation Area 1 we note that this includes areas where significant development is proposed in Council's Master Plan. In this area we found:

- There was significant flooding in this area in 1993, as shown by the aerial photograph taken on the afternoon of 6 October 1993, which was over 24 hours after the peak flood levels occurred in Seven Creeks (see **Appendix J** (northern area 1993 flood photo and Water Technology Area 1 TUFLOW extent).
- Water Technology provided Engeny with their 1993 Investigation Area 1 TUFLOW model that included this area that was used for the flood maps in their Area 1 Investigation area report. The Water Technology flood model showed almost no flooding in the Northern part of the precinct in the 1993 event as also shown on **Appendix J**.
- The contrast between the photographed flood extent and the Water Technology model flood extent as shown on the plan in **Appendix J** is very significant. The plan in **Appendix J** clearly shows the unsuitability of the Water Technology flood and clearly

shows that the Water technology flood model has not been calibrated to the historical flooding in this area.

- Please note that the flood extent on **Appendix J** is actually conservative compared with the flood extent on the photograph in that it shows the flood photograph from the afternoon of 6 October compared with the maximum flood extent from the model. The flooding predicted by Water Technology at the peak of the 1993 flood was for no flooding in the Northern part of the precinct. This is from the Investigation Area 1 model that is then used by Water Technology to model the 1 % AEP flood and to recommend the areas for development in the area.
- Water Technology also provided Engeny with their 1993 maximum flood model extents from their Shepparton Mooroopna regional flood model (that included the Broken River). **Appendix K** (northern area 1993 flood photo and Water Technology Regional Model TUFLOW extent) shows the maximum 1993 modelled flood extent from the Water Technology regional flood model from the peak of the flood compared with the actual flood photograph taken on the afternoon of 6 October 1993.
- Water Technology acknowledges (on pages 4 and 7) that there may be local rainfall and runoff that is not represented in their models. This lack of inclusion of local flows in a regional study that is focussed only on flooding controls associated with the major waterways is understandable if the results provide a good match to observed flooding for the main waterways and the results are only used for the main floodplain areas. In this case the Investigation Area 1 model is being used to set flood extents, development areas and their impact on flooding behaviour for the local tributary for the northern part of the Investigation Area.
- **Appendices J and K** clearly show that the Water Technology models seriously underestimate the flooding in the Northern part of the precinct.
- Engeny has highlighted a number of areas in the Northern part of Investigation Area 1 that are significantly flooded in 1993, but are proposed for development in the Master Plan. These areas are labelled as areas **A, B and C** on the plans in **Appendix L**.
- **Appendix L** shows side by side plans of the Investigation 1 area, the left hand side shows the proposed development Master Plan with other information and the right hand side shows the same area with the 1993 aerial flood photograph.
- Areas B and C on **Appendix L** were flooded to depths of 200 to 250 mm at the time of the aerial photograph taken in 1993. These depth estimates are based on using the ground levels from the Digital Elevation Model (DEM) supplied by Water Technology (we understand that Water Technology produced their DEM from DELWP supplied LiDAR survey) and measuring flood levels at the time of the photograph in 1993 based on ground levels where the photographed flood extents meet ground level.

- Measured flood levels at the time of the 1993 flood photograph in Areas B and C were approximately 114.30 m AHD compared with ground levels in the range of 114.05 to 114.10.
- Given that the aerial photograph was not taken at the peak of the flood we would expect that the peak flood depths in Areas B and C in 1993 were greater than 200 to 250 mm.

Summary regarding the 1993 flood modelling for the Northern Part of Investigation Area 1

Appendices J and K clearly show that the Water Technology models seriously underestimate the flooding in the Northern part of the precinct.

In my opinion the differences between the Water Technology modelling of the 1993 flood and the actual flooding in 1993 are so different that the Water Technology modelling cannot be relied upon to make flood management decisions in the Northern part of Investigation Area 1.

4.3.3 Suitable 1% AEP flood results for the Investigation Area

It is worth highlighting that while the 1993 flood was a very large flood event it was not equal in magnitude to a 1 % AEP flood, according to the analysis undertaken by Water Technology. Water Technology advise that the 1 % AEP flood event will be a bigger flood event which will inundate more land than the 1993 flood. The 1 % AEP flood is the reference event that will be used for all planning decisions.

For the Northern part of Investigation Area 1 Engeny has not attempted to produce 1 % AEP flood results. This is due to the lack of available inflow data to be able to replicate the 1993 flooding. My opinion is that further hydrologic work needs to be undertaken to replicate the 1993 flooding for the Northern part of Investigation Area 1 and that only then can this work be used as the basis for estimating 1 % AEP existing conditions flooding.

For the Southern part of Investigation Area 1 we have used the adjusted flood model as discussed in Section 4.3.1 above to provide an estimate of the flooding in the 1 % AEP flood. **Appendix M** (southern area Engeny adjusted 1 % flood plan) provides a plan of the southern part of the precinct that shows the 1 % AEP flood results from the adjusted model, including the flood extent and depths. My opinion is that this may provide a flood map and flood model that could be suitable for use to represent the 1 % AEP flood in this area as the model matches the recorded flooding in 1993².

² Use of this adjusted modelling by Engeny would require further review and consultation by various stakeholders prior to any changes being introduced to the Planning Scheme

4.3.4 Potential updates to flood overlays for the Southern Part of Investigation Area 1

There are aspects of making updates to flooding controls in planning schemes that are outside my area of expertise, as I do not have qualifications in Planning or Law. This section of my report is intended to relate only to my experience and expertise in relation to undertaking flood studies in my role as an engineer in the overall process.

The current planning scheme has flooding controls for the area that include:

- Floodway Zone
- Floodway Overlay; and
- Land Subject to Inundation Overlay.

The plans in **Appendix E** show the current flood related planning controls.

In Section 3.6 of their report Water Technology contemplate adjustments to the flood overlays compared with the current overlays based on their Investigation Area 1 report.

My understanding in relation to the work required to support a planning scheme amendment is that the work done by the City of Greater Shepparton and Water Technology may not have fully complied with the requirements to make a planning scheme change. According to the Victorian Floodplain Management Strategy (Part 11.1) a flood study must seek to:

- *“model the hydrologic inputs – including rainfall and runoff – that leads to floods of different sizes and calibrate these models against historic floods*
- *model the hydraulic behaviour of floods – including flood heights, extents and velocities as they vary with time – and calibrate these models against historical floods*
- *understand the varying hydraulic nature of the floodplain being studied*
- *understand the varying flood hazards within the floodplain*
- *assess the scale of potential flood damages for the existing community*
- *assess the potential for flood damage on areas of the floodplain that may be considered for future development*
- *analyse risk treatment options*
- *consult with local communities to take advantage of local knowledge*

- *consult with local Aboriginal communities to ensure cultural values are considered in assessing and mapping flood risks*
- *assess the consequences of floods of different sizes*
- *capture the local community's experience and knowledge of floods.*

Flood study outputs must be capable of being used by a variety of stakeholders. They are useful only if individuals, communities, government agencies and other organisations have access to, can understand, and act on high-quality information about the risks of flooding. The outputs should be integrated into the relevant flood database, where they can be readily accessible.

From the documents that I have reviewed I have not seen evidence that all of the steps required by the Victorian Floodplain Management Strategy have been undertaken in this case. Furthermore my experience is that prior to adopting a flood study for incorporation into a planning scheme that:

- The flood modelling and resulting flood maps and flood study report would be reviewed and approved for use for a planning scheme amendment by the Catchment Management Authority
- The flood modelling and resulting flood maps and flood study report would be reviewed and approved for use by the Department of Environment Land Water and Planning (DELWP). My understanding is that DELWP has an independent external technical review undertaken as part of their review.

I have not sighted any documentation that confirms that the work presented in the Investigation Area 1 – Model of Flood Behaviour Report has been approved by DELWP for use to amend the Planning Scheme.

If a flood study was completed in accordance with all of the appropriate procedures then a revised set of flood controls could be considered for Investigation Area 1. My view is that the flood report prepared by Water Technology and the work undertaken for Investigation Area 1 may not be sufficient on which to base a change to the flooding controls in the Planning Scheme.

Despite the limitations on the existing flood study I have considered an aspect of Water Technology's recommendations in relation to the delineation of proposed changes to LSIO and FO controls that would impact our client's property. The criteria used for the delineation of the boundary between LSIO and FO is important as it is likely to effect the location and extent of areas that could be developed within Investigation Area 1 as discussed later in this report in Section 4.3.5.

Water Technology (Section 3.6 of their report) referred to the current DELWP Practice Note on Applying Flood Controls in Planning Schemes (2015) in considering how the flooding in Investigation Area 1 could be delineated between Floodway Overlay (FO) and

Land Subject to Inundation Overlay (LSIO). The DELWP Practice Note considers a number of factors, concluding that a depth of 500 mm is an appropriate cutoff in this situation.

Water Technology then instead chose to apply the “new” Australian Rainfall and Runoff, specifically “Project 10, Appropriate Safety Criteria for People” instead of applying the DELWP Practice Note. The Project 10 document is a 2010 paper that was produced for discussion purposes during the development of what has become Australian Rainfall and Runoff 2016. The Project 10 report included similar provisions as those contained in the Melbourne Water Guidelines for Development in Flood Prone Areas (October 2008) limits related to safe depths of flow in urban roads instead of the considerations in the DELWP Guidelines.

This resulted in Water Technology recommending that an FO planning control should be applied to all land where the 1 % AEP flood depth is greater than 300 mm.

Water Technology claim that the industry is heading towards the depth and velocity limits in the Project 10 publication (and the Melbourne Water Guidelines) yet the DELWP Guideline is five years newer than the reference used by Water Technology and is also more relevant. The most recent published guideline related to the velocity and depth of floodwater and the hazard to the community is not the Project 10 publication, but rather it is Book 6, Chapter 7 of Australian Rainfall and Runoff 2016. However, like the Project 10 publication and the 2008 Melbourne Water Guideline, this publication does not consider the depth and/or velocity of floodwater that should be applied to delineating the difference between floodway and land subject to inundation planning controls.

My opinion is that Water Technology has misinterpreted the Project 10 publication (and the Melbourne Water Guideline) and that they have quoted a superseded reference related to safe limits in areas after development has occurred, rather than using a guideline that refers to the rural depth of flooding that informs planning authorities in relation to the application of FO versus LSIO controls for future land development.

Overall the most recent published guidance for the delineation of floodway areas is the DELWP 2015 Practice Note. Engeny considers that to define the boundary between LSIO and FO that the City of Greater Shepparton and Goulburn Broken CMA should apply the current DELWP Practice Note and adopt a depth limit of 500mm in a 1 % AEP flood to the define the boundary between LSIO and FO.

Engeny has produced a map that shows the 1 % AEP flood from our adjusted flood model, using the current DELWP Practice Note method to delineate the areas between LSIO and FO. We also note that the planning scheme has an area of Floodway Zone (FZ) along Seven Creeks through the subject site. We have not adjusted the FZ area.

Appendix N (southern area Engeny adjusted FO and LSIO plan) is a plan of the southern part of the precinct that shows:

- The existing Floodway Zone

- Potential FO area based on the adjusted 1 % AEP flood model and the DELWP Practice Note
- Potential LSIO area based on the adjusted 1 % AEP flood model and the DELWP Practice Note.

We note that the plans presented in **Appendix N** would have to be subject to consultation and review prior to being considered for use in amending the Planning Scheme.

4.3.5 Suitability of the proposed Master Plan for Investigation Area 1 in relation to flooding

From my consideration of all of the issues raised in this report I have considered the proposed Investigation Area 1 Master Plan and how it may need to be reconsidered based on my assessment of the flooding issues.

I have identified a number of areas that are shown to be developed in the Master Plan that are expected to experience significant flooding that may make the areas incompatible with urban development, other than for flood storage / stormwater management. These areas are marked as areas **A, B, C and D** on the plan in **Appendix L**. Given that Water Technology has stated that a 1 % flood in the area would exceed the 1993 flood we would expect that the depths in these areas in a 1 % AEP flood would be deeper than they were in 1993.

Figure 1-3 in the Water Technology report maps flood depths of zero to 300 mm in Areas A, B and C for the existing conditions 1 % AEP flood.

Based on the current designated 1 % AEP flood level of approximately 114.70 shown on the plans in **Appendix E** and ground surface levels of 114.05 to 114.10 in Areas B and C, we estimate that 1 % AEP depths in Areas B and C could be up to 600 to 650 mm in a 1 % AEP flood. These depths exceed 500 mm and if correct would indicate to me that these areas may appropriately be designated as FO areas in the Planning Scheme and may also not be suitable for urban development.

I have also identified some areas shown in the Master Plan that the Master Plan states as only being suitable for Potential Recreation Equine Use and/or Flood Plain Cut Area for Fill. This includes substantial areas in the Southern part of Investigation Area 1 that in my opinion would only be flooded to shallow depths (not FO) in a 1 % AEP flood and could therefore potentially be developed for urban purposes. Determining the actual extent of urban development would depend on an impact assessment similar to that described in section 3 of the Water Technology reports. The areas on the Southern part of the Investigation Area that could be considered for urban development (based on flooding criteria) are shown as **Areas X and Y** on the plan in **Appendix O** (Southern area potential extra development areas).

5. CONCLUSION

The Victorian Flood Strategy requires that flood studies “*model the hydraulic behaviour of floods – including flood heights, extents and velocities as they vary with time – calibrated against historical floods*”. This aligns with my view that for flood studies to be accurate and credible that they should be based on models that represent what really happens when floods occur. My view in this matter is that there are some aspects of the Water Technology report that do not sufficiently meet this requirement.

In relation to the results of our investigations I conclude that:

- Water Technology made adjustments to the flood hydrology for flows into the Seven Creeks system as described in Section 4.3.1 of this report, which are not explained in the Water Technology report.
- The Water Technology flood model for the 1993 flood overestimates the extent and depth of flooding in the Southern part of Investigation Area 1.
- Engeny has adjusted the roughness factors in the flood model to get the flood model to better match the actual gauged flooding in 1993 in the Southern part of Investigation Area 1.
- Engeny has used the adjusted flood model for the 1 % AEP flood in the southern part of Investigation Area 1 and has considered potential new FO and LSIO extents in this area.
- Engeny has identified potential additional areas of development for the southern part of Investigation Area 1 using the adjusted 1 % AEP flood model. These areas are shown as Areas **X** and **Y** on the plan in **Appendix O**.
- Engeny has identified that the Water Technology modelling significantly underestimates the flooding in the northern part of Investigation Area 1.
- The differences between the Water Technology modelling of the 1993 flood and the actual flooding in 1993 in the Northern part of Investigation Area 1 are so different that the Water Technology modelling cannot be relied upon to make flood management decisions in the Northern part of Investigation Area 1. These differences are clearly shown on the plan in **Appendix J**.
- Engeny has identified areas in the northern part of the Investigation Area 1 that are proposed for urban development and are in my opinion incorrectly shown by Water Technology as being flooded to depths less than 300 mm in the Water Technology report, but that are expected to be subject to flood depths of up to 650mm based on the current designated flood levels. These areas are shown as areas **A**, **B** and **C** on the plan in **Appendix L**.

6. STATEMENT

I have made all the inquiries that I believe are desirable and appropriate at this time and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

I have read the Planning Panel's Victoria "Guide to Expert Evidence" and agree to be bound by it.



Andrew Prout

BE Civil, PDMS, MIE Aust.

7. QUALIFICATIONS

- a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
- c. Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:
 - (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or
 - (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.
- d. Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.
- e. This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report.
- f. If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.
- g. This report does not provide legal advice.

APPENDIX A

Andrew Prout's CV

Andrew Prout

Senior Principal Water Resources Engineer

BE(Civil), PDMS, MIEAust



SUMMARY

Andrew established Engeny Water Management in Victoria and has gained more than 30 years professional experience both in the consulting engineering field and with government and semi-government authorities. Andrew is a leader in the surface water management field, having prepared Melbourne Water's current Drainage Design Guide and having lectured at university level. He has undertaken a number of drainage and flood studies as well as water conservation studies and projects to minimise the overall environmental footprints of projects. This included being project Director for the Werribee Plains Urban Water Conservation Study for the Australian Conservation Foundation.

Andrew has undertaken projects for a wide range of clients, including Councils, Melbourne Water, Catchment Management Authorities, Water Authorities, VicRoads, VicTrack and many public companies and land owners. He has also done work related to water issues for numerous major projects including Principal Surface Water designer or Peer Reviewer for Eastlink, Peninsula Link, Monash Upgrade, City Link as well as work on Federation Square, various windfarms, landfills, quarries and mines. His work has taken projects through all stages from studies to designs and construction.

Andrew has done a significant amount of work for local Councils over the last 20 years. This has included strategic drainage studies, preparation of drainage design guides, expert witness services, preparation of Development Contribution Plans and flood mapping. This work has covered most of the municipalities in Greater Melbourne, as well as a number of rural Victorian Councils, including Ballarat, Geelong, Corangamite, Warrnambool, Moyne, Moira, Bass Coast, Surf Coast and South Gippsland and some Councils in New South Wales and Queensland. He has spoken at conferences and made a number of professional presentations and been active in debates in the industry on topics such as water conservation, climate change impacts on water systems, urban flooding and catchment management. Andrew has provided professional advice to a wide variety of clients in a range of forums, including VCAT, Panel Hearings and court proceedings. His work in this area and in regional Victoria is summarised on the following pages

KEY AREAS OF EXPERTISE

- Flood mapping and Flood Mitigation
- Flood hazards and impacts on developments
- Coastal flooding and climate change impacts
- Wetlands and waterways
- Stormwater harvesting and water reuse
- Stormwater management and Water Sensitive Urban Design
- Drainage and stormwater treatment master planning and drainage schemes
- Surface water management for quarries and landfills
- EES and EIS work in relation to surface water, erosion and catchments

EXPERIENCE

Ballarat West PSP and DCP: City of Ballarat: Andrew and the team at Engeny were part of a large team that produced the Ballarat West Precinct Structure Plan and Development Contributions Plan for 1000 hectares in Ballarat. The work included catchment modelling for flooding and water quality and development of a master plan for development of the area. Andrew also prepared cost estimates for the works and produced an Expert Witness report for the Panel hearing for the Development Contributions Plan.

Marchington Avenue, Mornington, Flooding Related Expert Witness Report, Melbourne Water: In 2012 Andrew and his colleague Maria Verrocchi prepared a report related to a proposed residential development adjacent to Tanti Creek in Mornington. The report clearly described the flood hazards related to one of the proposed dwellings in terms of the Land Subject to Inundation and Floodway Overlays. Andrew presented the report at VCAT and Melbourne Water obtained a successful outcome.

Kerang / Dingwall Flooding Expert Witness project – Goulburn Murray Water: In 2013 Andrew undertook a detailed assessment of complex flooding patterns that occurred in 2011. The flooding was related to the catchments of the Loddon River and Wandella Creek and the interaction of the flood with the large floodplains and various infrastructure including roads, bridges, embankments, irrigation channels and syphons. Andrew also oversaw complex 2D flood modelling of the actual flood behaviour undertaken by his colleague Scott Dunn.

Toora Coastal Flood Risk Report, South Gippsland Shire. Andrew undertook a site review and prepared an Expert report for the South Gippsland Shire for a VCAT hearing in relation to six proposed dwellings in the Grip Road area in Toora. The report covered issues including local drainage and flooding, coastal flooding, sea level rise, climate change, wastewater disposal and related issues. Andrew gave evidence at VCAT which contributed to a successful outcome for the Shire and a report that has been referenced in various hearings and publications since the hearing.

Maribyrnong River Flood Hazard Report, Melbourne Water: In 2009 Andrew was engaged by Melbourne Water to provide a comprehensive report on flood hazards in the Maribyrnong Township in response to a development application. Andrew prepared a detailed report that covered historic flooding since 1870, flood warning systems and flood hazards and also provided expert witness services at a VCAT hearing. The work undertaken by Andrew was influential in a successful outcome for Melbourne Water.

Victorian Flood Review, Melbourne Water: Andrew was engaged by Melbourne Water to prepare a report that documented the roles of Melbourne Water and the Bureau of Meteorology in flood prediction and forecasting. The work involved liaison with Melbourne Water, Bureau of Meteorology, VicSES and production of a report in response to a recommendation from the Victorian Flood Review prepared by Neil Comrie.

Banyule Flood Mapping and Special Building Overlays, City of Banyule: Andrew and his colleague Paul Clemson have provided the City of Banyule with detailed advice regarding flood mapping of the flow paths associated with all of Councils drainage system. In addition to the flood mapping done by Paul and the team, detailed written advice in 2014 regarding how to determine process flood mapping results and options for using the results to control building and planning

processes.

Lockerbie Property Kalkallo, Surface Water Master Plan, Stockland. Andrew has been working with Stockland and National Pacific on a significant master planning project for the future urban development of over 1100 hectares in the Kalkallo area. The work involved consultation with the landowners, the Growth Area Authority, Melbourne Water, Council and other consultants. The master planning focussed on the drainage, wetlands and retarding basin components of a Structure Plan for the overall development as well as a creek corridor master plan for Merri Creek.

Modella Poultry Farm surface water report, landowner: In 2012 Andrew and his colleague Maria Verrocchi prepared a report related to surface water issues for a proposed poultry farm in Modella in the Koo Wee Rup district. Andrew presented the report at VCAT.

Powling Street Wetland, Port Fairy, community group: In 2013/14 Andrew represented a local community group in relation to a proposed residential subdivision adjacent to a sensitive wetland. Andrew provided advice, undertook a site visit and prepared a report regarding local flooding, coastal inundation and water quality issues. Andrew represented the community group at a VCAT hearing and the hearing resulted in a reduction in the subdivision that had been proposed.

Botanic Ridge Estate, City of Casey: In 2013/14 Andrew represented the City of Casey in relation to the Botanic Ridge Estate in Cranbourne. Andrew assessed the effectiveness of construction control measures, stormwater harvesting, stormwater treatment and flood control works for the Estate and impacts on the downstream property. Andrew produced a detailed report that considered reports from other parties and made recommendations to resolve the issues.

Sunshine North Industrial Estate Drainage review, Brimbank City Council: In 2013/14 Andrew undertook a review of the constructed drainage systems in this estate. A number of the drainage pipes were found to be damaged prior to handover to Council. Andrew reviewed CCTV footage, drainage design plans, contracts and specifications and provided an Expert Report to Council on the issues and how to manage them.

Bungower Road Kennels, Moorooduc for landowner: In 2013/14 Andrew prepared a report related to the suitability of the site for a proposed kennel development in relation to the land capability for wastewater disposal as well as stormwater harvesting and drainage requirements. Andrew prepared a report and made a presentation at VCAT that assisted the applicant to obtain a permit.

Maribyrnong River LSIO rezoning, Keilor, Melbourne Water: In 2012 Andrew undertook an independent review of a proposed Land Subject to Inundation Overlay for Melbourne Water along the Maribyrnong River in Keilor and Calder Park. Andrew's report assisted Melbourne Water to effectively negotiate all issues with an adjacent landowner.

O'Gradys Ridge Road Dam Break Expert Report, Southern Rural Water: In 2013 Andrew investigated the circumstances related to the failure of a large licensed farm dam. Andrew visited the site, assessed the role of Southern Rural Water, documented the downstream consequences of the dam failure and

completed a risk assessment and a report.

Werribee Flood Expert Report, Southern Rural Water: In 2012/13 Andrew studied flooding patterns in the Werribee East area associated with a severe storm in February 2011. Andrew oversaw work by his colleague Glenn Ottrey that included detailed hydrologic and 2D hydraulic modelling of the flooding behaviour for a range of scenarios. Andrew and Glenn's work was able to demonstrate how recent works had effected flooding in some locations and not in others. Andrew produced reports that assisted all parties to reach agreement where recent works had worsened flooding patterns and to defend claims where there has been no change in flooding.

Keysborough Expert Witness Report, landowner: In 2011/12 Andrew investigated the drainage issues associated with an industrial development in Keysborough South. This work included review of recent developments, Melbourne Water Drainage Scheme, temporary retarding and stormwater treatment works and the downstream system. Andrew produced a comprehensive report and appeared at hearings at VCAT.

Sheyna Drive Subdivision, Numurkah, Shire of Moira: In 2013 Andrew prepared a report regarding a proposed residential subdivision on flood prone land in Numurkah. Andrew reviewed the flooding of the site in 2012 and flood mapping of the area, as well as drainage patterns, the effect of irrigation infrastructure and the potential risks and issues associated with the proposed subdivision. Andrew obtained information from the Goulburn Broken CMA and Council. Andrew presented his report at VCAT and his evidence assisted Council in having the subdivision refused.

Tyers Street, Portland, Drainage Expert Witness Report, multiple parties: Andrew was engaged by a number of briefing parties to investigate urban flooding in Portland in Victoria and to recommend flood alleviation works to mitigate the flood risk for commercial properties in Portland. This 2010 report recommended a highly efficient, cost effective solution to the existing flooding problem, which was adopted by all parties.

Melbourne Water Drainage Scheme Reviews, Melbourne Water. Andrew has been project director for a number of drainage scheme reviews for Melbourne Water, including hydrologic modelling, stormwater quality modelling and development and costing for drainage infrastructure for proposed urban areas.

City of Knox, City wide drainage strategy: Andrew was Project Director for this municipality wide study into all aspects of the Council drainage system. The study assessed flooding risks, drain capacities and opportunities for Water Sensitive Design. Outputs included overland flow maps, capital works program and recommended planning scheme amendments and funding scheme.

City of Maribyrnong and City of Moreland Drainage Strategies: Responsible for management of these projects which involved preparation of a comprehensive strategy to enable Council to identify drainage problems and prioritise a capital works program to resolve all problems, including flooding and water quality related works. Information was supplied in MapInfo format including maps, reports, calculations and photographs.

Stormwater Drainage Strategies for Councils: Andrew developed methodologies and undertook comprehensive municipality wide strategies for a

number of councils in greater Melbourne. The strategies included risk based drainage flooding mapping and works programs as well as water sensitive design programs of works, funding advice, design guides and planning advice. Andrew has done studies of this type for many Councils including Darebin, Glen Eira, Manningham, Monash, Whitehorse and Stonnington.

Monash Flood Management Plan, Melbourne Water. Andrew was responsible for overseeing this project. The work included workshops, identifying flooding hot spots and developing a detailed action plan for Council, Melbourne Water and VicSES. Andrew brought his decades of experience in the area and working relationships to the project and contributed to a comprehensive plan for managing flood risks in the City of Monash.

Geelong Racecourse stormwater harvesting, Racing Victoria: Andrew developed this project with Racing Victoria and was Project Director for the completed study that identified a low cost and viable source of water for the racecourse by harvesting stormwater. Andrew then followed up with the detailed design and implementation of the works that provide over 70ML/annum of water to irrigate the racecourse. Major regional racecourses are important employers and are required for a viable training and racing industry. The Geelong project led to similar studies that Andrew undertook at Ballarat and Bendigo Racecourses.

Water Sensitive Road Drainage Scheme, Bandiana Link Road, VicRoads: Andrew has undertaken work for VicRoads in Wodonga to develop a water sensitive road design system for the Bandiana Link Road and to prepare a cost apportionment scheme to obtain contributions from all benefiting landowners. The results of the study have been used in negotiations with benefitting landowners to offset the value of the works built by VicRoads against the land acquisition compensation.

Surface Water assessment, Crowlands Windfarm: Andrew undertook a detailed surface water assessment of the proposed Crowlands windfarm in the Pyrenees in north western Victoria. His work included a site assessment, input to the windfarm design, assessment of erosion risks, concept design of waterway crossings (including the Wimmera River) and erosion control works and a detailed report.

Merri River and Russell Creek flood studies, Warrnambool, Glenelg Hopkins CMA and Shire of Warrnambool: Andrew was project manager for this flood study and undertook hydrologic modelling and hydraulic modelling, as well as producing the flood study report and recommendations.

Moyne River Flood Study, Port Fairy, Glenelg Hopkins CMA and Shire of Moyne: Andrew was project manager for this flood study and undertook hydrologic modelling and hydraulic modelling, as well as producing the flood study report and recommendations.

Shire of Moira Drainage Strategy: Andrew was project manager for a comprehensive drainage strategy for Council that included consideration of drainage patterns and urban pollutant loads and management for towns including Numurkah, Nathalia, Cobram, Katamatite, Katunga and Waaia.

Blackburn Creek rehabilitation, Melbourne Water: Andrew was Project Director for the design and superintendent for the construction of two stages of

waterway rehabilitation works on Blackburn Creek

Surface Water study for Nowingi waste facility EES, Office of Major Projects: Andrew was project manager for the surface water study for the proposed long term waste facility at Nowingi. Andrew prepared the EES specialist report and an Expert witness statement and gave evidence to the Panel hearing. The study covered issues including flooding risk, water balance and risk of surface water discharges from the site.

Baddaginnie Flood Study, Office of Major Projects: Andrew was Project Manager for this flood study in central Victoria. The project involved hydrology and hydraulic modelling for four creeks north of Violet Town and south of Baddaginnie. Andrew also undertook significant public consultation, including presentations at public meetings and briefing of Ministerial advisers and his work was central to Government decisions that the site was not appropriate for use for a long term waste facility due to flooding risks.

Dickson and Lyneham Wetlands, ACT Government: Andrew was Project Director for the design, approvals and then construction of two major wetlands in the northern suburbs of Canberra in 2009 and 2010. The wetlands will play a vital role in stormwater treatment and harvesting approximately 400 ML/annum of stormwater for use in open space irrigation. Andrew has overseen the preparation of the Final Sketch Plans, flood study, water treatment and water harvesting modelling and has developed a number of the technical solutions for this project. Andrew has also had a leading role in the agency and public consultation for the projects and the approval process.

Surface Water Study for Environmental Effects Statement for Mount Shamrock Quarry Extension: Andrew completed the surface water EES report and made an Expert Witness statement and presentation to the panel assessing the EES. Andrew's work related to the site water balance, surface water quality, interaction of surface water and groundwater, discharge licensing and flooding risks.

Ruffey Creek rehabilitation, Melbourne Water: Andrew was Project Director for the design and superintendent for the construction of works on Ruffey Creek in Doncaster in 2007/08. The creek was deeply incised and in poor condition. The works included rock work, batter works, planting and an off stream wetland.

Dollar Wind Farm Expert Witness Report and Presentation, Southern Hydro: Andrew was peer reviewer for the civil design study for the Dollar Wind Farm in South Gippsland for Southern Hydro. His report related to surface water management and erosion control for the proposed development of the wind turbine project. Andrew made a presentation and was cross examined at the panel hearing in Foster in 2005.

Spindrift Avenue waterway impact report, landowner: In 2010 Andrew prepared an expert witness report and assisted a landowner in mediation in relation to development and works on a property in Spindrift Avenue, Flinders.

Lower Stony Creek VCAT report, Melbourne Water. Andrew represented Melbourne Water in relation to filling and realignment of Lower Stony Creek in Tottenham. Andrew's role included briefing of Melbourne Water's barrister on technical issues, preparation of reports and maps and appearances at VCAT hearings.

Lower Stony Creek Flood Impact Study, Melbourne Water. Andrew was project manager for a flood study that analysed the flooding impact of recent fill and creek alignment works on Stony Creek in Tottenham.

Lower Stony Creek Waterway Design, Melbourne Water. To mitigate the effects of recent filling and realignment of the creek a design was prepared to reduce the flooding impact, stabilise the creek, improve the creek environment and to allow for access across the creek.

Yarra River Flood Risk report, City of Boroondara: Andrew investigated the flooding risks associated with a property in Coppin Grove, Hawthorn. The property is adjacent to the Yarra River and the owner had made an application to Council for a Planning Permit for dwellings on the high part of the site. Andrew prepared a flood risk report in accordance with the Planning and Environment Act to assist Council in deciding on the limit of residential development, the location of a path and the extent of Council's Public Acquisition Overlay.

Flood Risk Report, Jacksons Creek: In 2002 Andrew prepared a flood risk report in relation to a proposed supermarket adjacent to Jacksons Creek in Gisborne. The report was prepared for the owner of a nearby supermarket as part of their submission to VCAT.

Drainage Design Guide, Melbourne Water: Andrew was personally responsible for reviewing the previous design guides and rewriting them to produce the current Melbourne Water Drainage Design Guide. This guide is the industry standard for drainage throughout the greater Melbourne area.

Development Contributions Plan, City of Monash: Andrew prepared the City of Monash's Development Contribution Plan (DCP) for drainage works and worked with Council manager's to obtain approval from the Department of Infrastructure (now DPCD) to the DCP. The DCP meets all of the requirements of the Planning and Environment Act and could provide Council with substantial funds every year towards the cost of drainage improvement works.

Porter Street Retarding Basin, Manningham City Council: Andrew analysed the drainage in the catchment in relation to a proposed subdivision on land in Porter Street, Templestowe. Part of the site was low lying and flood prone. Andrew made a presentation to VCAT that resulted in a retarding basin being set aside as part of the subdivision.

Wensleydale Coal Mine, Winchelsea, Victoria: The project involved risk assessment and design of stabilisation works for this disused mine in south-west Victoria. Severe erosion of the creek through the site occurred following a flood in 1995. Andrew developed a site management plan and detailed design of major stabilisation works.

Waterway Condition Assessment, Melbourne Water: Manager of waterway condition assessment studies for the Bunyip River, Tarago River, King Parrot Creek and Woori Yallock Creek catchments.

Dromana Flood Study: Andrew was project director for this project for the Mornington Peninsula Shire in Victoria. The flood mapping was done with the 2D flood model TUFLOW. Scenarios modelled included a range of storms as well as potential climate change scenarios considering sea level rise and increases in rainfall intensity. Andrew provided a report and policy advice on the implications of the study results.

Gunbower Forest Watering, Goulburn Broken CMA and Goulburn Murray Water: Andrew undertook technical and peer reviews for the design of the water diversion scheme to provide additional environmental water for the Gunbower Forest.

Racecourse Lake / Murray Valley Highway irrigation channel technical review, Goulburn Murray Water: Andrew oversaw hydraulic analysis and recommendations to improve channel capacity without impacting on flooding patterns for this irrigation system between Kerang and Swan Hill.

Lake Mokoan alternative water supply, Goulburn Murray Water: Andrew undertook technical reviews of proposed channel and pipe works to provide irrigation water to customers following the decommissioning of Lake Mokoan near Benalla.

Hattah Lakes environmental watering, Mallee CMA: Andrew developed concepts for water diversions for Hattah Lakes including channel works and regulating structures to provide environmental watering that would closely replicate flow patterns prior to regulation of flows in the Murray River catchment.

Surface Water Study for Learmonth Saleyards and abattoir for the City of Ballarat. This work included a flood study, drainage study and design of surface water quality management systems. Andrew's work included an expert report and appearance at a Panel Hearing.

PROFESSIONAL HISTORY

2010 - present	Senior Principal Engineer, Engeny Water Management, Melbourne
2003 - 2010	Principal Water Surface Engineer, URS Australia Pty Ltd
2002 - 2003	Business Development Manager, Waterways & Water Resources, GHD Pty Ltd
2001 - 2002	Manager of Water Resources, Egis Consulting Australia Southern Region
1997 - 2001	Principal Engineer, Hyder Consulting
1994 - 1996	Senior Project Manager, Sinclair Knight Merz
1992 - 1994	Consulting Engineer, AGP Consulting
1993 - 1994, 1999 - 2001	Part-time Lecturer, Swinburne University
1990 - 1992	Works Program Engineer, Dandenong Valley and Western Port Authority
1986 - 1989	Planning and Investigation Engineer, Dandenong Valley Authority
1984 - 1986	Planning Engineer, Port of Melbourne Authority
1982 - 1984	Dandenong Valley Authority

EDUCATION

1992	Postgraduate Diploma in Management Studies, Melbourne University
1984	Bachelor of Engineering (Civil), Swinburne Institute of Technology

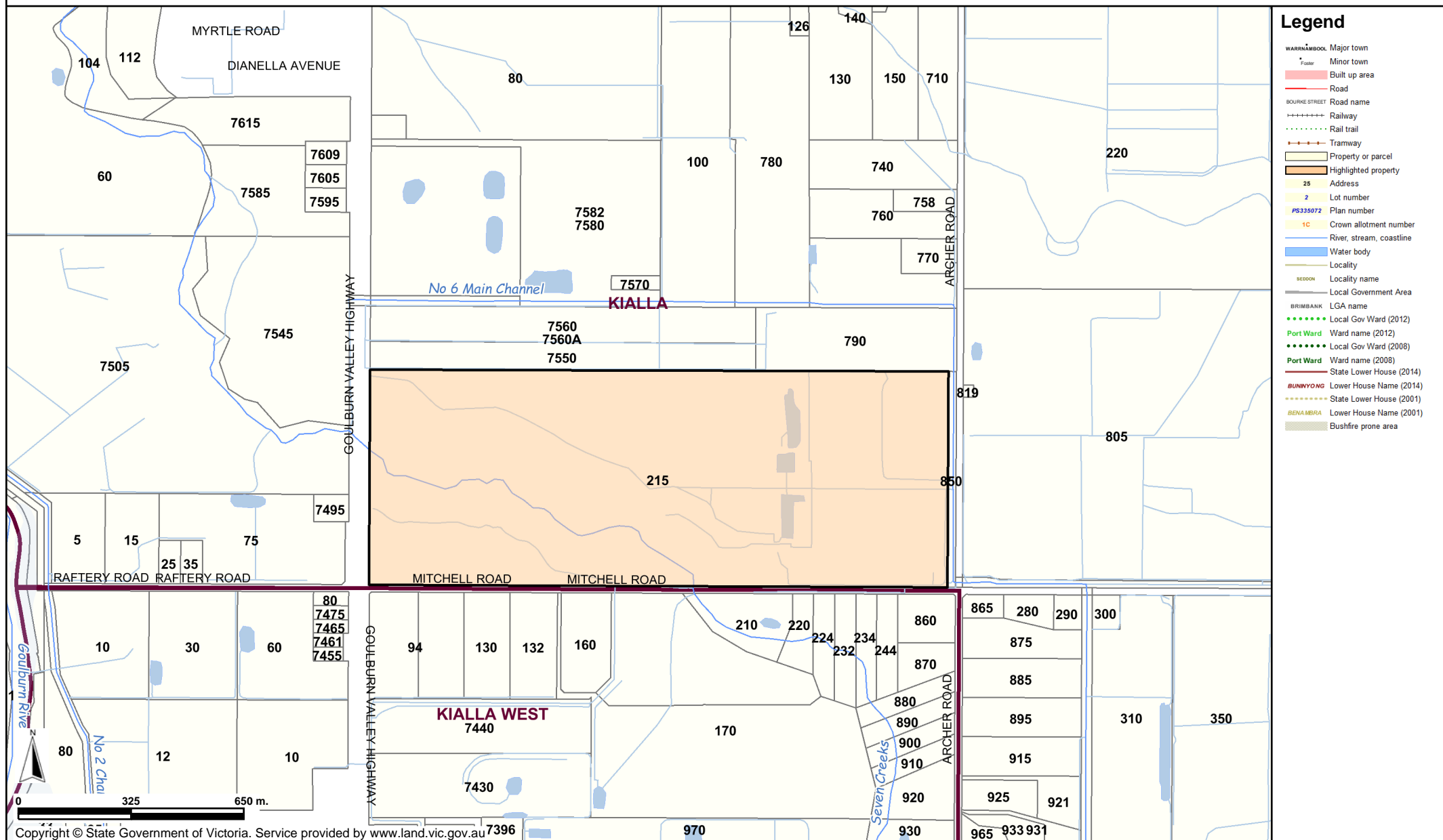
REGISTRATIONS / AFFILIATION

Member, Institution of Engineers, Australia

APPENDIX B

Site Locality Plan

215 Mitchell Road



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Disclaimer: This map is a snapshot generated from Victorian Government data. This material may be of assistance to you but the State of Victoria does not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for error, loss or damage which may arise from reliance upon it. All persons accessing this information should make appropriate enquiries to assess the currency of data.

Map Scale 1:14,778
June 21, 2017 11:57:15 AM

APPENDIX C

Instructions



Tel: (03) 9245 9700 Fax: (03) 9681 6765
www.sgl.net.au ABN 37 613 662 865

142 Albert Road, South Melbourne Vic 3205
PO Box 33042, Domain LPO, Melbourne Vic 3004
DX 30526 South Melbourne

Our Ref: BG:NK:5405

22 June 2017

Mr Andrew Prout
Engeny Water Management
PO Box 452
Canterbury VIC 3126

By email: andrew.prout@engeny.com.au
Pages in transmission: 2

RE: 215 MITCHELL ROAD KIALLA WEST
PROVISION OF EXPERT REPORT

Dear Andrew,

We act for Basic Property Holdings Pty Ltd.

Our client is the registered proprietor of the land at 215 Mitchell Road Kialla West, being the real estate more particularly described in certificate of title volume 10461 folio 596. Our client's land falls within an area identified by the City of Greater Shepparton as Investigation Area 1.

Investigation Area 1 is the subject of:

- *The Goulburn Valley Harness and Greyhound Racing Precinct Feasibility Study and Master Plan, July 2016;*
- 'Investigation Area 1 – Model of Flood Behaviour Report – July 2016' prepared by Water Technology Pty Ltd ("**Water Tech Report**"); and
- Amendment C199 to the City of Greater Shepparton Planning Scheme.

Investigation Area 1 was also part of the **Shepparton Mooroopna Floodplain Management Study, October 2002** the findings of which were included in the Greater Shepparton Planning Scheme through Amendment C23 part 1 and part 2 - see 2004 Panel Report for C23 part 2.

We request that you prepare an expert report which reviews:

- (a) The findings of the Water Tech Report;
- (b) The methodology of the Water Tech Report;
- (c) The methodology of flood studies which are prepared to support amendments to flood control provisions of a planning schemes'
- (d) Whether the Water Tech Report is in accordance with relevant Ministerial Directions and Planning Practice Notes;
- (e) Best method practices in preparing flood studies;

- (f) Flood control issues, based on your investigations, which may impact on the feasibility of the Master Plan contained in the Goulburn Valley Harness and Greyhound Racing Precinct Feasibility Study and Master Plan, July 2016;
- (g) Any other matters arising out of your investigations which you consider relevant in considering to the proposed amendment C199, the Master Plan and the Water Tech Report.

In preparing your Report we request that you also have regard to:

- (i) Planning Practice Note 11 – Applying for a Planning Permit under the Flood Provisions;
- (ii) Planning Practice Note 12 (PPN12) Applying the Flood Provisions in Planning Scheme;
- (iii) Planning Practice Note 46 (Strategic Assessment Guidelines);
- (iv) Ministerial Direction No 11 - Strategic Assessment of Amendments;
- (v) Planning Practice Note 13 – Incorporated and Reference Documents;
- (vi) Advisory Note on Delineating Floodways;
- (vii) The Planning Practice Note "Applying the Flood Provisions in Planning Schemes: A guide for councils";
- (viii) The DELWP's Victorian Floodplain Management Strategy 2016;
- (ix) Shepparton Mooroopna Floodplain Management Study, October 2002;
- (x) Greater Shepparton Planning Scheme Amendment C23, 2004 Panel Report 2004 for C23 part 2.

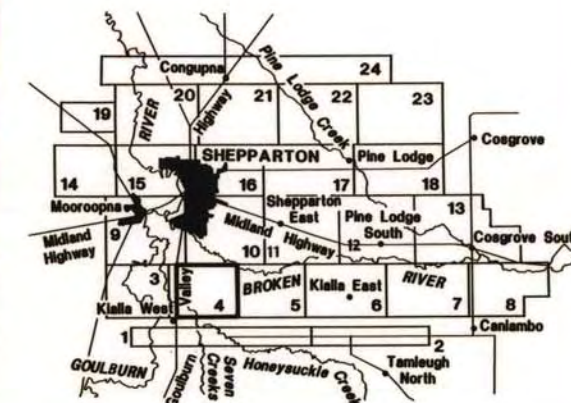
Yours faithfully,

Bronwyn Goddard

Bronwyn Goddard | Partner
STANTON GRANT LEGAL

APPENDIX D

Composite 1993 flood photograph



APPROX. NORTH

0 200 400 600 800 1000
METRES (APPROX.)

STATION NUMBER: 405269		GRID REFERENCE: 563 642	
PEAK INFORMATION			
DATE	TIME	GAUGE HEIGHT	FLOW (M ³ /d)
5/10	12.00pm	8.23	62,000
PHOTOGRAPHIC INFORMATION			
FILM: 5341033	RUN: 8A	PHOTO No.: 197	
6/10	2.25pm	7.40	38,000

PHOTOGRAPHY - LANDAIR SURVEYS
- 6th OCTOBER 1993 From 1156 to 1642hrs

REFERENCE - PROJECT KEY PLAN No. 201855.

PREPARED BY - LAND INFORMATION AND CARTOGRAPHIC SERVICES.

REFER PLANS:
201913 - Broken River, Benalla to Pine Lodge South
201915 - Killa and Killa West Area
201921 - Pine Lodge Creek (Shepparton Drain II)
201923 - Goulburn River, Shepparton To Loch Garry

DEPARTMENT OF
CONSERVATION AND
NATURAL RESOURCES

Prepared by  **HydroTechnology**

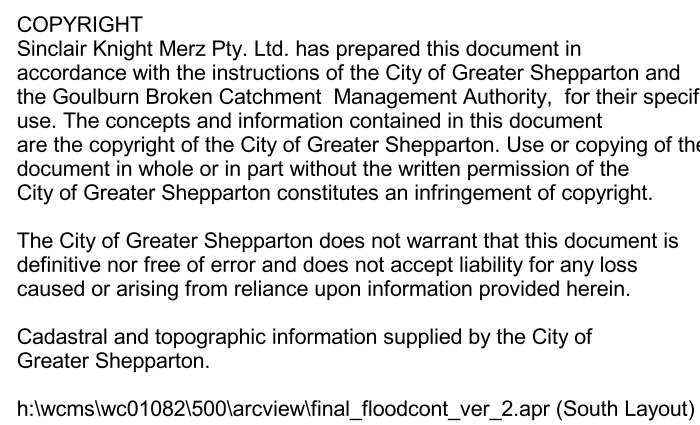
DOCUMENTATION OF 1993 FLOODS
SHEPPARTON AREA
FLOOD PHOTOMOSAIC

SHEET 4 OF 24

201916

APPENDIX E

Current Designated Flood Level Plans



This map has been prepared using the best available data and computer modelling and mapping techniques. The accuracy of this map however, is not absolute and reflects only the accuracy of the data and techniques used. Your Knight Risk Map Pty. Ltd. does not warrant that this map is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

The flood level lines shown on this plan define the surface level of the "1% Probability Flood". This is the flood prescribed by Sec. 204 of the Water Act - 1989, for floodplain management purposes and has a 1 in 100 chance of being equal or exceeded in any one year.

The derivation of these 1% flood level lines has been based on available historical flood level and flow information, hydrological and hydraulic modelling.

Areas outside the 1% percent probability flood limit may be inundated by rarer flood events.

For the purpose of determining flood levels for locations between flood level lines, it can be assumed that flood surface changes at a uniform rate between flood level lines.

The flood level lines shown on this plan can be used to assist in the determination of designated Levels in accordance with Clause 6.2 of the Building Regulations - 1994.

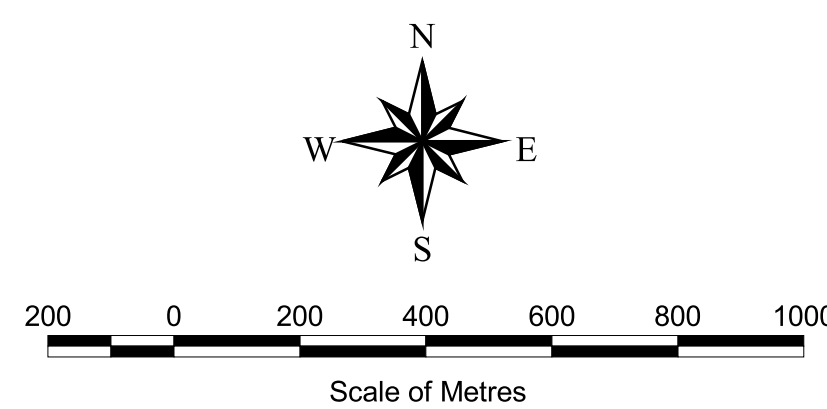
Although there may be buildings within the area covered by the flood level lines, it should not be assumed that the floor of any individual building is below the flood level. Buildings should be surveyed to determine whether their floors are above or below the 1% flood level.

Flood levels were declared by the Goulburn Broken CMA on the 22nd August, 2002.

under provisions of the Water Act 1989, Clause 203 on 22nd August, 2002.



A diagram of a three-story building. The top section is labeled 'North', the middle section is labeled 'Central', and the bottom section is labeled 'South'. The 'South' section is shaded with red diagonal lines. A yellow outline highlights the 'North' and 'Central' sections.



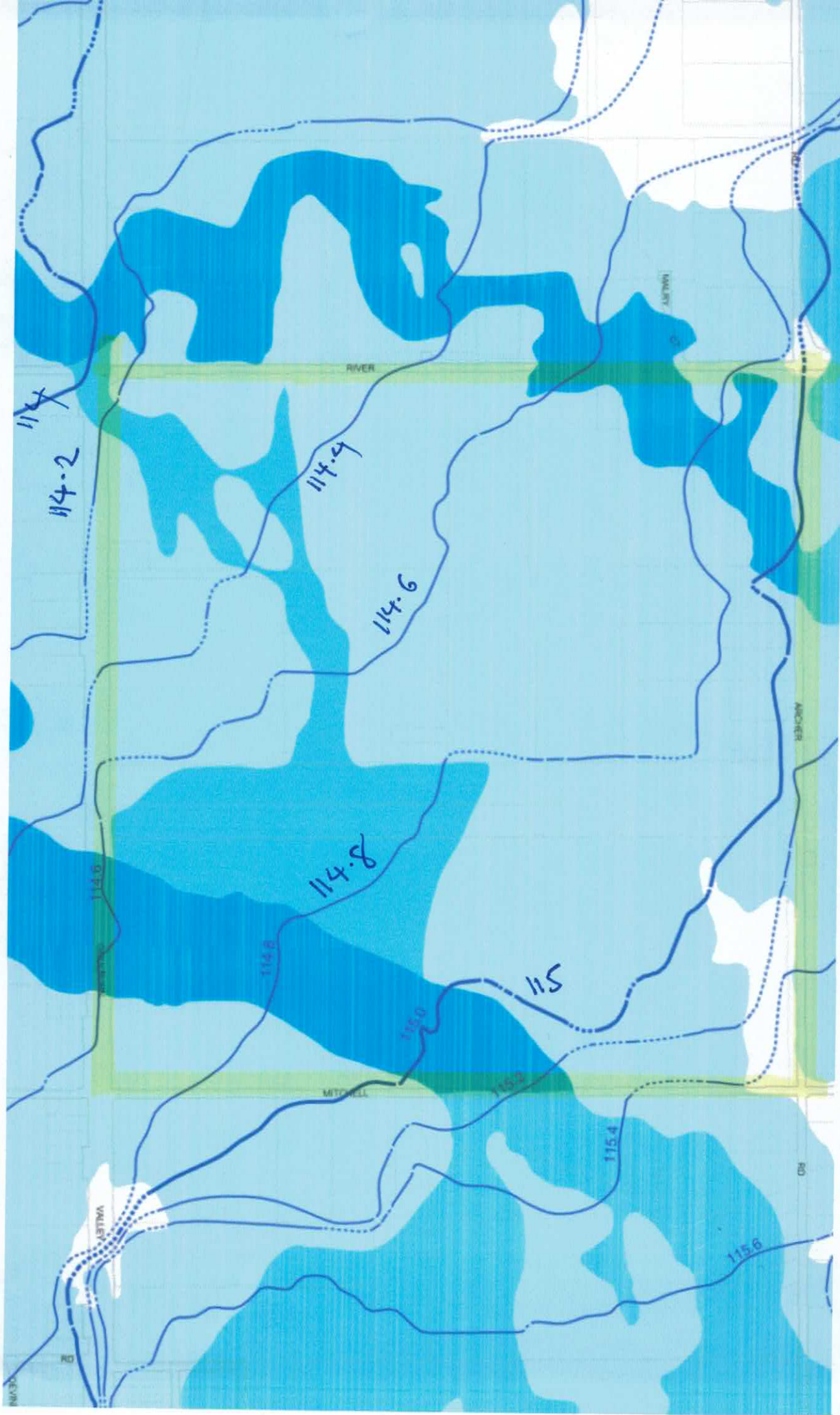
- Study Area
- Cadastral boundaries
- Flood Contours metres AHD (contour interval 200mm)

Indicated contour interval is generally 200mm, however in some locations a larger interval is used due to large difference in adjacent water levels. These large differences are due to flow over local obstructions (roads, channels, bunds, etc)

 Urban Flood Zone
 Floodway Overlay
 Land Subject to Inundation Overlay

Designation of Flood Levels

Plan No.: 540222
Sheet: 3 of 3
Date: August 2002



APPENDIX F

Email from Water Technology

From: Lachlan Inglis <Lachlan.Inglis@watertech.com.au>
Sent: Thursday, 27 April 2017 4:46 PM
To: Andrew Prout
Cc: Ben Tate; Bronwyn Goddard <bronwyng@sgl.net.au> (bronwyng@sgl.net.au); Glenn Ottrey; Greg Mckenzie <Greg.Mckenzie@shepparton.vic.gov.au> (Greg.Mckenzie@shepparton.vic.gov.au); Warwick Bishop
Subject: RE: Kialla West Flood Investigation Area 1 - request to confirm details

Hi Andrew,

Please find our response to your queries below.

For the 1993 flood scenario

- the model start time is 96 hours - **Yes – we had initial conditions based on the Shepparton Mooroopna Study and started the model prior to the rising limb of the inflow hydrographs rising steeply.**
- the model end time is 140 hours - **Yes- the peak flood level has passed the investigation area**
- the only inflow boundary conditions are named:
 - “SC_Kialla_West_east”, applied as a 2d_sa - **Yes – this is the inflow from Honeysuckle Creek**
 - “SC_Kialla_West_south2”, applied as a 1d_bc **Yes – this is a portion of the Seven Creeks flow**
 - “SC_Kialla_West_south1”, applied as a 2d_sa **Yes – this is a portion of the Seven Creeks flow**

For the 1% AEP event

- The model start time is 40 hours **Yes – we had initial conditions based on the Shepparton Mooroopna Study and started the model prior to the rising limb of the inflow hydrographs rising steeply.**
- The model end time is 100 hours **Yes- the peak flood level has passed the investigation area**
- the only inflow boundary conditions are named:
 - “SC_Kialla_West_east”, applied as a 2d_sa **Yes – this is the inflow from Honeysuckle Creek**
 - “SC_Kialla_West_south2”, applied as a 1d_bc **Yes – this is a portion of the Seven Creeks flow**
 - “SC_Kialla_West_south1”, applied as a 2d_sa **Yes – this is a portion of the Seven Creeks flow**

With regards to the development of flows, the hydrology/hydraulic calibration report is being provided to GSCC tomorrow.

Thanks,
Lachlan

Lachlan Inglis
Project Engineer | MIEAust

WATER TECHNOLOGY • +61 4 1406 9397 • www.watertech.com.au •

From: Andrew Prout [<mailto:Andrew.Prout@engeny.com.au>]
Sent: 27 April 2017 12:30 PM
To: Lachlan Inglis <Lachlan.Inglis@watertech.com.au>
Cc: Ben Tate <Ben.Tate@watertech.com.au>; Bronwyn Goddard <bronwyng@sgl.net.au> (bronwyng@sgl.net.au) <bronwyng@sgl.net.au>; Glenn Ottrey <Glenn.Ottrey@engeny.com.au>; Greg Mckenzie <Greg.Mckenzie@shepparton.vic.gov.au> (Greg.Mckenzie@shepparton.vic.gov.au) <Greg.Mckenzie@shepparton.vic.gov.au>
Subject: FW: Kialla West Flood Investigation Area 1 - request to confirm details

Hi Lachlan

I note from his auto reply that Ben is on leave this week. Could you please help us with a response to the email below.

Regards

Andrew Prout

Senior Principal Engineer

engeny logo -
email

P 03 9888 6978

M 0400 350 002

Suite 15, 333 Canterbury Road, Canterbury, VIC, 3126

PO Box 452 Canterbury VIC 3126

www.engeny.com.au

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From: Andrew Prout

Sent: Thursday, 27 April 2017 12:13 PM

To: Ben Tate

Cc: Glenn Ottrey; Bronwyn Goddard <bronwyng@sgl.net.au> (bronwyng@sgl.net.au); Greg Mckenzie

Subject: Kialla West Flood Investigation Area 1 - request to confirm details

Hi Ben

We would like to double check with Water Technology that we are running the models with the same parameters as used for all of the area covered by the Investigation Area 1 flood model and associated report. Can you please confirm that the following parameters should be used when running each of the models:

For the 1993 flood scenario

- the model start time is 96 hours
- the model end time is 140 hours
- the only inflow boundary conditions are named:
 - "SC_Kialla_West_east", applied as a 2d_sa
 - "SC_Kialla _West_south2", applied as a 1d_bc
 - "SC_Kialla_West_south1", applied as a 2d_sa

For the 1% AEP event

- The model start time is 40 hours
- The model end time is 100 hours
- the only inflow boundary conditions are named:
 - "SC_Kialla_West_east", applied as a 2d_sa
 - "SC_Kialla _West_south2", applied as a 1d_bc
 - "SC_Kialla_West_south1", applied as a 2d_sa

Is there any other information that can be provided by Water Technology regarding how the flows used in the TufLOW model were generated and/or how the model was calibrated?

Cheers

Andrew Prout

Senior Principal Engineer

engeny logo -
email

P 03 9888 6978

M 0400 350 002

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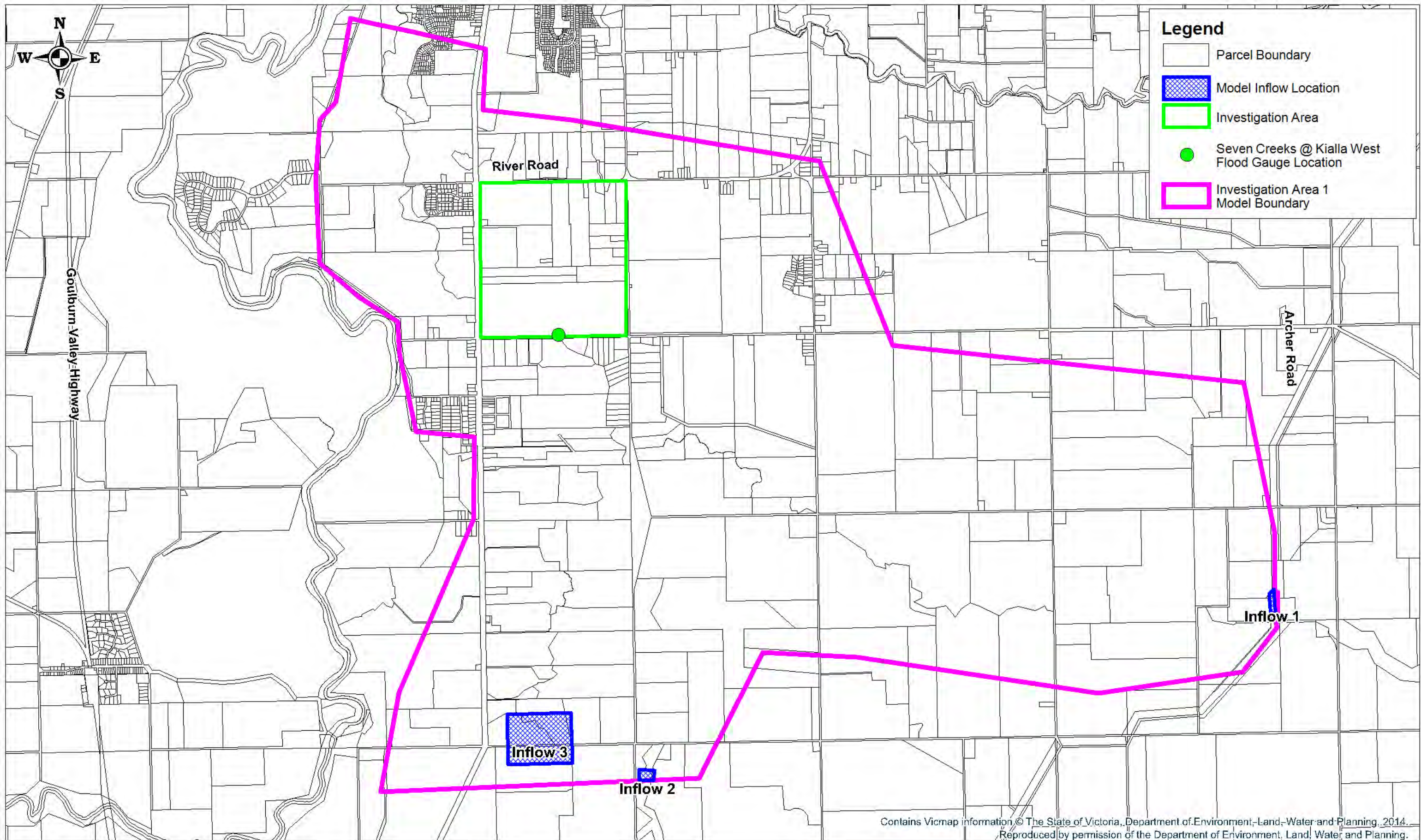
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APPENDIX G

Plan of TUFLOW model extent and locations of inflows



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0 100 200
 Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55

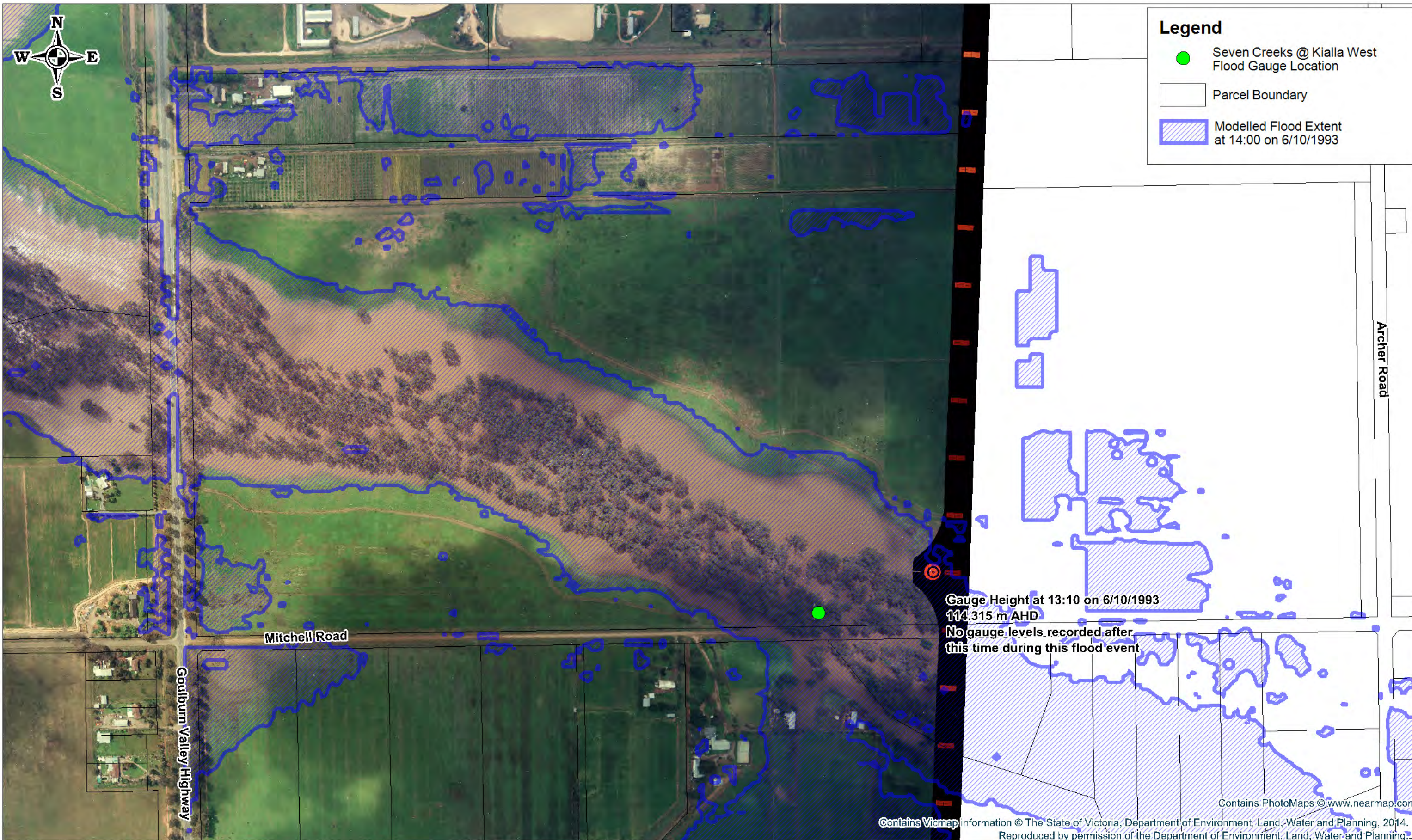
Goulburn Valley Equine and Greyhound Racing Precinct

Flood Model Layout

Job Number: V1177_001
 Revision: 0
 Drawn: GO
 Checked: AP
 Date: 3 May 2017

APPENDIX H

Southern Area 1993 Flood Photo and WT Flood Extent



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0 100 200
 Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55

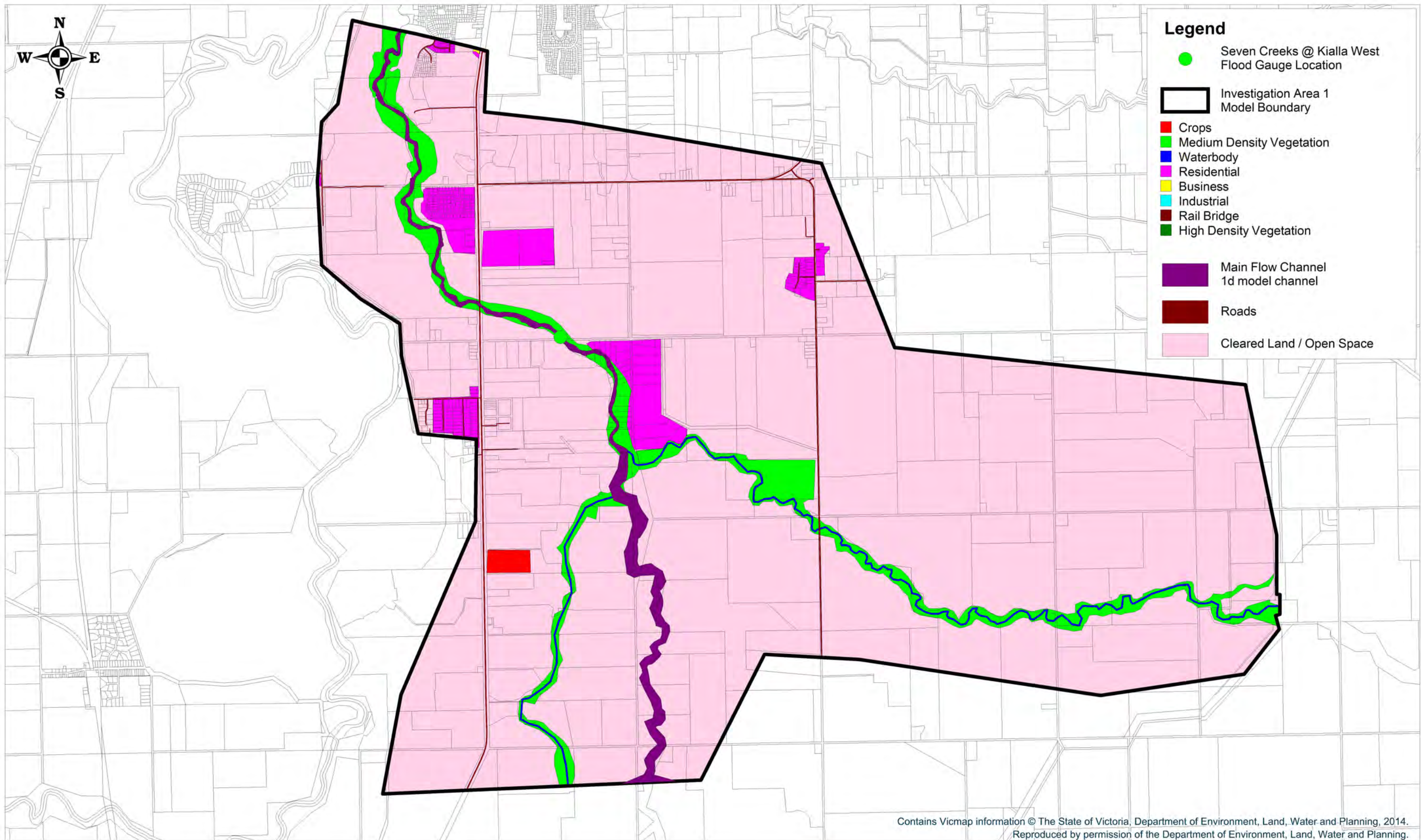
215 Michell Road Kialla

Aerial Photo of 1993 Flood
 Photo captured 14:25 6/10/1993
 Water Technology Modelled Flood Extent

Job Number: V1177_001
 Revision: 0
 Drawn: GO
 Checked: AP
 Date: 06 Apr 2017

APPENDIX I

TUFLOW material layer plan



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0 800 1600
Scale in metres (1:40,000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Goulburn Valley Equine and Greyhound Racing Precinct

Land Use (Tuflow Material) Map

Job Number: V1177_001
Revision: 0
Drawn: GO
Checked: AP
Date: 3 May 2017

APPENDIX J

Northern Area 1993 Flood Photo and Water Technology Area 1 1993 TUFLOW flood extent



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0 100 200
Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

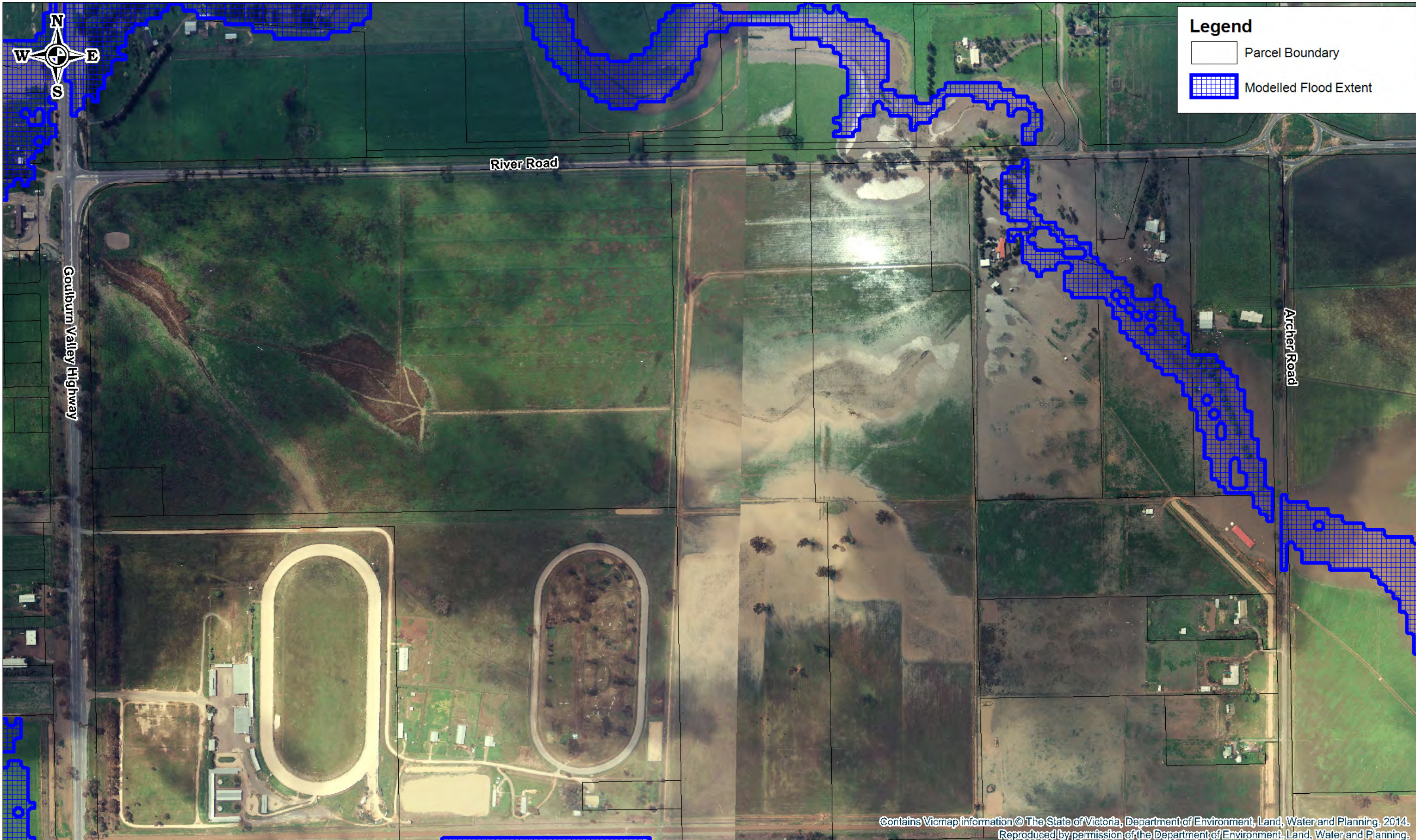
Goulburn Valley Equine and Greyhound Racing Precinct

1993 Flood Extent
Water Technology "Investigation Area 1" Model
Peak Flood Extent

Job Number: V1177_001
Revision: 0
Drawn: GO
Checked: AP
Date: 3 May 2017

APPENDIX K

Northern Area 1993 Flood Photo and Water Technology Regional 1993 TUFLOW flood extent



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0 100 200
Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

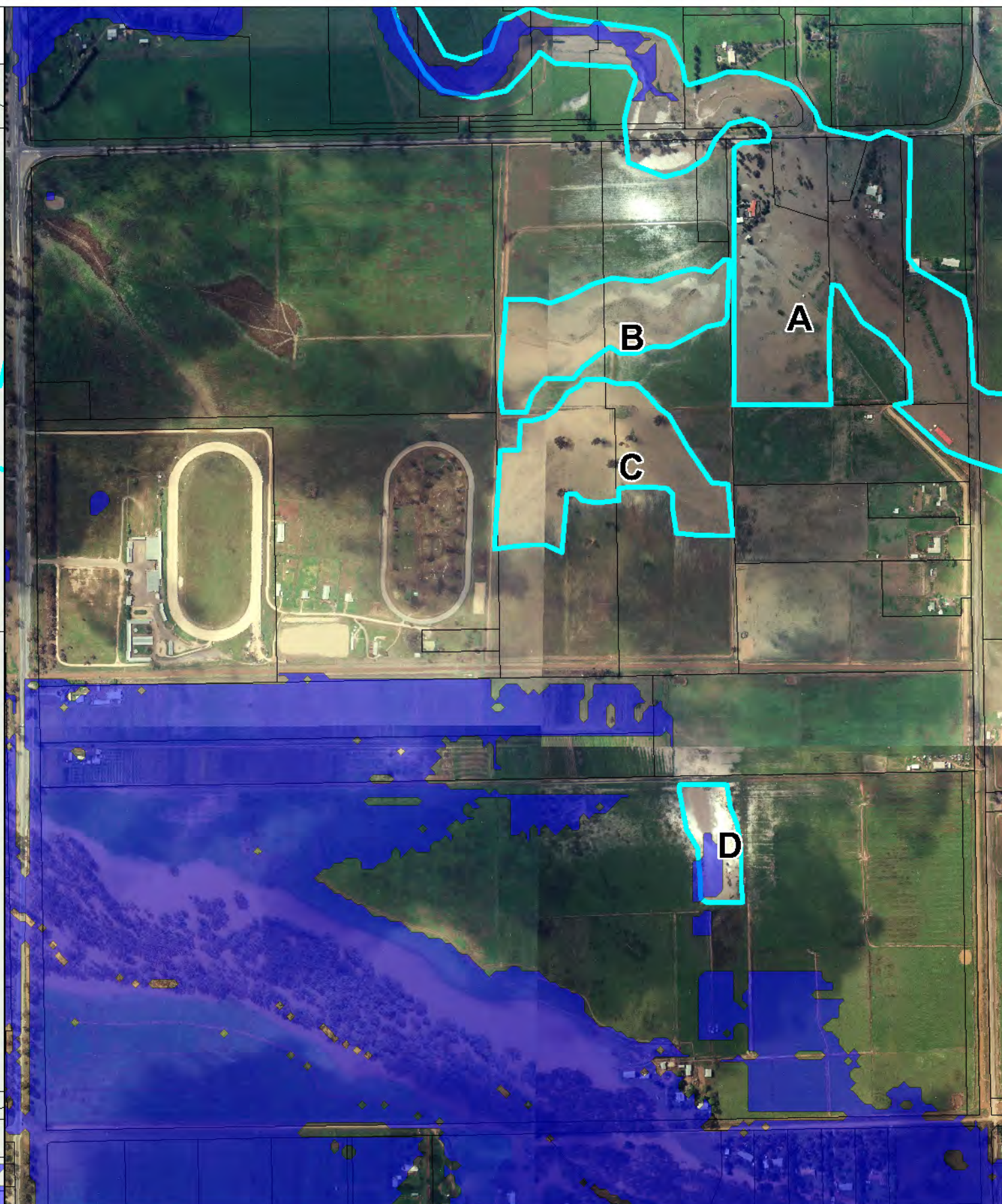
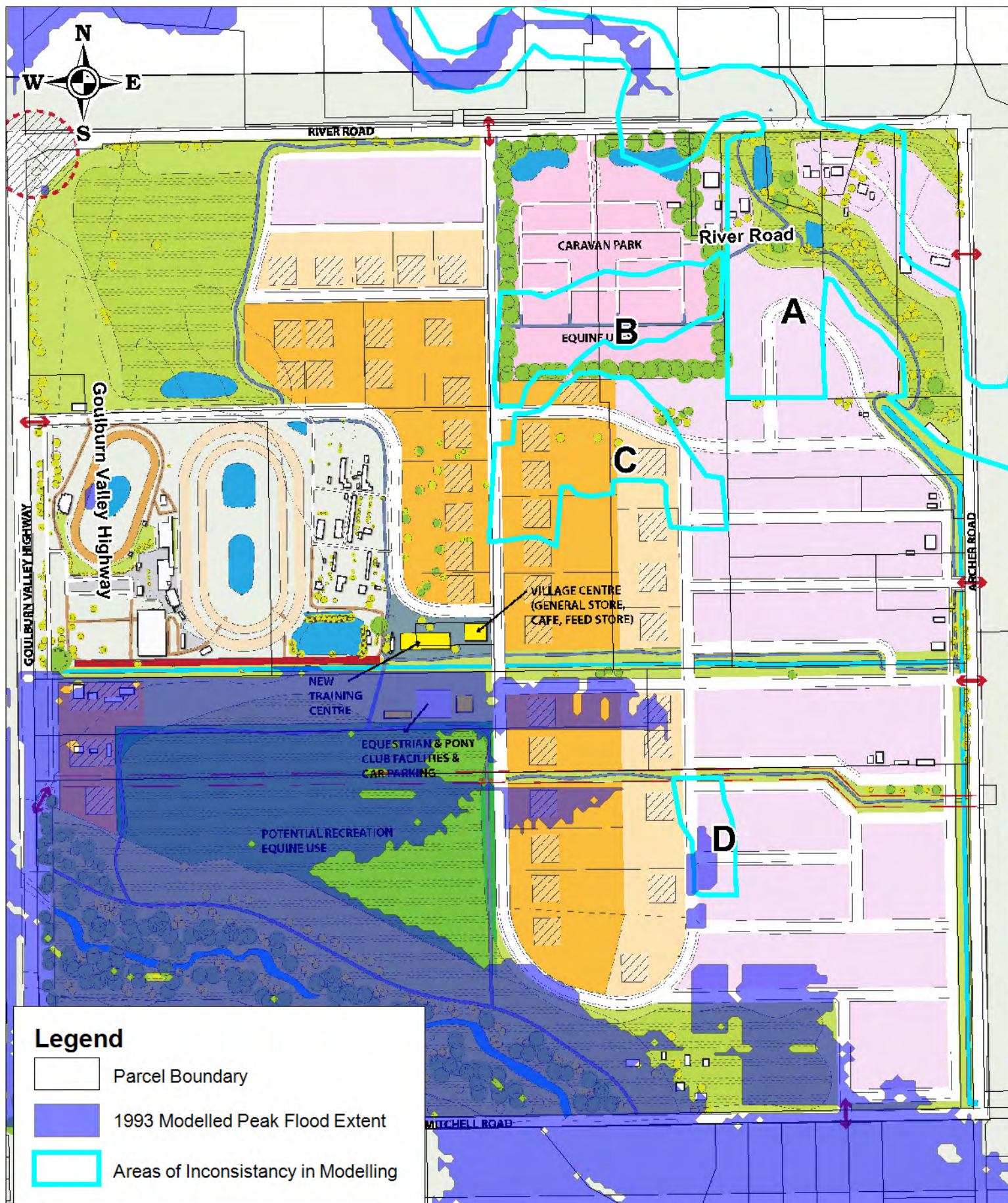
Goulburn Valley Equine and Greyhound Racing Precinct

1993 Flood Extent
Water Technology Shepparton Mooroopna Flood
Study Calibration Hydraulic Model
Peak Flood Extent

Job Number: V1177_001
Revision: 0
Drawn: GO
Checked: AP
Date: 3 May 2017

APPENDIX L

Master Plan and Flood Related Information



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0 100 200
 Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55

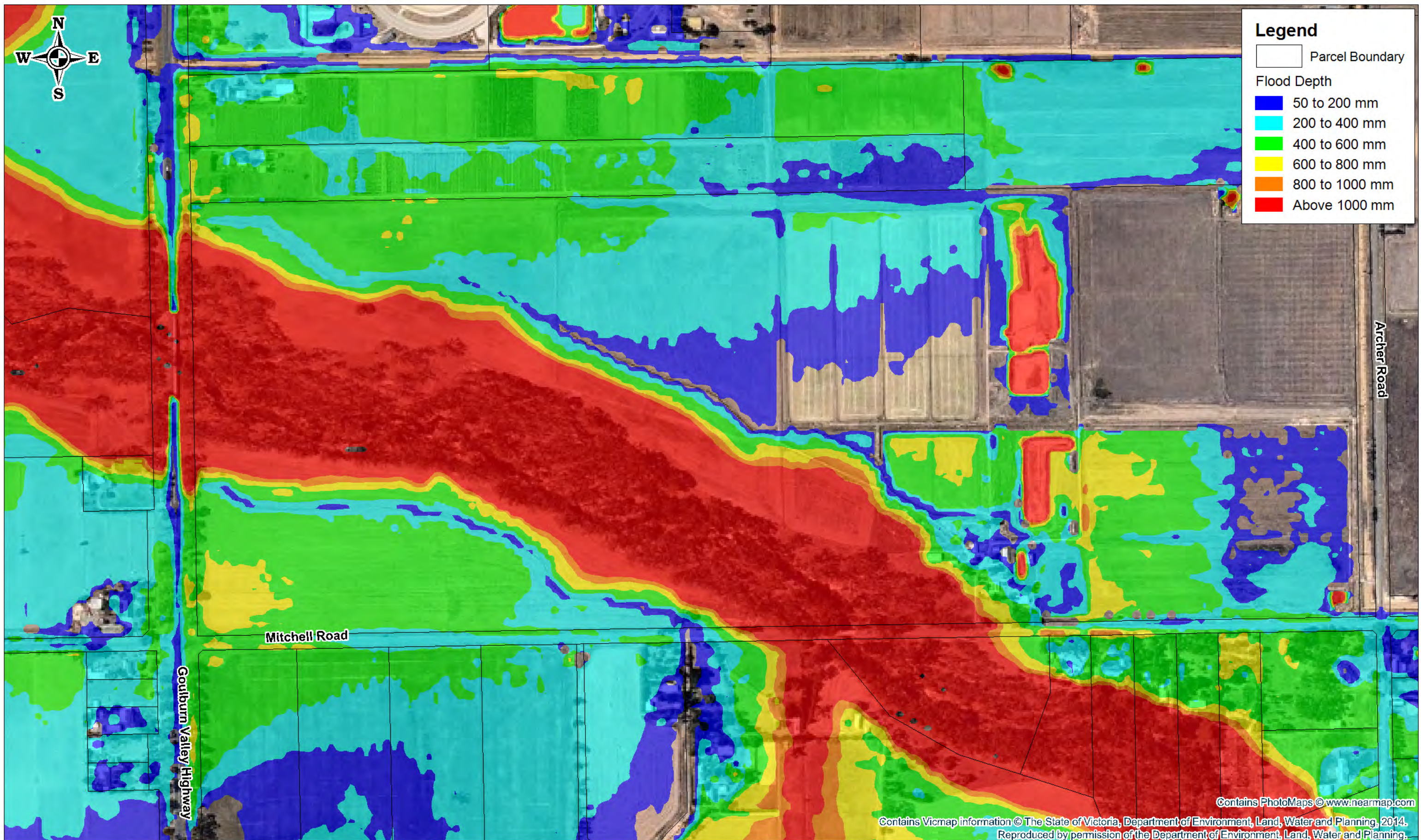
Goulburn Valley Equine and Greyhound Racing Precinct

1993 Flood Photograph
 Water Technology Investigation Area 1 Model Results
 1993 Modelled Peak Flood Extent

Job Number: V1177_001
 Revision: 0
 Drawn: GO
 Checked: AP
 Date: 21 June 2017

APPENDIX M

Southern Area Engeny Adjusted 1 % AEP Flood Plan



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0 100 200
Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

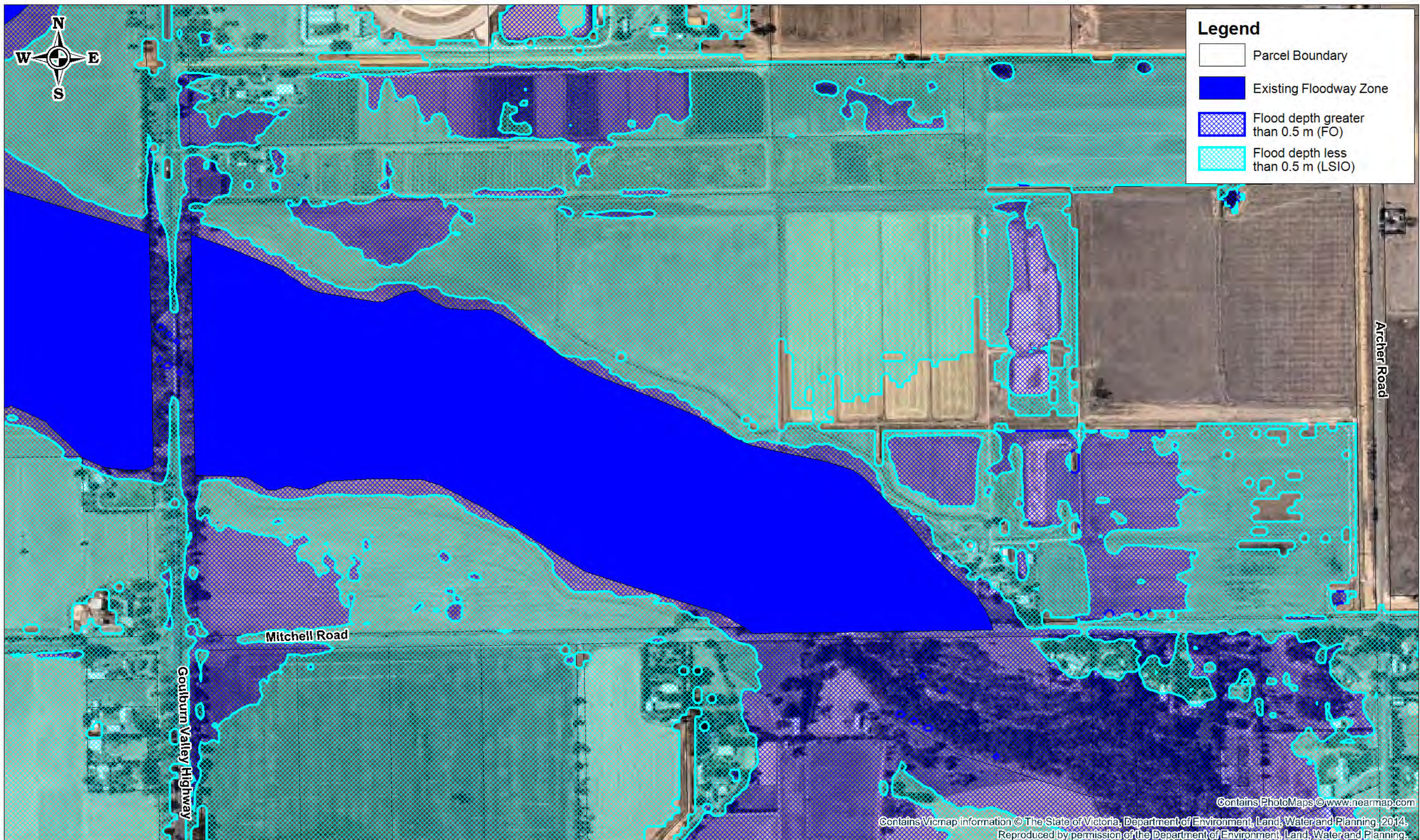
215 Michell Road Kialla

Engeny Adjusted 1% AEP Flood Model
Peak Flood Depth

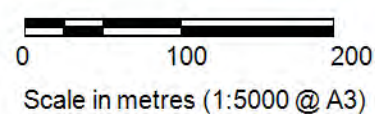
Job Number: V1177_001
Revision: 0
Drawn: GO
Checked: AP
Date: 24 May 2017

APPENDIX N

Southern Area Engeny adjusted FO and LSIO plan



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Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55

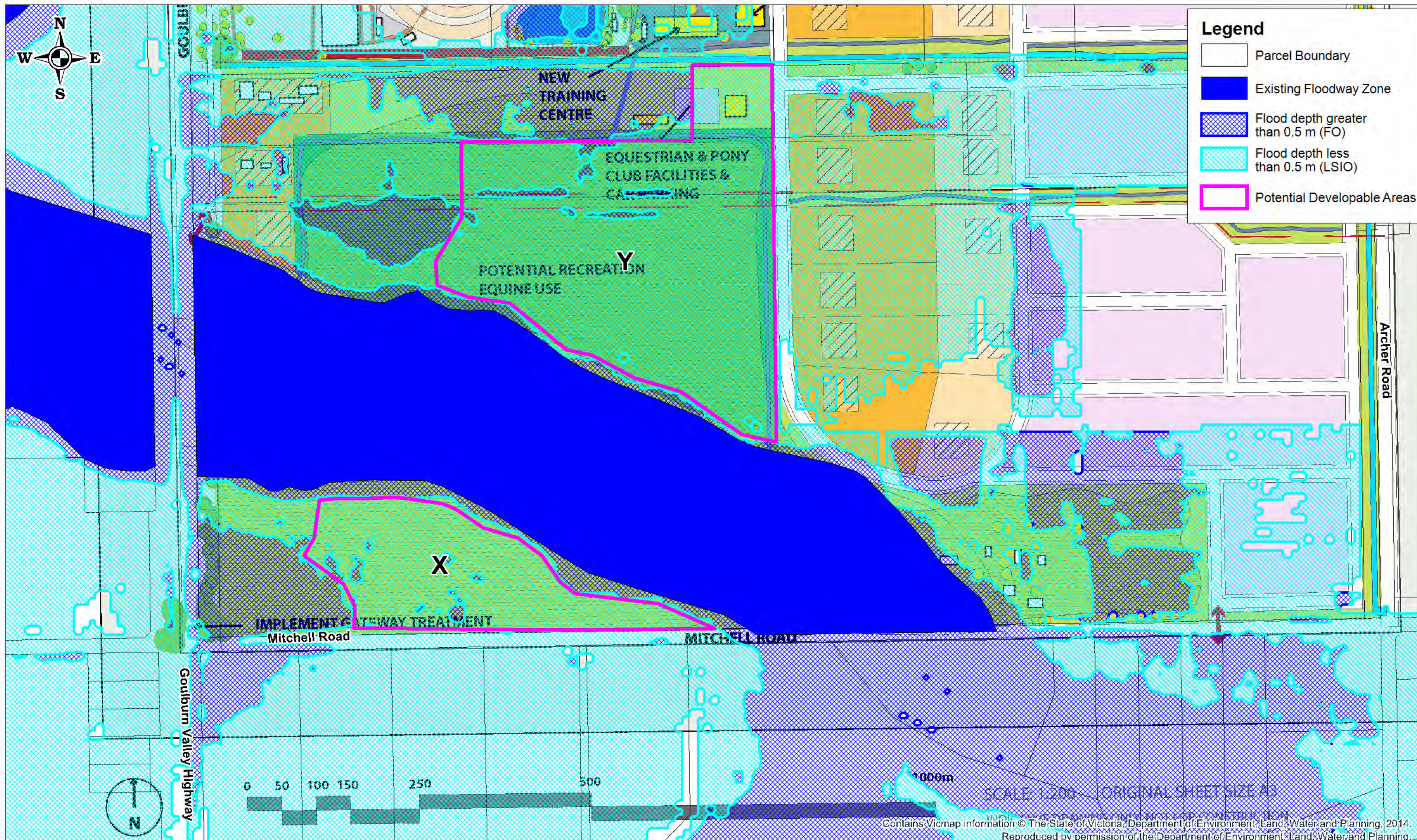
215 Mitchell Road Kialla

Potential Flood Overlays
 Engeny Adjusted 1% AEP Flood Model

Job Number: V1177_001
 Revision: 0
 Drawn: GO
 Checked: AP
 Date: 24 May 2017

APPENDIX O

Southern Area Potential Extra Development Areas



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 E: melb@engeny.com.au



0 100 200
 Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55

215 Mitchell Road Kialla

Potential Flood Overlays
 Engeny Adjusted 1% AEP Flood Model
 Potential Developable Area

Job Number: V1177_001
 Revision: 0
 Drawn: GO
 Checked: AP
 Date: 21 June 2017