

# Lake Wellington Catchment Land and Water Use Mapping

Agriculture Victoria Research

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## INTRODUCTION

This project is undertaken by Agriculture Victoria Research (AVR) in partnership with the West Gippsland Catchment Management Authority (WGCMA) and Southern Rural Water (SRW) to develop an accurate land use map/database for the Lake Wellington catchment area, and design a program for a cost effective and monitoring of land use change over time. Outputs from this project are used to provide critical information and data to inform current management and future projects such as planning and prioritising Sustainable Irrigation Program (SIP) program delivery and investment for the best outcomes / most efficient delivery, and measure and monitor the impacts of irrigation modernisation. This report outlines the project background, outcomes, methodology and analysis of results as confirmed at the project inception meeting.

### Project outcomes

The provision of a contemporary land use database will support SIP program partners, including the WGCMA, Agriculture Victoria (AV) and SRW to improve current management and future planning for the management of land and water resources and delivery of services in the Lake Wellington catchment area.

### Project background

#### **The Sustainable Irrigation Program and Lake Wellington Land and Water Management Plan**

The WGCMA delivers the SIP in West Gippsland in collaboration with partners from Department of Environment, Land, Water and Planning (DELWP), AV and SRW.

The aim of the SIP in West Gippsland is for a productive, efficient and sustainable irrigation industry supported by improved irrigation infrastructure. The program delivers farm planning, on-farm incentives, extension support, research and development to the Gippsland irrigation community with a focus on the Lake Wellington catchment area. The health of the Gippsland Lakes and the regions waterways, soils and biodiversity are protected by reducing irrigation losses, managing drainage and delivering salinity and nutrient management support. Resilience to drought and climate change is improved through increased water use efficiency whilst improving agricultural productivity. The program works alongside MID2030 modernisation activities in the Macalister Irrigation District (MID) to leverage government investment and amplify regional outcomes.

The SIP program is guided by the Lake Wellington Land and Water Management Plan (LWMP), which was developed in 2018 to replace the 2008 Macalister Land and Water Management Plan, and the 2005 West Gippsland Salinity Management Plan. The Lake Wellington LWMP provides a roadmap of priorities and programs for sustainable irrigation and has expanded the plan to encompass the Lake Wellington catchment (catchment area shown in Figure 1). The Plan addresses irrigation land and water management throughout Lake Wellington catchment, reflecting the presence of irrigation outside of the Macalister Irrigation District (MID) and the growing investment in new irrigation developments at various locations in the catchment.

#### **Land use in the Lake Wellington catchment**

Irrigation land use and management practices in the Lake Wellington catchment are changing, particularly in lowland irrigation areas around the MID. While dairy production remains the major irrigated agricultural land use, vegetable production is expanding and there is a general trend for larger and more intensive dairy farms. Land use change from irrigated dairy and beef to vegetable growing is occurring in places throughout the catchment.

These changes may increase the challenges to environmental management by irrigators and have been considered by the LWMP. They have the potential to increase baseline nutrient and sediment losses from the catchment's irrigation areas and could make the proposed State Environment Protection Policy (Waters) target to reduce Total Phosphorus loads to 100 t/y more challenging.

There is no current, reliable picture of irrigation land use within the Lake Wellington catchment. It is proposed that a land use program be implemented to identify all areas of irrigation land use within the Lake Wellington catchment and monitor how this is changing. For instance, shifts from livestock-pasture irrigation to vegetable production or other forms of horticulture. This will provide insights that will help the LWMP to identify and address any important emerging trends in irrigation land and water management.

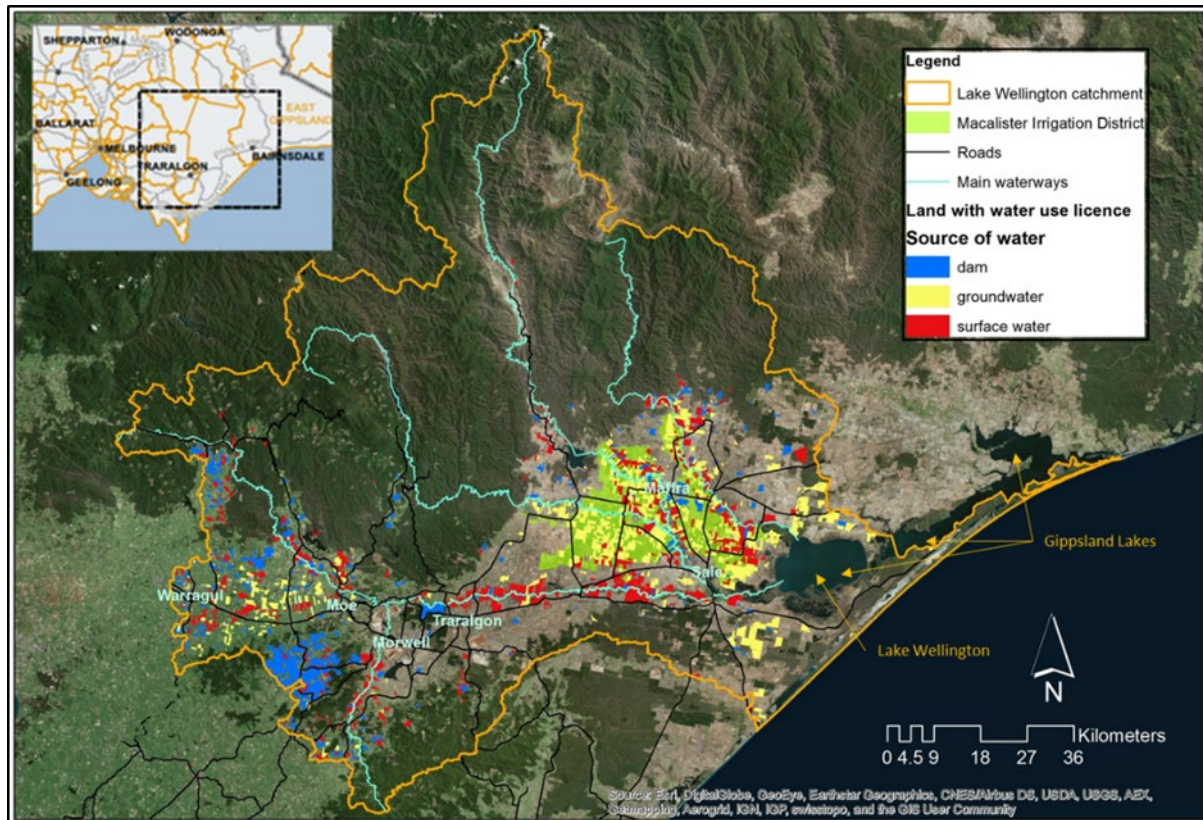


Figure 1. Lake Wellington catchment and the distribution of irrigation agriculture.

A contemporary land use database will support SIP program partners, including the WGCMA, AV and SRW to improve current management and future planning for the management of land and water resources and delivery of services in the Lake Wellington catchment area. This project also forms part of a DELWP program to undertake Regional Irrigated Land and Water Use Mapping (RILWUM).

The key drivers for each partner organisation are summarised as below:

#### SRW

- SRW have a business case for modernisation, with assumptions build in about water savings, land use change and irrigation method change. It's very important for SRW to measure changes in order to demonstrate the benefits.

#### WGCMA/AV

- CMA/AgVic will use the database to assist in planning and prioritising SIP program delivery and investment for the best outcomes and most efficient delivery of program. It will also be used to plan to meet future trends.
- The data is critical for monitoring and evaluation. SIP programs are designed to meet the SEPP (Waters) target for nutrients entering Lake Wellington, which is based on certain assumptions. If land use changes in different ways than anticipated, it will affect the ability of current programs to meet targets – thus, the land use data is necessary to help us see if we're on the right track with investment.
- The Lake Wellington Nutrient Model is soon to be developed in partnership with Monash and Melbourne Universities & a range of agency partners. An Australian Research Council grant was approved in December 2019. This model will be used as a decision support tool geared to estimate nutrient benefits from applying different management measures in different places. Land use will be a key input.

## DELWP

- DELWP is funding CMAs in Victorian irrigation areas to undertake Regional Irrigated Land and Water Use Mapping (RILWUM) as part of a program to map and monitor changes in irrigated land and water use in Victorian irrigation areas. This project forms part of that program.
- The mapping of land and water use in Victoria's irrigation regions will enable continued assessment of shifting water demands and land use change, this will:
  - build understanding of how irrigation regions are changing and adapting to reduced water availability;
  - inform water, agriculture and planning policy at the local, regional, state and national level;
  - provide essential input for economic modelling & analysis;
  - guide regional economic development investment;
  - inform the broader community and help landowners looking to expand, redevelop or contemplating exit options make informed decisions;
  - support Water Corporations strategic planning for infrastructure rationalisation and renewal and efforts to reduce operating and capital costs for long term viability.

### Project objectives

The focus of this project is to produce a land use database that:

- allows decision makers to track changes in irrigation land use over time
- where possible looks backward to assess changes over the last 10 years
- has a feasible mechanism in place to keep it up to date.

Therefore, this project is designed to achieve the following objectives;

- to develop an accurate land use mapping database for the Lake Wellington catchment area,
- to develop the capability required for land use data capture with SRW,
- to develop a recommended program for monitoring and recording land use change within the Lake Wellington catchment.

It is anticipated that spatial technology will be combined with on-ground knowledge of local industries and farms to form an accurate and, where feasible, "ground-truthed" picture of current and changing land use.

### Project deliverables

The key deliverables for this project are:

1. Project inception meeting with representatives from the project team, WGCMA, SRW, and Agriculture Victoria (AV) irrigation team
2. A maximum of 2 workshops in land use data capture for SRW staff and other key participants
3. 2019/20 land use mapping dataset for the Lake Wellington catchment
4. Presentation and workshop on project findings/methods with WGCMA and SRW
5. Final report including; workshop outcomes, project findings and recommendations for a program to monitor and record land use change in the Lake Wellington catchment.

Spatial and temporal scope of land use data to be collected.

- Land use mapping will be undertaken for Water Use Licences (supply channel and diversion) within the Lake Wellington catchment for the 2019/20 period as well as capture of 2010 land use if available.
- Diversion land use will be gathered for all diversion licenses (groundwater and stream) which have an irrigation purpose

Table 1. Contracted project deliverable status

<b>Deliverable(s)</b>	<b>Status</b>	<b>If not completed, please describe any impact on project delivery</b>	<b>Please explain how these products and services will be/were delivered to the next user</b>
Project inception meeting and methodology development (21/02/20)	Completed		Project inception report
A maximum of 2 workshops and training in land use data capture for SRW staff and other key participants	Held in Early April (08/04/2020)		Workshops and software deployment undertaken for SRW
2019/20 land use mapping dataset for the Lake Wellington catchment	Completed (09/07/2020)		Dataset delivered to SRW and ArcGIS online access to dataset established for SRW and WGCMA
Presentation and workshop on project findings/methods with WGCMA and SRW	Completed (01/09/2020)		Presentation undertaken to West Gippsland Sustainable Irrigation Group
Identifying irrigation enterprises and further diversions land parcels in the catchment.	Partially Completed	Algorithm development completed access to computing resource delayed no impact on overall project delivery	Enterprise dataset delivered to SRW and irrigation layer to be delivered on running of algorithm
Final report including; workshop outcomes, project findings and recommendations for a program to monitor and record land use change in the Lake Wellington catchment	Completed (This report, 30/09/2020)		Report delivered to WGCMA



## METHODOLOGY

The method of data collection in 2019/20 consisted of the following steps:

### Tool development

The ESRI ArcGIS online platform was determined to be suitable to support the land use data collection process. A web mapping app and a mobile based Collector app for ArcGIS app was developed by Spatial Information Sciences team at Agriculture Victoria (Department of Jobs, Precincts and Regions - DJPR) to enable ready capture of land use change data. Land use mapping was undertaken for water use and diversion licences (supply channel, groundwater and stream diversions) within the Lake Wellington catchment for the 2019/20 period as well as capture of 2010 land use if available. A single water use, or diversion licence can cover several land property titles and can be aligned with broader agricultural enterprises.

The project team undertook the following tasks to identify supporting datasets and establish software for land use data capture:

#### 1. Compilation and setup of ArcGIS and ArcGIS online data and mapping including:

- 2019/20 Water Use Licences (WUL) and diversions licence (Take and Use Licence, TUL) sourced from the Victorian Water Register
- Appropriate aerial and satellite imagery.
- Current irrigation infrastructure and outlets (outlets and channel infrastructure to be supplied by SRW)
- Cadastre and supporting VLUI (Victorian Land Use Information System) information
- WGCMA land use information
- Previous land use datasets

#### 2. Setup of ArcGIS online software to support SRW land use data capture (figure 2):

- Customising ArcGIS online and collector to support desktop data capture
- Definition and development of classification and supporting lookup tables
- Setup of ArcGIS collector to support field checking and validation

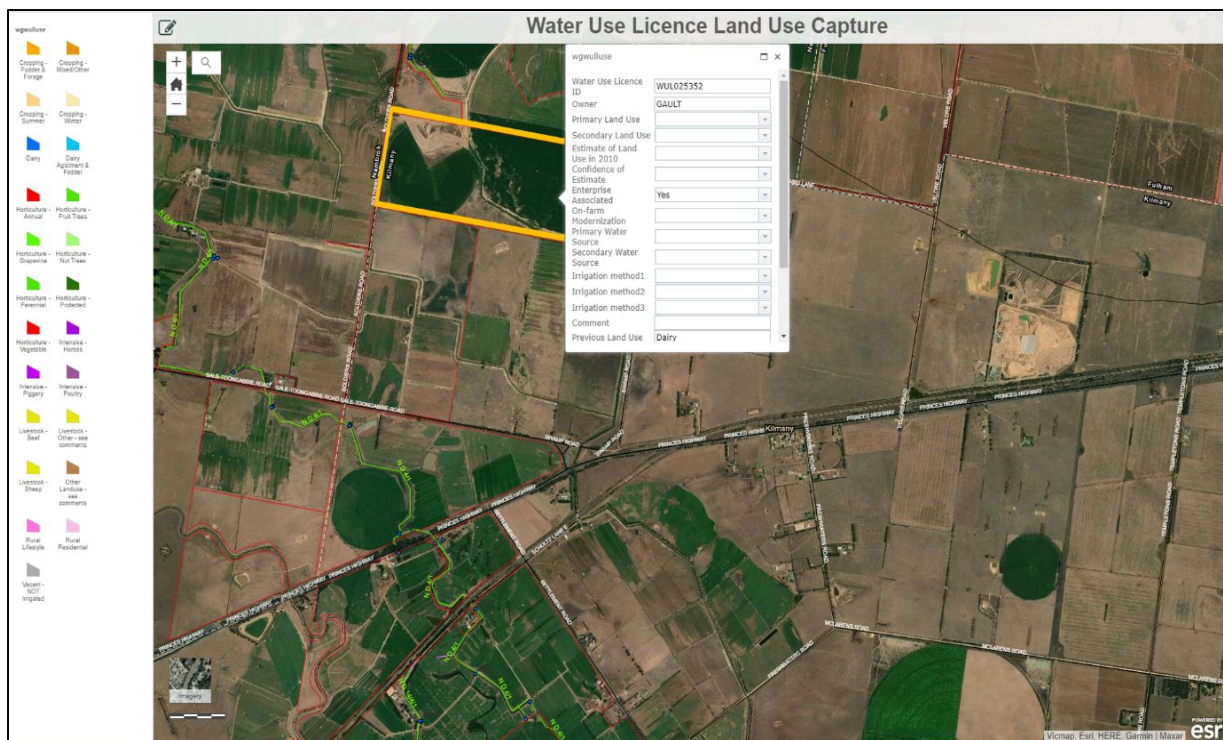


Figure 2. ArcGIS online land use data capture tool

## End user training (guide)

SRW irrigation planning and field staff at Maffra and Morwell were trained to build consistent interpretation in the land use classifications. A document was provided to introduce staff to the ArcGIS online land use capture process which is delivered for desktop through a web mapping app and the mobile based Collector for ArcGIS app that supports the capture of data in the field (Appendix 1). The project team ensured all software was operational on the participants computers/mobile devices and provided online and mobile support throughout the data capture process. SRW staff were assigned areas for land use data capture and completed these tasks as part of their work program.

## Data Capture

The following land use attributes were collected by SRW irrigation planners and field staff using the web and mobile apps which enabled end users to capture the data using standardised lists (drop downs):

1. Water Use License Number
2. Ownership (surname or company name)
3. Primary and secondary land use (categories aligned with those captured in the GMID and updates with input from West Gippsland including; Cropping–fodder and forage, Cropping–mixed/other, Cropping–summer, Cropping–winter, Dairy, Dairy agistment and fodder, Horticulture–perennial, Horticulture–fruit trees, Horticulture–grapevine, Horticulture–nut trees, Horticulture–annual, Horticulture–vegetable, Horticulture–protected, Intensive–horses, Intensive–piggery, Intensive–poultry, Livestock–beef, Livestock–sheep, Livestock–other–see comments, Other land use–see comments, Rural lifestyle, Rural residential, Vacant–not irrigated)
4. Estimate of land use in 2010 (categories aligned with those mentioned for primary and secondary land use)
5. Confidence of 2010 Estimate (Low/Middle/High)
6. Enterprise associated (Yes/No is the water use license associated with a broader enterprise)
7. On-farm modernization (Yes/No)
8. Primary and secondary water sources (Channel/Diversion-drain/Diversion-river/Groundwater)
9. Irrigation method 1, 2 and 3 (categories aligned with those captured in the GMID and updates with input from West Gippsland including; Drip, Low level sprinkler, Drip tapes/subsurface, Fast flow flood, Conventional flood, Pipe and riser, Pivot and linear move, and Fixed sprinkler)
10. Comments
11. Previous land use map
12. Previous land use source
13. Water use for irrigation season 2019-2020

## Analysis

The land and water use data captured was analysed by the Spatial Information Sciences team to compare 2009/10 and 2019/20 land use and water use in the Lake Wellington catchment. Noting that the water use information has been collected from the Lake Wellington WUL and TUL data and from information sourced from the Victorian Water Register. The analysis included the following:

1. Catchment delineation: All the data captured were delineated into surface irrigation supply (ie. MID) and Lake Wellington Diversions. Analysis outputs for land use categories are presented in the results section.

To track changes of land use between 2009/10 and 2019/20, data collected for each water year was grouped by primary land use for MID (Table 2) and West Gippsland Diversion (

2. Table 7). Changes in land area (ha and %) were then calculated.

MID irrigated area was categorised into water service areas for further analysis using the MID irrigation zone layer sourced from SRW. Similarly, the West Gippsland Diversion area was categorised into sub-catchments using River Health Units layer sourced from WGCMA. Land use change analysis were then studied for each sub area of MID (Table 3) and West Gippsland Diversion (

3. Table 8).
4. Water Use versus Land Use Analysis based on the land and water use data collected for MID (Table 4) and West Gippsland Diversion (Table 9).
5. Summary of irrigation methods employed in the MID irrigation area was also reported in Table 5 and Table 6.

### **Irrigation identification**

In reviewing the diversion license datasets, it was determined that some parcels which contained irrigation activity were not linked spatially to a diversion license. To aid further identification of irrigation activity and integration of this information into the land use data AVR tested the use of a satellite analysis approach to mapping these areas.

A map of irrigation activity is being developed using Machine Learning techniques to provide accurate information on the extent and distribution of irrigated areas. Mapping irrigation areas of the Lake Wellington catchment will be based on the use of Sentinel-1 Synthetic Aperture Radar (SAR) time series in combination with a single Sentinel-2 optical imagery.

The classification algorithm development has been undertaken but access to sufficient computing resources in the current COVID restrictions has delayed the implementation. It is intended to complete this analysis once computing resources are available.

### **Identifying irrigation enterprises**

Agricultural enterprises are often comprised of multiple irrigation licenses. Understanding the relationship of irrigation licenses to the broader agricultural enterprises they are connected to is an important component of land use information. AVR has undertaken the development of this component utilising SRW customer information to link to irrigation licenses. This layer is presented in the results and will be provided to SRW as a data layer.

## **RESULTS**

### **MID irrigation**

Primary land use in the MID irrigation zone as defined by industry type (Table 2) was mapped and analysed in 2009/2010 and 2019/20. The total land use (hectare – ha) for each land use category is presented in Table 7 and graphically in Figure 3. Figure 4 illustrates the land use maps for 2009/10 and 2019/20 in the MID.

The Combined Dairy land use categories made up the largest portion of land use in the MID in 2009/10 (45526 ha) and in 2019/20 (41024 ha) (Table 2). Since 2009/10, Combined Livestock land use by area represented the second largest land use (11346.80 ha in 2009/10, and 11578.81 ha in 2019/20). The spread of each land use category is summarised in Figure 3.

Cropping (fodder and forage) and annual horticulture (vegetable) land uses (Table 2 and Figure 3) represent the largest increases from 2009/10 to 2019/20 (186 to 1903 ha and 533 to 1927 ha respectively). The area of dairy saw the main decreased by 18.1 per cent, respectively between 2009/10 and 2019/20 (Table 2). The decrease of dairy land use area is evident in Figure 4 which shows all the changes in land use areas across the MID area.

Table 2. Primary Land use in the Lake Wellington MID area (hectare – ha), 2009/2010 versus 2019/2020.

Primary Land use	2009/2010 Area (ha)	2019/2020 Area (ha)	Changes in Area (ha)	Changes in Area (%)
Cropping - Fodder & Forage	9	1700	1691	18101.1
Cropping - Mixed/Other		4	4	
Cropping - Summer	177	199	22	12.4
<b>Combined Cropping</b>	<b>186</b>	<b>1903</b>	<b>1717</b>	<b>922.6</b>
Dairy	44533	36478	-8055	-18.1
Dairy Agistment & Fodder	993	4546	3554	358.0
<b>Combined Dairy</b>	<b>45526</b>	<b>41024</b>	<b>-4502</b>	<b>-9.9</b>
Horticulture - Protected		39	39	
Horticulture - Vegetable	533	1887	1354	254.1
<b>Combined Annual Horticulture</b>	<b>533</b>	<b>1927</b>	<b>1394</b>	<b>261.5</b>
Horticulture - Grapevine	51	51	0	0.0
<b>Combined Perennial Horticulture</b>	<b>51</b>	<b>51</b>	<b>0</b>	<b>0.0</b>
Intensive - Horses	169	231	62	36.6
Intensive - Piggery		12	12	
<b>Combined Intensive</b>	<b>169</b>	<b>243</b>	<b>74</b>	<b>43.4</b>
Livestock - Beef	11159	10761	-398	-3.6
Livestock – Mixed Beef & sheep		560	560	
Livestock - Sheep	186	241	56	29.9
Livestock - other	2	17	15	800.0
<b>Combined Livestock</b>	<b>11347</b>	<b>11579</b>	<b>232</b>	<b>2.0</b>
Other Landuse	156	275	119	76.6
Rural Lifestyle	271	829	559	206.4
Rural Residential	6	15	9	169.4
<b>Rural and Other Landuse</b>	<b>432</b>	<b>1119</b>	<b>687</b>	<b>159.2</b>
Licenses - NOT Irrigated		398	398	
<b>Total</b>	<b>58244</b>	<b>58244</b>		

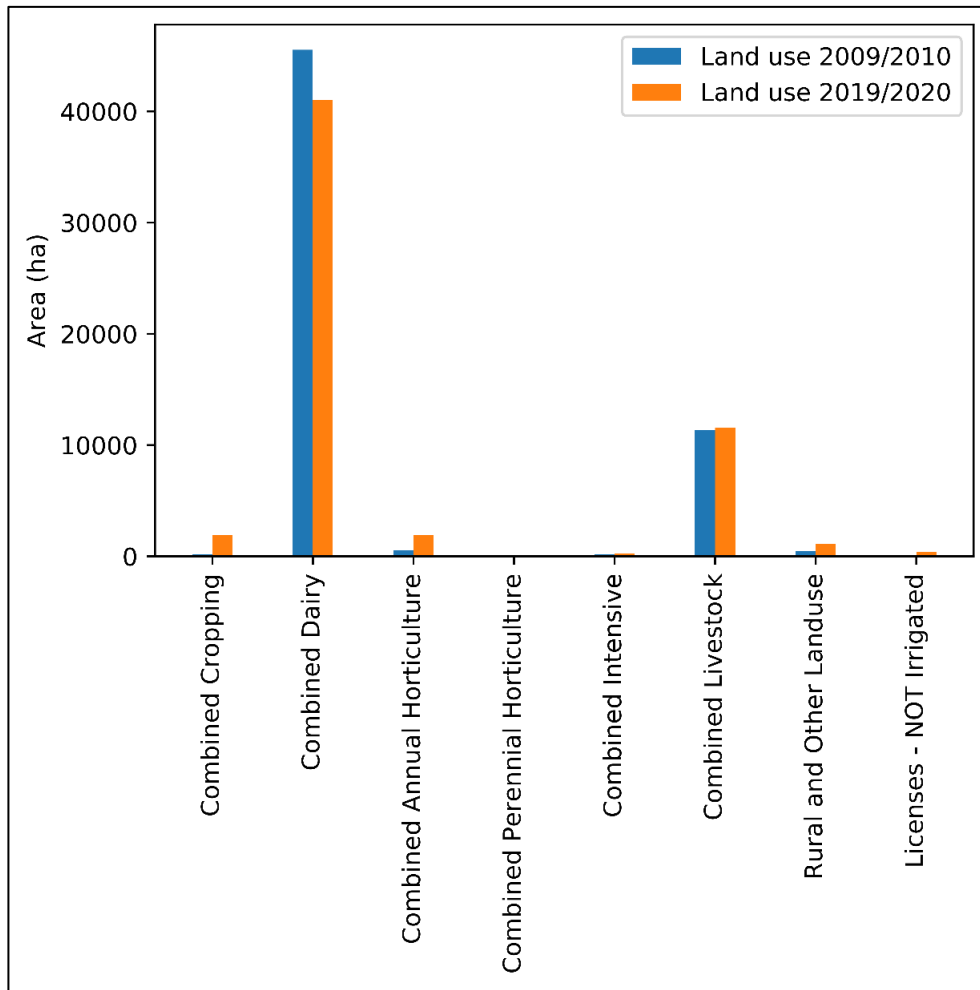
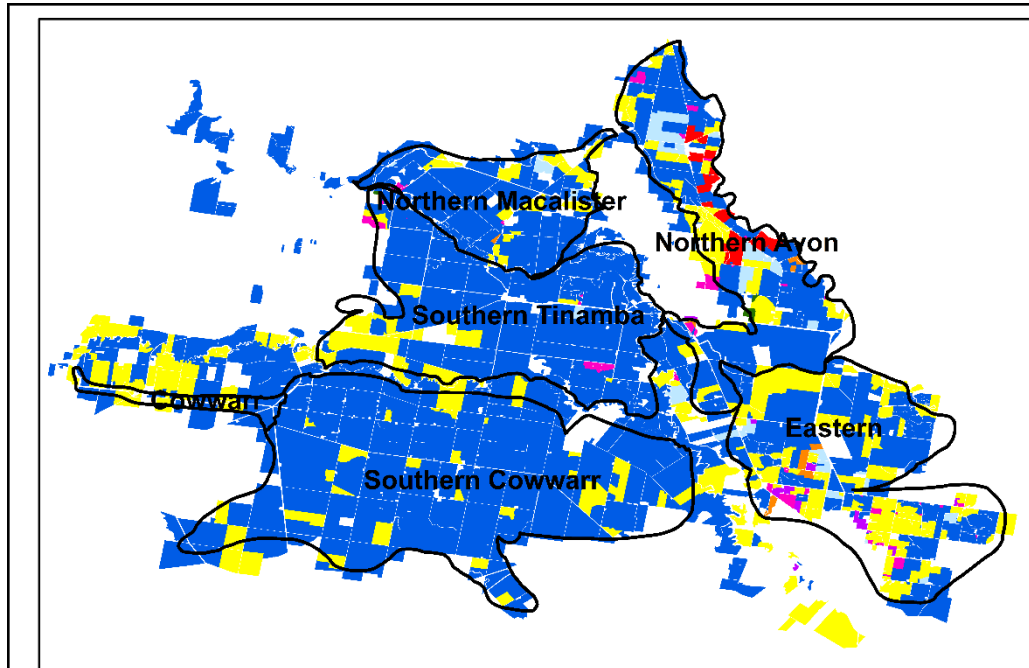


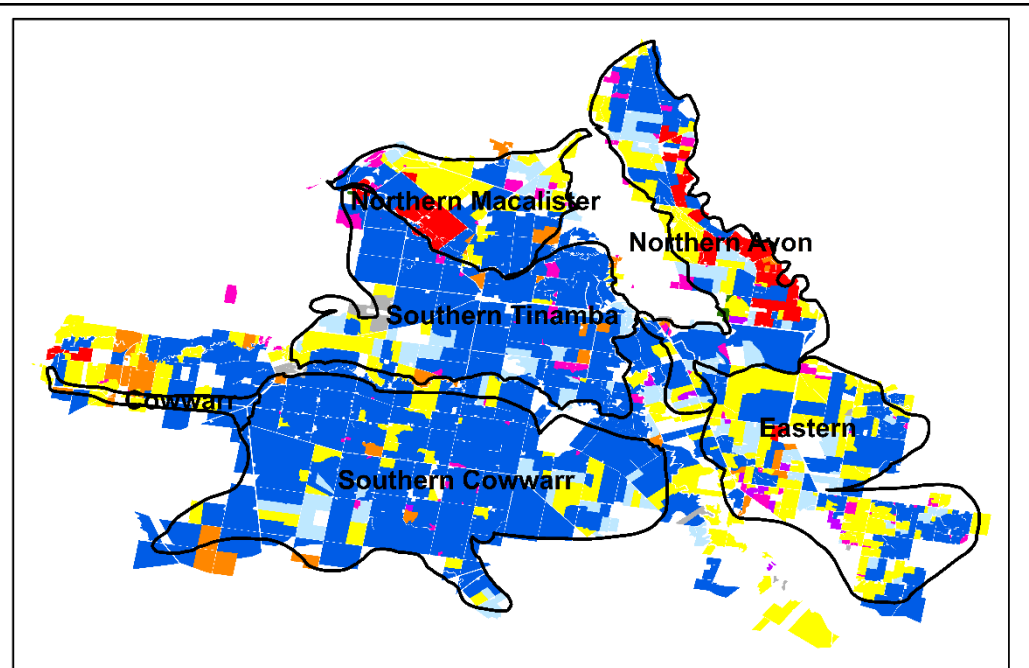
Figure 3. Primary land Use in the Lake Wellington MID area (hectare – ha), 2009/2010 versus 2019/2020.



**Lake Wellington MID Area**  
2009/2010 Landuse

0 5 10 20 Km

- |                          |                       |                          |
|--------------------------|-----------------------|--------------------------|
| Cropping                 | Intensive             | Horticulture - Annual    |
| Dairy                    | Livestock             | Horticulture - Perennial |
| Dairy Agistment & Fodder | Rural & Other Landuse | Licenses - NOT Irrigated |



**Lake Wellington MID Area**  
2019/2020 Landuse

0 5 10 20 Km

- |                          |                       |                          |
|--------------------------|-----------------------|--------------------------|
| Cropping                 | Intensive             | Horticulture - Annual    |
| Dairy                    | Livestock             | Horticulture - Perennial |
| Dairy Agistment & Fodder | Rural & Other Landuse | Licenses - NOT Irrigated |

Figure 4. Maps of Lake Wellington MID area showing the land use change between 2009/2010 and 2019/2020.

The pattern of land use change across each of the MID's water service areas (Cowwarr, Eastern, Northern Avon, Northern Macalister, Southern Cowwarr, Southern Tinamba, and River Source) is presented in Table 3. Dairy and Livestock - Beef land use categories remain the dominant land use of the MID area in the Lake Wellington in 2019/20. Dairy however experienced decrease in extent. Notably, in Northern Avon and Northern Macalister which saw increases in Vegetable extent.

Table 4 shows the number of WULs in each primary land use category in 2019/20 and the total annual water use against each primary land use.

Figure 5 illustrates share of water use by primary land use category for visualized comparison. Dairy (ie. irrigation licenses with an active dairy), the largest land use category in extent (36478) across the MID in 2019/20, accounted for 73.6 per cent of the share of water use which is the largest water use by irrigation. The Combined Livestock land use has the second largest water use in the MID in 2019/20, accounting for a 12.6 per cent of total share of water use. This share of water use by Combined Livestock land use coincides with the extent of Combined Livestock land use which has the second largest coverage in the MID. Perennial horticulture land use area which is the smallest category mapped in MID in 2019/20, had the lowest share of water use.

Table 3. Primary Land Use Change (ha and %) 2009/2010 to 2019/2020 in MID water service areas.

Area	Primary Land Use	2009/2010 Area (ha)	2019/2020 Area (ha)	Change by Area (ha)	Change by Area (%)
<b>Cowwarr</b>	Cropping - Fodder & Forage		79	79	
	Dairy	752	685	-68	-9.0
	Livestock - Beef	755	741	-14	-1.9
	Rural Lifestyle		3	3	
<b>Eastern</b>	Cropping - Summer	122	139	18	14.8
	Dairy	5263	4210	-1053	-20.0
	Dairy Agistment & Fodder	269	838	569	211.7
	Horticulture - Vegetable		53	53	
	Intensive - Horses	151	146	-6	-3.7
	Livestock - Beef	3150	2906	-244	-7.7
	Livestock - Other		560	560	
	Livestock - Sheep	80	86	6	6.9
	Other Land use	79	65	-14	-17.6
	Rural Lifestyle	71	166	95	134.3
	Rural Residential	6	6	0	0.0
Licenses - NOT Irrigated		15	15		
<b>Northern Avon</b>	Cropping - Summer	55	59	4	7.2
	Dairy	4665	3402	-1264	-27.1
	Dairy Agistment & Fodder	546	1004	458	83.9
	Horticulture - Grapevine	45	45	0	0.0
	Horticulture - Vegetable	533	1161	628	117.8
	Intensive - Horses	11	61	50	460.4
	Livestock - Beef	1575	1586	11	0.7
	Livestock - Other	2	2	0	0.0
	Other Land use	61	78	17	28.3
	Rural Lifestyle	96	171	75	78.2
Rural Residential		9	9		

	Licenses - NOT Irrigated		11	11	
<b>Northern Macalister</b>	Cropping - Fodder & Forage	9	197	188	2013.6
	Cropping - Mixed/Other		4	4	
	Dairy	4131	2402	-1729	-41.9
	Dairy Agistment & Fodder	67	207	141	210.9
	Horticulture - Vegetable		572	572	
	Livestock - Beef	634	1241	607	95.8
	Livestock - Sheep	2	53	50	2060.6
	Other Land use		59	59	
	Rural Lifestyle	26	135	108	410.2
<b>Southern Cowwarr</b>	Cropping - Fodder & Forage		631	631	
	Dairy	17610	15804	-1806	-10.3
	Dairy Agistment & Fodder		1320	1320	
	Intensive - Piggery		12	12	
	Livestock - Beef	1919	1604	-314	-16.4
	Livestock - Other		15	15	
	Livestock - Sheep	103	103	0	0.0
	Rural Lifestyle		70	70	
	Licenses - NOT Irrigated		73	73	
<b>Southern Tinamba</b>	Cropping - Fodder & Forage		287	287	
	Dairy	9817	8383	-1435	-14.6
	Dairy Agistment & Fodder	32	952	920	2905.1
	Horticulture - Grapevine	6	6	0	0.0
	Horticulture - Vegetable		31	31	
	Livestock - Beef	1181	1002	-179	-15.2
	Other Land use		0	0	
	Rural Lifestyle	69	214	145	209.2
	Licenses - NOT Irrigated		231	231	
<b>River Source</b>	Cropping - Fodder & Forage		506	506	
	Dairy	2294	1593	-701	-30.6
	Dairy Agistment & Fodder	79	225	146	183.8
	Horticulture - Protected		39	39	
	Horticulture - Vegetable		70	70	
	Intensive - Horses	7	25	17	241.5
	Livestock - Beef	1945	1681	-265	-13.6
	Other Land use	16	72	56	360.1
	Rural Lifestyle	8	71	63	778.9
Licenses - NOT Irrigated		68	68		



Table 4. Lake Wellington MID Water Use (ML) and Water Use Licence (WUL) numbers by Primary Land Use category, 2019/2020.

<b>Primary Land Use</b>	<b>Number of Licences</b>	<b>Water Use 2019/2020 (ML)</b>	<b>Share of Water Use 2019/2020 (%)</b>
Cropping - Fodder & Forage	32	1819.59	1.5
Cropping - Mixed/Other	1	11.00	0.0
Cropping - Summer	7	367.32	0.3
<b>Combined Cropping</b>	<b>40</b>	<b>2197.91</b>	<b>1.9</b>
Dairy	389	87295.51	73.6
Dairy Agistment & Fodder	88	7526.56	6.3
<b>Combined Dairy</b>	<b>477</b>	<b>94822.07</b>	<b>79.9</b>
Horticulture - Protected	1	23.00	0.0
Horticulture - Vegetable	21	4846.68	4.1
<b>Combined Annual Horticulture</b>	<b>22</b>	<b>4869.68</b>	<b>4.1</b>
Horticulture - Grapevine	3	20.30	0.0
<b>Combined Perennial Horticulture</b>	<b>3</b>	<b>20.30</b>	<b>0.0</b>
Intensive - Horses	14	468.72	0.4
Intensive - Piggery	1	0.00	0.0
<b>Combined Intensive</b>	<b>15</b>	<b>468.72</b>	<b>0.4</b>
Livestock - Beef	264	14419.91	12.2
Livestock - Other	6	434.00	0.4
Livestock - Sheep	9	130.85	0.1
<b>Combined Livestock</b>	<b>279</b>	<b>14984.76</b>	<b>12.6</b>
Other Landuse	12	149.18	0.1
Rural Lifestyle	93	1013.65	0.9
Rural Residential	5	0.00	0.0
<b>Rural and Other Landuse</b>	<b>110</b>	<b>1162.82</b>	<b>1.0</b>
Licenses - NOT Irrigated	12	76.80	0.1
<b>Total</b>	<b>958</b>	<b>118603.05</b>	<b>100.0</b>

### Share of water use by landuse

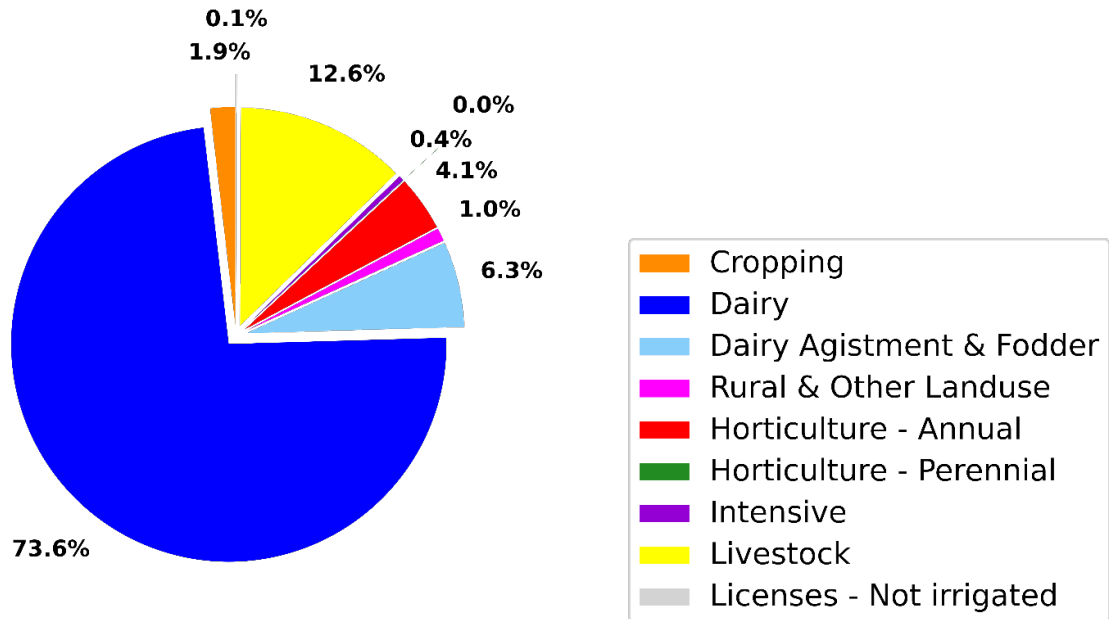


Figure 5. Share of water use by land use category in the Lake Wellington (Macalister) Irrigation District, 2019/2020.

Information collected on primary and secondary irrigation methods employed by each land use category is summarised in Table 5. This table shows that Conventional Flood irrigation system is the dominant form of irrigation for most of land use categories except for the Horticulture land use category which is mainly irrigated using Drip and Spray systems. Pivot and Linear moves are prominent in the Dairy category. Number of Licenses reported in Table 5 refers to the total number of parcels that use each irrigation system either as primary or secondary irrigation method. Table 6 presents a summary of secondary irrigation methods per primary irrigation method in MID in 2019/2020.

Table 5. Number of irrigation methods by land use category in Lake Wellington (Macalister) Irrigation District.

Primary Land Use	Irrigation method	Number of Licenses
<b>Cropping - Fodder &amp; Forage</b>	Conventional Flood	17
	Low Level Sprinkler	1
	Pivot and Liner Move	15
	Fixed Sprinkler	1
<b>Cropping - Mixed/Other</b>	Conventional Flood	1
<b>Cropping - Summer</b>	Conventional Flood	5
	Low Level Sprinkler	1
<b>Dairy</b>	Conventional Flood	348
	Fast Flow Flood	21
	Fixed Sprinkler	6
	Low Level Sprinkler	24
	Pipe and Riser	2
	Pivot and Liner Move	104

	Conventional Flood	76
	Fast Flow Flood	4
<b>Dairy Agistment &amp; Fodder</b>	Fixed Sprinkler	2
	Low Level Sprinkler	5
	Pivot and Liner Move	7
	Drip	1
	Drip tape/Subsurface	1
<b>Horticulture - Grapevine</b>	Fixed Sprinkler	1
	Low Level Sprinkler	1
	Pivot and Liner Move	1
<b>Horticulture - Protected</b>	Low Level Sprinkler	1
	Conventional Flood	4
<b>Horticulture - Vegetable</b>	Fixed Sprinkler	13
	Low Level Sprinkler	4
	Pivot and Liner Move	6
<b>Intensive - Horses</b>	Conventional Flood	14
	Low Level Sprinkler	1
<b>Intensive - Piggery</b>	Conventional Flood	1
	Conventional Flood	239
	Drip tape/Subsurface	1
<b>Livestock - Beef</b>	Fast Flow Flood	3
	Fixed Sprinkler	1
	Low Level Sprinkler	12
	Pivot and Liner Move	16
<b>Livestock - Other</b>	Conventional Flood	5
	Low Level Sprinkler	1
	Pivot and Liner Move	1
<b>Livestock - Sheep</b>	Conventional Flood	9
	Conventional Flood	1
	Drip tape/Subsurface	1
<b>Other Landuse</b>	Fixed Sprinkler	2
	Low Level Sprinkler	2
<b>Rural Lifestyle</b>	Conventional Flood	83
	Fixed Sprinkler	1
	Low Level Sprinkler	3
<b>Rural Residential</b>	Conventional Flood	1
<b>Licenses - NOT Irrigated</b>	Conventional Flood	2

Table 6. Summary of secondary irrigation methods per primary irrigation methods in Macalister Irrigation District, 2019/2020.

Primary Irrigation method	Secondary Irrigation method	Number of Licenses
		665
<b>Conventional Flood</b>	<b>Drip tape/Subsurface</b>	1
	<b>Fixed Sprinkler</b>	3
	<b>Low Level Sprinkler</b>	22
	<b>Pipe and Riser</b>	1
	<b>Pivot and Liner Move</b>	63
<b>Drip</b>		1
<b>Drip tape/Subsurface</b>		1
	<b>Pivot and Liner Move</b>	1
		18
<b>Fast Flow Flood</b>	<b>Conventional Flood</b>	2
	<b>Pipe and Riser</b>	1
	<b>Pivot and Liner Move</b>	6
		14
<b>Fixed Sprinkler</b>	<b>Conventional Flood</b>	2
	<b>Pivot and Liner Move</b>	1
		21
<b>Low Level Sprinkler</b>	<b>Conventional Flood</b>	9
	<b>Fixed Sprinkler</b>	2
		34
<b>Pivot and Liner Move</b>	<b>Conventional Flood</b>	38
	<b>Fast Flow Flood</b>	1
	<b>Fixed Sprinkler</b>	4
	<b>Low Level Sprinkler</b>	2

### West Gippsland Diversions

Primary land use in West Gippsland Diversions as defined by industry type (

Table 7) was mapped and analysed in 2009/2010 and 2019/20. The total land use (hectare – ha) for each land use category is presented in

Table 7 and graphically in Figure 6. also illustrates the land use maps for 2019/20 in comparison to 2009/10 in the West Gippsland Diversion area.

Comparison of the land use map of Lake Wellington Diversion area in 2009/10 and that of 2019/20 (

Table 7 and ) suggests that the land use mix across the Lake Wellington Diversion area has changed in area (ha) and distribution between 2009/10 and 2019/20. This change is more obvious in some land use categories (e.g. Horticulture-Grapevine, Horticulture-Fruit Trees, and Cropping-Fodder and Forage) compared with other land uses such as Intensive showing no change and Protected Horticulture which had minimal changes of 0.11

percentage. While Livestock and Dairy land use categories showed increase of area in 2019/20, Annual Horticulture area decreased in 2019/20 compared to 2009/10.

Table 7. Primary Land Use in the Lake Wellington Diversion area (ha), 2009/2010 versus 2019/2020.

Primary Land Use	2009/2010 Area (ha)	2019/2020 Area (ha)	Changes in Area (ha)	Changes in Area (%)
Cropping - Fodder & Forage	806	1657	852	105.7
Cropping - Mixed/Other	62		-62	
Cropping - Summer	320	261	-59	-18.4
<b>Combined Cropping</b>	<b>1187</b>	<b>1918</b>	<b>731</b>	<b>61.6</b>
Dairy	10144	10239	95	0.9
Dairy Agistment & Fodder	202	1358	1156	573.1
<b>Combined Dairy</b>	<b>10346</b>	<b>11597</b>	<b>1251</b>	<b>12.1</b>
Horticulture - Annual	380	447	67	17.7
Horticulture - Protected	80	80	0	0.1
Horticulture - Vegetable	11631	9989	-1642	-14.1
<b>Combined Annual Horticulture</b>	<b>12090</b>	<b>10516</b>	<b>-1574</b>	<b>-13.0</b>
Horticulture - Fruit Trees	71	208	137	194.0
Horticulture - Grapevine	4	45	40	983.6
Horticulture - Nut Trees	39	39	0	0.0
Horticulture - Perennial	223	188	-35	-15.7
<b>Combined Perennial Horticulture</b>	<b>337</b>	<b>480</b>	<b>143</b>	<b>42.3</b>
Intensive - Horses	65	65	0	0.0
Intensive - Piggery	71	71	0	0.0
<b>Combined Intensive</b>	<b>135</b>	<b>135</b>	<b>0</b>	<b>0.0</b>
Livestock - Beef	10447	13414	2967	28.4
Livestock - Other		21	21	
Livestock - Sheep	758	614	-144	-18.9
<b>Combined Livestock</b>	<b>11205</b>	<b>14049</b>	<b>2844</b>	<b>25.4</b>
Other Land Use	721	1353	632	87.7
Rural Lifestyle	58	59	1	1.1
Rural Residential	451	2	-449	-99.5
<b>Rural and Other Landuse</b>	<b>1230</b>	<b>1414</b>	<b>184</b>	<b>14.9</b>
Licenses - NOT Irrigated	22997	19419	-3579	-15.6
<b>Total</b>	<b>59528</b>	<b>59528</b>		

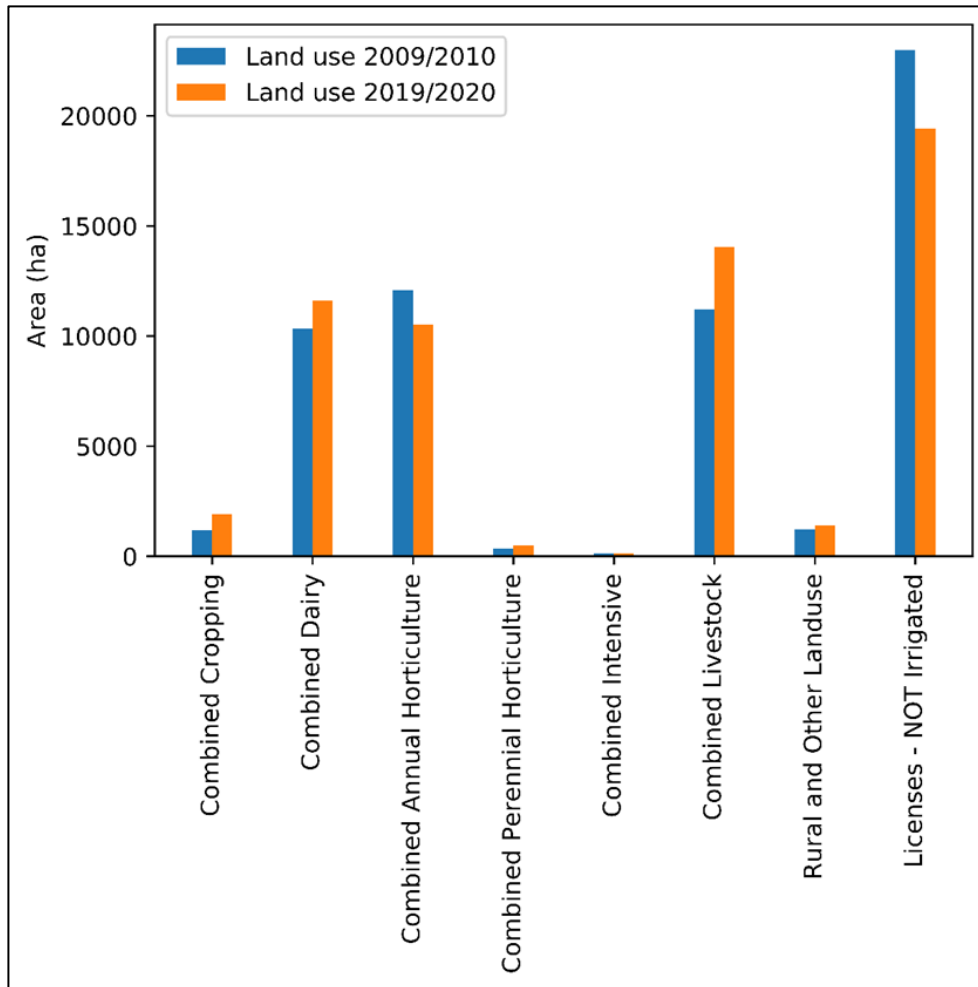


Figure 6. Primary land use in the Lake Wellington Diversion Area (hectare – ha), 2009/2010 versus 2019/2020

Table 8 presents comparison of land use (hectares and percentage change) between 2009/10 and 2019/20 across each of the Diversion sub-catchments including Lake Wellington, Avon River and Perry River, Lower Latrobe River, Macalister River, Thomson River, Moe River, Morwell River & Traralgon Creek, Upper Latrobe River, and Ninety Mile Beach. Figure 8 presents the maps of these changes. The dairy land use category experienced decrease in the majority of sub-catchments. However, Moe River and Upper Latrobe River sub-catchments show an approximate 30 and 69 per cent shift, respectively, in Dairy land use area. Unlike Dairy land use area, Dairy Agistment and Fodder land use experienced substantial increases in most of the sub-catchments. The Dairy Agistment and Fodder land use in Morwell River & Traralgon Creek expanded by 298 ha (633.5 per cent) between 2009/10 and 2019/20. Licences - not irrigated category was the other land use to decrease in extent in most of areas except for the Thomson River with a large increase from 7 ha in 2009/10 to 330 ha in 2019/20, and the Avon River with a 9.55 per cent increase from 5000 ha in 2009/10 and 5477 ha in 2019/20.

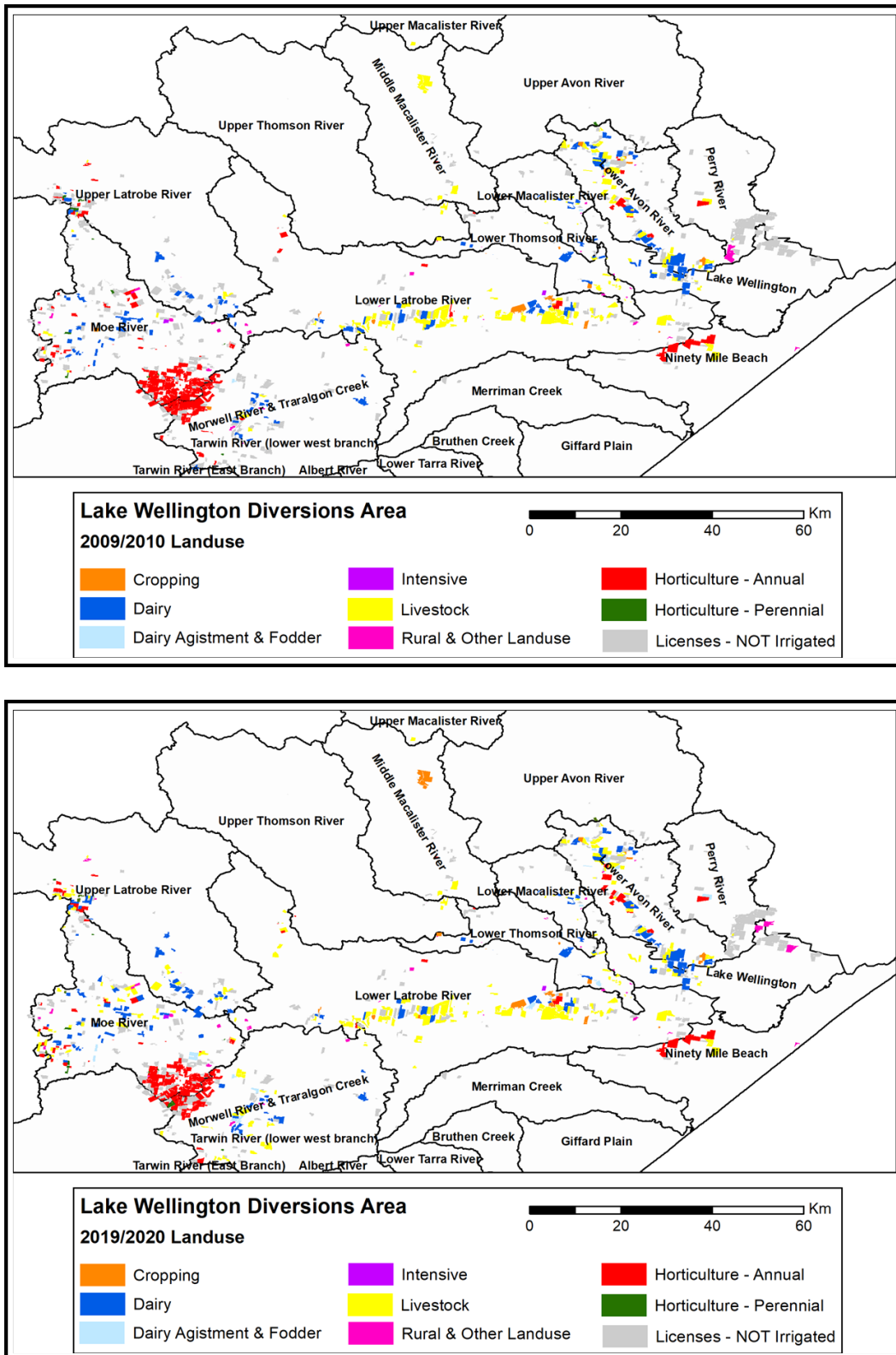


Figure 7. Maps of Lake Wellington Diversion area showing the land use change between 2009/2010 and 2019/2020.

Table 8. Primary Land Use Change (ha and %) between 2009/2010 and 2019/2020 in each Lake Wellington Diversion sub-catchment.

Sub-catchments	Primary Land Use	2009/2010 Area (ha)	2019/2020 Area (ha)	Change by sub-catchment area (ha)	Change by sub-catchment area (%)
<b>Lake Wellington</b>	Dairy	774	572	-202	-26.0
	Horticulture - Annual	1	1	0	0.0
	Livestock - Beef	326	527	202	61.9
	Other Land Use		516	516	
	Rural Lifestyle	6	6	0	0.0
	Licenses - NOT Irrigated	2226	1710	-516	-23.2
<b>Avon River (Upper &amp; Lower) and Perry River</b>	Cropping - Fodder & Forage	303	283	-20	-6.6
	Cropping - Summer	8	8	0	0.0
	Dairy	2955	2705	-250	-8.5
	Dairy Agistment & Fodder	122	403	281	231.5
	Horticulture - Perennial	36	36	0	0.0
	Horticulture - Vegetable	680	1068	388	57.1
	Livestock - Beef	2127	1673	-453	-21.3
	Livestock - Sheep	306	306	0	0.0
	Other Land Use	8	8	0	0.0
	Rural Lifestyle	19	19	0	0.0
	Rural Residential	424		-424	
Licenses - NOT Irrigated	5000	5477	478	9.6	
<b>Lower Latrobe River</b>	Cropping - Fodder & Forage	503	654	151	30.1
	Cropping - Summer	170	170	0	0.0
	Dairy	1939	1400	-539	-27.8
	Dairy Agistment & Fodder		117	117	
	Horticulture - Annual	91		-91	
	Horticulture - Perennial		2	2	
	Horticulture - Vegetable	458	341	-117	-25.5
	Intensive - Horses	65	65	0	0.0
	Livestock - Beef	5625	6268	643	11.4
	Livestock - Sheep	182	107	-76	-41.4
	Other Land Use	234	234	0	0.0
Licenses - NOT Irrigated	2808	2718	-90	-3.2	
<b>Macalister (Middle &amp; Lower) River</b>	Cropping - Fodder & Forage		646	646	
	Dairy	280	277	-3	-0.9
	Dairy Agistment & Fodder	33	33	0	0.0
	Horticulture - Annual	32	32	0	0.0
	Livestock - Beef	915	270	-646	-70.5
	Livestock - Sheep	173	173	0	0.0
	Rural Lifestyle	26	29	3	9.9
	Licenses - NOT Irrigated	689	689	0	0.0



<b>Thomson (Upper &amp; Lower) River</b>	Cropping - Fodder & Forage		75	75	
	Cropping - Summer	82	82	0	0.0
	Dairy	547	501	-46	-8.4
	Dairy Agistment & Fodder		97	97	
	Horticulture - Annual	17	24	8	47.0
	Livestock - Beef	419	379	-40	-9.5
	Livestock - Sheep	97		-97	
	Other Land Use	21	32	11	52.1
	Rural Lifestyle	7	5	-2	-26.2
	Rural Residential	2	2	0	19.9
	Licenses - NOT Irrigated	7	330	322	4405.9
<b>Moe River</b>	Cropping - Mixed/Other	62		-62	
	Cropping - Summer	1	1	0	-22.5
	Dairy	1642	2146	503	30.6
	Dairy Agistment & Fodder		364	364	
	Horticulture - Annual	193	219	26	13.3
	Horticulture - Fruit Trees	55	86	30	54.8
	Horticulture - Grapevine	4	23	19	468.9
	Horticulture - Nut Trees	39	39	0	0.0
	Horticulture - Perennial	37	69	32	88.6
	Horticulture - Protected	80	8	-71	-89.5
	Horticulture - Vegetable	5760	4586	-1173	-20.4
	Intensive - Piggery	71	71	0	0.0
	Livestock - Beef	203	1617	1413	696.0
	Livestock - Sheep		29	29	
	Other Land Use	283	325	42	14.9
	Rural Residential	26	0	-25	-98.5
Licenses - NOT Irrigated	5235	4108	-1127	-21.5	
<b>Morwell River &amp; Traralgon Creek</b>	Cropping - Summer	58		-58	
	Dairy	1008	1042	34	3.4
	Dairy Agistment & Fodder	47	344	298	633.5
	Horticulture - Fruit Trees	15	122	107	697.6
	Horticulture - Vegetable	2661	2125	-537	-20.2
	Livestock - Beef	267	1321	1054	394.9
	Livestock - Other		21	21	
	Other Land Use	142	142	0	0.0
	Licenses - NOT Irrigated	3366	2448	-918	-27.3
<b>Upper Latrobe River</b>	Dairy	947	1596	649	68.6
	Horticulture - Annual	46	171	125	273.4
	Horticulture - Grapevine		21	21	
	Horticulture - Perennial	151	82	-69	-45.9
	Horticulture - Protected		71	71	

	Horticulture - Vegetable	356	297	-59	-16.5
	Livestock - Beef	160	953	794	497.7
	Other Land Use	1	64	63	5156.9
	Licenses - NOT Irrigated	2481	886	-1595	-64.3
<b>Ninety Mile Beach</b>	Horticulture - Vegetable	1297	1297	0	0.0
	Livestock - Beef	406	406	0	0.0
	Other Land Use	32	32	0	0.0
	Licenses - NOT Irrigated	200	200	0	0.0

Land use mapping was undertaken for licenses within the West Gippsland Diversion area for the 2019/20 period as well as capture of 2010 land use if available. This license data provided additional data on water license volume (ML) which was sourced from the Victorian Water Register.

Table 9 shows the number of licenses in each primary land use category in 2019/20 and the total license volume held. The number of licenses is illustrated in Figure 9 for a better understanding of data. Figure 9 illustrates only a comparison of license numbers, not total volume held.

Table 9. Lake Wellington Diversion Area License volume (ML) and Diversion Licence numbers by Primary Land Use category, 2019/2020.

Primary Land Use	Number of Licences	License volume 2019/2020 (ML)	Share of Licence Volume 2019/2020 (%)
Cropping - Fodder & Forage	13	3532.40	4.4
Cropping - Summer	12	1958.40	2.4
<b>Combined Cropping</b>	<b>25</b>	<b>5490.80</b>	<b>6.8</b>
Dairy	154	22847.90	28.4
Dairy Agistment & Fodder	21	2059.50	2.6
<b>Combined Dairy</b>	<b>175</b>	<b>24907.40</b>	<b>31.0</b>
Horticulture - Annual	20	308.40	0.4
Horticulture - Protected	2	83.80	0.1
Horticulture - Vegetable	118	11579.20	14.4
<b>Combined Annual Horticulture</b>	<b>140</b>	<b>11971.40</b>	<b>14.9</b>
Horticulture - Fruit Trees	7	239.00	0.3
Horticulture - Grapevine	3	33.00	0.0
Horticulture - Nut Trees	2	43.00	0.1
Horticulture - Perennial	9	88.80	0.1
<b>Combined Perennial Horticulture</b>	<b>21</b>	<b>403.80</b>	<b>0.5</b>
Intensive - Horses	1	360.00	0.4
Intensive - Piggery	1	71.20	0.1
<b>Combined Intensive</b>	<b>2</b>	<b>431.20</b>	<b>0.5</b>
Livestock - Beef	216	18583.30	23.1
Livestock - Other	1	19.00	0.0
Livestock - Sheep	9	881.10	1.1
<b>Combined Livestock</b>	<b>226</b>	<b>19483.40</b>	<b>24.2</b>
Other Land Use	35	1370.00	1.7

Rural Lifestyle	9	213.00	0.3
Rural Residential	2	15.00	0.0
<b>Rural and Other Land Use</b>	<b>46</b>	<b>1598.00</b>	<b>2.0</b>
Licenses - NOT Irrigated	388	16095.30	20.0
<b>Total</b>	<b>1023</b>	<b>80381.30</b>	<b>100.0</b>

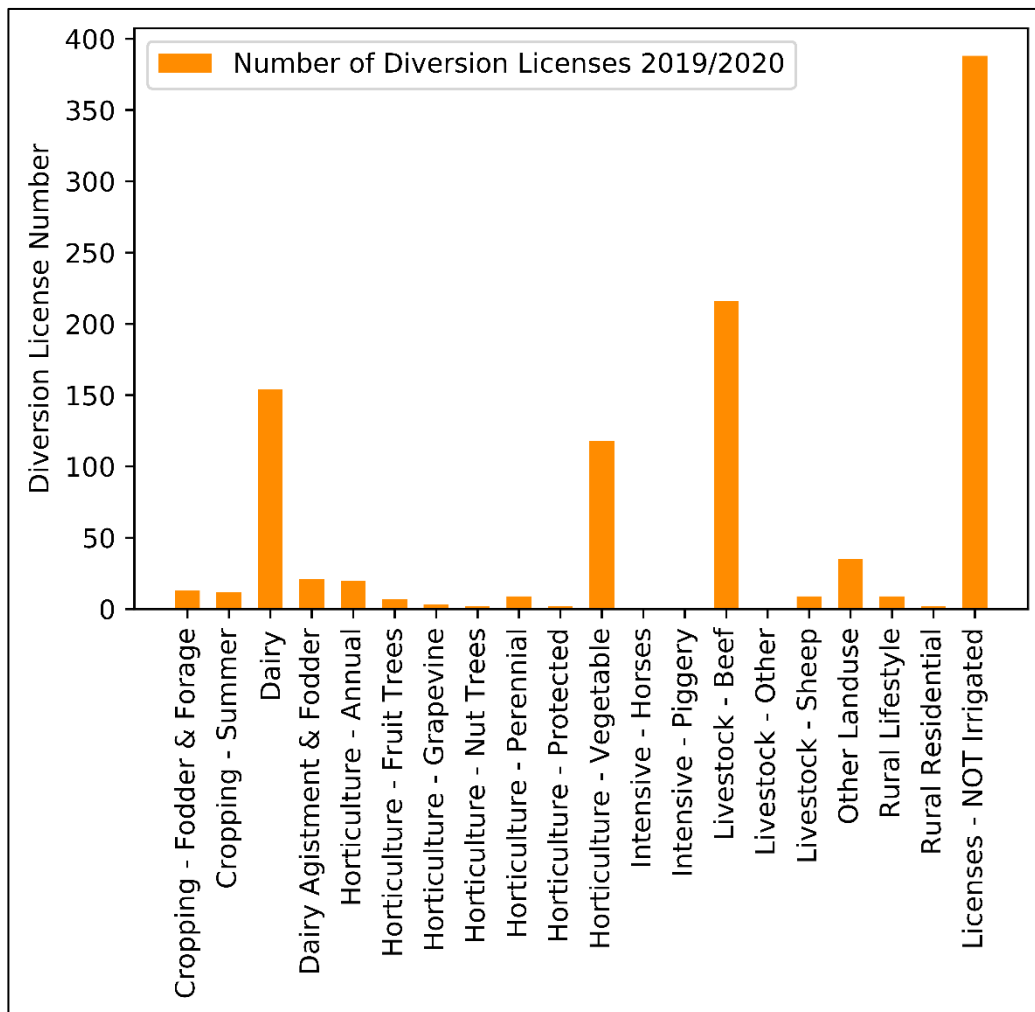


Figure 8. Number of Diversion Licences by Land Use category in the Lake Wellington Diversion area.

Figure 9 compares total volume held or used by leach and use category. The Dairy land use category has the largest share of water volume in the West Gippsland Diversion area in 2019/20, accounting for a total 28.42 per cent. Livestock accounted for 24.24 per cent of the share of water volume in 2019/20, made the second largest irrigation water volume. Licenses – Not irrigated, the largest land use category by area (ha) across the West Gippsland Diversion area, accounted for approximately 20 per cent of the share of water volume in 2019/20, making it the third largest irrigation water volume. Perennial Horticulture’s share of water volume (0.50 %) was the lowest, along with that of Intensive (0.54 %).

### Share of Diversion license volume by landuse

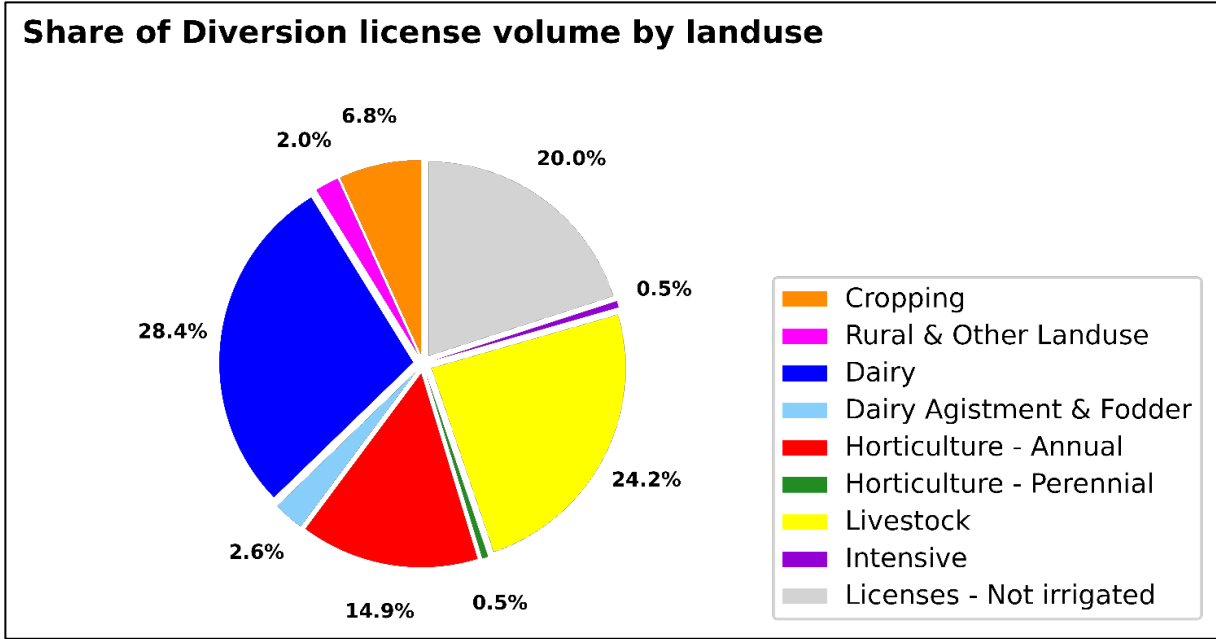


Figure 9. Share of Diversion Licence volume by Primary Land Use category in the Lake Wellington Diversion area, 2019/2020.

### Enterprise view

Results of the development of an agricultural enterprise view for the MID surface area is presented in Figure 10. This shows a single dairy enterprise and the individual water use licences that make it up. A corresponding dataset for the diversion areas has also been developed. These datasets comprise a table with the license number assigned to a common enterprise identifier. This identifier links to an owner name and billing address which can only be accessed by SRW to ensure privacy and data security.

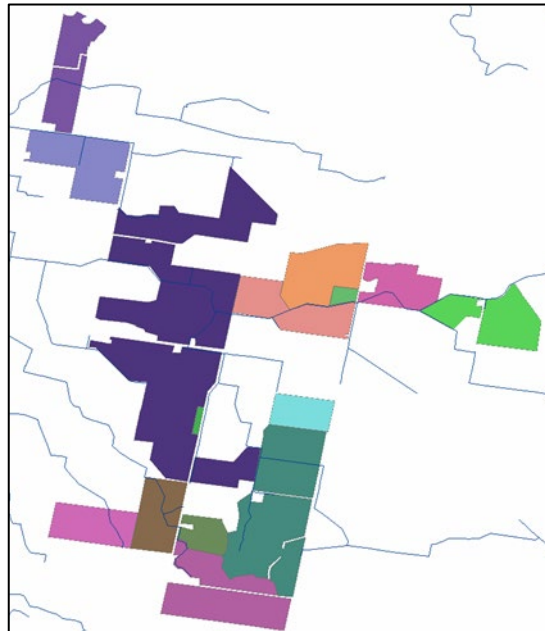


Figure 10. Water Use Licenses making up a Dairy Enterprise in the MID (blue lines - irrigation channels)

### Assessment of labour involved for mapping.

As part of the data capture undertaken by SRW staff an assessment of time involved was provided by SRW managers Matthew Cook and Luke Krupa the table below shows the total hours spent against licenses captured.

Total staff hours (5 staff)	Number of licenses assessed	Time per license
135	1987	~4 minutes

We also reviewed the edit times available through ArcGIS online which indicated a range of 1-6 minutes per license.

Almost all this assessment was conducted through the desktop application and demonstrates the effectiveness of utilising SRW irrigation officers who now the areas they are assessing. Feedback from these officers was that the developed applications were easy to use and provided enough ancillary information to support the assessment.

It is anticipated if this process is embedded as an annual or ongoing data capture exercise that this time per license will reduce as only a small proportion of the total number of licenses will change their land use and irrigation activity in any one year.

### Data provision and integration with SRW

SRW currently run an ArcGIS desktop environment for its GIS services but are looking to move to a web-based GIS set of tools over the next 12 months. These tools will be ESRI based and as such will be compatible with the databases and tools developed through this project.

For now, AVR will continue to maintain the ArcGIS online environment it has developed to support any further land use data capture and reporting as well as providing SRW with a database it can integrate into its internal GIS systems.

## CONCLUSION AND RECOMMENDATIONS

The focus of this project was to produce a land use database that:

- allows decision makers to track changes in irrigation land use over time
- where possible looks backward to assess changes over the last 10 years
- has a feasible mechanism in place to keep it up to date.

AVR in collaboration with WGCMA, SRW and DELWP has developed a land use mapping database that provides a comprehensive picture of irrigated land use in 2020 for the Lake Wellington catchment area and an assessment of land use and land use change from 2010.

The software and staff capability required was developed within SRW to undertake this mapping and to support potential future capture of land use change within the Lake Wellington Catchment area.

Recommendation for the further development of application of the outputs of this project are:

- That land use data collection become part of SRW irrigation staff ongoing activities with updating of data undertaken annually during times of lower activity.
- That senior management at SRW are briefed to ensure support for irrigation staff in undertaking this work.
- That management of land use data continues to be undertaken by AVR on behalf of the DELWP state-wide RILWUM program until SRW have the capability and support to undertake this.
- That the integration of WGCMA and regional Agriculture Victoria irrigation services staff into the capture and validation process be explored.

## Communication and Engagement

Table 10. Communication and engagement activities

<b>Date</b>	<b>Activity</b>
February 2020	Project Inception meeting – DELWP Melbourne
April 2020	Land use project management team progress meeting - online
May 2020	Land use mapping workshop with SRW - online
July 2020	Land Use mapping collection finalisation workshop with project management team - online
September 2020	Presentation of results to West Gippsland Sustainable Irrigation Group meeting
September 2020	Presentation of results to Sustainable Irrigation Program quarterly forum

## APPENDICES

### Appendix 1: West Gippsland irrigated land use data capture guide



Gippsland\_DataCap  
ture\_guide.pdf