WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Final Report

T4328 – BASELINE SURFACE WATER ASSESSMENTS – WIM100

Iluka Resources Limited

19 June 2019

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19 June 2019

Marcus Little
Principal Environmental Specialist
Iluka Resources Limited

Via email marcus.little@iluka.com

Dear Marcus

T4328 – BASELINE SURFACE WATER ASSESSMENTS – WIM100

Please see the attached Baseline Surface Water Assessment for the WIM100 project area (formerly referred to as the WIM100 East project area).

This report is the final report which documents the data collation and flood risk assessment for WIM100.

If you have any comments, please don't hesitate to contact me.

Yours sincerely

Ben Hughes
Principal Engineer

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WATER TECHNOLOGY PTY LTD

CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Iluka Resources Limited (Iluka) holds Exploration Licence EL4282 in the southern Wimmera region south of Horsham. Heavy mineral sand deposits have been identified through exploration drilling within EL4282, and Iluka have defined three adjacent project areas covering the identified in-ground resource; WIM50, WIM50 North and WIM100 (formerly WIM100 East). This report outlines the data collated and determines the hydrological and hydraulic characteristics, as well the biodiversity values and linkages between the hydrological regime and biodiversity values within the WIM100 project area, as shown in Figure 1-1.

All surface water termination points and flow paths are a considered to be sensitive environmental receptors from both an environmental and agricultural water user perspective. Water quality and quantity in overland flow paths should be understood and maintained.

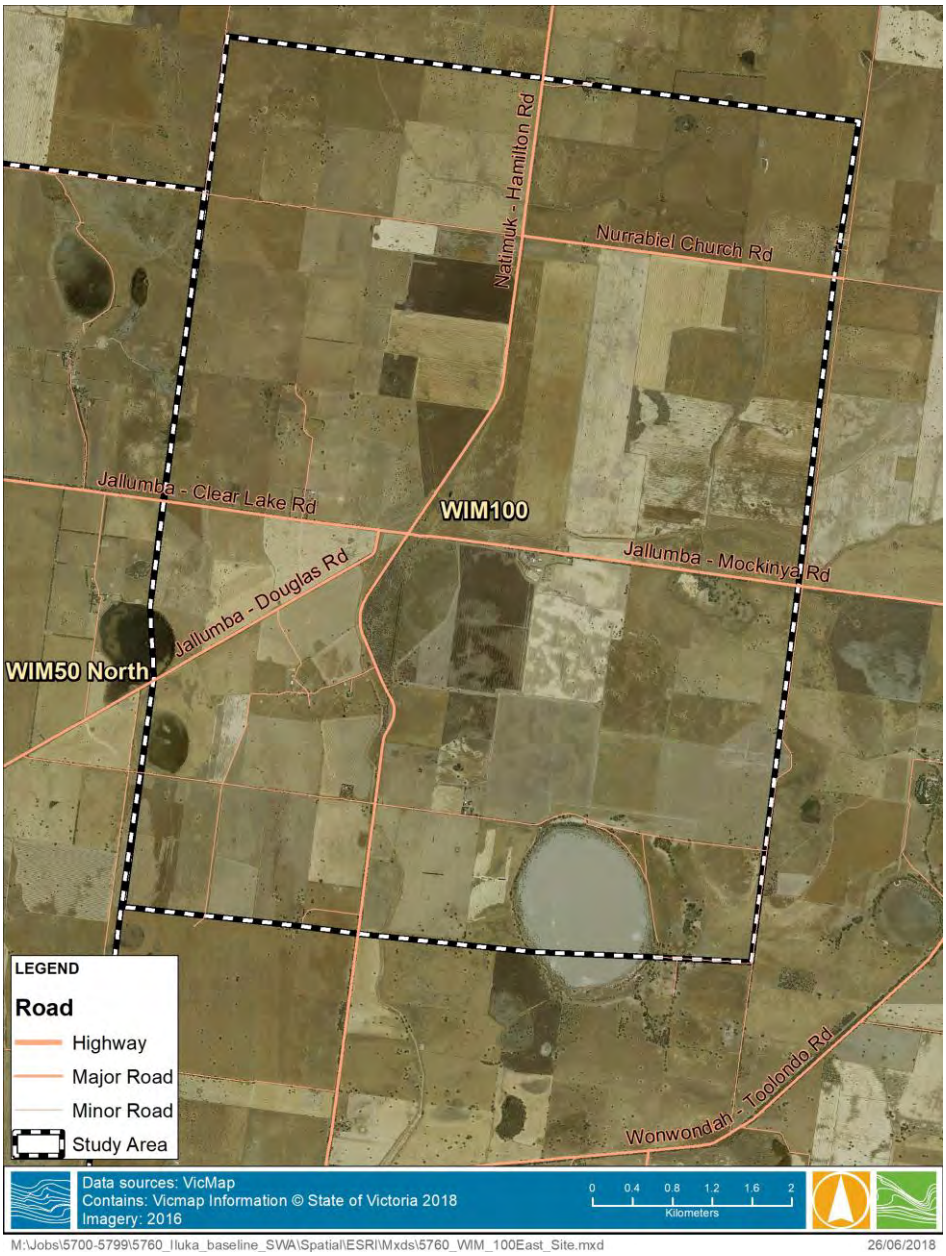


FIGURE 1-1 WIM100 STUDY AREA

2 REPORTING STAGES AND SCOPE

This report outlines the data collated and baseline hydrological, hydraulic and ecological regimes across the WIM100 project area. The report forms Stage 4 of the project, with all stages listed below:

- Stage 1 – Project Inception Meeting (complete).
- Stage 2 – Data Collation and Review (complete).
- Stage 3 - Modelling and Draft Reporting (complete).
- **Stage 4 – Final Reporting (this report)**

The objectives this report addresses were outlined in the project brief, and are as follows:

- Identify hydrologic controls (topographic and infrastructure) and surface water drainage lines (including differentiation between water distribution channels that are redundant or still in use) (the presence and status of topographic and infrastructure features is discussed in Section 5.3.2, while their impact is discussed in Section 6.4).
- Identify surface water catchments (both upstream of and within the project areas) and flow patterns across each deposit project area (Section 0).
- Determine design rainfall events for each deposit project area (Section 6.1).
- Determine peak flood flow rates and volumes at key locations within the surface water drainage network at each project area for design rainfall events (Section 0).
- For each project area review the potential for flood risk, and whether sufficient information is available to undertake flood modelling and flood risk mapping (Section 7).
- Recommend the most appropriate and cost-effective approach for developing any recommended flood risk mapping (Flood risk mapping is discussed in Section 6.4 shown in Appendix A).
- Identify and describe any significant surface water dependent ecological systems which may be impacted by changes to existing surface water regimes for each deposit project area (Section 0).
- Develop key data sets for surface water hydrology across the deposit project areas that will underpin any future impact assessments (results were provided as model result files that can be used to extract flow rates and volumes).
- For each deposit project area identify any recommended surface water monitoring locations (Section 7.2).
- A suite of surface water quality monitoring parameters and associated monitoring frequency (Section 7.2).

3 DATA COLLATION

3.1 Overview

This data collation completed as part of this project outlined the data availability within WIM100, highlighting any shortfalls or gaps which were either filled or determined as minor enough not to impact project outcomes. The data collation is discussion and figures also mention the WIM50 and WIM50 North project areas, which are in direct proximity to the WIM100 project area. The primary data required for the surface water assessment within included:

- High Resolution LiDAR
- Satellite and Aerial Imagery
- Rainfall data
- Streamflow Data (where appropriate)
- Spatial Land Use (planning zones, overlays, roads, rail, land parcels)
- Hydraulic Structures

Water Technology are an authorised re-seller of VicMap data, which includes LiDAR, Satellite Imagery, Spatial land use and hydraulic structures (limited availability). In most cases, Water Technology already has access to the required data, however some gaps are present.

3.2 Previous Studies

Two major relevant studies have been completed in proximity to the project area, these include:

- Water Technology (2013) Natimuk Flood Investigation Study Report
  - The Natimuk Flood Investigation completed runoff routing and hydraulic modelling of the Natimuk Creek catchment. The model outputs were used to develop flood mapping and flood intelligence products for the Natimuk township. The hydrological model parameters using during this study will be utilised as a basis for those adopted or as a comparison to those adopted during modelling of the Wimmera study areas.
- SKM (2006) Wetland Extent and Drainage Line Mapping Project
  - This project mapped wetlands and drainage lines across the Wimmera CMA management region using generalised GIS techniques. The layers were used as a reference for assessing potentially impacted areas within the Wimmera study areas.

Wetland Extent and Drainage Line Mapping Project[1] and Natimuk Flood Investigation[2] were reviewed and informed key parts of the modelling undertaken in this project.

[1] Wetland Extent and Drainage Line Mapping Project, SKM 2006
[2] Natimuk Flood Investigation, Water Technology 2012

3.3 Hydrological Data

3.3.1 Rainfall Data

Rainfall data from the Bureau of Meteorology is available on a daily and sub-daily basis. Water Technology has access to this data through numerous previous projects across Victoria. Figure 3-1 shows the location of rainfall gauges across the Wimmera region.

Daily rainfall data is available across Australia at relatively high densities, however, sub-daily gauges (pluviographs) recording six minute increments, are less common. In both locations one pluviograph is within 30km of the investigation area, along with numerous daily rainfall gauges. At distance of 30km from a site of interest the rainfall data measured by a pluviograph is unlikely to closely represent rainfall totals occurring at that site, however it can provide guidance for the temporal distribution of rainfall totals measured at closer, more representative daily rain gauging stations. Further discussion on the use of sub daily rainfall stations for mine operation will be included in the assessment reporting.

The gauges in proximity to the WIM100 project area include:

- Sub-daily Gauges:
  - Kanagulk (79097).
- Daily Gauges:
  - Clear Lake (79008).
  - Telangatuk (79078).

Sub-daily rainfall records for the Clear Lake gauge, as shown in Figure 3-1.

Annual rainfall across the closest gauges is quite low with averages ranging from 611 mm/year (Balmoral) to 437 mm/year (Natimuk).

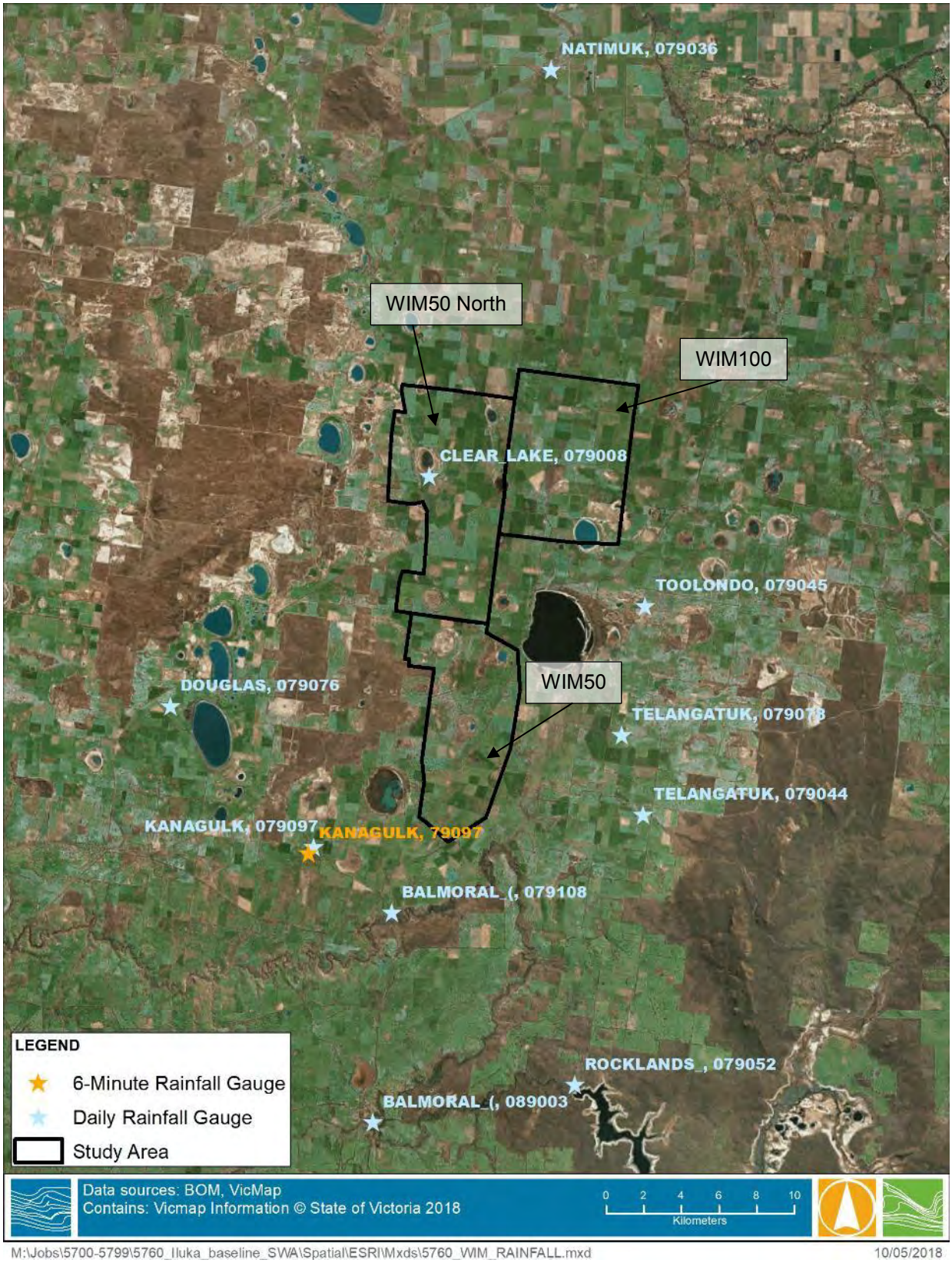


FIGURE 3-1 RAINFALL GAUGE LOCATIONS – WIMMERA

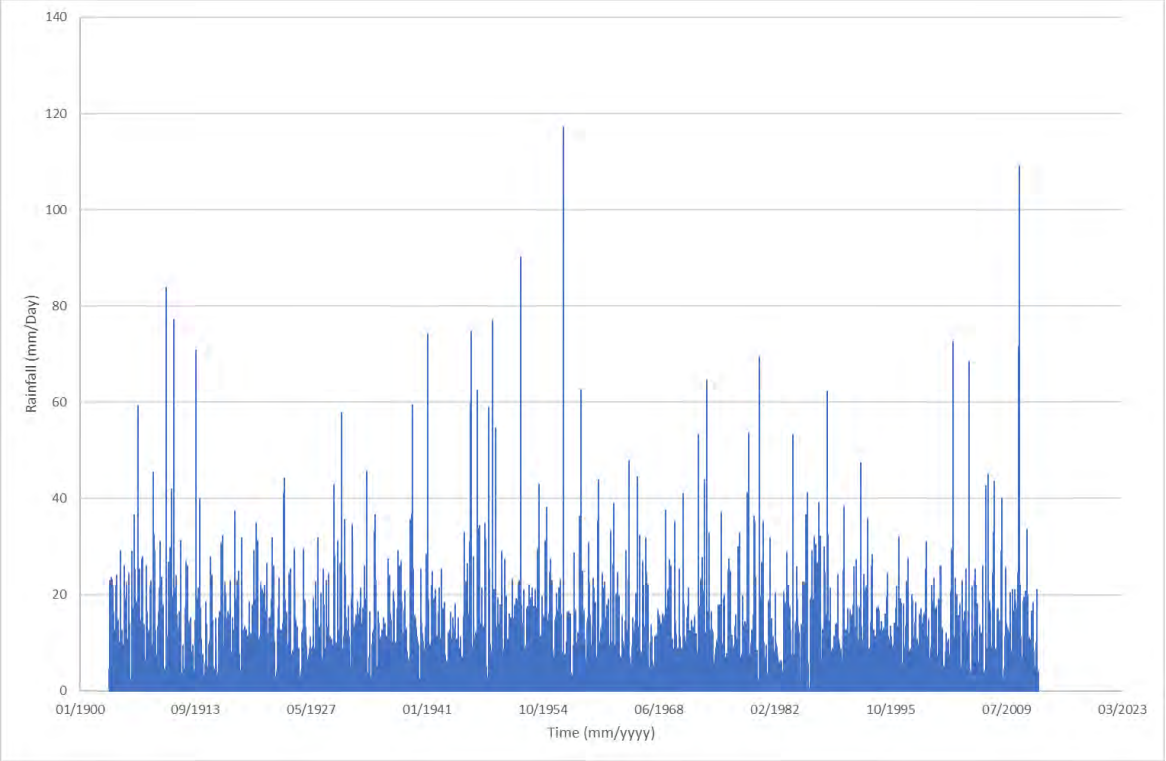


FIGURE 3-2 DAILY RAINFALL DATA AT CLEAR LAKE (79008)

3.3.2 IFD Data

Intensity Frequency Duration (IFD) curves and data is available across both catchments from the Bureau of Meteorology. IFD data was obtained for the region across a range of Annual Exceedance Probabilities (AEP) and used for input into hydrological and/or hydraulic models, depending on the modelling method.

Figure 3-3 shows the IFD data for the Wimmera region for standard Bureau of Meteorology AEPs from 63.2% (2 year ARI) to 1% (100 year ARI). This data has been extracted at the area centroid.

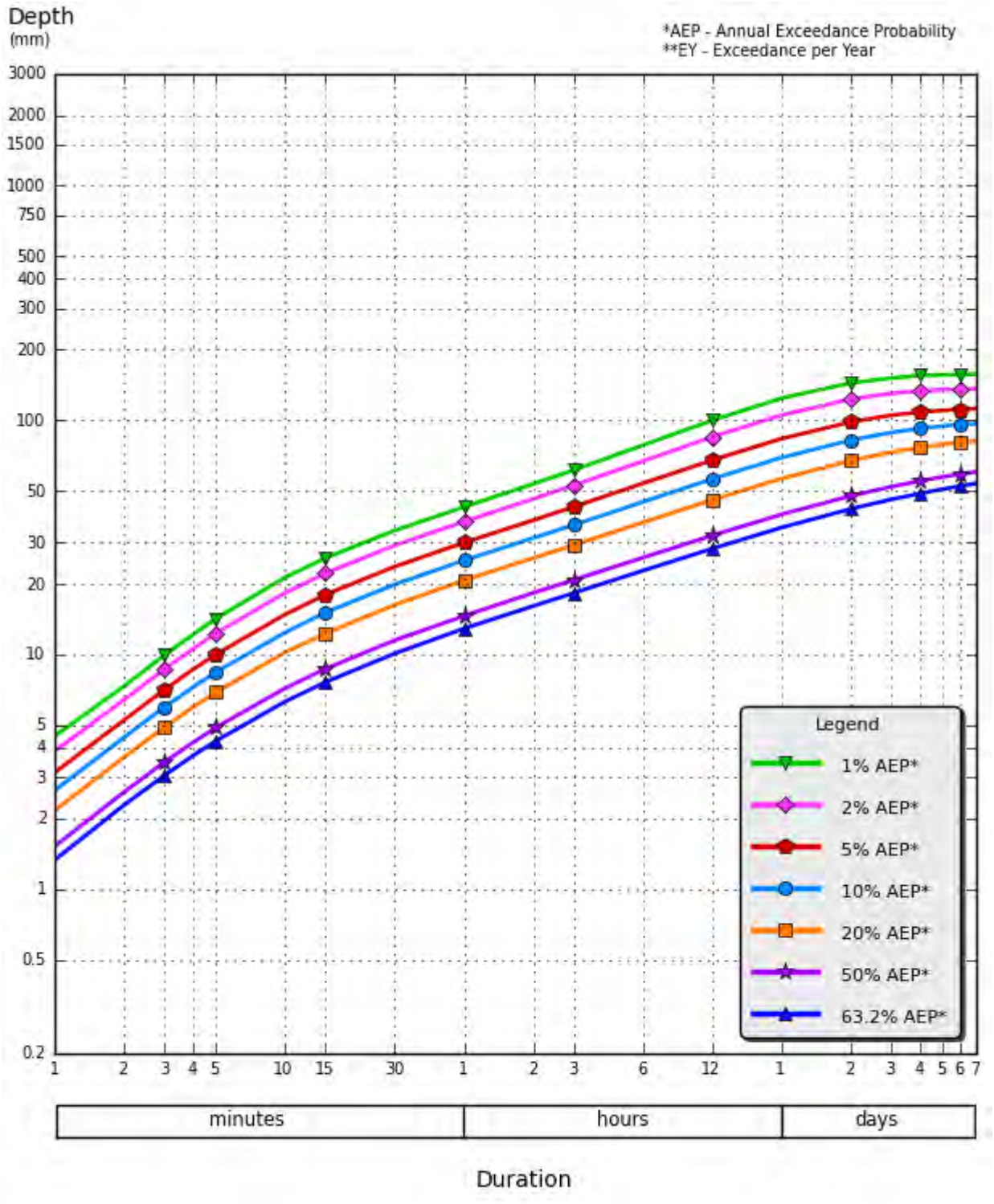


FIGURE 3-3 IFD DATA FOR WIMMERA (36.9125 (S), 141.8625 (E))

3.4 Streamflow/height/quality data

There are no streamflow/height/quality gauges within or close to the WIM100 project area, however there are several gauges around Toolondo Reservoir south of the WIM100 project area. Unfortunately, these gauges are all related to water supply and their records are an indication of water transferred by operated infrastructure rather than natural streamflow.

If development of the subject site is to occur specific water quality gauging will be required. Flow and water level gauging is not anticipated to be necessary. Potential locations for water quality gauging are discussed in Section 8.3.

The location of the gauges in proximity to the WIM100 project is shown in Figure 3-4.

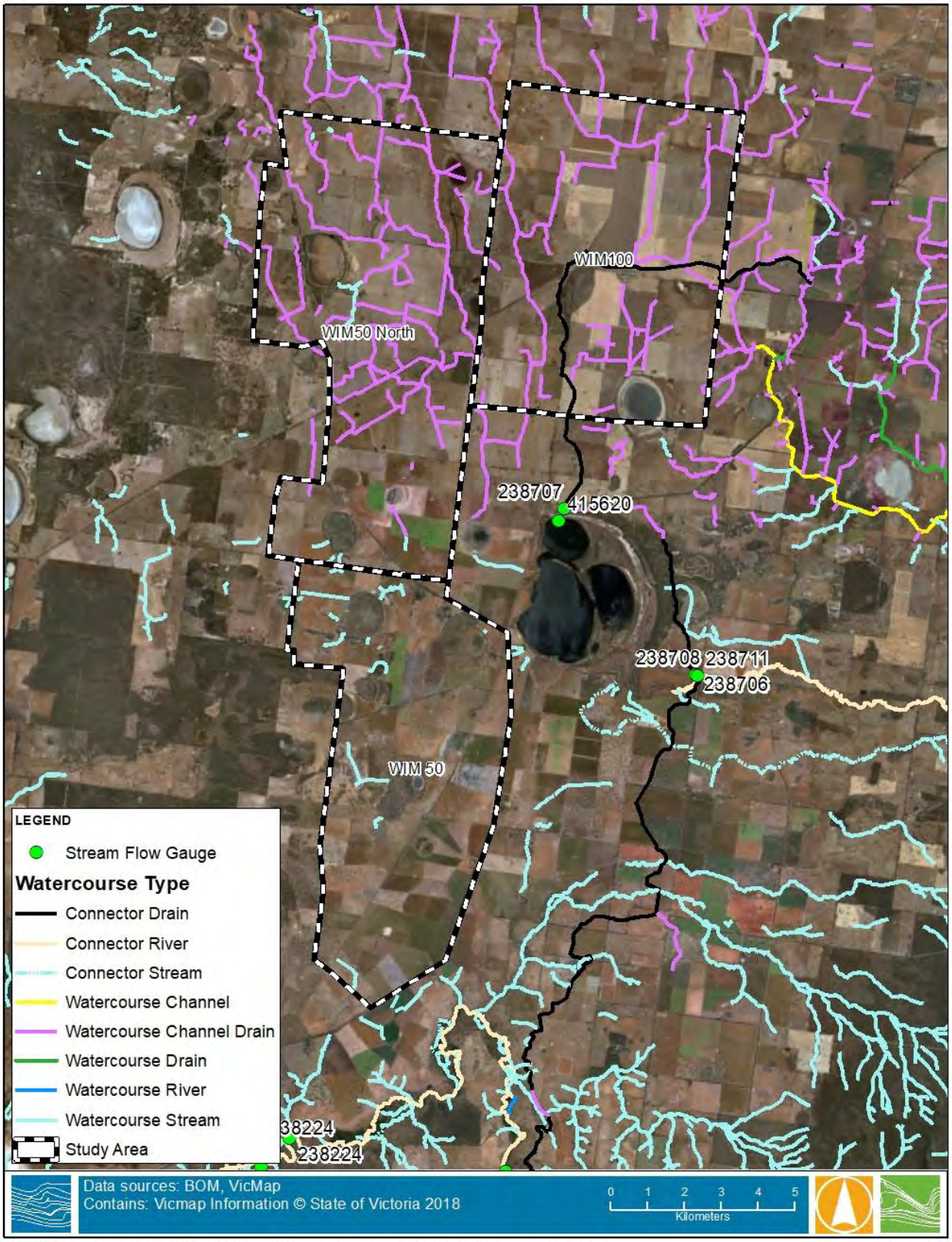


FIGURE 3-4 STREAMFLOW GAUGE AVALIABILITY - WIMMERA

3.5 Spatial Data

3.5.1 Topographic Data

Topographic LiDAR data across Victoria is available to Water Technology through DELWP. The quality of this data is measured in terms of its vertical and horizontal accuracy and grid resolution. The availability of data across the Wimmera region is outlined Table 3-1, detailing the key Metadata for each dataset across the Wimmera region.

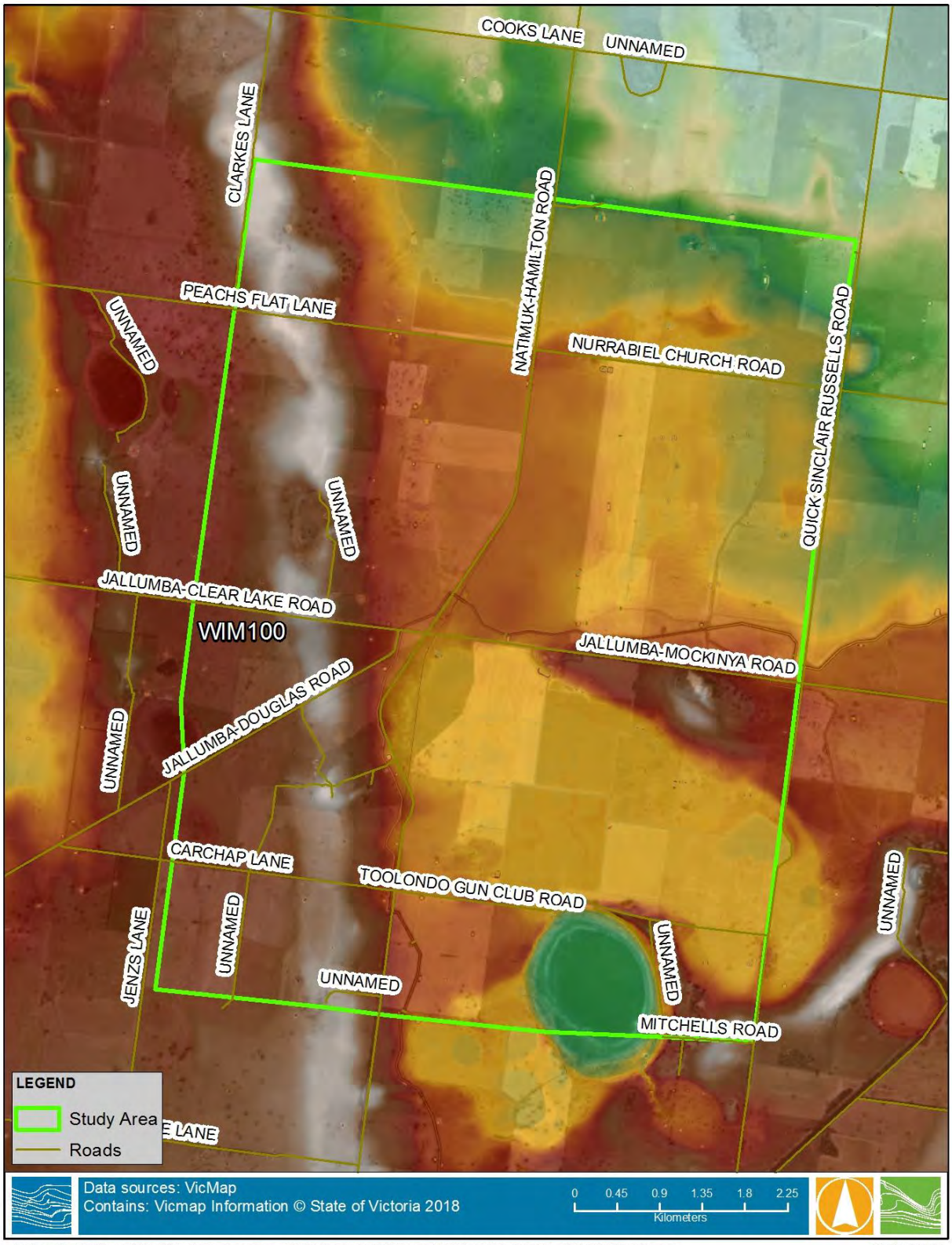
TABLE 3-1 LIDAR METADATA SUMMARY - WIMMERA

Dataset	Date of Capture	Point Density	Horizontal Accuracy (m)	Vertical Accuracy (m)	Resolution
2009-10 Victorian State-wide Rivers LiDAR Project - Wimmera CMA	20/10/2010	4 pts/m^2	0.3	0.2	1m
2011-12 Floodplains LiDAR Stage 2 - Wimmera CMA	8/12/2011	1.8 pts/m^2	0.2	0.1	1m
2009-10 Victorian State-wide Rivers LiDAR Project - Glenelg Hopkins CMA	1/12/2009	4 pts/m^2	0.3	0.2	1m
2005 Wimmera CMA LiDAR	2005	-	-	0.5	2m
VicMap State-wide DTM 10m	-	-	-	-	10m
VicMap State-wide DTM 20m	-	-	-	-	20m

The 2011-12 and 2005 LiDAR datasets have been verified to road crest feature survey across several projects to demonstrate their accuracy, most notably the Natimuk Flood Investigation[2]. The more recent data was shown to be more consistent but both datasets were within their stated accuracy and suitable for use as the basis for flood mapping.

During this project the 2005 Wimmera CMA LiDAR was adopted as the preferable dataset and completely covered the WIM100 project area

This data is shown in Figure 3-5.



Q:\Archive\5700-5799\5760_Iluka_baseline_SWA\Spatial\ESRI\Mxds\5760_WIM_LIDAR_AVALIABILITY.mxd 29/05/2019

FIGURE 3-5 TOPOGRAPHY AVALIABILITY – WIM100 – 2005 WIMMERA CMA LIDAR

3.5.2 Satellite and Aerial Imagery

Imagery across the Wimmera region is available through VicMap, across a range of projects. Table 3-2 and Table 3-3 show the availability of imagery across the Wimmera region. Table 3-2 outlines the datasets with full coverage while Table 3-3 shows datasets with partial coverage.

TABLE 3-2 WIMMERA (FULL COVERAGE)

Imagery Project	Capture Date
2012-13 South West Rural Photography: Horsham	24 Jan 2013 - 17 Feb 2013
2016 Wimmera Rural Horsham LGA	22 Dec 2016

TABLE 3-3 WIMMERA (PARTIAL COVERAGE)

Imagery Project	Capture Date
2016-17 Wimmera Towns Aerial Photography: Toolondo	22 Dec 2016
2016-17 Wimmera Towns Aerial Photography: Clearlake	22 Dec 2016
2012-13 South West Rural Photography: Southern Grampians	24 Jan 2013 - 17 Feb 2013
2011 Floods-Natimuk Photography	12 Jan 2011
2010-11 Floods – Wimmera & Yarriambiack Ck Floodplains	18 Jan 2011 - 22 Jan 2011

3.6 Planning Scheme Overlays

The WIM100 project area falls within the Horsham Rural City Council local government area. The Planning Scheme contains a range of Planning Overlays relevant to this surface water assessment project as shown in Table 3-4 and Figure 3-5 below.

TABLE 3-4 WIMMERA PLANNING OVERLAY DESCRIPTIONS

Zone Code	Zone Description (Horsham)
LSIO	LAND SUBJECT TO INUNDATION OVERLAY
ESO2	ENVIRONMENTAL SIGNIFICANCE OVERLAY - SCHEDULE 2
ESO4	ENVIRONMENTAL SIGNIFICANCE OVERLAY - SCHEDULE 4
ESO5	ENVIRONMENTAL SIGNIFICANCE OVERLAY - SCHEDULE 5

The most significant layers in the Wimmera region are the ESO4 and LSIO as they cover the largest region.

Schedule 2 to the ESO is for the Natimuk-Douglas Wetlands. The Horsham planning scheme outlines the following requirements.

Statement of Environmental Significance (ESO2)

The Natimuk-Douglas Wetlands consist of more than 30 saline and freshwater lakes. The lakes are seasonally visited by substantial numbers of migratory water birds and on this basis have been nominated as wetlands of

international significance under the RAMSAR Convention. Grazing and other activities in the vicinity of the lakes have threatened plant species and habitat values.

Environmental Objective to be Achieved (ESO2)

- To protect, maintain and enhance the environmental qualities of the Natimuk-Douglas Wetlands
- To ensure the Natimuk Douglas Wetlands are preserved as a haven for migratory birds
- To limit the impact of farming and other activities upon the Natimuk Douglas Wetlands, by encouraging the fencing of wetlands from stock
- To encourage the revegetation of wetlands where appropriate, in consultation with the Department of Sustainability and Environment

Schedule 4 to the ESO is for Water Catchment Protection. The Horsham planning scheme outlines the following requirements.

Statement of Environmental Significance (ESO4)

The Wimmera Systems Proclaimed Catchment (Special Water Supply Catchment Area listed in Schedule 5 to the Catchment and Land Protection Act 1994) in the southern area of the municipality supplies water to Horsham and the wider region. Maintaining the quality of water supply in the catchment is an environmental and economic imperative.

Environmental Objective to be Achieved (ESO4)

- To ensure the protection and maintenance of water quality and water yield within the Wimmera Systems Proclaimed Catchment.

Schedule 5 to the ESO is for Channel and Reservoir Protection. The Horsham planning scheme outlines the following requirements.

Statement of Environmental Significance (ESO5)

Wimmera Mallee Water supplies domestic and stock water to more than 60,000 people and properties across the supply region. The security of supply and protection of channels and reservoirs from potential sources of pollution is critical to the operation of one of Victoria's largest water supply systems.

Environmental Objective to be Achieved (ESO5)

- To maintain and enhance the quality and supply of irrigation and domestic water throughout the Wimmera region.
- To protect water reservoirs and channels from potential sources of pollution.

The LSIO layer has a range of restrictions which will contingent on the type of construction, the general requirements are ensuring no obstruction to overland flow, ensuing all building floor levels are constructed a minimum of 300mm above the 1% AEP flood level and safe access and egress from the site can be achieved.

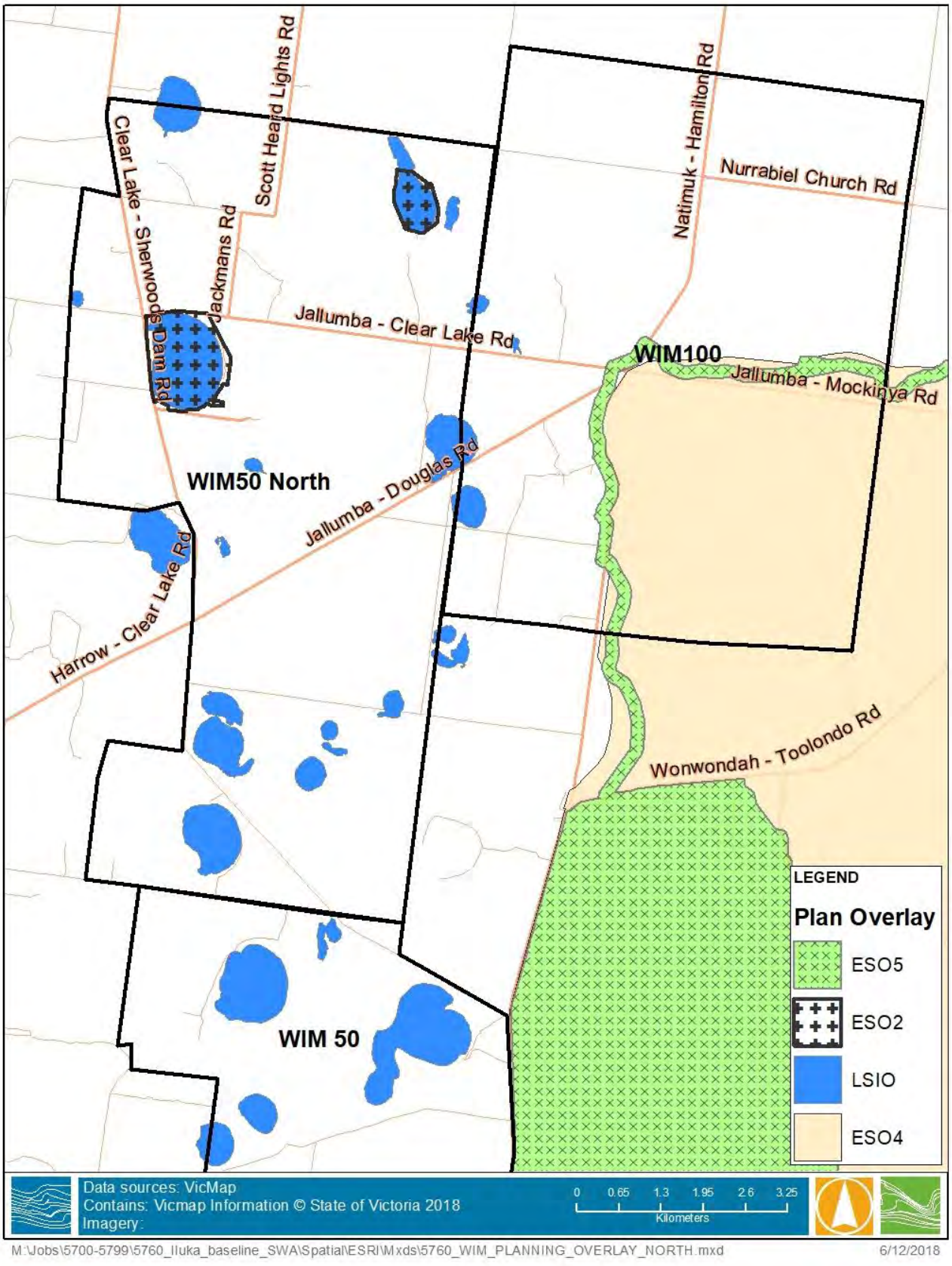


FIGURE 3-6 WIMMERA PLANNING OVERLAYS

3.7 Previous Investigations

3.7.1 Overview

The Request For Quotation (RFQ) issued by Iluka Resources listed several projects which may add value to the assessment of WIM100. These are listed below including commentary on their applicability for this project:

- McAuley & Armour, 1992 Preliminary Hydrogeological Assessment of the Relationship between the Rocklands-Toolondo Channel and Land Degradation, Telangatuk East Area.
  - Study area was south of the WIM100 project area in the Glenelg River catchment. The focus of the investigation was the impact of seepage from the Rocklands-Toolondo-Channel on land degradation in the Telangatuk East area. Although the background useful, the study focused on a specific issue which will not be relevant for development of the Wim100 subject site.
- Smart J, 2001(b) Lakes and Swamps in the Douglas-Toolondo Area - Report to Basin Minerals Holdings N.L.
  - The objective of the investigation was to provide an understanding of the hydrogeology of the lakes and swamps in the Douglas – Toolondo area and to establish the means of on-going monitoring of selected lakes and swamps near areas likely to be mined. The study area was south east of the WIM100 project area. There is mention of Jallumba Marsh within the report.
- Martinick McNulty, 2001 Surface Water Runoff Assessment Douglas Project – Stage 1 Area.
  - This project was superseded by the Douglas Mine Surface Water Management System Modelling – Update (Water Technology, 2017).
- URS, 2008(a) Proposed Project Echo: Surface Water, Groundwater and Water Supply Desktop Assessment.
  - The aim of the study was to collate all relevant information sources on the surface water and groundwater for a proposed mine area around Nurrabiel, east of the WIM100 project area. Of relevance to this report, the study noted the area to be relatively flat to gently sloping with a number of low lying areas or wetlands that are subject to inundation.
- URS, 2009 Surface Water and Groundwater Desktop Assessment –BEFN Project.
  - The aim of the study was to collate all relevant information sources on the surface water and groundwater for a proposed mine area around between Toolondo ad Douglas, west of the WIM100 project area. Of relevance to this report, the study noted there is potential for surface water to be diverted from current drainage paths, waterways and wetlands but no analysis was undertaken
- Water Technology, 2013 Natimuk Flood Investigation Study Report.
  - The study completed flood modelling north of the WIM100 project area for the township of Natimuk. The modelling undertaken was calibrated and provided a basis for the model parameters adopted in this project. Further detail is provided below.
- Water Technology, 2017(a) Douglas Mine Surface Water Management System Modelling.
  - This project was superseded by the Douglas Mine Surface Water Management System Modelling – Update (Water Technology, 2017).
- Water Technology, 2017(a) Douglas Mine Surface Water Management System Modelling –Update (draft)
  - The project was a specific surface water management plan for the Douglas Mine south east of the WIM100 project area. The project was used for a base understanding of mineral sand mine operations to ensure the outputs from this project suit Iluka's requirements.

3.7.2 Natimuk Flood Investigation

Modelling covering the northern end of the WIM100 project area was completed during the Natimuk Flood Investigation[2]. The extents of this model are shown in Figure 3-7. This study covered a small area of the WIM100 project area and had relevant of rainfall infiltration losses. The model adopted a Rain on Grid methodology and was verified to more detailed calibrated modelling within Natimuk.

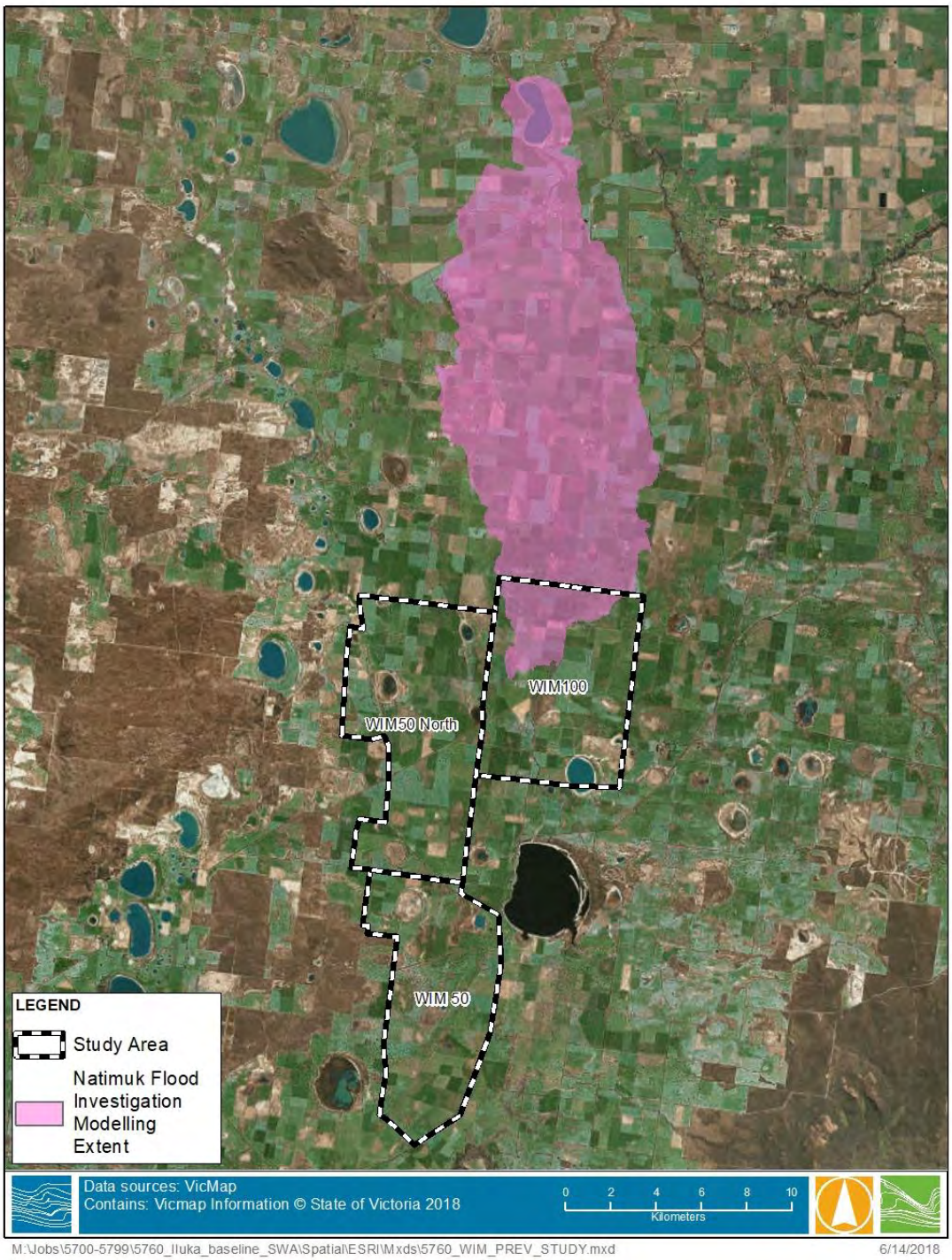


FIGURE 3-7 WIMMERA – PREVIOUS FLOOD MODELLING EXTNET

3.8 Legislative Requirements

3.8.1 Natural Watercourses and Wetlands

The *Water Act 1989* defines a 'designated waterway' as "a natural channel in which water regularly flows, whether or not the flow is continuous". Within Victoria, each CMA has a mapping of their designated waterways. WIM100 is at the southern end of the Wimmera CMA management region. Wimmera CMA has statutory responsibilities under the Water Act 1989 and 'By-law No.2 Waterway Protection 2014' to monitor, manage, enforce, and administer control over all works which may impact upon designated waterways throughout the Wimmera region to ensure works undertaken do not adversely affect the health of those waterways.

Not only natural waterways fall within the classification of a designated waterway with numerous man-made channels also featuring in the CMA mapping.

Designated waterways are outlined in Figure 3-8 for the WIM100 project area, they are limited to excavated channels (Toolondo channel, Arapiles channel) and Red Gum Swamp.

Drainage works to be connected (directly or indirectly) to a designated waterway must not occur without the permission of Wimmera CMA through a Works on Waterways Licence. Furthermore, drainage works that are connected to designated waterways cannot be altered or removed without the permission of the Wimmera CMA.

Additional to the designated waterways within the WIM100 project area (with Wimmera CMA statutory authority), mapping used by GWMWater shows numerous waterways, as shown in Figure 3-9. These are highlighted as "Watercourse Channel Drain".

Various waterways and decommissioned channels are present the Wimmera region. Channels throughout the WIM100 project area have been picked up in the LiDAR survey, and were therefore included in this assessment. Further detail around these channels is included in Section 5.3.2 with reference to the hydraulic model results. Similarly, there are several wetlands highlighted across Wimmera region. As noted in Section 3.2, these were mapped in 2006 by Wimmera CMA.

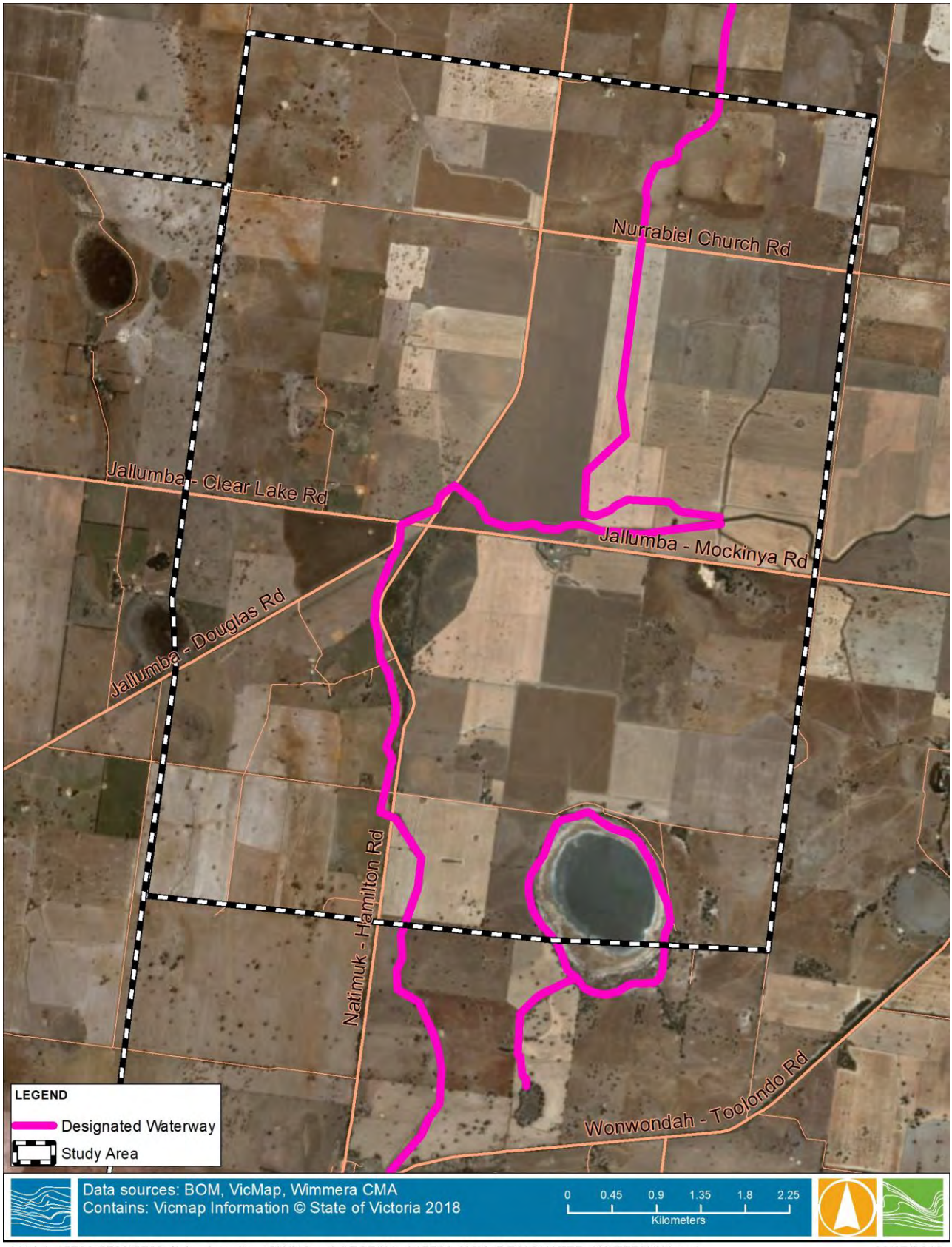


FIGURE 3-8 DESIGNATED WATERWAYS IN THE WIM100 PROJCT AREA

FIGURE 3-9 GWMWATER CHANNEL SYSTEM

3.8.2 Surface water quality - State Environmental Protection Policy

The State Environmental Protection Policy (Waters of Victoria – January 2018) (SEPP) are intended to help protect Victoria's water environments by providing a set of agreed environmental outcomes. In terms of this project, this revolves around the quality of surface water entering and exiting prospective project site. The project brief referred to several key water quality indicators and categories, these are outlined in Table 8-1 along with their associated objectives for rivers and streams outlined in the SEPP draft policy for surface waters in lowland river reaches of the Wimmera catchments and the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for fresh and marine water quality (Toxicant default guideline values for protecting aquatic ecosystems 2018). A table of available toxicants in the ANZECC guidelines has been provided as an attachment.

TABLE 3-5 SEPP AND ANZECC SURFACE WATER CHEMISTRY OBJECTIVES

Water quality indicator	Physical/Chemical objective
SEPP Waters of Victoria (Draft 2018)	
Salinity (µS/cm@ 25°C)	≤2000
Acidity/alkalinity (pH units)	≤6.8 and ≤7.8 (25th and 75th percentiles)
Total Phosphorus (µg/L)	≤50
Total Nitrogen (µg/L)	≤900
Dissolved oxygen (percent saturation)	≥65 and 110 (25th percentile and maximum)
Turbidity (NTU)	≤40 (75th percentile)
ANZECC (99% level of species protection)	
Ammonia (NH3) (Total) (µg/L)	320
Aluminium (pH >6.5) (µg/L)	27
Arsenic (AsIII) (µg/L)	1
Arsenic (AsV) (µg/L)	0.8
Boron(µg/L)	90
Cadmium (µg/L)	0.6
Chromium (CrVI) (µg/L)	0.01
Copper (µg/L)	1
Cyanide (µg/L)	4
Lead (µg/L)	1
Manganese (µg/L)	1200
Mercury (µg/L)	0.06
Nickel (µg/L)	8
Selenium (µg/L)	5
Silver (µg/L)	0.02
Thallium (µg/L)	0.03

Water quality indicator	Physical/Chemical objective
Uranium (µg/L)	0.5
Zinc (Total) (µg/L)	2.4
Chlorine (µg/L)	0.4

4 INITIAL SITE VISIT

The initial site visit to the Wimmera area was also used to identify areas of interest including culverts, flow restrictions and wetlands. All sites were inspected from public roads or reserves, and no access to private land was undertaken. Figure 4-1 and Figure 4-2 show the points of interest and locations of wetlands throughout the Wimmera region as identified in the site visit. Table 4-1 shows the images from the site visit and associated point of interest.

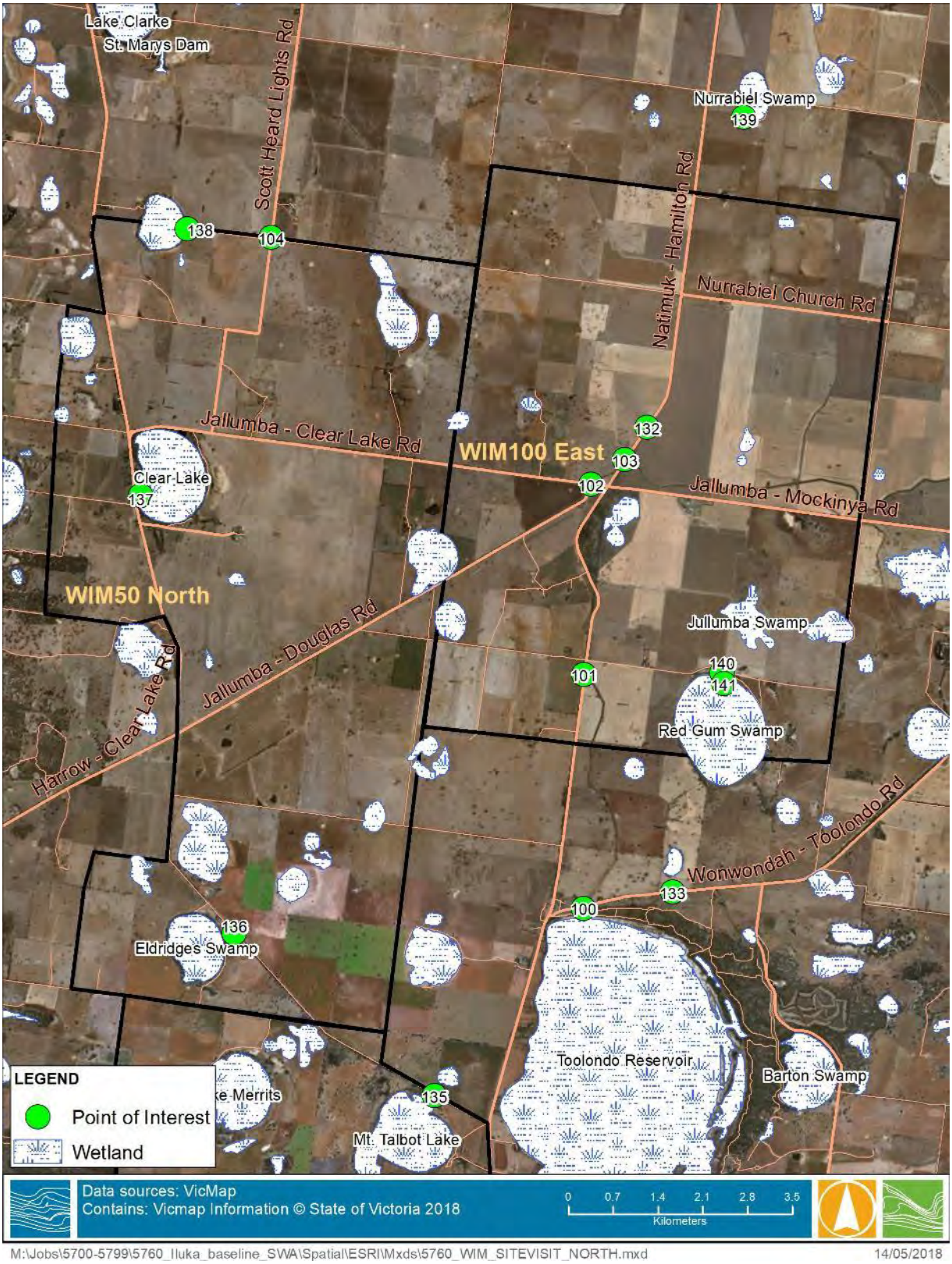


FIGURE 4-1 POINTS OF INTEREST AND WETLANDS (WIMMERA – NORTH)

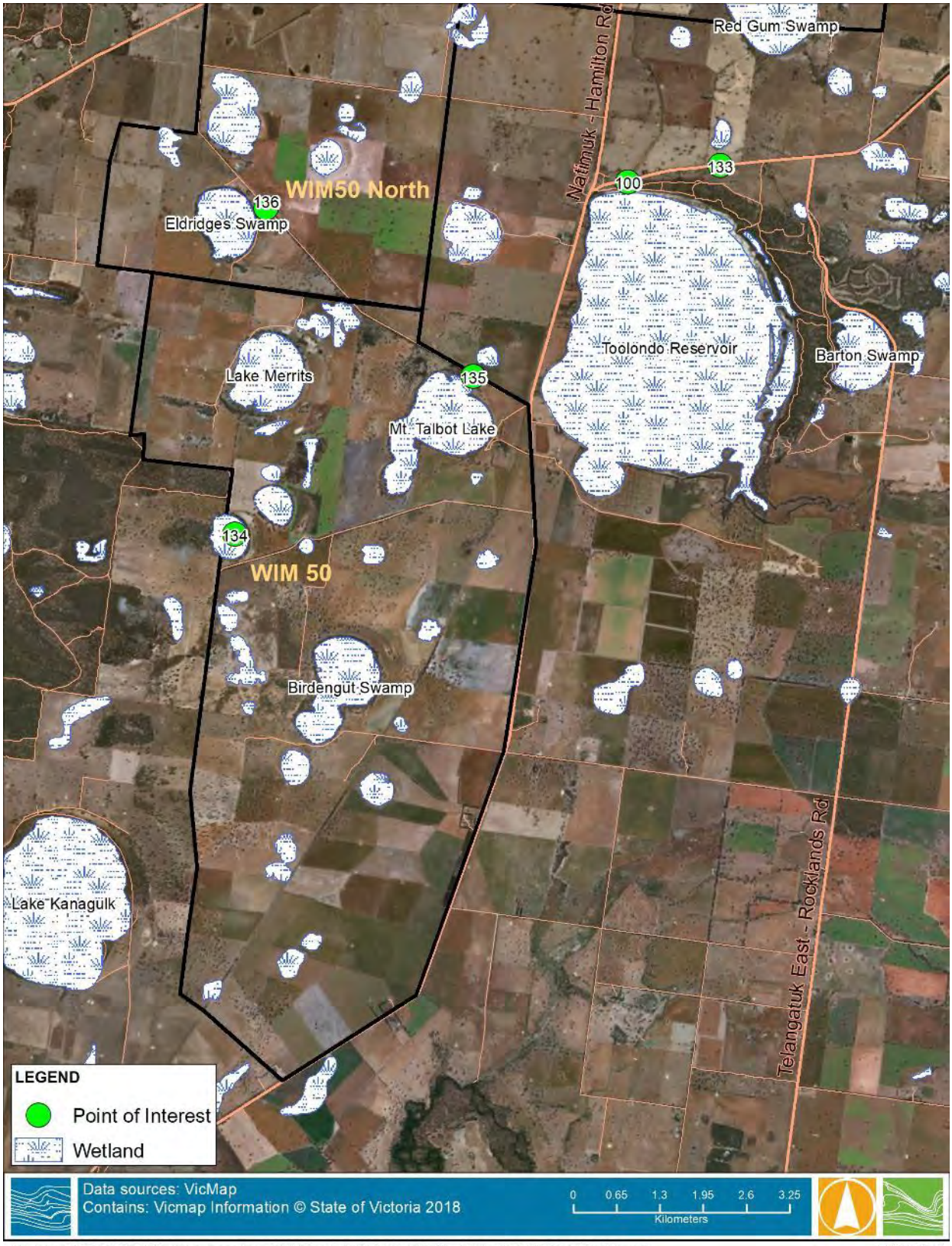


FIGURE 4-2 POINTS OF INTEREST AND WETLANDS (WIMMERA – SOUTH)